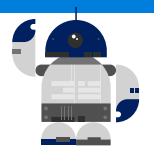
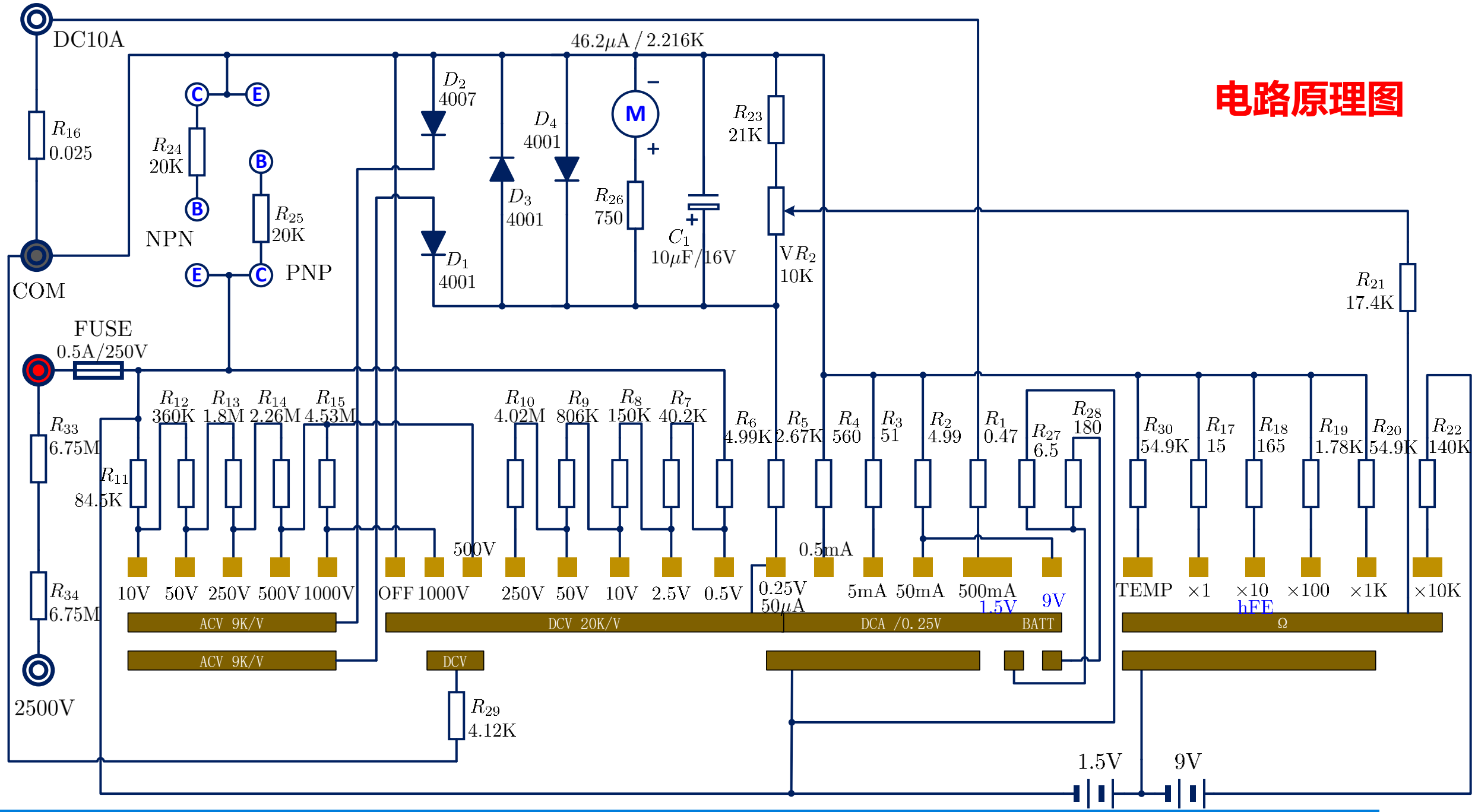
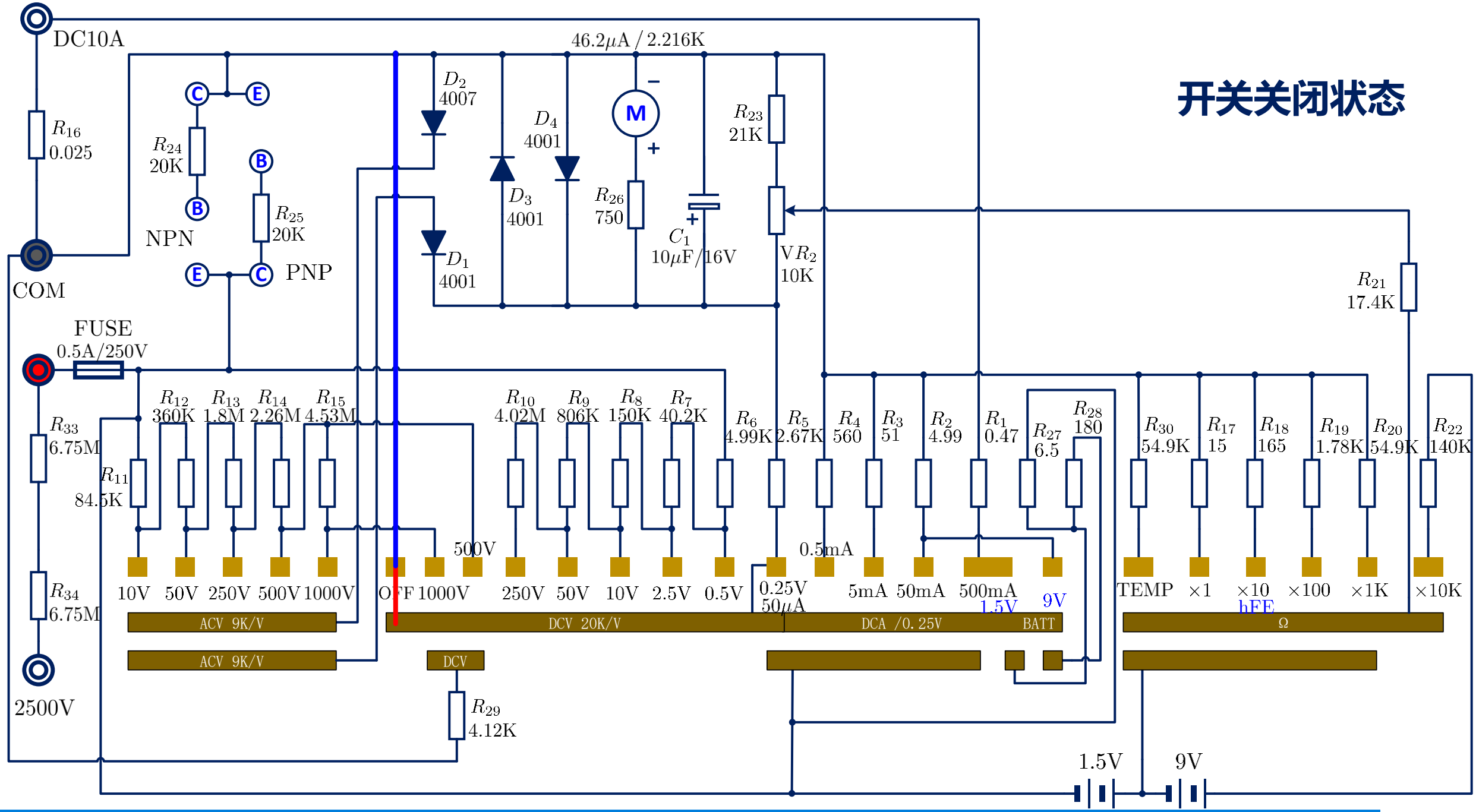
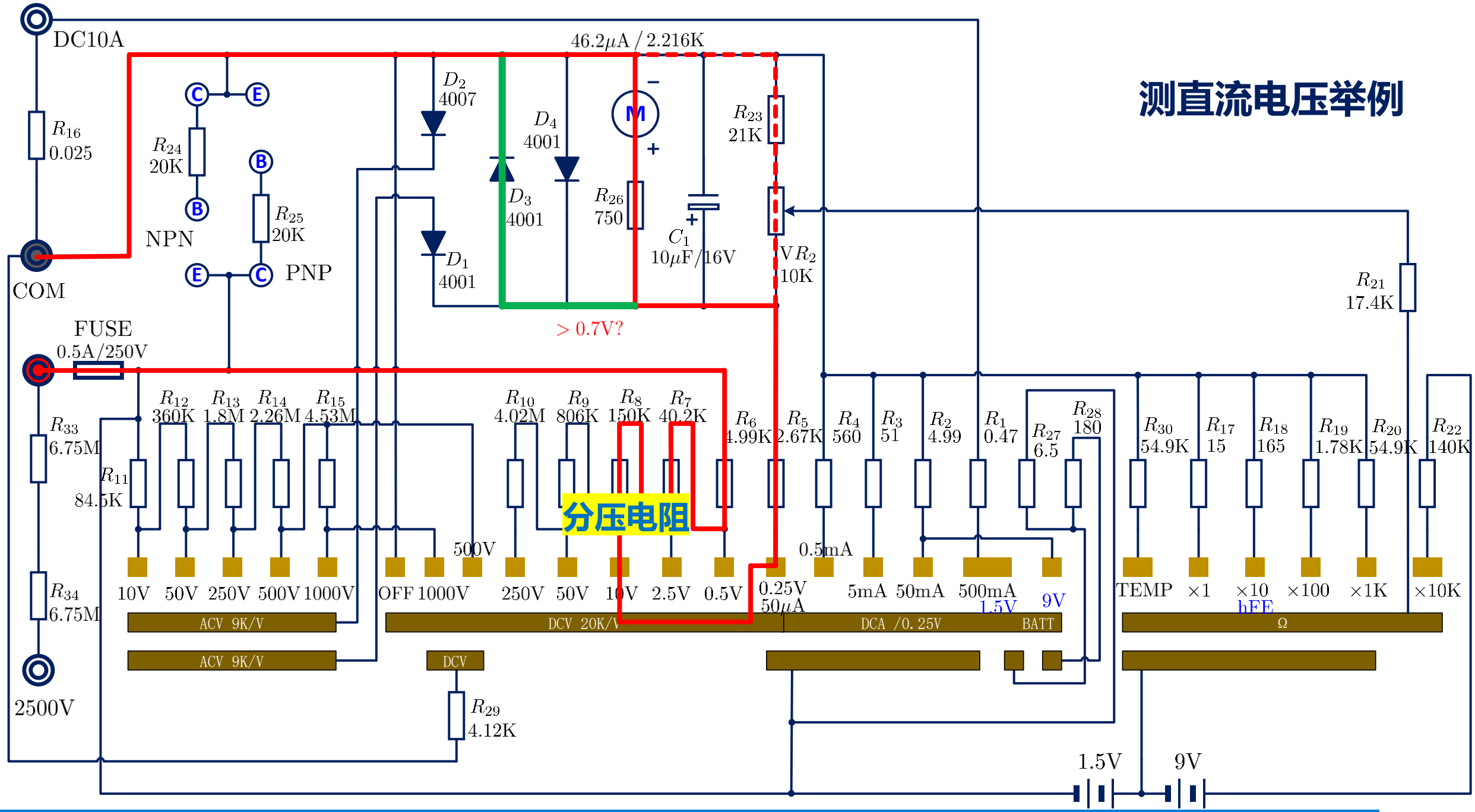


