

SISTEME CU CIRCUITE INTEGRATE ANALOGICE

Facultatea: Electronică, Telecomunicații și Tehnologia Informației (ETTI UTCN)

Nume student: Lupu Miruna

Grupa: 2133

Specializarea: Electronică Aplicată

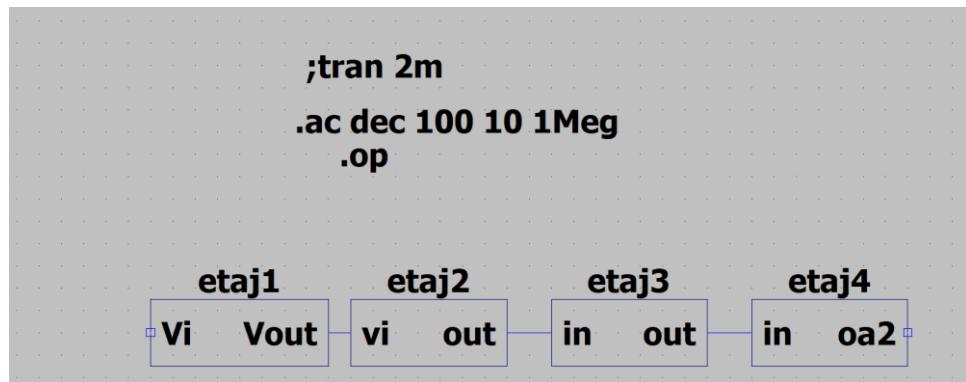
CUPRINS

1. Tematica proiectului.....	pag. 3
2. Schema electrică a circuitului.....	pag. 4
3. Caracterizarea etajului 1.....	pag. 5
3.1. Dimensionarea etajului 1.....	pag. 6
3.1.1 Parametrii DCOP.....	pag. 9
3.1.2. Parametrii de semnal mic.....	pag. 13
3.1.3. Parametrii de semnal mare.....	pag. 20
4. Caracterizarea etajului 2.....	pag. 25
4.1. Dimensionarea etajului 2.....	pag. 26
4.1.1 Parametrii DCOP.....	pag. 29
4.1.2. Parametrii de semnal mic.....	pag. 30
4.1.3. Parametrii de semnal mare.....	pag. 32
5. Caracterizarea etajului 3.....	pag. 33
5.1. Dimensionarea etajului 3.....	pag. 34
5.1.1 Parametrii DCOP.....	pag. 38
5.1.2. Parametrii de semnal mic.....	pag. 39
5.1.3. Parametrii de semnal mare.....	pag. 45
6. Caracterizarea etajului 4.....	pag. 47
6.1. Dimensionarea etajului 4.....	pag. 48
6.1.1 Parametrii DCOP.....	pag. 51
6.1.2. Parametrii de semnal mic.....	pag. 52
6.1.3. Parametrii de semnal mare.....	pag. 54
7. Concluzii.....	pag. 55
8. Notițe	pag. 57
9. Bibliografie.....	pag. 58

1. Tematica proiectului

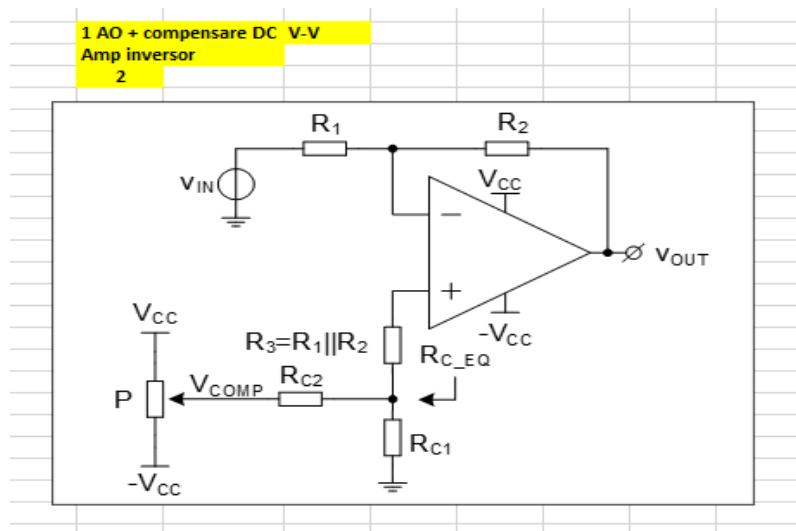
Nr	grupa	Nume student	Etaj 1				Etaj 2				Etaj 3				Etaj 4				AO		
			Sursa semnal	amplitudine minima (pt castig maxim ptca)	amplitudine maxima (pt castig minim ptca)	unitate masura	Tip Etaj 1	Castig etaj 1 (liniar)	tip Etaj 2	H0 castig liniar in banda de frecvență	Rintrare minim	Banda	Q	tip Etaj 3	castig minim (pas minim) [dB]	rezolutie (pas minim) [dB]	nr pasi	castig maxim [dB]	tip Etaj 4 (liniar)		
163	160	2133 Luu Miruna	1	3.34E-02	1.33E-01	V (single ended)	2	19	3	1	2.00E+03	8.00E+03	0.707	2	4	3	5	16	4.00E+03	18	1

2. Schema electrică a circuitului

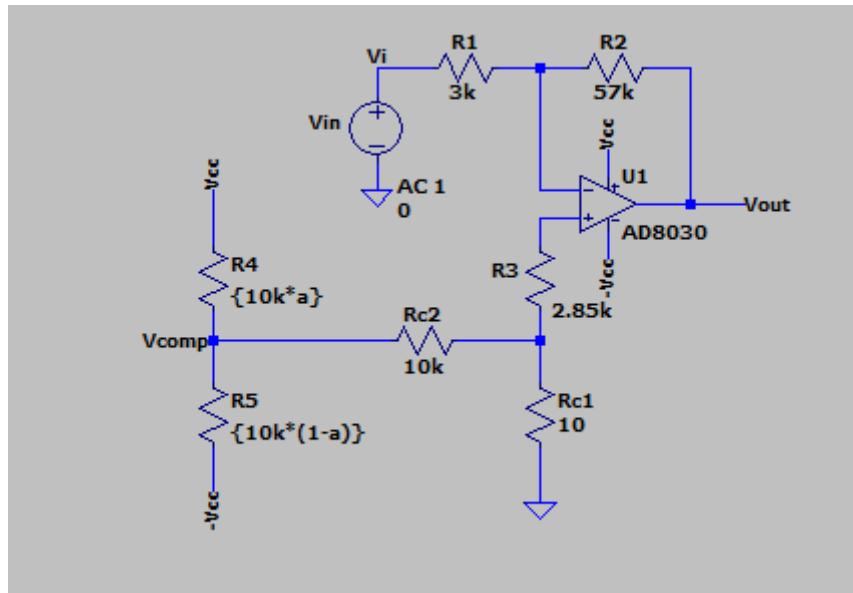


3. Caracterizarea etajului 1

Sursa_semnal									
nr	Marime fizica	tip sursa	Valoare DC	Amplitudine minima (pentru PGA setat la castig maxim) [V sau A]	Amplitudine maxima (pentru PGA setat la castig maxim) [V sau A]	frecventa maxima "fin_max"			
1	tensiune	single ended	0 spec individual	spec individual	=banda filtru (LPF) sau fmax banda de trecere (BPF)				
Etaj 1 - amplificator									
Sursa seignal nr.	nr	semnal intrare	semnal iesire	tip	Rin_min [Ohms]	regaj Out_DC			
1	2	tensiune	tensiune	amplificator inversor cu 1AO	spec individual	2kOhm	da	> fin_max	fara distorsiuni la fin_max pt ampl_in*castig (SR, THD<1%)



3.1. Dimensionarea etajului 1



1.0. Schema electrică a 1-AO Amp inversor

Conform specificațiilor individuale, câstigul etajului 1 va fi 19 dB. Prin urmare, vom presupune că $R_1 = 3\text{k}\Omega$, iar $R_2 = 57\text{k}\Omega$, întrucât R_2 trebuie să fie de 2 ori mai mare ca și R_1 . Astfel vom putea calcula rezistența $R_3 = R_1 \parallel R_2$.

$$R_3 = \frac{R_1 \cdot R_2}{R_1 + R_2} = \frac{3\text{k}\Omega \cdot 57\text{k}\Omega}{3\text{k}\Omega + 57\text{k}\Omega} = \frac{171\text{k}\Omega \cdot \text{k}\Omega}{60\text{k}} = 2.85\text{k}\Omega \quad (1.1.1)$$

$$A_V = \frac{-R_2}{R_1} = \frac{-57\text{k}\Omega}{3\text{k}\Omega} = -19 \quad (1.1.2)$$

$$R_{EQ^+} = R_{EQ^-} \leftrightarrow R_1 \parallel R_2 = R_3 + R_{C-EQ} \quad (1.1.3)$$

$$R_{C-EQ} = R_{C1} \parallel (R_{C2} + R_4) \quad (1.1.4)$$

$$\text{Pentru: } R_{C1} \ll R_{C2} \rightarrow R_{C1} \ll R_3 = R_1 \parallel R_2 \quad (1.1.5)$$

$$R_{C_EQ^+} \cong R_3 + R_{C1} \cong R_3 = R_1 \parallel R_2 = R_{C_EQ^-} \quad (1.1.6)$$

$$V_{OUT_{I_B,V_{OS}}} \leq V_{OS} \cdot \left(1 + \frac{R_2}{R_1}\right) + I_{OS} \cdot R_2 \quad (1.1.7)$$

$$V_{OUT_{V_{COMP}}} = V_{COMP} \cdot \frac{R_{C1}}{R_{C1} + R_{C2}} \cdot \left(1 + \frac{R_2}{R_1}\right) \cong \pm \alpha V_{CC} \cdot \frac{R_{C1}}{R_{C1} + R_{C2}} \cdot \left(1 + \frac{R_2}{R_1}\right) \quad (1.1.8)$$

Pentru a reduce efectul dezechilibrului impedanțelor la intrarea amplificatorului operațional și pentru a minimiza efectele I_{B+} și I_{B-} :

$$R_{C1} \ll R_3 \text{ și } R_{C1} \ll R_{C2} \quad (1.1.9)$$

Astfel, vom presupune că rezistența R_{C2} are valoarea $10k\Omega$, iar rezistența R_{C1} este de 10Ω .

Totodată, am luat valoarea rezistenței R_4 ca fiind $10k\Omega \cdot \alpha$, iar a rezistenței R_5 ca fiind $10k\Omega \cdot (1 - \alpha)$.

Menționez faptul că eu voi folosi un **Amplificator Operațional AD8030**, având tensiunea de alimentare $\pm 5V$ și voi compara rezultatele obținute cu cele din datasheet.

$$V_{CC} = \pm 5V \quad V_{COMP} \in [-5V; +5V] \quad \alpha \in [0; 1] \quad (1.2.1)$$

Din relația 1.1.4. putem calcula R_{C_EQ} :

$$R_{C_EQ} = 10 \parallel (10k\Omega + \alpha \cdot 10k\Omega)$$

$$\text{pentru } \alpha = 0 \Rightarrow R_{C_EQ} = 10 \parallel 10k\Omega \cong 10 \Omega$$

$$\text{pentru } \alpha = 1 \Rightarrow R_{C_EQ} = 10 \parallel 20k\Omega \cong 10 \Omega$$

Din relația 1.1.6. rezultă:

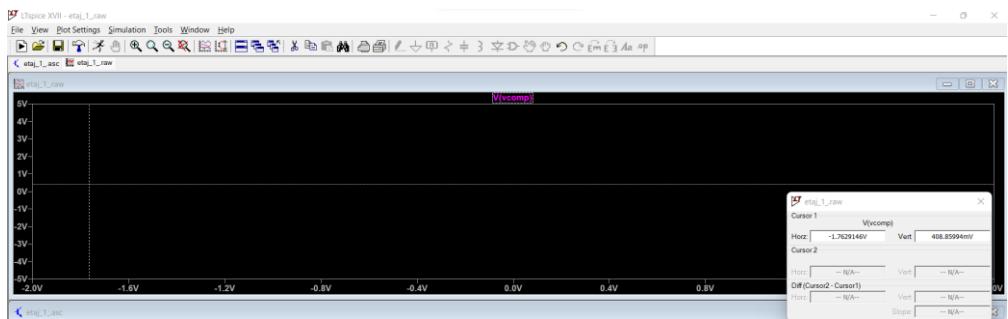
$$R_{C_EQ^+} = 2.85k\Omega + 10\Omega \cong 2.85k\Omega = R_3 = R_{C_EQ^-}$$

Din relația 1.1.8. rezultă:

$$V_{OUT_{V_{COMP}}} = \pm \alpha \cdot 5 \cdot \frac{10\Omega}{10\Omega + 10k\Omega} \cdot \left(1 + \frac{57k\Omega}{3k\Omega}\right) \cong \pm \alpha \cdot \frac{1k}{10k\Omega} = \pm \alpha \cdot 0.1$$

$$\text{pentru } \alpha = 0 \Rightarrow V_{OUT_{V_{COMP}}} = 0$$

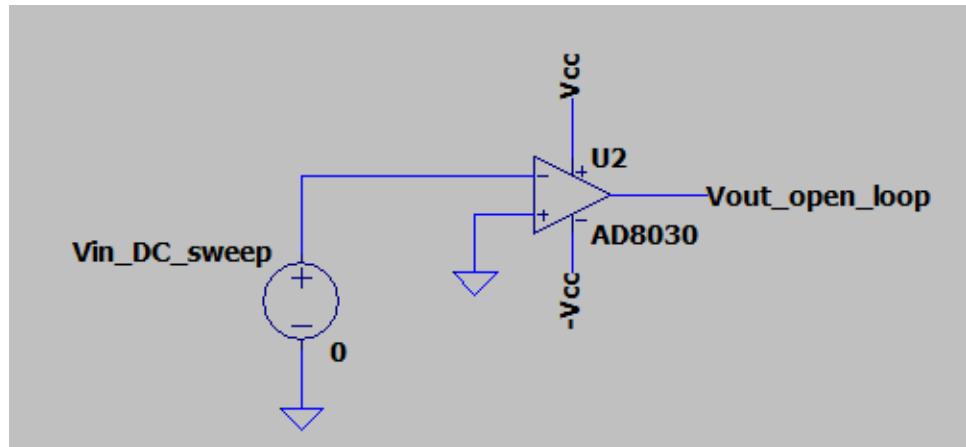
$$\text{pentru } \alpha = 1 \Rightarrow V_{OUT_{V_{COMP}}} = \pm 0.1$$



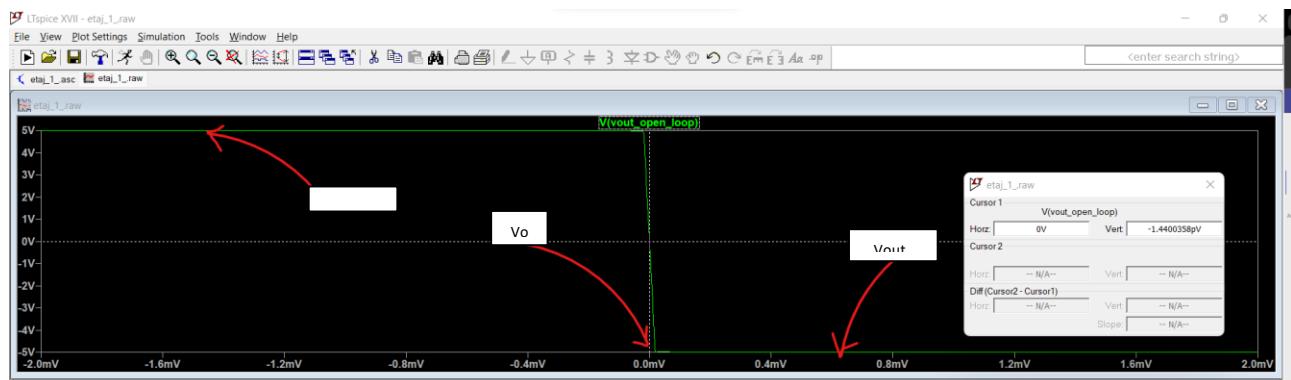
1.1. Tensiunea V_{comp} în domeniul de variație $[-5V ; +5V]$

3.1.1 Parametrii DCOP

- Tensiunea de offset si câștigul in tensiune al operationalului in bucla deschisa:

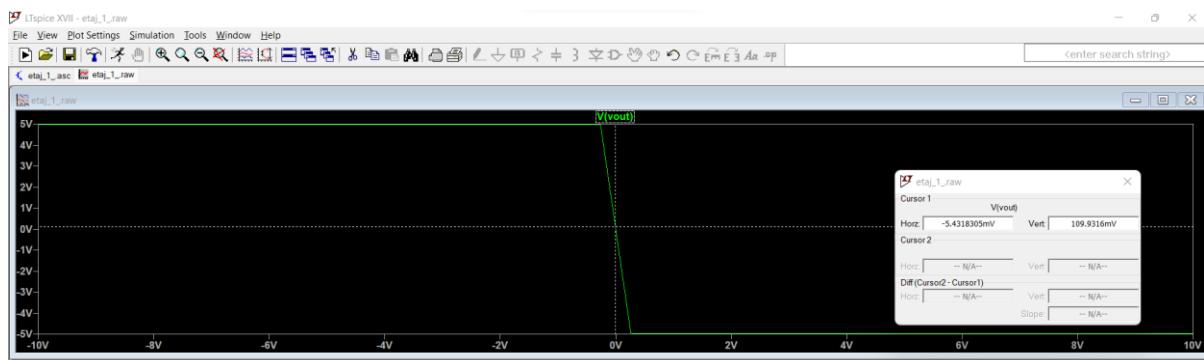


1.3. Testbench pentru măsurarea tensiunii de offset din caracteristica de frecvență a AO în bucla deschisă – analiza DC sweep



