RESISTOR TROUBLESHOOTING

AET 27

Courtesy of the United States Air Force

INTRODUCTION

Tired of throwing away those portable CD players that break on you? Don't have the money to fix your car stereo?

INTRODUCTION

Well, if you pay real close attention to the methods you are about to learn on troubleshooting, you might be able to fix them yourself.

INTRODUCTION

We will now employ the wealth of knowledge gained over the past units to accomplish a primary task of an electronics technician – troubleshooting to locate a faulty component.

INTRODUCTION

Objective 8a:

Use test equipment and a trainer to troubleshoot basic resistive circuits IAW the PC checklist.

Meas: PC

(1) Safety/ORM

(2) Series

(3) Parallel

(4) Series-parallel

INTRODUCTION

Let’s begin our lesson with a discussion of Safety & Operational Risk Management.

PRESENTATION

Safety/ORM

Use common sense.

Adhere to all safety precautions and procedures.

Apply the six step ORM process if applicable.

SERIES CIRUIT

Purpose of Troubleshooting?

SERIES CIRUIT

Finding Faulty Components

1. Visual Inspection

   Charred/Burnt components

   Bad Solder Connections

   Broken Wires

   Poor Contacts

   Open Lamp Filaments

   Open Fuse

SERIES CIRUIT

Finding Faulty Components

2. Verifying Defective Components

“Circuit Under Test”

Resistance Checks

Fuses

Lamps

Switches

Circuit Isolation

SERIES CIRUIT

Finding Faulty Components

3. Logic and Systematic Troubleshooting Techniques

   Make a measurement only if you know what a good reading should be

   Make as few measurements as possible

   Best meter for circuit and circumstances

Troubleshooting

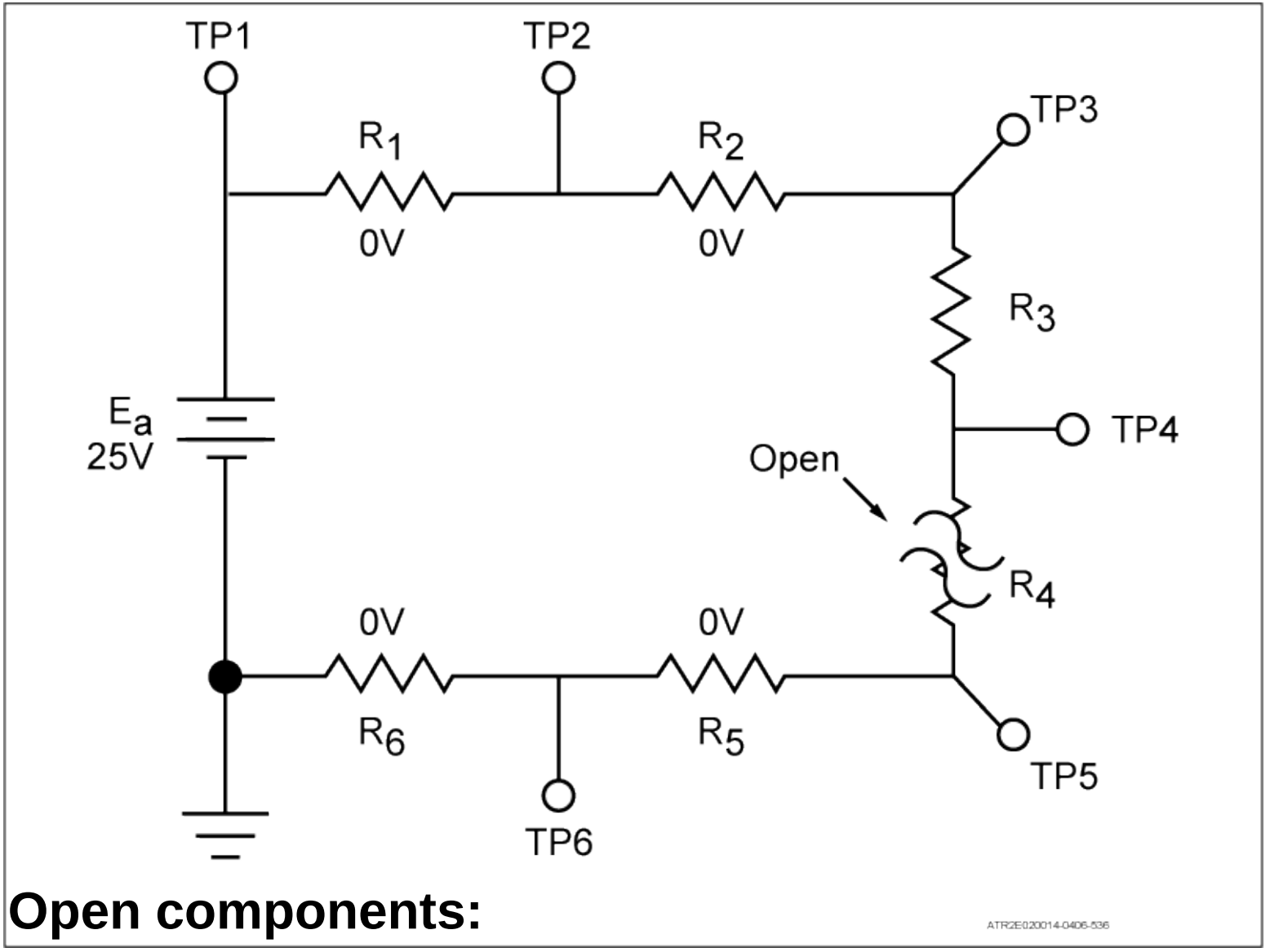
Troubleshooting Series Circuits

1. Open components
2. Shorted components
3. Components with changed values

Series Circuits Review

Parameter	Series Circuit	Parallel Circuit
Voltage	The sum of the voltage drops across the individual loads is equal to the source voltage.	The voltage across each branch is the same as the source voltage.
Resistance	The total resistance is equal to the sum of the individual resistances.	The total resistance is equal to the reciprocal of the sum of the reciprocals of the individual resistances.
Current	There is only one path for current to flow.	There is more than one path for current to flow.
	The current at every point in the circuit is the same.	The total current is equal to the sum of the branch currents.
Power	The total power consumed is equal to the sum of the power consumptions of the individual loads.	

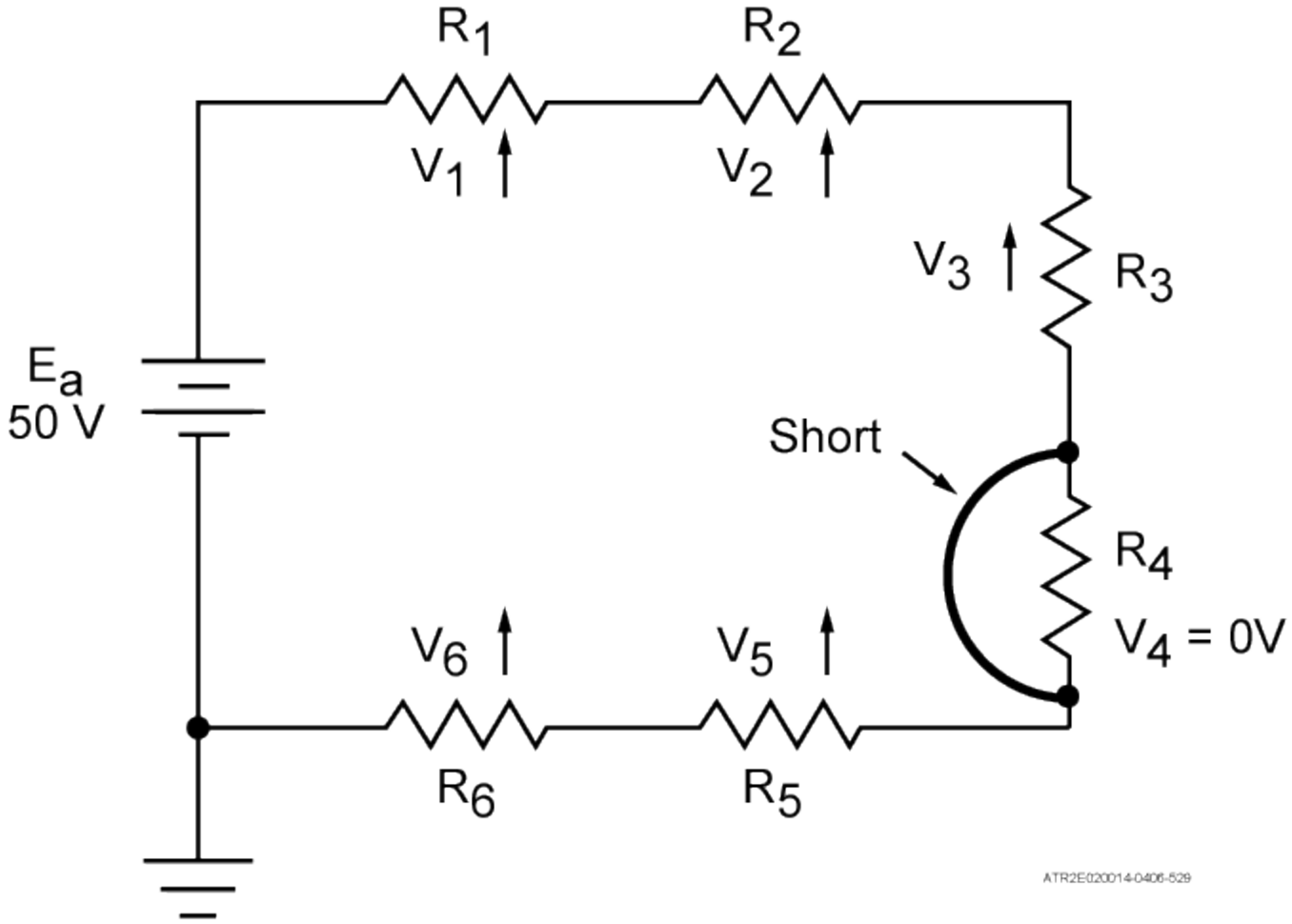
Troubleshooting Series Circuits



Open components:

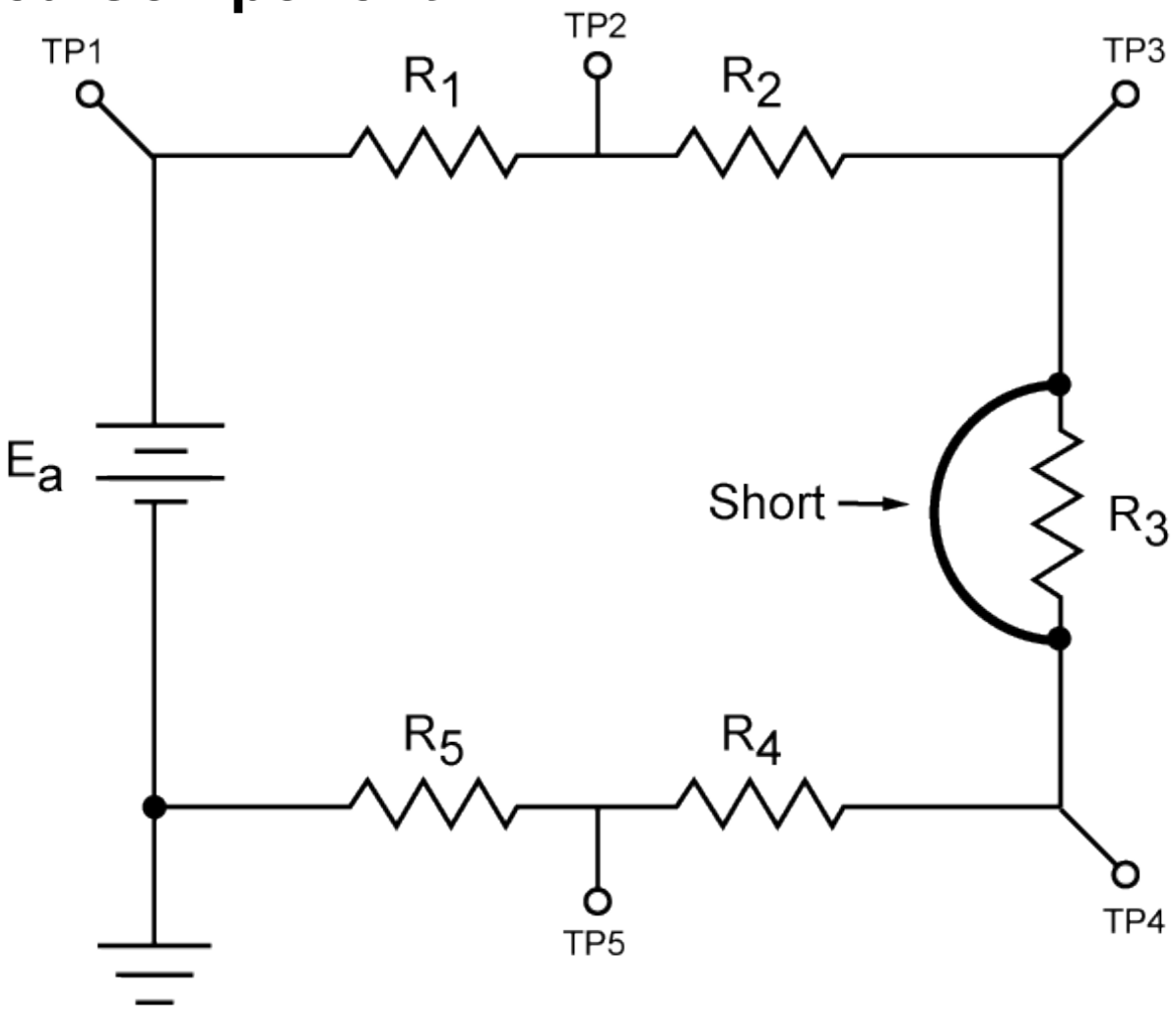
Troubleshooting Series Circuits

Shorted Component



Troubleshooting Series Circuits

Shorted Component



What happens to voltage, current, and resistance?

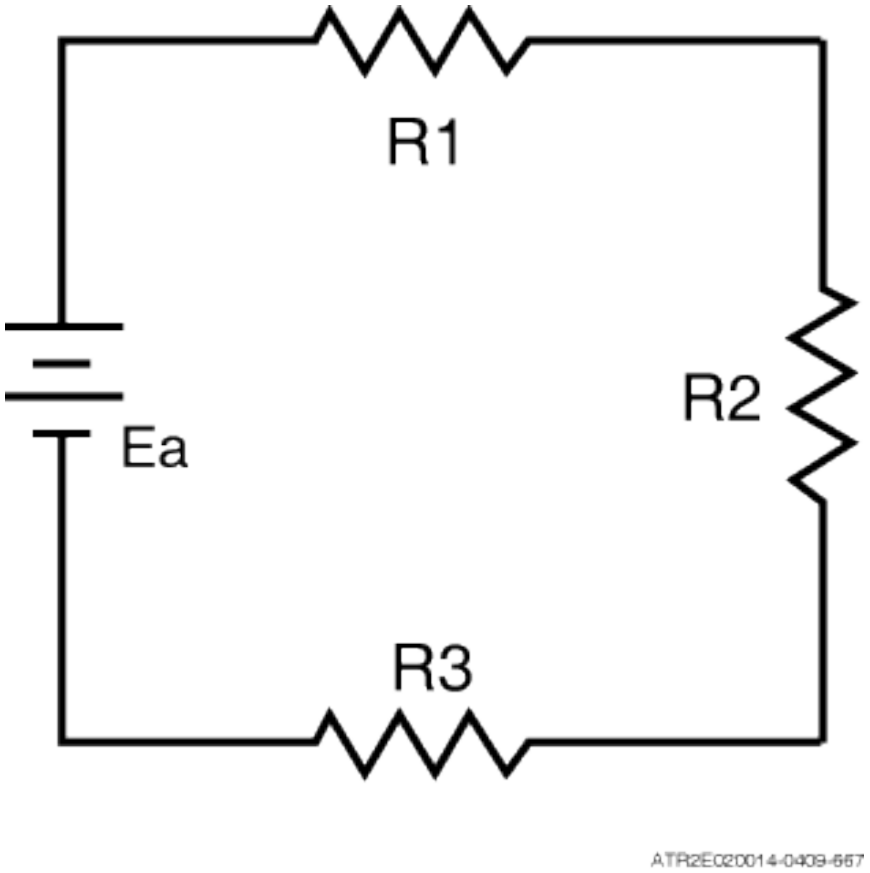
Troubleshooting Series Circuits

Change in Value of R_3

Given:
Ea=120V
R_1=10kΩ
R_2=15kΩ
R_3=15kΩ

What happens if R_3 decreases to 10kΩ?

What happens if R_3 increases to 35kΩ?



