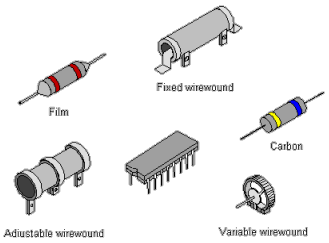
Unit 10
Resistors



Jan 29-10:29 AM

Resistance

SLIDE FROM UNIT 5

- Denoted by "R"
- Oppose to the flow of the current (goes against)
- measured in ohm (Ω)
- measured by an ohmmeter
- due to not wanting to get rid of valence e- or the fact e- are bumping into to many other electrons
- depends on the size, type and temperature of material
- resistance causes heat in the conductor

$$R = \frac{V}{I}$$

↑V cause ↑R

↓V cause ↓R

↑I cause ↓R

↓I cause ↑R

Feb 1-11:29 AM

- depends on the size, type and temperature of material

If length increases then so does resistance

Ex} A 60 ft #22 insulated copperwire has resistance of 1 then a 120 ft wire has approximately 2Ω

if you double length you double resistance

Length is directly proportional to resistance of conductor

Larger diameter the less resistance

↓ Gauge

Temperature has different results depending on the material

Most cases: Increase temperature causes increase of resistance

-known as positive temperature coefficient ↑ ↑

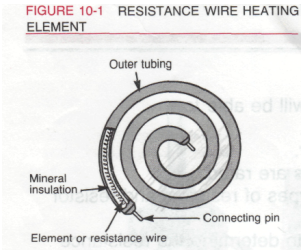
Negative temperature coefficient: means resistance decreases as temperature increases (or opposite) ↑ ↓

If resistance doesn't change when material changes temperature then this is known as "constant temperature coefficient" ⌒ ⌒

Feb 19-10:48 PM

Resistance Wire

- used to produce heat for heating electricity



- Nichrome wire is the most populare resistance wire.
  *high-resistance
  * made of nickle and chromium

- used in heating elements in stoves, dryers, toasters and other heating appliances

- when a voltage is applied to the heating element, the high resistance of the wire converts most of teh electrical energy in to heat energy.

Feb 10-4:22 PM

Resistors

-A resistor is an electrical component added to a circuit *to lower the current flow* or *reduce the voltage*

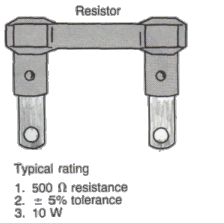
-A resistor are rated in 3 ways:
1) Resistance

-measured in ohms (Ω)

2) Can't measure an exact number of ohms of resistors; therefore, most resistors carry a *percentage tolerance* or *accuracy rating*.

3) Amount of power the resistor can safely handle in watts (W)
- resistors carry current that produces heat
-

FIGURE 10-3 RESISTOR RATINGS



Feb 10-5:03 PM

1 OHM is the amount of resistance that will allow 1 ampere of current to flow in a circuit to which 1 voltage is applied.

If 1 Volt causes 1 ampere of current in a circuit then the resistance of the circuit is 1 ohm.

$$R = \frac{V}{I}$$

Feb 19-10:32 PM

OHM

1Ω

$1000\ \Omega = 1\ k\Omega$

$1\ 000\ 000\ \Omega = 1\ M\Omega$

Prefix	Analog value
p (pico)	10^{-12}
n (nano)	10^{-9}
μ (micro)	10^{-6}
m (milli)	10^{-3}
k (kilo)	10^{3} (1000)
M (mega)	10^{6} (1,000,000)
G (Giga)	10^{9} (1,000,000,000)
T (Tera)	10^{12} (1,000,000,000,000)

Feb 19-10:37 PM

Types of Resistors

Two ways to classify resistor:

- Classified according to their construction
- Classified according to their function

Feb 19-12:02 PM

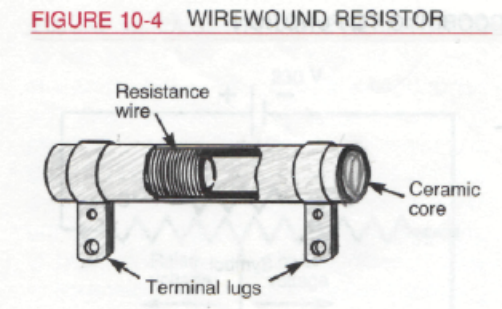
Construction

Wirewound Resistor

- high-resistance wire wrapped around an insulated cylinder
- rate of resistance is related to length of wire used
- most expensive to manufacture
- used in circuits with high currents or require accurate resistance

lots of power

FIGURE 10-4 WIREWOUND RESISTOR



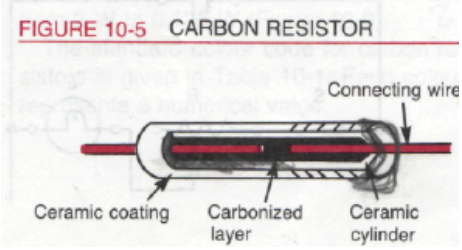
Feb 19-8:58 PM

Construction

Carbon Resistor

- made from consisting of carbon and a filler material.
- Resistance is determined by the amount of carbon used in making the resistor
- Cheapest to manufacture (so most common used)
- cannot handle large currents
- actual resistance can vary by 20% from actual rate

