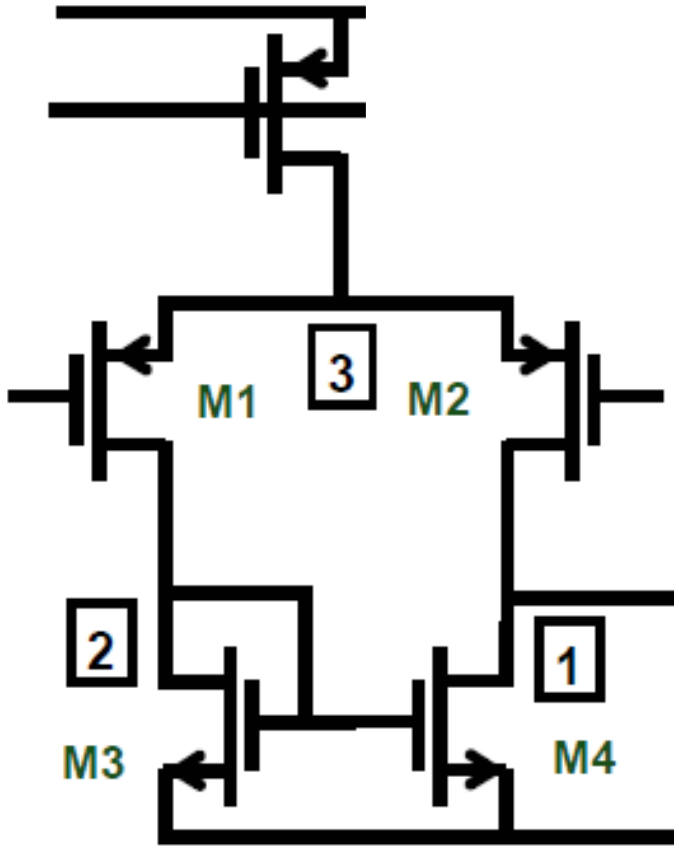
Homework 4

课后作业

- 对一偏置电流为100uA的五管OTA，共模电压为0.9V，设计晶体管的尺寸，
  1. 使其在单位增益负反馈时系统性失调小于**0.1mV**；
  2. 使其随机性失调的标准差（std）小于**1mV**；
  3. 使其共模抑制比大于 **50dB**。



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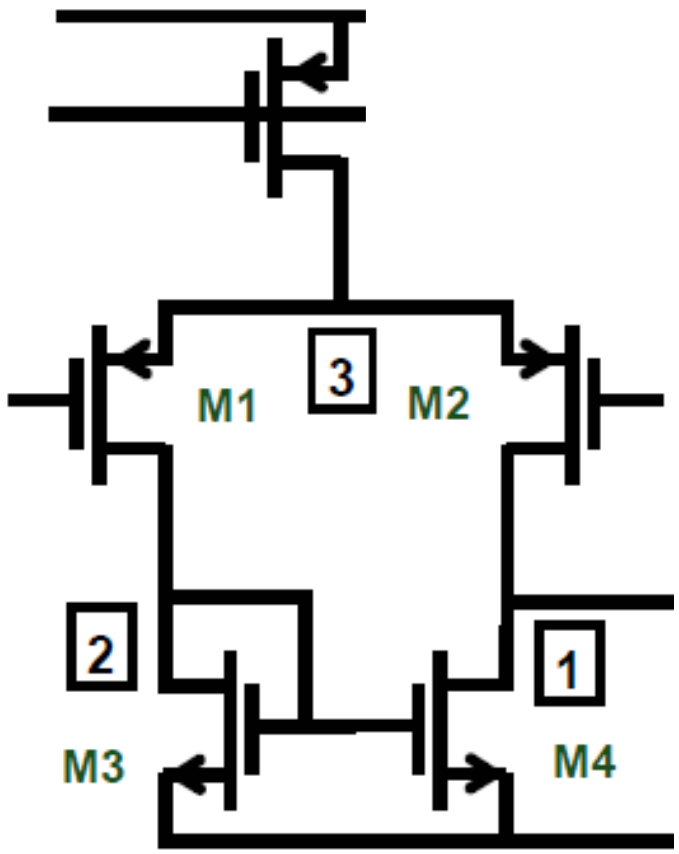
  1. 使其在单位增益负反馈时系统性失调小于**0.1mV**；

