4. COMPONENT VALUE CODES

4.1. Resistor Values and Tolerances
4.2. Capacitor Values and Tolerances

Electronic components have various ways of denoting the values; increasingly (due to advances in printing technology) they have numbers printed on.

Decimal points are often denoted by placing the multiplier in as a decimal point, e.g. resistors labelled 5R6 = 5.6ohms; 4k7= 4.7kohms, and capacitors labelled 2u2 (or 2µ2) = 2.2 microfarads.

4.1. Resistor Values and Tolerances

Resistors are often labelled with colour bands to ease the problem of marking such small components.

3 band resistor: The first two bands stand for the first two digits, and the third band shows the number of zeros.

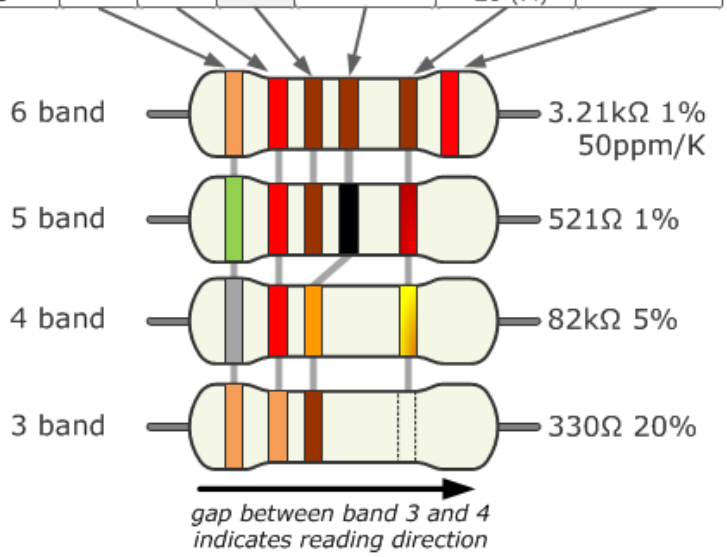
4 band resistor: The first two bands stand for the first two digits, the third band shows the number of zeros, and the fourth shows the tolerance.

5 band resistor: The first three bands stand for the first three digits, the fourth band shows the number of zeros, and the fifth shows the tolerance.

6 band resistor: The first three bands stand for the first three digits, the fourth band shows the number of zeros, the fifth shows the tolerance, and the sixth shows the temperature coefficient.

Color	Signficant figures			Multiply	Tolerance (%)	Temp. Coeff. (ppm/K)
black	0	0	0	x 1		250 (U)
brown	1	1	1	x 10	1 (F)	100 (S)
red	2	2	2	x 100	2 (G)	50 (R)
orange	3	3	3	x 1K		15 (P)
yellow	4	4	4	x 10K		25 (Q)
green	5	5	5	x 100K	0.5 (D)	20 (Z)
blue	6	6	6	x 1M	0.25 (C)	10 (Z)
violet	7	7	7	x 10M	0.1 (B)	5 (M)
grey	8	8	8	x 100M	0.05 (A)	1(K)
white	9	9	9	x 1G		
gold			3th digit only for 5 and 6 bands	x 0.1	5 (J)	
silver				x 0.01	10 (K)	
none					20 (M)	

The code shown at the right side is used for the values and tolerances.



Resistor Tolerance (accuracy)

A tolerance of 10% means that the component value may be anything between the nominal value - 10% and the nominal value + 10%, so a 10% tolerance 12k resistor may have a value between (12-1.2) and (12+1.2), or 10.8k - 13.2k.

These tolerances may seem to reflect poor manufacture but in most circuits they are quite satisfactory. Relaxing the tolerance enables the manufacturer to sell them more cheaply.

Find the values and tolerances of the resistors banded as follows.

	First Band (1^{st} digit)	Second Band (2^{nd} digit)	Third Band (Multiplier)	Fourth Band (Tolerance)	
1	red	violet	orange	silver	…….
2	blue	grey	brown	gold	…….
3	green	blue	red	silver	…….
4	red	red	green	-----	…….
5	brown	black	orange	-----	…….
6	orange	orange	brown	gold	…….
7	yelow	orange	red	gold	…….
8	brown	green	green	-----	…….
9	violet	green	brown	red	…….
10	white	brown	red	red	…….

