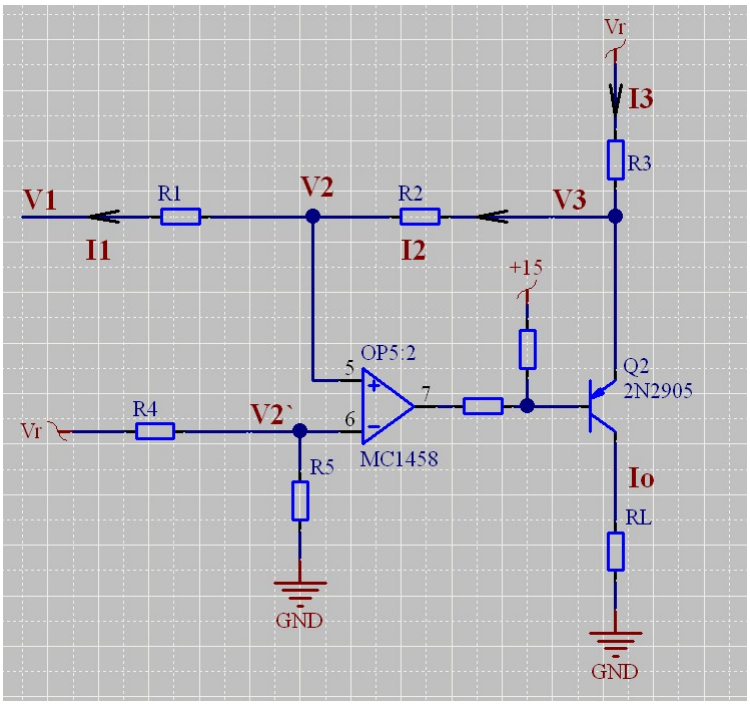
VI 变换电路分析

V/I 变换电路如图：



设 $I_0 \approx I_3$ ， 虚地 $V2 = V2`$

电路电量关系：

$$I_0 = \frac{1}{R3}\left[\frac{R2}{R1}V1 - \frac{R1+R2}{R1}V2 + Vr\right] = \frac{1}{R3}\left[\frac{R2}{R1}V1 - \frac{R1+R2}{R1}\frac{R5}{R4+R5}Vr + Vr\right]$$