消除系统性失调 ➡ $V_2=V_1=0.9V$

$$V_{GST3,4} = 500mV$$

$$\left(\frac{W}{L}\right)_{3,4} = 1.4:1$$

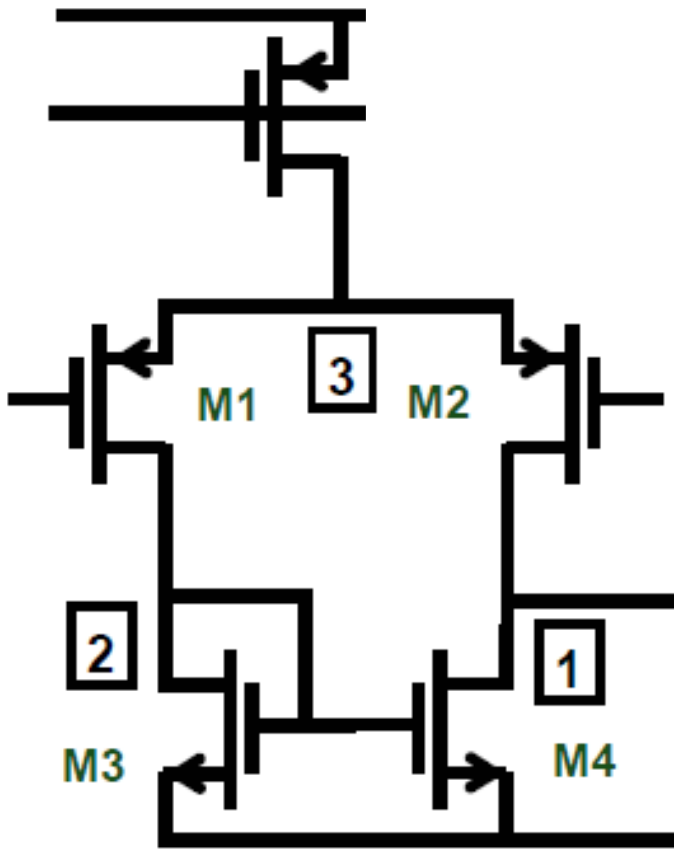


课后作业

- 对一偏置电流为100uA的五管OTA，共模电压为0.9V，设计晶体管的尺寸，
  2. 使其随机性失调的标准差（std）小于 **1mV**；

$$V_{OS} = \Delta V_{T1} + \frac{g_{m3}}{g_{m1}}\Delta V_{T3} + \frac{V_{GST1}}{2}S$$

$$S = \frac{\Delta W/L_1}{W/L_1} + \frac{\Delta W/L_3}{W/L_3}$$



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$$V_{OS} = \Delta V_{T1} + \frac{g_{m3}}{g_{m1}}\Delta V_{T3} + \frac{V_{GST1}}{2}S$$

$$S = \frac{\Delta W/L_1}{W/L_1} + \frac{\Delta W/L_3}{W/L_3}$$

$$\sigma_{\Delta VT} = \frac{A_{VT}}{\sqrt{WL}}$$ ← 2 (mV*um)

$$\frac{\Delta W/L}{W/L} = A_{WL}\sqrt{\frac{1}{W^2} + \frac{1}{L^2}}$$

1.8 (%*um)

+50 % for pMOST

1. 将S项忽略　　**2. 令gm1=gm3，简化设计**

课后作业

- 使其随机性失调的标准差（std）小于**1mV**；

  考虑差分对，考虑正态分布

$$\sigma_{\Delta VT} = \frac{A_{VT}}{\sqrt{WL}}$$ ← 2 (mV*um)

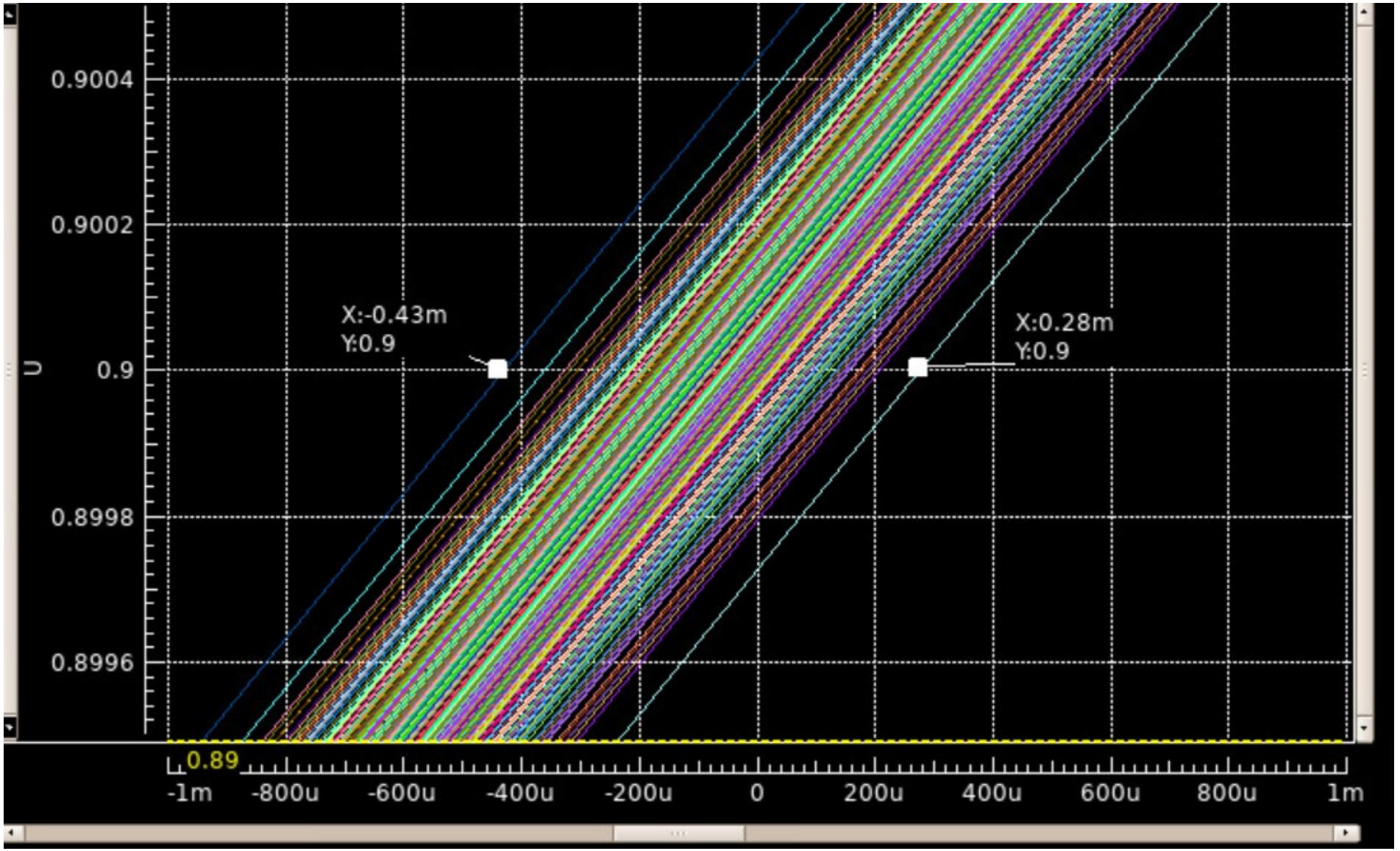
$$\sigma V_{T1} = \sigma V_{T3} = 0.5mV$$

$$WL_3 = 16um^2$$

$$WL_1 = 36um^2$$

$$\left(\frac{W}{L}\right)_{3,4} = \frac{4.7u}{3.4u} \qquad \left(\frac{W}{L}\right)_{1,2} = \frac{36u}{1u}$$