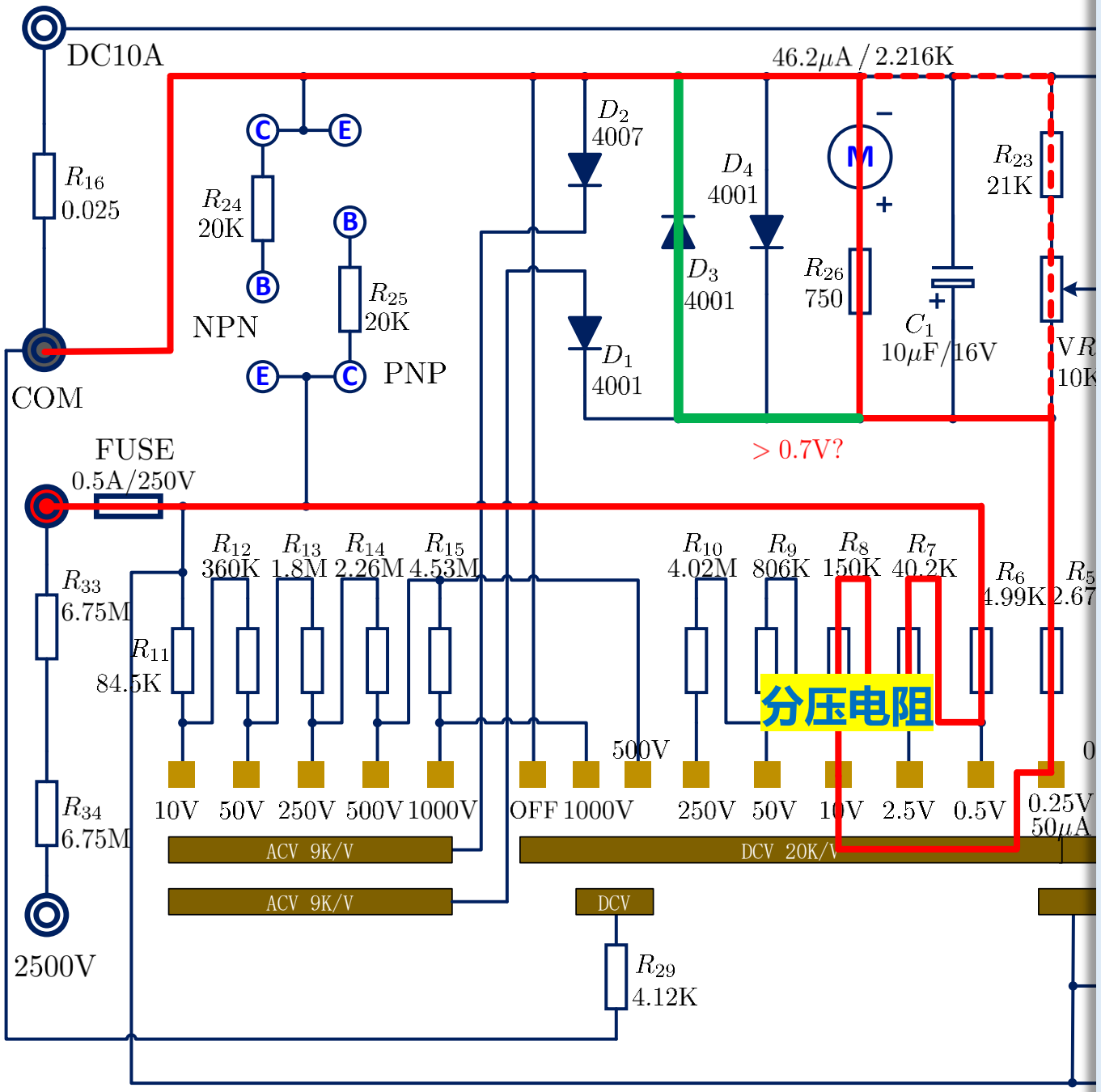
电工实习—基于电路分析

李灿 | 12#503A | lic@jsnu.edu.cn | https://sslic.cn/cs

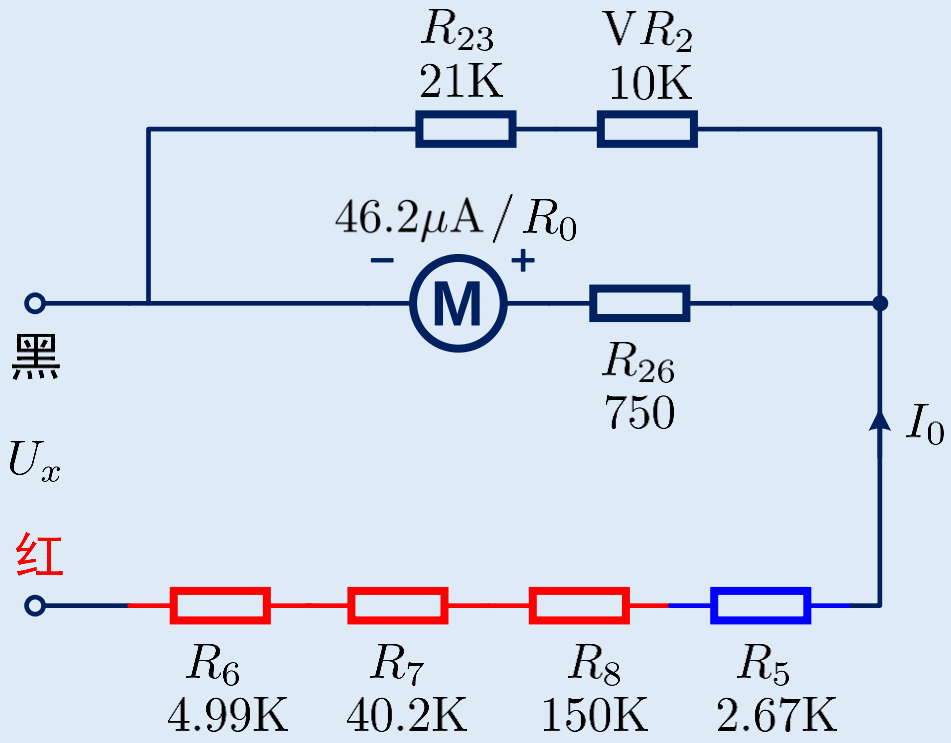

电路原理图
DC10A
46.2μA / 2.216K
R_{16} 0.025
R_{24} 20K
NPN
R_{25} 20K
PNP
D_2 4007
D_4 4001
D_3 4001
D_1 4001
M
R_{26} 750
C_1 10μF/16V
R_{23} 21K
VR$_2$ 10K
R_{21} 17.4K
COM
FUSE 0.5A/250V
R_{33} 6.75M
R_{34} 6.75M
2500V
R_{11} 84.5K
R_{12} 360K
R_{13} 1.8M
R_{14} 2.26M
R_{15} 4.53M
R_{10} 4.02M
R_9 806K
R_8 150K
R_7 40.2K
R_6 4.99K
R_5 2.67K
R_4 560
R_3 51
R_2 4.99
R_1 0.47
R_{27} 6.5
R_{28} 180
R_{30} 54.9K
R_{17} 15
R_{18} 165
R_{19} 1.78K
R_{20} 54.9K
R_{22} 140K
R_{29} 4.12K
10V 50V 250V 500V 1000V
OFF 1000V
500V
250V 50V 10V 2.5V 0.5V
0.25V 50μA
0.5mA
5mA 50mA 500mA
1.5V 9V
TEMP ×1 ×10 ×100 ×1K ×10K
hFE
ACV 9K/V
ACV 9K/V
DCV 20K/V
DCA /0.25V
BATT
Ω
DCV
1.5V
9V


开关关闭状态
DC10A
46.2μA / 2.216K
R_{16} 0.025
R_{24} 20K
R_{25} 20K
NPN
PNP
D_2 4007
D_4 4001
D_3 4001
D_1 4001
M
R_{26} 750
C_1 10μF/16V
R_{23} 21K
VR$_2$ 10K
R_{21} 17.4K
COM
FUSE 0.5A/250V
R_{33} 6.75M
R_{34} 6.75M
2500V
R_{11} 84.5K
R_{12} 360K
R_{13} 1.8M
R_{14} 2.26M
R_{15} 4.53M
R_{10} 4.02M
R_9 806K
R_8 150K
R_7 40.2K
R_6 4.99K
R_5 2.67K
R_4 560
R_3 51
R_2 4.99
R_1 0.47
R_{27} 6.5
R_{28} 180
R_{30} 54.9K
R_{17} 15
R_{18} 165
R_{19} 1.78K
R_{20} 54.9K
R_{22} 140K
R_{29} 4.12K
10V 50V 250V 500V 1000V
OFF 1000V 500V
250V 50V 10V 2.5V 0.5V
0.25V 50μA
0.5mA 5mA 50mA 500mA
1.5V 9V
TEMP ×1 ×10 ×100 ×1K ×10K
hFE
ACV 9K/V
DCV 20K/V
DCA /0.25V
BATT
Ω
ACV 9K/V
DCV
1.5V
9V


