PLUSIVO

Mastering The Art of Measurement

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Introduction

In this guide, you are going to learn how to measure DC voltage and AC voltage, DC current, resistance, diodes, and continuity test using Digital MultiMeter (**DMM**).

1. Overview

The compact digital multimeter can be used to measure DC voltage and AC voltage, DC current, resistance, diodes, continuity test, and other parameters. This multimeter is the ideal tool for laboratories, factories, enthusiasts, and families.

Please take the time and read these operating instructions before use and retain them for future reference. Failure to follow these instructions may lead to serious injury and damage to property.

2. Safety Notes

1. When measuring, do not enter a limit that exceeds the range.
2. When changing the function and range, the test leads should leave the test point.
3. In the resistance mode, please do not add voltage to the input.

In general, if something unusual happens or if you suspect that something is wrong or has malfunctioned, do not do anything with the product and immediately contact the seller for assistance (email address: office@plusivo.com)

3. General Characteristics

- Maximum display value: 1999 (31/2) bit, automatic polarity display
- Sampling rate: about 3 times per second
- Over range indication: the highest bit is "1"
- Low voltage display: "" symbol appears
- Working environment: (0~40) °C, relative humidity < 80%
- Power: 3 V battery (2 x AAA)
- Accuracy: ± (reading % + the least significant digits)
- Ambient temperature: (23±5) °C, relative humidity < 75%, calibration guarantee period for one year from the day of production.

3.1 DC Voltages (DC Volts)

Range	Accuracy	Resolution Ration
200 mV	±(0.5% + 4)	100 µV
2 V		1 mV
20 V		10 mV
200 V		100 mV
600 V	±(1.0% + 5)	1 V

Input impedance: 1 MΩ

3.2 AC Voltages (AC Volts)

Range	Accuracy	Resolution Ration
200 V	±(1.2% + 10)	100 mV
600 V		1 V

Input impedance: 1 MΩ
Frequency response: (40~200) Hz

3.3 DC Current

Range	Accuracy	Resolution Ration
2 mA	±(1.5% + 3)	1 µA
20 mA		10 µA
200 mA		100 µA
10A	±(2.0% + 5)	10 mA

Maximum input current: 10 A (not more than 10 seconds)
Overload protection: 0.2 A / 250 V fuse (10 A range is without insurance)

3.4 Resistance

Range	Accuracy	Resolution Ration
200 Ω	±(1.0% + 5)	0.1 Ω
2 kΩ	±(0.8% + 3)	1 Ω
20 kΩ		10 Ω
200 kΩ		100 Ω
2 MΩ	±(1.0% + 15)	1 kΩ

Overload protection: 250 V DC and AC peak

3.5 Diode and Continuity Test

Range	Display	Test Conditions
	The diode forward voltage	DC current is about 1 mA Reverse voltage: 3 V
	Buzzer sound Test Resistance smaller than (20 ±1) Ω	Circuit starting voltage: about 3 V

Overload Protection: 250 V DC or AC peak

4. Reference Table

4.1 Table of SI Units

Quantity	SI Unit	Abbreviation
Voltage	Volts	V
Current	Ampere	A
Power	Watt	W
Energy	Joule	J
Electric charge	Coulomb	C
Resistance	Ohm	Ω
Capacitance	Farad	F
Inductance	Henry	H
Frequency	Hertz	Hz

4.2 Table of Prefixes

Prefix	Power	Numeric Representation
Tera (T)	10^{12}	1 trillion
Giga (G)	10^{9}	1 billion
Mega (M)	10^{6}	1 million
Kilo (k)	10^{3}	1 thousand
No prefix	10^{0}	1 unit
Milli (m)	10^{-3}	1 thousandth
Micro (μ)	10^{-6}	1 millionth
Nano (n)	10^{-9}	1 billionth
Pico (p)	10^{-12}	1 trillionth

5. Measurement

5.1 DC Voltage Measurement

1. Insert the black wire to "COM" and the red wire to the "V/Ω" port;

2. Put the range switch to the corresponding DC voltage range and then put the test probes to the source to be measured. The polarity will be shown on the display.

Figure 1. The measured voltage in this figure is 12.35 V DC.

Figure 2. The measured voltage in this figure is 4.71 V DC.

Note:

1. If the range of the voltage to be measured is unknown, put the range switch to the highest rank, then according to the value displayed, turn to the corresponding range
2. If on the display is shown "1", this means that the range is exceeded and the range switch must be set to a higher gear
3. Do not measure a voltage over 600 V, because there is a risk to damage the instrument circuit
4. When measuring a high voltage circuit, pay attention not to touch any high voltage part of the circuit.

5.2 AC Voltage Measurement

1. Insert the black probe to "COM" and the red probe to "V/Ω";

2. Put the range switch to the corresponding ACV range and then put the test probes to the source to be measured.

Figure 3. The measured voltage in this figure is 240 V AC.

Note:

1. If the range of the voltage to be measured is unknown, put the range switch to the highest rank, then according to the value displayed, turn to the corresponding range

2. If on the display is shown "1", this means that the range is exceeded and the range switch must be set to a higher gear

3. Do not measure a voltage over 600 Vrms, because there is a risk to damage the instrument circuit

4. When measuring a high voltage circuit, pay attention not to touch any high voltage part of the circuit.

5.3 DC Current Measurement

1. Insert the black probe to "COM". The red probe can be inserted to "V/Ω" for measuring up to 200 mA, or insert the red probe to "10 A" for a maximum 10 A measurement.

For 200 mA or less, you can set-up the probes of the multimeter like this:

For 200 mA to 10 A, the red probe should be inserted to the 10 A DC port. Please see below.

2. Put the range switch to the corresponding DC current range (Figure 4 is set at 200 mA and Figure 5 is set at 10 A) and then put the multimeter (the 2 probes) in series with the part of the circuit that you want to measure how much current it draws. The polarity will be shown on the display.

Figure 4. The measured current in this figure is 129.8 mA.

Figure 5. The measured current in this figure is 3.07 A.

Note:

1. If the range of the current to be measured is unknown, put the range switch to the highest rank, then according to the value displayed, turn to the corresponding range.

2. If the display is shown "1", this means that the range exceeded and the range switch must be set to a higher gear.

3. The maximum input current is 200 mA or 10 A (depending on the port that the red probe was inserted). If you try to measure a current higher than the maximum input specifications, the fuse will blow. Check the fuse if you have no reading on the display.

5.4 Battery Test

1. Insert the black wire to "COM" and the red wire to the "V/Ω" port;

2. Put the range switch to the corresponding Battery you want to measure. The polarity will be shown on the display.

For the 1.5 V battery test, there is a 40 ohm-resistor test load that is included internally in the multimeter. What the screen shows is the current flow in mA, the higher current you get, the stronger battery you have.

Figure 6. The measured current in this figure is 38.4 mA.

For the 9 V battery test, there is a 400 ohm-resistor test load that is included internally in the multimeter. What the screen shows is the current flow in mA, the higher current you get, the stronger battery you have.

Figure 7. The measured current in this figure is 21 mA.

5.5 Resistance Measurement

1. Insert the black wire to "COM" and the red wire to the "V/Ω" port;

2. Put the range switch to the corresponding resistor range and connect the two test probes to the element you want to measure.

Figure 8. The measured resistance in this figure is 9.89 kΩ.

Figure 9. The measured resistance in this figure is 6.2 Ω.

Note:

1. If the resistance value exceeds the selected range value, on the display will be shown "1" and the range switch should be changed to a higher gear. When the measured resistance value is more than 1 MΩ, the reading takes a few seconds to stabilize, which in high resistance mode is normal.

2. When the input is open, the overload condition is displayed.

3. When measuring the on-line resistance, make sure that all the power of the circuit under test is turned off and all the capacitors are fully discharged.

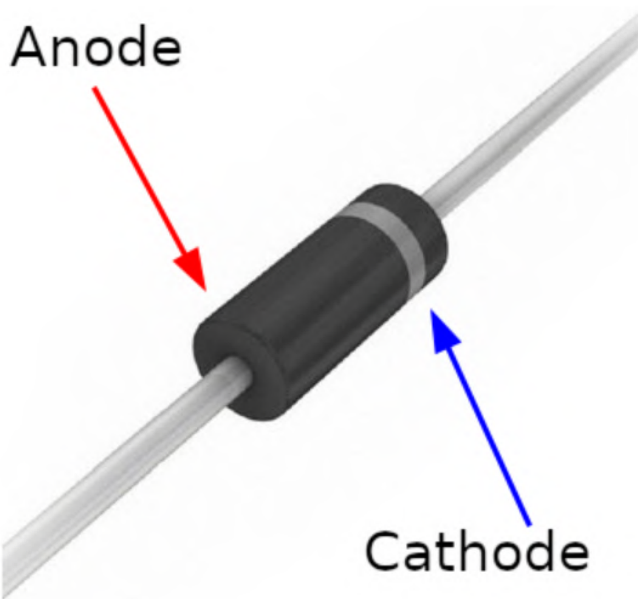
4. Do not input voltage in the resistance range.

5. Do not touch the two test probes at the same time, because the resistance of your body will be added in parallel to the resistance that you want to measure.

5.6 Diode Test

1. Insert the black probe to "COM" and the red probe to "V/Ω" (note that the polarity of the red probe is "+").

2. Put the range switch to " ▶| ". Connect the black probe to the cathode and the red probe to the anode.



The display will show the approximate forward voltage drop.

Figure 10. The measured forward voltage in this figure is 0.683 V.

Figure 11. If you connect the probes incorrectly, the display will show "1".

5.7 Continuity Test

1. Insert the black probe to "COM" and the red probe to "V/Ω"

2. Put the range switch to " •))) ". Connect the probes to the circuit or the component you want to test the conductivity for it.

If a conductor path is connected, the multimeter will beep, the display will show the resistance of the circuit or the component.

Figure 12. If a conductor path is connected the multimeter will beep.

If a conductor path is broken, the multimeter will not beep, the display will show "1".

Figure 13. If a conductor path is broken the multimeter will not beep.

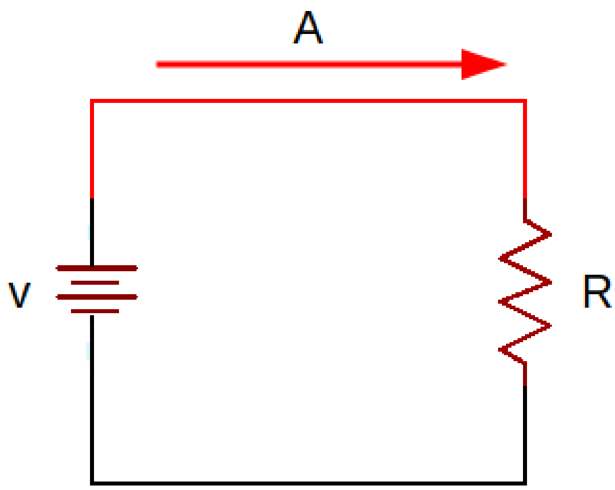
6. Basic Concepts

6.1 Ohm's Law

It is a law that illustrates the relationship between the voltage, the current, and the resistance.