输入 V1、输出 I_0 关系：

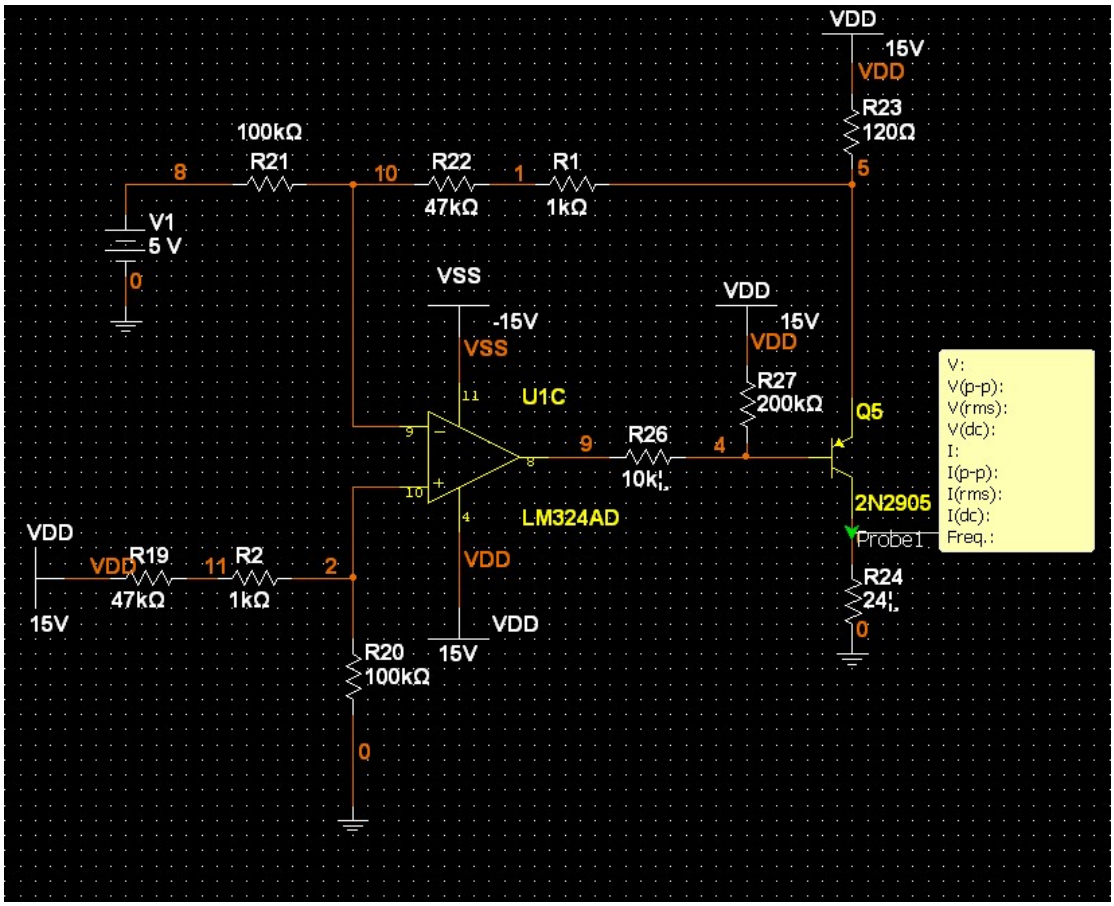
$$I_0 = \frac{1}{R3}\left\{\frac{R2}{R1}V1 + \left(1 - \frac{R1+R2}{R1}\bullet\frac{R5}{R4+R5}\right)Vr\right\}$$

0-5V 转换 0-20mA

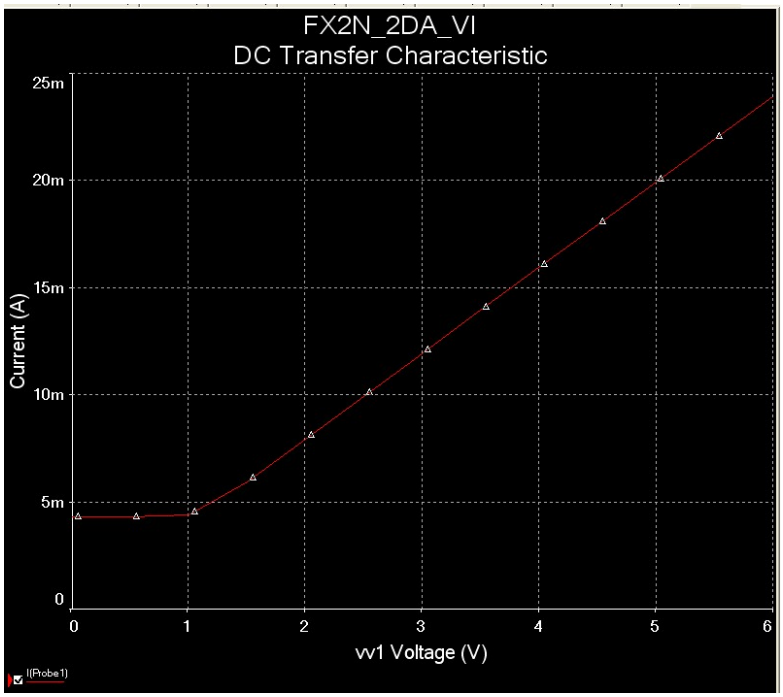
令 $\frac{R1+R2}{R1}\bullet\frac{R5}{R4+R5} = 1$