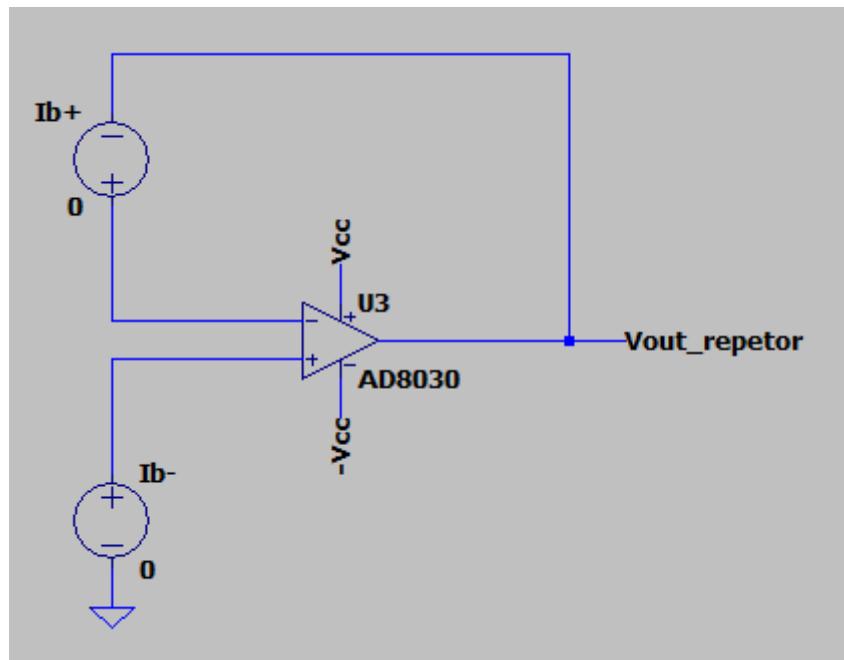
1.4. Rezultatul simulării DC sweep – open_loop

- Tensiunea de ieșire a amplificatorului operațional:



1.5. Rezultatul simulării DC sweep – tensiunea de ieșire

- Curenții de polarizare:

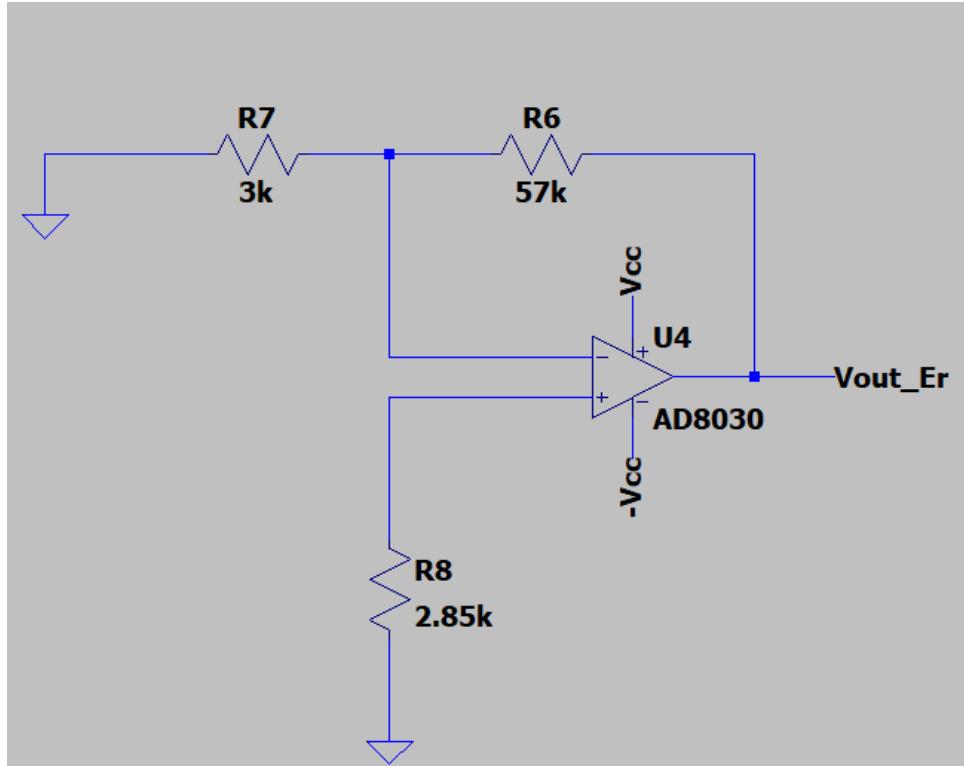


1.6. Testbench pentru măsurarea curenților de polarizare – analiza DCOP

I(Ib+):	1.7e-006	device_current
I(Ib-):	1.7e-006	device_current

1.7. Rezultatul simulării DCOP

- Efectul erorilor statice:



1.8. Testbench-ul utilizat pentru vizualizarea tensiunii de eroare statică de la ieșirea amplificatorului inversor

$$V_{OUT_EROARE} = V_{OUT_EROARE_{IB+}} + V_{OUT_EROARE_{IB-}}$$

|v(vout_er) : 3.33522e-007 voltage

1.9. Rezultatul simulării DC op

- Compensarea / ajustarea nivelului DC la ieșire:

Pentru a fi îndeplinită condiția de compensare a erorii DC, trebuie îndeplinită următoarea condiție:

$$\begin{aligned} &\text{pentru } V_{IN} = 0 \text{ vrem ca } V_{OUT} = 0 \\ &V_{OUT} = A_V \cdot V_{IN} + V_{OUT_EROARE} + V_{COMP} \quad (1.2.2) \\ &\text{dar } V_{OUT_EROARE} + V_{COMP} \text{ trebuie să fie } 0 \end{aligned}$$

$$\Rightarrow V_{OUT} = A_V \cdot V_{IN} \quad (1.2.3)$$

Mai departe vom calcula α pentru a compensa nivelul DC la ieșire, pe baza rezultatului DCOP vom presupune $V_{COMP} = 0.33 \mu V$:

$$V_{COMP} = \frac{\left(\frac{V_{CC}}{\alpha \cdot P} + \frac{-V_{CC}}{(1-\alpha) \cdot P}\right)}{\left(\frac{1}{\alpha \cdot P} + \frac{1}{(1-\alpha) \cdot P}\right)} = \frac{(V_{CC} \cdot (1-\alpha) \cdot P - V_{CC} \cdot \alpha \cdot P)}{(1-\alpha) \cdot P + \alpha \cdot P} =$$

$$= V_{CC} - \alpha \cdot P - \alpha \cdot P \cdot V_{CC} = V_{CC} \cdot (1 - 2 \cdot \alpha \cdot P) \quad (1.2.4)$$

$$0.33 \cdot 10^{-6} = 5 \cdot (1 - 2 \cdot \alpha) \Rightarrow 1 - 2 \cdot \alpha = 0.066 \cdot 10^{-6} \Rightarrow 2 \cdot \alpha \cong 1.02 \Rightarrow \alpha = 0.5$$

$$\Rightarrow \alpha = 500m$$

.param a 500.000466m

```
--- Operating Point ---

V(vcc) :      5          voltage
V(-vcc) :     -5          voltage
V(n022) :    0.00485968  voltage
V(n025) :    0.00485967  voltage
V(vout) :    0.000339777 voltage
V(vi) :       0          voltage
V(n028) :    1.69746e-005 voltage
V(vcomp) :   -3.3308e-007 voltage
V(n010) :      0          voltage
V(vout_open_loop) : 0          voltage
V(n017) :      0          voltage
V(n018) :   -3.33301e-007 voltage
V(vout_repetor) : -3.33301e-007 voltage
V(n007) :    0.00484272  voltage
V(n012) :    0.0048427  voltage
V(vout_ex) :  3.33522e-007 voltage
V(n021) :    0.00485968  voltage
V(n024) :    0.00485967  voltage
V(vout2) :   0.000339777 voltage
V(vi2) :       0          voltage
V(n027) :    1.69746e-005 voltage
V(vcomp2) :  -3.3308e-007 voltage
V(n023) :    -5.2519    voltage
V(n026) :    -3.99897   voltage
V(vout1) :    4.98037   voltage
V(vi3) :     -10         voltage
V(n029) :   -0.0139713  voltage
V(vcomp1) :  -0.00279798 voltage
V(n006) :    0.00485968  voltage
V(n011) :    0.00485967  voltage
V(adif) :    0.000339777 voltage
V(n005) :      0          voltage
V(n020) :    1.69746e-005 voltage
V(n019) :   -3.3308e-007 voltage
V(vdd) :       5          voltage
V(-vdd) :     -5          voltage
V(n002) :    0.00485968  voltage
V(n008) :    0.00485967  voltage
V(acm) :    0.000339777 voltage
V(n001) :      0          voltage
V(n014) :    1.69746e-005 voltage
V(n013) :   -3.3308e-007 voltage
V(n003) :      0          voltage
V(n004) :    0.00485968  voltage
V(n009) :    0.00485967  voltage
V(aps) :    0.000339777 voltage
V(n016) :   1.69746e-005 voltage
```

2.0. Resultate DCOP

3.1.2. Parametrii de semnal mic

- Câstig la joasă frecvență

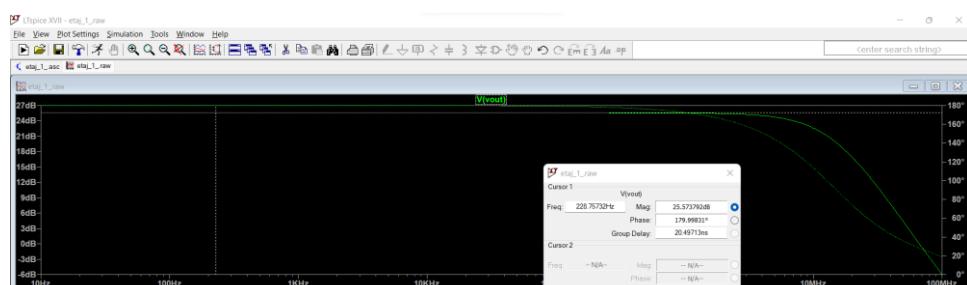
Pentru a afla câstigul la joasă frecvență vom utiliza analiza AC:

.ac dec 100 10 100Meg

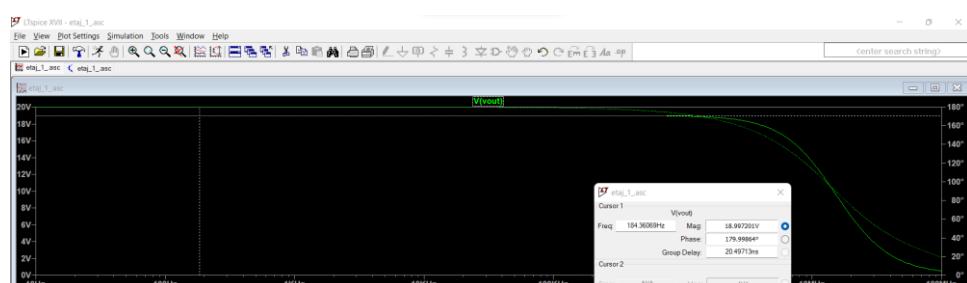
Din specificațiile date, câstigul liniar este 19, adică:

$$|A_V| = \left| -\frac{R_2}{R_1} \right| = |-19| = 19 \quad (1.2.5)$$

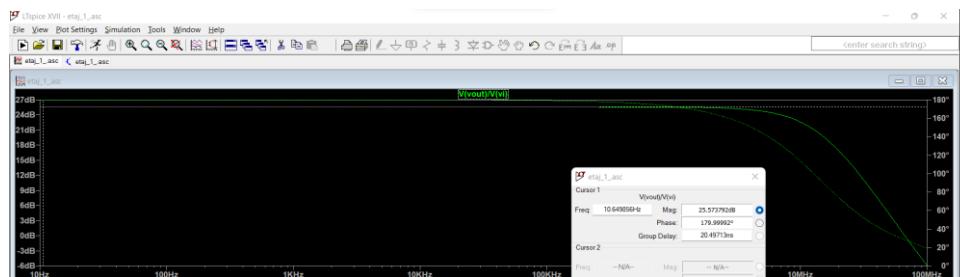
$$A_{V_{dB}} = 20 \cdot \log 19 = 25.6 \text{ dB} \quad (1.2.6)$$



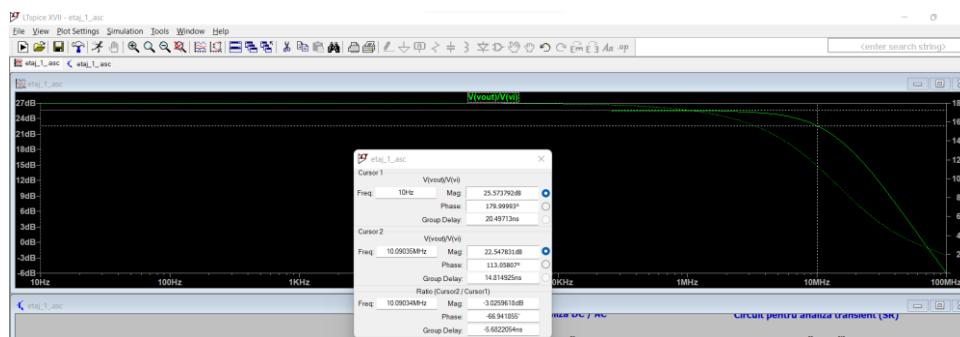
2.1 Caracteristica de ieșire in decibeli



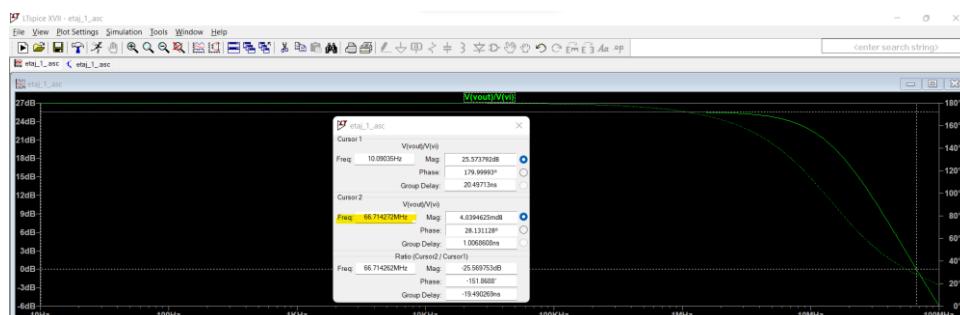
2.2. Caracteristica de ieșire liniara



2.3. Castigul la joasa frecventa



2.4. Banda la $-3dB$



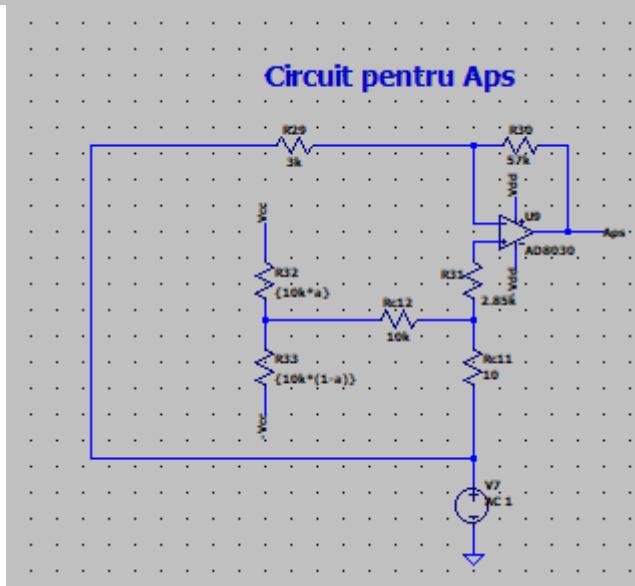
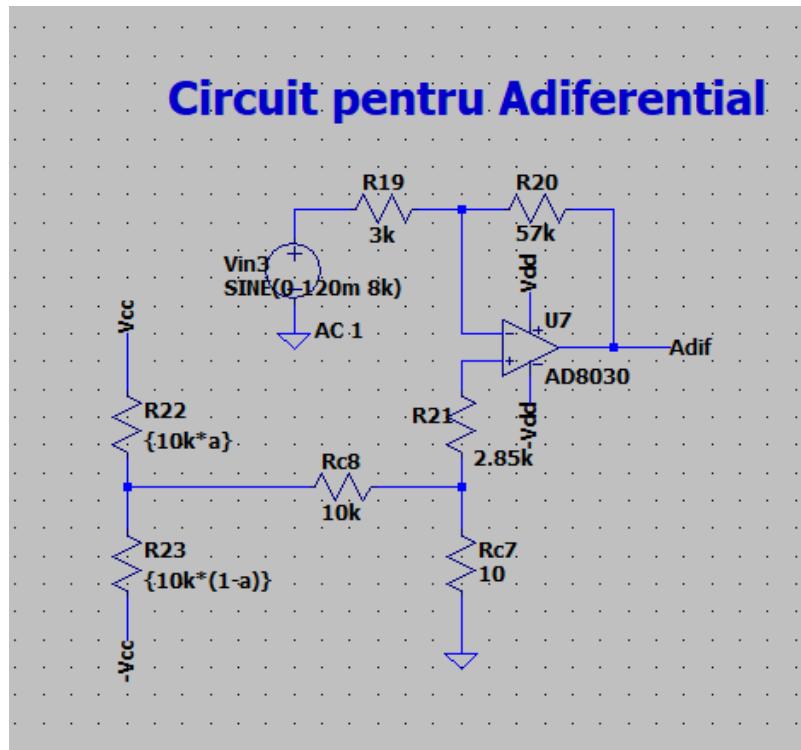
2.5. Frecventa la care castigul este unitar