FIGURE 10-5 CARBON RESISTOR



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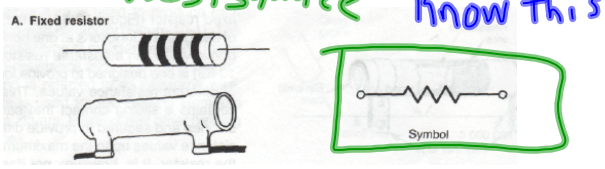
Function

Fixed Resistor

- Functions at one non-variable ohmic value

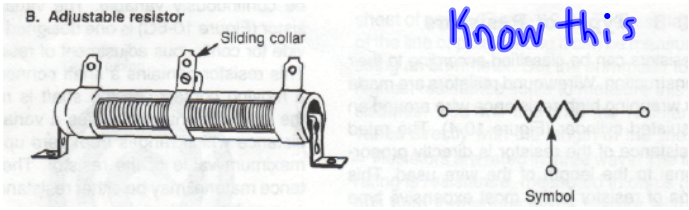


Feb 19-8:58 PM

Function

Adjustable Resistor

- designed to provide for a range of different resistance values
- has a sliding contact that can be positioned and secured to provide different resistance values (up to the maximum value of the resistor)
- not designed for continuous adjustments



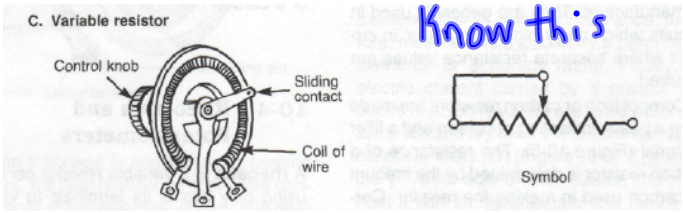
Feb 19-8:58 PM

Function

http://wn.com/variable_resistor#/videos

Variable Resistor

- designed for continuous adjustments of resistance
- Shaft connected to moving contact
- shaft rotates and thesliding contact provide a variable resistance from 0 to maximum



A resistor may have one or more fixed tapping points so that the resistance can be changed by moving the connecting wires to different terminals. Some wirewound power resistors have a tapping point that can slide along the resistance element, allowing a larger or smaller part of the resistance to be used.

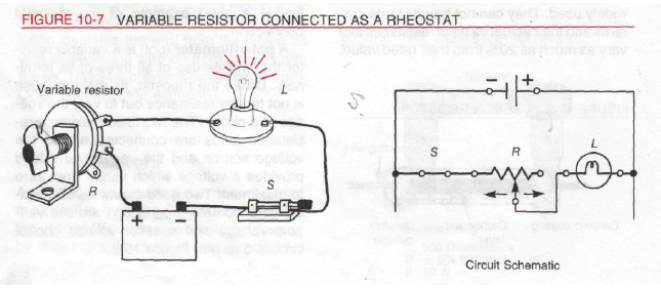
Feb 19-8:58 PM

Rheostats & Potentiometers

http://vimeo.com/25186895

Rheostat:

- is a variable resistor
- uses only 2 of its terminals to vary the resistance
- Ex) Dash light dimmer in car



Feb 19-9:13 PM

Rheostats & Potentiometers

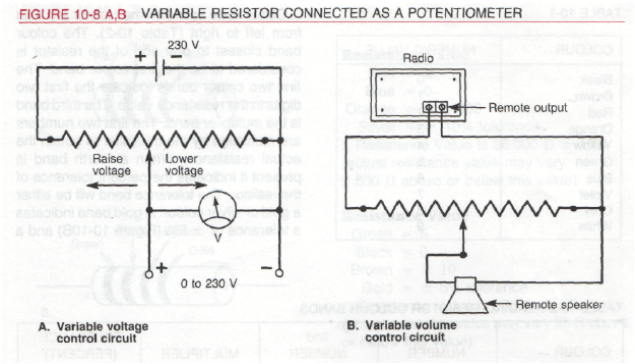
Potentiometer:

- is a variable resistor

-uses all 3 of its terminals to vary the voltage

- the 2 fixed maximum resistance leads are connected across the voltage which varies from 0 to maximun.

-Ex) Speaker volume



Feb 19-11:15 PM

Resistor Colour Code

- Carbon resistors use bands of colour to represent resistance value and tolerance.

- Colour bands makes it easier to read regardless where it is located in the circuit.

