Understanding the Resistor Color Code

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Resistor Color Code

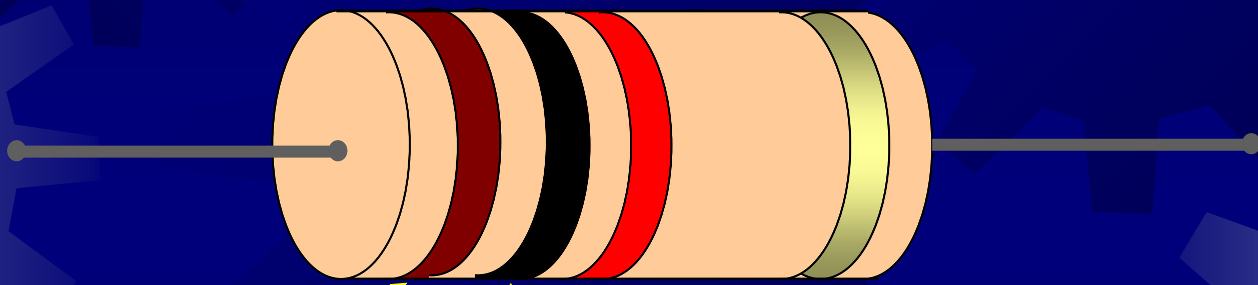
- Manufacturers typically use a color band system known as the resistor color code
- Within this power point, you will learn how to identify the nominal resistance and the tolerance of a resistor

Resistor Color Code

- The power rating is *not* indicated in the resistor color code and must be determined by experience using the physical size of the resistor as a guide.
- For resistors with ±5% or ±10% tolerance, the color code consists of 4 color bands.
- For resistors with ±1% or ±2% tolerance, the color code consists of 5 bands.

4-Band Resistors

The resistor nominal value is encoded in the color code in Powers of Ten Notation. The template for determining the nominal value and tolerance of a resistor with 4 color bands is given below:



1^{st} Band = 1^{st} Significant Digit

2^{nd} Band = 2^{nd} Significant Digit

3^{rd} Band = Multiplier

4^{th} Band = Tolerance

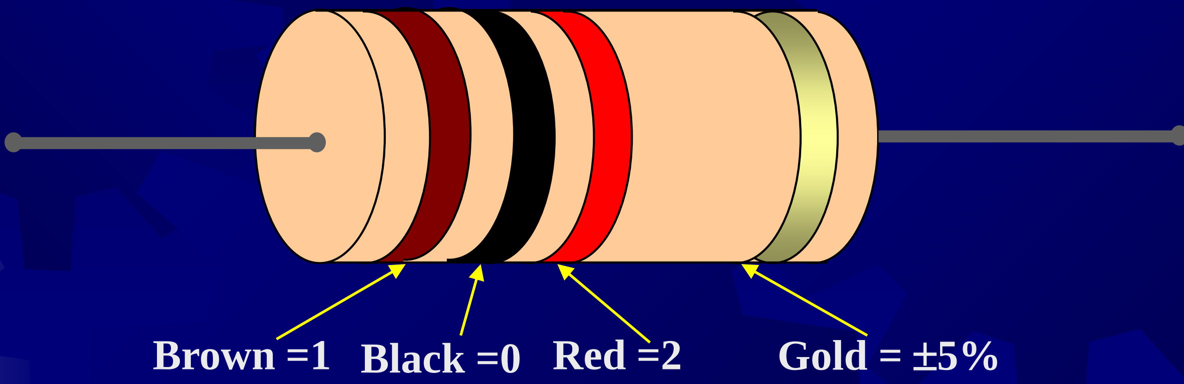
$$\_\_\_ \;\; \_\_\_ \times 10^{\_\_\_}\ \Omega \pm \_\_\_\_\ \%$$

How do we know which color corresponds to which number?

Answer: Using the Resistor Color Code Table

	Color	Digit	Multiplier	Tolerance
	Black	0	$10^0 = 1$	
	Brown	1	$10^1 = 10$	±1%
	Red	2	$10^2 = 100$	±2%
	Orange	3	$10^3 = 1,000$	
	Yellow	4	$10^4 = 10,000$	
	Green	5	$10^5 = 100,000$	
	Blue	6	$10^6 = 1,000,000$	
	Violet	7	$10^7 = 10,000,000$	
	Gray	8	$10^8 = 100,000,000$	
	White	9	$10^9 = 1,000,000,000$	
	Silver		$10^{-2} = 0.01$	±10%
	Gold		$10^{-1} = 0.1$	±5%
	No band	---	---------	±20%

Example 1. Determine the nominal resistance value and the tolerance for the resistor shown below.