- Produsul amplificare-banda finit GBW:

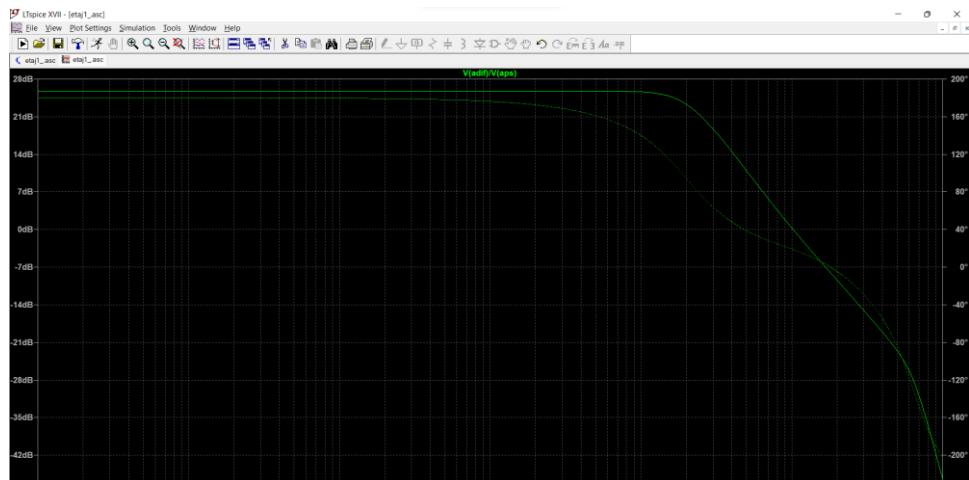
$$GBW_{closed_loop} = A_0 \cdot BW_{open_loop} \cong \frac{a_0}{2\pi\tau} = GBW_{OA} \quad (1.2.7)$$

$$BW = \frac{GBW}{|A_V|+1} \quad (1.2.8)$$

- PSRR



$$PSRR = \frac{a_{DIFF}}{a_{PS}} ; \quad PSRR_{dB} = 20 \cdot \log \left(\frac{a_{DIFF}}{a_{PS}} \right) \quad (1.2.9)$$



2.6. Castig PSSR

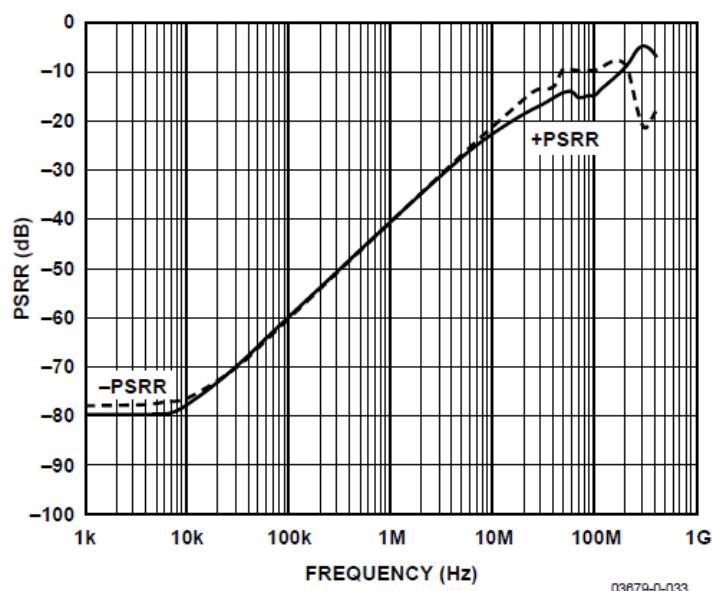
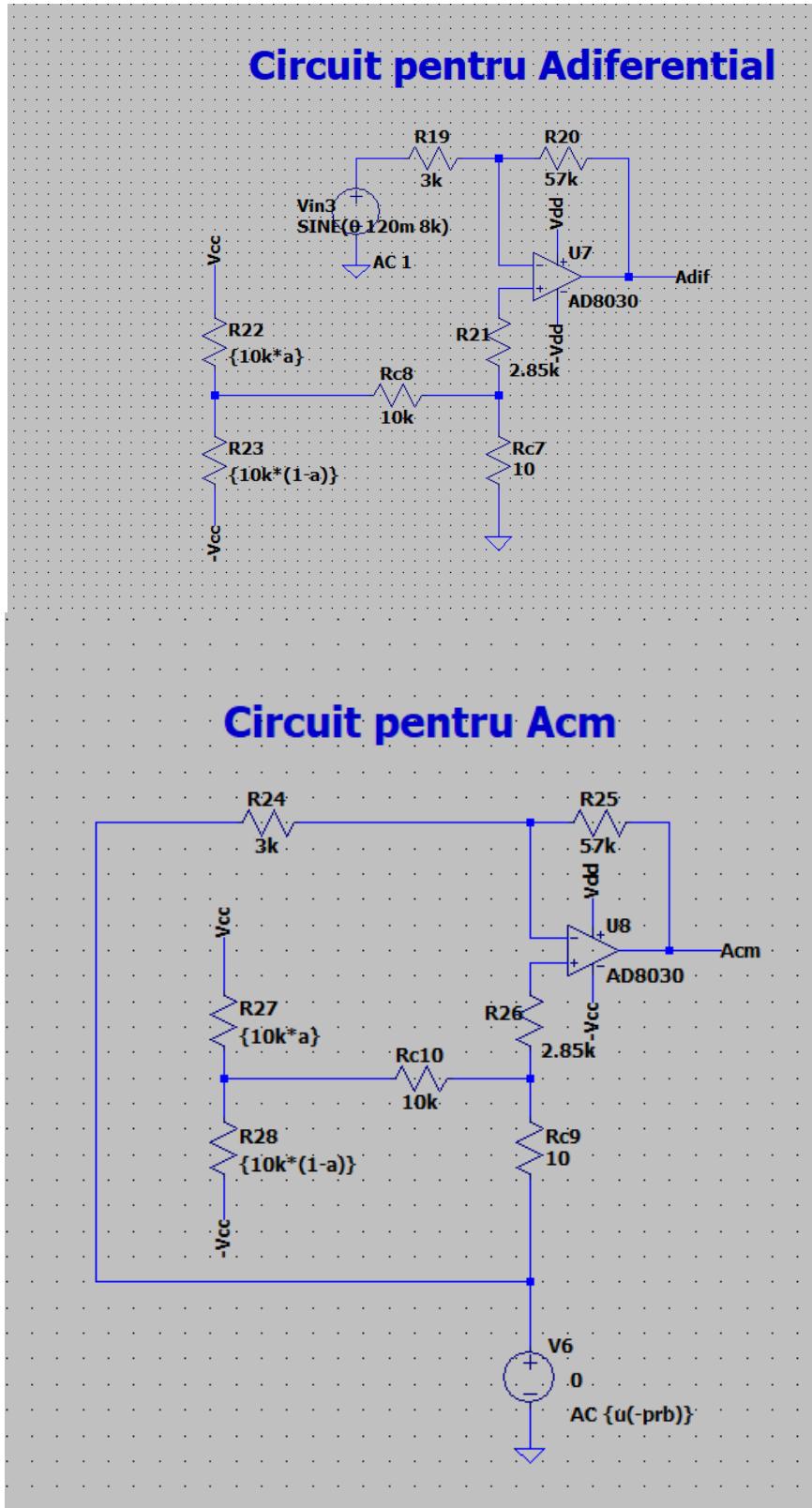


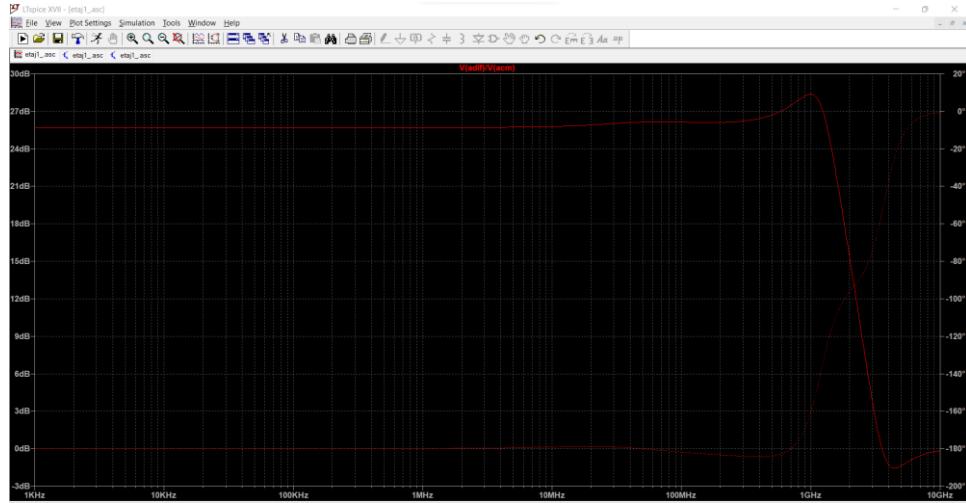
Figure 35. PSRR vs. Frequency

2.7. Datasheet PSRR

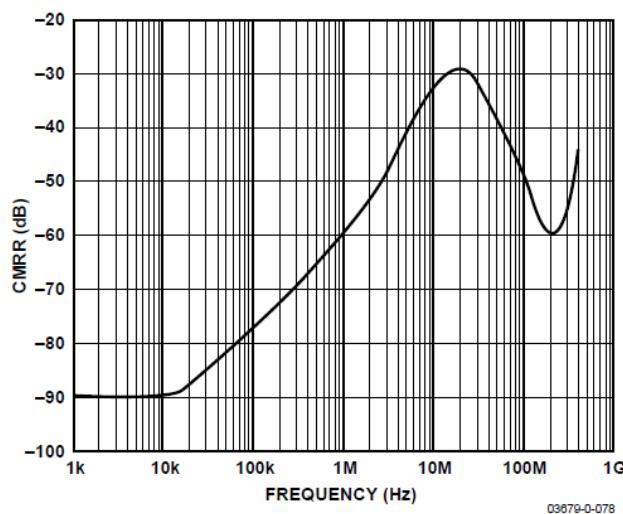
- CMRR



$$CMRR = \frac{a_{DIFF}}{a_{CM}} ; \quad CMRR_{dB} = 20 \cdot \log \left(\frac{a_{DIFF}}{a_{CM}} \right) \quad (1.3.0)$$



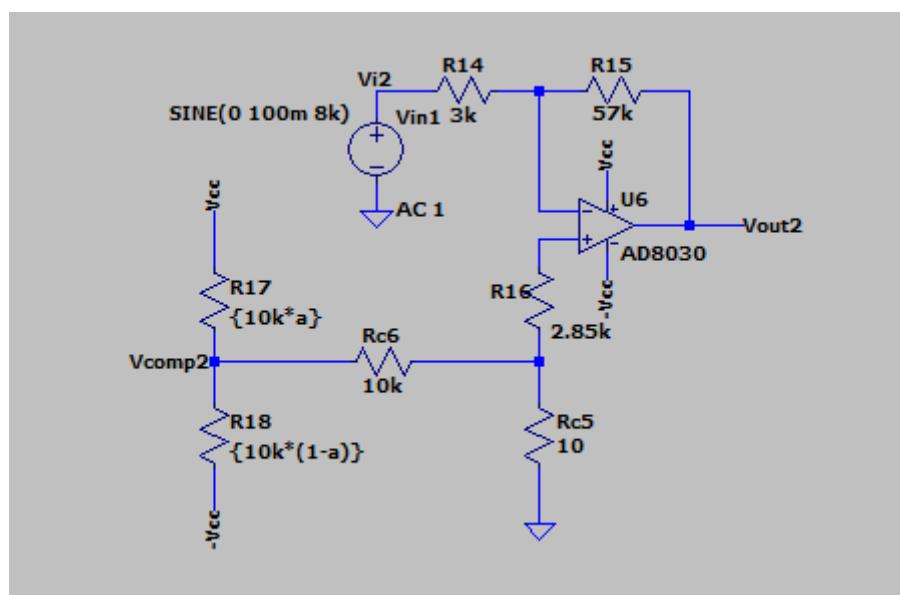
2.8. Castig CMRR



2.9. Datasheet CMRR

3.1.3. Parametrii de semnal mare

- Analiza transient



3.0. Analiza transient pentru THD <1%

```

.step prb=-1
N-Period=1
Fourier components of V(vout2)
DC component:0.00033354

Harmonic          Frequency        Fourier      Normalized      Phase
Number           [Hz]            Component    Component   [degree]     Phase [deg]
1                1.000e+04       1.891e+00   1.000e+00   179.92°      0.00°
2                2.000e+04       1.268e-04   6.704e-05   -77.70°      -257.62°
3                3.000e+04       1.780e-03   9.409e-04   163.34°      -16.58°
4                4.000e+04       6.983e-05   3.692e-05   71.88°       -108.04°
5                5.000e+04       3.222e-04   1.704e-04   143.44°      -36.48°
6                6.000e+04       1.110e-04   5.866e-05   -66.73°      -246.65°
7                7.000e+04       1.247e-03   6.595e-04   -25.89°      -205.81°
8                8.000e+04       6.681e-05   3.532e-05   -48.27°      -228.19°
9                9.000e+04       7.615e-04   4.026e-04   -47.27°      -227.20°
10               1.000e+05       9.115e-05   4.819e-05   -18.11°      -198.03°

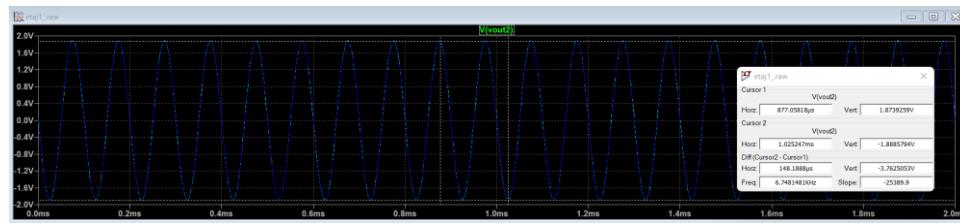
Total Harmonic Distortion: 0.123462% (0.143563%)

.step prb=1
N-Period=1
Fourier components of V(vout2)
DC component:0.000216552

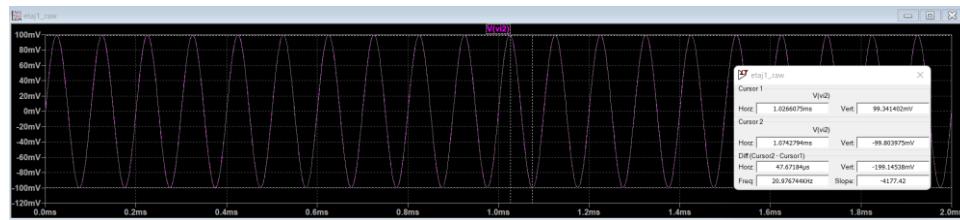
Harmonic          Frequency        Fourier      Normalized      Phase
Number           [Hz]            Component    Component   [degree]     Phase [deg]
1                1.000e+04       1.892e+00   1.000e+00   179.92°      0.00°
2                2.000e+04       3.249e-04   1.717e-04   -31.21°      -211.13°
3                3.000e+04       1.851e-03   9.785e-04   175.34°      -4.58°
4                4.000e+04       6.470e-04   3.420e-04   109.63°      -70.30°
5                5.000e+04       1.524e-05   8.055e-06   101.56°      -78.36°
6                6.000e+04       4.228e-04   2.235e-04   -162.59°      -342.52°
7                7.000e+04       1.631e-03   8.624e-04   -4.55°       -184.48°
8                8.000e+04       1.870e-04   9.885e-05   -93.58°      -273.50°
9                9.000e+04       4.446e-04   2.350e-04   -44.98°      -224.91°
10               1.000e+05       5.350e-04   2.828e-04   -15.07°      -195.00°

Total Harmonic Distortion: 0.142920% (0.157164%)

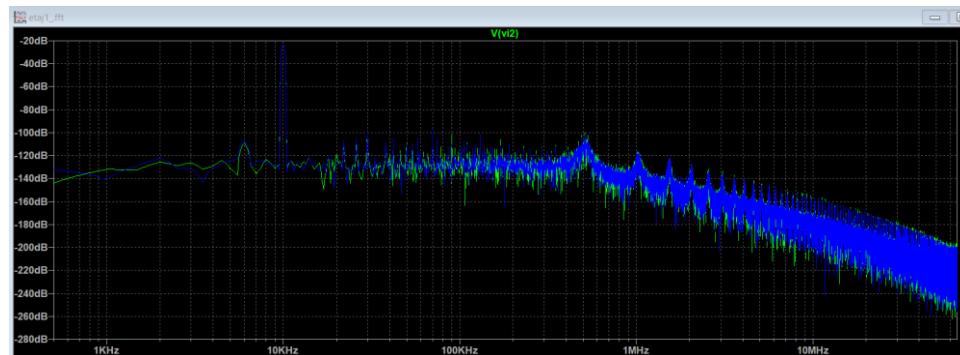
```