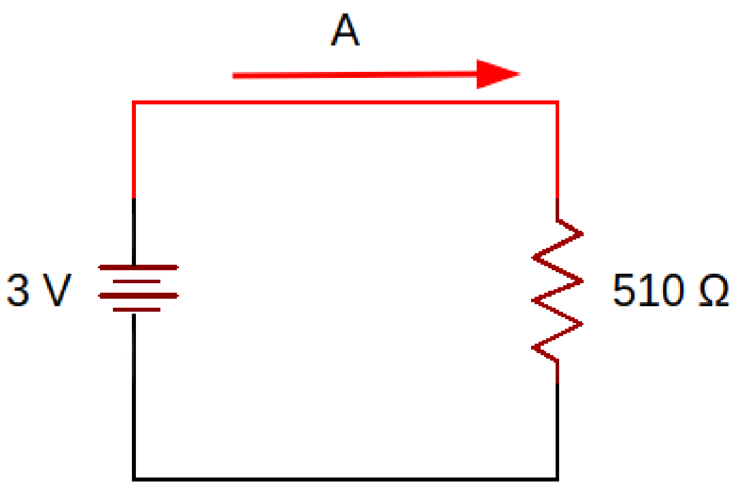
$$V = I \cdot R$$
$$R = \frac{V}{I}$$
$$I = \frac{V}{R}$$

I is the current through the resistor.
V is the voltage around the resistor.
R is the resistance.



6.1.1 Example

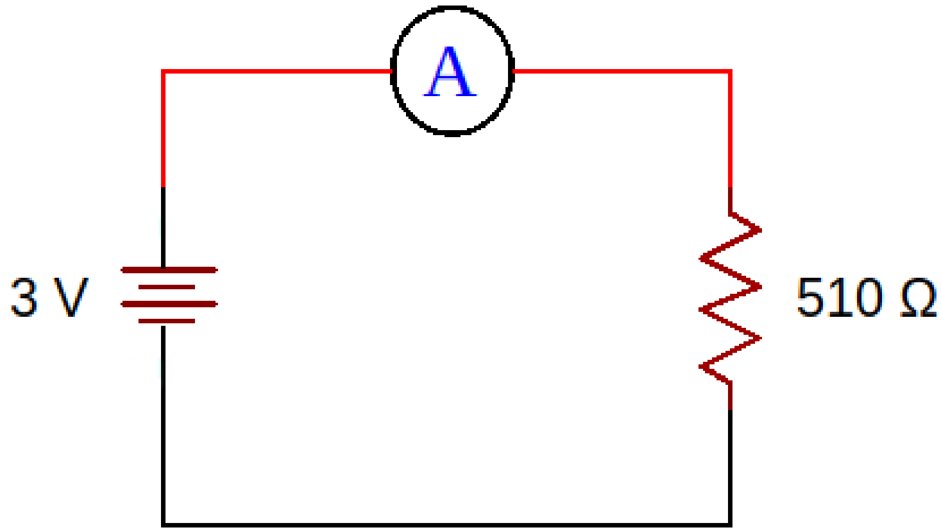
Calculate the current in this circuit.



Simply, we can use Ohm’s law: $I = \frac{V}{R}$

$$\frac{3\,V}{510\,\Omega} = 0.00588\,A = 5.88\,mA$$

If we built this circuit in reality and measure the current using the multimeter as in the following schematic:



We should read on the screen of the multimeter: **5.88 mA**

But this is if we have an ideal circuit, in reality, we will not get this specific value because each component in this circuit has tolerance, for example, if we measure the resistance:

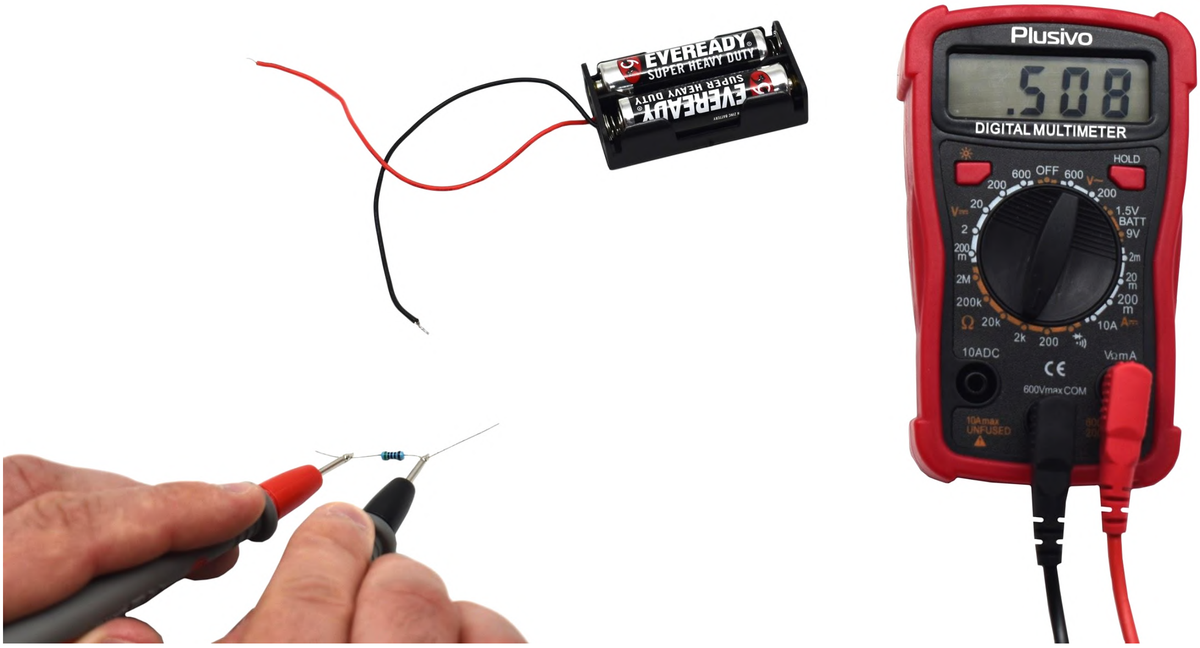


Figure 14. The measured resistance in this figure is 508 Ω.

Note:
Disconnect the battery when measuring the resistance, otherwise, the multimeter may be damaged.

If we measure the voltage around the resistor:

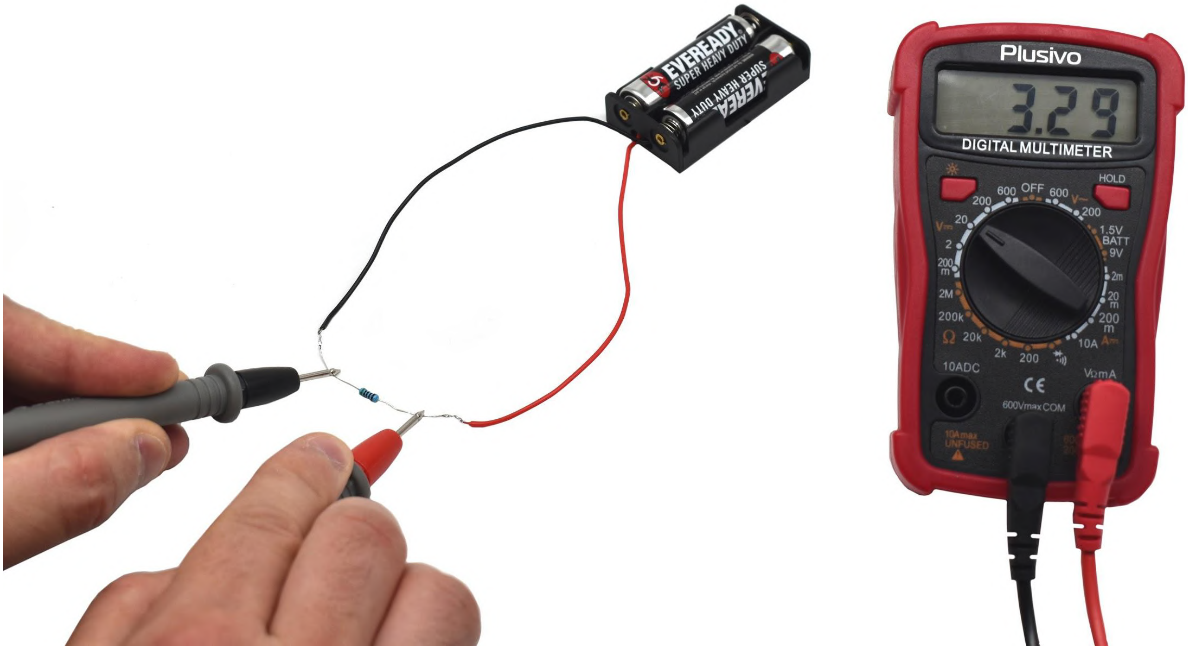


Figure 15. The measured voltage in this figure is 3.29 V DC.

If we calculate the new values: $\frac{3.28\,V}{508\,\Omega} = \ 6.45\,mA$

But in reality, it will be less than 6.45 mA because of the resistance of the multimeter itself:

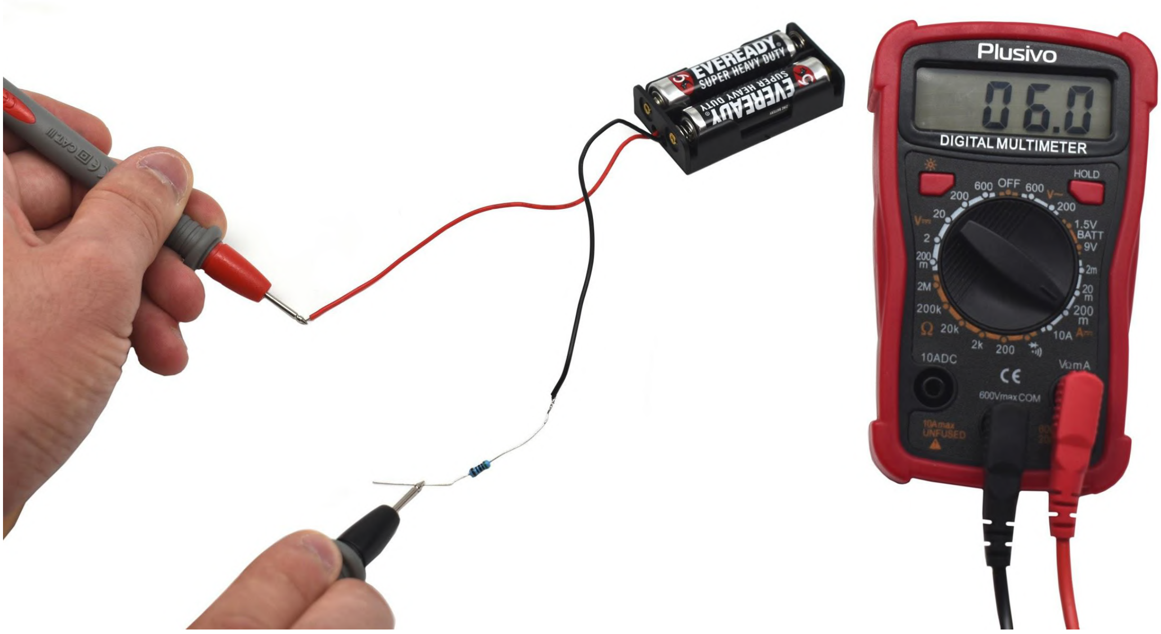


Fig. 16. The measured current in this figure is 6 mA

But indeed, we can count on our calculation "$3\,V\ /\ 510\,\Omega\ =\ 5.88\,mA$" because **5.88 mA** is almost equal to **6 mA**.

6.2 Joule's Law for Electrical Power

Electric power is the rate of the emitting power from a resistor per unit time, the unit of power is watt.