Solution:

$$\underline{1}\ \ \underline{0} \times 10^{\underline{2}}\ \Omega \pm \underline{5}\ \%$$

Nominal value **= 10×10^{2}Ω**

= 1,000Ω

Tolerance = ±5%.

- It is typical to express the resistance value in:

  kΩ if the resistance ≥ 1,000Ω

  MΩ if the resistance ≥ 1,000,000Ω.

- To convert from Ω to kΩ, Ω to MΩ, or vice-versa, use the table below:

- In the previous example we would say the resistor has a nominal value of: $\frac{1{,}000\Omega}{1{,}000} = 1k\Omega$

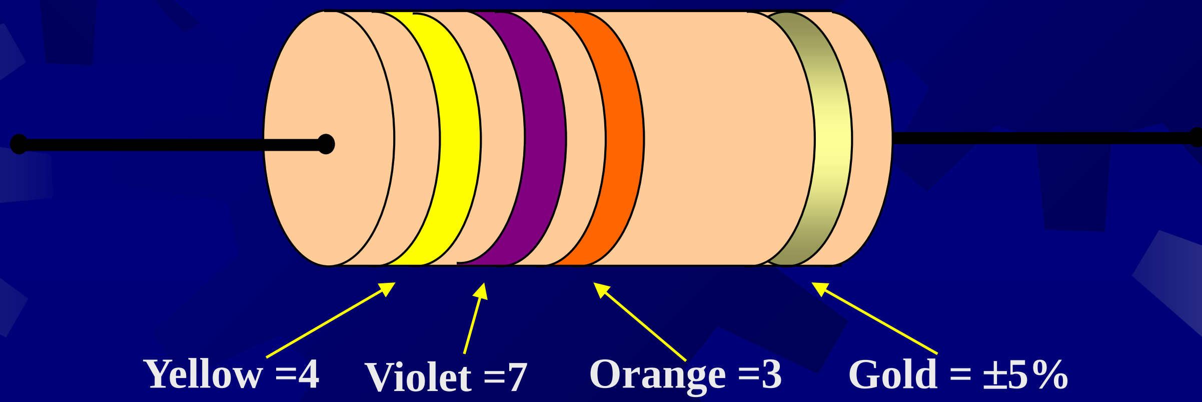
Table 2. Ω, kΩ, MΩ Conversion Table

To Convert From	To	Action
Ω	kΩ	Divide by 1,000
Ω	MΩ	Divide by 1,000,000
kΩ	Ω	Multiply by 1,000
MΩ	Ω	Multiply by 1,000,000

Example 2. a) Determine the nominal value and tolerance for the resistor below.

b) What is the minimum resistance value this resistor can actually have?

c) What is the maximum resistance value this resistor can actually have?



<u>Solution:</u>

$$\underline{4}\ \ \underline{7} \times 10^{\underline{3}}\ \Omega \pm \underline{5}\ \%$$

Resistor nominal value $= 47\times10^{3}\Omega$

$= 47{,}000\Omega$

$= 47\text{k}\Omega$.

Tolerance = ±5%

Solution: continued

- Minimum resistance value:

  Multiply the nominal value by the tolerance and then *subtract* this from the nominal value:

$$= 47k\Omega - 47k\Omega * 0.05$$
$$= 47k\Omega - 2.35k\Omega$$
$$= 44.65k\Omega$$

- Maximum resistance value:

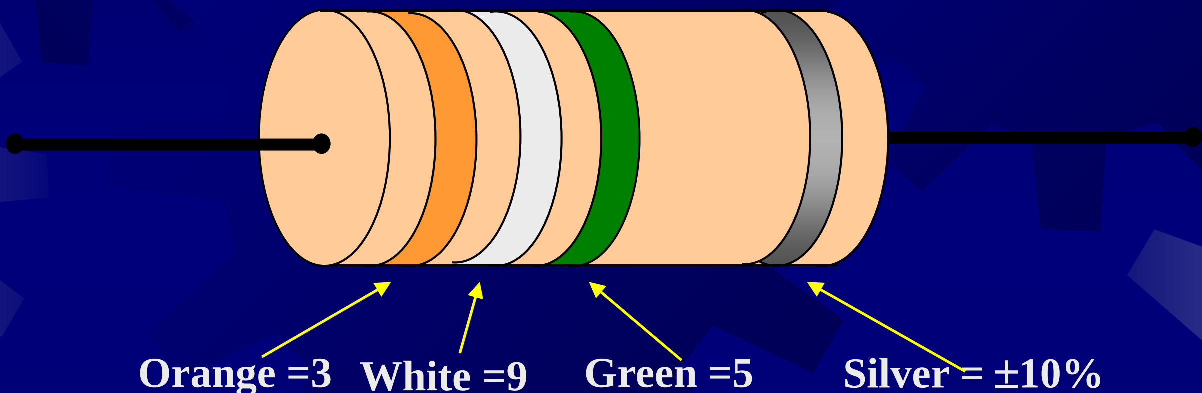
  Multiply the nominal value by the tolerance and then *add* this to the nominal value:

$$= 47k\Omega + 47k\Omega * 0.05$$
$$= 47k\Omega + 2.35k\Omega$$
$$= 49.35k\Omega$$

Example 3. a) Determine the nominal value and tolerance for the resistor below.

b) What is the minimum resistance value this resistor can actually have?

c) What is the maximum resistance value this resistor can actually have?



Solution:

$$\underline{3}\ \underline{9} \times 10^{\underline{5}}\ \Omega \pm \underline{10}\ \%$$

Resistor nominal value $= 39\times10^{5}\Omega$

$= 3{,}900{,}000\Omega$

$= 3.9\text{M}\Omega$.

Tolerance = $\pm 10\%$

Solution: continued

- Minimum resistance value:
  nominal value – nominal value * tolerance:

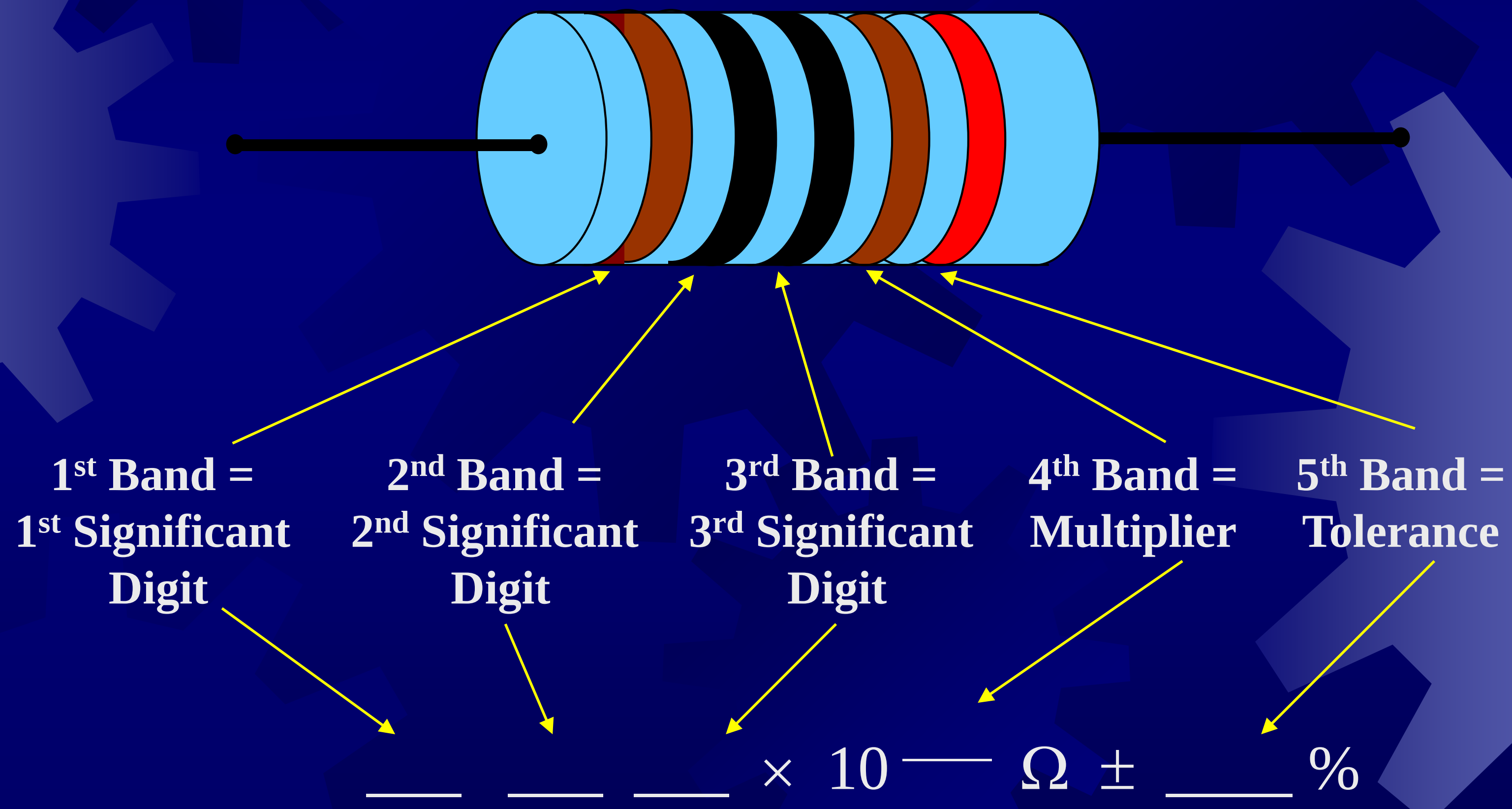
$$= 3.9M\Omega - 3.9M\Omega * 0.1$$
$$= 3.9M\Omega - 0.39M\Omega$$
$$= 3.51M\Omega$$

