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Engineering Design Project-II
(UTA 024)

THAPAR INSTITUTE
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Engineering Design-III
(UTA 011)
Buggy Lab

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- Resistor
- Classification and Identification

What are color codes?

In electronics, color codes are **a way of labelling** of passive electronic components such as **resistors** and, less frequently, **capacitors** and **inductances**.
The color coding standard is defined and maintained by the International Electrotechnical Commission and described in the IEC 60062 publication (the document is better known just as IEC 62).

Apart from this formal aspect, the two most important reasons for their popularity are:
Optimal readability: Reading a **sequence of colored rings** painted around cylindrical resistors is much easier then reading a sequence of serigraphed numerals on objects of the same size.

Low cost: In automated production, marking small cylinders with colored rings is much easier than printing numbers on them.

Advantages of color coding

Fig. 1

Classification of Resistor

There are different types of resistors available in the market with diverse rating and sizes. Some of these are described below.

- ❖Wire wound resistors
- ❖Metal film resistors
- ❖Thick film and Thin film resistors
- ❖Network and Surface Mount Resistors
- ❖Variable Resistors
- ❖Special resistors (LDR)

Wire wound Resistors

These resistors vary in physical appearance and size. These wire-wound resistors are commonly a length of wires usually **made** of an **alloy** such as **nickel chromium** or **copper-nickel manganese** alloy. These resistors are the oldest type of resistors having excellent properties like **high power ratings** and **low resistive values**. During their use, these resistors can become very hot, and for this reason these are housed in a finned metal case

Fig. 2

Metal film Resistor

These resistors are made from **metal oxide** or small rods of **ceramic-coated metal**. These are similar to carbon-film resistors and their resistivity is controlled by the thickness of the coating layer. The properties like **reliability**, **accuracy** and **stability** are considerably **better** for these resistors. These resistors can be obtained in a wide range of resistance values (from a few ohms to millions of ohms).

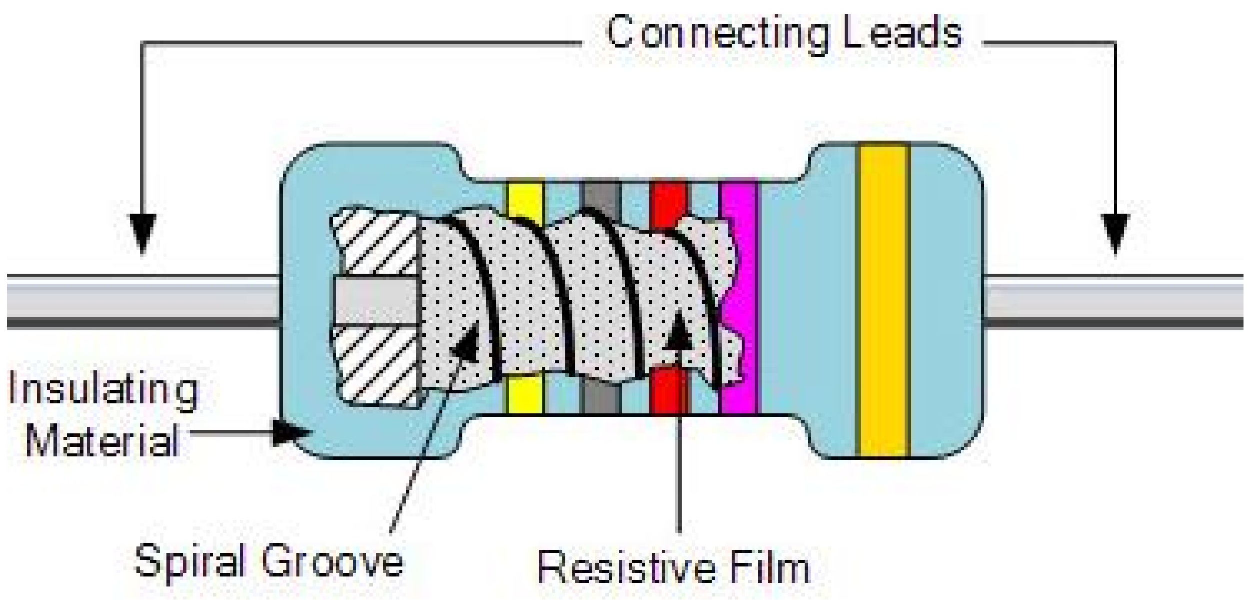


Fig. 3

Thick film and Thin film Resistors

Usually **thick film** resistors are **made** by **mixing ceramics** with **powered glass**, and these films have **tolerances** ranging from **1 to 2%,** and a temperature coefficient between + 200 or +250 and -200 or -250.