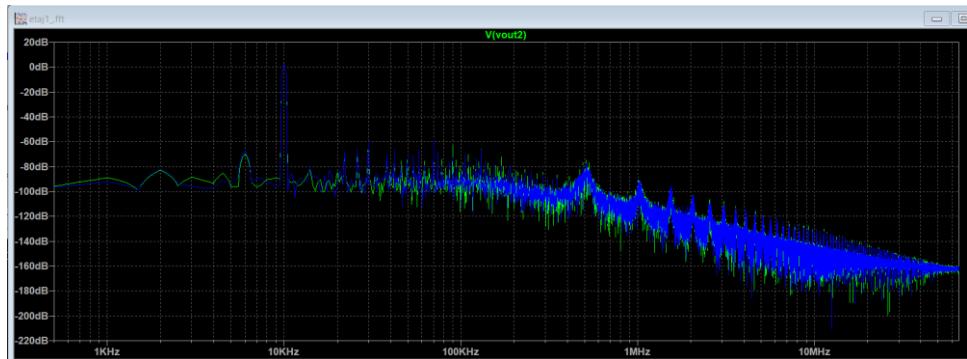
3.1. Domeniul liniar al tensiunii de ieșire



3.2. Domeniul liniar al tensiunii de intrare

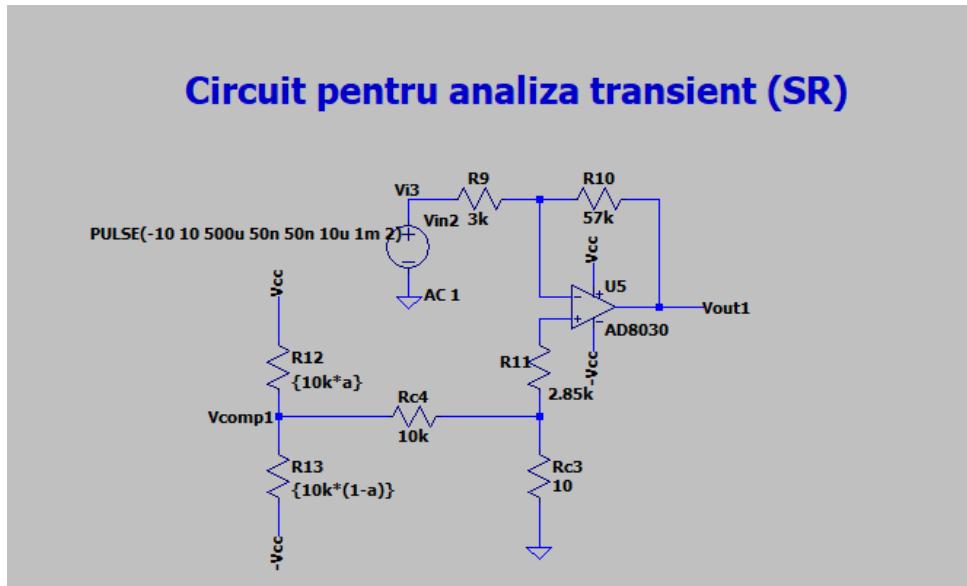


3.3. Spectrul tensiunii de intrare



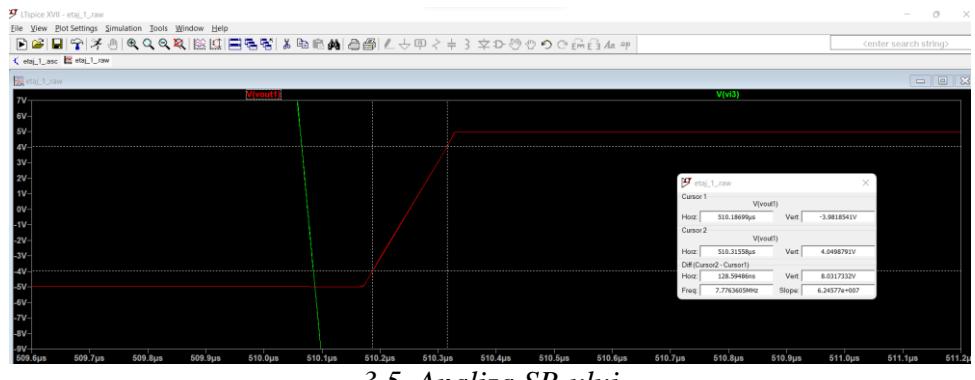
3.4. Spectrul tensiunii de ieșire

- Slew-rate (SR)



$$SR = \left(\frac{\partial V_{OUT}}{\partial t} \right)_{MAX} \quad \left[\frac{V}{\mu s} \right] \quad (1.3.1)$$

Vom măsura SR-ul folosind două curtoare. Primul cursor îl vom poziționa la 10% din tensiunea de ieșire, iar cel de-al doilea cursor îl vom poziționa la 90%.



3.5. Analiza SR-ului

SPECIFICATIONS

SPECIFICATIONS WITH ± 5 V SUPPLY

Table 1. $V_S = \pm 5$ V @ $T_A = 25^\circ\text{C}$, $G = +1$, $R_L = 1 \text{ k}\Omega$ to ground, unless otherwise noted. All specifications are per amplifier.

Parameter	Conditions	Min	Typ	Max	Unit
DYNAMIC PERFORMANCE					
-3 dB Bandwidth	$G = +1, V_0 = 0.1 \text{ V p-p}$	80	125		MHz
	$G = +1, V_0 = 2 \text{ V p-p}$	14	19		MHz
Bandwidth for 0.1 dB Flatness	$G = +2, V_0 = 0.1 \text{ V p-p}$		6		MHz
Slew Rate	$G = +1, V_0 = 2 \text{ V Step}$		62		$\text{V}/\mu\text{s}$
	$G = -1, V_0 = 2 \text{ V Step}$		63		$\text{V}/\mu\text{s}$
Settling Time to 0.1%	$G = +2, V_0 = 2 \text{ V Step}$		80		ns

3.6. Datasheet slew-rate

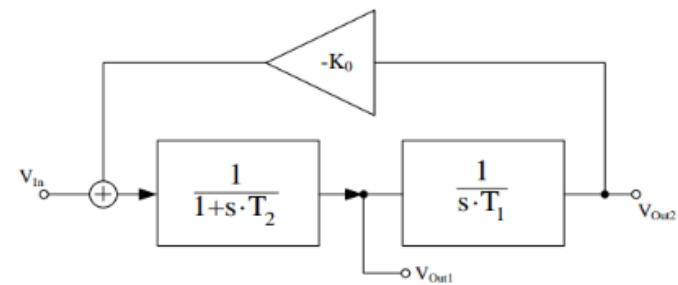


4. Caracterizarea etajului 2

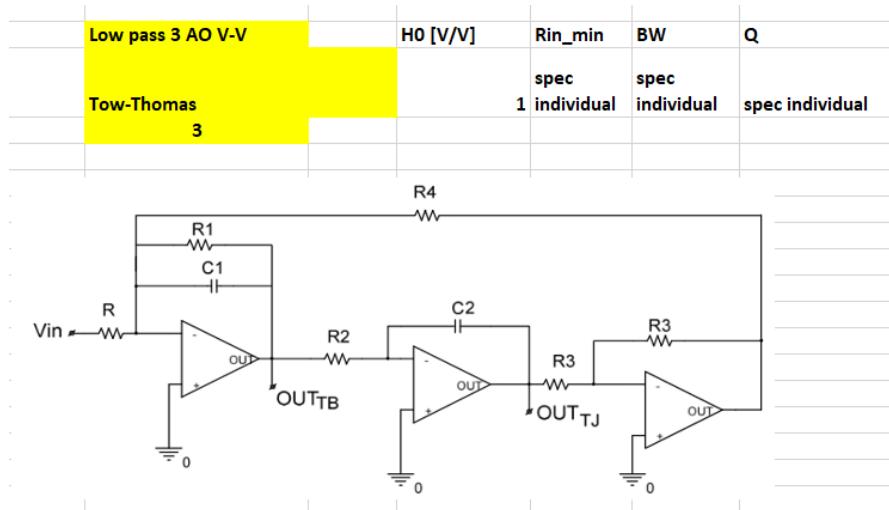
Etaj 2 - Filtru									
Etaj 1	nr	semnal intrare	semnal ieșire	tip funcție de transfer	topologie	de treccere [V/V sau dB]	Rin_min	BW	centrala filtru trece-banda
12.3.4.5.6.7.10	1	tensiune	tensiune	reacție LPF	Sallen-Key	1	2.00E+03	spec individual	spec individual <i>(fara distorsion la fru_max 0.01% cang THD(tz))</i>
12.3.4.5.6.7.10	2	tensiune	tensiune	reacție LPF	Rauch	1	2.00E+03	spec individual	spec individual <i>(fara distorsion la fru_max 0.01% cang THD(tz))</i>
12.3.4.5.6.7.10	3	tensiune	tensiune	reacție LPF	Tow-Thomas V-V	1	2.00E+03	spec individual	spec individual <i>(fara distorsion la fru_max 0.01% cang THD(tz))</i>

-Tow Thomas

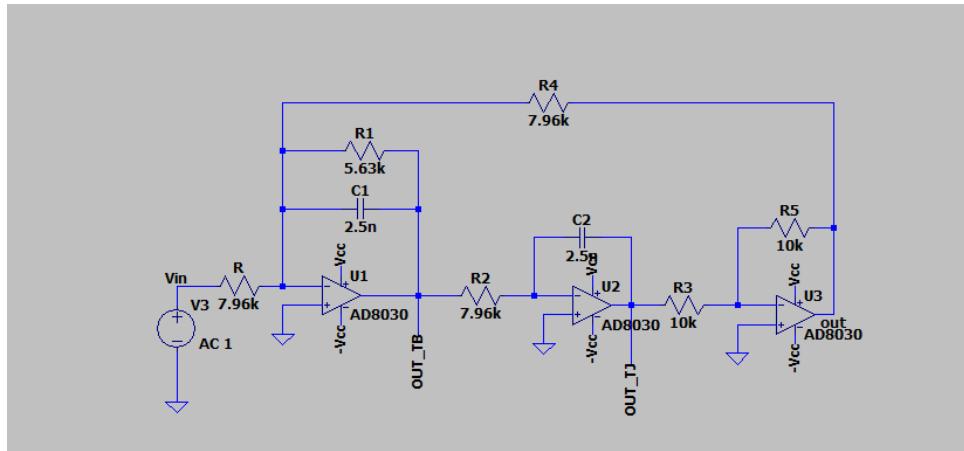
Diagrama bloc:



Circuitul Tow-Thomas este un circuit electronic folosit pentru filtrarea semnalelor. Este un tip de filtru activ realizat cu amplificatoare operaționale și rezistențe.



4.1. Dimensionarea etajului 2



$$H_0 = \frac{R_4}{R} = 1 \quad (2.1.1)$$

$$C_1 = C_2 = C \quad (2.1.2)$$

$$R_4 = R_2 \quad (2.1.3)$$

$$\text{Din (2.1.1), (2.1.3)} \Rightarrow R_4 = R = R_2 \quad (2.1.4)$$

$$\omega_0 = \frac{1}{\sqrt{R_2 \cdot R_4 \cdot C_1 \cdot C_2}} \Rightarrow \omega_0 = \frac{1}{R \cdot C} \quad (2.1.5)$$

$$\mathbb{Q} = R_1 \cdot \sqrt{\frac{C_1}{C_2} \cdot \frac{1}{R_2 \cdot R_4}} = \frac{R_1}{R} = 0.707 \quad (2.1.6)$$

$$\text{Din (2.1.6)} \Rightarrow R_1 = 0.707 \cdot R = 0.707 \cdot R_2 = 0.707 \cdot R_4 \quad (2.1.7)$$

$$I_{R_1} = \frac{V_{OUT_TB}}{R_1} \quad (2.1.8)$$

$$I_{R_4} = \frac{V_{OUT_TB}}{s \cdot R_2 \cdot C_2 \cdot R_4} \quad (2.1.9)$$

$$V_{OUT} = \frac{V_{OUT_TB}}{s \cdot R_2 \cdot C_2} \quad (2.2.0)$$

$$V_{OUT_TJ} = -\frac{V_{OUT_TB}}{s \cdot R_2 \cdot C_2} \quad (2.2.1)$$

$$I_R = \frac{V_{IN}}{R} \quad (2.2.2)$$

$$I_{total} = \frac{V_{IN}}{R} + \frac{V_{OUT_TB}}{R_1} + \frac{V_{OUT_TB}}{s \cdot R_2 \cdot C_2 \cdot R_4} \quad (2.2.3)$$

$$V_{OUT_TB} = -I_{total} \cdot \frac{1}{s \cdot C_1} = -\frac{1}{s \cdot C_1} \cdot \left(\frac{V_{IN}}{R} + \frac{V_{OUT_TB}}{R_1} + \frac{V_{OUT_TB}}{s \cdot R_2 \cdot C_2 \cdot R_4} \right) \quad (2.2.4)$$

$$H_{(s)bandpass} = \frac{V_{OUT_TB}}{V_{IN}} = \frac{s \cdot \left(-\frac{1}{R \cdot C_1} \right)}{s^2 + s \cdot \left(\frac{1}{R_2} \cdot C_1 \right) + \frac{1}{C_1 \cdot C_2 \cdot R_2 \cdot R_1}} = H_0 \cdot \frac{s \cdot \left(\frac{\omega_0}{Q} \right)}{s^2 + s \cdot \left(\frac{\omega_0}{Q} \right) + \omega_0^2} \quad (2.2.5)$$

$$H_{(s)lowpass} = \frac{V_{OUT_TJ}}{V_{IN}} = \frac{1}{s^2 + s \cdot \left(\frac{1}{R_2} \cdot C_1 \right) + \frac{1}{C_1 \cdot C_2 \cdot R_2 \cdot R_1}} = H_0 \cdot \frac{1}{s^2 + s \cdot \left(\frac{\omega_0}{Q} \right) + \omega_0^2} \quad (2.2.6)$$

$$H_{(s)} = \frac{V_{OUT_}}{V_{IN}} = \frac{\frac{1}{C_1 \cdot C_2 \cdot R_2 \cdot R_4}}{s^2 + s \cdot \left(\frac{1}{R_2} \cdot C_1 \right) + \frac{1}{C_1 \cdot C_2 \cdot R_2 \cdot R_4}} = H_0 \cdot \frac{\omega_0^2}{s^2 + s \cdot \left(\frac{\omega_0}{Q} \right) + \omega_0^2} \quad (2.2.7)$$

Pe baza formulelor de mai sus, vom nota astfel:

$$R = R_2 = R_4 = 7.96k\Omega \quad (2.2.8)$$

$$alegem R_3 = R_5 = 10k\Omega \quad (2.2.9)$$

$$C_1 = C_2 = C = 2.5 nF \quad (2.3.0)$$

4.1.1 Parametrii DCOP

```

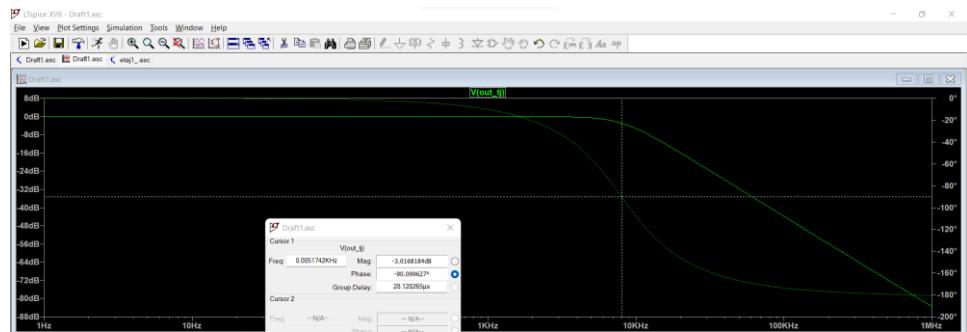
--- Operating Point ---
V(vcc) :      5          voltage
V(-vcc) :     -5          voltage
V(n001) :  8.56418e-007  voltage
V(out_tb) : -0.0135315  voltage
V(n003) :  5.31436e-007  voltage
V(out_tj) : -0.022603   voltage
V(n002) : -2.69811e-007  voltage
V(out) :  0.00560245   voltage
V(vin) :      0          voltage
I(C2) :  5.65088e-023  device_current
I(C1) :  3.38308e-023  device_current
I(R5) :  5.60272e-007  device_current
I(R1) : -2.40361e-006  device_current
I(R4) :  7.03718e-007  device_current
I(R3) :  2.26027e-006  device_current
I(R2) :  1.7e-006       device_current
I(R) :  1.0759e-010    device_current
I(V3) :  1.0759e-010    device_current
I(V2) :  0.00390928   device_current
I(V1) : -0.00391438   device_current
Ix(u1:1) : -1.7e-006   subckt_current
Ix(u1:2) : -1.7e-006   subckt_current
Ix(u1:3) :  0.00130437  subckt_current
Ix(u1:4) : -0.00130507  subckt_current
Ix(u1:5) :  4.10361e-006 subckt_current
Ix(u2:1) : -1.7e-006   subckt_current
Ix(u2:2) : -1.7e-006   subckt_current
Ix(u2:3) :  0.00130446  subckt_current

