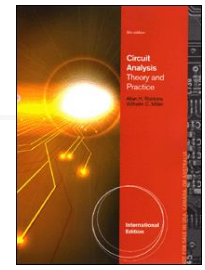


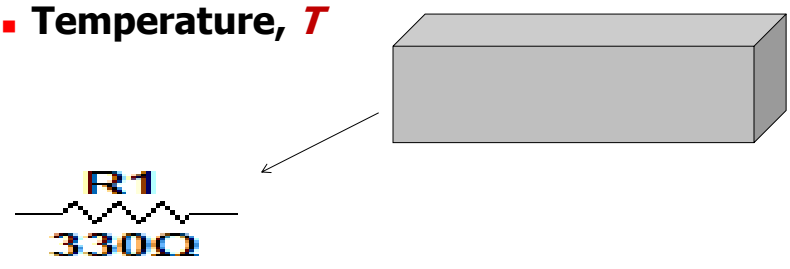
Chapter 03

Resistance

Resistance of Conductors

- **Resistance of material** depends on several factors:
  - **Type of Material, ρ**
  - **Conductor length, λ or *l***
  - **Cross-sectional area, *A***
  - **Temperature, *T***

$$R = \rho * l / A$$



Temperature Effects

- For **most conductors**, **a temperature increase causes an increase in resistance**.
  - Increase is relatively **linear**
  - Said to have a **positive temperature coefficient (PTC)**.

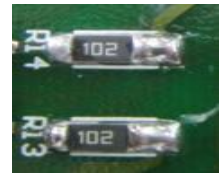
$T \uparrow \quad R \uparrow$

- In **semiconductors** and insulators, a temperature increase results in decrease in resistance.
  - Said to have a **negative temperature coefficient (NTC).**

$T \uparrow \quad R \downarrow$

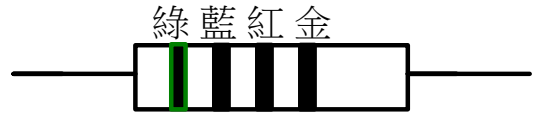
Color Coding of Resistors

- **Smaller resistors**:
  - **Surface Mount Devices**
  - **Use color coding**
  - Colored bands provide a recognizable code
  - Read from **left** to **right**
    - **Left** is defined as side of resistor **closest to band**



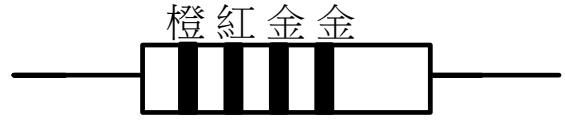
Example: 4-Color Code Resistor

Example 1:



$R = 56 \times 10^2\ \Omega \pm 5\% =$ **5.6kΩ ± 5%**

Example 2:



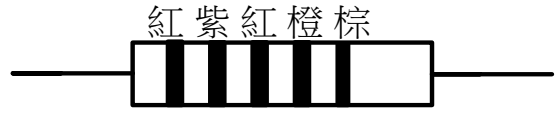
$R = 32 \times 10^{-1}\ \Omega \pm 5\% =$ **3.2Ω ± 5%**

5-Color Code Resistor

	Color 1	Color 2	Color 3	Color 4	Color 5
	Number 1	Number 2	Number 3	Powers of 10	Tolerance
黑Black	0	0	0	10^0	—
棕Brown	1	1	1	10^1	±1%
紅Red	2	2	2	10^2	±2%
橙Orange	3	3	3	10^3	—
黃Yellow	4	4	4	10^4	—
綠Green	5	5	5	10^5	±0.5%
藍Blue	6	6	6	10^6	—
紫Violet	7	7	7	10^7	—
灰Grey	8	8	8	10^8	—
白White	9	9	9	10^9	—
金Gold	—	—	—	10^{-1}	±5%
銀Silver	—	—	—	10^{-2}	±10%
—	—	—	—	—	—