Feb 19-11:18 PM

- Power rate is determined by the size

-From 2 W to 0.125 W

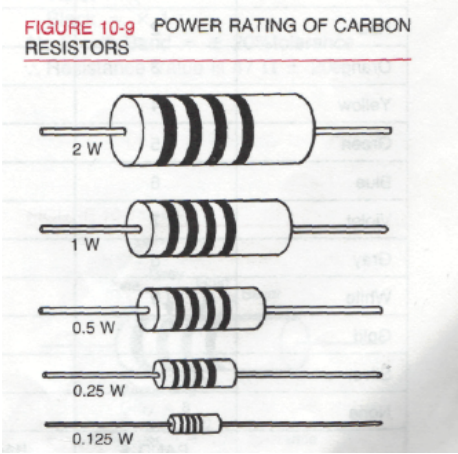


FIGURE 10-9 POWER RATING OF CARBON RESISTORS

Feb 19-11:37 PM

STANDARD Colour Code

TABLE 10-1

COLOUR	NUMERIC VALUE
Black	0
Brown	1
Red	2
Orange	3
Yellow	4
Green	5
Blue	6
Violet	7
Grey	8
White	9

Feb 19-11:46 PM

60 x 10

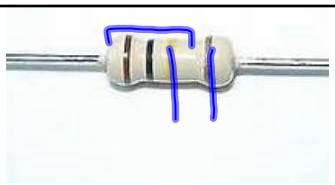
RESISTOR Colour Code

TABLE 10-2 READING RESISTOR COLOUR BANDS

COLOUR	1st NUMBER	2nd NUMBER	MULTIPLIER	TOLERANCE (PERCENT)
Black	0	0	1	
Brown	1	1	10	
Red	2	2	100	
Orange	3	3	1 000	
Yellow	4	4	10 000	
Green	5	5	100 000	
Blue	6	6	1 000 000	
Violet	7	7	10 000 000	
Gray	8	8	100 000 000	
White	9	9	1 000 000 000	
Gold			0.1	5
Silver			0.01	10
None				20
	BAND 1	BAND 2	BAND 3	BAND 4

Feb 19-11:56 PM

Colour Code BANDS



- Read left to right

- The colour band closest to one end of the resistor is where you start

- First 2 colour bands represents first 2 digits in resistance value.

- 3rd band represents multiplier

*The first 2 numbers are multiplied by the multiplier to obtain the actual resistance.

- when 4th band is present it represents the percentage tolerance of resistor.

*either gold or silver
± 5% ± 10%

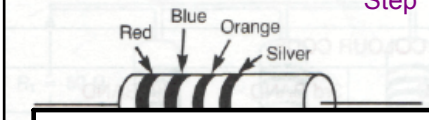
never see ± 20%

Feb 19-11:47 PM

FIGURE 10-10 A, B, C

PDF File.

Step 1: Match the color bands to the number



Resistance Value
Red = 2
Blue = 6

26000 Ω ± 10%

Step 3: Calculate the percentage value to add and subtract

total Ω x percent as decimal

0.10 x 26 000 = 2600

or

total Ω x percent ÷ 100

or

26 000 x 10 ÷ 100 = 2600

Step 4: Calculate the high and low by adding to the total Ω

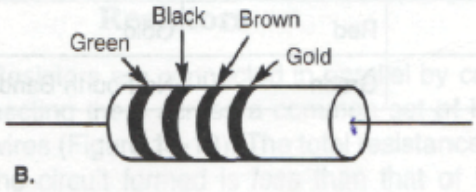
Actual High = 26000Ω + 2600

= 28 600 Ω

Actual low = 26000Ω - 2600

= 23 400 Ω

Feb 19-11:55 PM



B.

Resistance Value
Green = 5
Black = 0
Brown = × 10
Gold = ± 5% tolerance
∴ Resistance Value is 500 Ω ± 5%
(actual resistance value may vary 25 Ω above or below this value)

0.05 x 500 = 25

Actual High = 500 + 25

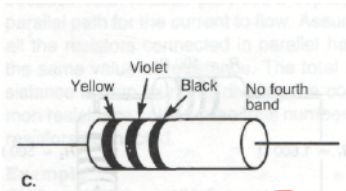
525 Ω

Actual low = 500 - 25

475 Ω

500 ± 25 Ω

Feb 20-12:01 AM



Resistance Value
Yellow = 4
Violet = 7
Black = 1
No Fourth Band = ±20%
∴ Resistance Value is Ω ± 20%

