

Basic Electronics Series

Resistor Color Codes

Reading and Understanding the Codes

Resistor Color Codes

Most standard resistors today use a color-band code to identify the resistor values.

- Resistor Value
- Resistor Tolerance
- Resistor Temperature Coefficient*
- Resistor Failure Rate*

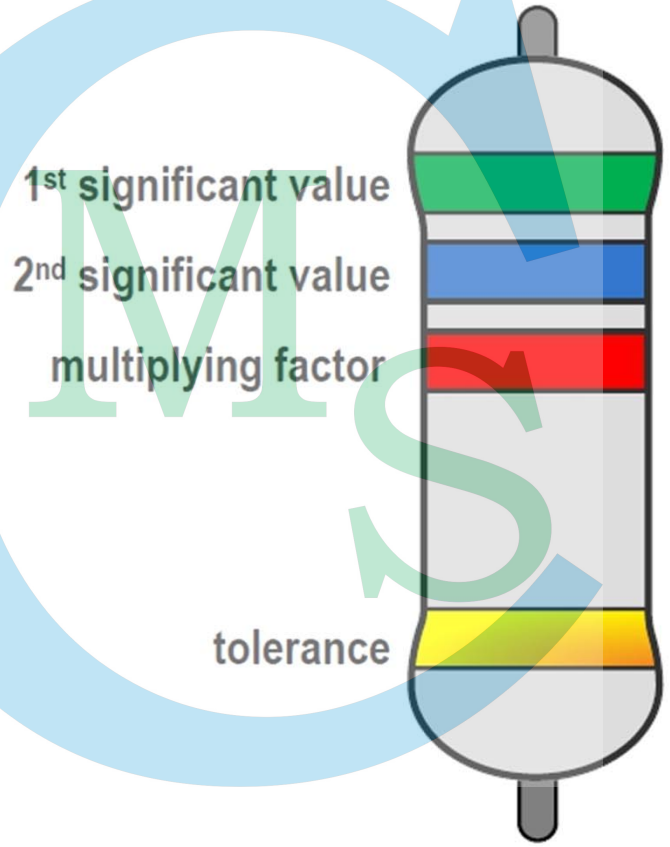
*The temperature coefficient is provided on 6-band resistors, which are not often seen in everyday use. The failure rate is a Mil-Spec requirement.

The Color Code

Color	1st Digit	2nd Digit	3rd Digit	Multiplier	Tolerance %	Temp. Coeff. ppm/K
Black	0	0	0	X1		250 (U)
Brown	1	1	1	X10	1 (F)	100 (S)
Red	2	2	2	X100	2 (G)	50 (R)
Orange	3	3	3	X1K		15 (P)
Yellow	4	4	4	X10K		25(Q)
Green	5	5	5	X100K	0.5 (D)	20 (Z)
Blue	6	6	6	X1M	0.25 (C)	10 (Z)
Violet	7	7	7	X10M	0.1 (B)	5 (M)
Grey	8	8	8	X100M	0.05 (A)	1 (K)
White	9	9	9	X1G		
Gold			3rd digit only for 5 and 6 bands	X0.1	5 (J)	
Silver				X0.01	10 (K)	
Blank					20 (M)	

3 and 4 Bands

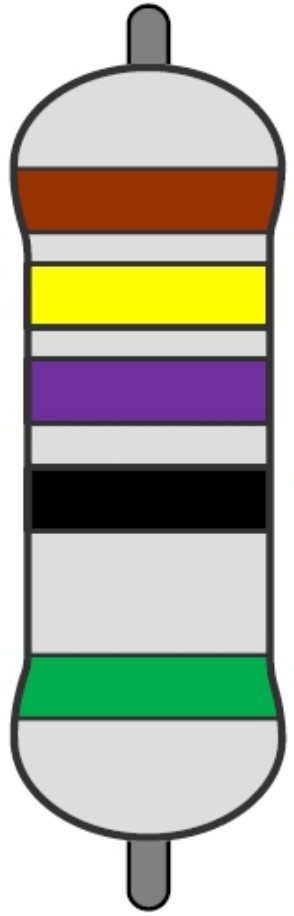
- 3- and 4-band resistors are read in the same manner.
  - » The only difference is that the 4-band resistor has a defined tolerance other than 20%.