```

3.7. Analiza DCOP

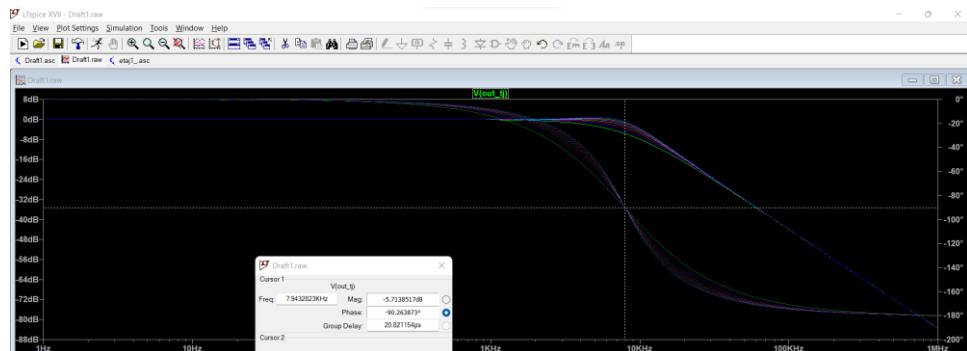


4.1.2. Parametrii de semnal mic



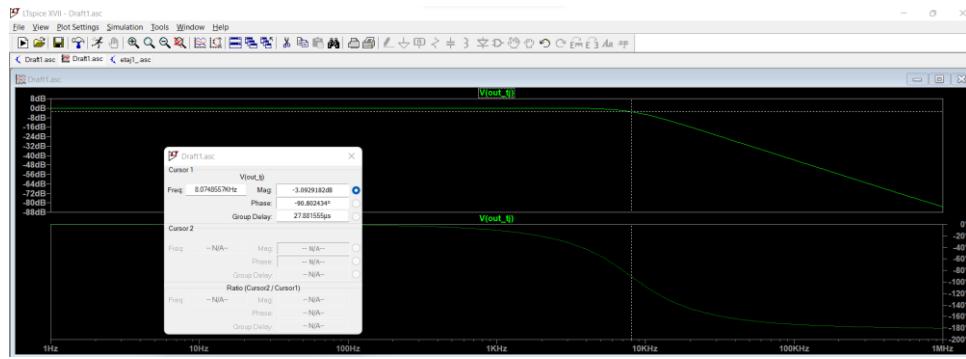
3.8. Caracteristica FTJ

Valoarea gain peakingului se află la un defazaj de -90° și putem măsura astfel frecvența de tăiere, adică $8k\Omega$

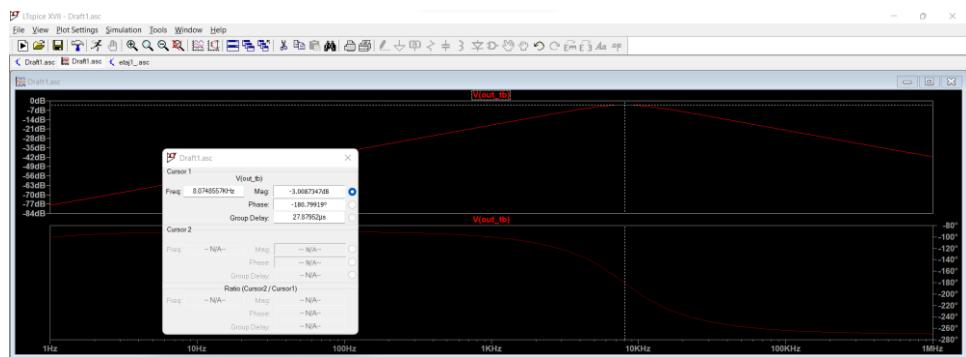


3.9. Analiza parametrică

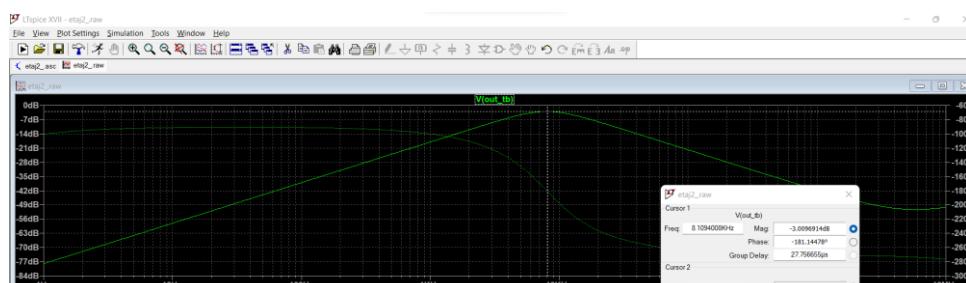
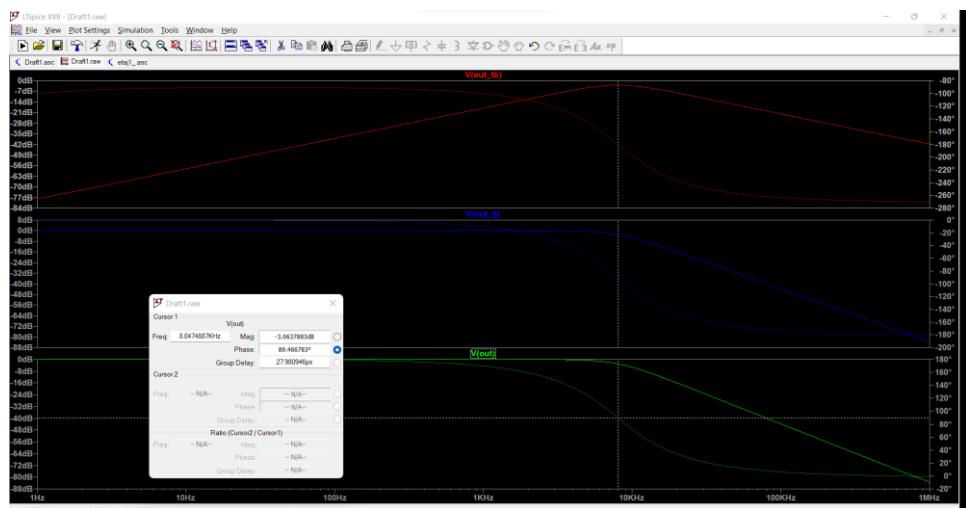
Am rulat o analiză parametrică pentru a putea observa că, factorul de calitate crește, iar gain peaking-ul este mai mare, însă toate caracteristicile de fază converg în punctul de -90° , rezultând că frecvența de tăiere rămâne aceeași.



4.0. Caracteristica FTJ: OUT_TJ



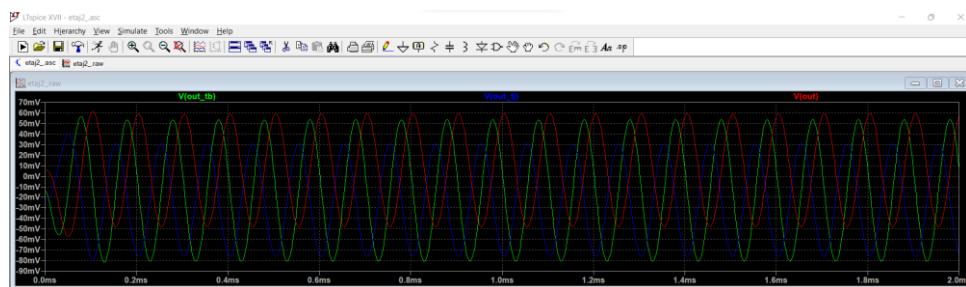
4.1. Caracteristica FTB: OUT_TB



Castiga banda de trecere = 8 kHz \rightarrow specificații

4.1.3. Parametrii de semnal mare

- Analiza transient



4.2. Analiza transient

```

L LTspice XVII - etaj2_osc
File Edit Hierarchy View Simulator Tools Window Help
< etaj2_osc > etaj2_raw
L LTspice XVII - etaj2_osc
V(out_tb) V(out) V(out)
70mV 60mV 50mV 40mV 30mV 20mV 10mV 0mV -10mV -20mV -30mV -40mV -50mV -60mV -70mV -80mV -90mV
0.0ms 0.2ms 0.4ms 0.6ms 0.8ms 1.0ms 1.2ms 1.4ms 1.6ms 1.8ms 2.0ms

```

```

L SPICE Error Log: C:\Users\DELL\OneDrive\Documente\LTspiceXVII\etaj2_osc.log
6 6.000e+04 4.301e-06 8.034e-05 -70.88° 36.92°
7 7.000e+04 5.358e-06 1.039e-04 -59.83° 47.99°
8 8.000e+04 6.264e-06 1.170e-04 -71.09° 36.72°
9 9.000e+04 4.807e-06 9.981e-05 -75.69° 32.11°
10 1.000e+05 4.380e-06 8.182e-05 -56.20° 51.60°
Total Harmonic Distortion: 0.030146% (0.076518%)

N-Period=1
Fourier components of V(out_tb)
DC component: -0.0135329

Harmonic Number Frequency [Hz] Fourier Component Normalized Component Phase [degree] Normalized Phase [deg]
1 1.000e+04 6.702e-02 1.000e+00 162.21° 0.0°
2 2.000e+04 7.870e-06 1.174e-04 92.39° -69.82°
3 3.000e+04 5.659e-06 8.459e-05 17.66° -144.55°
4 4.000e+04 2.991e-06 4.463e-05 -111.64° -273.85°
5 5.000e+04 6.959e-06 1.038e-04 153.19° -9.01°
6 6.000e+04 6.875e-06 1.026e-04 91.69° -70.52°
7 7.000e+04 4.939e-06 6.229e-05 14.25° -147.96°
8 8.000e+04 2.738e-06 4.081e-05 -128.58° -290.79°
9 9.000e+04 6.258e-06 9.337e-05 148.66° -13.35°
10 1.000e+05 5.567e-06 8.306e-05 93.45° -68.75°
Total Harmonic Distortion: 0.025572% (0.063720%)

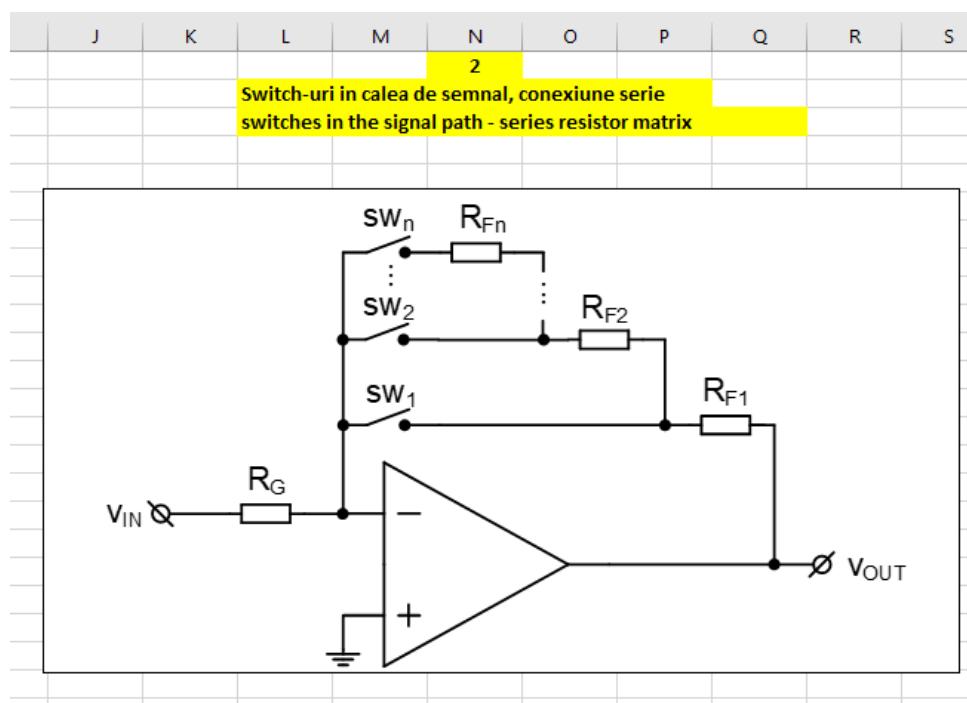
N-Period=1
Fourier components of V(out)
DC component: 0.00560522

Harmonic Number Frequency [Hz] Fourier Component Normalized Component Phase [degree] Normalized Phase [deg]
1 1.000e+04 5.352e-02 1.000e+00 72.20° 0.0°
2 2.000e+04 4.423e-06 8.264e-05 83.93° 11.74°
3 3.000e+04 5.574e-06 1.041e-04 110.51° 38.31°
4 4.000e+04 6.775e-06 1.266e-04 99.40° 27.20°
5 5.000e+04 5.440e-06 1.016e-04 89.00° 16.81°
6 6.000e+04 4.299e-06 8.033e-05 109.12° 36.93°
7 7.000e+04 5.050e-06 1.020e-04 120.20° 45.01°
8 8.000e+04 6.264e-06 1.170e-04 108.83° 34.73°
9 9.000e+04 4.806e-06 9.980e-05 104.30° 32.11°
10 1.000e+05 4.378e-06 8.180e-05 123.80° 51.61°
Total Harmonic Distortion: 0.030149% (0.076518%)

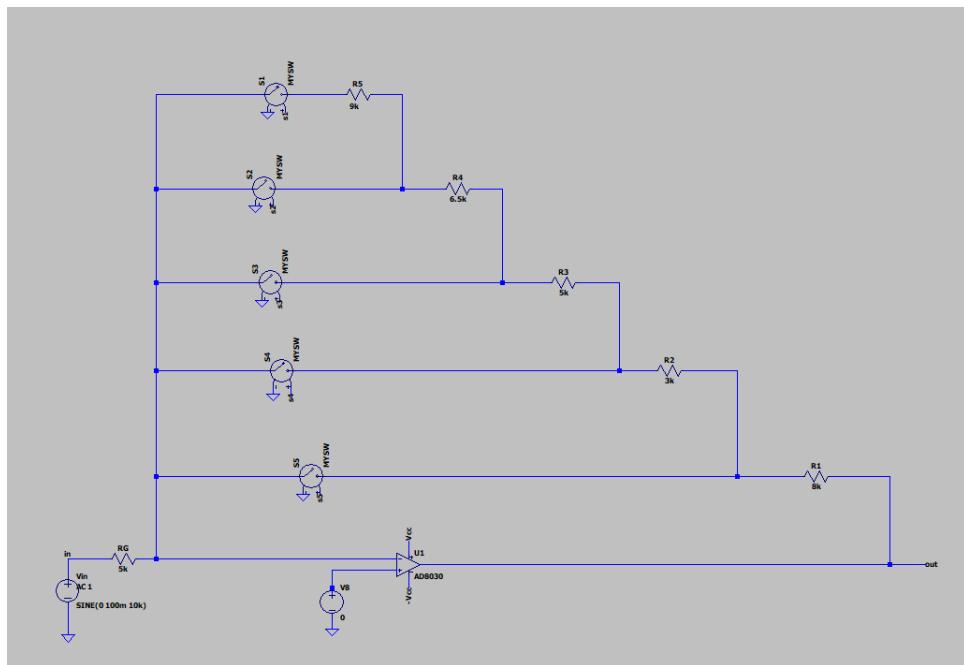
```

5. Caracterizarea etajului 3

Etaj 3 - PGA							
Nr	tip	casig minim [dB]	rezolutie (pas minim) [dB]	numar pasi	casig maxim [dB]	Rin_min [Ohm]	banda
1	inversor, RF conexiune paralel	spec individual	spec individual	spec individual	spec individual	>Fin_max	fara distorsii la fin_max pt ampl_in_min*casing_max_PGA si ampl_in_max*casing_min_PGA (THD<1%)
2	inversor, RF conexiune serie	spec individual	spec individual	spec individual	spec individual	>Fin_max	fara distorsii la fin_max pt ampl_in_min*casing_max_PGA si ampl_in_max*casing_min_PGA (THD<1%)