47 x 1 = 47Ω

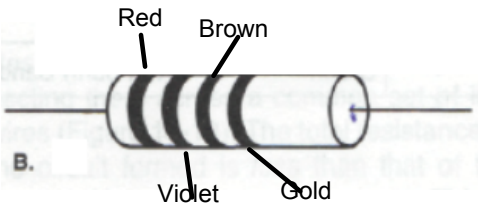
0.2 x 47 = 9.4

Actual High = 47Ω + 9.4
56.4Ω

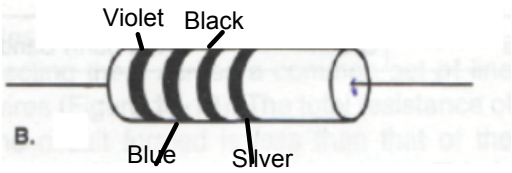
Actual low = 47Ω - 9.4
37.6Ω

Feb 20-12:05 AM

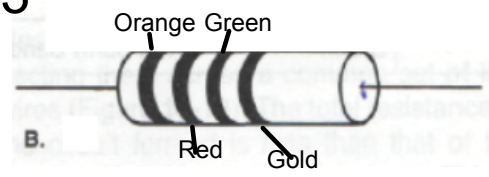
1



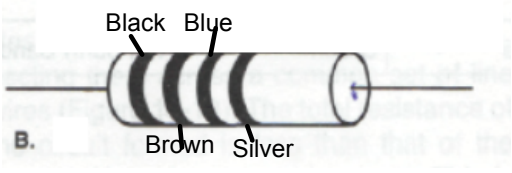
2



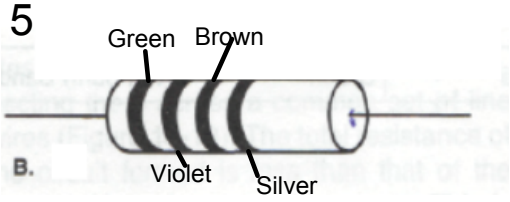
3



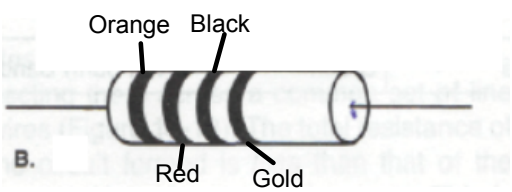
4



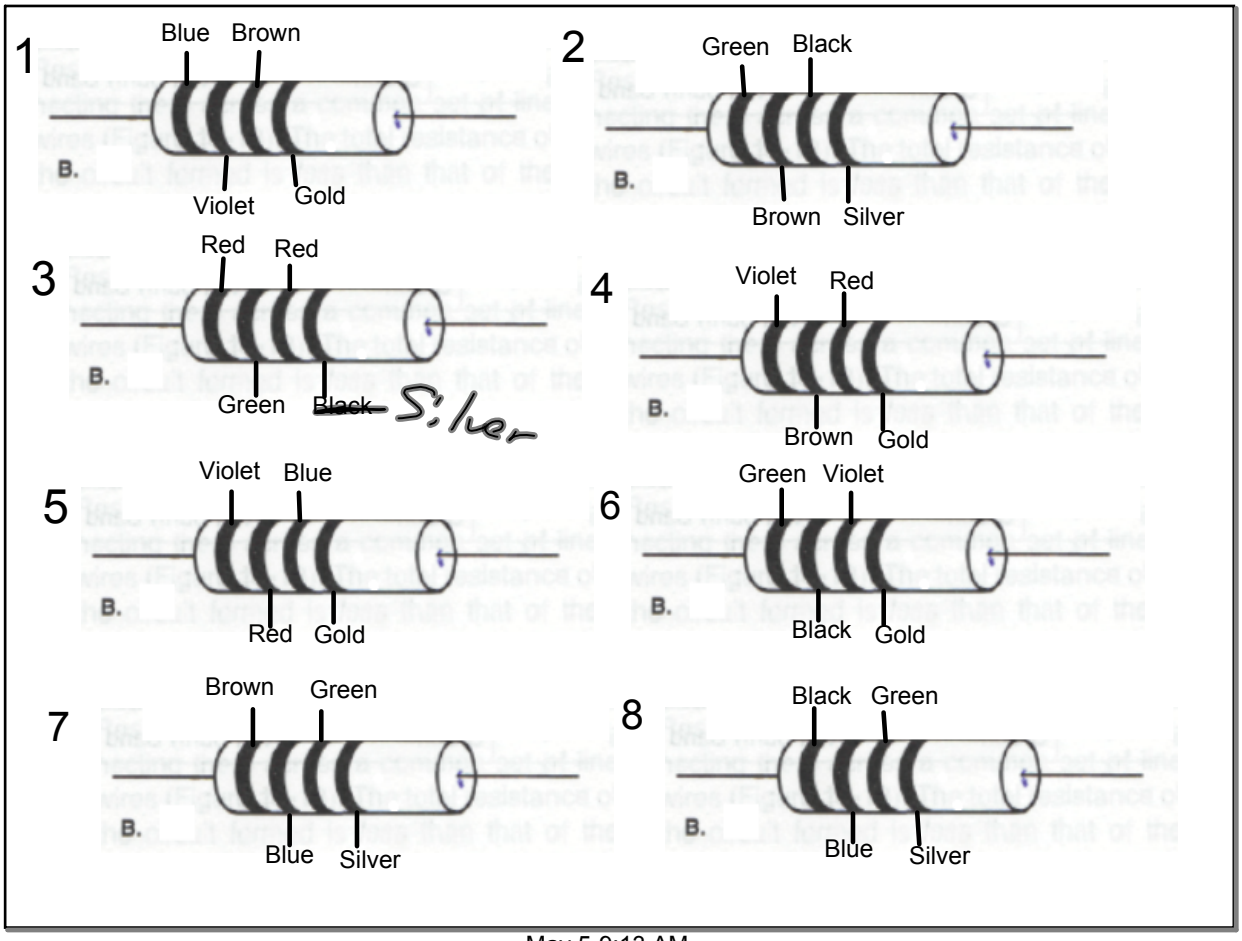
5



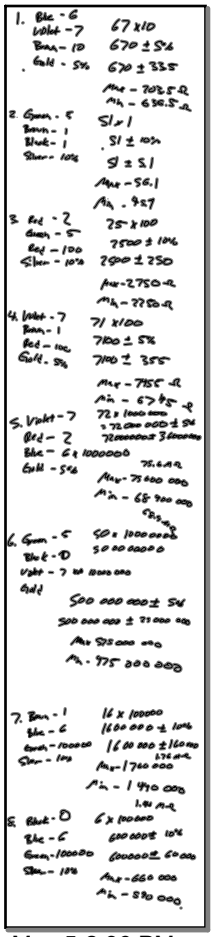
6



Apr 30-8:37 AM



May 5-9:13 AM



May 5-2:36 PM

Step 1: Match the color bands to the number

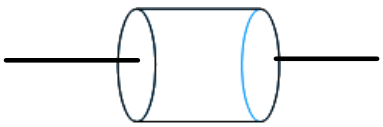
Step 2: 1st digit ____ 2nd digit ____ x Multiplier ± ____ tolerance →
band1 band2 band3 band4

Step 3: Calculate the percentage value to add and subtract

Step 4: Calculate the high and low by adding to the total Ω

Apr 21-6:54 PM

You Try



6 100 000Ω x 0.2 = 1 220 000Ω

OR

6.1 MΩ x 0.2 = 1.22 MΩ

Actual High

6 100 000Ω + 1 220 000Ω
= 7 320 000 Ω
or
7.23 MΩ

Resistance Value

blue = 6
brown = 1
green =
NO Fourth Band =
∴ Resistance Value is

6 100 000Ω ± 20%

OR

6.1 MΩ ± 20%