These resistors are preferred for **microwave** active and passive power components such as microwave power terminations, microwave power resistors and microwave power attenuators. These are mostly **used** for applications that require **high accuracy and high stability**.

Thin film resistors are **made** by **sputtering some resistive material** on to an **insulating substrate** (a method of vacuum deposition), and are therefore **more expensive than the thick film** resistors. Thin film resistors have better temperature coefficients, lower capacitance, low parasitic inductance and low noise.

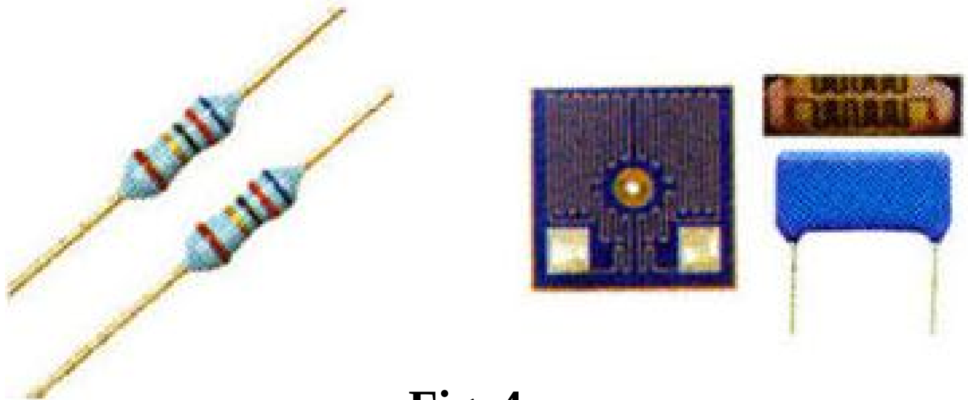


Fig. 4

Thin film resistors

Thick film resistors

Surface mount Resistors

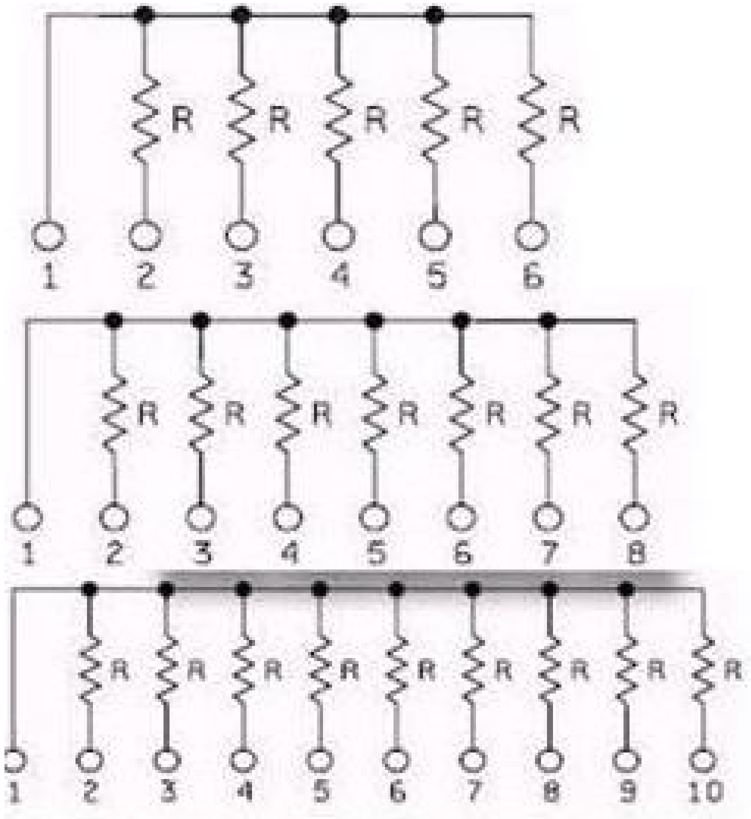
Surface mount resistors come in a variety of packages size and shape agreed by the EIA (Electronic Industry Alliance). These are made by depositing a film of resistive material and **don't have enough space** for **color-code bands** owing to small size.