5.1. Dimensionarea etajului 3



Conform specificatiilor $R_{IN_{min}} = 4k\Omega$, vom alege $R_{IN} = 5k\Omega$ (3.1.0)

$$R_{IN} = R_G = 5k\Omega \quad (3.1.1)$$

$$|A_V| = \{4dB, 7dB, 10dB, 13dB, 16dB\} = \left\{1.6 \frac{V}{V}, 2.2 \frac{V}{V}, 3.2 \frac{V}{V}, 4.5 \frac{V}{V}, 6.3 \frac{V}{V}\right\} \quad (3.1.2)$$

$$|A_V| = \frac{R_{F_echivalent}}{R_G} \quad (3.1.3)$$

Din (3.1.3) \Rightarrow

$$R_{F_5} + R_{F_4} + R_{F_3} + R_{F_2} + R_{F_1} = 6.3 \cdot R_G = 6.3 \cdot 5k\Omega = 31.5k\Omega \Rightarrow R_{F_5} = 31.5k\Omega - 22.5k\Omega = 9k\Omega$$

$$R_{F_4} + R_{F_3} + R_{F_2} + R_{F_1} = 4.5 \cdot R_G = 4.5 \cdot 5k\Omega = 22.5k\Omega \Rightarrow R_{F_4} = 22.5k\Omega - 16k\Omega = 6.5k\Omega$$

$$R_{F_3} + R_{F_2} + R_{F_1} = 3.2 \cdot R_G = 3.2 \cdot 5k\Omega = 16k\Omega \Rightarrow R_{F_3} = 16k\Omega - 11k\Omega = 5k\Omega \quad (3.1.4)$$

$$R_{F_2} + R_{F_1} = 2.2 \cdot R_G = 2.2 \cdot 5k\Omega = 11k\Omega \Rightarrow R_{F_2} = 11k\Omega - 8k\Omega = 3k\Omega$$

$$R_{F_1} = 1.6 \cdot R_G = 1.6 \cdot 5k\Omega = 8k\Omega$$

$$R_{Feedback_total} = R_{F_1} + R_{F_2} + R_{F_3} + R_{F_4} + R_{F_5} = 31.5k\Omega \quad (3.1.5)$$

$$R_{total} = R_G + R_{Feedback_total} = 5k\Omega + 31.5k\Omega = 36.5k\Omega \quad (3.1.6)$$

$$A_{VK} = \frac{V_{OUT}}{V_{IN}} = -\frac{\sum_{i=1}^k R_K}{R_{IN}} \quad (3.1.7)$$

$$BW = \frac{GBW}{1 + |A_{VK}|} \quad (3.1.8)$$

Switch in calea de semnal - conexiune serie															
GBW_AO [Hz]	Rg	R1	R2	R3	R4	R5	s1 [V]	s2 [V]	s3 [V]	s4 [V]	s5	Av [linear]	Av [dB]	Rin[ohm]	BW [Hz]
8.00E+04	5.00E+03	8.00E+03	3.00E+03	5.00E+03	6.50E+03	9.00E+03	0	0	0	0	5	6.30E+00	1.60E+01	5.00E+03	1.10E+04
							0	0	0	5	5	4.50E+00	1.31E+01	5.00E+03	1.45E+04
Rtotal_feedback							0	0	5	5	5	3.20E+00	1.01E+01	5.00E+03	1.90E+04
							0	5	5	5	5	2.20E+00	6.85E+00	5.00E+03	2.50E+04
							5	5	5	5	5	1.60E+00	4.08E+00	5.00E+03	3.08E+04

SW5	SW4	SW3	SW2	SW1	RIN=RG	RFechv	Av[dB]	Av[V/V]
Vcc	0	0	0	0	5K	9K	16	6.3
Vcc	Vcc	0	0	0	5K	6.5K	13	4.5
Vcc	Vcc	Vcc	0	0	5K	5K	10	3.2
Vcc	Vcc	Vcc	Vcc	0	5K	3K	7	2.2
Vcc	Vcc	Vcc	Vcc	Vcc	5K	8K	4	1.6



5.1.1 Parametrii DCOP

* C:\Users\DELL\OneDrive\Documente\LTspiceXVII\etaaj3_.asc

--- Operating Point ---

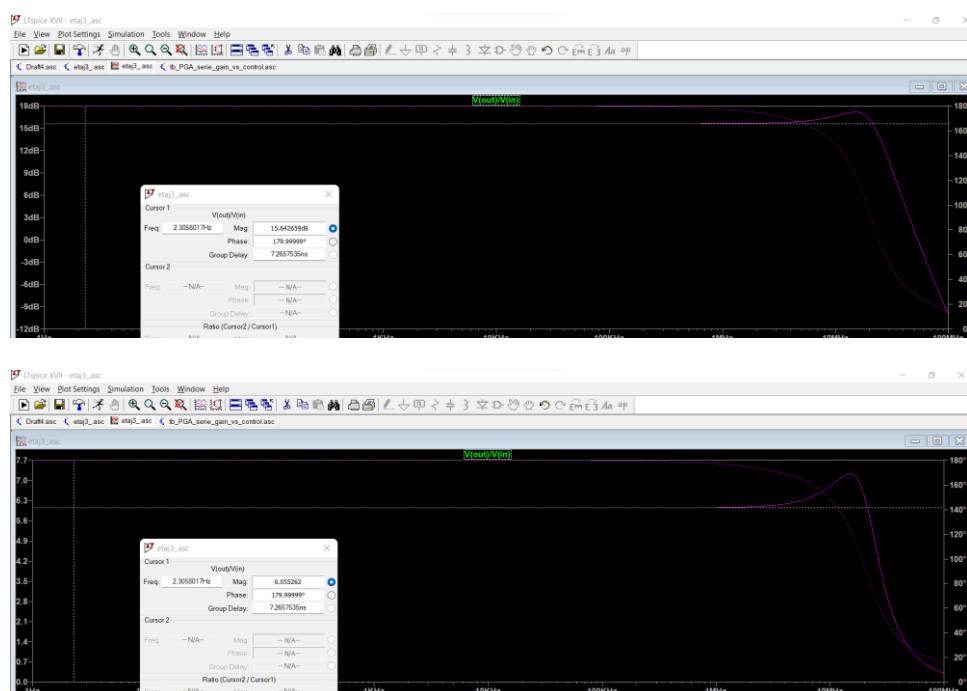
```
V(n003) :      3.86513e-007  voltage
V(n002) :      3.86513e-007  voltage
V(n004) :      3.86513e-007  voltage
V(n005) :      3.86513e-007  voltage
V(n006) :      3.84814e-007  voltage
V(out) :      -0.013599   voltage
V(n001) :      3.86513e-007  voltage
V(in) :        0            voltage
V(vcc) :       5            voltage
V(-vcc) :     -5           voltage
V(s1) :        5            voltage
V(s3) :        5            voltage
V(s2) :        5            voltage
V(s4) :        5            voltage
V(s5) :        5            voltage
V(n007) :     0             voltage
I(Rg) :        7.73027e-011 device_current
I(R1) :      -1.69992e-006 device_current
I(R2) :      -5.66641e-013 device_current
I(R3) :      -1.13328e-019 device_current
I(R4) :      -2.44336e-026 device_current
I(R5) :        0            device_current
I(S5) :      -1.69992e-006 device_current
I(S4) :      -5.66641e-013 device_current
I(S3) :      -1.05879e-019 device_current
I(S2) :       5.29396e-020 device_current
I(S1) :       5.29396e-020 device_current
I(V8) :       1.7e-006    device_current
I(V7) :        0            device_current
I(V6) :        0            device_current
I(V5) :        0            device_current
I(V4) :        0            device_current
I(V3) :        0            device_current
I(V2) :       0.00130267  device_current
I(V1) :      -0.00130437  device_current
I(Vin) :      7.73027e-011 device_current
Ix(u1:1) :    -1.7e-006   subckt_current
Ix(u1:2) :    -1.7e-006   subckt_current
Ix(u1:3) :    0.00130437  subckt_current
Ix(u1:4) :   -0.00130267  subckt_current
Ix(u1:5) :   1.69992e-006 subckt_current
```

4.3. Analiza DCOP

5.1.2. Parametrii de semnal mic

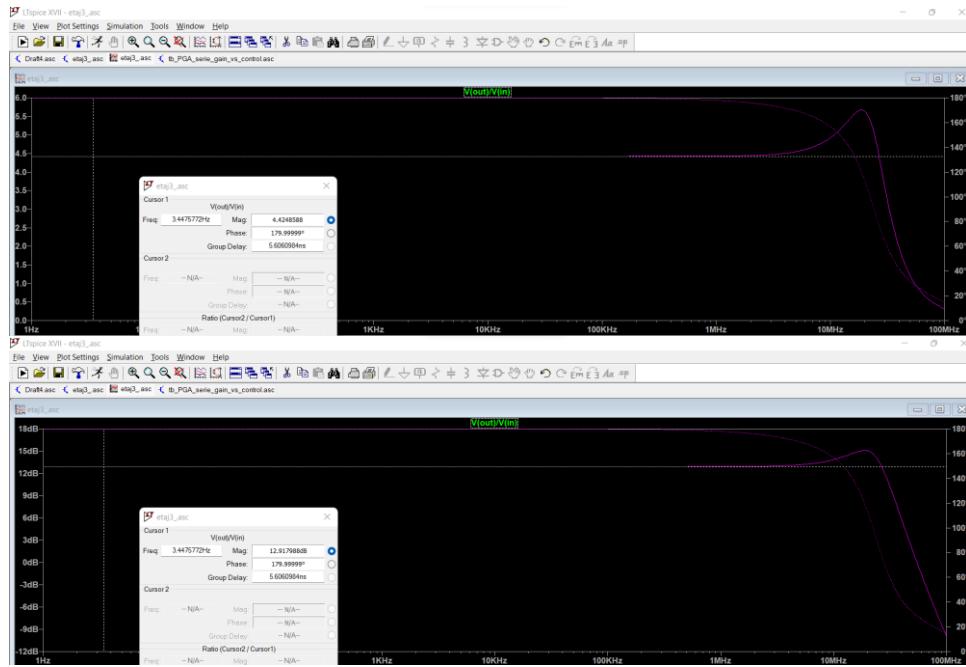
- Analiza AC

Conform tabelului de la punctul 5.1, vom rula fiecare analiză pentru fiecare întrerupător:



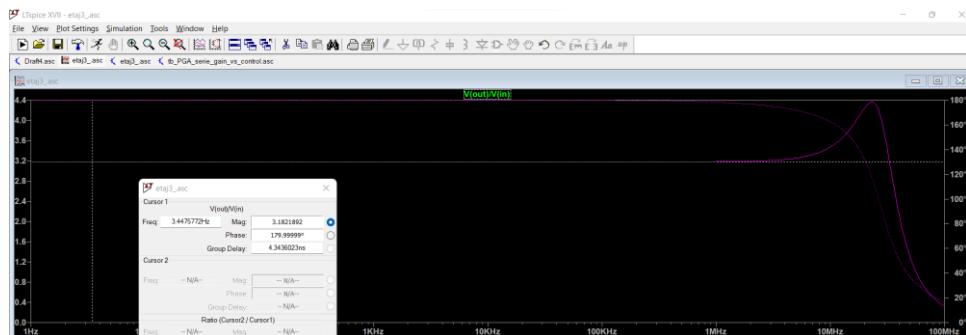
4.4. Caracteristica Av pentru *sw1-ON, restul OFF*

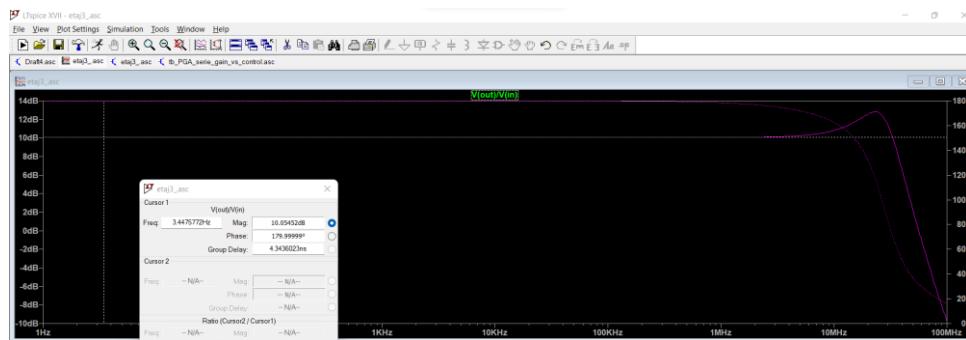
După cum am calculat, atunci când comutăm sw1 pe ON (restul vor fi OFF), Av_linear ne-a dat 6.05 (calcule 6.3), iar Av_dB ne-a dat 15.64 dB (calcule 16 dB), ceea ce corespunde caracteristicii noastre cu o oarecare eroare.



4.5. Caracteristica Av pentru sw1-ON, sw2-ON, restul OFF

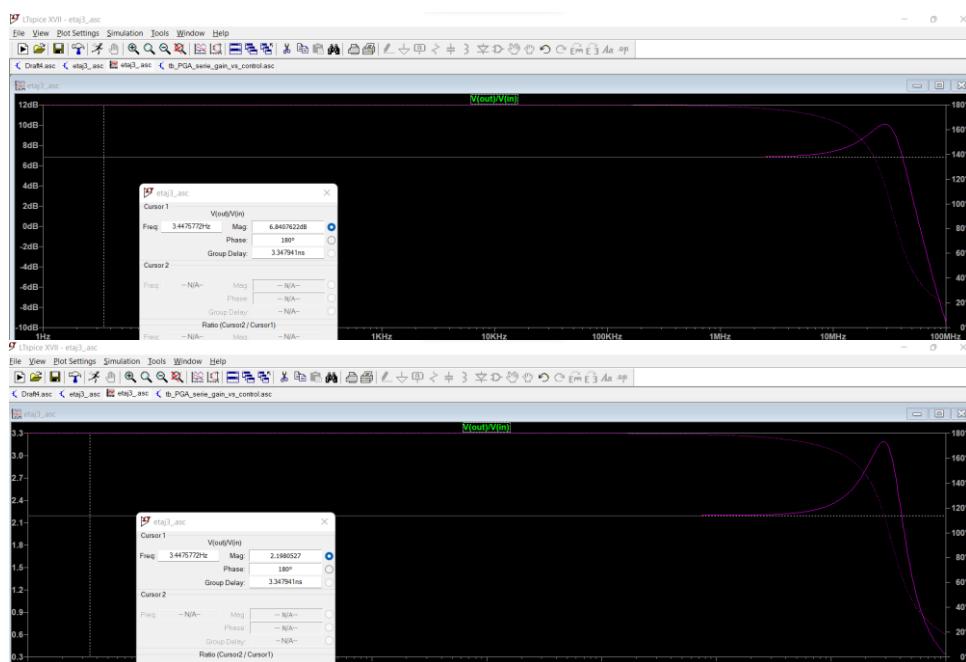
După cum am calculat, atunci când comutăm sw1 pe ON și sw2 pe ON (restul vor fi OFF), Av_linear ne-a dat 4.42 (calcule 4.5), iar Av_dB ne-a dat 12.92 dB (calcule 13 dB), ceea ce corespunde caracteristicii noastre cu o oarecare eroare.





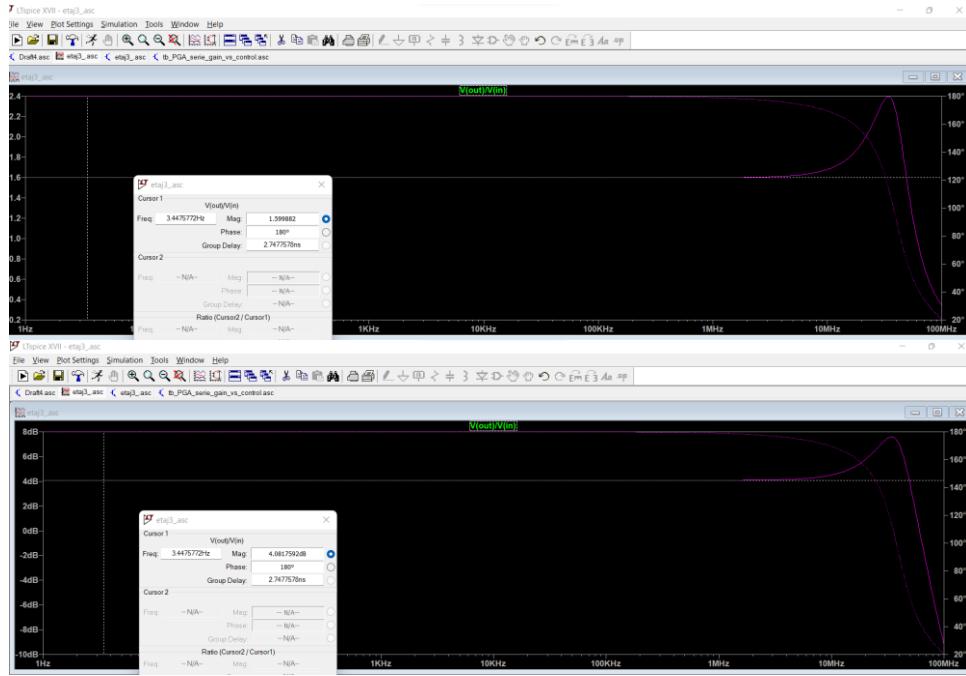
4.6. Caracteristica Av pentru sw1-ON, sw2-ON, sw3-ON, restul OFF

După cum am calculat, atunci când comutăm sw1 pe ON, sw2 pe ON și sw3 pe ON (restul vor fi OFF), Av_linear ne-a dat 3.18 (calcule 3.2), iar Av_dB ne-a dat 10.05 dB (calcule 10.1 dB), ceea ce corespunde caracteristicii noastre cu o oarecare eroare.



4.7. Caracteristica Av pentru toate sw ON, mai putin sw5- OFF

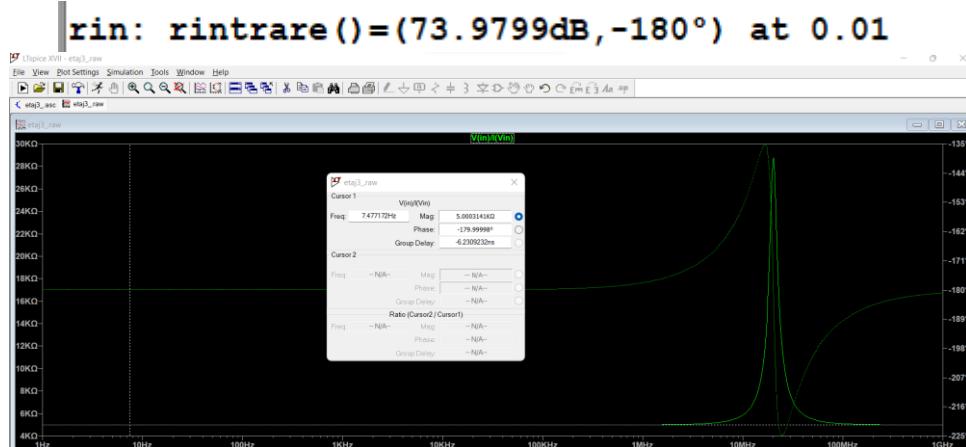
După cum am calculat, atunci când comutăm toate sw pe ON (mai putin sw5 care ii fi OFF), Av_linear ne-a dat 2.19 (calcule 2.2), iar Av_dB ne-a dat 6.84 dB (calcule 6.85 dB), ceea ce corespunde caracteristicii noastre cu o oarecare eroare.



