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High Gain, Wide Bandwidth and Optimal Swing op-amp in CMOS Technology

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Abstract— Nowadays, opera	ational amplifiers (op-amps) are w	idely used in numerous advanced e	lectronic systems. Most of
op-amps need a high gain, w	vide bandwidth, and an optimal sw	ing. However, meeting these require	ements all at the same time
has been a challenging proble	em for analogue circuits designers.	For different systems, many various	structures have been used,
and each has improved one o	f features of the amplifier in some	way. In the present study, attempted	was made to reach the best
conditions for gain, bandwid	th, and swing through appropriate	parametric models. Of course, it is	considered that the rest of
circuit conditions do not unde	ergo undesirable changes and get th	ne best values [1].	

Keywords- CMOS Technology, op-amp, CMFB Circuit

I. INTRODUCTION

Amplifiers with more than one stage are those that provide the designer with high swing and high gain; however, one of the most important problems of such amplifiers is their low speed and lack of stability required for the circuit. The method used for parameterization is based on a two-stage, high-gain, optimal-swing, and wide-bandwidth amplifier design. Such a method is different from former ones in type of parameterization, voltage selection, and reliance on obtaining measures of integer values. In this paper, three new approaches to the integrated circuit operational amplifier designs have been discussed under conditions of high gain, wide bandwidth, and optimal swing in the CMOS. These conditions, of course, can only be realized when the parameters' values could be changed in COMS devices, and it is achieved when the devices are properly biased in design modes.

For the first approach, form of the computations are given in terms of equations relevant to this method. By using such relations, specifications of the input stage transistors (including PMOS transistors that have a common architecture) were accurately calculated. However, for the second approach, a new architecture is also proposed in the stages design by which 0.18 micrometer data has been calculated in CMOS technology under conditions of desirable feed and the most appropriate threshold voltages. The third approach is also obtained homogenously and in appropriate compliance with an parameterization. Amplifying structure designed in the is of two-stage amplifiers, and the compensation method was used to solve problems of instability and low speed. Such compensation is

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of a hybrid type and was adopted from [2]. Circuit performance in the stimulation results is confirmed by HSPICE software.

From the perspective of analogue systems, an op-amp amplifier should have the following structural conditions:

- 1. The input resistance should be infinite,
- 2. The output resistance should be zero,
- 3. Open-loop voltage gain should be infinite,
- 4. Bandwidth should be infinite,
- 5. While voltage difference in the input is zero, the output voltage should also be zero, and,
- 6. Characteristic curve should not change with temperature.

These are desirable conditions that the design should try to enhance.

II. ANALYSIS

In the present research, gain, bandwidth, and swing were specifically studied; meanwhile, some other parameters were also considered. For example, it has been attempted to have the least power consumption. To have a high gain, wide bandwidth, and an optimal swing op-amp, using a twostage voltage amplifier is one the best existing structures. Cascode method was also used to enhance the gain and POMS input was prioritized. For the second stage, in compliance with the above-mentioned design which is the basis of the parameterization in this paper, a common source amplifier was used [2, 3]. Given the previous works in this field and review of the existing references, the best structural model is shown in Fig 1.



Fig 1. Structure of an op-amp in CMOS technology with a high gain and wide bandwidth.

To analyze ac, small signal equivalent circuit could be used as shown in Fig 2.



Fig 2. Small signal model. For the amplifier shown in Fig 2, the gain is given through the following relation:

(1)

$$Gain = g_{m1}(g_{m2} + \frac{1}{R_c}) \times \frac{g_{m2}g_{m4}}{d_0}$$

The parameters in 1 are as follows:

(2) $R_{c} = r_{ds7} \parallel \frac{g_{m2}r_{ds2}(r_{ds1} \parallel r_{ds6})}{1 + g_{m3}r_{ds3}}$ (3) $d_{0} = \frac{g_{m2}g_{m3}}{R_{L}R_{B}}$ (4) $R_{B} = g_{m2}r_{ds2}(r_{ds1} \parallel r_{ds6}) \parallel g_{m3}r_{ds3}r_{ds7}$ (5) $R_{L} = (r_{ds4} \parallel r_{ds5})$