Comprehension questions

1. Why are resistors coded with coloured bands?

2. What do the colours represent?

3. What does each band indicate?

4. What would be the effect of making resistors with a much higher tolerance?

5. Betwen which values might a resistor marked green, blue, orange and silver vary?

4.2. Capacitor Values and Tolerances

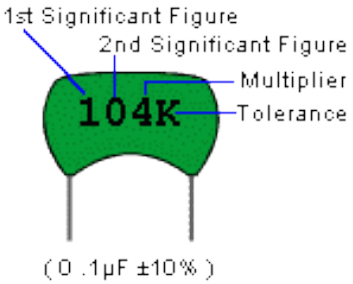
The capacitors have specific values which are marked on to the body of the capacitor, that helps to understand the capacitance and other properties of it. The important values for the capacitor are the capacitance, tolerance, voltage rating, temperature coefficient etc. These are usually marked on the body of the capacitor in the alphanumeric form. There are many decimal values that are used as capacitor values where the reading becomes difficult without the help of a capacitor value chart. To reduce the confusion involved with the letters, numbers, and decimals used in representing capacitor values and also to prevent

misreading the values of the capacitor, an international color coding scheme was introduced. The capacitor color code represents a simple and efficient way of reading capacitor values and tolerances.

Capacitors have various methods for marking the value:

- **a.** Value written "normally" - e.g. 2.2µF = 2.2 microFarads
- **b.** Written using the prefix as the decimal point - e.g. 2u2 = 2.2 microFarads
- **c.** Using a three digit code: two digits are value, and then the number of zeros, with the value in picoFarads: e.g. 334 = 330000 pF = 330nanoFarads.
- **d.** Using a three-band colour code similar to the resistor code, to give the value in picoFarads

Extra numbers or bands may indicate the tolerance and the maximum working voltage. The following table shows different type of capacitors and their capacitance, tolerance, temperature coefficient, and maximum voltage values based on colors.



More recently a different type of capacitor coding has come to be in use. In **small types of capacitors such as film or disc form**, instead of the color coding, the capacitance is given as a letter or a number code. The code consists of 2 or 3 numbers and an optional tolerance letter code to identify the tolerance.

When a 2 letter code is used, the value of the capacitor is denoted in picofarads such as 10 = 10pf, 22 = 22 pf, and 100 = 100 pf etc.

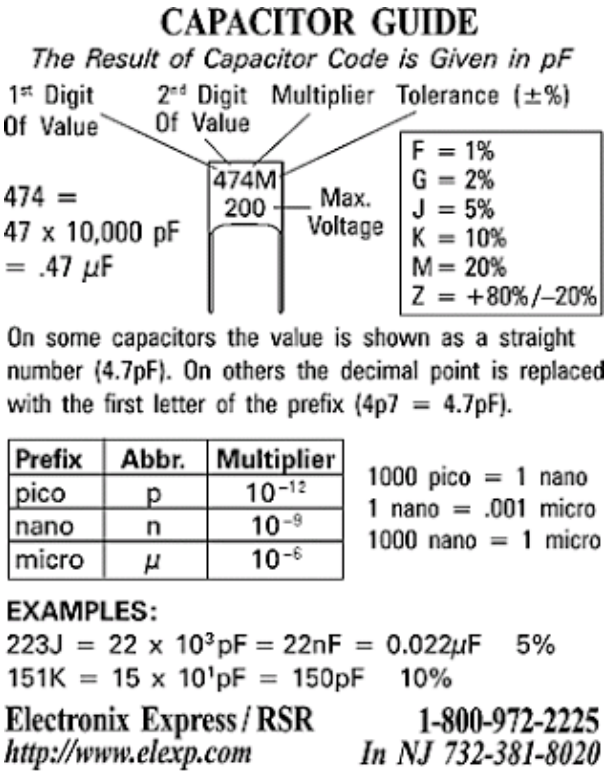
The 3 letter code is used to denote the value of capacitor, the first two digits for the first and the second value of the capacitor and the third one is multiplier in picofarads which multiplies in multiples of 10.

For example a capacitor with a value 251 = 25 * 10 = 250 pf and 102 = 10 * 100 = 1000 pF etc.

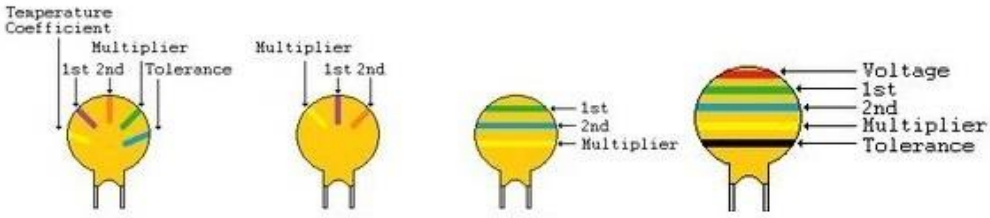
There is an additional letter included in a 3 digit code to include the tolerance measurement of the capacitor.