R_T =

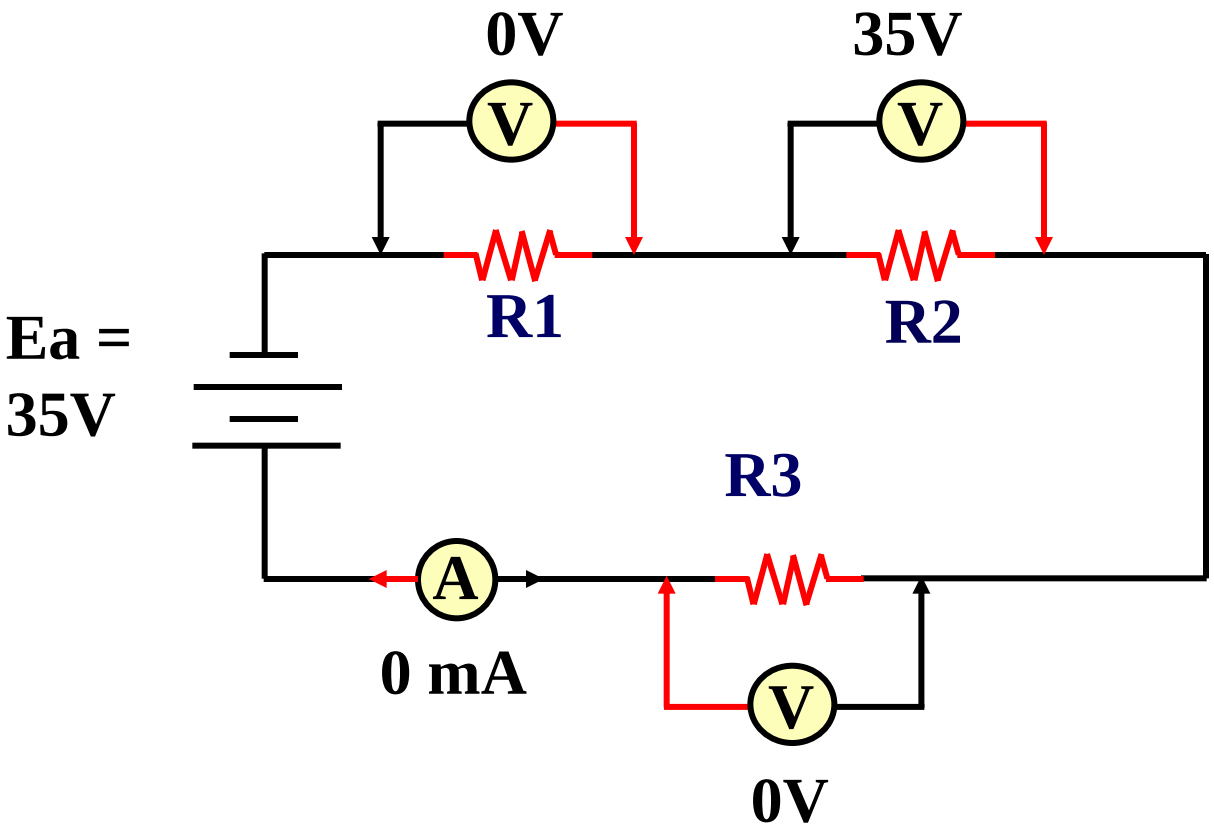
I_T =

E_{R1} =

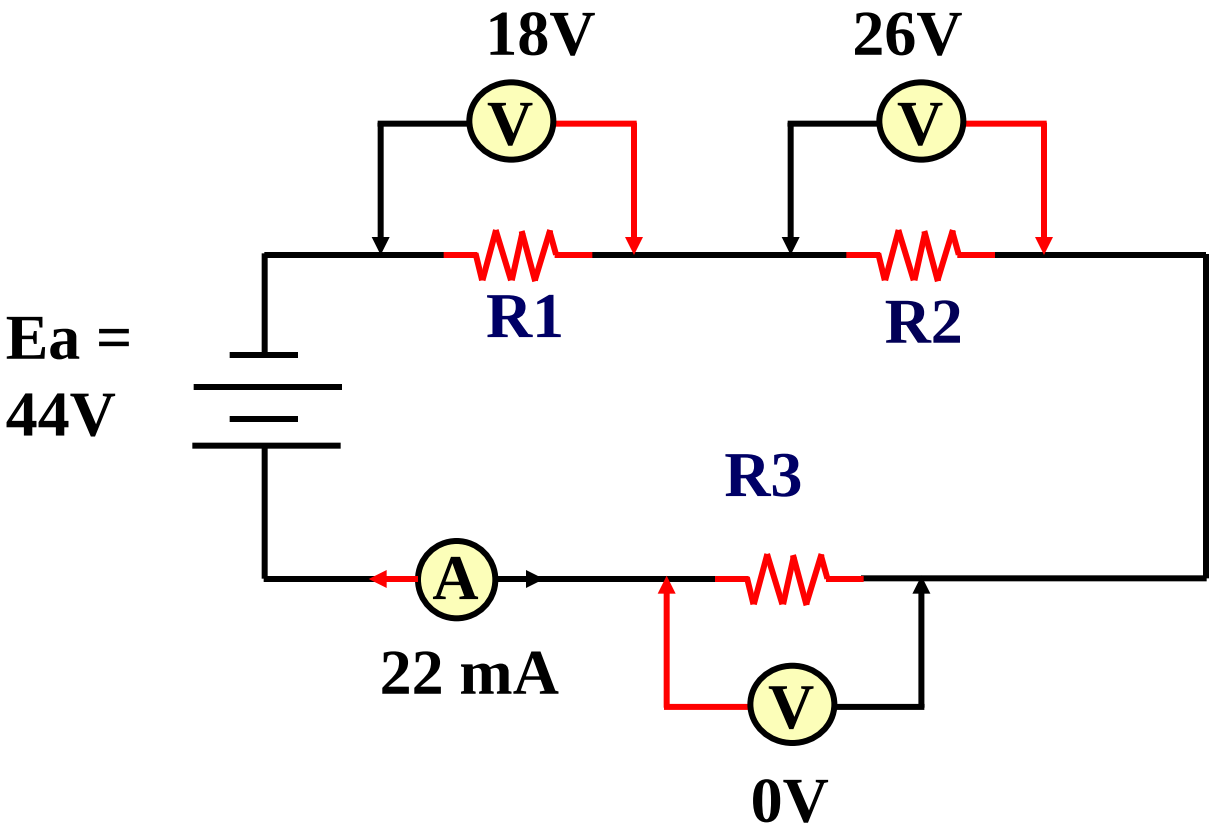
E_{R2} =

E_{R3} =

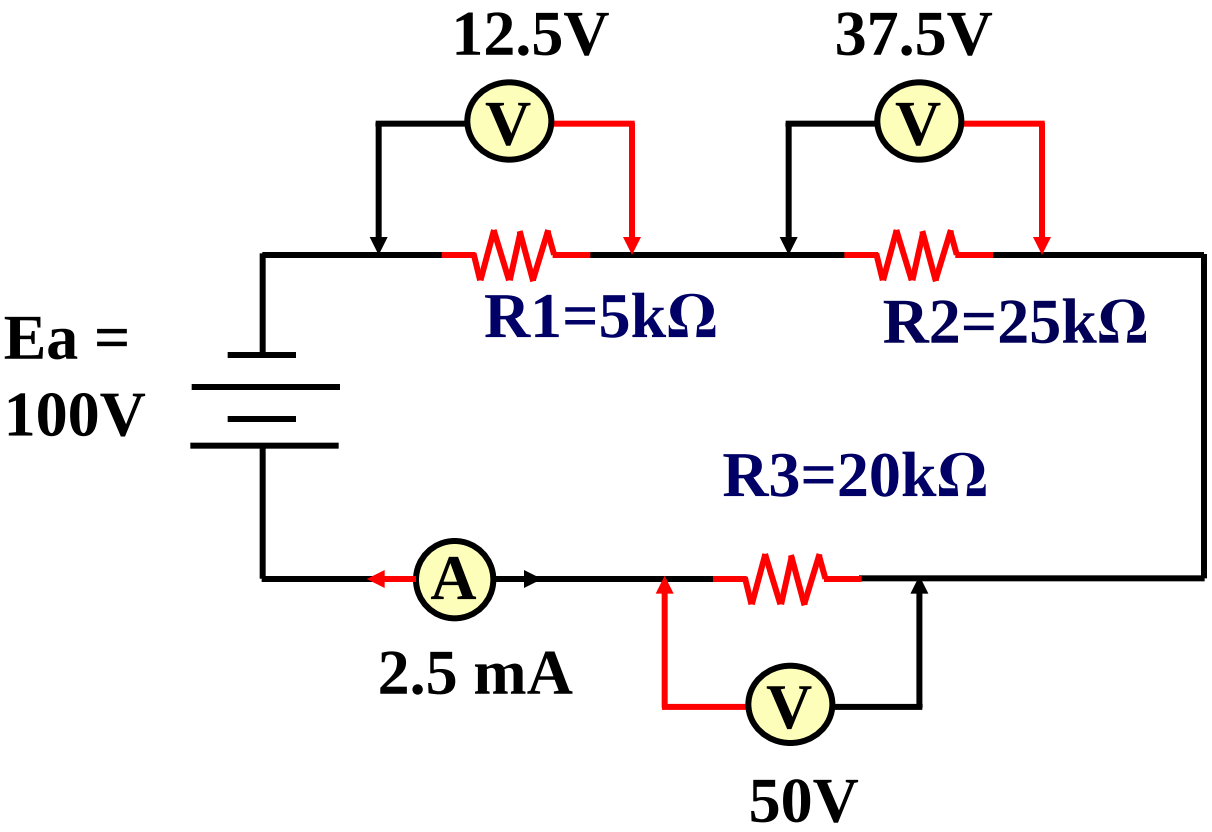
Troubleshooting Series Circuits



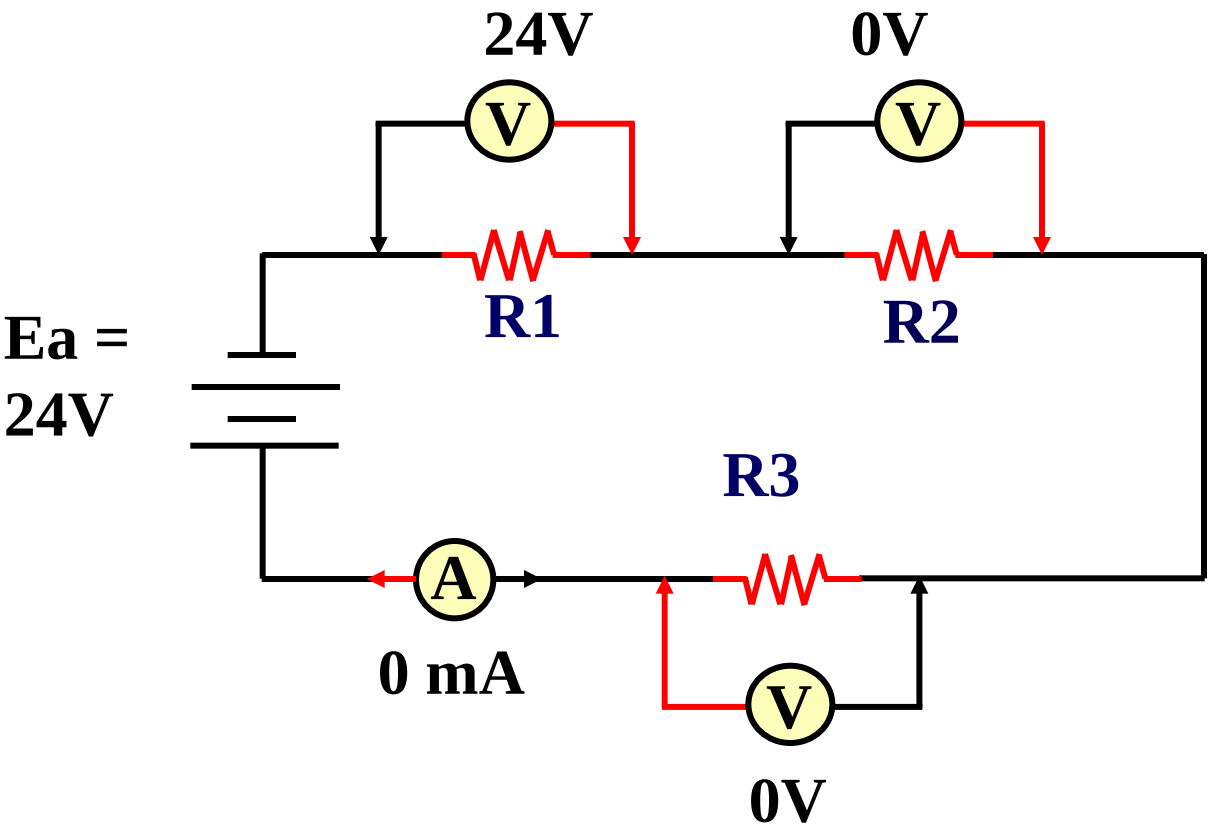
Troubleshooting Series Circuits



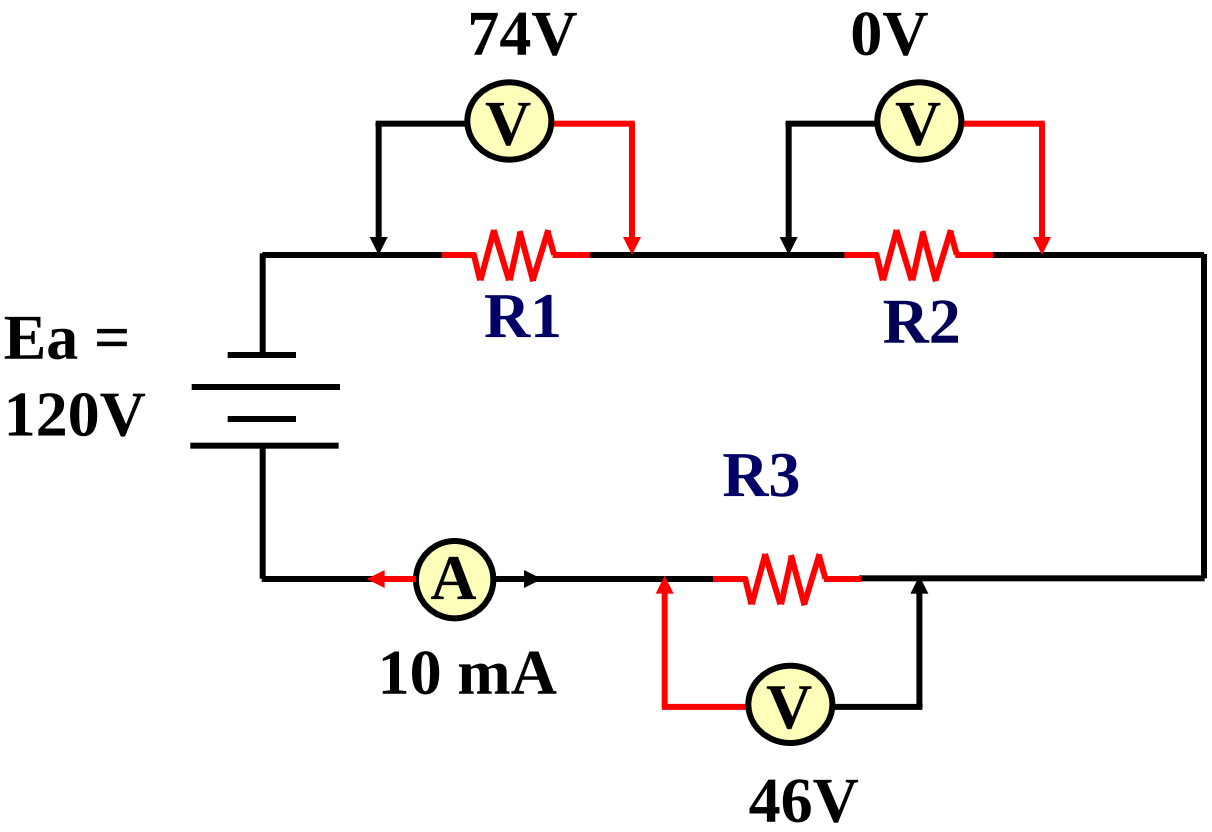
Troubleshooting Series Circuits



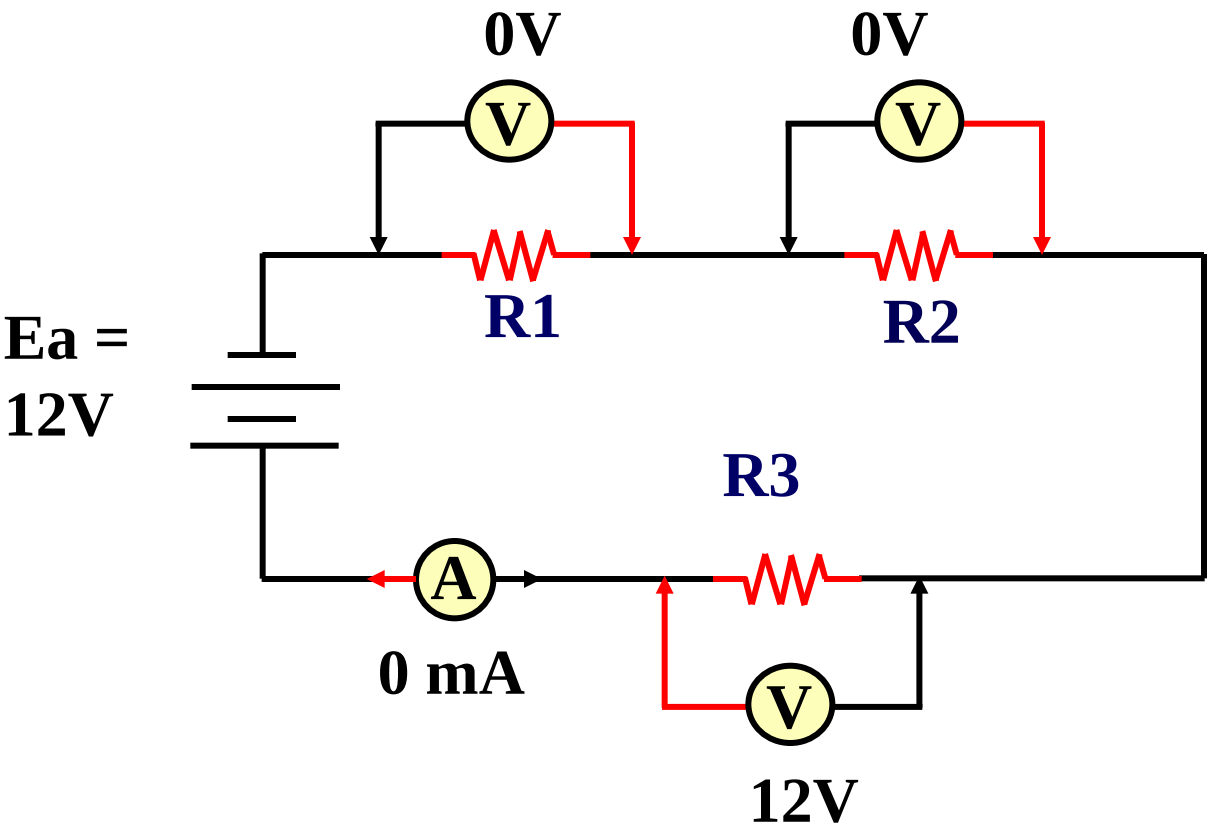
Troubleshooting Series Circuits



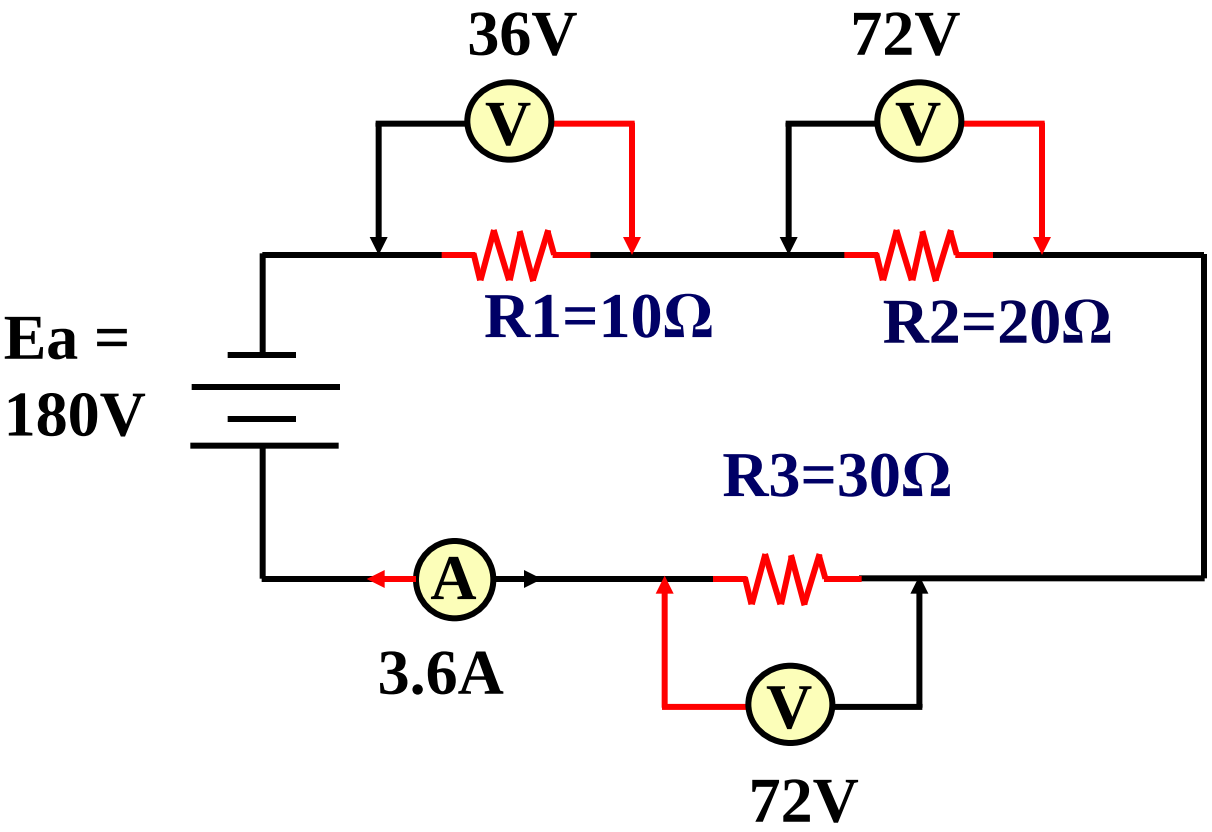
Troubleshooting Series Circuits



Troubleshooting Series Circuits



Troubleshooting Series Circuits



Troubleshooting Series Circuits

Summary Troubleshooting Series Circuits

	Voltage across component	Voltage across other components	Resistance across component	Resistance across other components	Circuit Current
OPEN	Source V	Zero V	Infinite	Normal	Zero
SHORT	Zero V	Increased V	Zero ohms	Normal	↑
W ↑	Increased	Decreased	Increased	Normal	↓
W ↓	Decreased	Increased	Decreased	Normal	↑

Troubleshooting Parallel Circuits

Parallel Circuits:

Not Easy to Troubleshoot

Open components

Using conductance

Shorted components

Basic troubleshooting techniques

Troubleshooting Parallel Circuits

Visual inspection

Verifying defective component

Logical and systematic troubleshooting techniques

Parallel Circuits Review

Parameter	Series Circuit	Parallel Circuit
Voltage	The sum of the voltage drops across the individual loads is equal to the source voltage.	The voltage across each branch is the same as the source voltage.
Resistance	The total resistance is equal to the sum of the individual resistances.	The total resistance is equal to the reciprocal of the sum of the reciprocals of the individual resistances.
Current	There is only one path for current to flow.	There is more than one path for current to flow.