5.6KΩ 5%

5 Bands

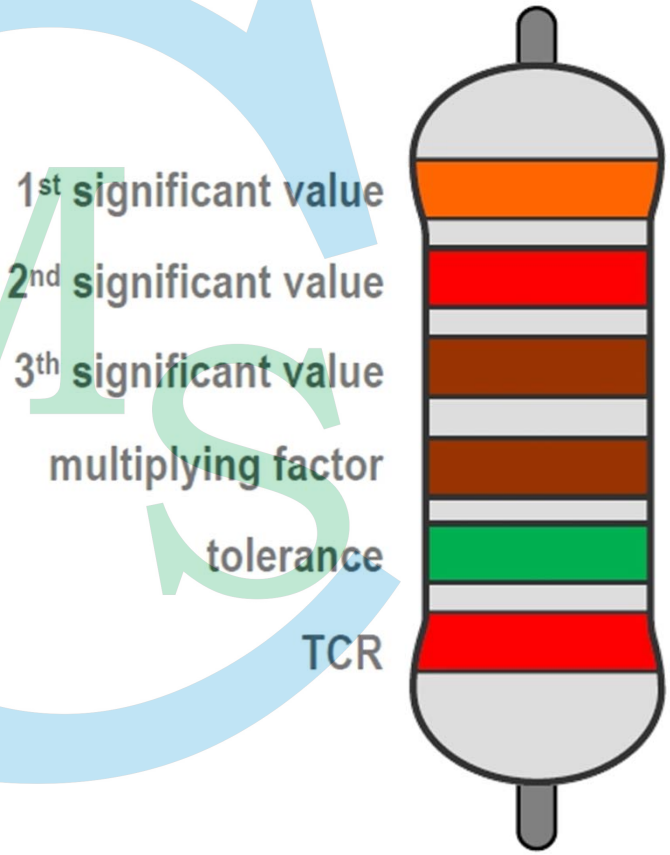
- 5-band resistors are usually of a higher precision value than are the 3- or 4-band resistors.
  - » We now have three significant digits rather than two as in the 3-band and 4-band varieties.



147Ω 0.5%

6 Bands

- 6-band resistors are usually precision resistors, but also carry some additional information regarding resistor temperature coefficient or typical failure rates (Mil-spec resistor types).



3210Ω 0.5% 50ppm/K

Tips for Reading Codes

- The reading direction might not always be clear.
  - » Sometimes the increased space between band 3 and 4 give away the reading direction.
  - » Also, the first band is usually the closest to a lead.
  - » A gold or silver band (the tolerance) is always the last band.

- It is a good practice to check the manufacturer's documentation to be sure about the coding system used.
  - » Even better is to measure the resistance with a multi-meter or ohmmeter.
  - » In some cases this might even be the only way to figure out the resistance; for example when the color bands are burnt off.
- The four band color code is the most common variation.
  - » These resistors have two bands for the resistance value, one multiplier and one tolerance band.

- If the tolerance band is left blank, the result is a 3 band resistor.
  - » This means that the resistance value remains the same as a 4 band resistor of the same colors, but the tolerance is 20%.
- Resistors with high precision have an extra band to indicate a third significant digit.
  - » Therefore, the first three bands indicate the significant digits, the fourth band is the multiply factor and the fifth band represents the tolerance.

- There are exceptions to this.
  - » For example, sometimes the extra band indicates failure rate (military specification) or temperature coefficient (older or specialized resistors).
- Resistors with 6 bands are usually for high precision resistors that have an additional band to specify the temperature coefficient (ppm/K).
  - » The most common color for the sixth band is brown (100 ppm/K).
    - o This means that for a temperature change of 10 ˚C, the resistance value can change 0.1%. For special applications where temperature coefficient is critical other colors are sometimes assigned.