4.8. Caracteristica Av pentru toate sw ON

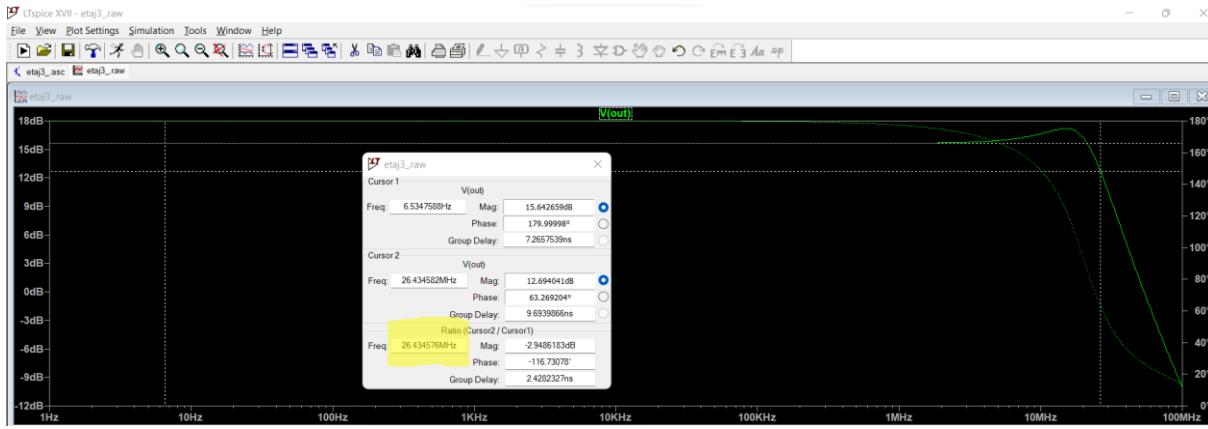
După cum am calculat, atunci când comutăm toate sw pe ON, Av_linear ne-a dat 1.59 (calcule 1.6), iar Av_dB ne-a dat 4.08 dB (calcule 4.08dB), ceea ce corespunde caracteristicii noastre.

- Rezistența de intrare

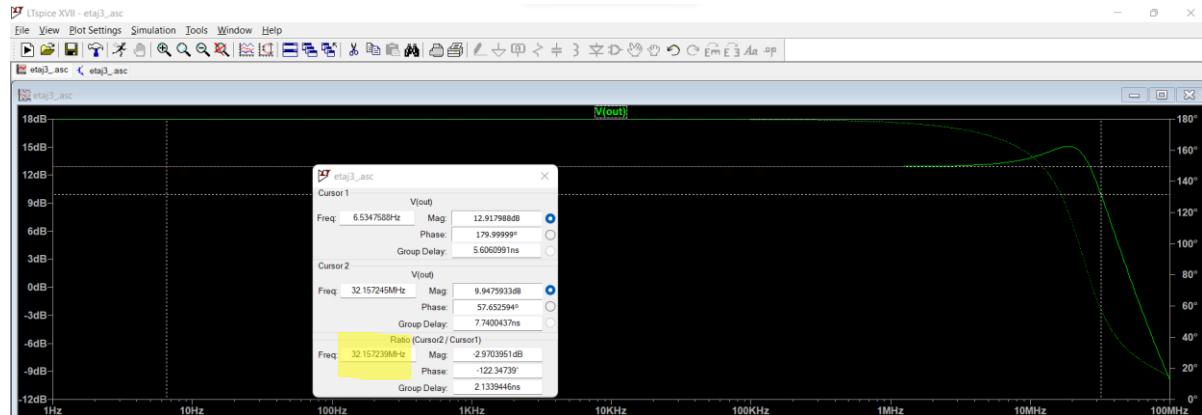


4.9. Impedanța de intrare: $R_g=5k\Omega$

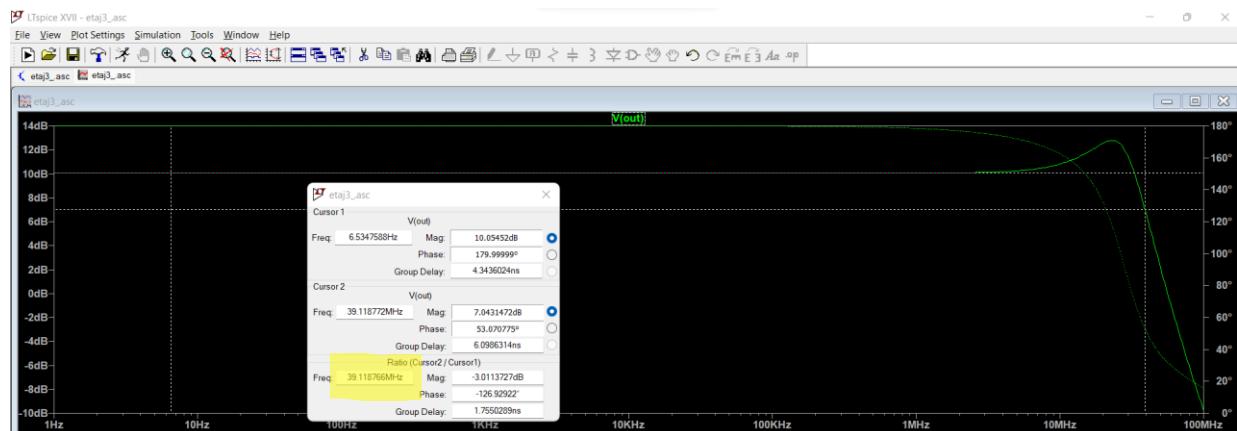
- Banda PGA pentru fiecare switch



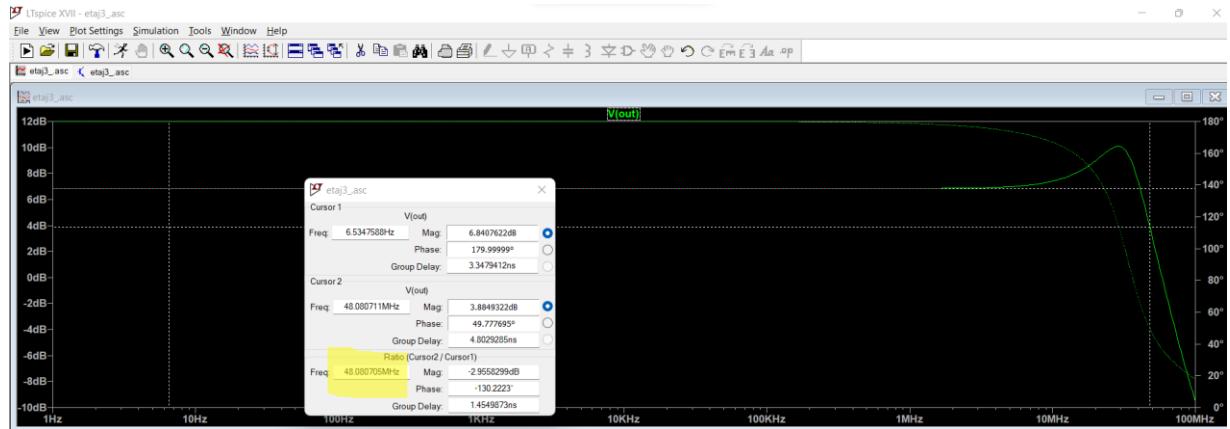
5.0. Banda -3dB PGA, sw1-ON (26.4 MHz)



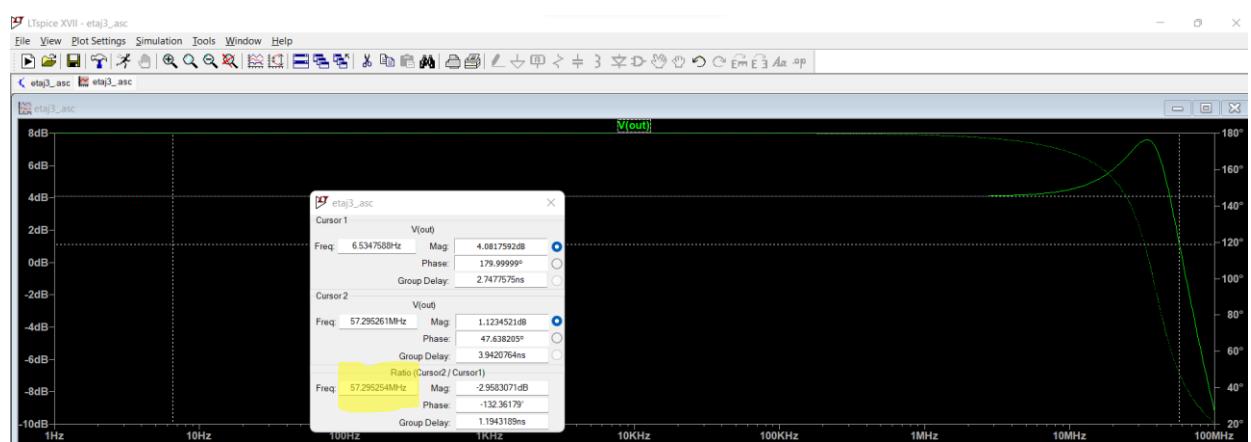
5.1. Banda -3dB PGA, sw1,2-ON (32.16 MHz)



5.2. Banda -3dB PGA, sw1,2,3-ON (39.12 MHz)



5.3. Banda -3dB PGA, sw1,2,3,4-ON (48.08 MHz)

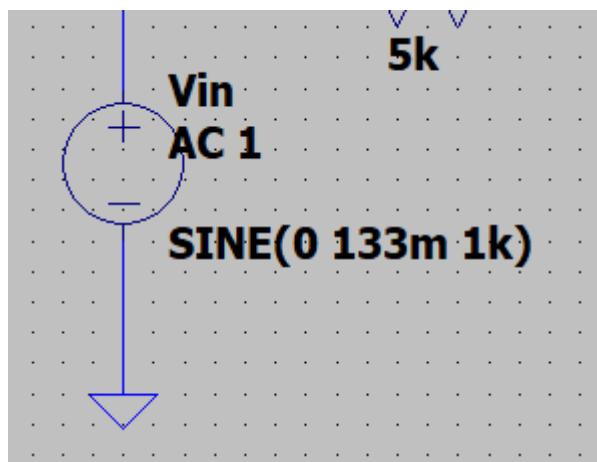


5.4. Banda -3dB PGA, toate sw-ON (57.59 MHz)

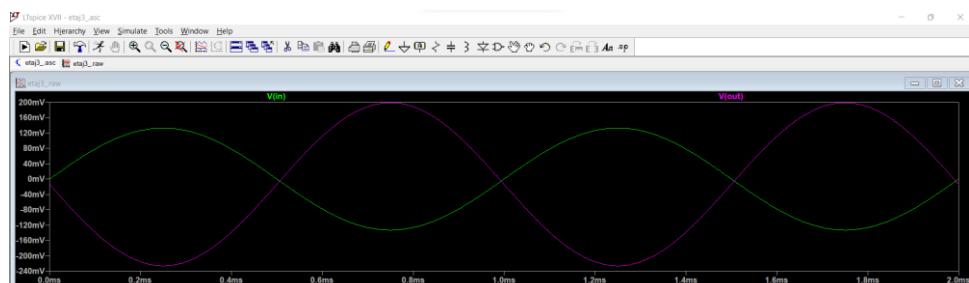
5.1.3. Parametrii de semnal mare

- Domeniul liniar pentru castigul minim

Pentru a afla domeniul liniar pentru câștigul minim PGA, vom seta amplitudinea maximă dată din specificații ca fiind 133mV:



Am setat frecvența 1k pentru a avea THD<1%.



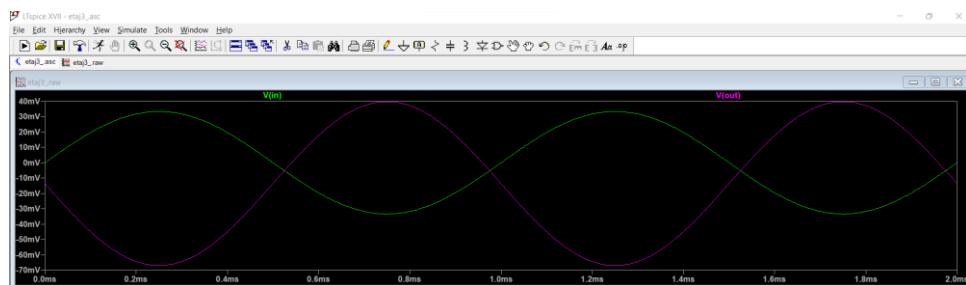
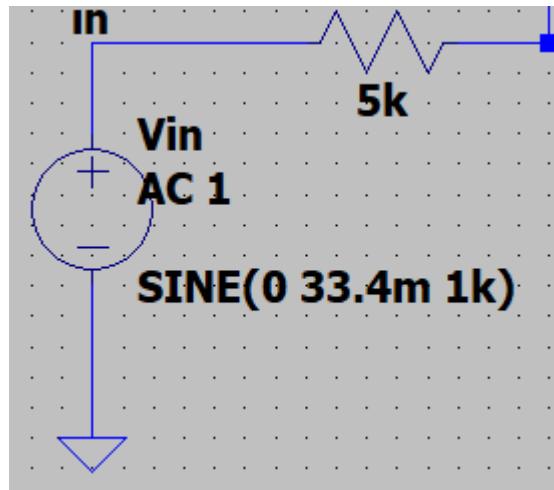
5.5. Domeniul liniar pentru castigul minim

Amplitudinea maxima a semnalului de intrare este de 132.57332mV, iar a semnalului de ieșire este 199.11342mV.

Total Harmonic Distortion: 0.000096% (0.006009%)

- Domeniul liniar pentru castigul maxim

Pentru a afla domeniul liniar pentru câștigul maxim PGA, vom seta amplitudinea minima dată din specificații ca fiind 33.4mV:



5.5. Domeniul liniar pentru castigul maxim

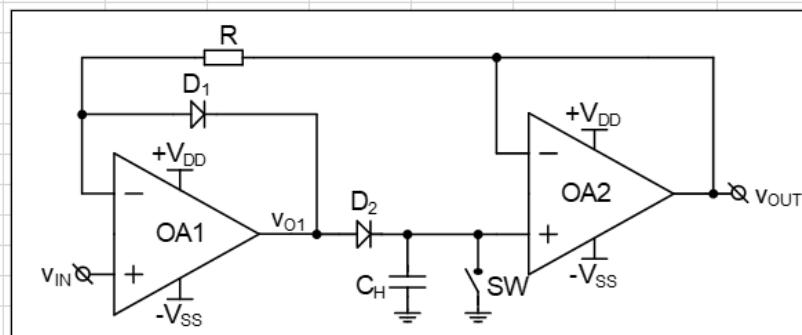
Amplitudinea maxima a semnalului de intrare este de 33.374033mV, iar a semnalului de iesire este 39.812269mV.