	The current at every point in the circuit is the same.	The total current is equal to the sum of the branch currents.
Power	The total power consumed is equal to the sum of the power consumptions of the individual loads.	

Troubleshooting Parallel Circuits

Open Components:

- **Hard to troubleshoot since voltage is common.**
- **Open component in a parallel circuit can be found by calculating conductance (G).**
- **Conductance is the reciprocal of resistance.**
- **The symbol for conductance is “G”.**
- **The unit of measure for conductance is “siemens” and the symbol for the unit of measure is “S”.**

Troubleshooting Parallel Circuits

Calculating Conductance:

Recall: $R_T = \dfrac{1}{\frac{1}{R_1}+\frac{1}{R_2}+\frac{1}{R_3}+....}$

Conductance is reciprocal

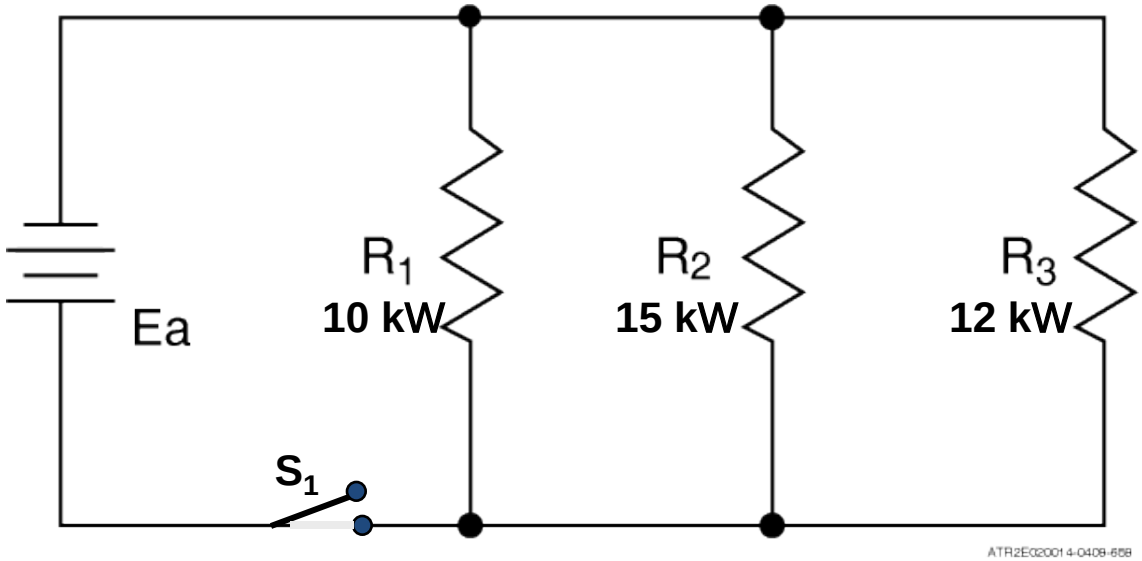
$G_{\#} = \dfrac{1}{R_{\#}}$ or $G_T = \dfrac{1}{R_1} + \dfrac{1}{R_2} + \dfrac{1}{R_3}$ ... or $G_T = \dfrac{1}{R_T}$

Resistance reciprocal

$R_{\#} = \dfrac{1}{G_{\#}}$ or $R_T = \dfrac{1}{G_1+G_2+G_3+\ldots}$ or $R_T = \dfrac{1}{G_T}$

Troubleshooting Parallel Circuits

Calculating Conductance: Where's the open?



Calculate R_T
R_T = 4 kW
Calculate G_T
G_T = 250 µS
Measure R_T
R_T = 6 kW
Calculate Measured G_T
Measured G_T = 166.7 µS

Calculated G_T – Measured G_T = G of open
250µS – 166.67 = 83.3 µS
Calculate R of open
1 / 83.3 µS = 12 kW

Where's the open?

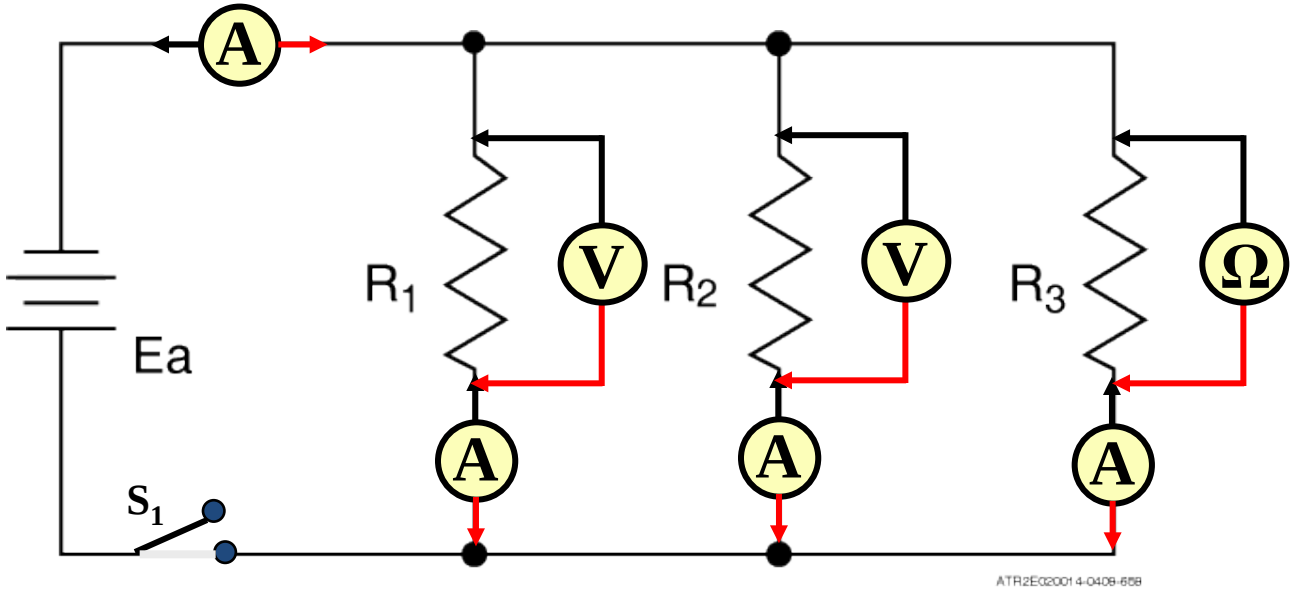
R_3

Troubleshooting Parallel Circuits

Calculating Conductance: Where's the open?

Practice:

Ea = 62V
R_1 = 4.8kΩ
R_2 = 6.2kΩ
R_3 = 3.6kΩ
Meas. R_T = 2.06kΩ



Calculated R_T =
Calculated G_T =
Measured R_T =
Measured G_T =
G of open =
R of open =
Open =

Did E_{R2} change do to the open?