测直流电压举例
DC10A
46.2μA / 2.216K
R_{16} 0.025
R_{24} 20K
NPN
R_{25} 20K
PNP
D_2 4007
D_4 4001
D_3 4001
D_1 4001
R_{26} 750
C_1 10μF/16V
R_{23} 21K
VR$_2$ 10K
R_{21} 17.4K
COM
FUSE 0.5A/250V
> 0.7V?
R_{33} 6.75M
R_{34} 6.75M
R_{11} 84.5K
R_{12} 360K
R_{13} 1.8M
R_{14} 2.26M
R_{15} 4.53M
R_{10} 4.02M
R_9 806K
R_8 150K
R_7 40.2K
R_6 4.99K
R_5 2.67K
R_4 560
R_3 51
R_2 4.99
R_1 0.47
R_{27} 6.5
R_{28} 180
R_{30} 54.9K
R_{17} 15
R_{18} 165
R_{19} 1.78K
R_{20} 54.9K
R_{22} 140K
分压电阻
10V 50V 250V 500V 1000V OFF 1000V 500V 250V 50V 10V 2.5V 0.5V 0.25V 50μA 0.5mA 5mA 50mA 500mA 1.5V 9V
TEMP ×1 ×10 hFE ×100 ×1K ×10K
ACV 9K/V
DCV 20K/V
DCA /0.25V
BATT
Ω
ACV 9K/V
DCV
R_{29} 4.12K
2500V
1.5V
9V



测直流电压举例



$$U_x = [R_6 + R_7 + R_8 + R_5 + (R_{26} + R_0) // (R_{23} + \mathrm{VR}_2)]I_0$$

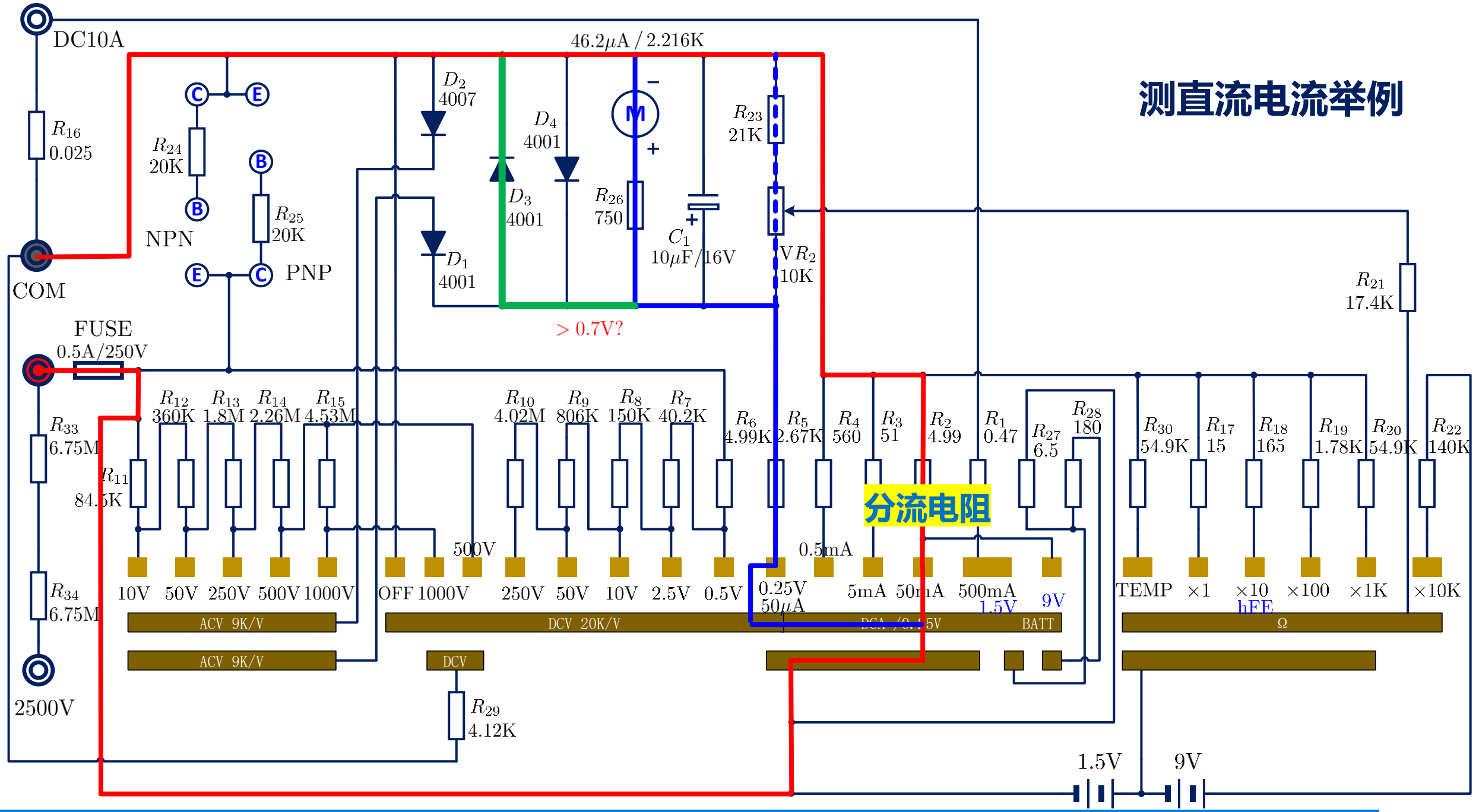
$$I = \frac{R_{23} + \mathrm{VR}_2}{R_{23} + \mathrm{VR}_2 + R_{26} + R_0} I_0$$

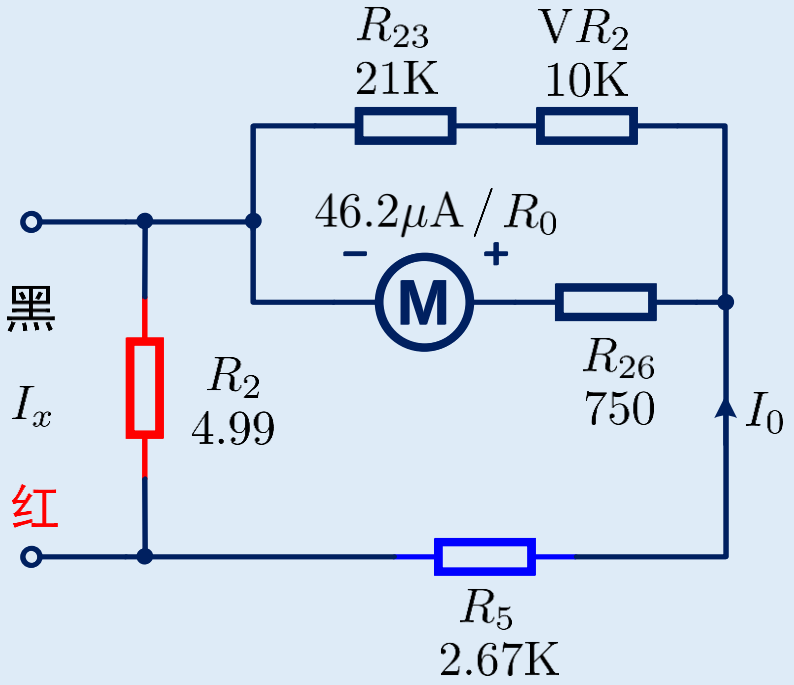
解出 $U_x = f(R_6 + R_7 + R_8)I$

$$U_\mathrm{m} = f(R_6 + R_7 + R_8)I_\mathrm{g}$$

f 单调增

$U_\mathrm{m} = 10\mathrm{V}$ $I_\mathrm{g} = 46.2\mu\mathrm{A}$


测直流电流举例
DC10A
46.2μA / 2.216K
R_{16} 0.025
R_{24} 20K
R_{25} 20K
NPN
PNP
COM
D_2 4007
D_1 4001
D_4 4001
D_3 4001
R_{26} 750
C_1 10μF/16V
R_{23} 21K
VR2 10K
> 0.7V?
FUSE 0.5A/250V
R_{21} 17.4K
R_{33} 6.75M
R_{34} 6.75M
R_{11} 84.5K
R_{12} 360K
R_{13} 1.8M
R_{14} 2.26M
R_{15} 4.53M
R_{10} 4.02M
R_9 806K
R_8 150K
R_7 40.2K
R_6 4.99K
R_5 2.67K
R_4 560
R_3 51
R_2 4.99
R_1 0.47
R_{27} 6.5
R_{28} 180
R_{30} 54.9K
R_{17} 15
R_{18} 165
R_{19} 1.78K
R_{20} 54.9K
R_{22} 140K
分流电阻
10V 50V 250V 500V 1000V
OFF 1000V
500V
250V 50V 10V 2.5V 0.5V
0.25V 50μA
0.5mA
5mA 50mA 500mA
1.5V 9V
TEMP ×1 ×10 ×100 ×1K ×10K
hFE
ACV 9K/V
ACV 9K/V
DCV 20K/V
DCA /0.25V
BATT
Ω
DCV
R_{29} 4.12K
2500V
1.5V 9V