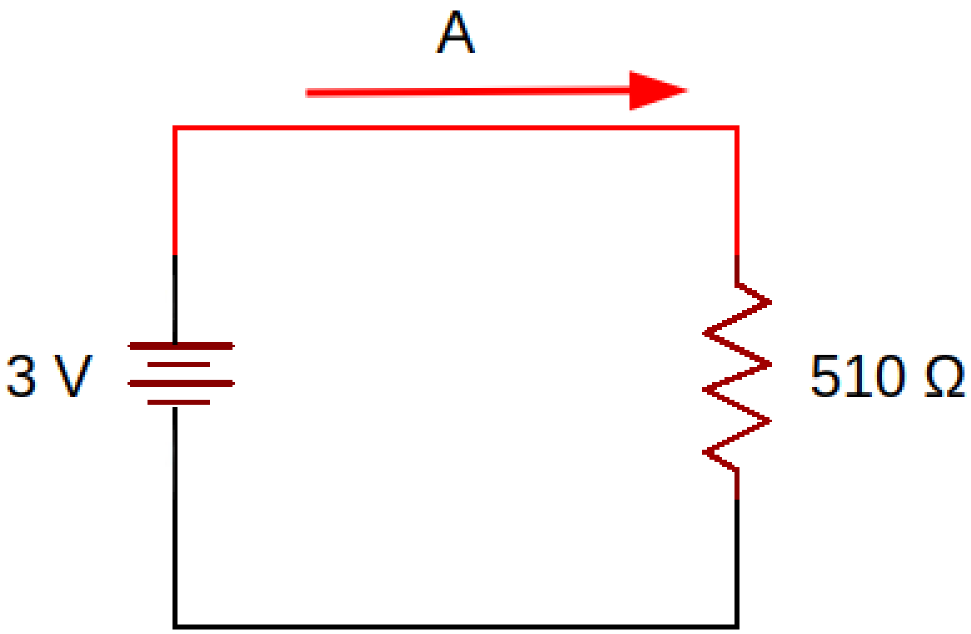
$$P = I \cdot V$$
$$P = I^2 \cdot R$$
$$P = \frac{V^2}{R}$$

P is the power on the resistor.
I is the current through the resistor.
V is the voltage around the resistor.
R is the resistance.

Note: There are many types of emitting power, it may be a rotary power, light, heat, etc.

6.2.1 Example

Calculate the power on the resistor.



To calculate the power on the resistor, we need any two values of these: **Voltage**, **Current** or **Resistance**.

In our example, we have the voltage and the resistance, so we can use this formula:

$$P = \frac{V^2}{R}$$
$$\frac{(3\,V)^2}{510\,\Omega} = 0.0176\,W = 17.6\,mW$$

Let us see what we will get if we built this circuit in reality and calculate the power using the multimeter.

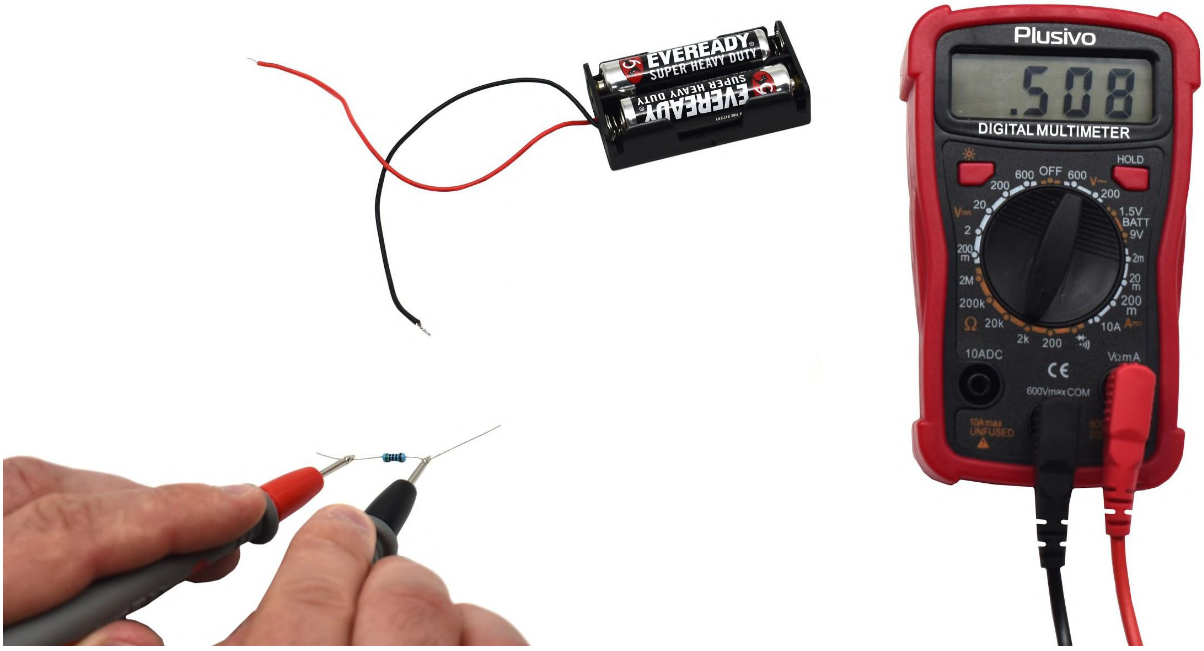


Figure 17. The measured resistance in this figure is 508 Ω.

Note:
Disconnect the battery when measuring the resistance, otherwise, the multimeter may be damaged.

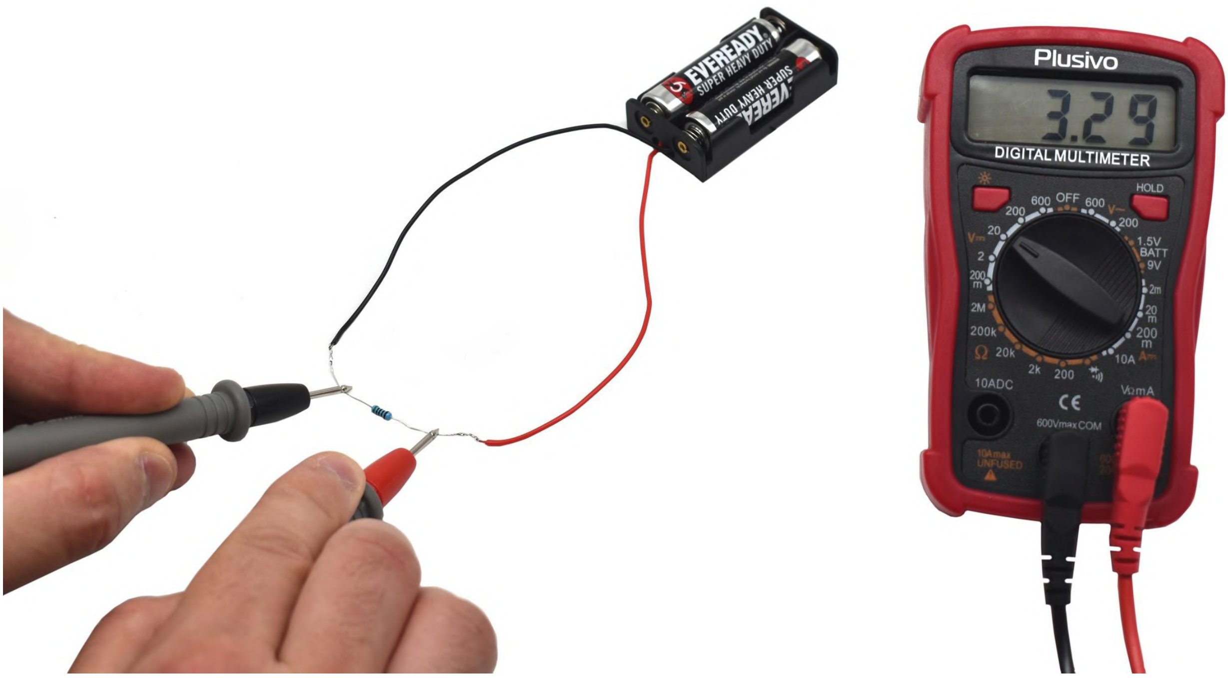


Figure 18. The measured voltage in this figure is 3.29 V DC.

So if we calculate the new values: $\frac{(3.29\,V)^2}{508\,\Omega} = 21.3\,mW$

We can count on our calculation "$\frac{(3\,V)^2}{510\,\Omega} = 0.0176\,W = 17.6\,mW$"

because

17.6 mW is almost equal to **21.3 mW**.

If we want to use the current to calculate the power.

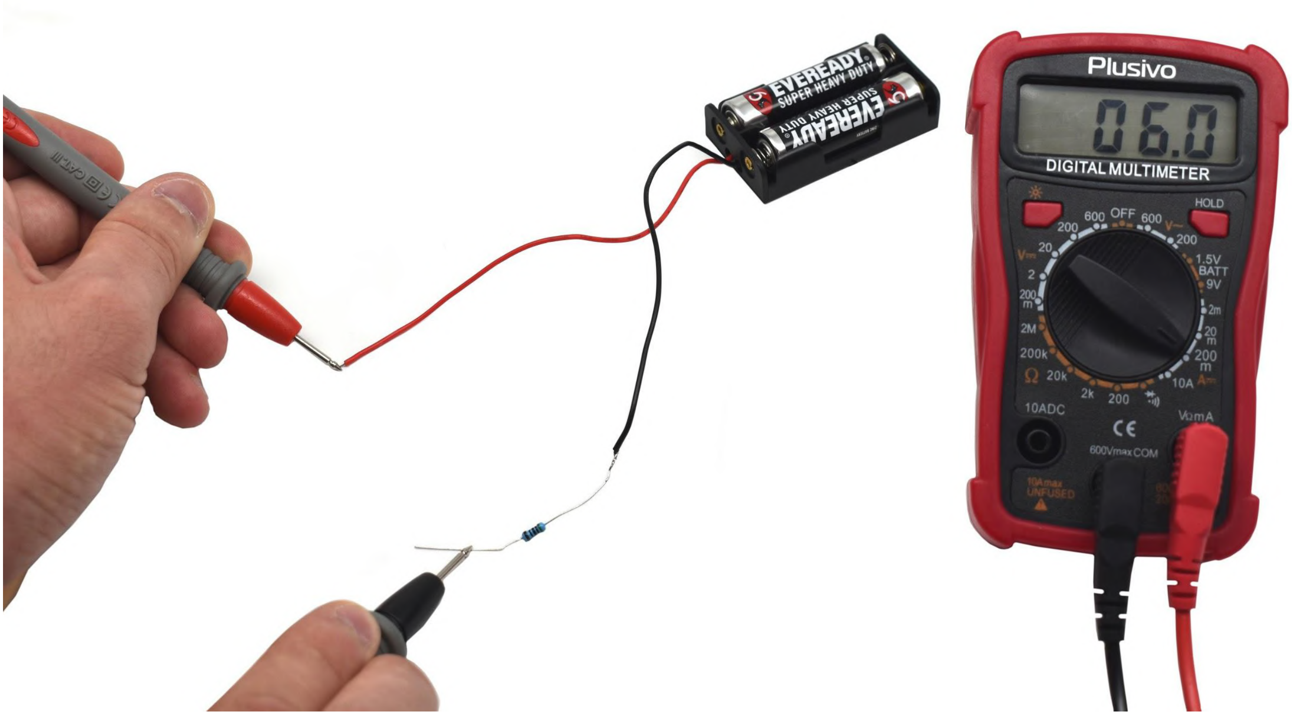


Figure 19. The measured current in this figure is 6 mA.