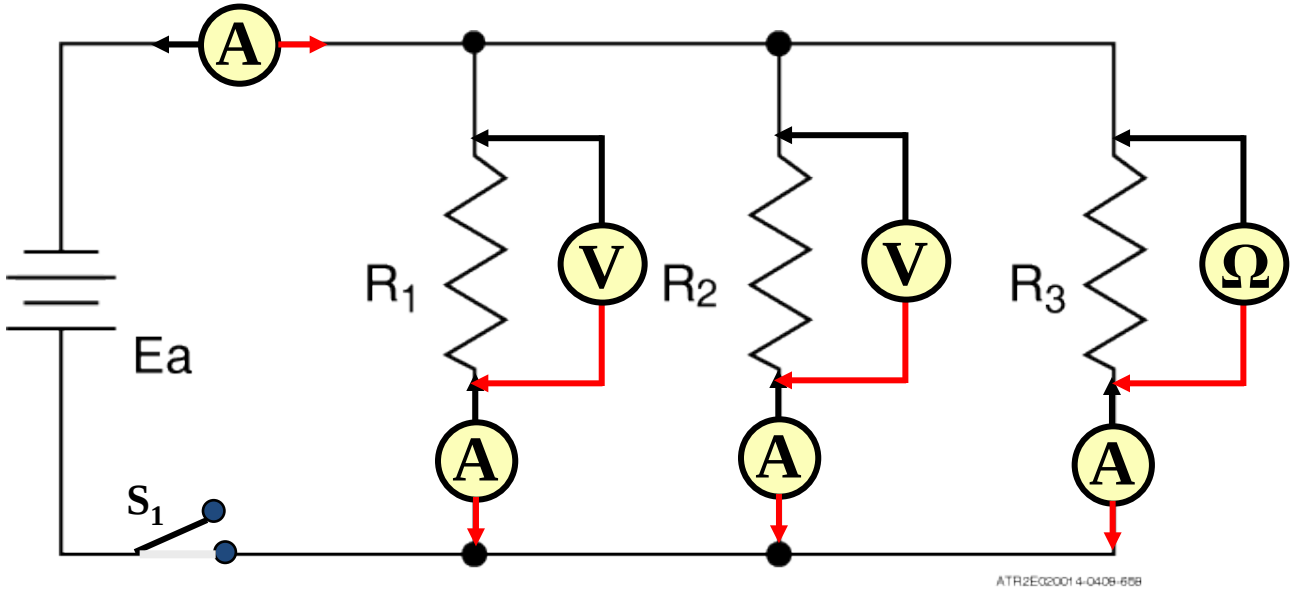
Did I_{R1} and I_{R3} change value?

Troubleshooting Parallel Circuits

Calculating Conductance: Where's the open?

Practice:

Ea = 25V
R_1 = 1.2kΩ
R_2 = 5.6kΩ
R_3 = 8.7kΩ
Meas. R_T = 3.41kΩ



Calculated R_T =
Calculated G_T =
Measured R_T =
Measured G_T =
G of open =
R of open =
Open =

Did E_{R3} change do to the open?

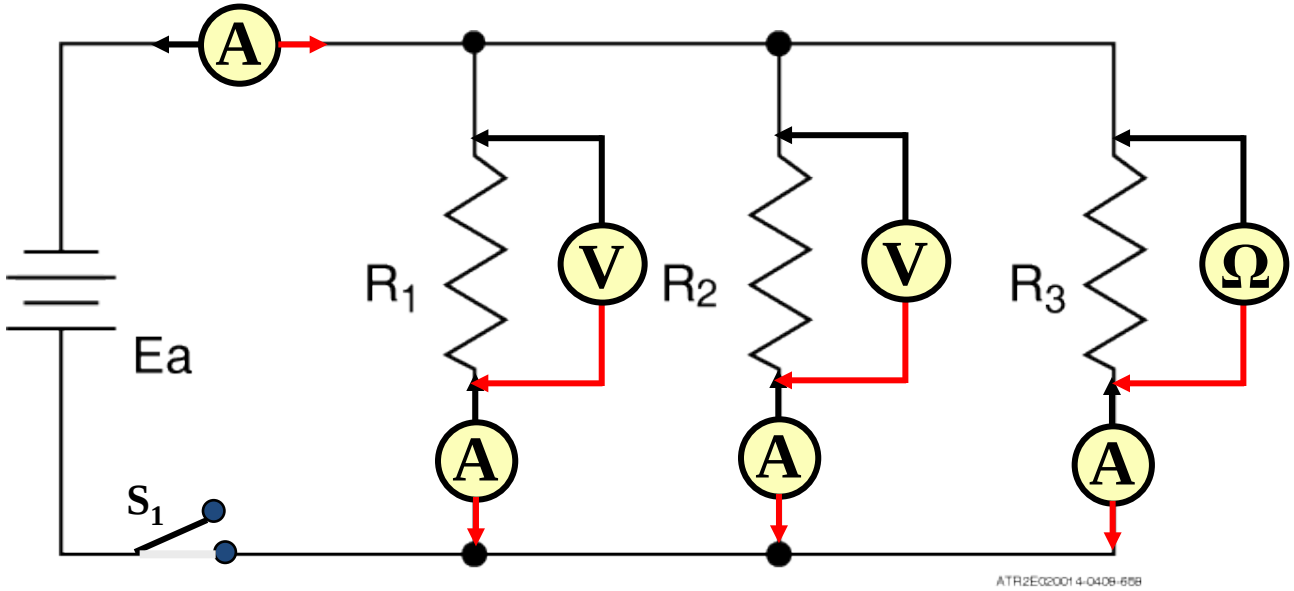
Did I_{R1} and I_{R3} change value?

Troubleshooting Parallel Circuits

Calculating Conductance: Where's the open?

Practice:

Ea = 120V
R_1 = 10Ω
R_2 = 15Ω
R_3 = 12Ω
Meas. R_T = 5.45Ω



Calculated R_T =
Calculated G_T =
Measured R_T =
Measured G_T =
G of open =
R of open =
Open =

Did E_{R2} change do to the open?

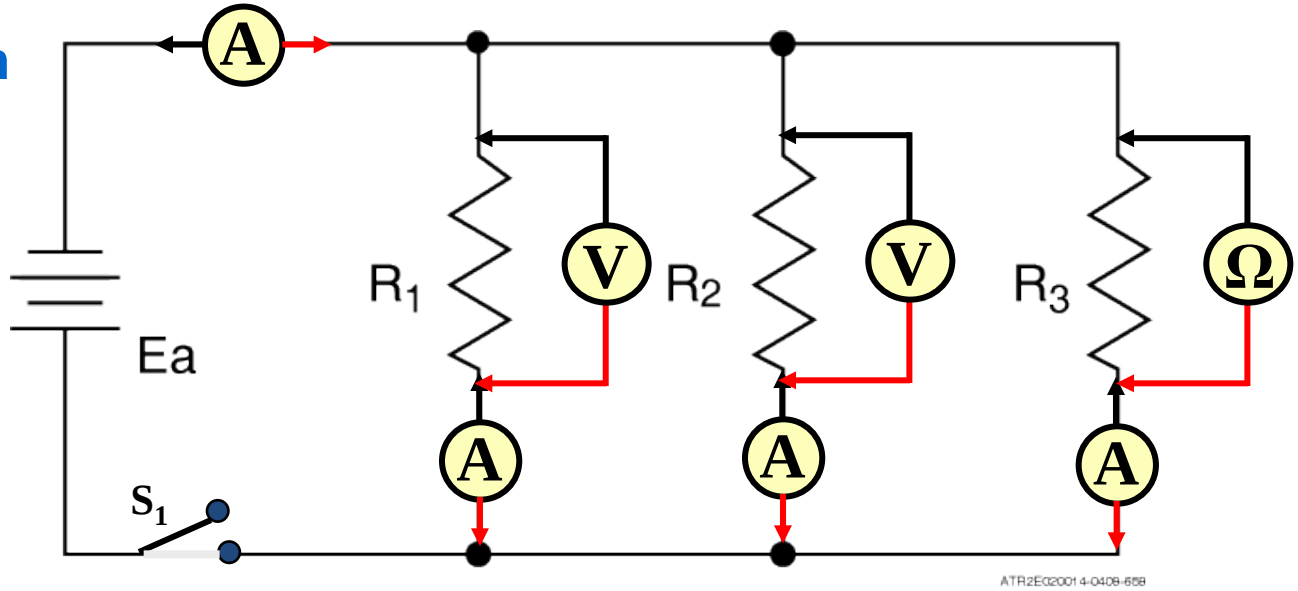
Did I_{R1} and I_{R3} change value?

Troubleshooting Parallel Circuits

Calculating Conductance: Where's the open?

Practice: Your Own

Ea =
R_1 =
R_2 =
R_3 =
Meas. R_T =



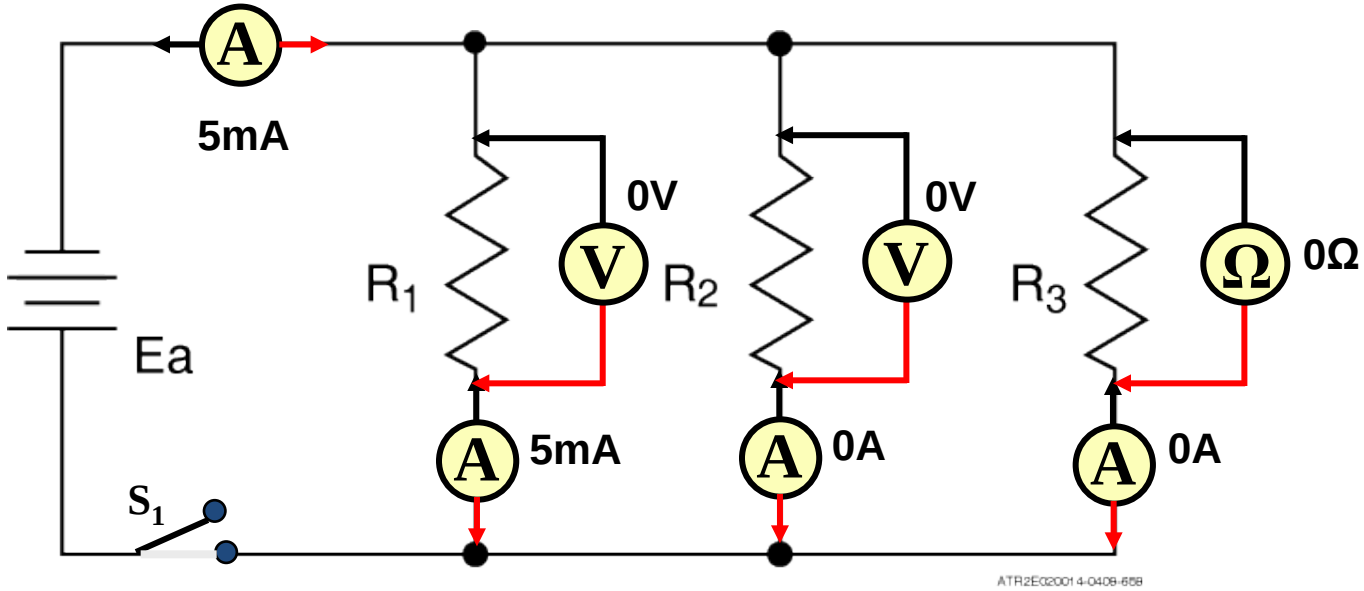
Calculated R_T =
Calculated G_T =
Measured R_T =
Measured G_T =
G of open =
R of open =
Open =

Troubleshooting Parallel Circuits

Shorted Components
One Resistor per Branch

Practice:

Ea = 35V
R_1 = 21kΩ
R_2 = 21kΩ
R_3 = 21kΩ



Calculate R_T =

Calculate I_T =
Calculate I_{R1} =
Calculate I_{R2} =
Calculate I_{R3} =

Take Measurements

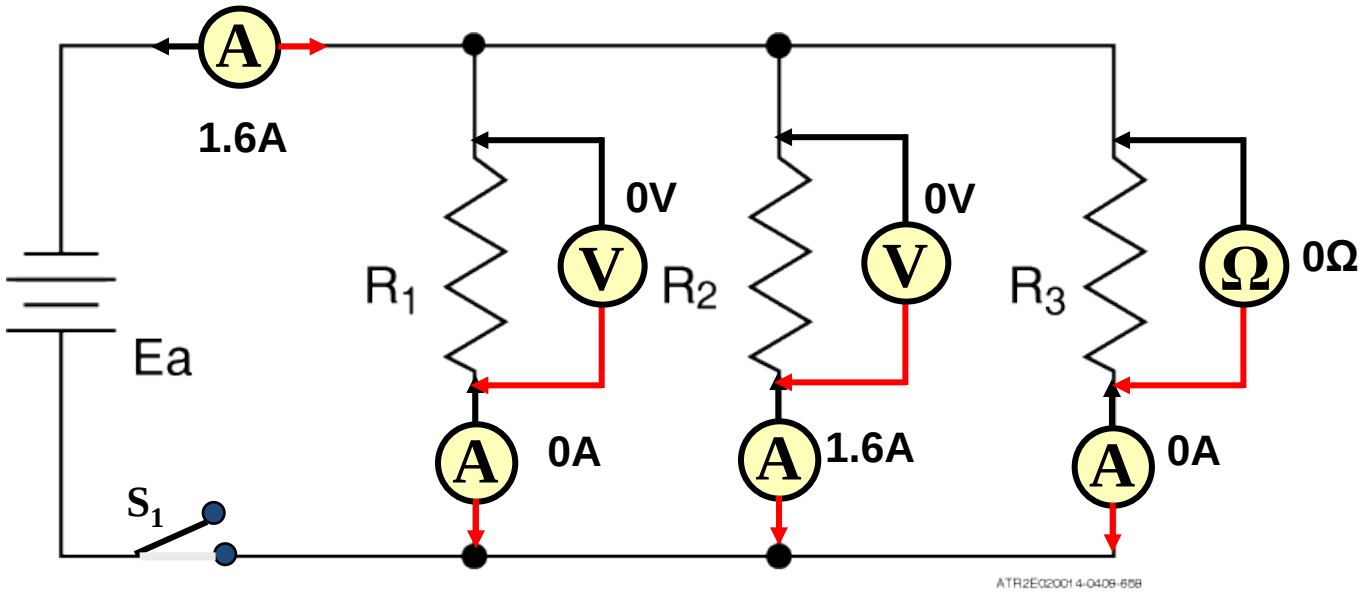
Where's the short?