仿真结果


0.9004
0.9002
0.9
0.8998
0.8996
U
X:-0.43m
Y:0.9
X:0.28m
Y:0.9
0.89
-1m
-800u
-600u
-400u
-200u
0
200u
400u
600u
800u
1m

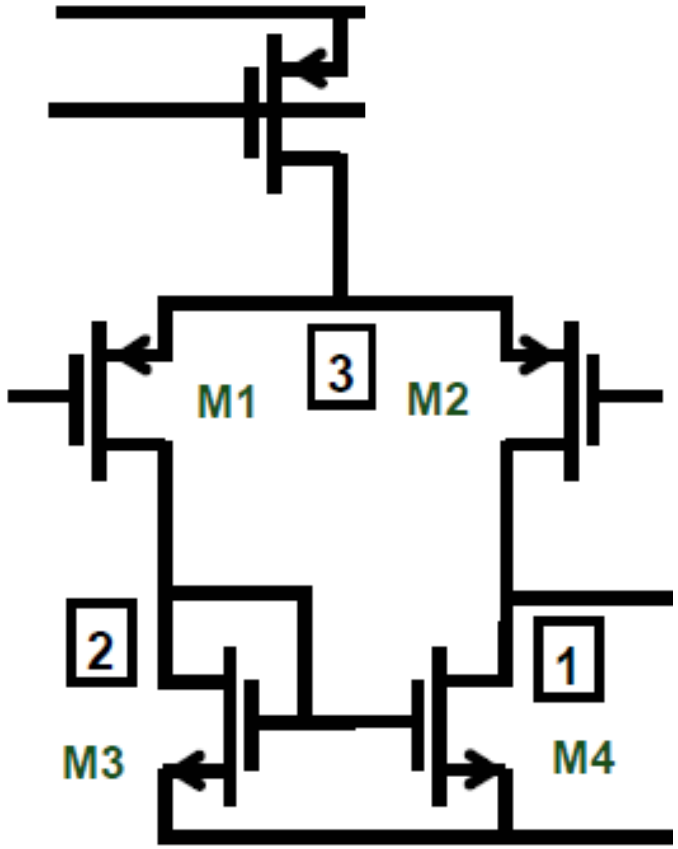
课后作业

- 对一偏置电流为100uA的五管OTA，共模电压为0.9V，设计晶体管的尺寸，
  3. 使其共模抑制比大于 **50dB**。

$$CMRR_s = 2g_{m1}g_{m3}R_B \cdot (r_{02}||r_{04})$$

$$g_{m1} = 635u, \quad g_{m3} = 208u,$$
$$g_{ds2} = 1.89u, \quad g_{ds4} = 0.85u$$