$$I = \frac{R_{23} + VR_2}{R_{23} + VR_2 + R_{26} + R_0} I_0$$

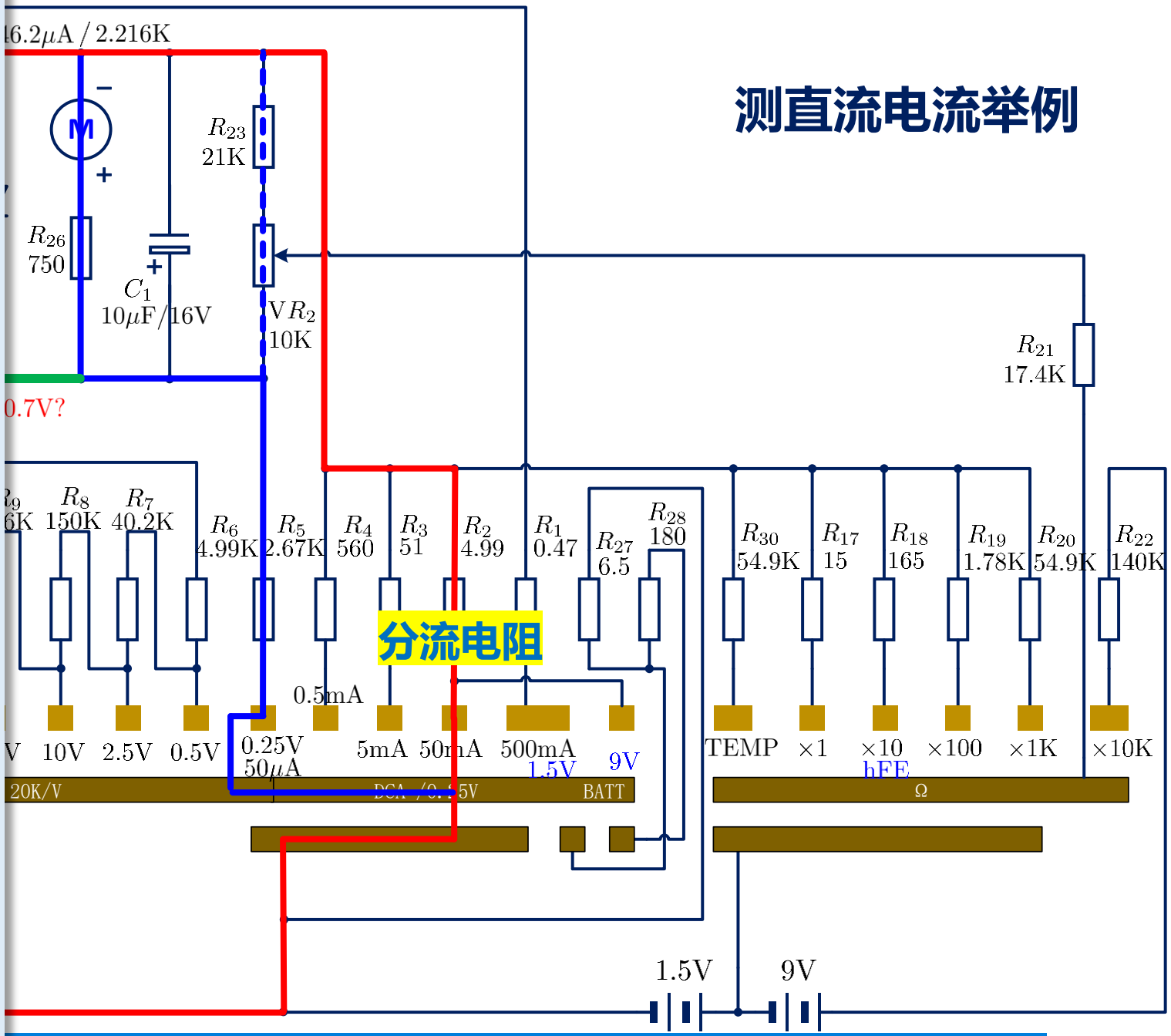
$$I_0 = \frac{R_2}{R_2 + R_5 + (R_{26} + R_0) \,//\, (R_{23} + VR_2)} I_x$$

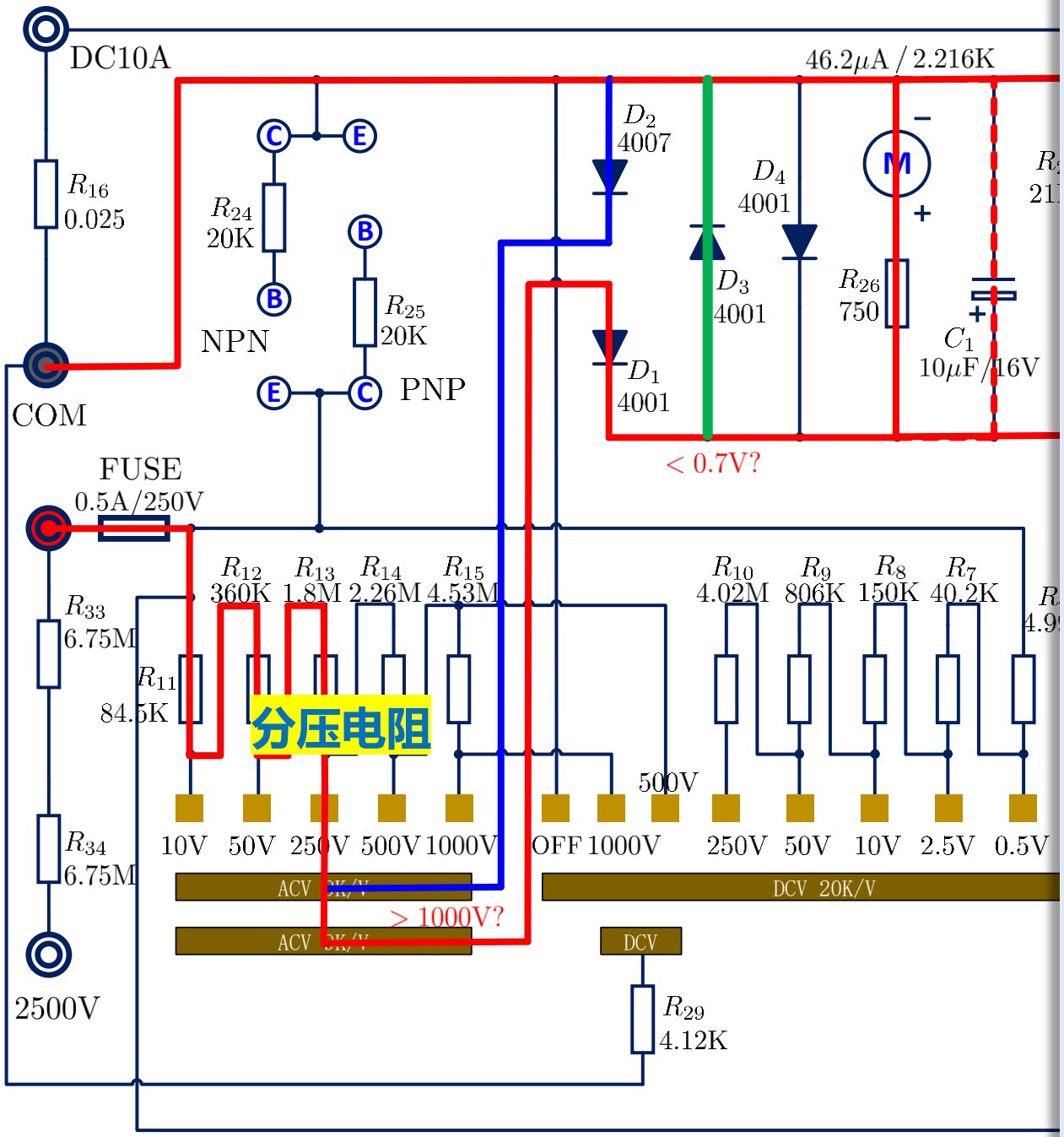
解出 $I_x = f(R_2)I$

$I_m = f(R_2)I_g$　　f 单调减

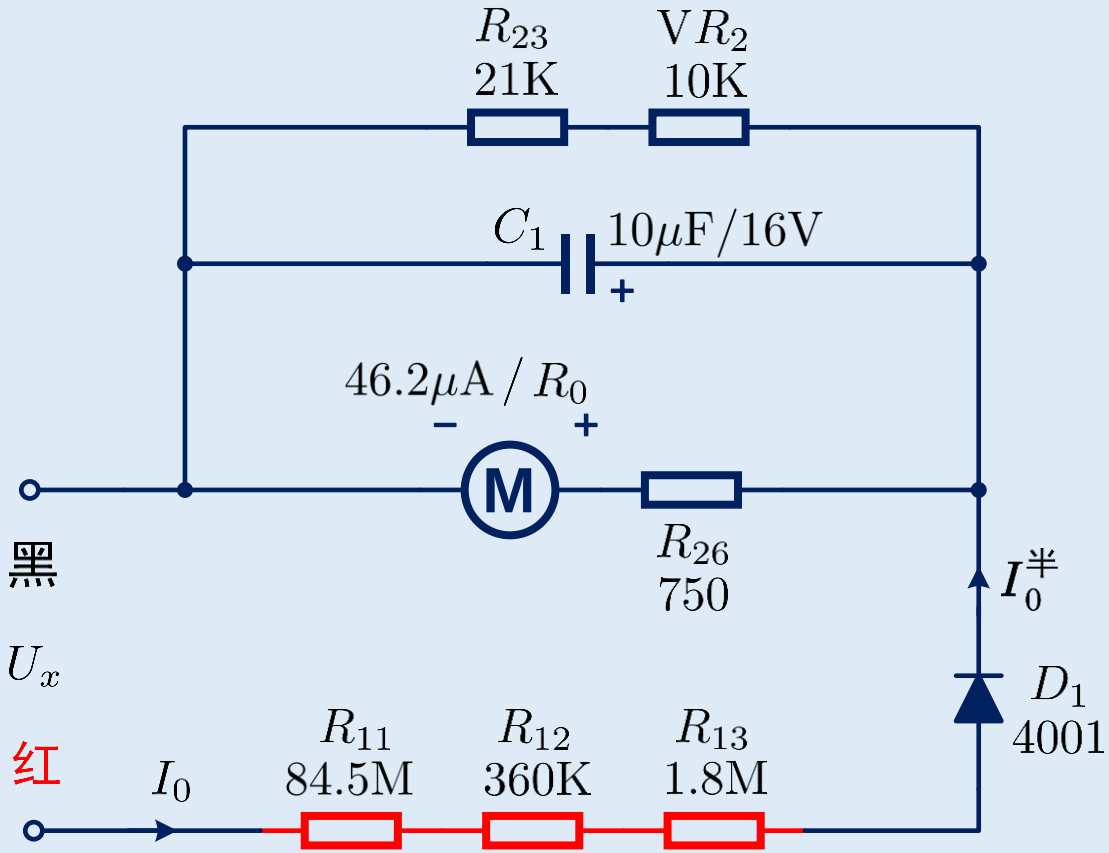
$I_m = 50\text{mA}$　　$I_g = 46.2\mu\text{A}$