- Maximum resistance value:
  nominal value + nominal value * tolerance:

$$= 3.9M\Omega + 3.9M\Omega * 0.1$$
$$= 3.9M\Omega + 0.39M\Omega$$
$$= 4.29M\Omega$$

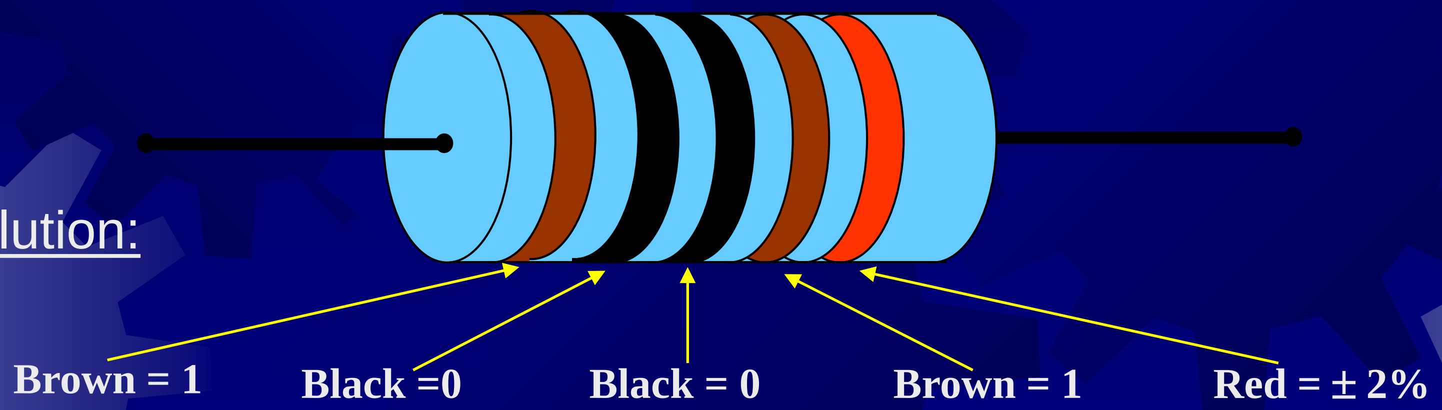
5-Band Resistors

- For resistors with ±1% or ±2% tolerance, the color code consists of 5 bands.
- The template for 5-band resistors is:



Example 4. Determine the nominal resistance and tolerance for the resistor shown below.