Troubleshooting Parallel Circuits

Shorted Components
One Resistor per Branch

Practice:

Ea = 12V
R_1 = 20Ω
R_2 = 30Ω
R_3 = 12Ω
Meas. R_T = 7.5Ω



Calculate R_T =

Calculate I_T =
Calculate I_{R1} =
Calculate I_{R2} =
Calculate I_{R3} =

Take Measurements

Where's the short?

Troubleshooting Parallel Circuits

Shorted Components
One Resistor per Branch

Practice: Your Own

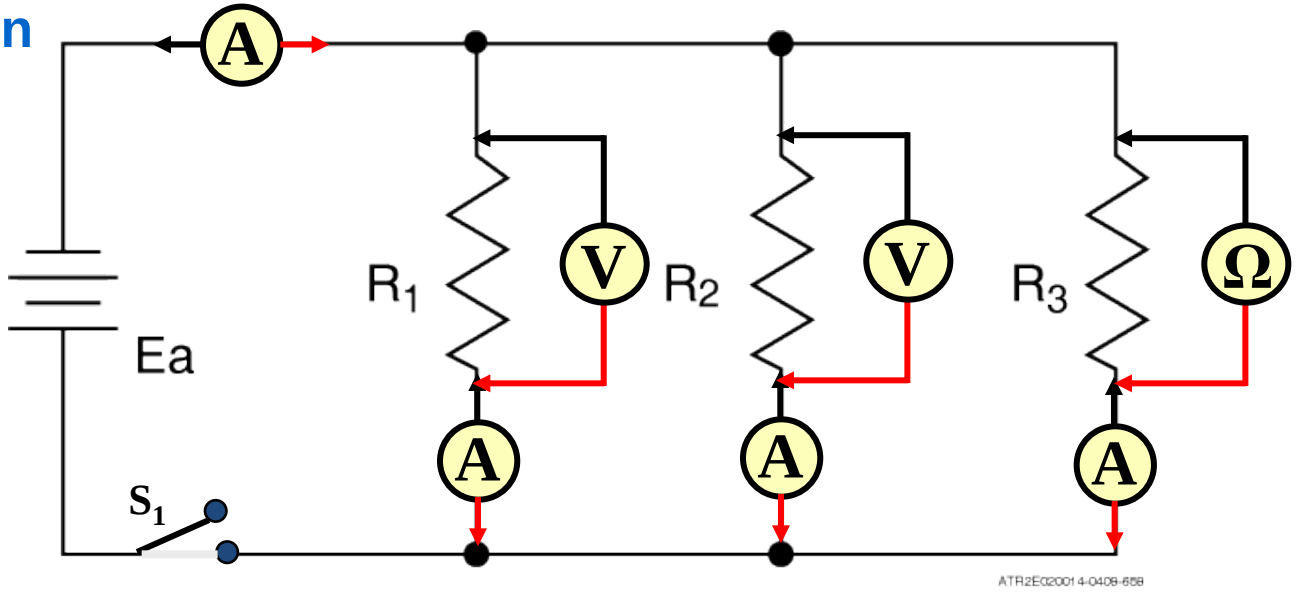
Ea =
R_1 =
R_2 =
R_3 =
Meas. R_T =

Calculate R_T =

Calculate I_T =
Calculate I_{R1} =
Calculate I_{R2} =
Calculate I_{R3} =

Take Measurements

Where's the short?

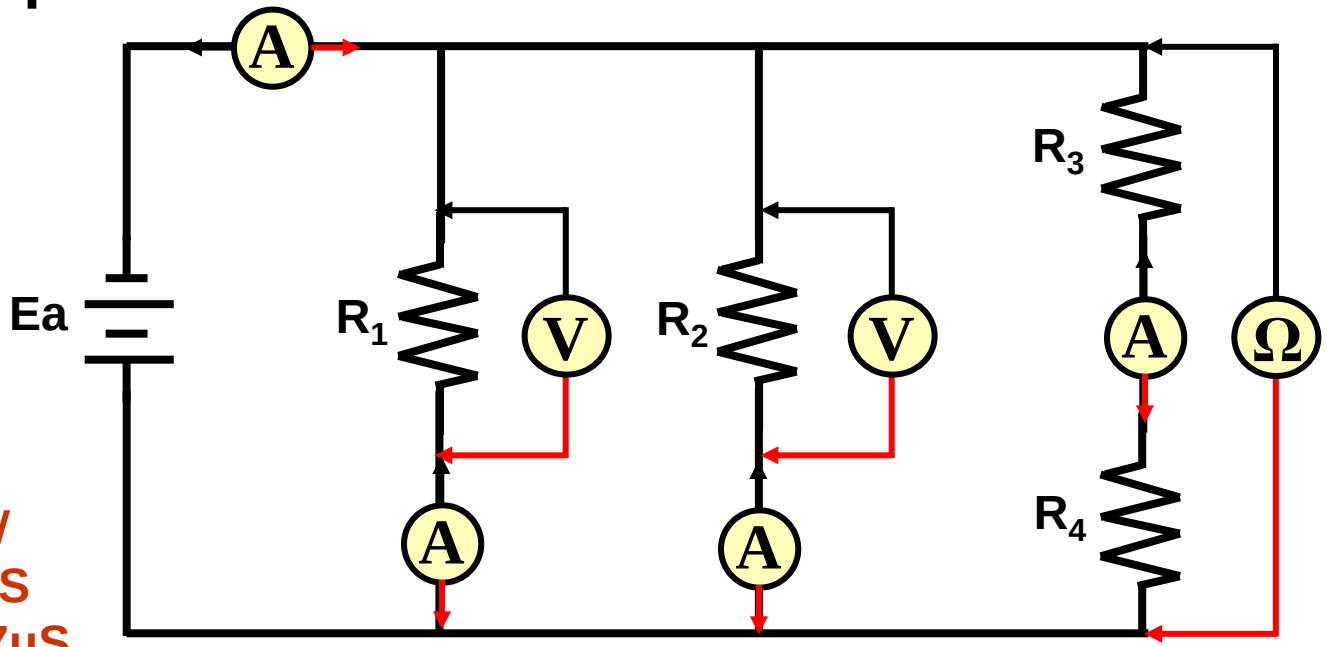


Troubleshooting Parallel Circuits

Shorted Components
Two Resistors per Branch

Practice:

Ea = 12V
R_1 = 10kΩ
R_2 = 15kΩ
R_3 = 10kΩ
R_4 = 2kΩ
Meas. R_T = 7.5Ω



Calculate R_T = 4 kW
Calculate G_1 = 100μS
Calculate G_2 = 66.67μS
Calculate G_3 (R_3+R_4) = 83.33μS
Calculate G_T (G_1+G_2+G_3) = 250 μS
Measure R_T = 3.75 kW
Measure G_T = 266.67 μS
Calculate G_T R_3 only = 266.67 μS
Calculate G_T R_4 only = 666.67 μS

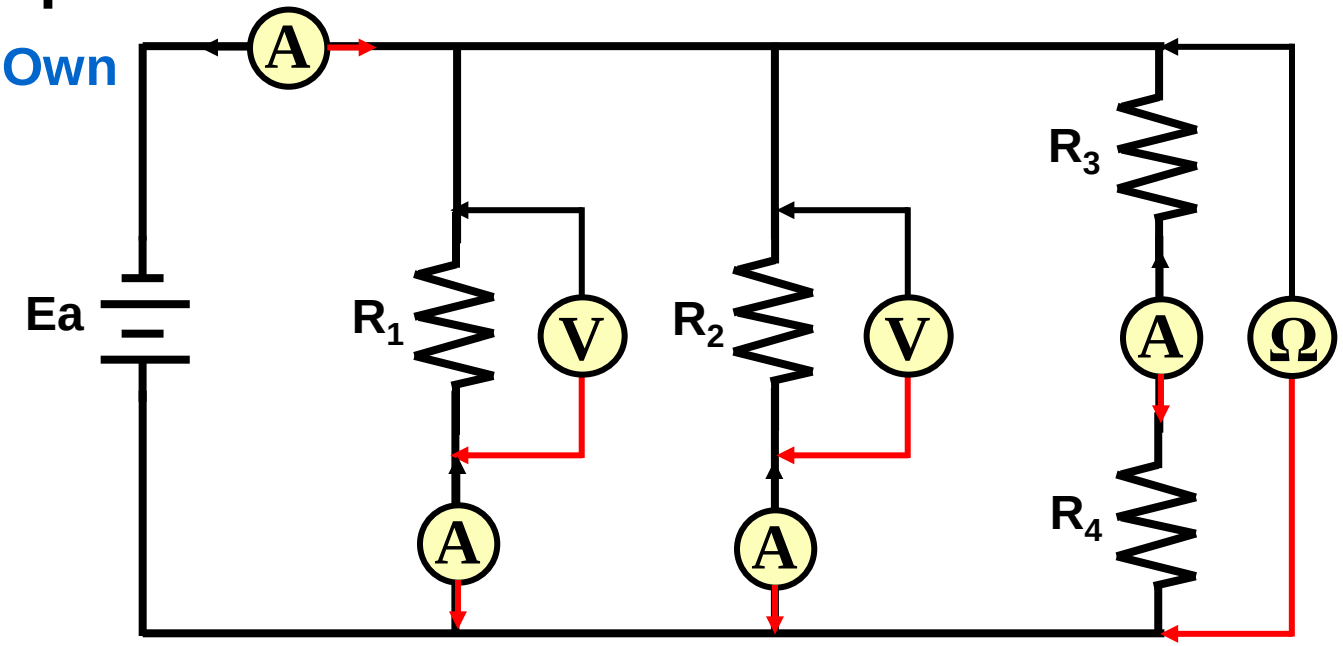
Compare R_3 and R_4 only G_T to Measured G_T
Shorted resistor is the one that DOES NOT match.