测直流电流举例





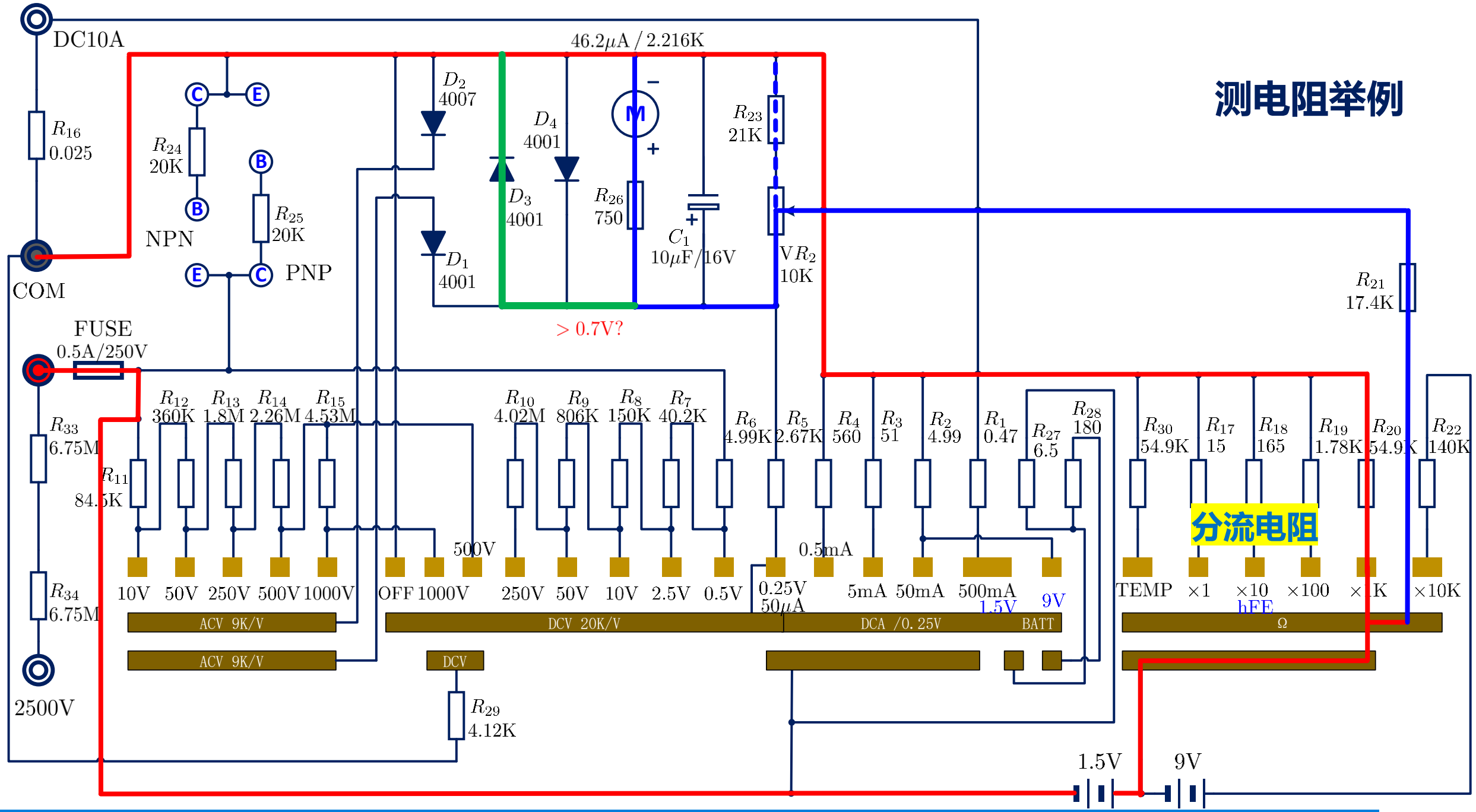
测交流电压举例



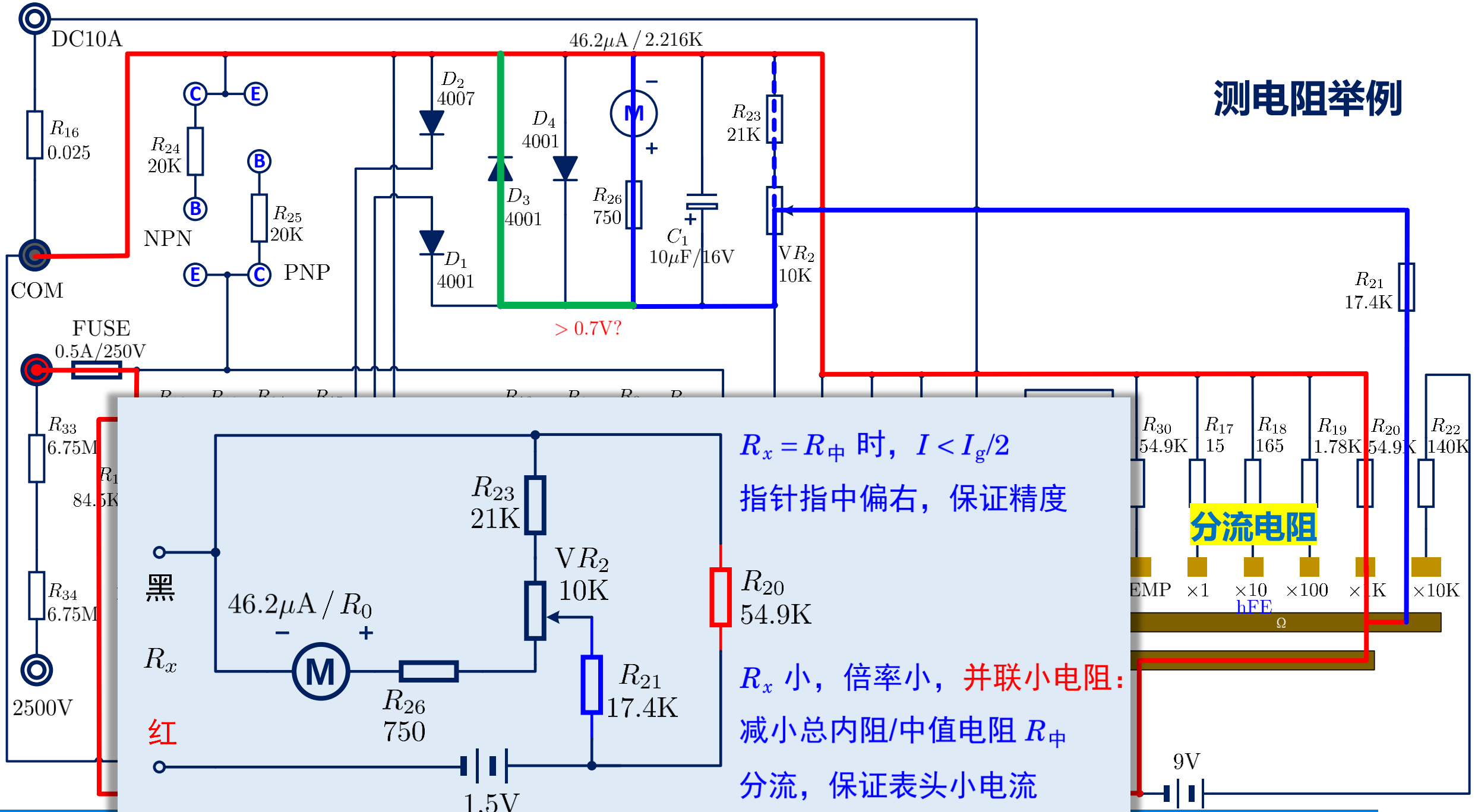
$$U_x = f(R_{11}+R_{12}+R_{13})I$$

$$U_m = f(R_{11}+R_{12}+R_{13})I_g$$

f 单调增


测电阻举例
DC10A
46.2μA / 2.216K
R_{16} 0.025
R_{24} 20K
NPN
R_{25} 20K
PNP
D_2 4007
D_4 4001
D_3 4001
D_1 4001
R_{26} 750
C_1 10μF/16V
R_{23} 21K
VR2 10K
R_{21} 17.4K
COM
FUSE 0.5A/250V
> 0.7V?
R_{33} 6.75M
R_{34} 6.75M
R_{11} 84.5K
R_{12} 360K
R_{13} 1.8M
R_{14} 2.26M
R_{15} 4.53M
R_{10} 4.02M
R_9 806K
R_8 150K
R_7 40.2K
R_6 4.99K
R_5 2.67K
R_4 560
R_3 51
R_2 4.99
R_1 0.47
R_{27} 6.5
R_{28} 180
R_{30} 54.9K
R_{17} 15
R_{18} 165
R_{19} 1.78K
R_{20} 54.9K
R_{22} 140K
分流电阻
10V 50V 250V 500V 1000V
OFF 1000V
500V
250V 50V 10V 2.5V 0.5V
0.25V 50μA
0.5mA
5mA 50mA 500mA
1.5V 9V
TEMP ×1 ×10 ×100 ×1K ×10K
hFE
ACV 9K/V
ACV 9K/V
DCV 20K/V
DCA /0.25V
BATT
Ω
DCV
R_{29} 4.12K
2500V
1.5V
9V