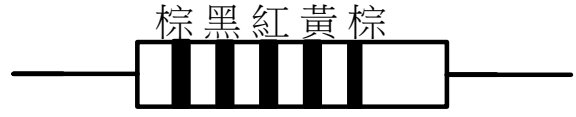
Example: 5-Color Code Resistor

Example 1:



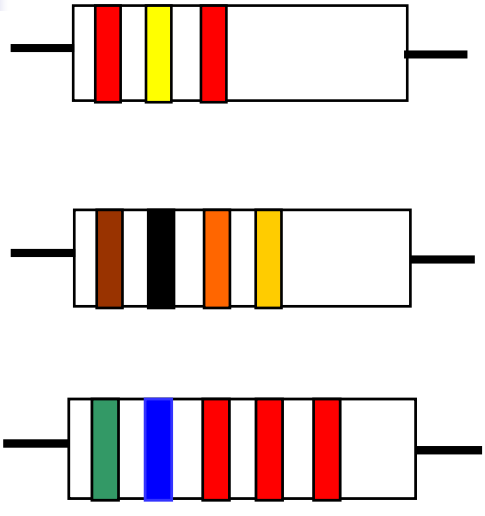
R = 272 x 10^3 Ω ± 1% = **272kΩ ± 1%**

Example 2:



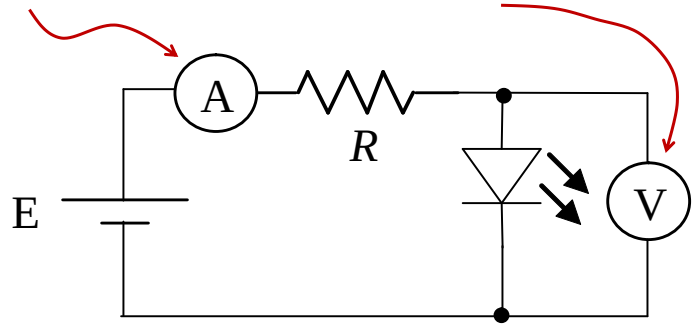
R = 102 x 10^4 Ω ± 1% = **1.02MΩ ± 1%**

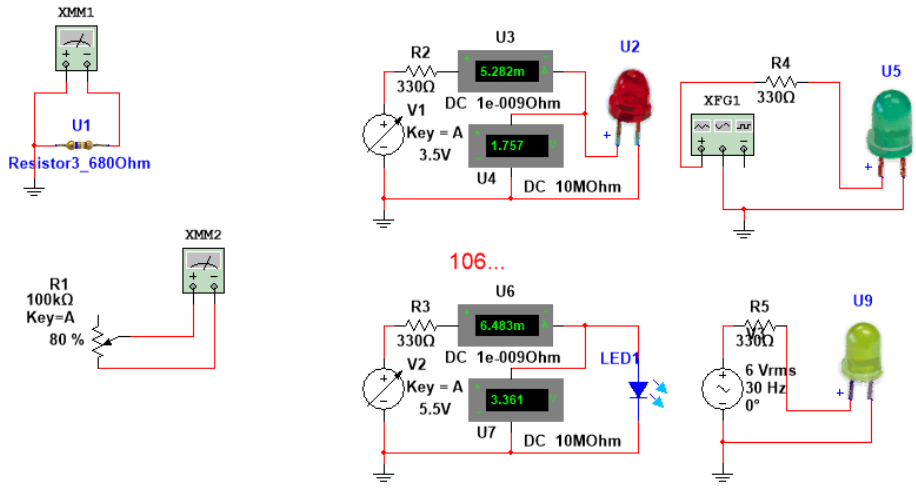
Exercise 3: What Resistances are for Color-code Resistors ?



LED – Light Emitting Diode

- In **reverse direction**, **LED off**.
- In **forward direction**, **LED on**,
  I_D=10~20mA , about V_{LED}= 1.7V





Kernel abilities

1. How to calculate the resistance of a wire? Please give an example.
2. How to recognize the resistance and tolerance of a color-code resistor? Please give an example.
3. What is the characteristics for a thermistor or a photoconductive cell? Please give their example.
4. What is LED and its characteristics? Please give an example.