The **tolerance** may be as low as **0.02%** and consists of 3 or 4 letters as an indication. The smallest size of the 0201 package is a tiny 0.60mm x 0.30mm resistor and this three number code works in a similar way to the color code bands on wire-ended resistors.

Fig. 5

Network Resistors

Network resistors are a combination of resistances that give identical value to all pins. These resistors are available in dual inline and single inline packages. Network resistors are commonly used in applications such as ADC (**Analog to digital converters**) and **DAC,** pull up or pull down.



Network Resistor SIP package

DIP Network

SIP Network

Fig. 6

Variable Resistors

Most commonly used types of variable resistors are **potentiometers** and **presets**. These resistors consist of fixed value of resistance between two terminals and are mostly used for setting the sensitivity of sensors and voltage division. A wiper (moving part of the potentiometer) **changes the resistance** that can be rotated with the **help of a screw driver**.

These resistors have three tabs, in which the wiper is the middle tab that acts as a voltage divider, when all the tabs are used. When the middle tab is used along with the other tab, it becomes a rheostat or variable resistor. When only the side tabs are used, then it behaves as a fixed resistor.

Fig. 7

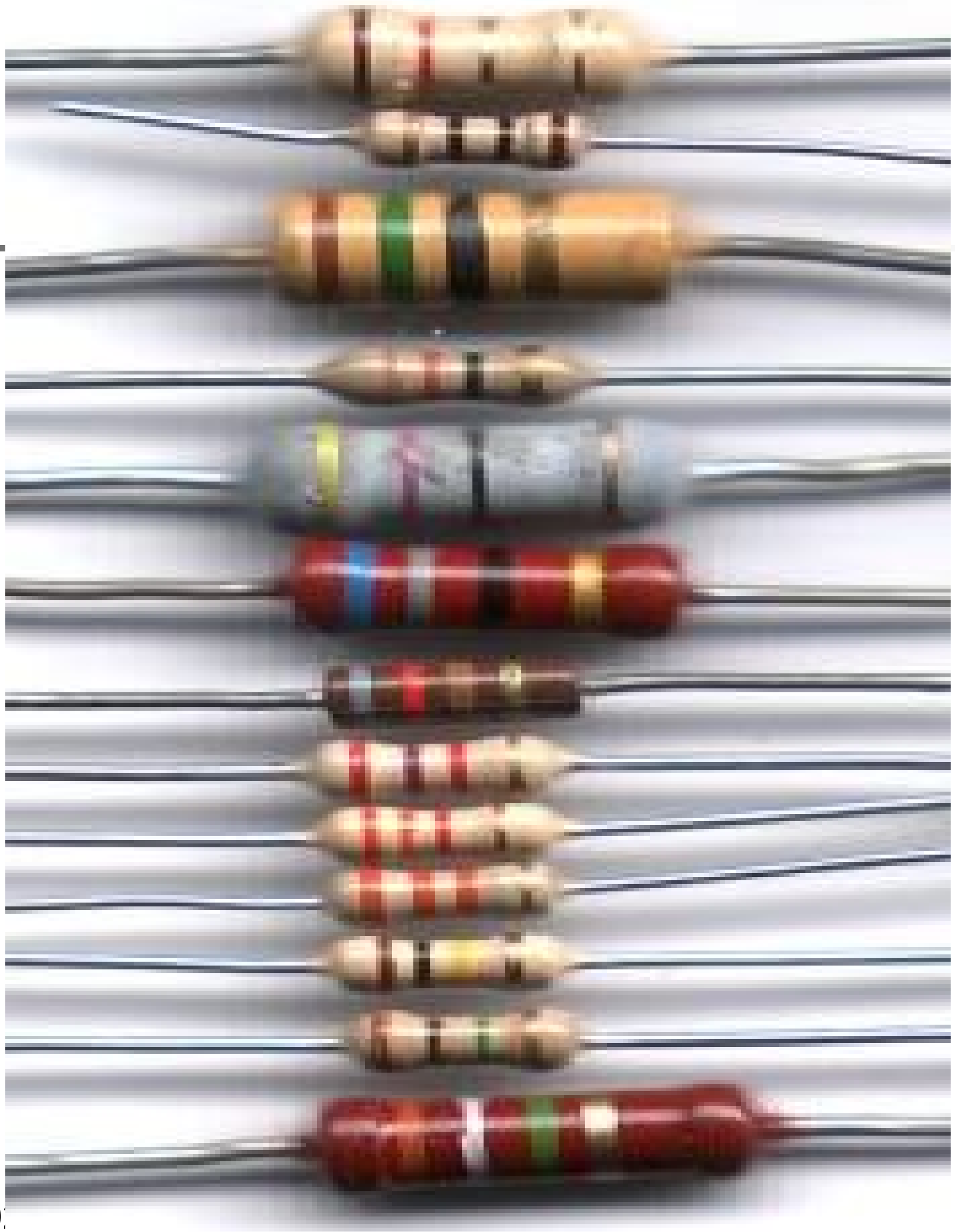
Light-dependent Resistors (LDR)