$$R_B > \sim 3K\Omega$$



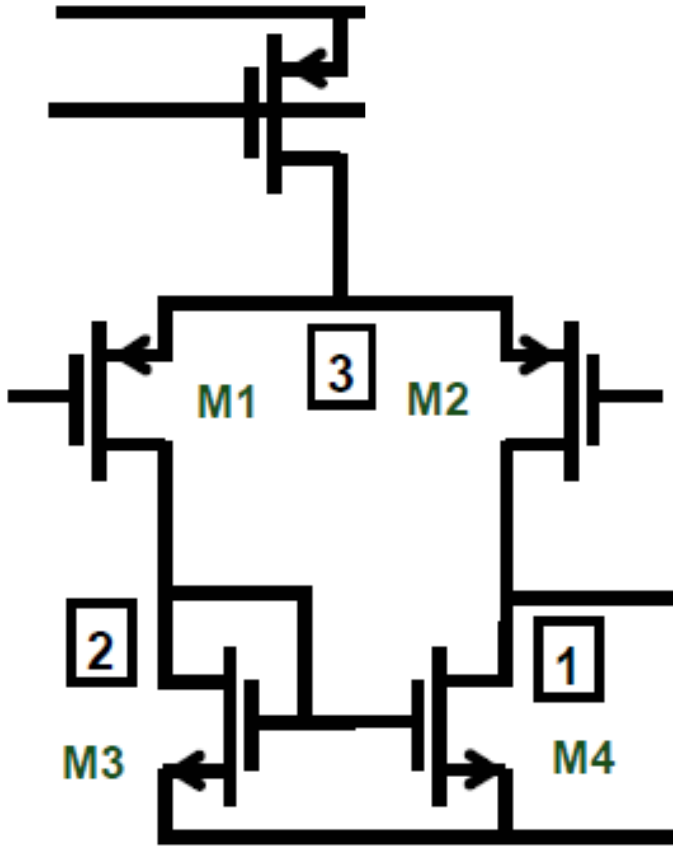
课后作业

- 对一偏置电流为100uA的五管OTA，共模电压为0.9V，设计晶体管的尺寸，

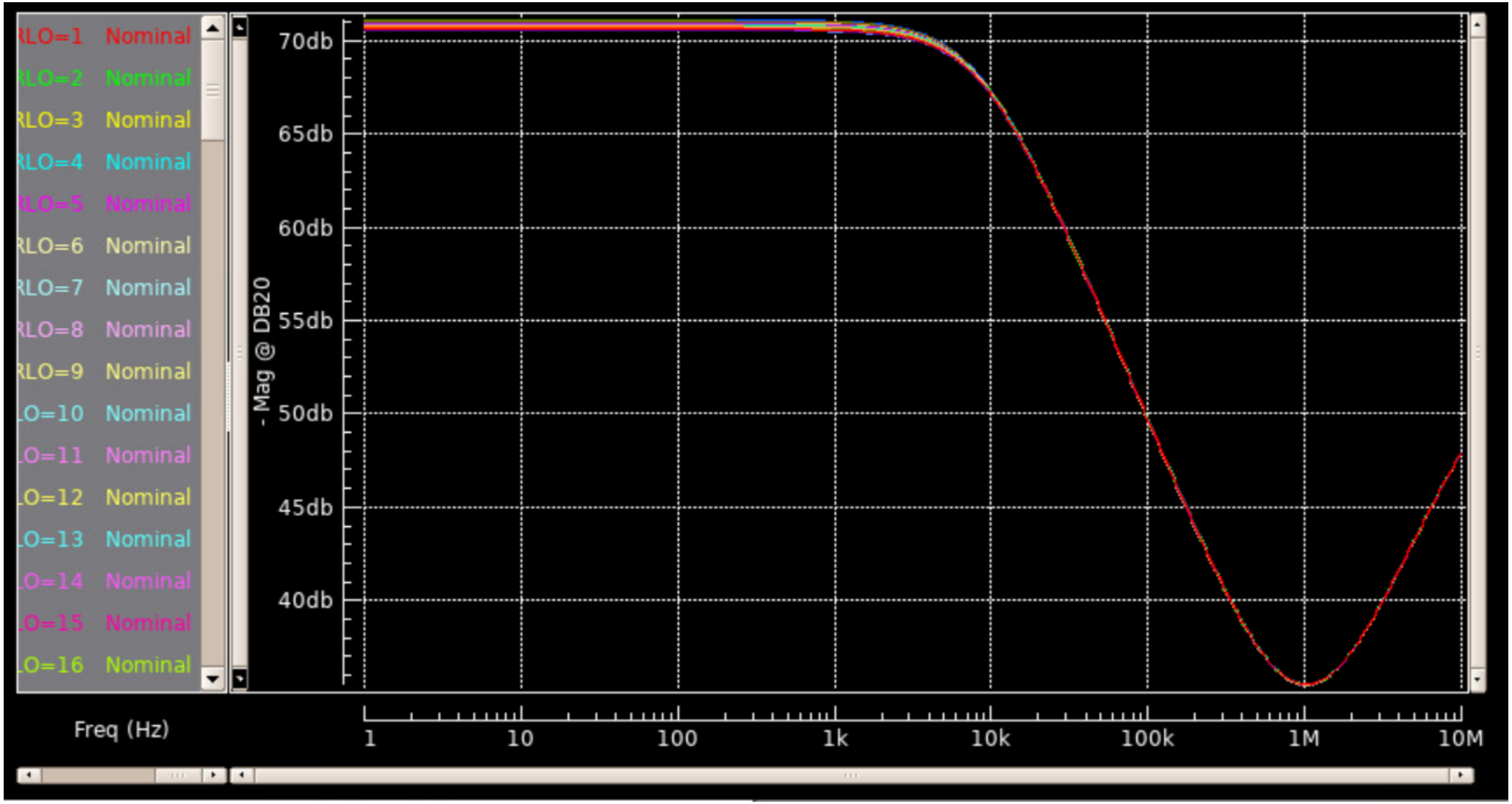
  3. 使其共模抑制比大于 **50dB**。

$$CMRR_r = \frac{V_E L_B}{V_{OS}}$$

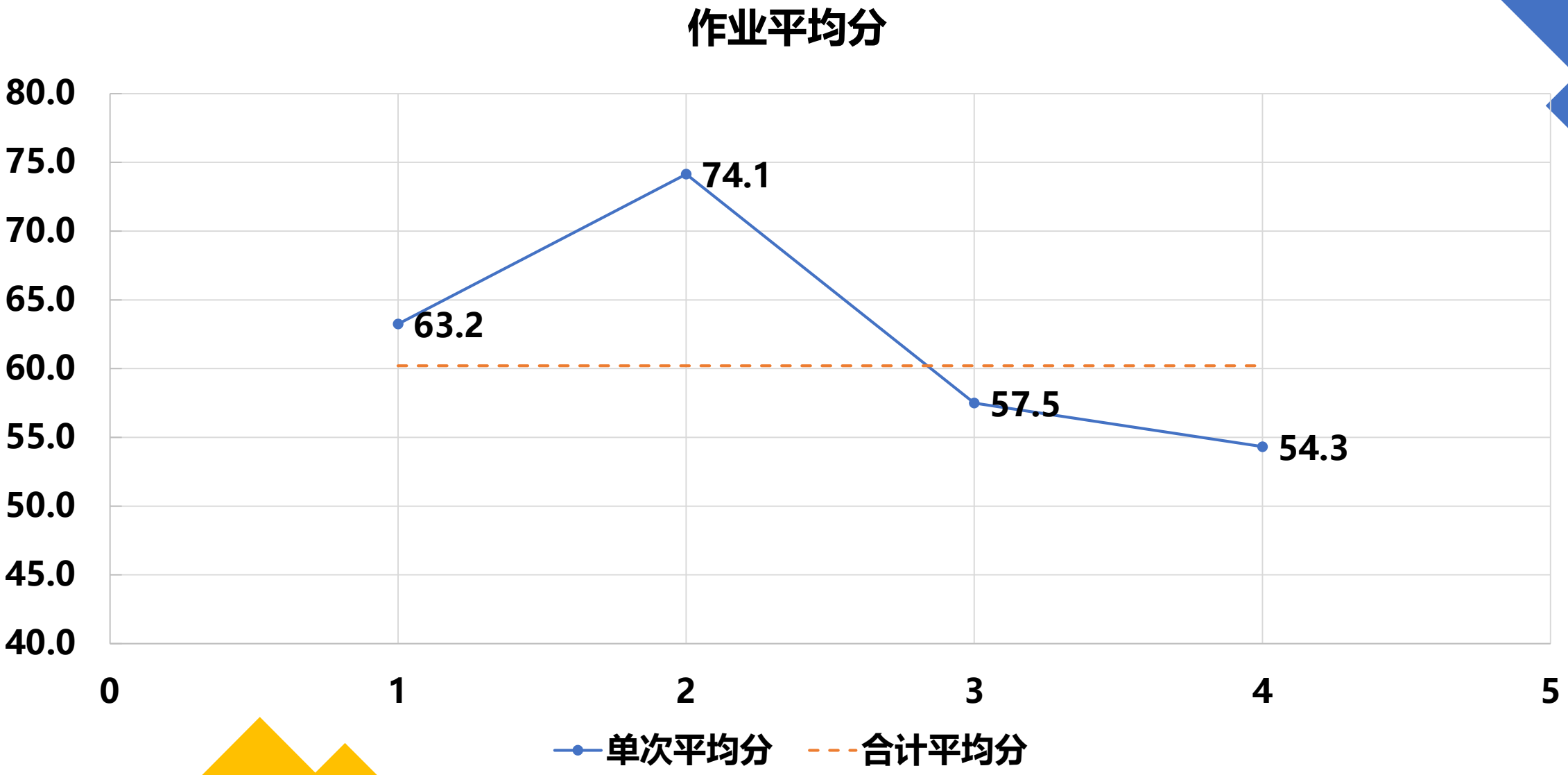
$$L_B > \sim 10nm$$

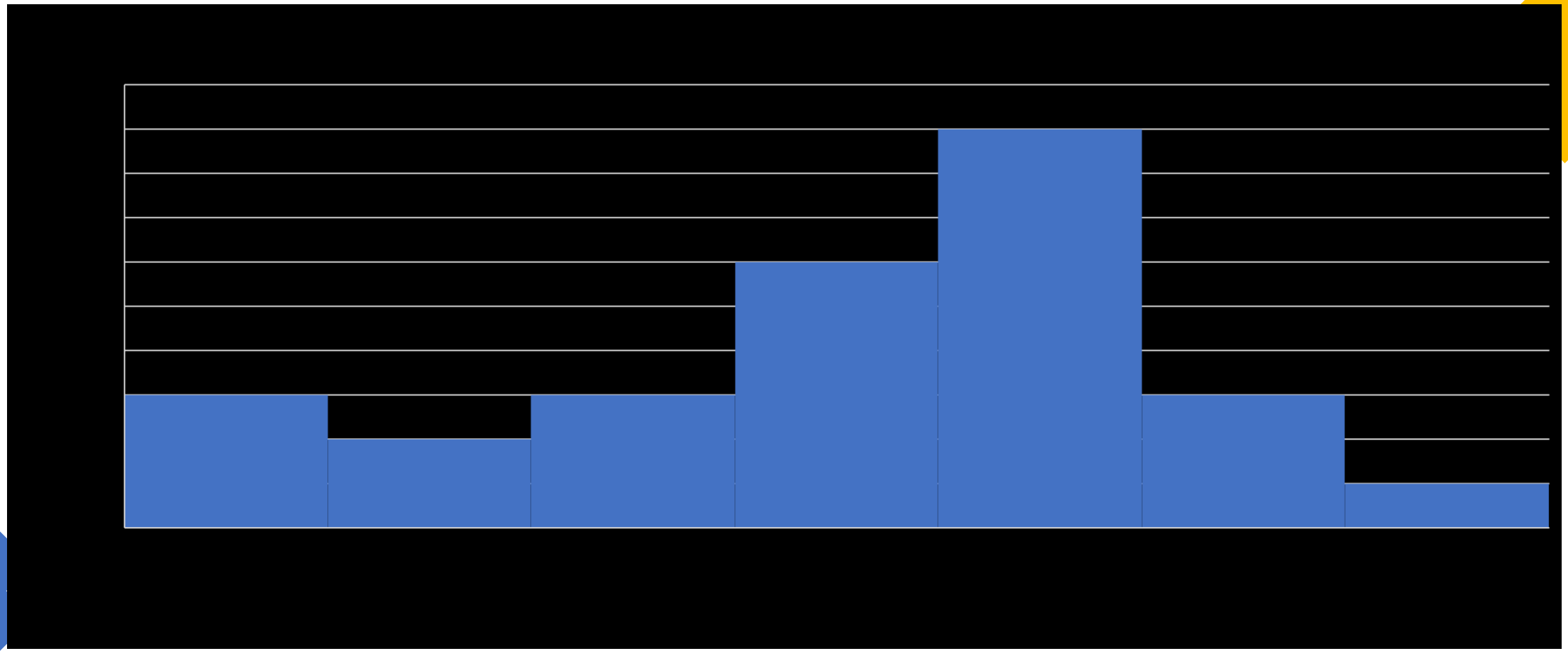


仿真结果


RLO=1 Nominal
RLO=2 Nominal
RLO=3 Nominal
RLO=4 Nominal
RLO=5 Nominal
RLO=6 Nominal
RLO=7 Nominal
RLO=8 Nominal
RLO=9 Nominal
LO=10 Nominal
LO=11 Nominal
LO=12 Nominal
LO=13 Nominal
LO=14 Nominal
LO=15 Nominal
LO=16 Nominal
70db
65db
60db
55db
50db
45db
40db
- Mag @ DB20
Freq (Hz)
1
10
100
1k
10k
100k
1M
10M

