Lab 5 Parallel dc Circuits

Name _____ **Section** _____

PURPOSE

To experimentally demonstrate the characteristics and laws associated with direct current parallel circuits.

EQUIPMENT

LAB SUPPLIED PARTS SERIAL NUMBERS

DC power supply _____

DMM _____

PARTS KIT PARTS

Resistors 1 -- 3.3 kΩ, 1 -- 4.7 kΩ and 2 -- 1kΩ ¼ watt

Set of meter leads

Set of clip to clip jumper leads

INTRODUCTION

1) The formulas to the right are the same. Use either of these to find the total resistance of two or more resistances in parallel.

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

or

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

2) Since all the components in a parallel circuit are connected across the supply, the voltage across any of the components is equal to the supply voltage.

$$E = V_1 + V_2 + V_3 + \cdots + V_n$$

Kirchhoff's Current Law

Kirchhoff's Current Law states that the sum of the currents entering a circuit point must equal the sum of the currents leaving that circuit point.

Applying this to a simple parallel circuit yields an equation that demonstrates that the total circuit current is equal to the sum of the individual branch currents. See Figure 1. $I_T = I_1 + I_2 + I_3$

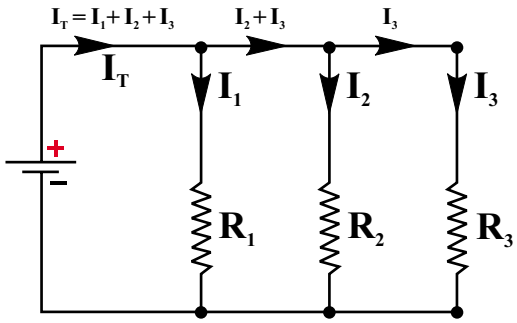


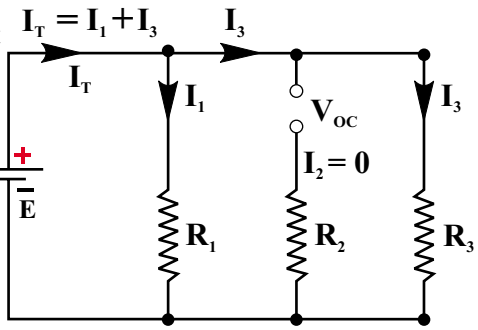
Fig 1 Kirchhoff's Current Law

Inserting an Open Circuit

If an open is inserted into the parallel circuit shown in Fig. 2(a), current stops flowing in the branch that contains R_2.

This means that R_2 will have no current and thus no voltage drop. Components that pass no current will have no effect on the circuit's equivalent resistance. R_T is affected by R_1 and R_3 only.

By applying Kirchhoff's voltage law, it can be determined that the applied voltage will appear across an open (V_{OC}) inserted into a parallel circuit.



$$I_T = I_1 + I_3$$
$$V_{OC} = E$$
$$R_T = \frac{1}{\frac{1}{R_1} + \frac{1}{R_3}}$$

Fig 2(a) Understanding open circuits in parallel circuits

In Figure 2 (b), an open circuit is inserted in a different place.. Now there is no current in the branches of the circuit that contain R_2 and R_3.

The total current I_T is simply I_1.

The equivalent resistance R_T is simply R_1.

There will be no voltage drop across R_2 or R_3. If we measure V_{OC}, we will read the supply voltage E

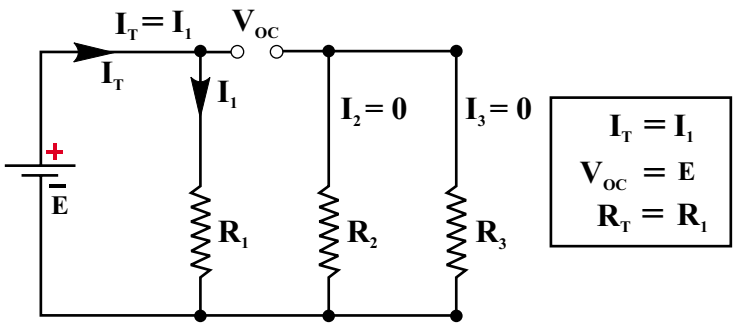


Fig 2(b) Understanding open circuits in parallel circuits

Procedure - Calculations

1) Use the nominal values of the resistors shown in Figure 4 to calculate and record the equivalent circuit resistance R_T. ***Show calculation***