测电阻举例



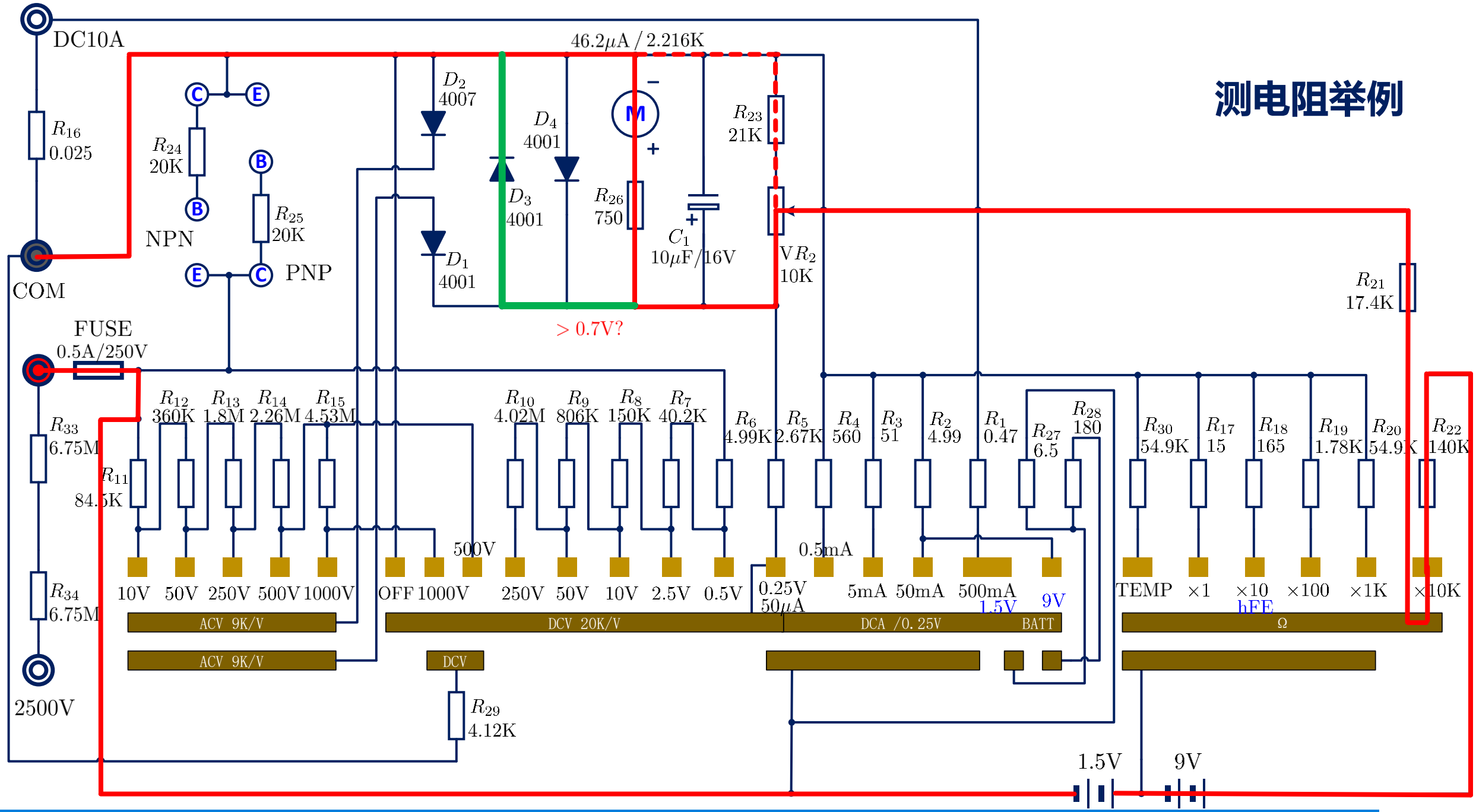
$R_x = R_{中}$ 时，$I < I_g/2$

指针指中偏右，保证精度

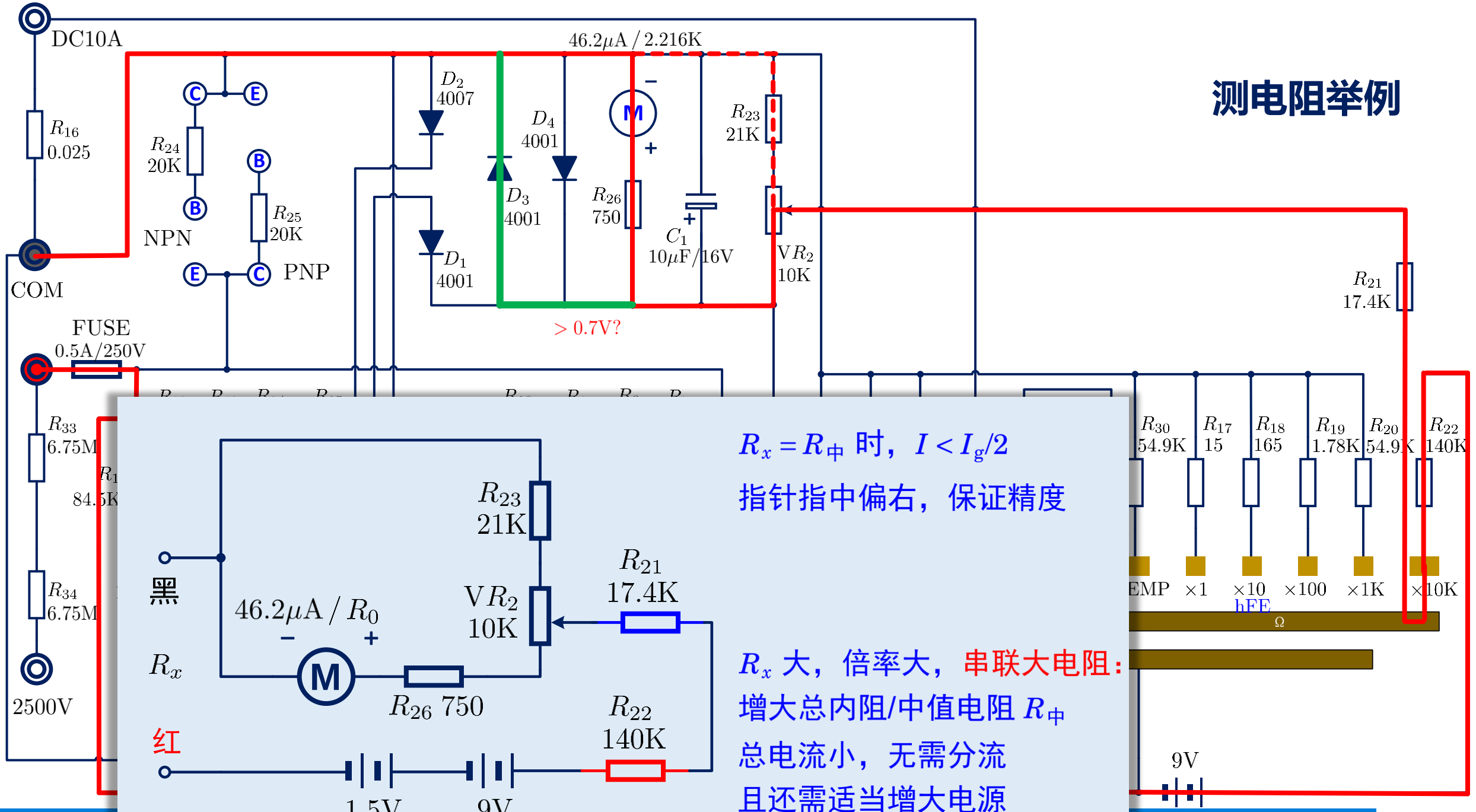
R_x 小，倍率小，并联小电阻：

减小总内阻/中值电阻 $R_{中}$

分流，保证表头小电流


测电阻举例
DC10A
46.2μA / 2.216K
R_{16} 0.025
R_{24} 20K
NPN
R_{25} 20K
PNP
D_2 4007
D_4 4001
D_3 4001
D_1 4001
R_{26} 750
C_1 10μF/16V
R_{23} 21K
VR$_2$ 10K
R_{21} 17.4K
COM
FUSE 0.5A/250V
> 0.7V?
R_{33} 6.75M
R_{34} 6.75M
R_{11} 84.5K
R_{12} 360K
R_{13} 1.8M
R_{14} 2.26M
R_{15} 4.53M
R_{10} 4.02M
R_9 806K
R_8 150K
R_7 40.2K
R_6 4.99K
R_5 2.67K
R_4 560
R_3 51
R_2 4.99
R_1 0.47
R_{27} 6.5
R_{28} 180
R_{30} 54.9K
R_{17} 15
R_{18} 165
R_{19} 1.78K
R_{20} 54.9K
R_{22} 140K
10V 50V 250V 500V 1000V
OFF 1000V
500V
250V 50V 10V 2.5V 0.5V
0.25V 50μA
0.5mA
5mA 50mA 500mA
1.5V 9V
TEMP ×1 ×10 ×100 ×1K ×10K
hFE
ACV 9K/V
ACV 9K/V
DCV 20K/V
DCA /0.25V
BATT
Ω
DCV
R_{29} 4.12K
2500V
1.5V
9V