By adjusting the above parameters, we improved gain value for the amplifier. In designing the amplifying circuit, frequency response should also be considered; therefore, by



conducting relevant analyses, the amount and location of the pole and circuit zeros can be calculated via:

$$(6) \\ S_{p1} = -\frac{1}{g_{m4}C_mR_LR_B} \\ (7) \\ S_{p2} \cong -\frac{4g_{m2}g_{m3}}{C_m(g_{m2}+g_{m3})} \\ (8) \\ |S_{p3,4}| = \sqrt{\frac{g_{m4}(g_{m2}+g_{m3})}{C_BC_L}} \\ (9) \\ S_{z1} = -\frac{2g_{m3}}{C_m} \\ (10) \\ S_{z2,3} \approx \pm \sqrt{\frac{2g_{m2}g_{m4}}{C_mC_B}}$$

In the above relations, values of C_m and C_B are:

(11)

$$C_m = 2C_a = 2C_s$$

(12)
 $C_B = C_{db2} + C_{db3} + C_{gs4} + C_{gd2} + C_{gd2}$

By choosing appropriate values for circuit zeros and poles, the amount of bandwidth and settling time in the circuit could be determined. To reduce the order of voltage amplifying circuit, by equalizing the first zero and the second pole, one order of the system may be reduced and changed into a third order system [4, 5].

By using the above relations, voltage amplifier could be designed, and the intended parameters may be specified. Given that a pole and a zero should neutralize each other, this relation is obtained via

 $g_{m2} = g_{m3}$. By observing such facts and choosing values in Table 1 for circuit transistors, we have values for circuit transistors.

l'a	ble	1.	gm	paramet	ter 1	tor	circuit	transist	ors.
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	gm		gm
M1b وM1b	5.6	M4a e M4b	25
M2b و M2b	0.54	M5a g M5b	21
M3a g M3b	0.64	M6a 9 M6b	6.1
M7a و M7b	0.62	M8	7.7

To design circuit transistors, relevant formulas could be used; however, by using Gm-Ic design method, values mentioned above could be easily designed with high accuracy. Table 2. sizes for transistors.

	W(µm)	L(nm)		W(µm)	L(nm)	
وM1a	40	180 m-2	وM4a	60	180	
M1b	-10	100, 11–2	M4b	00	100	
و M2a	5	180	وM5a	60	180 m-2	
M2b	5	100	M5b	00	100, 11-2	
M3a و	30	180	وM6a	50	360	
M3b	50	100	M6b	50	500	
وM7a	70	360	M8	90	180	
M7b	70	500	WIG	,0	100	
	VB1=1.	1 VB2=1.22	VB3=1	VB4=1.3		

It is important to consider transistors' settings at the saturation zone. In addition, because of the priority of parameterization mechanism in this paper, operating points for all transistors are given:

subckt	x1	x1	x1	Х	1			
elemen	t	1:m1a	1:m1b	1:m	2a	1:m2b		
model		0:pch.4	0:pch.4	0:nc	h.8	0:nch.8		
region	Sat	uration	Saturation	Satura	ation	Saturation	l I	
id -	4.825	752593e-04	4 -4.825752	2593e-04	3.57654	8951e-05	3.576548	8951e-05
ibs	5.005	269911e-2	0 5.005269	9911e-20 -	4.88702	6304e-21 -	4.88702	6305e-21
ibd	1.977	7675101e-1	6 1.97767	5101e-16	-1.28949	94600e-17 -	1.28949	4600e-17
vgs	-6.20	6872742e-0	1 -6.20687	'2742e-01	5.48571	15938e-01	5.48571	5938e-01
vds	-8.49	2588680e-0	01 -8.49258	38680e-01	1.25337	71009e-01	1.25337	71010e-01
vbs	0.	0.	0.	0.				
vth	-5.06	1574777e-0	1 -5.06157	'4777e-01	5.18431	19979e-01	5.18431	.9979e-01
vdsat	-1.31	6178287e-	01 -1.3161	78287e-01	7.5850	33532e-02	7.5850	33531e-02
vod	-1.14	5297965e-0	01 -1.14529	97965e-01	3.0139	59595e-02	3.01395	59594e-02
beta	4.47	6408730e-0	2 4.47640	8730e-02	1.60856	53650e-02	1.60856	63650e-02
gam ef	f 6.7	'61707306e	-01 6.7617	707306e-0	1 9.667	809240e-0	1 9.6678	809240e-0
gm	5.64	0295191e-(03 5.64029	95191e-03	5.41932	23881e-04	5.41932	23881e-04
gds	1.09	7008850e-0	4 1.09700	8850e-04	6.34554	14486e-05	6.34554	4480e-05
gmb	1.87	78677258e-	03 1.8786	77258e-03	1.5877	'30862e-04	1.5877	30862e-04
cdtot	8.29	8385626e-	14 8.29838	35626e-14	5.75319	90737e-15	5.75319	90737e-15
cgtot	1.31	5513144e-:	1.31551	l3144e-13	7.67308	87529e-15	7.67308	37529e-15
cstot	1.83	5163766e-1	3 1.83516	3766e-13	9.47294	43571e-15	9.47294	3571e-15
cbtot	1.59	6907257e-:	1.59690)7257e-13	9.88833	31504e-15	9.88833	31504e-15
cgs	9.797	7284182e-1	4 9.79728	4182e-14	4.73882	9563e-15	4.73882	9563e-15
cgd	2.59	8244435e-1	4 2.59824	4435e-14	1.84612	26900e-15	1.84612	26900e-15