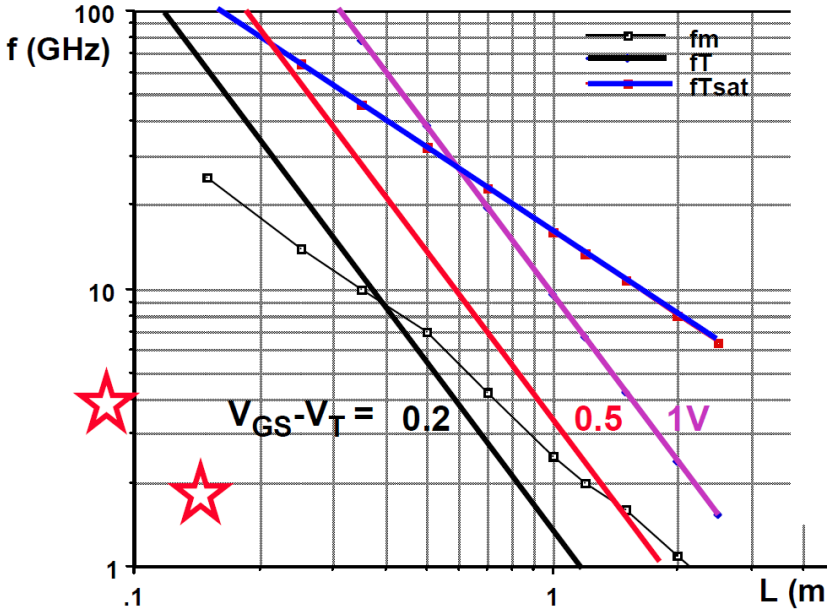
Homework Analysis 1-4


作业平均分
80.0
75.0
70.0
65.0
60.0
55.0
50.0
45.0
40.0
0
1
2
3
4
5
74.1
63.2
57.5
54.3
单次平均分
合计平均分



Homework 5

- **已知要求GBW=50MHz，CL=5pF。设计一相位裕度大于70°的米勒运放。通过仿真结果，给出该设计运放的：**
  1. **FOM**
  2. **相位裕度**
  3. **输入等效总噪声**