消去 Vr，有： $I_0 = \frac{1}{R3}\bullet\frac{R2}{R1}V1$

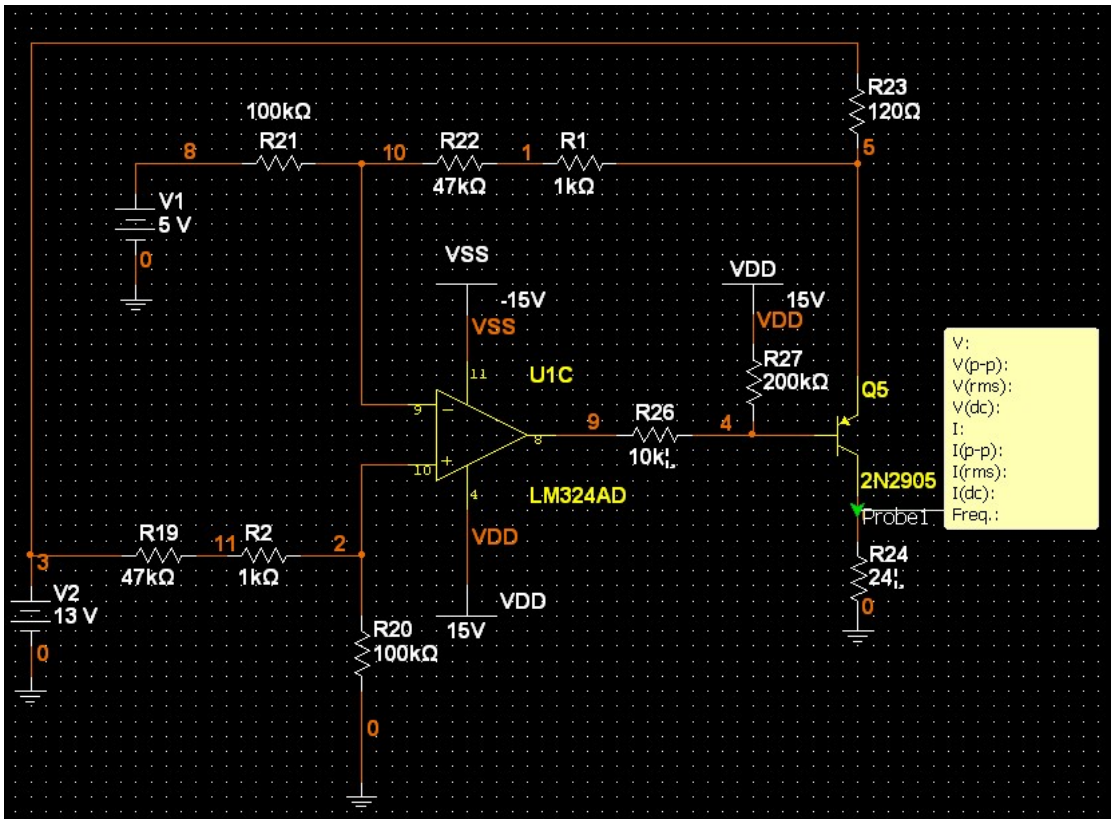
设 R3=120R, V1=5V, I_0=20mA, $\frac{R2}{R1} = \frac{R3I_0}{V1} = \frac{0.12\times 20}{5} = 0.48$ ，取 R1=100K, R2=48K.