subckt	x1	x1	x1	X	1			
elemen	t	1:m3a	1:m3b	1:m6	6a	1:m6b		
model		0:pch.4	0:pch.4	0:nch	1.4	0:nch.4		
region	Sat	uration	Saturation	Satura	tion	Saturation	1	
id -	3.576	548833e-0	5 -3.5765488	33e-05 5	5.18340	7511e-04	5.183407511e-04	
ibs	3.735	5023691e-2	1 3.7350236	92e-21 -0	5.88761	3840e-20 -	6.887613840e-20	
ibd	5.65	4445644e-1	7 5.6544456	44e-17 -	7.93036	59770e-14 ·	7.930369772e-14	
vgs	-5.13	9482974e-0	01 -5.1394829	974e-01	5.9676	55072e-01	5.967655072e-01	
vds	-7.17	1827902e-0	01 -7.1718279	902e-01	6.7142	84062e-01	6.714284062e-01	
vbs	0.	0.	0.	0.				
vth ·	-5.06	7495087e-0	01 -5.0674950)87e-01	4.91470	06578e-01	4.914706578e-01	
vdsat	-7.4	34601071e-	02 -7.434601	072e-02	1.2675	542813e-01	1.267542813e-01	
vod	-7.19	8788667e-0	03 -7.198788	668e-03	1.0529	48494e-01	1.052948494e-01	
beta	1.69	2370096e-0	02 1.6923700)96e-02	6.41357	77115e-02	6.413577115e-02	
gam ef	f 6.7	761706737e	-01 6.76170	6737e-01	1 5.884	063276e-0	1 5.884063276e-01	L
gm	6.46	9830135e-0	04 6.4698301	135e-04	6.1798	66280e-03	6.179866280e-03	
gds	1.16	7943674e-0	05 1.1679436	674e-05	6.98842	24102e-05	6.988424102e-05	
gmb	2.1	68025579e-	04 2.168025	579e-04	1.7192	205166e-03	1.719205166e-03	
cdtot	3.18	35882712e-	14 3.185882	712e-14	6.6357	33185e-14	6.635733185e-14	
cgtot	3.99	1703455e-1	14 3.9917034	455e-14	1.3539	82059e-13	1.353982059e-13	
cstot	5.47	6295098e-1	.4 5.4762950)98e-14	1.83756	67281e-13	1.837567281e-13	
cbtot	6.04	5047860e-1	14 6.0450478	360e-14	1.4385	58747e-13	1.438558747e-13	
cgs	2.40	4878005e-1	4 2.4048780	05e-14	1.06247	79017e-13	1.062479017e-13	
cod	9 76	5894719e-1	5 9 7658947	719e-15	1 8282	18637e-14	1 828218637e-14	