We can use the first formula which is:

$P = I \cdot V$

$3.29\,V \cdot 6\,mA = 0.0197\,W = 19.7\,mW$

And the second formula which is:

$P = I^2 \cdot R$

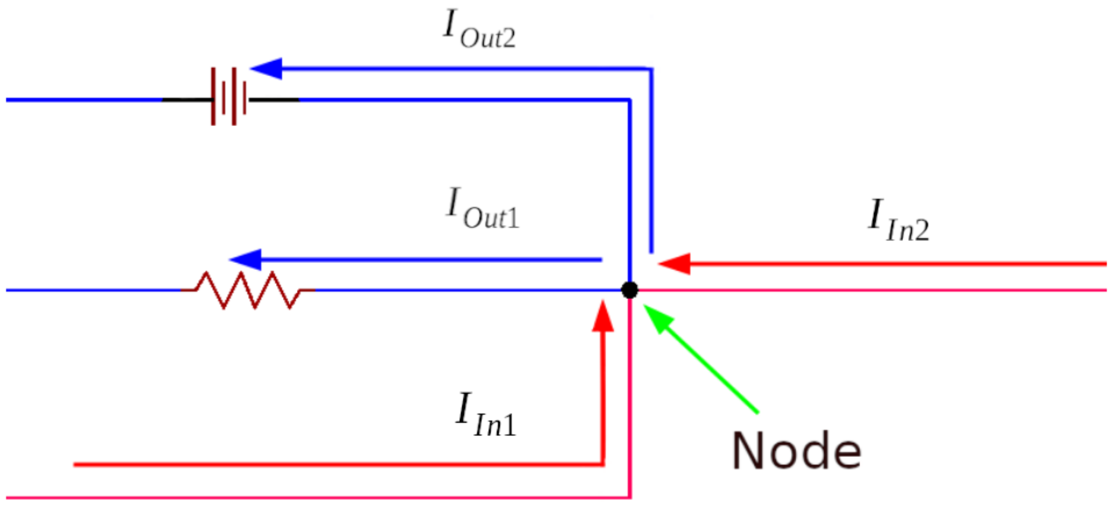
$(6\,mA)^2 \cdot 510\,\Omega = 0.0183\,W = 18.3\,mW$

So all the formulas are almost equal to each other: **21.3 mW, 19.7 mW, 18.3 mW**

6.3 Kirchhoff's Law

6.3.1 Kirchhoff's Current Law

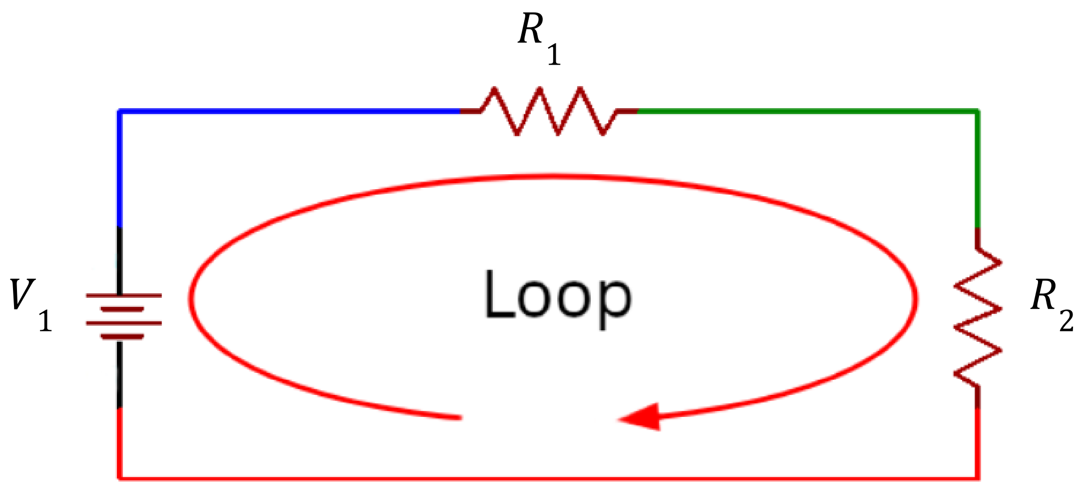
Currents entering the node equals currents leaving the node.



$$I_{In1} + I_{In2} = I_{Out1} + I_{Out2}$$

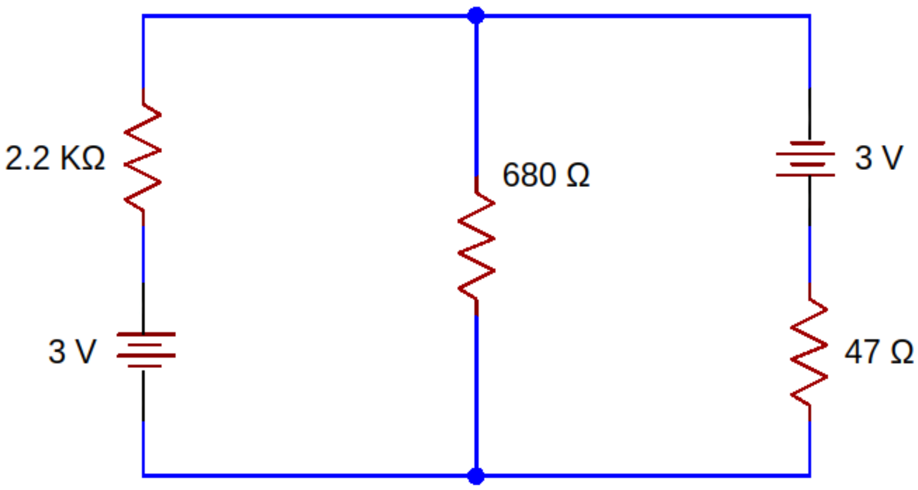
6.3.2 Kirchhoff's Voltage Law

The sum of all the voltages around the loop is equal to zero.

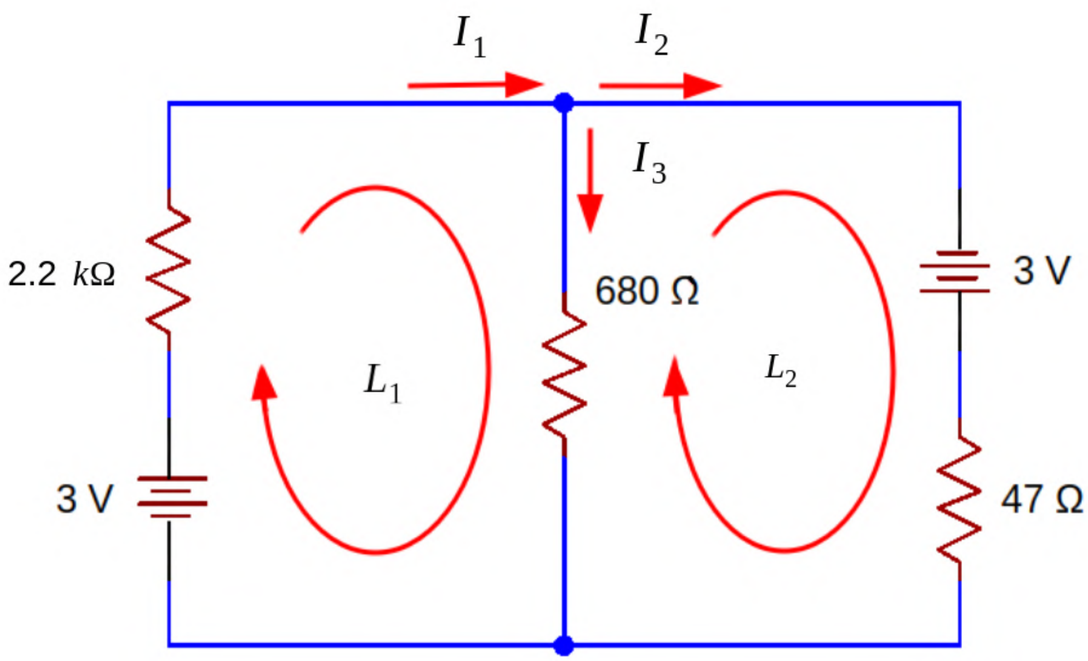


6.3.3 Example

Calculate the voltage around the resistors.



In this case, we are going to use Kirchhoff's law, we need to suppose the paths for the current to use Kirchhoff's current law, and we need to suppose two loops to use Kirchhoff's voltage law.



To use Kirchhoff's voltage law, we need to know some rules, for example, in L_1 if the loop passes the battery from - to + we write it in the equation (+3 V), but if the loop passes the battery from + to - we write it in the equation (-3 V). Let us take 2.2 $k\Omega$ resistor as an example, if the loop passes the resistor in the same direction with the current we write it $\left(-\ 2.2\ k\Omega\ \cdot\ I_1\right)$, but if the loop passes the resistor in the opposite direction with the current we write it $(+\ 2.2\ k\Omega \cdot I_1)$.

We get this equation from L_1.

Equation 1: $3\ V\ -\ (I_1 \cdot 2.2\ k\Omega)\ -\ (I_3 \cdot 680\ \Omega)\ =\ 0\ V$

We get this equation from L_2.

Equation 2: $(I_3 \cdot 680\ \Omega)\ +\ 3\ V\ -\ (I_2 \cdot 47\ \Omega)\ =\ 0\ V$

We get this equation from **the node**.

Equation 3: $I_1\ =\ I_2\ +\ I_3$

Now, let us do some math to calculate I_1, I_2 and I_3.

Equation 1: $3\ V\ -\ (I_1 \cdot 2.2\ k\Omega)\ -\ (I_3 \cdot 680\ \Omega)\ =\ 0\ V$

$$3\ V\ -\ (I_3 \cdot 680\ \Omega)\ =\ I_1 \cdot 2200\ \Omega$$

$$I_1 = \frac{3\ V}{2200\ \Omega} - \frac{I_3 \cdot 680\ \Omega}{2200\ \Omega}$$

$I_1\ =\ 0.001363\ A\ -\ (I_3 \cdot 0.3091) \rightarrow$ This becomes equation 4

Equation 2: $(I_3 \cdot 680\ \Omega)\ +\ 3\ V\ -\ (I_2 \cdot 47\ \Omega)\ =\ 0\ V$

$$I_2 \cdot 47\ \Omega\ =\ (I_3 \cdot 680\ \Omega)\ +\ 3\ V$$

$$I_2 = \frac{I_3 \cdot 680\ \Omega}{47\ \Omega} + \frac{3\ V}{47\ \Omega}$$

$I_2\ =\ (I_3 \cdot 14.468)\ +\ 0.0638\ A \rightarrow$ This becomes equation 5

Equation 4: $I_1\ =\ 0.001363\ A\ -\ (I_3 \cdot 0.3091)$

Equation 5: $I_2\ =\ (I_3 \cdot 14.468)\ +\ 0.0638\ A$

From **Equation 3:** $I_1\ =\ I_2\ +\ I_3$, we will use the derived I_1 and I_2 from previous calculation to get I_3, thus,

$$0.001363\ A\ -\ (I_3 \cdot 0.3091)\ =\ (I_3 \cdot 14.468)\ +\ 0.0638\ A\ +\ I_3$$

$$-\ I_3 \cdot 0.3091\ =\ (I_3 \cdot 14.468)\ +\ 0.0638\ A\ -\ 0.001363\ A\ +\ I_3$$