Solution:



$$\underline{\;1\;}\;\underline{\;0\;}\;\underline{\;0\;} \times 10^{\underline{1}}\;\Omega \pm \underline{\;2\;}\;\%$$

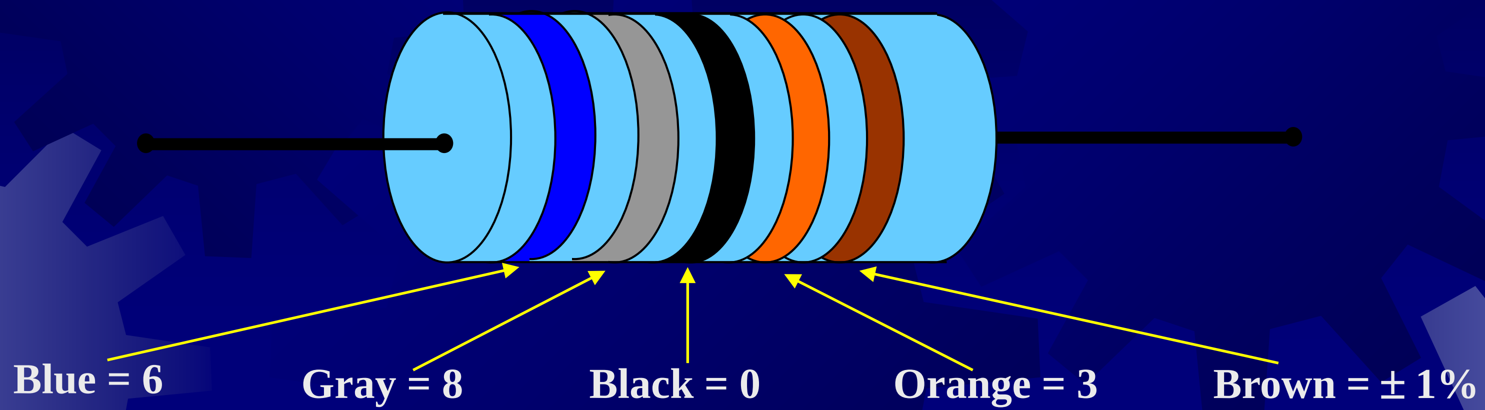
Resistor nominal value $= 100 \times 10^{1}\Omega$

$= 1{,}000\Omega$

$= 1\text{k}\Omega$.

Tolerance = $\pm 2\%$

Example 5. Determine the nominal resistance and tolerance for the resistor shown below.



Solution:

$$\underline{\ 6\ }\ \underline{\ 8\ }\ \underline{\ 0\ } \times 10^{\underline{3}}\ \Omega \pm \underline{\ 1\ }\ \%$$

Resistor nominal value $= 680 \times 10^{3} \Omega$

$= 680{,}000 \Omega$

$= 680 \text{k}\Omega$.

Tolerance = $\pm 1\%$

Which side of a resistor do I read from?

- A question that often arises when reading the color code of real resistors is: how do I determine which side of a resistor do I read from?

Answer:

- For 4-band resistors a gold or silver band is always the last band.
- If the resistor has 5 bands or if there is no tolerance band (±20%), then the first band is the one located closest to a lead.

Converting the Nominal Resistance and Tolerance into the Color Code

We are given the nominal value and the tolerance and we have to come up with the color code.