测电阻举例



$R_x = R_{中}$ 时，$I < I_g/2$

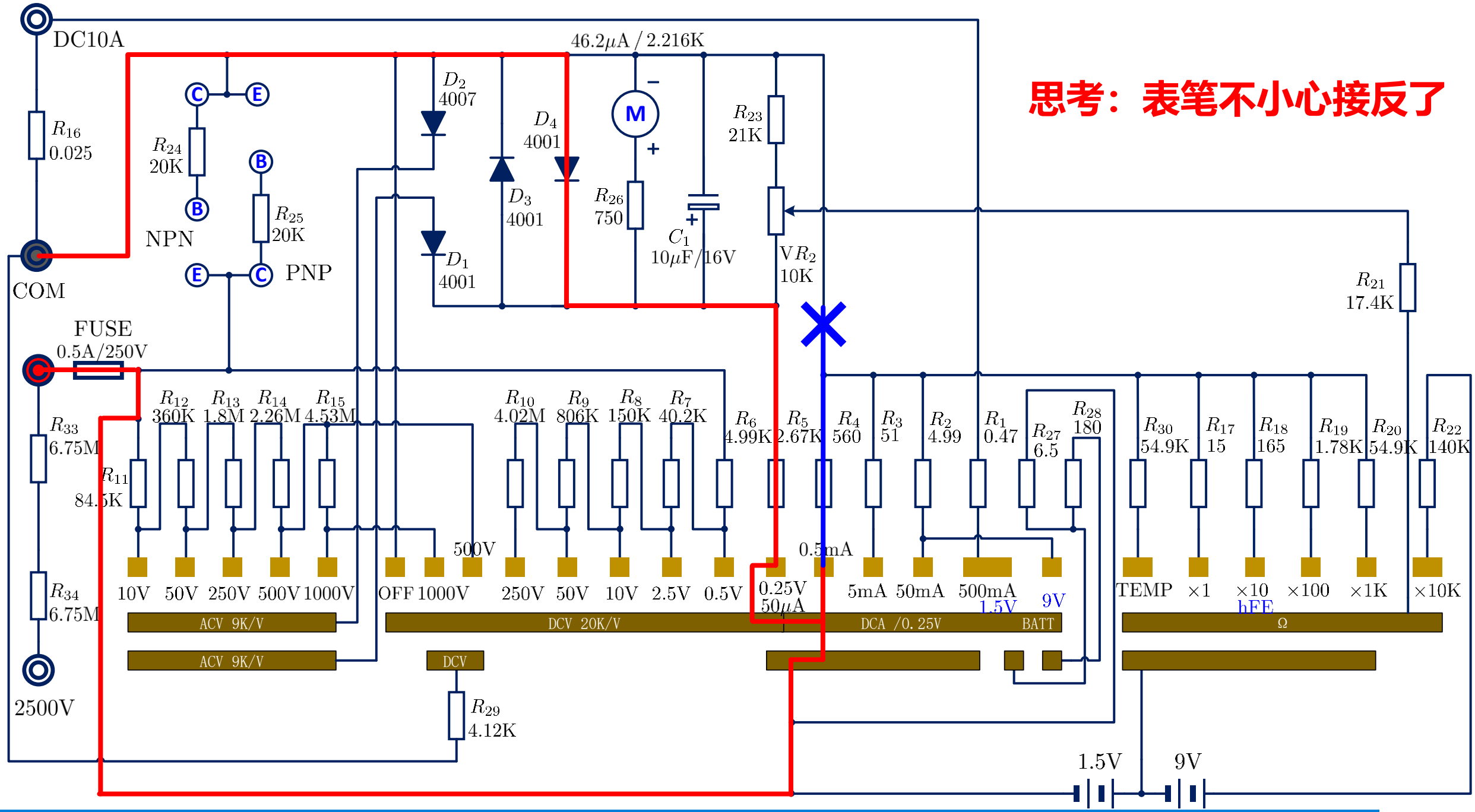
指针指中偏右，保证精度

R_x 大，倍率大，串联大电阻：

增大总内阻/中值电阻 $R_{中}$

总电流小，无需分流

且还需适当增大电源


思考：表笔不小心接反了
DC10A
46.2μA / 2.216K
R_{16} 0.025
R_{24} 20K
R_{25} 20K
NPN
PNP
D_2 4007
D_4 4001
D_3 4001
D_1 4001
M
R_{26} 750
C_1 10μF/16V
R_{23} 21K
VR2 10K
R_{21} 17.4K
COM
FUSE 0.5A/250V
R_{33} 6.75M
R_{34} 6.75M
R_{11} 84.5K
R_{12} 360K
R_{13} 1.8M
R_{14} 2.26M
R_{15} 4.53M
R_{10} 4.02M
R_9 806K
R_8 150K
R_7 40.2K
R_6 4.99K
R_5 2.67K
R_4 560
R_3 51
R_2 4.99
R_1 0.47
R_{27} 6.5
R_{28} 180
R_{30} 54.9K
R_{17} 15
R_{18} 165
R_{19} 1.78K
R_{20} 54.9K
R_{22} 140K
10V 50V 250V 500V 1000V
OFF 1000V
500V 250V 50V 10V 2.5V 0.5V
0.5mA 0.25V 50μA
5mA 50mA 500mA
1.5V 9V
TEMP ×1 ×10 ×100 ×1K ×10K
hFE
ACV 9K/V
ACV 9K/V
DCV 20K/V
DCA /0.25V
BATT
Ω
DCV
R_{29} 4.12K
2500V
1.5V
9V

一. 电阻

R1 = 2.47 (0.5)
R2 = 4.99
R3 = 51
R4 = 560
R5 = 2.67K
R6 = 4.99K
R7 = 40.2K
R8 = 150K
R9 = 806K
R10 = 4.02M
R11 = 84.5K
R12 = 360K
R13 = 1.8M
R14 = 2.26M
R15 = 4.53M
R16 = 1.025
R17 = 15
R18 = 165
R19 = 1.78K
R20 = 54.9K
R21 = 17.4K
R22 = 140K
R23 = 21K
R24 = 20K (5%)
R25 = 20K (5%) 19.6
R26 = 750 (5%) 730
R27 = 6.5
R28 = 180

R29 = 4.12K
R30 = 54.9K
R33 = 6.75M
R34 = 6.75M

二. 其他

电位器 10K

1N4001 (3)

1N4007 (1)

保险丝座(2)

电解电容(1) 10μF/16V

保险丝管(1) 250V/0.5A

三. 其他件

大旋钮

小旋钮

晶体管插座

晶体管插片(6)

电刷片

~~正极~~ ~~负极~~ 电池夹 { 正极(1) 负极(1)

电刷架

连接线(5)

输入插座(4)

~~支架~~

压簧(2)

钢珠(2)

自攻螺钉(4)

螺钉(1)

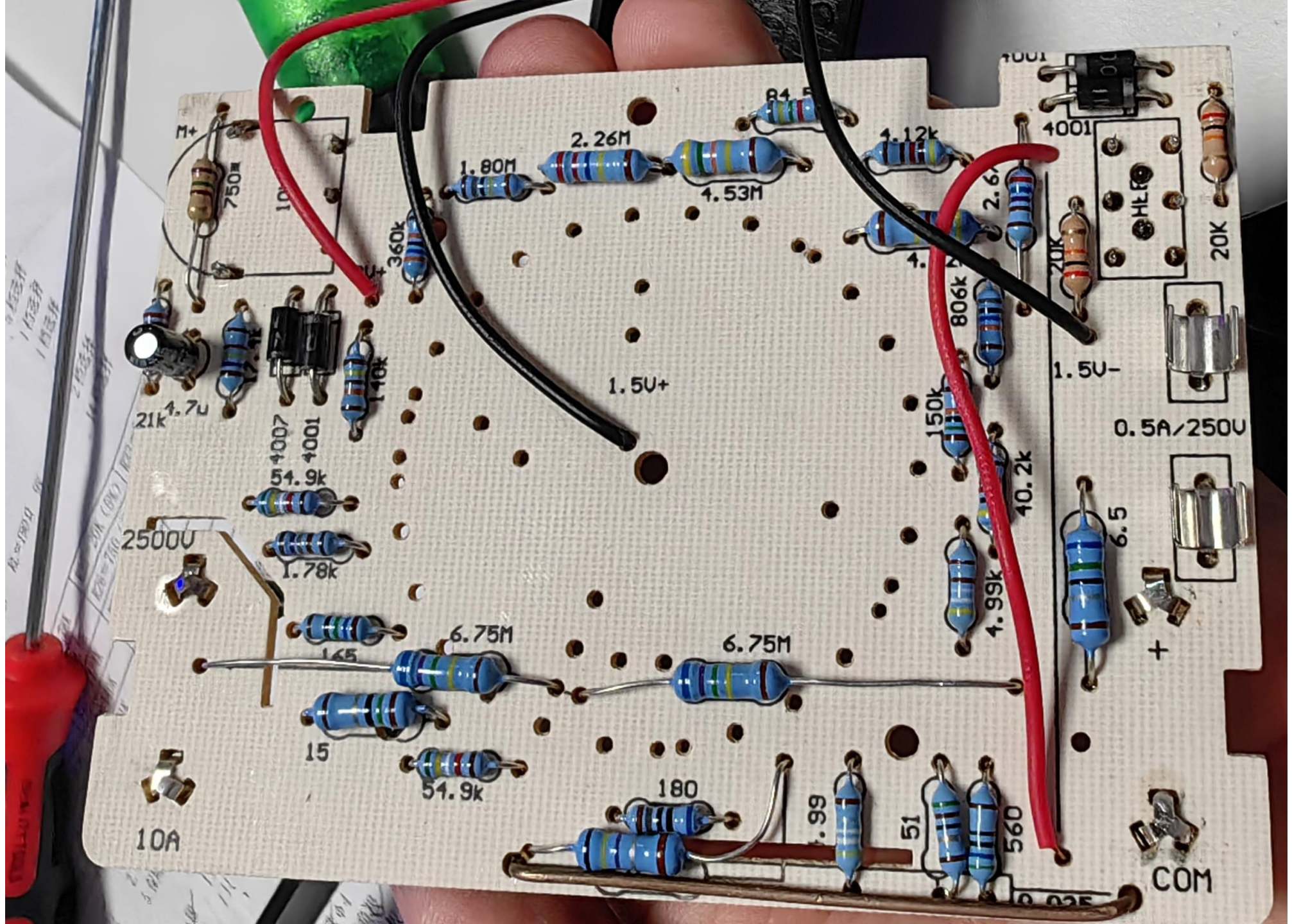
线路板

表笔

表头

2号电池

9号电池


M+
750m
360k
1.80M
2.26M
4.53M
4.12k
4001
HLR
20K
20K
1.5V+
1.5V-
806k
150k
40.2k
4.99k
6.5
0.5A/250V
21k
4.7u
4007
4001
10k
54.9k
2500V
1.78k
6.75M
6.75M
165
15
54.9k
180
51
560
10A
COM

直流电压测量及读数

调至合适的量程（先大后小）

被测电压 = 指针示数 × 量程 ÷ 满偏示数

$$U = 6.2 \times 2.5 \div /10 = 1.55\text{V}$$

量程为 10V，50V，250V 时，可直接读数

直流电压测量及读数

调至合适的量程（先大后小）

被测电压 = 指针示数 × 量程 ÷ 满偏示数

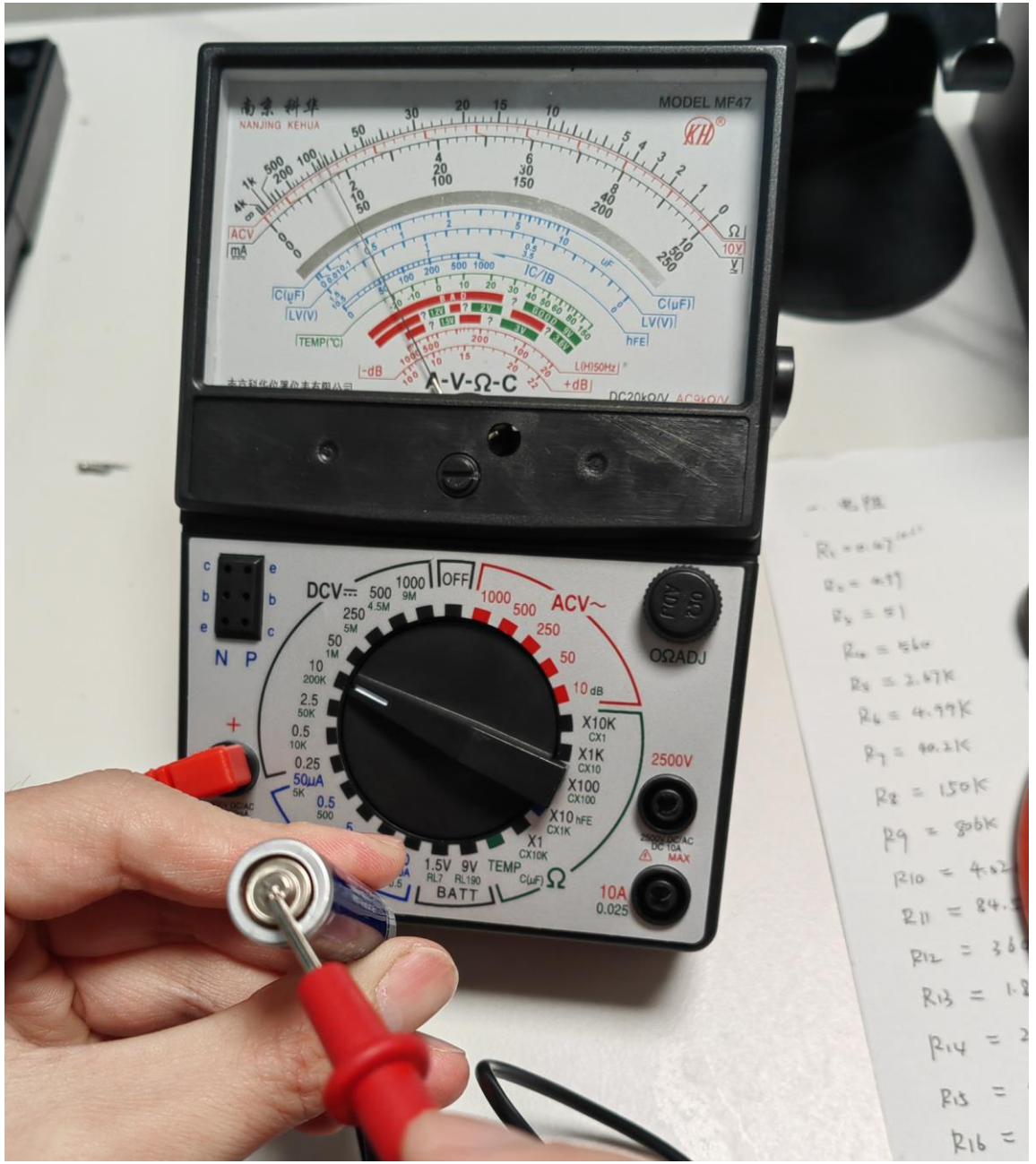
$$U = 6.2 \times 2.5 \div /10 = 1.55\text{V}$$