$$-\ I_3 \cdot 0.3091\ =\ (I_3 \cdot 14.468)\ +\ 0.062437\ +\ I_3$$

$$-\ 0.062437\ =\ (I_3 \cdot 0.3091)\ +\ (I_3 \cdot 14.468)\ +\ I_3$$

$$-\ 0.062437\ =\ 15.7771 \cdot I_3$$

$$I_3\ =\ -\ 0.003957\ A$$

Equation 4: $I_1\ =\ 0.001363\ A\ -\ (I_3 \cdot 0.3091)$

$$I_1\ =\ 0.001363\ A\ -\ (-\ 0.003957\ A \cdot 0.3091)$$

$$I_1\ =\ 0.001363\ A\ +\ 0.001223\ A$$

$$I_1\ =\ 0.002586\ A$$

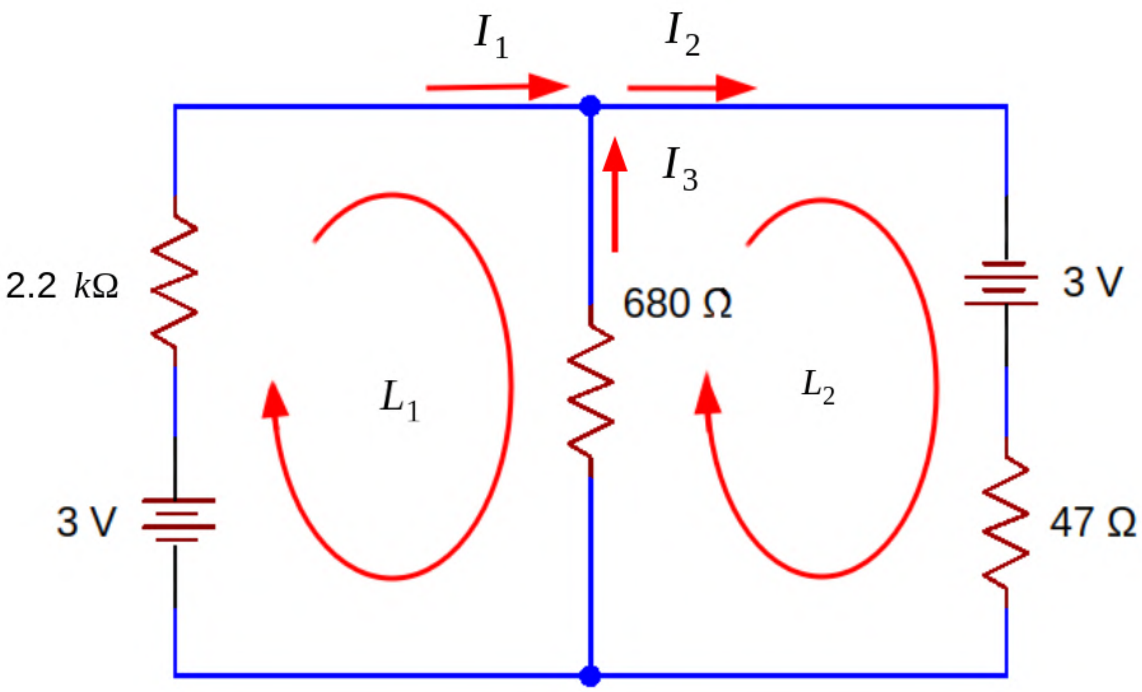
Equation 5: $I_2\ =\ (I_3 \cdot 14.468)\ +\ 0.0638\ A$

$$I_2\ =\ (-\ 0.003957\ A \cdot 14.468)\ +\ 0.0638\ A$$

$$I_2\ =\ -\ 0.05725\ A\ +\ 0.0638\ A$$

$$I_2\ =\ 0.00655\ A$$

Do not forget that we have supposed the directions of the currents, in the final answer if we get a positive answer, like I_1 and I_2 the direction we have supposed is true, but if we get a negative answer, like I_3 the direction we have supposed is wrong, so we must reverse it.



The equation $I_1 = I_2 + I_3$ will be changed to: $I_2 = I_1 + I_3$

Now, it is easy to calculate the voltage on the resistors using Ohm's law: $V = I \cdot R$

The voltage on 2.2 kΩ

$$V = I_1 \cdot 2.2\ k\Omega$$
$$V = 0.002586 \cdot 2200\ \Omega$$
$$V = 5.7\ V$$

The voltage on 680 Ω

$$V = I_3 \cdot 680\ \Omega$$
$$V = 0.003957 \cdot 680\ \Omega$$
$$V = 2.7\ V$$

The voltage on 47 Ω

$$V = I_2 \cdot 47\ \Omega$$
$$V = 0.00655\ A \cdot 47\ \Omega$$
$$V = 0.3\ V$$

Now, let us make this circuit in reality and measure the voltage around the resistors using the multimeter.

The measured voltage around the 2.2 kΩ resistor is 6.23 V.

Figure 20. The measured voltage in this figure is 6.23 V DC.

The measured voltage around the 680 Ω resistor is 2.94 V.

Figure 21. The measured voltage in this figure is 2.94 VDC.

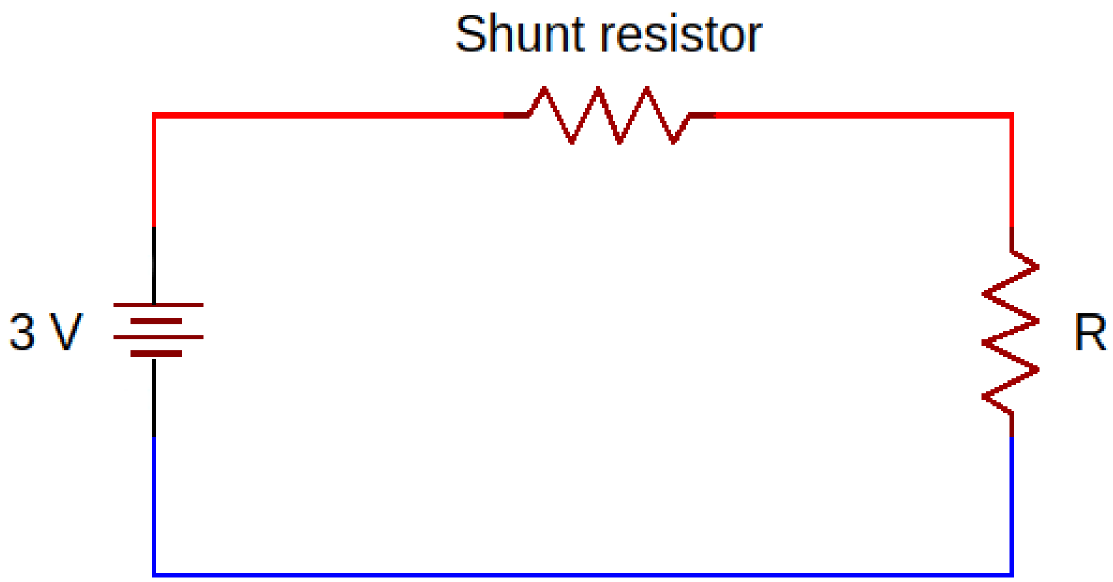
The measured voltage around the 47 Ω resistor is 0.33 V.

Figure 22. The measured voltage in this figure is 0.33 V DC.

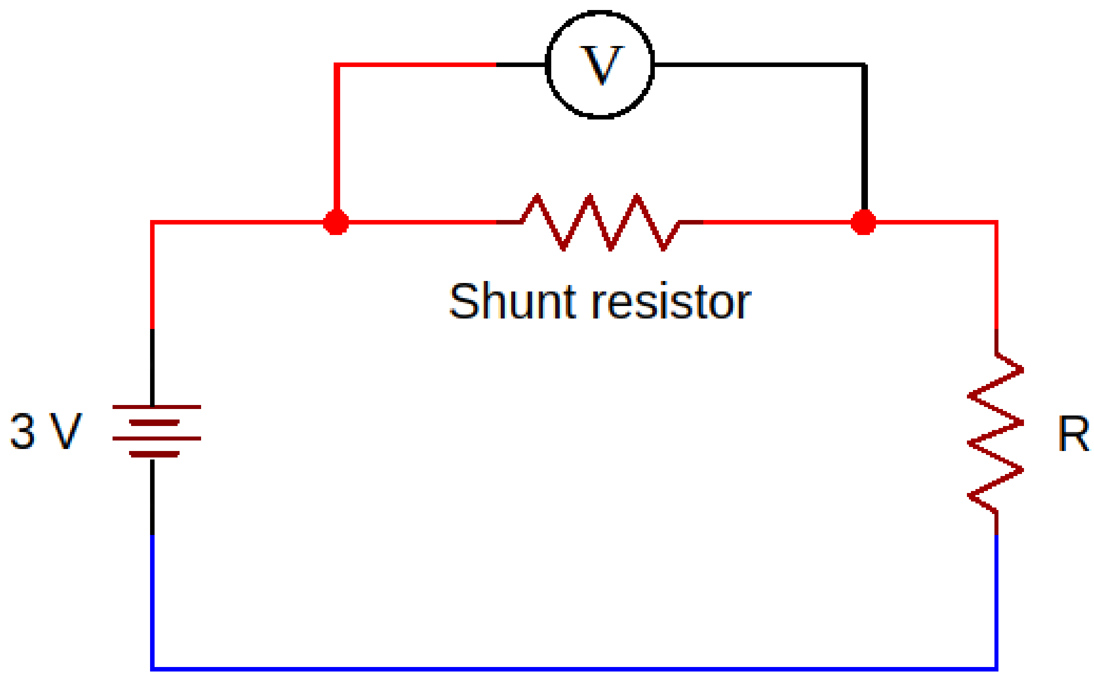
So we can count on our calculation, we will always find these small differences between the calculations and the real measurements because of the tolerance of the components.

6.4 Shunt Resistor

It is a way to measure current through a bath in the circuit using a small value resistor, we cut the circuit and connect it again using the shunt resistor. In most cases, it should be a high power resistor to handle the current passing through it.

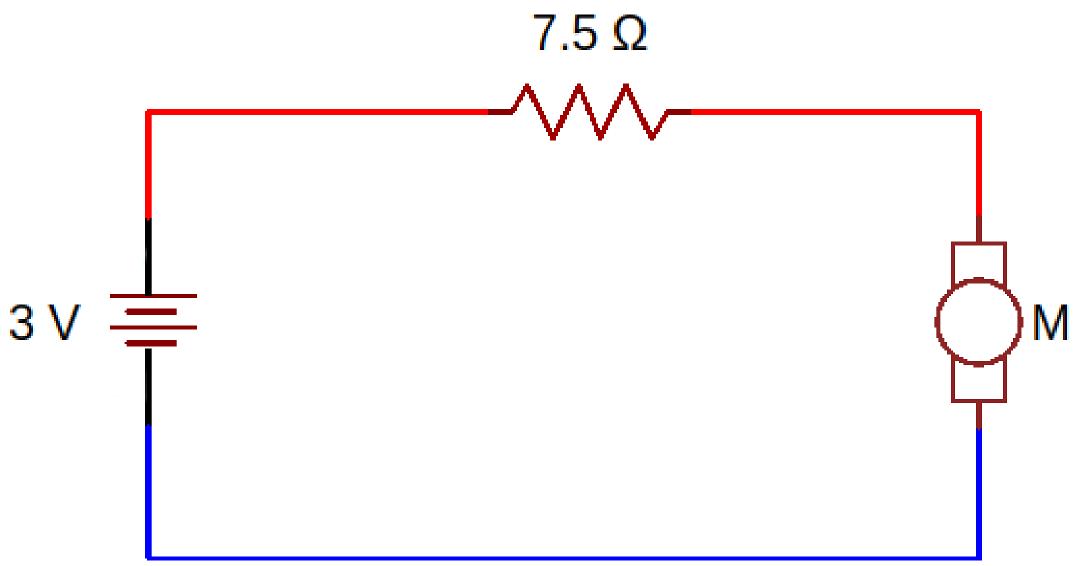


So depending on ohm's law "$V = I \cdot R$", we have a shunt resistor, and we have a current passing through it, so the voltage will be generated around it. And then we will measure this voltage using the multimeter, this way we have converted the current into voltage.



6.4.1 Example

In this circuit, we are going to use a 7.5 Ω resistor as a shunt, calculate the current using Ohm's law.