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and the state of t				_				
SUDCKU 2	XI	XI .	X1	х х	<u>a</u>			
element	1:m/a	1	.:m/b	1:m	8	1:m4a		
model	0:pch.	4 0	:pch.4	0:pc	h.4	0:nch.4		
region	Saturation	n Sati	uration	Satura	ation	Saturation	L	
id -3.	57654891	9e-05 -3.	576548	919e-05 -	9.651505	5249e-04	5.30578092	7e-03
ibs 4.	03245391	9e-21 4.	032453	920e-21	9.897147	7131e-20 -	6.30807439	7e-19
ibd 1	41842601	2e-16_1	418426	5012e-16	1 67101	5263e-16 -	1 25430492	4e-15
V08 -5	0000000	00e-01 -5	00000	0000e-01	-7 00000	0000e-01	7 9676550	71e-01
vde .2	8605170	260-01-0	86051	70266-01	-2 70312	72580.01	5 0715100	080.01
vus 2	0	0		/0200 01	2.15512	72500 01	5.5715150	000 01
vus	7204407	U.	72044	07140 01	E 0072E	04110 01	E 1270762	7.01
Vui -4	0.0050170	146-01 -4	0.0050	07146-01	-3.06723	04116-01	1 7005020	022-01
vasat -	8.2353170	134e-02 -	8.2333.	17034e-02	-1.8042	68345e-01	1.7985020	122e-01
vod -2	2.7055928	63e-02 -2	2.70559	2863e-02	-1.91274	19589e-01	2.8296787	84e-01
beta 1	5316079	62e-02 1	53160	7962e-02	4.99064	3855e-02	1.8/282253	31e-01
gam eff	5.516458	303e-01	5.5164	58303e-0	1 6.7617	707857e-0	1 9.619787	714e-01
gm 6	5.2490693	32e-04 6	5.24906	9332e-04	7.72892	6666e-03	2.5021522	22e-02
gds 9	.2760692	50e-06 9	.27606	9250e-06	7.42394	4109e-04	1.23762064	16e-03
gmb	2.0718925	86e-04	2.07189	92586e-04	2.62952	25505e-03	7.0866166	24e-03
cdtot 1	1 1271780	71e-13 1	1 12717	8071e-13	1 05582	6556e-13	5 9120486	76e-14
cgtot 1	5666783	00e-13 1	56667	8300e-13	1 52887	0026e-13	1 0739605	71e-13
cstot 2	2815101	50e.13 2	28151	0159e-13	2 12219	0331e-13	1 3307020	21e-13
chtot 2	3880856	14e-13 2	38808	5614e-13	1 00310	4267e-13	1 0700834	70e-13
	11228611	12012 1	11228	5014C-15	1 16858	08700 13	7 72550586	8 1/
cgs I	.11336011	14014	11330	22240 14	2.06152	60290-14	2 1001220	D1014
cga 2		246-14 2		55246-14	2.90152	00286-14	2.1901550	516-14
subckt	x1	x	1	x1				
subckt elemer	x1 ht 1	m4b	1	x1 1:m5a	1	.m2p		
subckt elemen model	x1 nt 1	x m4b nch 4	:1	x1 1:m5a):nch 4	1	:m5b		
subckt elemen model	x1 nt 1 0:	x m4b nch.4	:1 (x1 1:m5a):pch.4	1 0 Sat	:m5b :pch.4		
subckt elemen model region	x1 nt 1 Satur	x m4b nch.4 ration	1 (Sat	x1 1:m5a 0:pch.4 turation	1 0 Sat	:m5b :pch.4 turation	780004	. 0.2
subckt elemen model region id	x1 nt 1 Satur 5.30578	x m4b nch.4 ation 80928e	1 (Sat -03 -5	x1 1:m5a 0:pch.4 turation .30578(1 0 Sat 0923e-0	:m5b :pch.4 turation)3 -5.30	57809246	e-03
subckt elemen model region id ibs	x1 0: Satur 5.30578 -6.3080	x m4b nch.4 ation 80928e 74398e	1 (Sat -03 -5 -19 5	x1 1:m5a 0:pch.4 turation .305780 .460374	1 0 Sat 0923e-0 4263e-1	::m5b :pch.4 turation)3 -5.30 19 5.46	5780924e 0374264e	e-03
subckt elemen model region id ibs ibd	x1 0: Satur 5.30578 -6.3080 -1.2543	x m4b nch.4 ation 80928e 74398e 04849e	1 Sat -03 -5 -19 5 2-15 4	x1 1:m5a 0:pch.4 uration .305780 .460374 4.02536	1 0 Sat 0923e-0 4263e-1 6385e-	.:m5b :pch.4 turation)3 -5.30 19 5.460 13 4.02	5780924e 0374264e 5366498	e-03 e-19 e-13