量程为 10V，50V，250V 时，可直接读数

$$U = 1.61\text{V}$$

大于 1000V 时，红表笔接 2500V 插孔！

切勿带电操作！



交流电压测量及读数

调至合适的量程（先大后小）

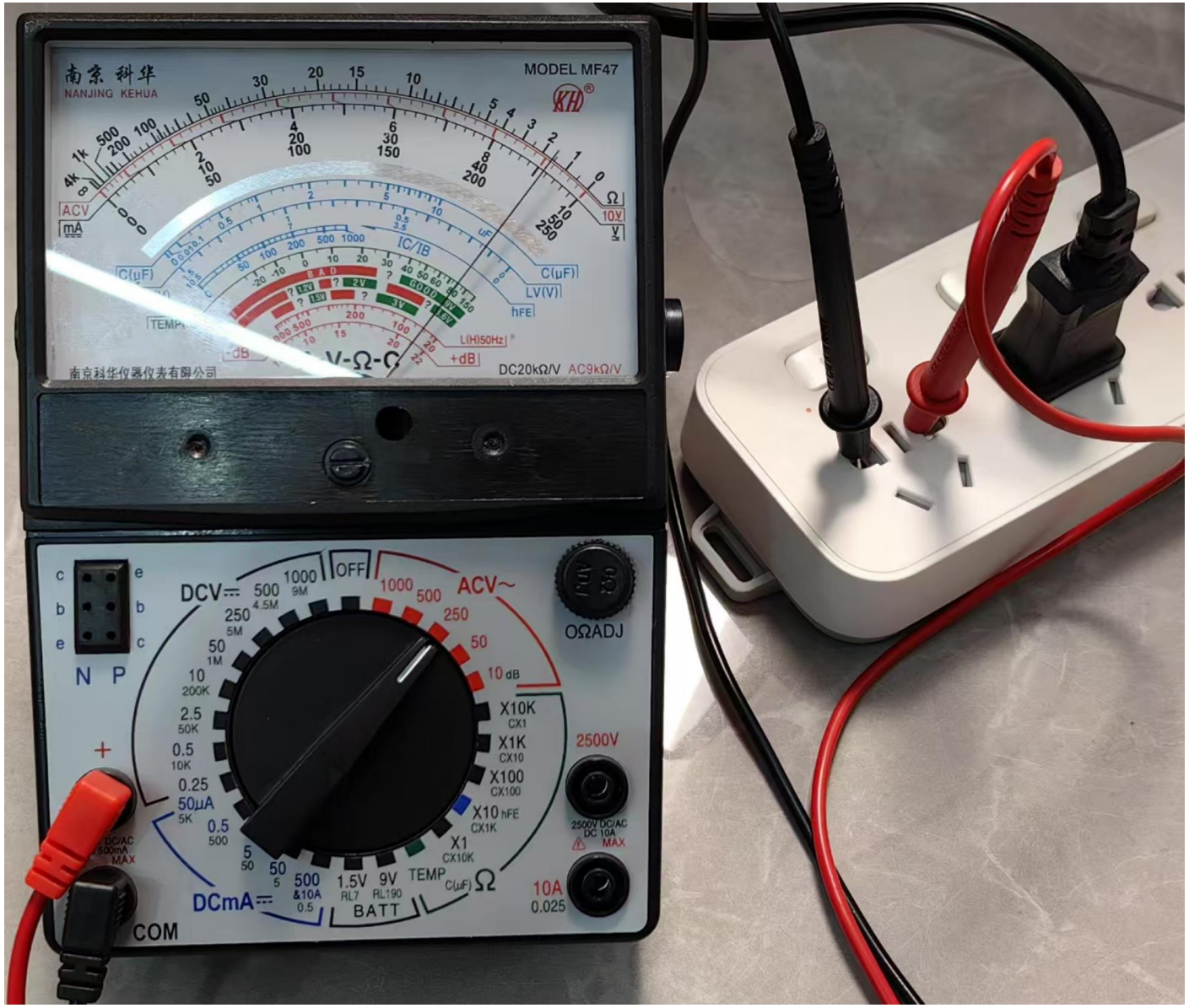
被测电压 = 指针示数 × 量程 ÷ 满偏示数

量程为 10V，50V，250V 时，可直接读数

$$U = 226\text{V}$$

大于 1000V 时，红表笔接 2500V 插孔！

切勿带电操作！



直流电流测量及读数

调至合适的量程（先大后小）

被测电流 = 指针示数 × 量程 ÷ 满偏示数

电表必须串入电路，不能直接用表笔接在元件两端！

大于 500 mA 时，红表笔接 10 A 插孔！

切勿带电操作！

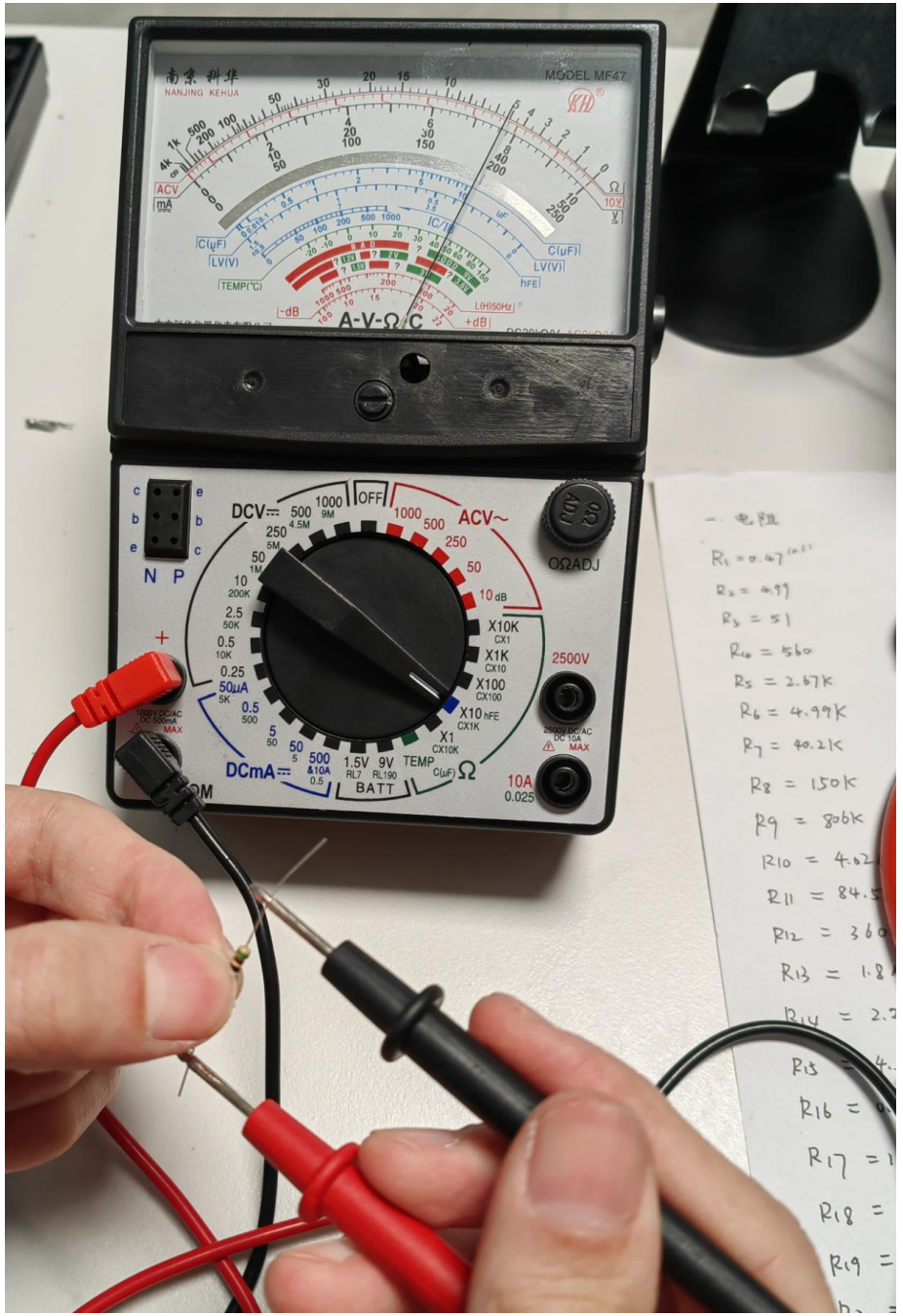
电阻的测量及读数

调至合适的量程（先大后小）

被测电阻 = 指针示数 × 倍率

$$R = 5.1 \times 10 = 51\,\Omega$$

欧姆档改变量程后，要短接表笔调零！



防烫

注意尖锐物体

用电安全

有问题及时提问