Light-dependent resistors are very useful in different electronic circuits, especially in clocks, alarms and street lights. When the resistor is in darkness, its resistance is very high (1 Mega Ohm) while in light, the resistance falls down to a few kilo Ohms.

These resistors come in different shapes and colors. Depending on the ambient light, these resistors are used to turn ‘on’ or turn ‘off’ devices.

Fig. 8

Metal and Thin-film Resistors



Color Codes

Table . Color codes used on passive electronic components

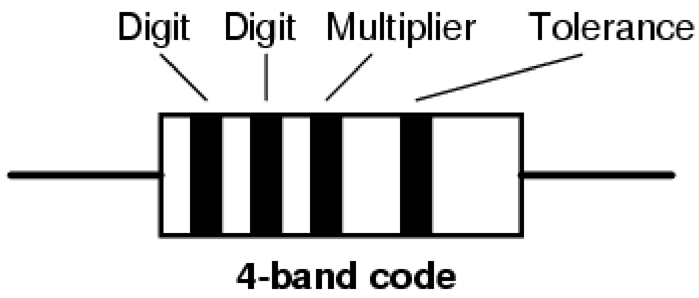
Color	digit	Multiplier: 10^digit	Resistors: tolerance	Temp.coef. ppm/°C
Silver		*0.01	10% (K)	not used
Golden		*0.1	5% (J)	not used
Black	0	*1	not used	not used
Brown	1	*10	1% (F)	100
Red	2	*100	2% (G)	50
Orange	3	*1 000	not used	15
Yellow	4	*10 000	not used	25
Green	5	*100 000	0.5% (D)	not used
Blue	6	*1 000 000	0.25% (C)	10
Violet	7	*10 M	0.1% (B)	5
Gray	8	*100 M	0.05%	not used
White	9	*1 G	not used	1
None				

ppm: parts-per million

Four band-color codes

A four-color code consists of a 3-color code for the numeric value (two bands for mantissa and one for exponent), followed by a *single color-band code for tolerance class*.

The tolerance classes covered by the 4-color codes are ±10% (silver), 5% (golden) and 2% (red).



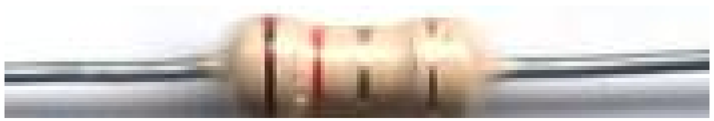


Fig. 9

The **Fig. 9** shows a color-coded 1.2 Ω resistor of ±5% tolerance class.

Five band-color codes

Five-color codes are very similar and consist of a 4-color code for the numeric value (three bands for mantissa and one for exponent), followed by a single color-band code for tolerance class.

The tolerance classes covered by 5-color codes are ±1% (brown), 0.5% (green), 0.25% (blue), 0.1% (violet) and the almost purely theoretical 0.05% (gray).

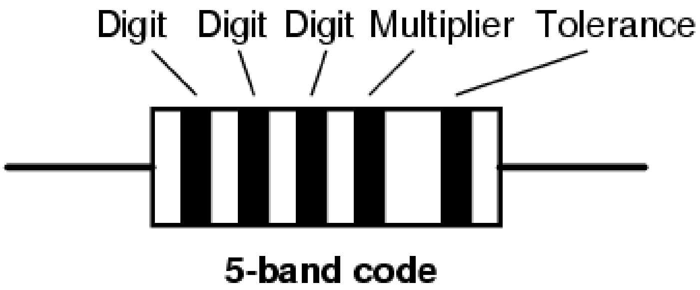
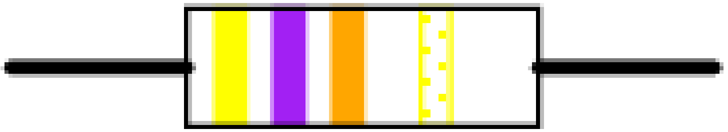