1. 选择 α β γ
2. 找到满足GBW最小的f_T
3. 根据增益要求选择L_6
   - 得到f_{TH6}
4. 根据C_L和L_6计算W_6

- 2 3 **3**
- f_T=1.2GHz
- L_6=0.2um

  f_{TH6}=30GHz => **i=0.04**
- **W_6=375um**

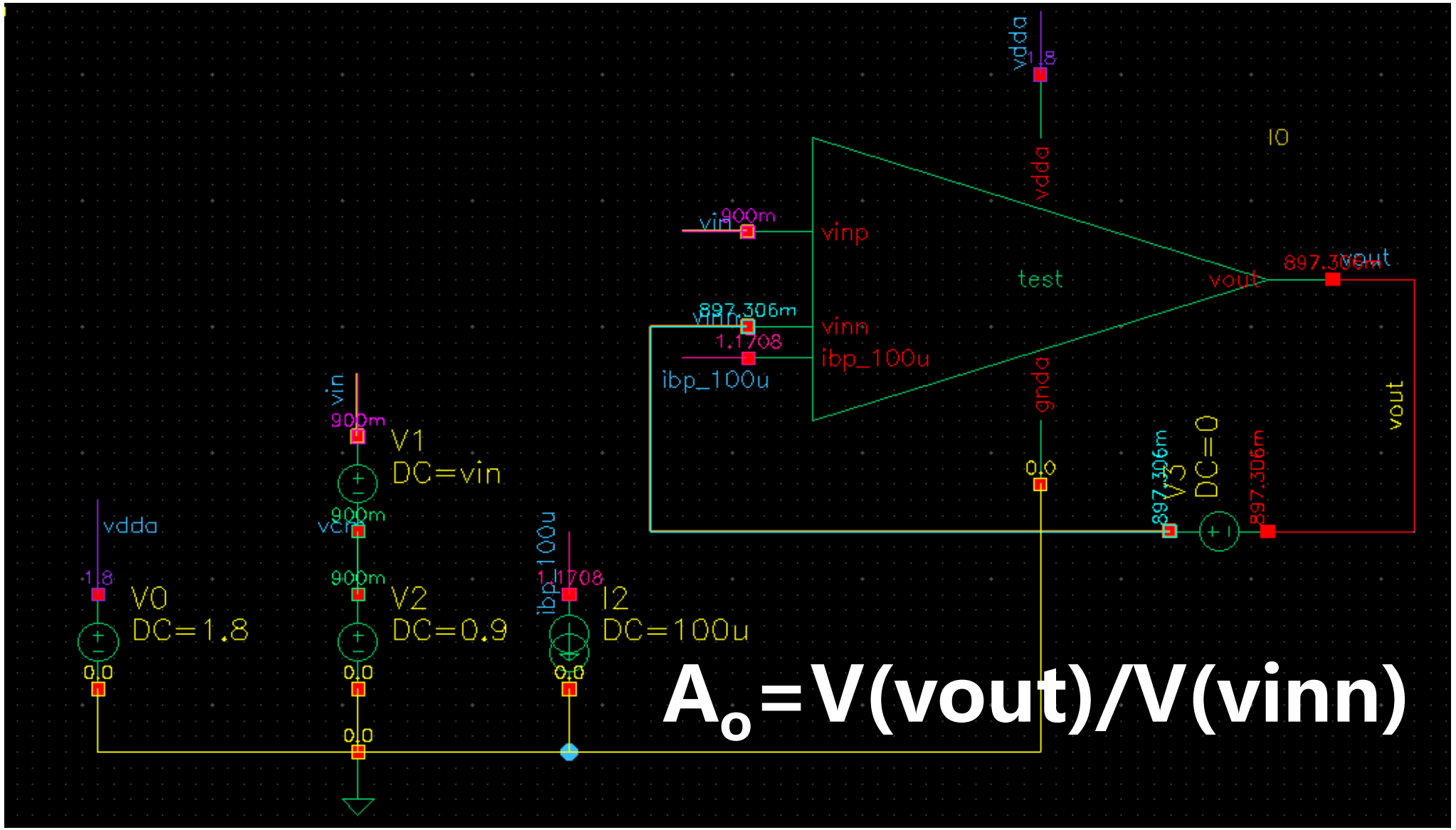
C_{GS}=2kW, k = 2fF/um, for minL

- **已知要求GBW=50MHz，CL=5pF。设计一相位裕度大于70°的米勒运放。通过仿真结果，给出该设计运放的：**
  1. **FOM**
  2. **相位裕度**
  3. **输入等效总噪声**

5. 根据I_{DSH6}和反型系数i计算I_{DS6}
   - KP_n=280uA/V^2
6. 通过选择的 α 和C_L计算C_C
7. 通过C_C计算g_{m1}和I_{DS1}

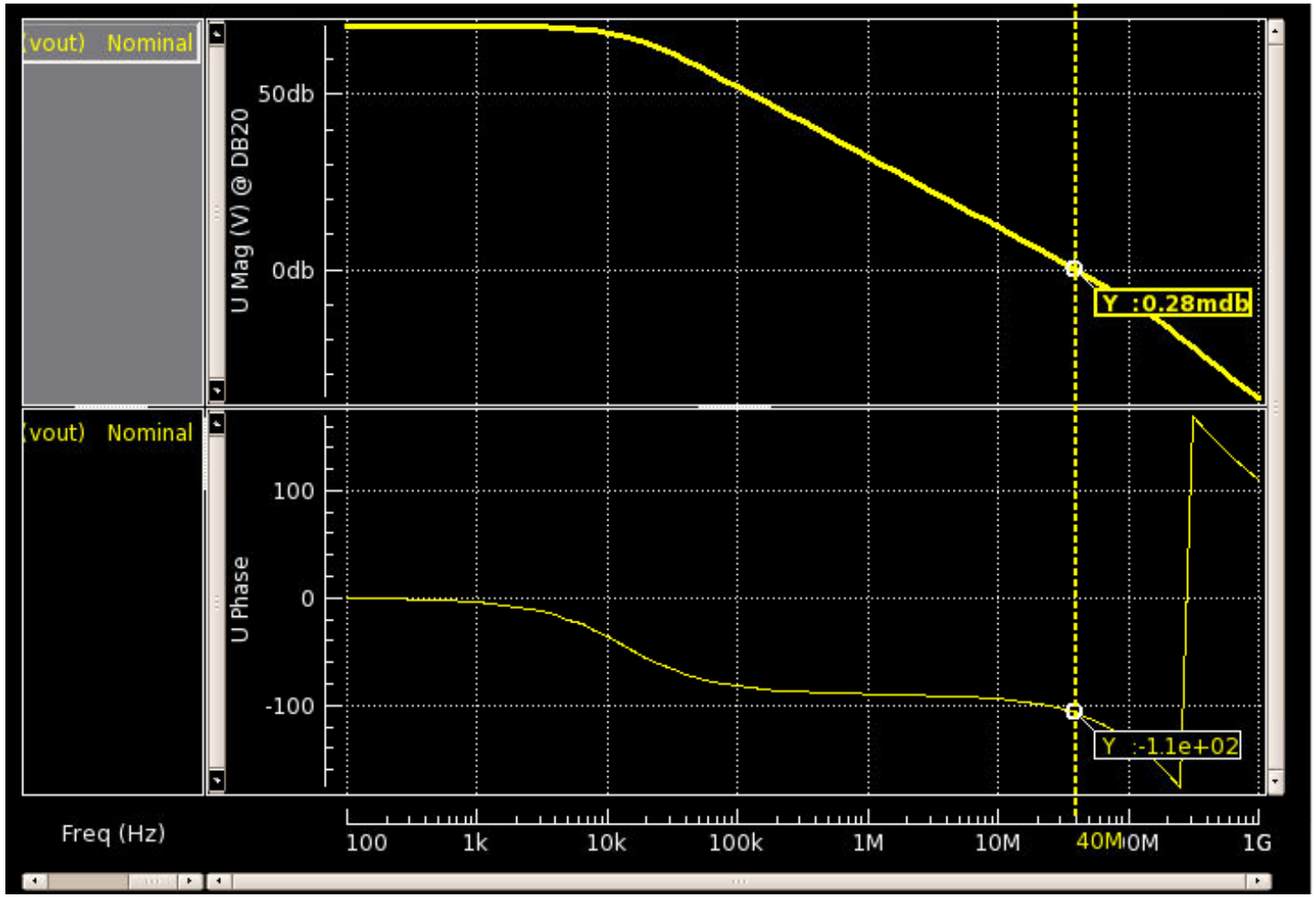
- I_{DSH6}=10.5mA
- I_{DS6}=10.5m*0.04=**420uA**
- C_C=2.5pF
- g_{m1}=785u
- I_{DS1}=**78.5uA**
- W1/L1=**28u/0.5u**