Actual Low

6 100 000Ω – 1 220 000Ω
= 4 880 000 Ω
or
4.88 MΩ

Feb 21-7:08 PM

Ω - 1 Ω

KΩ - 1000 Ω

MΩ - 1000 000 Ω

7.000000. Ω

7 MΩ

57.000. Ω

57 KΩ

4600 Ω

4.6 KΩ

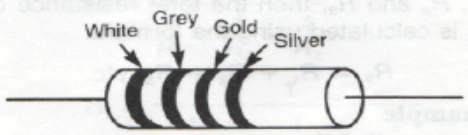
May 6-2:05 PM

-resistor values less than 10Ω will bear colour gold or silver on THIRD band

if on 3rd Band

(Figure 10-11) A gold third band requires you to multiply the value indicated by the first two digits by 0.1. A silver third band indicates a multiplier of 0.01.

FIGURE 10-11



White = 9
Grey = 8
Gold = × 0.1
Silver = ± 10% Tolerance
∴ Resistance value is
9.8Ω + 10%

9 8 x 0.1 = 9.8 Ω

9.8 ± 10%

9.8 ± 0.98

Max = 9.8 + 0.98 = 10.78 Ω

Min = 9.8 − 0.98 = 8.82 Ω

Feb 21-7:15 PM

Use the colour code chart to determine the resitor code

TABLE 10-3

GIVEN RESISTANCE VALUE	COLOUR CODE			
	1st BAND	2nd BAND	3rd BAND	4th BAND
360 Ω ± 5%	Orange	Blue	Brown	Gold
10 Ω ± 10%	Brown	Black	Black	Silver
4 700 Ω ± 20%	Yellow	Violet	Red	No Fourth Band
5 Ω ± 10%	Green	Black	Gold	Silver
8 000 Ω ± 5%	Grey	Black	Red	Gold
3 300 000 Ω ± 20%	Orange	Orange	Green	No Fourth Ban