Fig. 10

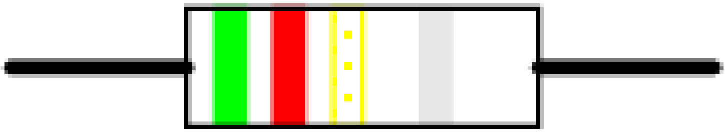
The **Fig. 10** shows a color-coded 1000 Ω resistor of ±1% tolerance class. Notice that in this case there is a legitimate doubt about orientation.

Examples:



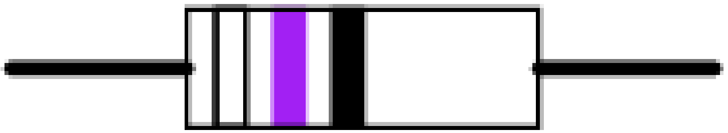
Yellow-Violet-Orange-Gold

A resistor colored *Yellow-Violet-Orange-Gold* would be 47 kΩ with a tolerance of +/- 5%.



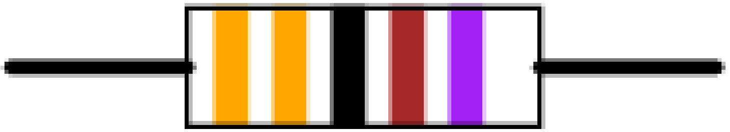
Green-Red-Gold-Silver

A resistor colored *Green-Red-Gold-Silver* would be 5.2 Ω with a tolerance of +/- 10%.



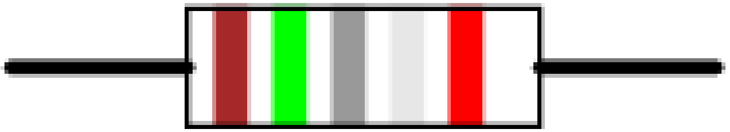
White-Violet-Black

A resistor colored *White-Violet-Black* would be 97 Ω with a tolerance of +/- 20%. When you see only three color bands on a resistor, you know that it is actually a 4-band code with a blank (20%) tolerance band.



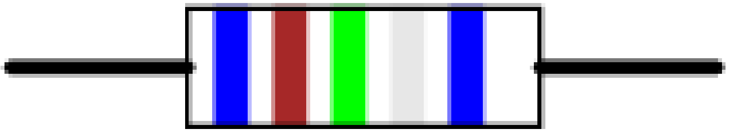
Orange-Orange-Black-Brown-Violet

A resistor colored *Orange-Orange-Black-Brown-Violet* would be 3.3 kΩ with a tolerance of +/- 0.1%.



Brown-Green-Grey-Silver-Red

A resistor colored *Brown-Green-Grey-Silver-Red* would be 1.58 Ω with a tolerance of +/- 2%.



Blue-Brown-Green-Silver-Blue

A resistor colored *Blue-Brown-Green-Silver-Blue* would be 6.15 Ω with a tolerance of +/- 0.25%.

Temperature coefficient band

Occasionally, one can encounter resistors with either **six color** bands or resistors with five bands, the last one of which the last one is anomalous for a tolerance class specification (orange, yellow or white). In such cases, the last band defines the worst-case temperature-dependence coefficient of the component.

As an example, the picture on the right shows a 15kΩ ±10% resistor with a temperature coefficient not worse than 25 ppm/°C.

Fig. 11

Temperature-tolerance color-coding is used very rarely and may differ slightly among producers. Consequently, whenever you see something out of ordinary, be careful, use your tester and, if still in doubt, check with the supplier.

A resistor's Temperature Coefficient of Resistance (TCR) tells how much its value changes as its temperature changes. It is usually expressed in ppm/°C (parts per million per degree Centigrade) units.

What does that really mean?

Let's use an example:

Riedon's 50 ohm 100 Series precision resistor has a (standard) TCR of 20ppm/°C. That means its resistance will not change more than 0.000020 ohms (20/1,000,000) per degree Centigrade temperature change (within the rated temperature range of -55 to +145°C, measured from 25°C room temperature.)

Thanks !