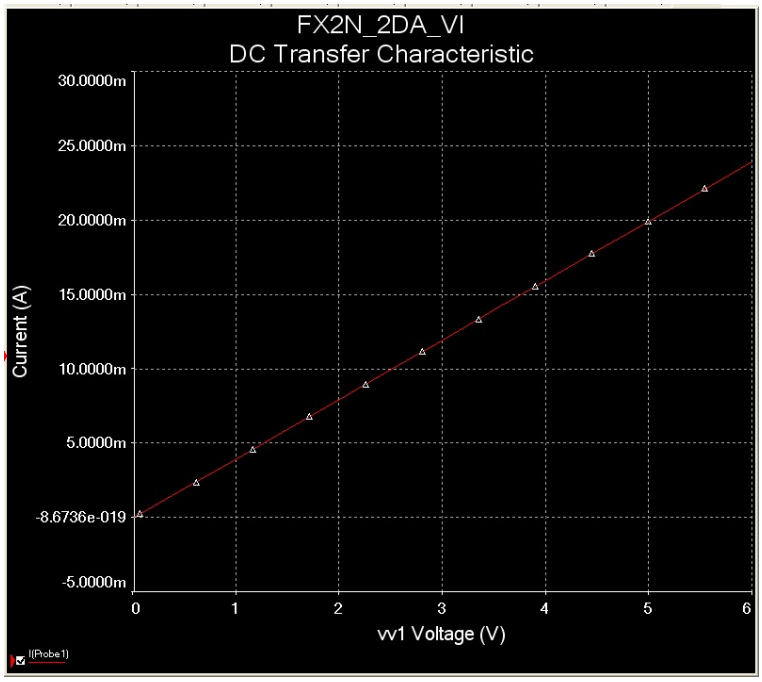

VDD
15V
VDD
R23
120Ω
100kΩ
R21
8
10
R22
47kΩ
1
R1
1kΩ
5
V1
5 V
0
VSS
-15V
VSS
VDD
15V
VDD
U1C
11
R27
200kΩ
Q5
9
R26
10kΩ
4
LM324AD
2N2905
Probe1
V:
V(p-p):
V(rms):
V(dc):
I:
I(p-p):
I(rms):
I(dc):
Freq.:
VDD
15V
VDD
R19
47kΩ
11
R2
1kΩ
2
VDD
R24
24Ω
0
VDD
15V
R20
100kΩ
0

运放饱和效应。


FX2N_2DA_VI
DC Transfer Characteristic
25m
20m
15m
10m
5m
0
Current (A)
0
1
2
3
4
5
6
vv1 Voltage (V)
I(Probe1)

减少运放饱和效应，降低 Vr。





0-5V 转换 4-20mA

输入 V1、输出 I_0 关系：

$$I_0 = \frac{1}{R3}\left\{\frac{R2}{R1}V1 + \left(1 - \frac{R1+R2}{R1}\bullet\frac{R5}{R4+R5}\right)Vr\right\}$$

设 Vr=13V，R3=120R,：

$$4 = \frac{1}{0.12}\left(1 - \frac{R1+R2}{R1}\bullet\frac{R5}{R4+R5}\right)\times 13 \qquad (1)$$

$$20 = \frac{1}{0.12}\left\{\frac{5R2}{R1} + \left(1 - \frac{R1+R2}{R1}\bullet\frac{R5}{R4+R5}\right)\times 13\right\} \qquad (2)$$

式(2)-(1): $16 = \frac{1}{0.12}\bullet\frac{5R2}{R1}$

得： $\frac{R2}{R1} = \frac{0.12\times 16}{5} = 0.384$

代入式 (1): $\frac{R1+R2}{R1}\bullet\frac{R5}{R4+R5} = 1 - \frac{0.12}{13}\times 4 = 0.963$

设 R1=100K, R2=38.4K

由 $\frac{R2}{R1} = 0.384$ ， $\frac{R1+R2}{R1}\bullet\frac{R5}{R4+R5} = 0.963$

$\frac{R5}{R4+R5} = 0.963\bullet\frac{100}{100+38.4} = 0.6958$

设 R5=15K，

得： $R4 = \frac{1-0.6958}{0.6958}\times 15 = 6.56K$

取：R1=100K， R2=38.4K，R3=120R， R4=6.56K， R5=15K

0-5V 转换 4-20mAV/I 变换电路如图：