4-Band Resistors

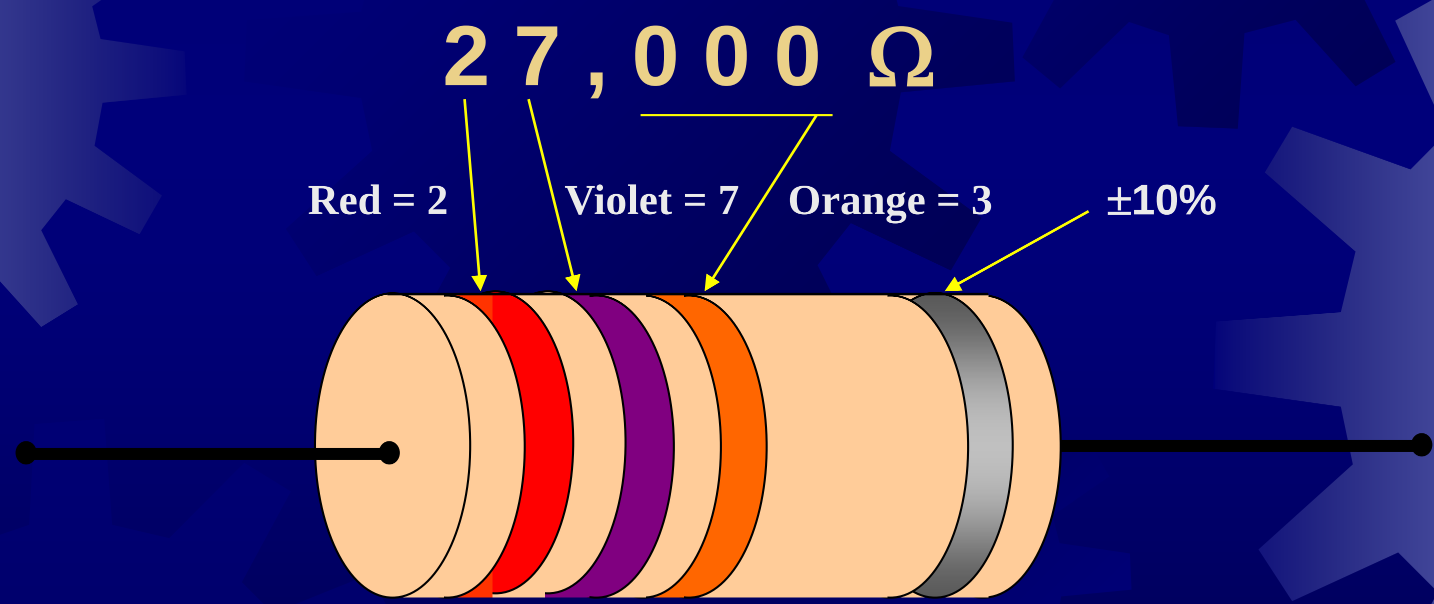
1. Resistors with ±5% and ±10% Tolerance will have **4-bands**
2. Convert nominal value to ohms (**Ω**)
3. 1st digit (from left to right) of nominal value = 1st color band
4. 2nd digit of nominal value = 2nd band
5. Number of zeros remaining = 3rd (multiplier) band
6. Tolerance = 4th band

Example 6. Specify the color code of a resistor with nominal value of 27kΩ and a tolerance of ±10%.

Solution:

1) Since resistor Tolerance = ±10% it will have 4-bands.

2) Convert the nominal resistance value to Ω from kΩ.



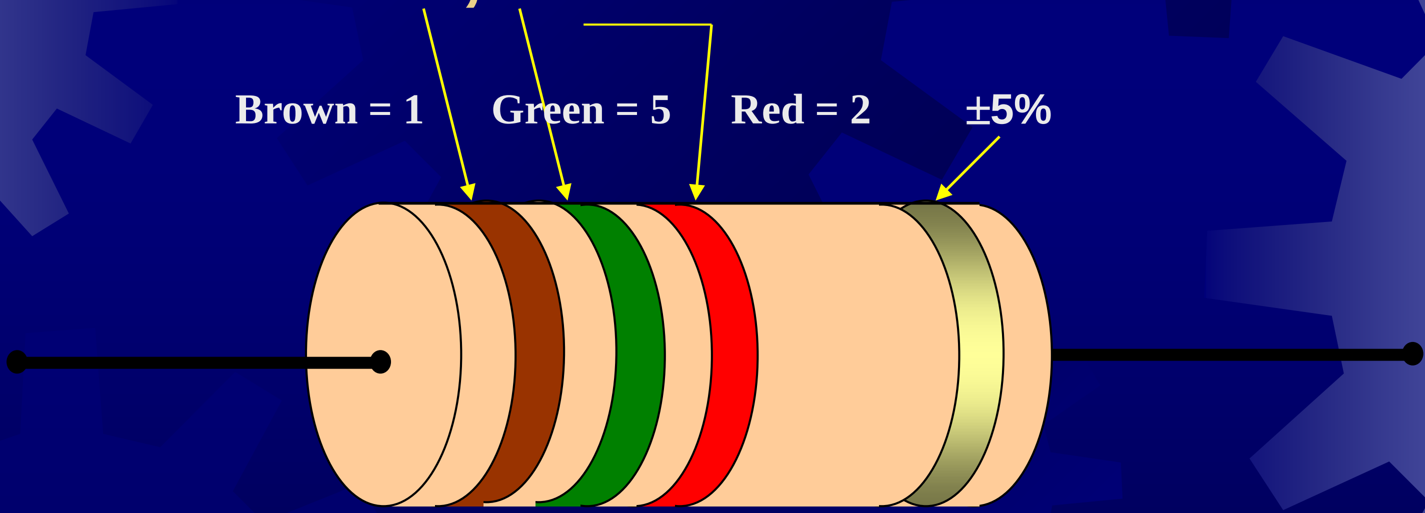
Example 7. Specify the color code of a resistor with nominal value of 1.5kΩ and a tolerance of ±5%.