For example a capacitor with a value 103J printed on the body, which denotes the 1st and 2nd digits as the 1st and 2nd value of the capacitor and the 3rd one is denoted as the multiplier in picofarads and the letter J is the tolerance.

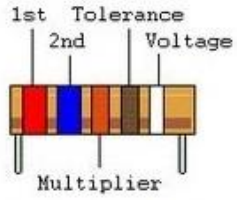
10 * 1000 = 10,000 pf and the letter J denotes a tolerance of +/- 5%



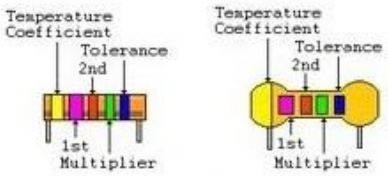
The capacitance is 10,000 pF which is equivalent to 10 nF or 0.010 mF with a tolerance of +/- 5%



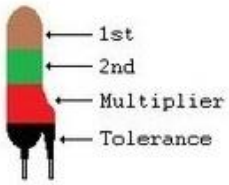
Ceramic Disk Capacitor



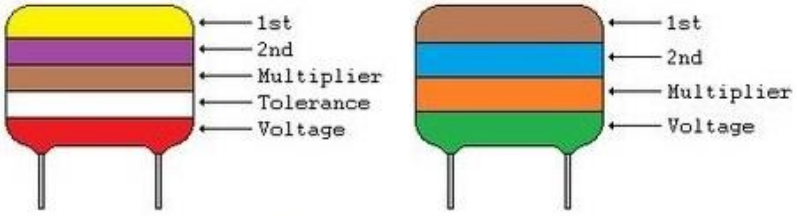
Ceramic Capacitor



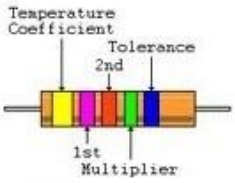
Radial Lead Ceramic



Pin Capacitor



Metalized Polyester Capacitors



Axial Lead Ceramic

Capacitor Colour Code Table

Band Colour	Digit A	Digit B	Multiplier D	Tolerance (T) > 10pf	Tolerance (T) < 10pf	Temperature Coefficient (TC)
Black	0	0	x1	± 20%	± 2.0pF	
Brown	1	1	x10	± 1%	± 0.1pF	-33×10^{-6}
Red	2	2	x100	± 2%	± 0.25pF	-75×10^{-6}
Orange	3	3	x1,000	± 3%		-150×10^{-6}
Yellow	4	4	x10,000	± 4%		-220×10^{-6}
Green	5	5	x100,000	± 5%	± 0.5pF	-330×10^{-6}
Blue	6	6	x1,000,000			-470×10^{-6}
Violet	7	7				-750×10^{-6}
Grey	8	8	x0.01	+80%,-20%		
White	9	9	x0.1	± 10%	± 1.0pF	
Gold			x0.1	± 5%		
Silver			x0.01	± 10%		

Capacitor Voltage Colour Code Table

Band Colour	Voltage Rating (V)				
	Type J	Type K	Type L	Type M	Type N
Black	4	100		10	10
Brown	6	200	100	1.6	
Red	10	300	250	4	35
Orange	15	400		40	
Yellow	20	500	400	6.3	6
Green	25	600		16	15
Blue	35	700	630		20
Violet	50	800			
Grey		900		25	25
White	3	1000		2.5	3
Gold		2000			
Silver					

Capacitor Voltage References

Type J : Dipped Tantalum Capacitors.

Type K : Mica Capacitors.

Type L : Polyester/Polystyrene Capacitors.

Type M: Electrolytic 4 Band Capacitors.

Type N : Electrolytic 3 Band Capacitors.

Name the colour bandings of the following capacitors.

1. (pin) 100pF, 20% _____

2. (pin) 180pF, 10% _____

3. (ceramic) 22nF, 5%250V _____

4. (pin) 47nF, 20% _____

Answer the following questions.

1. A 4-band resistor's first three colour bands are; brown, black, and red, - What is its value?

2. Which digit does the colour yellow denote on a resistor colour band?

3. A 47 Kohm resistor would have which colours on its first 3 bands?

4. Which digit does the colour orange denote on a resistor colour band?

5. A 4-band resistor's first three colour bands are; red, yellow, black, - What is its value?

6. Which digit is represented by a black band on a resistor?

7. A 4-band resistor's colour bands are; brown, green, red, and gold - Betwen which values might the resistor vary?

8. Which colour represents the digit 6 in the resistor colour code?

9. Which digit is represented by a red band on a resistor?