subckt elemen model region id ibs ibd vgs	x1 0: Satur 5.30578 -6.3080 -1.2543 7.9676	x m4b nch.4 ation 80928e 74398e 04849e 55072e	1 Sat -03 -5 -19 5 2-15 4 e-01 -9	x1 1:m5a 0:pch.4 turation .305780 .460374 4.02536 9.02848	1 0 5at 0923e-0 4263e-1 6385e- 60997e-	2:m5b 2:pch.4 turation 03 -5.305 19 5.460 13 4.02 01 -9.02	5780924e 0374264e 5366498 28480997	e-03 e-19 e-13 e-01
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subckt elemen model region id ibs ibd vgs vds vds vbs	x1 0: Satur 5.30578 -6.3080 -1.2543 7.9676 5.9715 0	x m4b nch.4 ation 30928e 74398e 04849e 55072e 18998	(1 Sat -03 -5 -19 5 -19 4 e-01 -9 e-01 -9	x1 1:m5a 0:pch.4 turation .30578(0 5.460374 4.02536 9.02848 1.20284	1 0 5a 0923e-0 4263e-1 6385e- 6385e- 0997e- 8099e-	1:m5b 1:pch.4 turation 03 -5.309 19 5.460 13 4.02 01 -9.02 +00 -1.20	57809246 03742646 5366498 8480997 02848100	e-03 e-19 e-13 e-01 De+00
subckt elemen model region id ibs ibd vgs vds vds vbs vth	x1 0: Satur 5.30578 -6.3080 -1.2543 7.9676 5.9715 0. 5.1379	x m4b nch.4 vation 80928e 04849e 55072e 18998e 0 76287e	(1 Sat -03 -5 -19 5 -15 4 e-01 -9 e-01 -9	x1 1:m5a 0:pch.4 turation .30578(0 .460374 4.02536 9.02848 1.20284 0. 5.04584	1 0 923e-0 4263e-1 6385e- 0997e- 80997e- 88099e- 8487e-	1:m5b :pch.4 turation 03 -5.309 19 5.460 13 4.02 01 -9.02 +00 -1.20 01 -5.04	57809246 03742646 5366498 8480997 02848100	e-03 e-19 e-13 e-01 De+00 e-01
subckt elemen model region id ibs ibd vgs vds vds vds vth vdsat	x1 0: Satur 5.30578 -6.3080 -1.2543 7.9676 5.9715 0. 5.1379 1.798	x m4b nch.4 ation 80928e 74398e 04849e 55072e 189986 0 76287e 502022	(1 Sat -03 -5 -19 5 e-15 4 e-01 -1 e-01 -1	x1 1:m5a 0:pch.4 turation .305780 .460374 4.02536 9.02848 1.20284 0. 5.04584	1 0 923e-0 4263e-1 6385e- 6385e- 80997e- 8099e- 8487e- 37325e	1:m5b :pch.4 turation)3 -5.30! 19 5.460 13 4.02 01 -9.02 +00 -1.20 01 -5.04 -01 -3.0	57809246 03742646 5366498 8480997 02848100 5848487 523732	e-03 e-19 e-13 e-01 De+00 e-01
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subckt elemen model region id ibs ibd vgs vds vbs vth vdsat vod	x1 0: Satur 5.30578 -6.3080 -1.2543 7.9676 5.9715 0. 5.1379 1.798 2.8296	x m4b nch.4 ation 30928e 74398e 04849e 55072e 18998 0 76287e 502022 578785	() Sat -03 -5 -19 5 -19 -1 -19 -1 -19 5 -19 5 -1	x1 1:m5a 0:pch.4 turation .305780 .460374 4.02536 9.02848 1.20284 0. 5.04584 -3.0352 3.98265	1 0 923e-0 4263e-1 6385e- 0997e- 8099e-1 8487e- 37325e 32510e-	1:m5b :pch.4 turation 03 -5.309 19 5.466 13 4.02 01 -9.02 +00 -1.2 01 -5.04 -01 -3.08 -01 -3.08	57809246 03742640 5366498 8480997 02848100 5848487 3523732 82632510	e-03 e-19 e-13 e-01 De+00 e-01 5e-01 De-01
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To analyze the theory, first we assigned a power value to stage FOLDED CASCODE, (for example, 10 MW). Now, it could be said that the whole DC current can flow through transistors M6a and M6b. As a result, power consumption could be calculated via:

(13) $\mathbf{p} = \mathbf{V}\mathbf{D}\mathbf{D} \times (\mathbf{I}_{M6a} + \mathbf{I}_{M6b})$

Transistors M6a and M6b are similar, thus their currents are equal. Therefore, the current for each is almost 2.8 MA, and we considered 1.4 MA as the current for the rest of the transistors. Now, differential output swing 2V should be taken into account, which results in relation 14: (14)

$$\max swing = 2\begin{bmatrix} VDD - (VOD_{M6a} + VOD_{M2a}) \\ + |VOD_{M3a}| + |VOD_{M7a}| \end{bmatrix}$$

$$VOD_{M6a} + VOD_{M2a} + |VOD_{M3a}| + |VOD_{M7a}| = 0.8v$$

We consider the effective voltages for POMS transistors 0.25 V, because their mobility is low; also, transistor M6a has a higher effective voltage, since under such conditions its

current is larger than 0.18 V. As a result, the effective voltage for transistor M2a will be 0.12 V. for the ratio of length to width of transistors PMOS and NMOS, we have:

$$\binom{(15)}{\binom{W}{L}_{n}} = \frac{2I_{D}}{\mu_{n}C_{ox}(V_{GS} - V_{th})^{2}}$$

(16)

$$\left(\frac{W}{L}\right)_{p} = \frac{2I_{D}}{\mu_{p}C_{ox}(V_{GS} - V_{th})^{2}}$$

Consider

$$\mu_n C_{ox} = 150 \frac{\mu A}{V^2}$$
 and $\mu_p C_{ox} = 50 \frac{\mu A}{V^2}$, then

$$\left(\frac{W}{L}\right)_{M6a} = 1152$$

(18)

$$\left(\frac{W}{L}\right)_{M2a} = 1296$$

$$\left(\frac{W}{L}\right)_{M1a} = 1296$$

$$\left(\frac{W}{L}\right)_{M3a} = 896$$

$$(\frac{W}{L})_{M7a} = 896$$

The design is based on the obtained values and attempt was made to have round non-decimal numbers so that better results would be yielded. However, it should be noted that channel length modulation was not taken into account and SPICE provided a more accurate model for stimulation. By using SPICE and changing the length and width, the output optimal values are given. Variables and parameters measured are all based on the existing mathematical models and inspired by the best references in the field of analogue studies.



Application of CMFB circuit

For this entirely differential structure, two CMFB circuits were used to increase circuit speed [6, 7]. Such circuits apply output sample and adjust voltages shown in Fig 1 to obtain the best matching. Circuit model for the ideal CMFB is shown in Fig 3.



Fig 3. Circuit CMFB.

III. STIMULATION RESULTS FOR THE

OPERATIONAL AMPLIFIER (OP-AMP) UNDER

DESIRABLE CONDITIONS

To stimulate the circuit (see Fig. 1), HSPICE software and 0.18 Micrometer library of CMOS were used. Stimulation results for ac voltage amplifier are shown in Fig 4. To obtain the gain, we considered the input 1 V by using the software method; as a result, the output became equal to op-amp gain. Value of gain in this amplifier is 72 DB. When the gain is to be 0 Db, bandwidth is given in MHz. Thus, bandwidth for the designed amplifier is 526 MHz. Phase margin is 75°. Given that the result of the gain multiplied by the bandwidth is a constant, the increased gain results in bandwidth reduction. Therefore, it is important to select parameters properly to have all desirable conditions [8, 9].



Fig 4. Stimulation results for ac operational amplifier.

SR calculation

To calculate SR, we the differential amplifier of two-step voltages (with the highest changes in input) with a range from about 20 to 50 MV in the amplifier inputs so that the largest changes are given in the differential output. To obtain negative SR, we apply the input voltages inversely. Fig 5. and Fig 6. show values obtained for positive and negative SR:







Fig 6. Negative SR value.

To have an appropriate amount of output voltage swing, the two-stage structure should be used. Swing value for the circuit output is shown in Fig 7. To obtain the value of the swing, first we should put the op-amp in the open-loop state, and very low amplitude and frequency should be applied to the input. The initial value in which the output is distorted indicates maximum swing in the output. In other words, we apply sinusoidal signal in the input and we will have it amplified in the output. We increase input amplitude to the extent that the signal starts to cut off in the output [9]. For the amplifier, power consumption is 20 MW.



Fig 7. Swing value for circuit output of op-amp in the differential state.

IV. RESULT

Engineers expect to reach the optimal results at the qualitative level of a circuit with respect to different parameters. Gain, bandwidth, and swing are three principles for designing such circuits, which can ultimately yield optimal results. By taking some steps in this regard, practical desirable results are certainly obtained .In this paper, we parametrically improved an op-amp that has been designed by using structures of two-stage amplifiers and relying on compensation methods of circuits. For the two-stage operational amplifier with differential model based on the CASCODE design, we adjusted the parameters to reach an appropriate gain, a desirable swing, and a wide bandwidth, which are the most important specifications of operational amplifiers. In addition, in the process, attempt was made to considerably reduce power consumption.

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