Solution:

1) Since resistor Tolerance = ±5% it will have 4-bands.

2) Convert the nominal resistance value to Ω from kΩ.

1,500 Ω



Converting the Nominal Resistance and Tolerance into the Color Code

5-Band Resistors

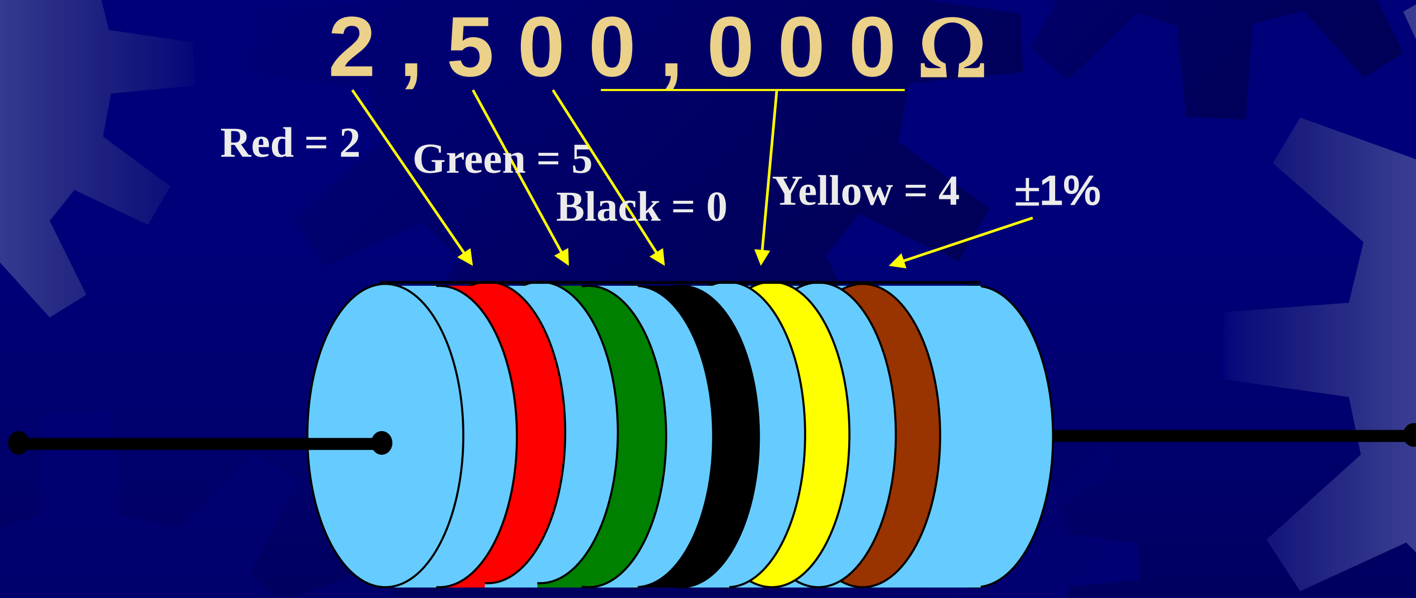
1. Resistors with ±1% and ±2% Tolerance will have **5-bands**
2. Convert nominal value to ohms (**Ω**)
3. 1st digit (from left to right) of nominal value = 1st color band
4. 2nd digit of nominal value = 2nd band
5. 3rd digit of nominal value = 3rd band
6. Number of zeros remaining = 4th (multiplier) band
7. Tolerance = 5th band

Example 8. Specify the color code of a resistor with nominal value of 2.5MΩ and a tolerance of ±1%.

Solution:

1) Since resistor Tolerance = ±1% it will have 5-bands.

2) Convert the nominal resistance value to Ω from MΩ.



Congratulations!
You now know how to work with the resistor color code

It's that simple!