5 = Green
0 = Black

50 x 0.1

Feb 21-7:33 PM

Units are important:

a) 52 KΩ = 52 x 1000 = 52000 Ω

GIVEN RESISTANCE VALUE	1st BAND	2nd BAND	3rd BAND	4th BAND
a) 52 KΩ ± 5%	green	red	orange	gold
b) 6 MΩ ± 10 %	blue	black	green	silver
c) 3.8 KΩ ± 20%	orange	grey	red	None

a) 52 KΩ
= 52 x 10^3 Ω
= 52 000Ω

digit 1 = 5 green

digit 2 = 2 red

multiplier = 1 000 orange

b) 6 MΩ x 1000000
= 6 x 10^6 Ω
= 6 000 000Ω

digit 1 = 6 blue

digit 2 = 0 black

multiplier = 100 000 green

c) 3.8 KΩ
= 3.8Ω x 10^3
= 3 800

digit 1 = 3 orange

digit 2 = 8 grey

multiplier = 100 red

Feb 21-7:43 PM

Ex) Determine the resistor code

Blue Green Red

Step 1) Match colors to number

Band 1) Blue = 6 } 65
2) Green = 5
3) Red = x100
4) None = 20%

__ __ x multiplier ± tol
2 digits

65 x 100 Ω ± 20%

Step 2) $R_1 = 6500\ \Omega \pm 20\%$

Step 3) % x total Ω

0.20 x 6500 Ω

1300 Ω

High (+)
6500 Ω + 1300 Ω
7800 Ω

Low (-)
6500 Ω - 1300
5200 Ω

Apr 23-1:56 PM

Ex) Determine the resistor code

Blue Gray Silver Silver

6 8 x 0.01 ± 10%

0.68 Ω ± 10%

Apr 23-1:59 PM

Ex) 56 MΩ ± 5%

× 1000 000

1 KΩ = 1000 Ω

1 MΩ = 1000 000 Ω

56 000 000 Ω ± 5 %

green blue blue gold

7 KΩ ± 20 %

Change to Ω

× 1000

7000 Ω ± 20 %

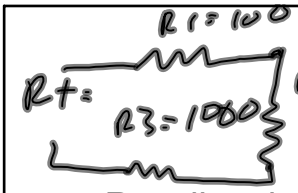
Violet black Red

Apr 23-1:59 PM

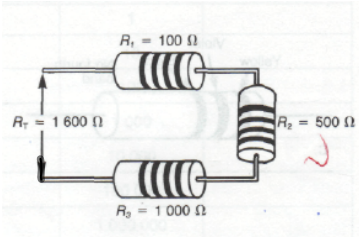
Assignment On Resistor colour Code

worksheet 8 & hand drawn

Feb 21-8:02 PM



Resistor in SERIES



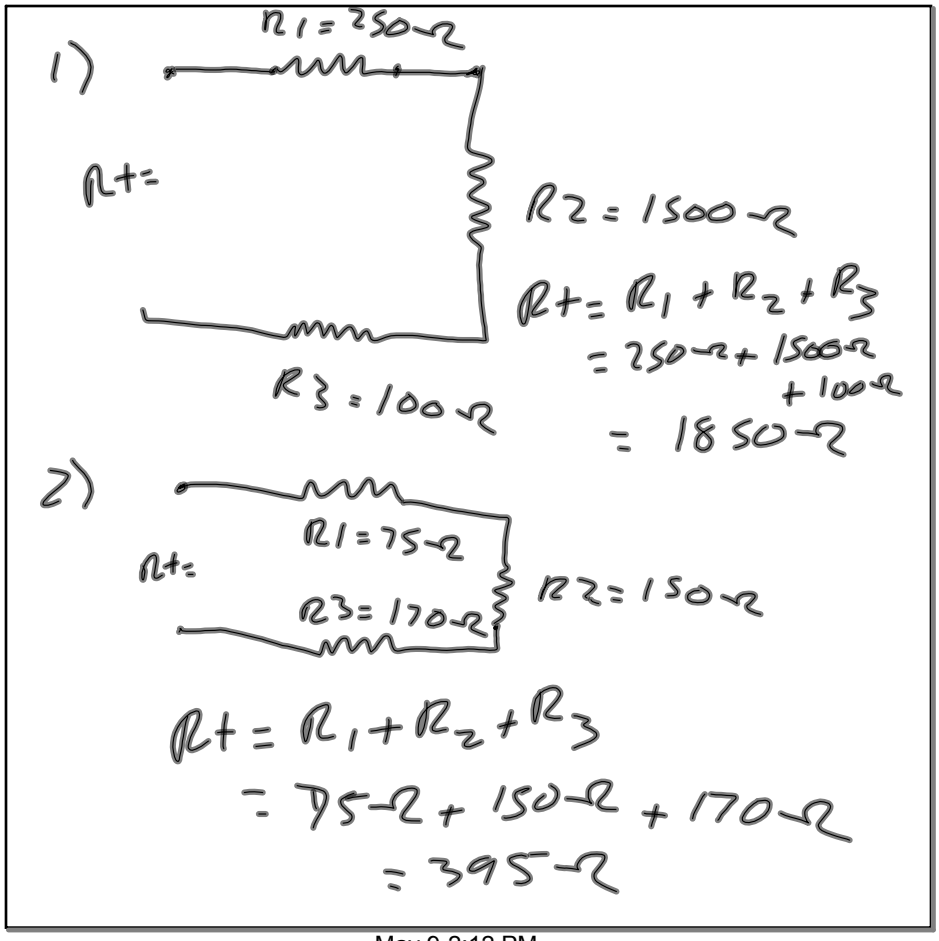
Recall series are connected end-to-end

Total resistance is the sum of individual resistance.