Now, we need to measure the voltage around the 7.5 Ω shunt resistor using the multimeter.

Figure 23. The measured voltage in this figure is 1.88 V DC.

Using Ohm's law "$V = I \cdot R$"

$$1.88\,V = I \cdot 7.5\,\Omega$$

$$I = \frac{1.88\,V}{7.5\,\Omega} = 0.251\,A = 251\,mA$$

Now, let us measure the current using the multimeter to compare it with our calculations.

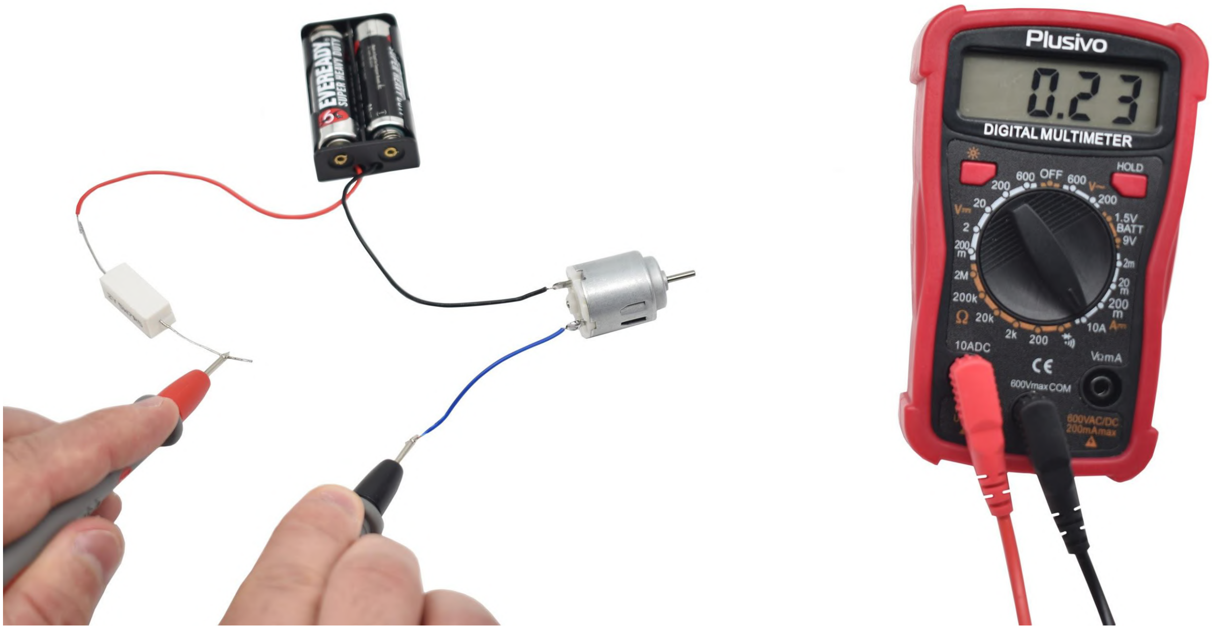


Figure 24. The measured current in this figure is 230 mA.

But there is a tolerance for the resistor, let us measure the resistor.

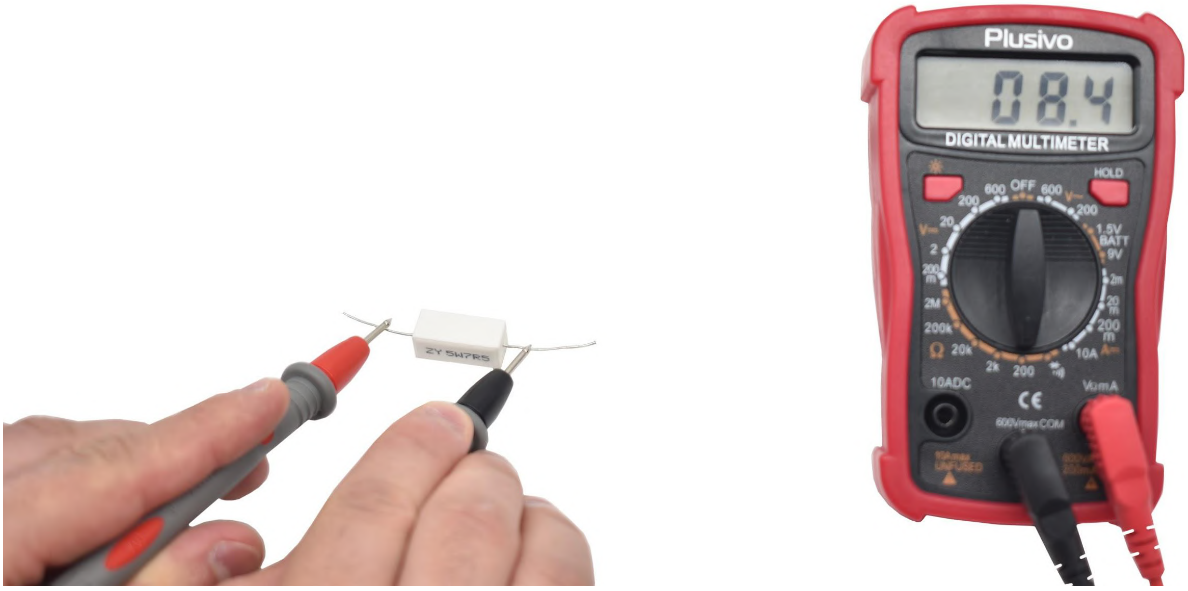


Figure 25. The measured resistance in this figure is 8.4 Ω.

If we calculate it again using Ohm's law "$V = I \cdot R$"

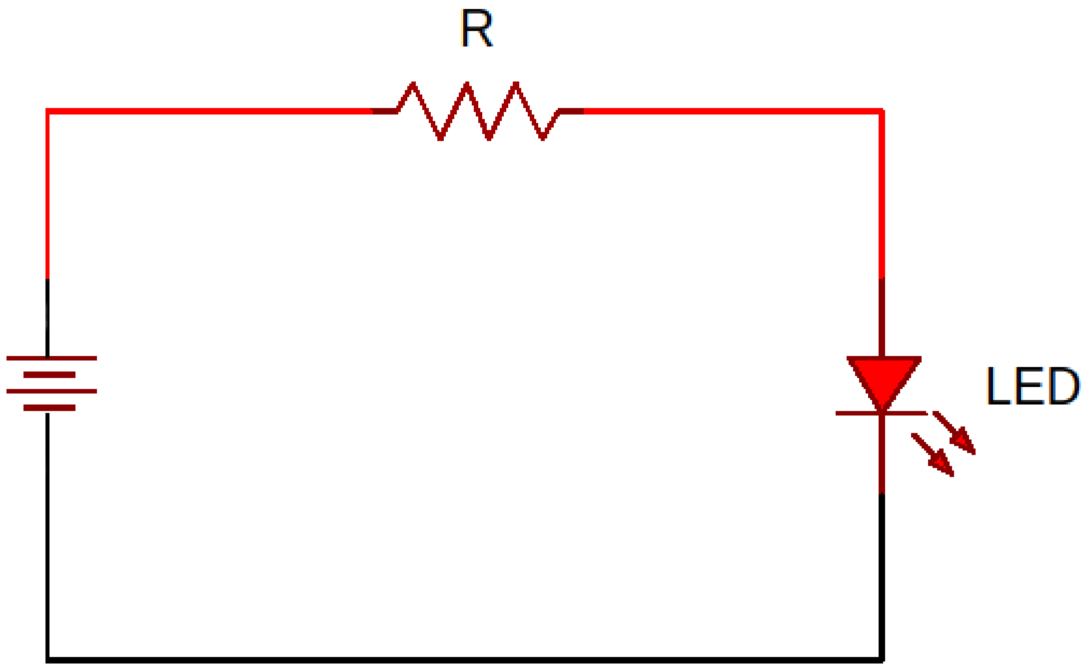
$1.88\,V = I \cdot 8.4\,\Omega$

$$I = \frac{1.88\,V}{8.4\,\Omega} = 0.224\,A = 224\,mA$$

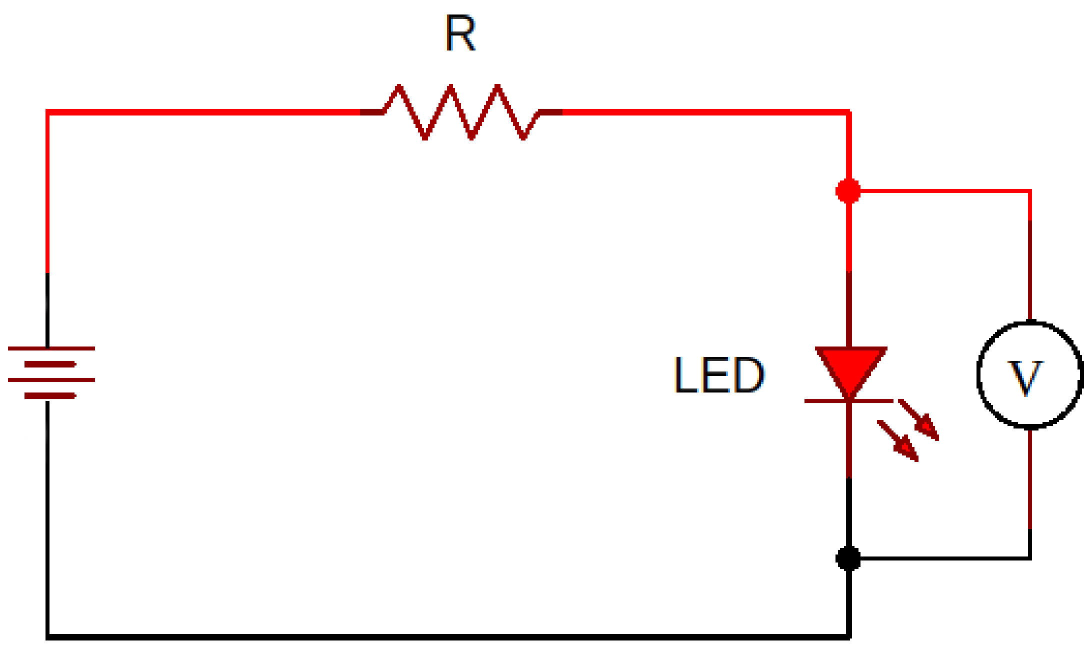
So, we can count on this way to measure the current, **224 mA** almost equal to **230 mA**.

6.5 Choosing the Right Resistor for an LED

To calculate the resistor for an LED, we need to know the forward voltage for the LED, LEDs are different from the resistors, we need to limit the current passing through it because it does not work on Ohm's law.