Troubleshooting Parallel Circuits

Shorted Components
Two Resistors per Branch

Practice: Your Own

Ea =
R_1 =
R_2 =
R_3 =
R_4 =
Meas. R_T =

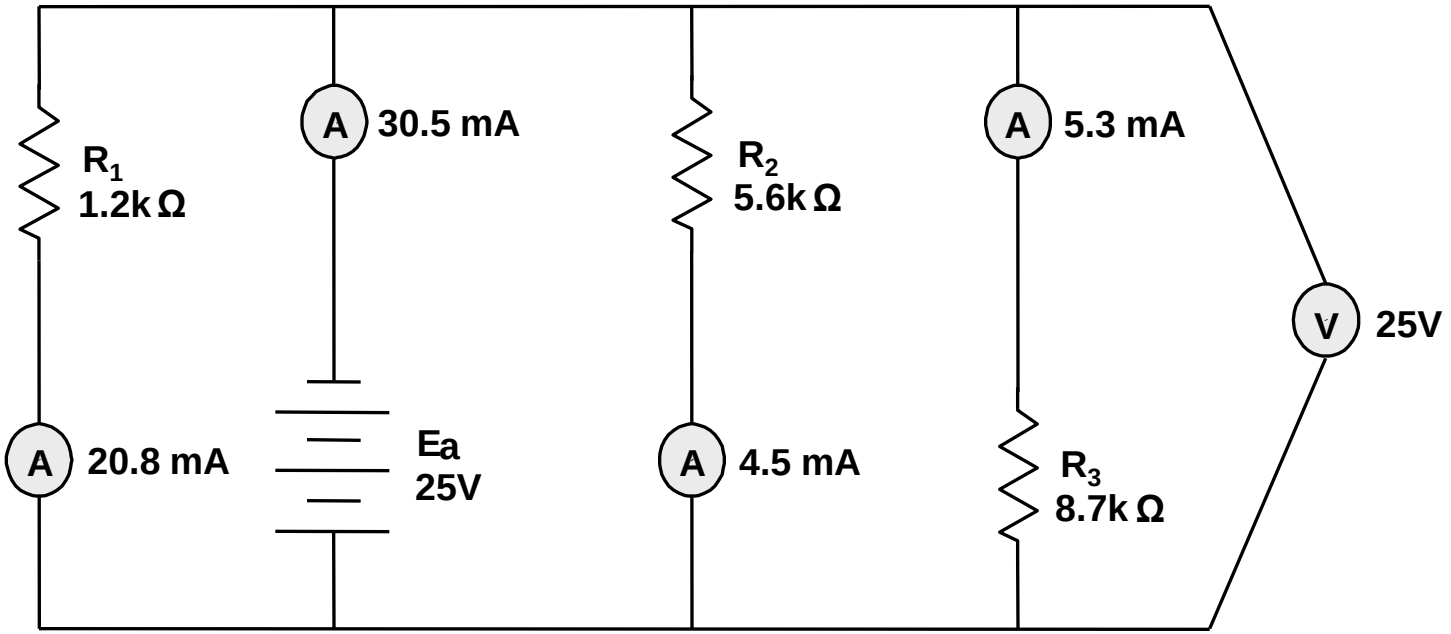


Calculate R_T =
Calculate G_1 =
Calculate G_2 =
Calculate G_3 (R_3+R_4) =
Calculate G_T (G_1+G_2+G_3) =
Measure R_T =
Measure G_T =
Calculate G_T R_3 only =
Calculate G_T R_4 only =

Compare R_3 and R_4 only G_T to Measured G_T
Shorted resistor is the one that DOES NOT match.

Troubleshooting Parallel Circuits

Changed Value:



Finding a changed value component in a parallel circuit will normally require that individual components be isolated and ohms checked to find the fault.

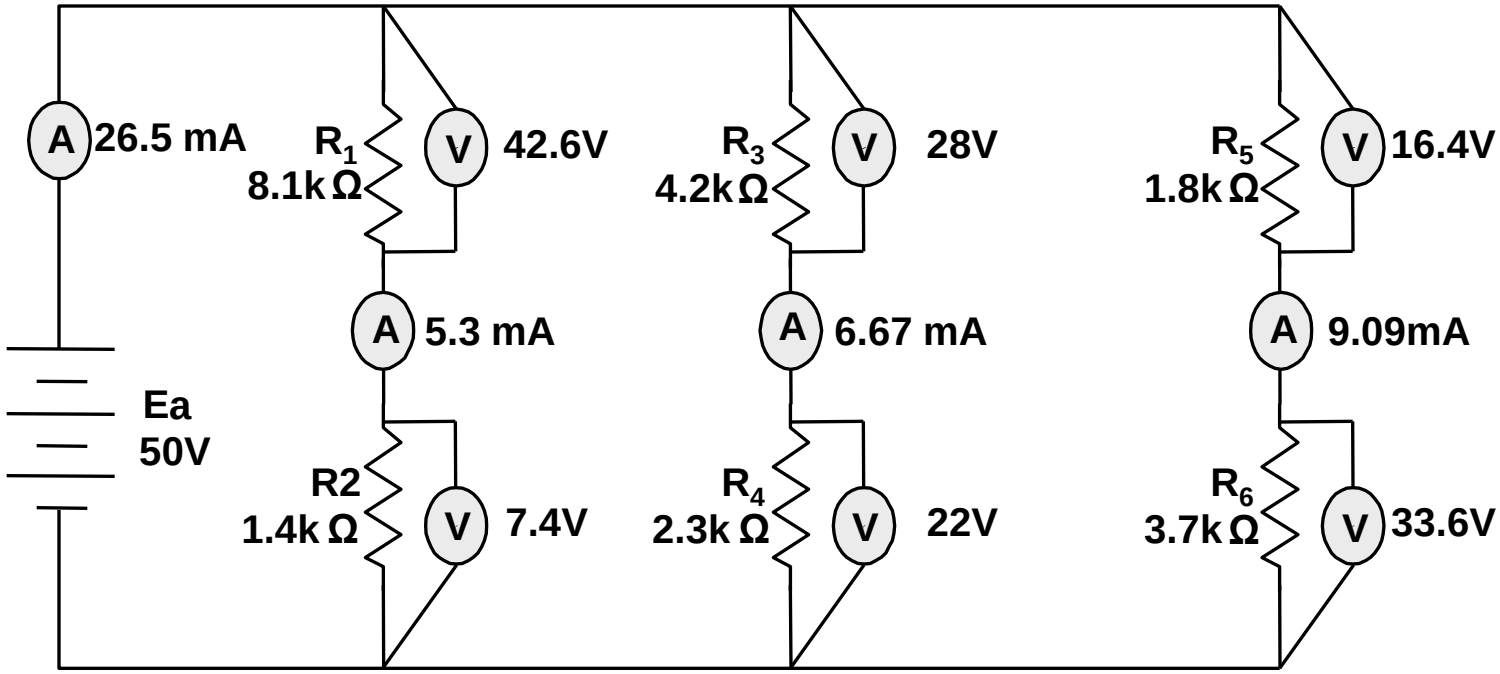
Troubleshooting would be easy if we had meters built in the circuit like the one above.

Use the readings in the circuit above to determine which resistor has changed and did it increase or decrease in value.

How about R_3 decreased.

Troubleshooting Parallel Circuits

Changed Value:



Use the readings in the circuit above to determine which resistor has changed and did it increase or decrease in value.

How about R_4 increased.

TROUBLESHOOTING SERIES-PARALLEL CIRCUIT

Series-parallel

Both Circuit Characteristics

Series and Parallel circuit Comparison

Combine series and parallel troubleshooting techniques

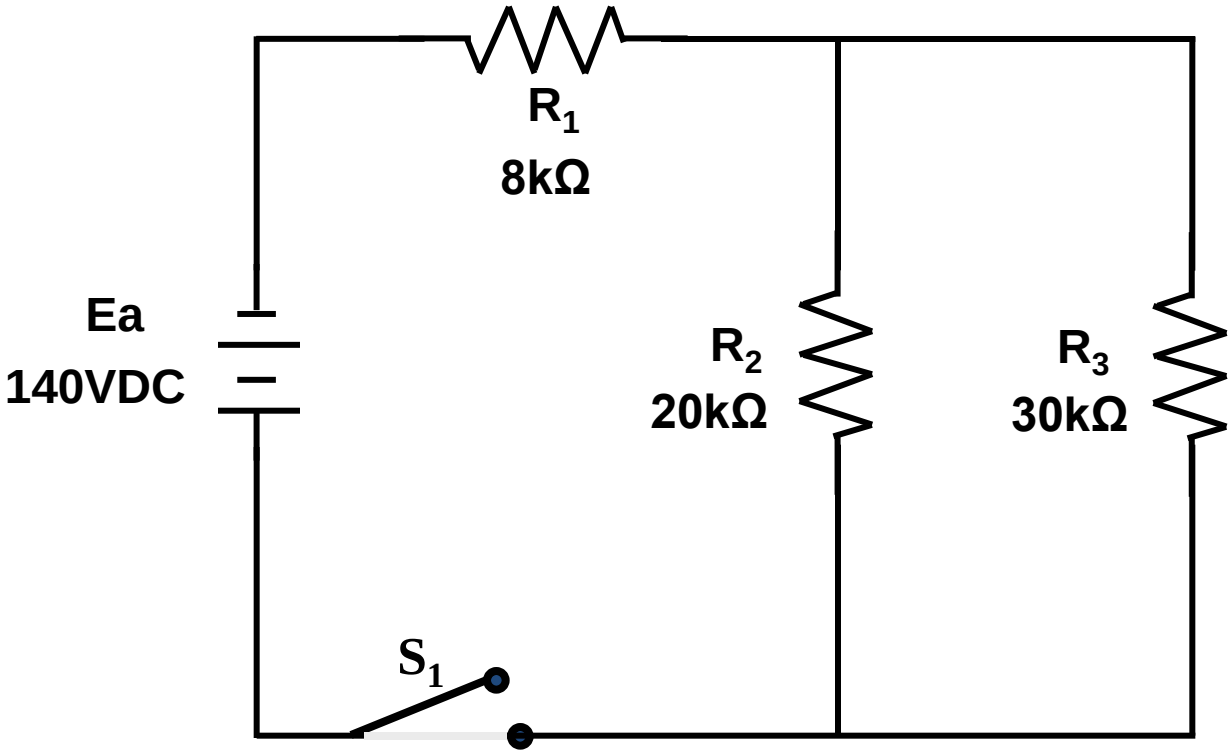
Series circuit troubleshooting summary

TROUBLESHOOTING SERIES-PARALLEL CIRCUIT

Series and Parallel Circuit Comparisons

Parameter	Series Circuit	Parallel Circuit
Voltage	The sum of the voltage drops across the individual loads is equal to the source voltage.	The voltage across each branch is the same as the source voltage.
Resistance	The total resistance is equal to the sum of the individual resistances.	The total resistance is equal to the reciprocal of the sum of the reciprocals of the individual resistances.
Current	There is only one path for current to flow.	There is more than one path for current to flow.
	The current at every point in the circuit is the same.	The total current is equal to the sum of the branch currents.
Power	The total power consumed is equal to the sum of the power consumptions of the individual loads.	

TROUBLESHOOTING SERIES-PARALLEL CIRCUIT



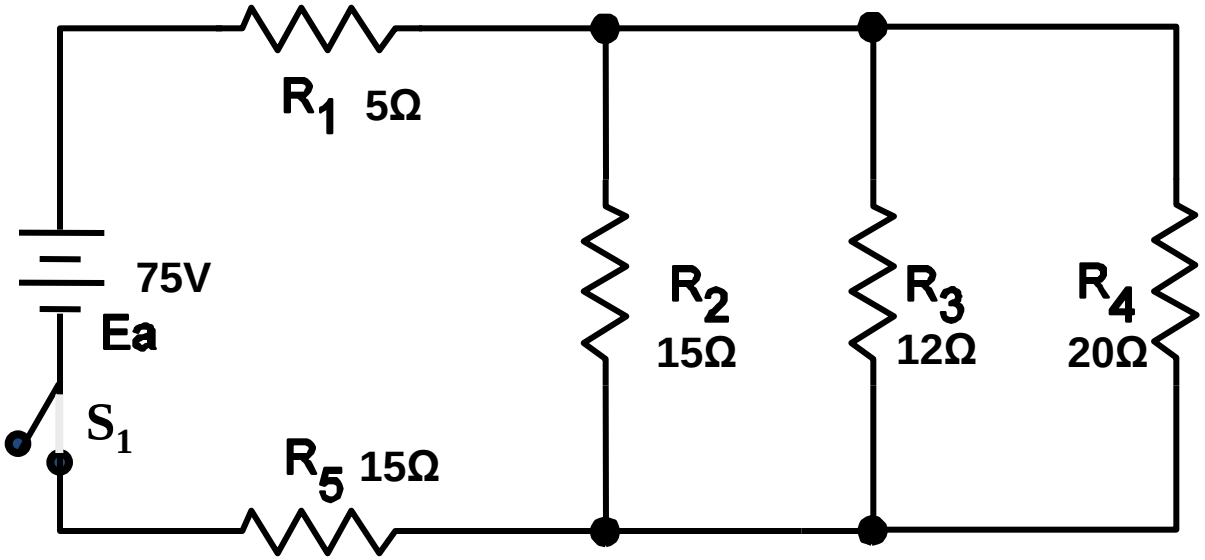
Normal/Faulted

R_e =
R_T =
I_T =
E_{R1} =
E_{R2} =
E_{R3} =

If:

R_2 Open
R_3 Shorted
R_3 Changed W

TROUBLESHOOTING SERIES-PARALLEL CIRCUIT



Normal/Faulted

R_e =
R_T =
I_T =
E_{R1} =
E_{R2} =
E_{R3} =
E_{R4} =
E_{R5} =

If:

R_5 Open
R_1 Shorted
R_5 Changed W

RESISTOR TROUBLESHOOTING

Appraisal

Objective 8a:

Use test equipment and a trainer to troubleshoot basic resistive circuits IAW the PC checklist.