$$R_T = R_1 + R_2 + R_3 \quad , \text{ etc.}$$

$$Rt = 100\,\Omega + 500\,\Omega + 1000\,\Omega$$
$$= 1600\,\Omega$$

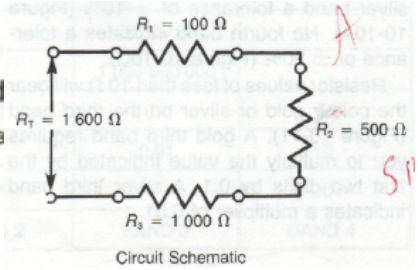
Feb 21-8:05 PM



May 9-2:12 PM

Example

Suppose that three resistors are connected in series. R_1 is 100 Ω, R_2 is 500 Ω, and R_3 is 1 000 Ω. The total resistance is then:



Circuit Schematic

$$R_T = R_1 + R_2 + R_3$$
$$R_T = 100\ \Omega + 500\ \Omega + 1\ 000\ \Omega$$
$$R_T = 1\ 600\ \Omega$$

Mar 11-10:58 AM

Resistor in Parallel Connection

Resistors are connected in parallel

Total resistance is LESS than that of the lowest resistant value.

Because each resistors provides a separate parallel path for the current flow

Total resistance is calculated using fractions.

Feb 21-8:05 PM

Resistor in Parallel Connection

If the Resistance all have the same value then,

Total resistance is calculated using fractions.

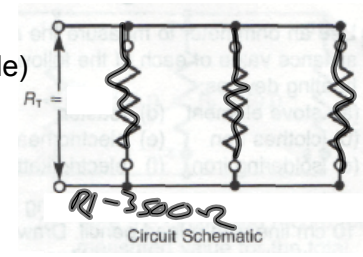
$$R_T = \frac{R\,(Common\ Value)}{number\ of\ resistors} = \frac{75\,\Omega}{3} = 25\,\Omega$$

Feb 21-8:05 PM

Resistor in Parallel Connection

All the R are the same

Example)



Circuit Schematic

$R_T = \frac{3500\,\Omega}{3} = 1167\,\Omega$

Total resistance is calculated using fractions.

$$R_T = \frac{R\,(Common\ Value)}{number\ of\ resistors}$$

Example
Suppose that three 150 Ω resistors are connected in parallel. The total resistance is then:

=
=
=

mmon value)
of resistors

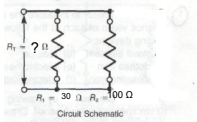
Feb 21-8:05 PM

Resistor in Parallel Connection

2 Unequal Resistor Value

Total Resistance of 2 unequal values of resistors connected in parallel:

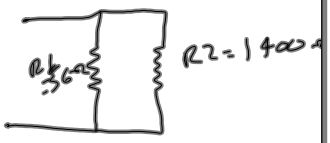
$$R_T = \frac{R_1 \times R_2}{R_1 + R_2}$$



$R_t = \frac{30 \times 100}{30 + 100}$

$= \frac{3000}{130}$

$= 23\ \Omega$



$R_t = \frac{R_1 \times R_2}{R_1 + R_2} = \frac{56 \times 1400}{56 + 1400}$

$= \frac{78\,400}{1456} = 54\ \Omega$

Feb 21-8:05 PM

1. A circuit consists of 3 resistors connected in series. The resistors are 50 ohms, 75 ohms and 1500 ohms. What is the total resistance in the circuit.

$R_t = R_1 + R_2 + R_3 = 50\Omega + 75\Omega + 1500\Omega = 1625\ \Omega$

2. A circuit consists of 3 resistors connected in series. The resistors are 175 ohms, 1800 ohms and 2400 ohms. What is the total resistance in the circuit.

$R_t = 175\ \Omega + 1800\ \Omega + 2400\ \Omega = 4375\ \Omega$

3. A circuit consists of 3 resistors connected in parallel. The value of each resistor is 750 ohms. What is the total resistance of the circuit?

$R_t = \frac{\text{common value}}{3} = \frac{750\ \Omega}{3} = 250\ \Omega$

4. A Circuit contains 3 resistors connected in parallel. R1 has a value of 150 ohms, R2 has a value of 1300 Ohms, and R3 has a value of 65 ohms. What is the total resistance in the circuit.

5. A circuit contains 2 resistors connected in parallel. R1 has a value of 3500 ohms, and R2 has a value of 500 ohms. What is the total resistance of the circuit.