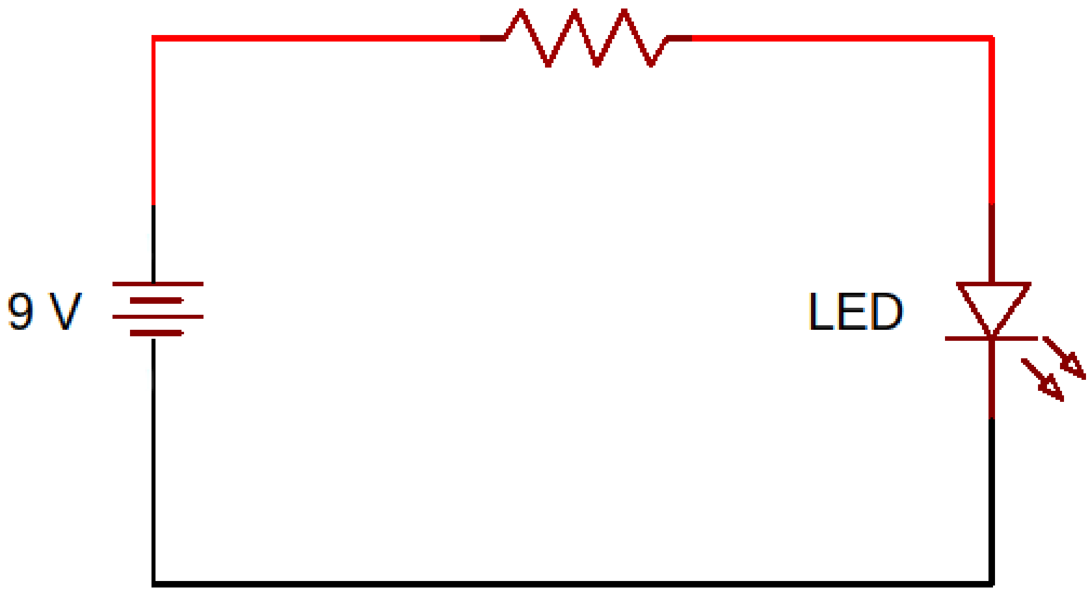
We need to know the voltage around the LED. Usually, a 5 mm LED needs 15 - 30 mA to be in good lighting. After knowing the forward voltage for the LED, it is easy to calculate the resistance.



To measure the forward voltage we connect a high value resistor, so we ensure that a low current will pass through the LED.

6.5.1 Example

Calculate the resistance in the following circuit for a red LED to make it consume around 20 mA.



Now, we need to build the circuit with a red LED, and we will use a high resistor, in our case, we will use a **2.2 kΩ** resistor and measure the forward voltage using the multimeter.

Figure 26. The measured voltage in this figure is 1.878 V DC

And if we measure the current in this circuit.

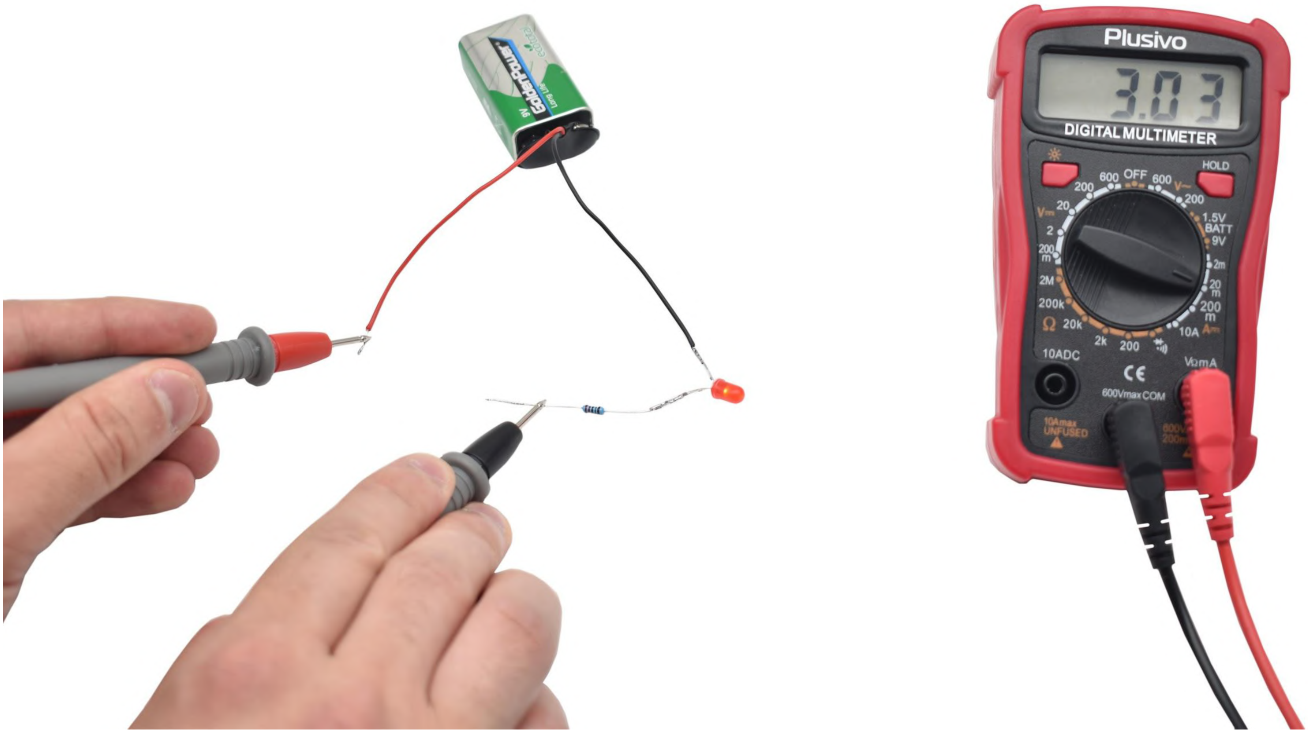


Figure 27. The measured current in this figure is 3.03 mA.

Now, let us calculate the value of the resistor. We have a **9 V** battery, the voltage on the LED is **1.878 V**, so the voltage on the resistor is: $9\,V - 1.878\,V = 7.122\,V$

Now, let us use Ohm's law:

$$R = \frac{V}{I}$$

$$R = \frac{7.122\,V}{20\,mA} = 356.1\,\Omega$$

And the closest standard value is 330 Ω.

Now, let us build the circuit again using a 330 Ω resistor and measure the forward voltage again and the current.

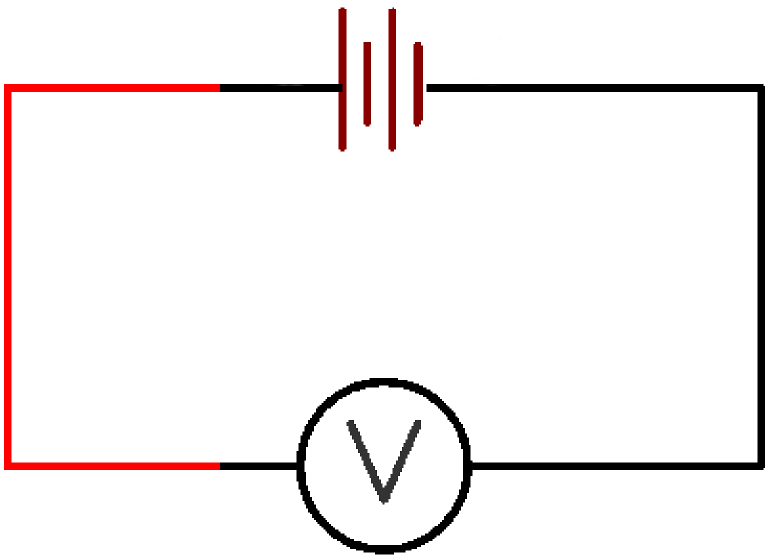
Figure 28. The measured voltage in this figure is 2.01 V DC.

Figure 29. The measured current in this figure is 18.82 mA.

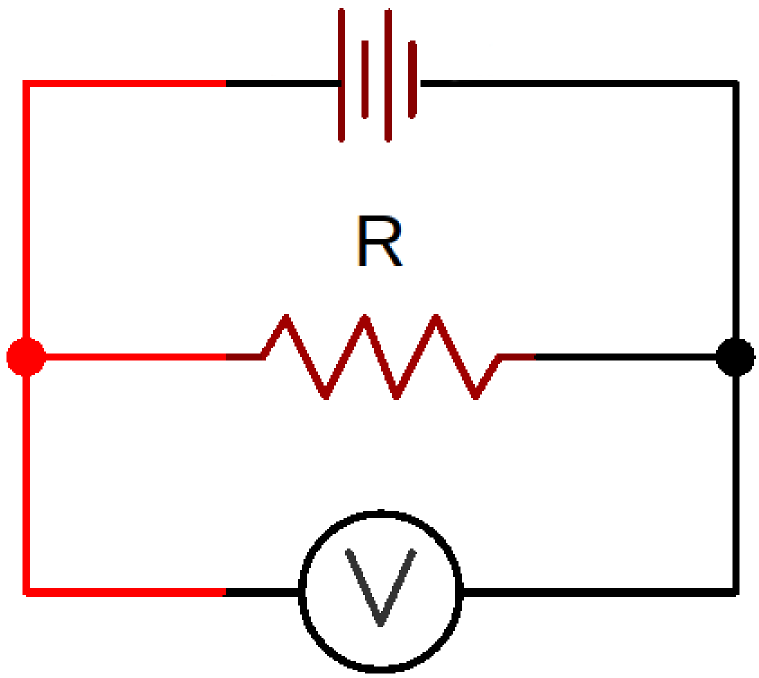
18.82 mA is so close to 20 mA.

6.6 Measuring Internal Resistance of a Battery

We need to follow these steps to measure the internal resistance of a battery using the multimeter. First, we need to measure the voltage of the battery.



Second, we connect a resistor with the battery and measure its voltage.



Third, we will do some calculations using Ohm's law.

- Calculate the current passing through the resistor: $\frac{R_V}{R} = I$
- Subtract the voltage of the battery from the voltage on the resistor: $B_V - R_V = B_{RV}$
- Now, we have the current and the voltage on the internal resistance, so we can calculate the value of the internal resistor: $\frac{V}{I} = I_{BR}$

6.6.1 Example

To measure the internal resistance of a 9 V battery, we need to measure the voltage of the battery first.

Figure 30. The measured voltage in this figure is 8.96 V DC.

Second, we connect a resistor with the battery and measure its voltage, in our case we will connect a 510 Ω resistor.

Figure 31. The measured voltage in this figure is 8.50 V DC.

Third, we will do some calculations using Ohm's law.

- Calculate the current passing through the resistor: $\frac{R_V}{R} = I$

$$\frac{8.50\,V}{510\,\Omega} = 0.0167\,A = 16.7\,mA$$

- Subtract the voltage of the battery from the voltage of the resistor: $B_V - R_V = B_{RV}$

$$8.96\,V - 8.50\,V = 0.46\,V$$

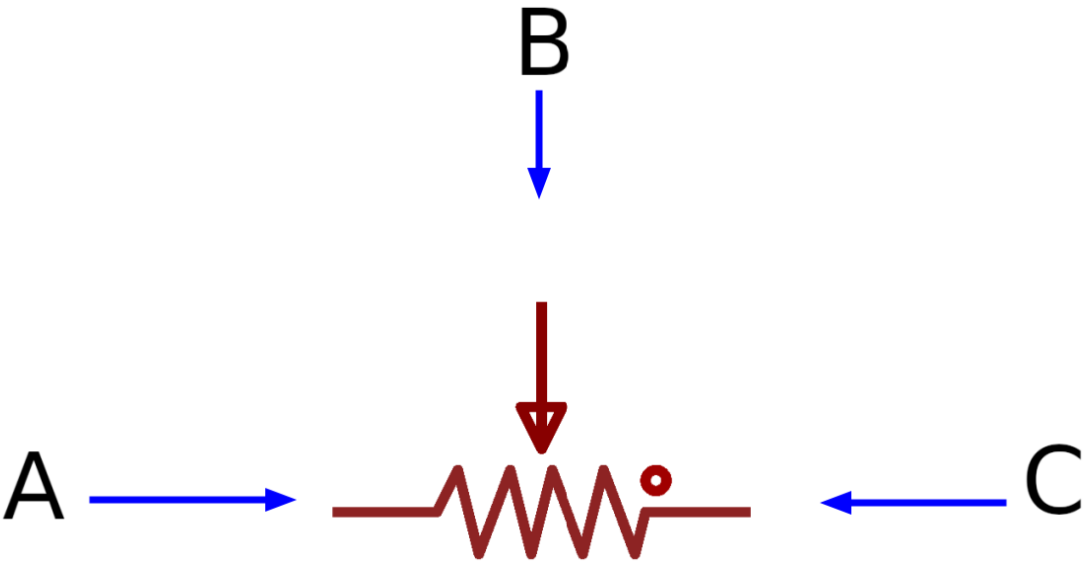
- Now, we have the current and the voltage on the internal resistance, so we can calculate the value of the internal resistor: $\frac{V}{I} = I_{BR}$

$$\frac{0.46\,V}{0.0167\,A} = 27.54\,\Omega$$

6.7 Testing Some Components Using Multimeter

In this section, we are going to test some components using a multimeter.