RESISTOR TROUBLESHOOTING

70. One of the first things you should do to isolate a faulty component is to perform _____.

RESISTOR TROUBLESHOOTING

71. When performing an ohms check, an open is indicated by a reading of _____ .

a. 1000 MΩ
b. 10 MΩ
c. 0 Ω
d. ∞ Ω

RESISTOR TROUBLESHOOTING

72. When making measurements to find a faulty component, you should perform as _____ measurements as possible.

a. few
b. many

RESISTOR TROUBLESHOOTING

73. The symbol for conductance is

a. G
b. I
c. R
d. P

RESISTOR TROUBLESHOOTING

74. The unit of measurement for conductance is _____.

a. siemens
b. ampere
c. volt
d. ohm

RESISTOR TROUBLESHOOTING

75. When performing an ohms check, a short is indicated by a reading of _____ .

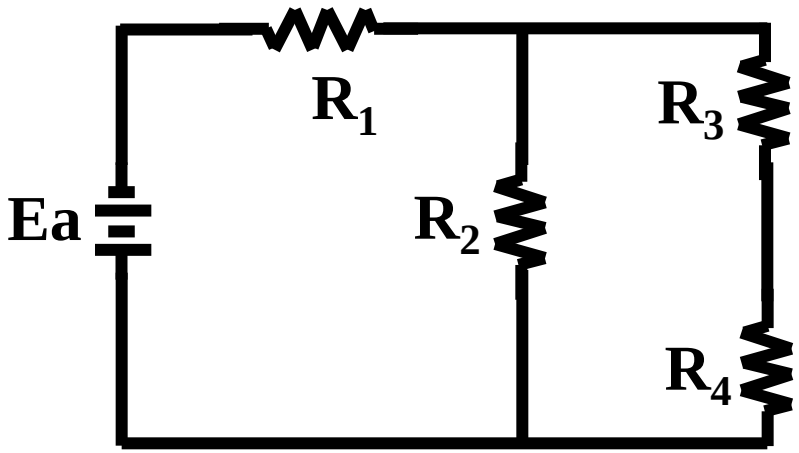
a. 1000 MΩ
b. 10 MΩ
c. 0 Ω
d. ∞ Ω

RESISTOR TROUBLESHOOTING

76. Total conductance can be used to find an open in a series circuit.

a. true
b. false

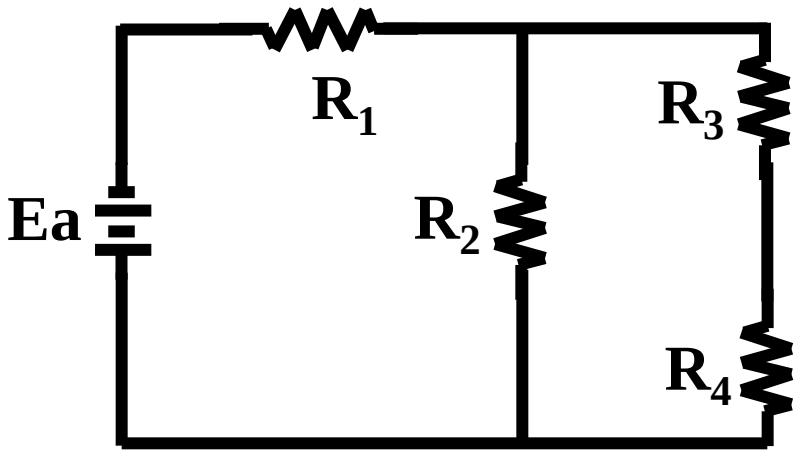
RESISTOR TROUBLESHOOTING



77. In the circuit above, if R_4 shorts the current through R_2 will _____.

a. remain the same
b. decrease
c. increase

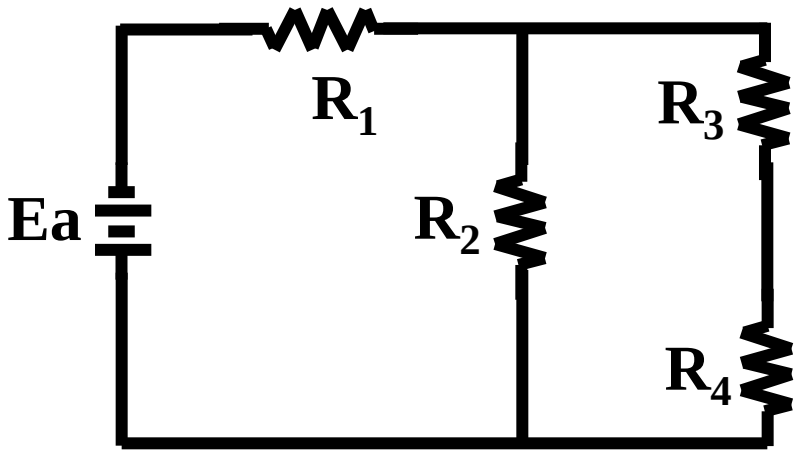
RESISTOR TROUBLESHOOTING



78. In the circuit above, if R_2 opens the current through R_2 will be _____.

a. 10 ma
b. 0 mw
c. 0 V
d. 0 A

RESISTOR TROUBLESHOOTING



79. In the circuit above, if R_1 opens the current through R_3 will be _____.

a. 0 A
b. 0 V
c. 0 mw
d. 10 ma

Let's check your Answers.

RESISTOR TROUBLESHOOTING

70. One of the first things you should do to isolate a faulty component is to perform _____.

a. resistance measurements
b. current measurements
c. voltage measurements
d. a visual inspection

RESISTOR TROUBLESHOOTING

71. When performing an ohms check, an open is indicated by a reading of _____ .

a. 1000 MΩ
b. 10 MΩ
c. 0 Ω
d. ∞ Ω

RESISTOR TROUBLESHOOTING

72. When making measurements to find a faulty component, you should perform as _____ measurements as possible.

a. few
b. many

RESISTOR TROUBLESHOOTING

73. The symbol for conductance is

a. G
b. I
c. R
d. P

RESISTOR TROUBLESHOOTING

74. The unit of measurement for conductance is _____.

a. siemens
b. ampere
c. volt
d. ohm

RESISTOR TROUBLESHOOTING

75. When performing an ohms check, a short is indicated by a reading of _____ .

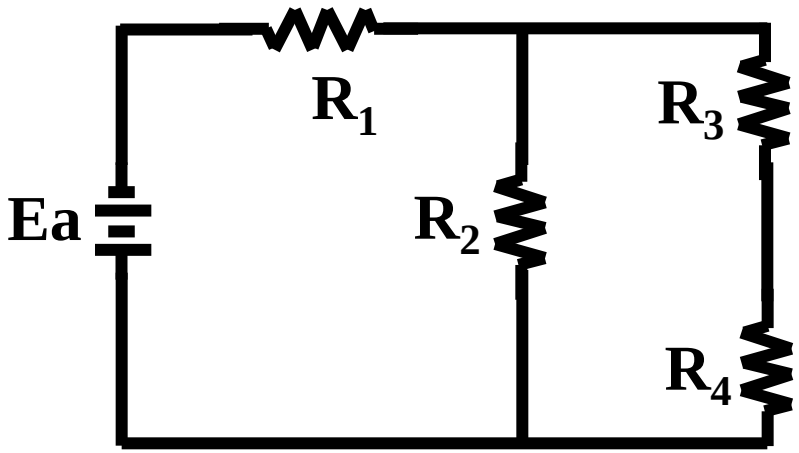
a. 1000 MΩ
b. 10 MΩ
c. 0 Ω
d. ∞ Ω

RESISTOR TROUBLESHOOTING

76. Total conductance can be used to find an open in a series circuit.

a. true
b. false

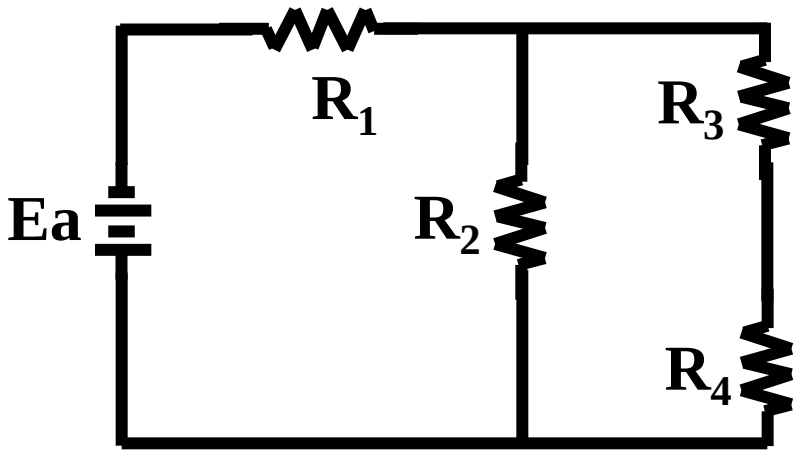
RESISTOR TROUBLESHOOTING



77. In the circuit above, if R_4 shorts the current through R_2 will _____.

a. remain the same
b. decrease
c. increase

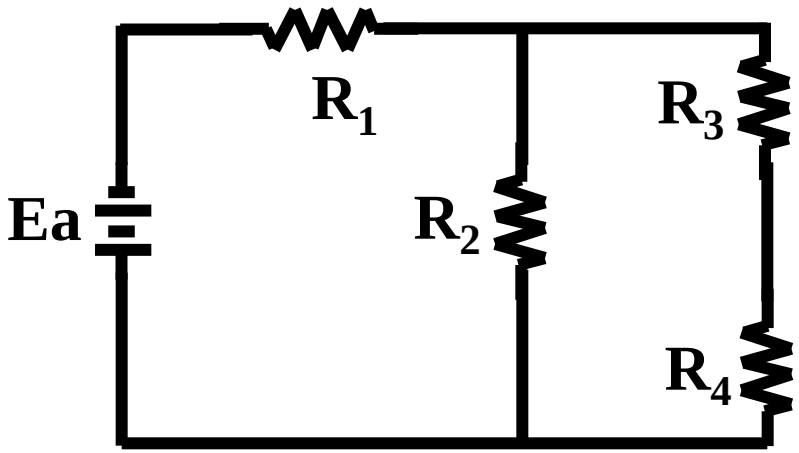
RESISTOR TROUBLESHOOTING



78. In the circuit above, if R_2 opens the current through R_2 will be _____.

a. 10 ma
b. 0 mw
c. 0 V
d. 0 A

RESISTOR TROUBLESHOOTING



79. In the circuit above, if R_1 opens the current through R_3 will be _____.

a. 0 A
b. 0 V
c. 0 mw
d. 10 ma

CONCLUSION

Summary:

1. Safety/ORM
2. Series Circuit Troubleshooting
3. Parallel Circuit Troubleshooting
4. Series-parallel Circuit Troubleshooting

CONCLUSION

Remotivation:

The primary task of an electronic technician is to locate and replace defective components. The basic math and electronic principles learned in Block I are essential to accomplishing this vital task. Remember what you have learned! This material is one of the building blocks you will need to successfully complete this course.

CONCLUSION

Assignment:

Direct students to perform reading and workbook assignments as applicable. (Assignments may be deferred to the end of the day)

CONCLUSION

Closure:

This concludes the instruction for Block I; DC Circuits.