6. Caracterizarea etajului 4

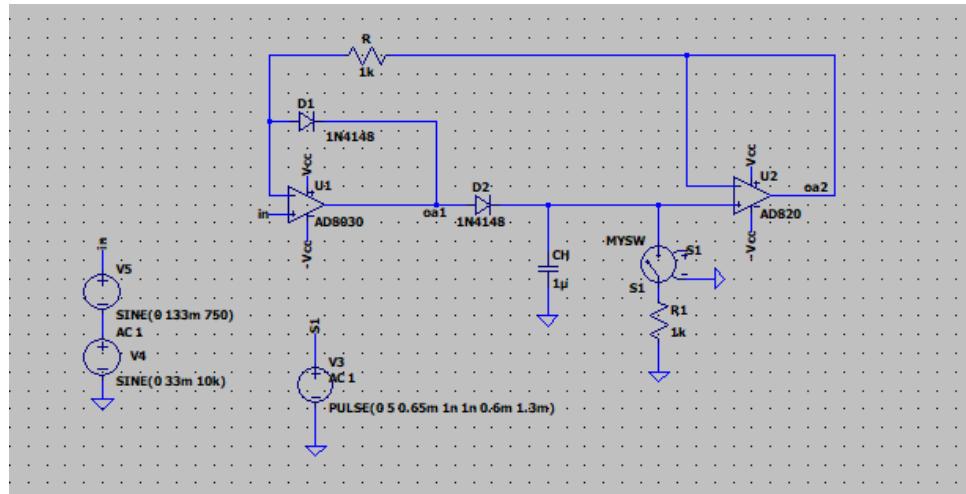
Etaj 4 - Redresor/Convertor AC-DC/Detector de varf			
Nr	tip	castig [V/V]	semnal mare - circuitul are functia dorita pe domeniul =
18	Detector de varf - Peak Detect (pozitiv)	-	vin_max

C. PeakDetect

18 positive peak detect



6.1. Dimensionarea etajului 4



Presupunem ca D_1, D_2 –OFF

1. Cazul 1

$$V_{IN} = V_{CC}$$

$$V^+ = V_{CC} \quad (4.1.1)$$

$$V_1^- = V_2^- = V_2^+ = V_{CH} = 0$$

$$\text{Din (4.1.1)} \Rightarrow V^+ > V^- \Rightarrow V_{OA_1} = V_{CC} \quad (4.1.2)$$

$$V_{AK_1} = 0 - V_{CC} = -V_{CC} = -5V < 0 \Rightarrow D_1 = OFF \quad (4.1.3)$$

$$V_{AK_2} = V_{CC} - 0 = V_{CC} = 5V > 0 \Rightarrow D_2 = ON \quad (4.1.4)$$

$$V_{OA_1} = V_{IN} \quad (4.1.5)$$

$$V_{CH} \cong V_{IN} \Leftrightarrow V_{IN} \geq 0 \quad (4.1.6)$$

2. Cazul 2

$$V_{IN} = -V_{CC}$$

$$V^+ = -V_{CC} \quad (4.1.7)$$

$$V^- = V_{CH}$$

$$V_{CH} > 0$$

$$Din \quad (4.1.7) \Rightarrow V^- > V^+ \Rightarrow V_{OA_1} = -V_{CC} \quad (4.1.8)$$

$$V_{AK_1} > 0 \Rightarrow D_1 = ON \quad (4.1.9)$$

$$V_{AK_2} < 0 \Rightarrow D_2 = OFF \quad (4.2.0)$$

$$V_{CH} = V_{IN} \Leftrightarrow V_{IN} \geq 0 \quad (4.2.1)$$

$$V_{CH} = V_{OA_2} \Leftrightarrow V_{IN} < 0 \quad (4.2.2)$$

Am ales valoarea rezistenței R $1k\Omega$, a rezistenței R_1 $1k\Omega$ iar a condensatorului C_H $1\mu F$ pentru a avea un THD cât mai mic. Totodată, am schimbat al doilea AO cu un AD820 pentru o analiză mai eficientă și am adăugat rezistența R_1 în serie cu întretrerupătorul pentru a micșora valoarea curentului din switch.

6.1.1 Parametrii DCOP

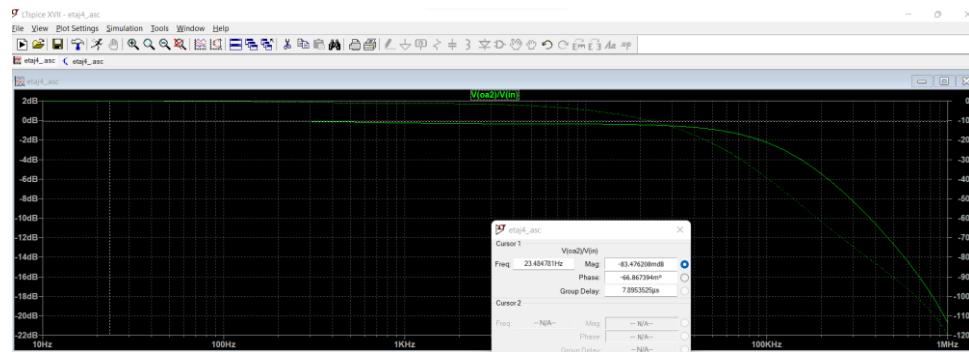
--- Operating Point ---

```
V(n001) :      7.99099e-008  voltage
V(oa1) :     -0.0202686  voltage
V(n002) :     -0.00169856  voltage
V(oa2) :     -0.0016985  voltage
V(vcc) :        5          voltage
V(-vcc) :       -5         voltage
V(in) :         0          voltage
V(n004) :       0          voltage
V(n003) :    -0.000849278  voltage
V(s1) :         0          voltage
I(Ch) :    -1.69856e-021 device_current
I(D2) :   -8.47278e-010 device_current
I(D1) :   1.42143e-009 device_current
I(R1) :   -8.49278e-010 device_current
I(R) :    -1.69858e-006 device_current
I(S1) :   -8.49278e-010 device_current
I(V3) :         0          device_current
I(V5) :    1.7e-006  device_current
I(V4) :    1.7e-006  device_current
I(V2) :    0.0020052 device_current
I(V1) :   -0.0020069 device_current
Ix(u1:1) :   -1.7e-006 subckt_current
Ix(u1:2) :   -1.7e-006 subckt_current
Ix(u1:3) :   0.00130444 subckt_current
Ix(u1:4) :  -0.00130104 subckt_current
Ix(u1:5) :   2.26871e-009 subckt_current
Ix(u2:1) :  1.99991e-012 subckt_current
Ix(u2:2) :  1.99991e-012 subckt_current
Ix(u2:3) :  0.000702468 subckt_current
Ix(u2:4) : -0.000704167 subckt_current
Ix(u2:5) :  1.69858e-006 subckt_current
```

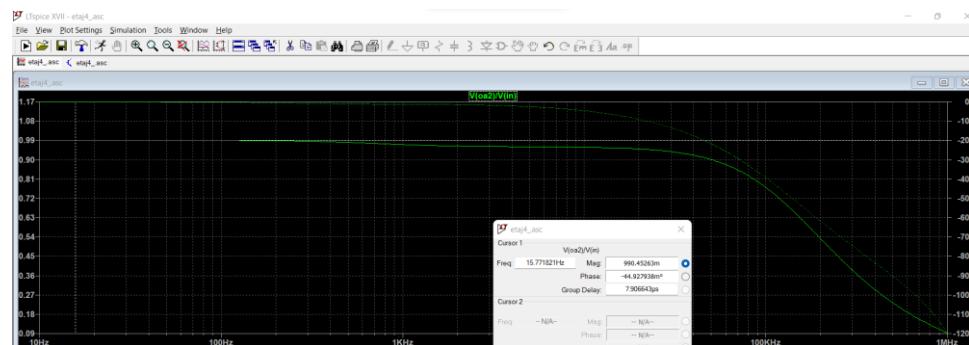
5.6. Analiza DCOP

6.1.2. Parametrii de semnal mic

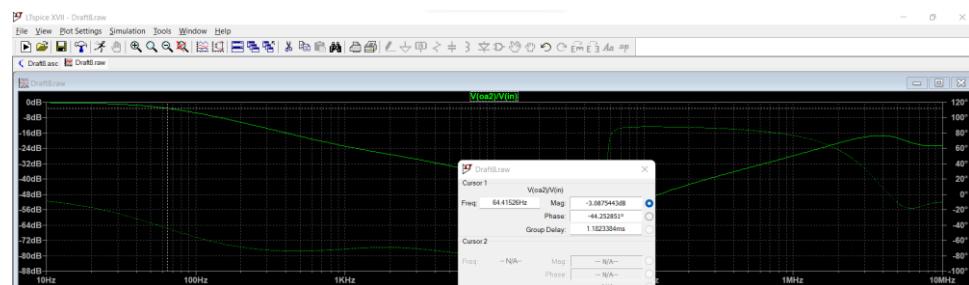
- Analiza AC

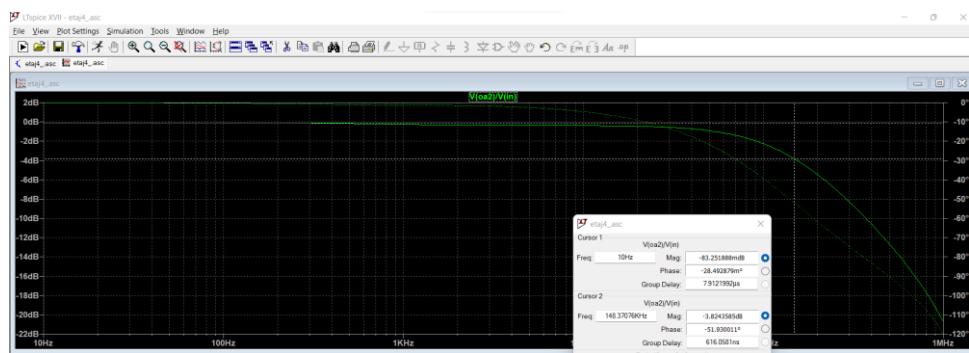


5.7. Av in decibeli



5.8. Av linear

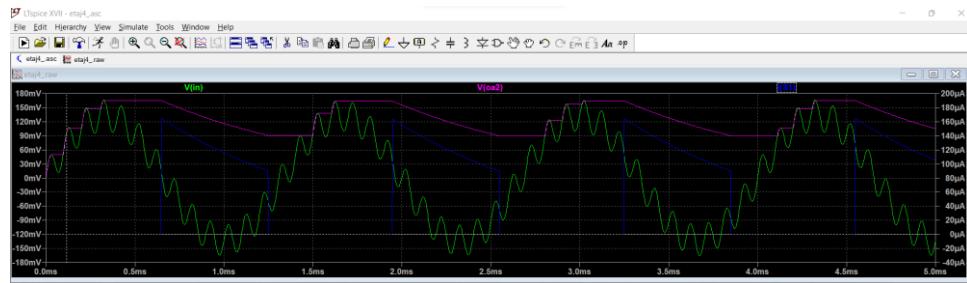




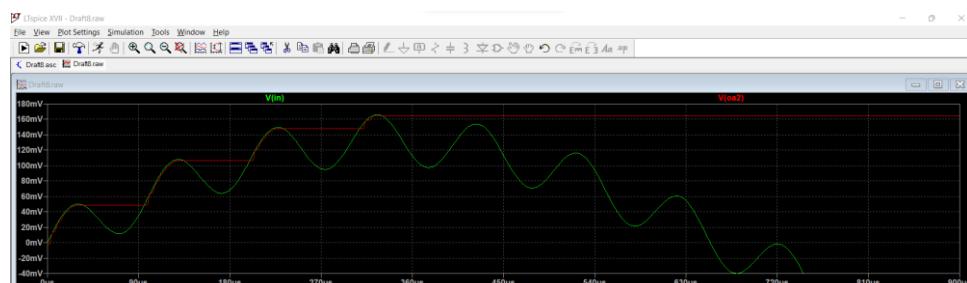
5.9. Banda la -3dB

6.1.3. Parametrii de semnal mare

- Analiza transient



6.0. Analiza transient



6.1. $V_{out}=V_{in}$ (peak)



6.2. Leakage current prin condensatorul CH



7. Concluzii

- Etajul 1

ETAJUL 1												
Condiții de simulație	AC				Valori momentan				Diferențe			
	Ar(1/V)	Ar(dB)	C10R(10) ⁻² m datorită distorsiunii	P10R_Ar(10) ⁻² m datorită distorsiunii	Ar(1/V)	Ar(dB)	P10R(dB)	C10R(dB)	Ar(1/V)	Ar(dB)		
V _{CC} =+5V; V _{OC} =-5V	10	25.55	9.00E-11	1.00E-11	11.00E-02	25.57E-02	25.57E-02	25.57E-02	2.00E-03	6.21E-03	6.43E-03	5.40E-03

- Etajul 2

ETAJUL 2										
Condiții de simulație	AC				Valori momentan				Diferențe	
	H(1/V)	H(dB)	Banda	H _{min}	H(1/V)	H(dB)	Banda	H(1/V)	H(dB)	Banda
V _{CC} =+5V; V _{OC} =-5V	1	0	8.00E-03	1.00E-03	1.000001	8.43E-04	1.04E-03	-8.31E-03	-1.41E-04	-3.78E-03

- Etajul 3

ETAJUL 3													
Condiții de simulație	AC				Valori momentan				Diferențe				
	amp1_curent_microm POA	amp1_curent_microm POA	curent_microm (dB)	curent_microm (dB)	Par_microm	amp1_curent_microm POA	amp1_curent_microm POA	curent_microm (dB)	curent_microm (dB)	amp1_curent_microm POA			
V _{CC} =+5V; V _{OC} =-5V	3.34E-02	1.11E-02	4.00E-02	1.00E-02	4.00E-02	+1.00E-02	-1.00E-02	-4.00E-02	-1.00E-02	3.14E-02	1.00E-02	-1.00E-02	1.00E-02

- Etajul 4

ETAJUL 4			
<u>Conditii de simulare</u>	<u>Specificatii</u>	<u>Valori masurate</u>	<u>Diferenta</u>
AD8030 OpAmp model	castig linear	castig linear	castig linear
Vcc+=5V; Vcc-=5V	1.00E+00	9.90E-01	9.54E-03



8. Notițe

AD8029/AD8030/AD8040

SPECIFICATIONS

SPECIFICATIONS WITH ± 5 V SUPPLY

Table 1. $V_s = \pm 5$ V @ $T_a = 25^\circ\text{C}$, $G = +1$, $R_L = 1\text{k}\Omega$ to ground, unless otherwise noted. All specifications are per amplifier.

Parameter	Conditions	Min	Typ	Max	Unit
DYNAMIC PERFORMANCE					
-3 dB Bandwidth	$G = +1$, $V_o = 0.1$ V p-p	80	125		MHz
	$G = +1$, $V_o = 2$ V p-p	14	19		MHz
Bandwidth for 0.1 dB Flatness	$G = +2$, $V_o = 0.1$ V p-p		6		MHz
Slew Rate	$G = +1$, $V_o = 2$ V Step		62		V/ μ s
	$G = -1$, $V_o = 2$ V Step		63		V/ μ s
Settling Time to 0.1%	$G = +2$, $V_o = 2$ V Step		80		ns
NOISE/DISTORTION PERFORMANCE					
Spurious Free Dynamic Range (SFDR)	$f_c = 1$ MHz, $V_o = 2$ V p-p		-74		dBc
	$f_c = 5$ MHz, $V_o = 2$ V p-p		-56		dBc
Input Voltage Noise	$f = 100$ kHz		16.5		nV/ $\sqrt{\text{Hz}}$
Input Current Noise	$f = 100$ kHz		1.1		pA/ $\sqrt{\text{Hz}}$
Crosstalk (AD8030/AD8040)	$f = 5$ MHz, $V_o = 2$ V p-p		-79		dB
DC PERFORMANCE					
Input Offset Voltage	PNP Active, $V_{CM} = 0$ V		1.6	5	mV
	NPN Active, $V_{CM} = 4.5$ V		2	6	mV
Input Offset Voltage Drift	$T_{MIN} \text{ to } T_{MAX}$		30		$\mu\text{V}/^\circ\text{C}$
Input Bias Current ¹	NPN Active, $V_{CM} = 4.5$ V		0.7	1.3	μA
	$T_{MIN} \text{ to } T_{MAX}$		1		μA
	PNP Active, $V_{CM} = 0$ V		-1.7	-2.8	μA
	$T_{MIN} \text{ to } T_{MAX}$		2		μA
Input Offset Current			± 0.1	± 0.9	μA
Open-Loop Gain	$V_o = \pm 4.0$ V	65	74		dB
INPUT CHARACTERISTICS					
Input Resistance			6		$\text{M}\Omega$
Input Capacitance			2		pF
Input Common-Mode Voltage Range			-5.2 to +5.2		V
Common-Mode Rejection Ratio	$V_{CM} = -4.5$ V to +3 V, $R_L = 10\text{k}\Omega$	80	90		dB
DISABLE PIN (AD8029)					
DISABLE Low Voltage			$-V_s + 0.8$		V
DISABLE Low Current			-6.5		μA
DISABLE High Voltage			$-V_s + 1.2$		V
DISABLE High Current			0.2		μA
Turn-Off Time	50% of DISABLE to <10% of Final V_o , $V_o = -1$ V, $G = -1$		150		ns
Turn-On Time	50% of DISABLE to <10% of Final V_o , $V_o = -1$ V, $G = -1$		85		ns
OUTPUT CHARACTERISTICS					
Output Overdrive Recovery Time (Rising/Falling Edge)	$V_o = +6$ V to -6 V, $G = -1$		55/45		ns
Output Voltage Swing	$R_o = 1\text{k}\Omega$	$-V_s + 0.22$	$+V_s - 0.22$		V
	$R_o = 10\text{k}\Omega$	$-V_s + 0.05$	$+V_s - 0.05$		V
Short-Circuit Current	Sinking and Sourcing		170/160		mA
Off Isolation (AD8029)	$V_o = 0.1$ V p-p, $f = 1$ MHz, DISABLE = Low		-55		dB
Capacitive Load Drive	30% Overshoot		20		pF
POWER SUPPLY					
Operating Range		2.7	12		V
Quiescent Current/Amplifier		1.4	1.5		mA
Quiescent Current (Disabled)	DISABLE = Low	150	200		μA
Power Supply Rejection Ratio	$V_s = \pm 1$ V	73	80		dB

¹Plus, +, (or no sign) indicates current into pin; minus (-) indicates current out of pin.

8. Bibliografie

[1] Sisteme cu Circuite Integrate Analogice- notite curs- Marius Neag

[2] Tutoriale video- Raul Ciprian Onet

[3] Tow-Thomas Biquad Filters:

https://www.youtube.com/watch?v=OBJmKUgmBNc&ab_channel=SemiconductorAcademy

[4] Tow-Thomas Biquad Filters: https://www.youtube.com/watch?v=4X6-aA5OK84&ab_channel=SemiconductorAcademy

[5] Peak Detector Circuit Explained:

https://www.youtube.com/watch?v=w4531AVjBYY&ab_channel=ALLABOUTELECTRONICS