6.7.1 Potentiometer Test



First, we need to measure the resistance between A - C.

Figure 32. The measured resistance in this figure is 48.8 kΩ.

And then we measure the resistance between A - B and B - C, the sum of the two values must be equal to A - C.

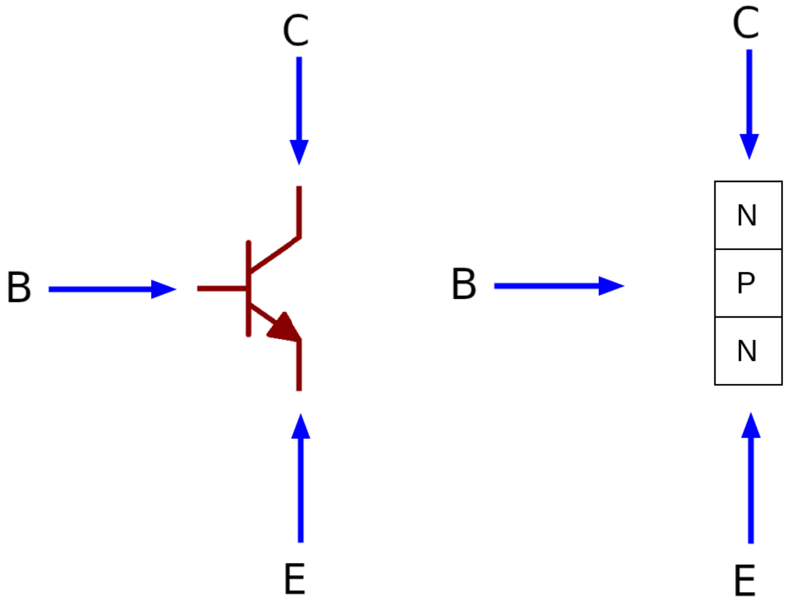
Figure 33. The measured resistance in this figure is 14.6 kΩ.

Figure 34. The measured resistance in this figure is 34.7 kΩ.

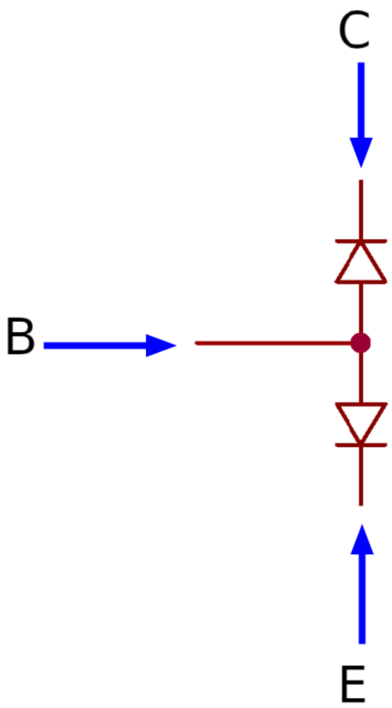
$14.6\ k\Omega\ +\ 34.7\ k\Omega\ =\ 49.3\ k\Omega$, which is almost equal to 48.8 kΩ

6.7.2 BJT Transistor Test

NPN



The NPN Type consists of two N-Regions separated by a P-Region, so we can suppose a diode between B - C and between B - E.



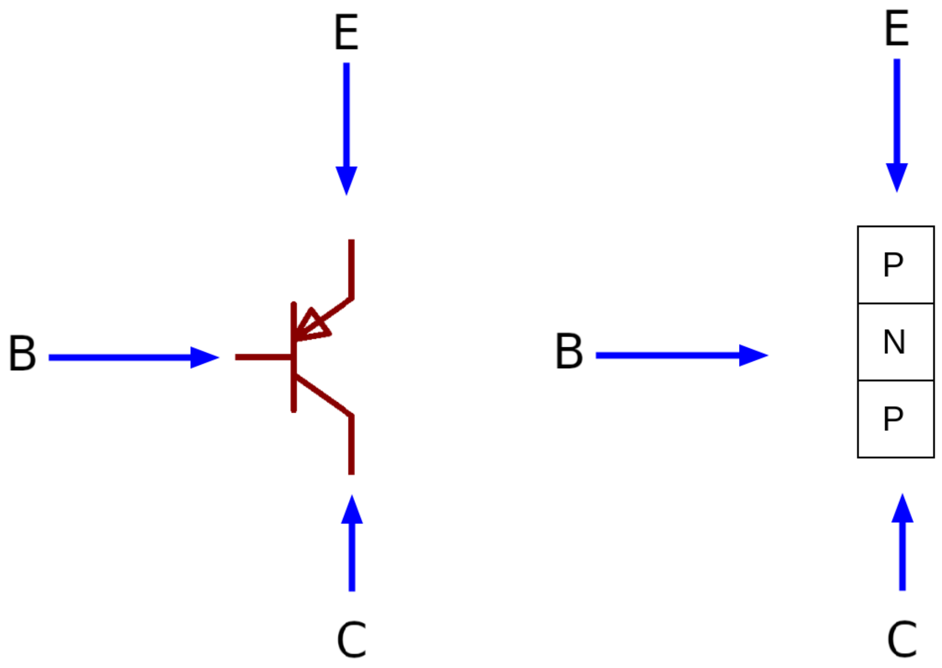
Now, we can test the NPN transistor as 2 diodes. To test the first diode (B - C), we need to connect the red probe to the anode which is the base of the transistor and connect the black probe to the cathode which is the collector of the transistor.

Figure 35. The measured forward voltage in this figure is 0.667 V.

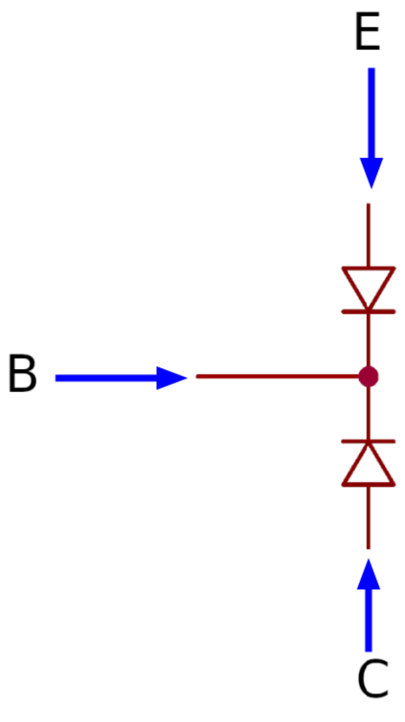
To test the second diode (B - E), we need to connect the red probe to the anode which is the base of the transistor and connect the black probe to the cathode which is the emitter of the transistor.

Figure 36. The measured forward voltage in this figure is 0.669 V.

PNP



The PNP type consists of two P-Regions separated by N-Region, so we can suppose a diode between B - C and between B - E.



Now, we can test the PNP transistor as 2 diodes. To test the first diode (B - E), we need to connect the black probe to the cathode which is the base of the transistor and connect the red probe to the anode which is the emitter of the transistor.

Figure 37. The measured forward voltage in this figure is 0.671 V.

To test the second diode (B - C), we need to connect the black probe to the cathode which is the base of the transistor and connect the red probe to the anode which is the collector of the transistor.

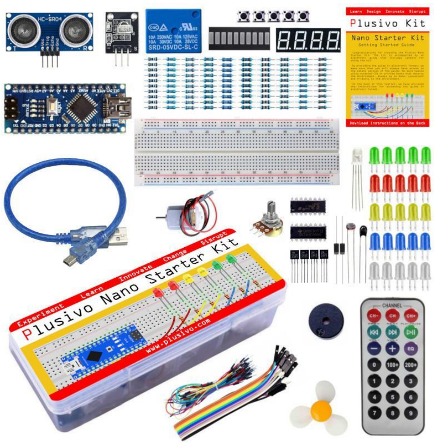
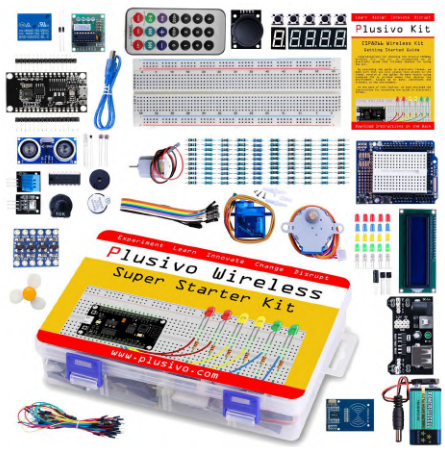
Figure 38. The measured forward voltage in this figure is 0.672 V.

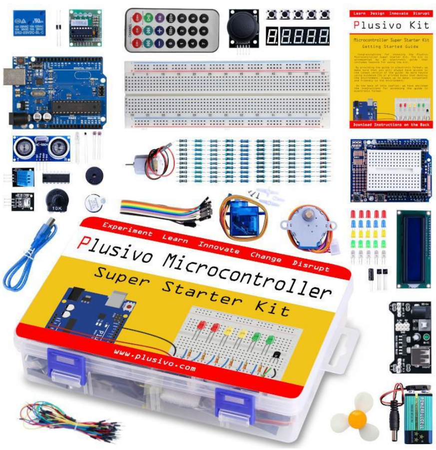
PLUSIVO KITS

MULTIMETER KITS

Digital Multimeter Kit	AC Current Clamp Meter	AC/DC Clamp Meter
		

KITS FOR LEARNING ELECTRONICS

Nano Super Starter Kit	Wireless Super Starter Kit with ESP8266 (Programmable With Arduino IDE)
	

Microcontroller Super Starter Kit	Pi 4 Super Starter Kit
	

SOLDERING KITS

Soldering Kit V0	Soldering Kit V1	Soldering Kit with Multimeter	Soldering Kit V3
			

WIRE KITS

A. 6 spools of different colors

Stranded Silicone Coated Wires	Gauge/No. of Strands	Length
	18 AWG / 150 strands	5 meters each color
	20 AWG / 100 strands	7 meters each color
	22 AWG / 60 strands	7 meters each color
	24 AWG / 40 strands	9 meters each color
	30 AWG / 11 strands	20 meters each color

Solid PVC Coated Wires	Gauge	Length
	18 AWG	5 meters each color
	20 AWG	7 meters each color
	22 AWG	10 meters each color
	24 AWG	11 meters each color

B. 2 colors (Red and Black)

12 Gauge Silicone Wire Kit	Length / Number of Strands
	3 m each color / 680 strands
	8 m each color / 680 strands

LED KITS

3mm and 5mm LED Kit (310 pcs)	5 mm Diffused LED Kits (600 pcs)
	

3 mm Diffused LED Kits (1000 pcs)	3 mm Clear Lens LED Kits (1000 pcs)
	

OTHER PLUSIVO KITS

Resistor Kit	Transistor Kit
	

Dupont Connector Kit	Potentiometer Kit
	

Pi 4 Power Adapter Kit	Solder Wire and Paste Kit
	

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