Loop Gain仿真


vdda
1.8
I0
vinp
900m
vin
test
vout
897.306m
vinn
1.1708
ibp_100u
gnda
0.0
V3
DC=0
V1
DC=vin
V0
DC=1.8
V2
DC=0.9
I2
DC=100u
$A_o = V(vout)/V(vinn)$

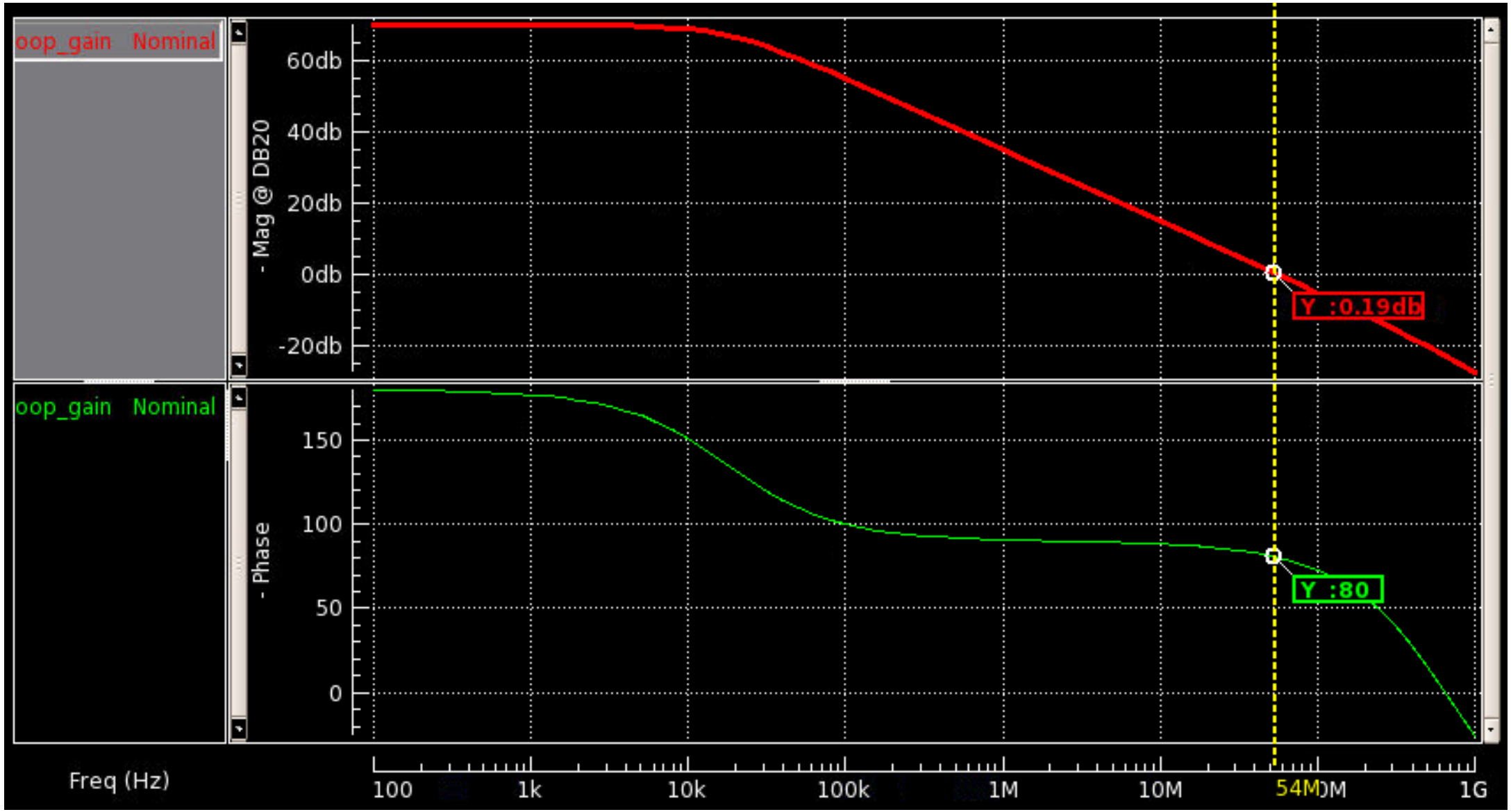
仿真结果

[PM0]
region = Saturati
id = -78.1278u
ibs = 5.6807e-20
ibd = 14.4282a
vgs = -639.5856m
vds = -879.1882m
vbs = 0.0000
vth = -443.6520m
vdsat = -193.9362m
vod = -195.9335m
gm = 702.9307u
gds = 3.8089u
gmb = 224.1048u
cdtot = 34.9319f
cgtot = 108.1365f
cstot = 134.3769f
cbtot = 83.6754f
cgs = 89.2852f
cgd = 11.7448f
i1 = -78.1278u
i2 = 0.0000
i3 = 78.1278u
i4 = 879.2027f



[NM2]
region = Cutoff
id = 406.0396u
ibs = -2.6970e-19
ibd = -289.8949p
vgs = 421.6335m
vds = 920.4203m
vbs = 0.0000
vth = 473.4460m
vdsat = 54.1268m
vod = -51.8125m
gm = 8.8316m
gds = 170.2431u
gmb = 2.3050m
cdtot = 338.3632f
cgtot = 488.4598f
cstot = 515.2213f
cbtot = 629.1785f
cgs = 221.5820f
cgd = 137.2870f
i1 = 406.0399u
i2 = 0.0000
i3 = -406.0396u
i4 = -312.9054p

仿真结果


oop_gain Nominal
60db
40db
20db
0db
-20db
- Mag @ DB20
Y :0.19db
oop_gain Nominal
150
100
50
0
- Phase
Y :80
Freq (Hz)
100
1k
10k
100k
1M
10M
54M
1G