$R_t = \frac{R_1 \times R_2}{R_1 + R_2} = \frac{3500 \times 500}{3500 + 500}$

$= \frac{1\,750\,000\ \Omega}{4000\ \Omega}$

$= 437.5\ \Omega$

May 12-1:39 PM

Resistor in Parallel Connection

2 Unequal Resistor Value

Example) Suppose that a 60 Ω resistor is connected in parallel with one of 40 Ω. The total resistance is then:

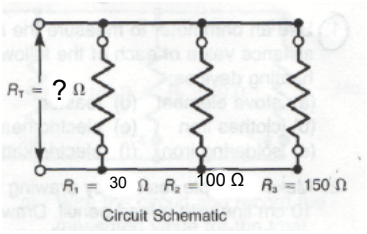
Feb 21-8:05 PM

Resistor in Parallel Connection

3 or more Unequal Resistor Value

Total Resistance of 3 unequal values of resistors connected in parallel:

$$R_T = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}}$$



Circuit Schematic

$$R_T = \frac{1}{1/30 + 1/100 + 1/150}$$

$$= \frac{1}{0.033 + 0.01 + 0.0067}$$

$$= \frac{1}{0.050} = 20\,\Omega$$

Feb 21-8:05 PM

4. A Circuit contains 3 resistors connected in parallel. R1 has a value of 150 ohms, R2 has a value of 1300 Ohms, and R3 has a value of 65 ohms. What is the total resistance in the circuit.

$$R_t = \frac{1}{1/R_1 + 1/R_2 + 1/R_3}$$

$$R_t = \frac{1}{1/150 + 1/1300 + 1/65}$$

$$R_t = \frac{1}{0.0067 + 0.00077 + 0.015}$$

$$R_t = \frac{1}{0.02247}$$

$$= 44.5$$

$$= 45\ \Omega$$

May 12-2:20 PM

Resistor in Parallel Connection

3 or more Unequal Resistor Value

Example
Suppose that a 120 Ω, 60 Ω, and 40 Ω resistor, are all connected in parallel. The total resistance is then:

Mar 11-11:00 AM

1. A circuit consists of 3 resistors connected in series. The resistors are 3600 ohms, 7500 ohms and 1100 ohms. What is the total resistance in the circuit.

$R_T = R_1 + R_2 + R_3 = 3600\Omega + 7500\Omega + 1100\Omega$
$12.2\,k\Omega = 12200\Omega$

2. **A circuit consists of 3 resistors connected in series. The resistors are 1750** ohms, 100 ohms and 2200 ohms. What is the total resistance in the circuit.

$R_T = R_1 + R_2 + R_3 = 1750\Omega + 100\Omega + 2200\Omega$
$= 4050\Omega = 4.1\,k\Omega$

3. **A circuit consists of 3 resistors connected in parallel. The value of each resistor** is 1350 ohms. What is the total resistance of the circuit?

$R_T = \frac{\text{Common Value}}{\#\text{ Resistors}} = \frac{1350}{3} = 450\Omega$

4. **A Circuit contains 3 resistors connected in parallel. R1 has a value of 15** ohms, R2 has a value of 13 Ohms, and R3 has a value of 16 ohms. What is the total resistance in the circuit.

$R_T = \frac{1}{1/R_1 + 1/R_2 + 1/R_3} = \frac{1}{1/15 + 1/13 + 1/16}$

5. **A circuit contains 2 resistors connected in parallel. R1 has a value of 3100** ohms, and R2 has a value of 7500 ohms. What is the total resistance of the circuit.

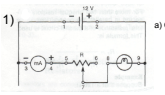
$R_T = \frac{R_1 \times R_2}{R_1 + R_2} = \frac{3100 \times 7500}{3100 + 7500}$

$= \frac{23{,}250{,}000}{10600} = 2193\Omega$
$= 2.2\,k\Omega$

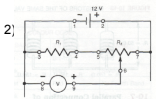
$\frac{1}{0.207} = 4.8\Omega = 5\Omega$

May 12-2:18 PM

Unit 10 Assignment

1) 

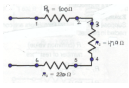
a) Complete the number sequence chart for the above diagram.

2) 

a) Complete the number sequence chart for the above diagram.

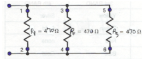
3) Write out 10 resistor codes and their corresponding color bands.

4) a) Calculate the total resistance of the below diagram.

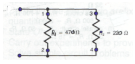


b) Complete the number sequence chart for the above diagram.

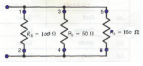
5) a) Calculate the total resistance of the below diagram.



6) a) Calculate the total resistance of the below diagram.



7) a) Calculate the total resistance of the below diagram.



Mar 12-11:32 AM

Questions 1 - 11

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Self Evaluation

I will chooses some

(1,2,4,5,6,7,8,10,11(all))

Hand in

Mar 11-11:43 AM

May 12-8:35 AM