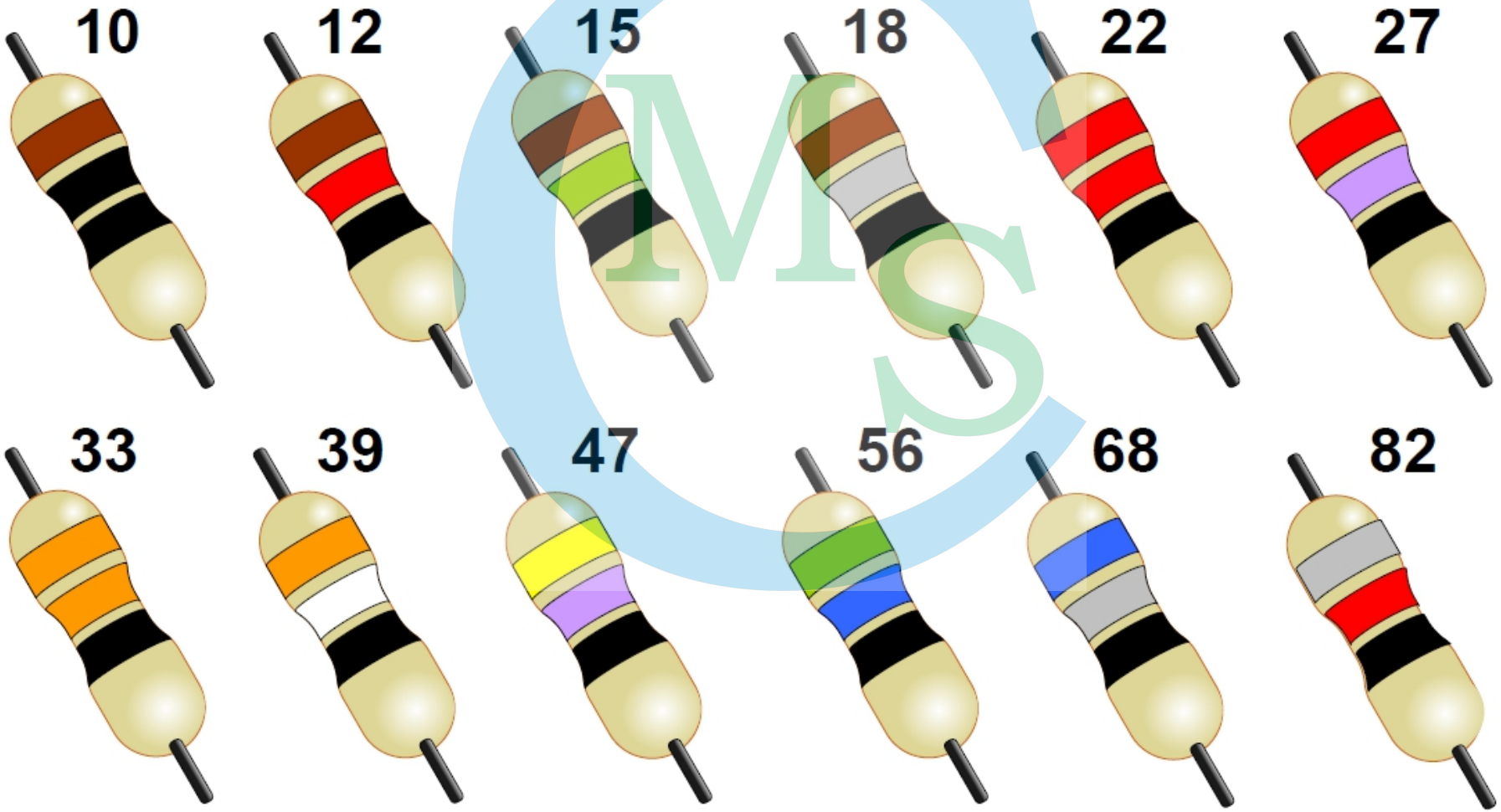
Special Cases

- Reliability Band
  - » Resistors that are produced according to military specifications, sometimes include an extra band to indicate reliability.
    - o This is specified in failure rate (%) per 1000 hours of service.
    - o This is rarely used in commercial electronics.
    - o Mostly the reliability band can be found on four band resistors.
    - o More information about the reliability can be found in the US military handbook MIL-HDBK-199.

- **Single black band or zero-ohm resistor**
  - » A resistor with a single black band is called a zero-ohm resistor.
    - o Principally it is a wire link with its only function that of connecting traces on a PCB.
    - o Using the resistor package has the advantage of being able to use the same automated machines to place components on a circuit board.
- **Deviating colors**
  - » For high voltage resistors, often the colors gold and silver are replaced with yellow and gray.
    - o This is to prevent having metal particles in the coating.

- **5 band resistor with a 4th band of gold or silver**
  - » Five band resistors with a fourth band of gold or silver form an exception, and are used on specialized and older resistors.
    - o The first two bands represent the significant digits, the 3th the multiply factor, the 4th the tolerance and the 5th the temperature coefficient (ppm/K).
- The other major exception to the color code is when it is not used at all!
  - » Some precision resistors will be printed with the value and tolerance directly on the resistor body, as well as the TC and maker's name.

Examples



Example

Resistance: 1KΩ

Tolerance: ±5%

Example

Resistance: 6.8MΩ

Tolerance: ±10%

Example

Resistance: 390Ω

Tolerance: ±5%

Example

Resistance: 56Ω

Tolerance: ±5%

Example

Resistance: 471Ω

Tolerance: ±1%

Example

Resistance: 1KΩ

Tolerance: ±0.5%

Example

Resistance: 51KΩ

Tolerance: ±1%

Example

Resistance: 270KΩ

Tolerance: ±0.1%

Example

Resistance: 4.7KΩ

Tolerance: ±1%

Example

Resistance: 1MΩ

Tolerance: ±1%

Things to Remember

- Sometimes, the color code is difficult or impossible to read properly
  - » In those cases, use an ohmmeter to ascertain the resistance of a resistor, but remember…
    - o That you most likely cannot measure it accurately in-circuit due to parallel resistances, and…
    - o That the resistor should fall within a plus-or-minus value (the tolerance) of its nominal value.
      - ▪ Thus, a 4.7KΩ 1% resistor can be anywhere from 4653Ω to 4747Ω – 4700Ω ±47Ω.

QUESTIONS?