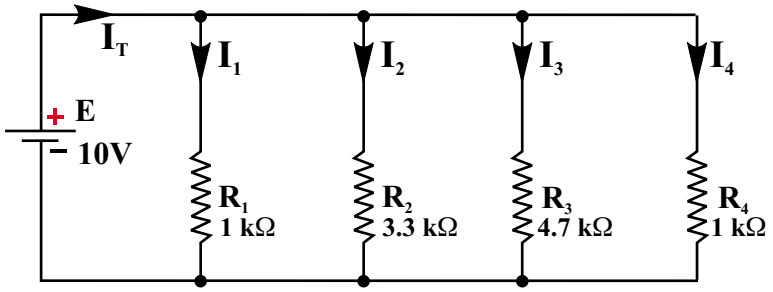


Fig 4

$$R_T = \frac{1}{\frac{1}{R_1}+\frac{1}{R_2}+\frac{1}{R_3}+\frac{1}{R_4}}$$

R_T = _____

2) Using R_T and the voltage source, find the total circuit current I_T. ***Show calculation.***

$$I_T = \frac{E}{R_T}$$

I_T = _____

Branch Currents using Ohm's Law

3) Find each branch current. These are I_1, I_2, I_3 & I_4. Use the nominal value of the resistors and the supply voltage. Insert these values into Table 1. ***Show 1 complete calculation***
Add The currents I_1 to I_4. They should equal I_T above.

Sample $I_1 = \frac{E}{R_1}$

Resistor	Current
R_1	I_1=
R_2	I_2=
R_3	I_3=
R_4	I_4=
$I_1+I_2+I_3+I_4$	I_T=

Table 1 Branch currents using Ohm's Law

Branch Currents using the Current Divider Rule

4) Find each branch current again using the current divider rule. The calculated values should agree with Table 1. Insert these values in table 2. . ***Show 1 complete calculation***
Add The currents I_1 to I_4. They should equal I_T above.

Sample $I_1 = \frac{R_T}{R_1} I_T$

Resistor	Current
R_1	I_1=
R_2	I_2=
R_3	I_3=
R_4	I_4=
$I_1+I_2+I_3+I_4$	I_T=

Table 2 Branch currents using The Current Divider Rule

Procedure - Measurements

Voltage

1) Build the circuit shown in Figure 4. Set the power supply to 10V using the DMM.

   Do not change the power supply settings for the remainder of the lab.

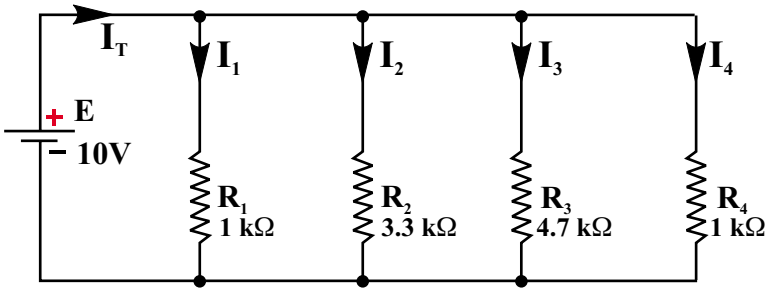


Fig 4 Build this circuit

2) Measure the voltage across each resistor in the network. Insert the values in Table 3.

   It should be equal to the supply voltage and should be the same for each resistor in the network.

   The voltage across all parallel elements in a circuit will be the same.

Voltage
V_1 =
V_2 =
V_3 =
V_4 =
E =

Table 3
Measured voltage across each resistor

Current

3) Set the DMM to measure current.

   Measure and record the currents I_1 to I_4. Record them in Table 4.

   Measure and record I_T. Record it in the last line of Table 4.

   The measured value of IT should reasonably agree with the calculated values on page 1.

Current
I_1 =
I_2 =
I_3 =
I_4 =
I_T =

Table 4
Measured Current in each branch.

4) Use the individual branch currents from Table #4 to calculate the currents I_{234} and I_{34} shown inFigure #5. Record these values below.

I_{234} = _____ I_{34} = _____

5) Using the DMM as an ammeter, measure I_{234} and I_{34}

   Record these values below.

I_{234}_____ I_{34} _____

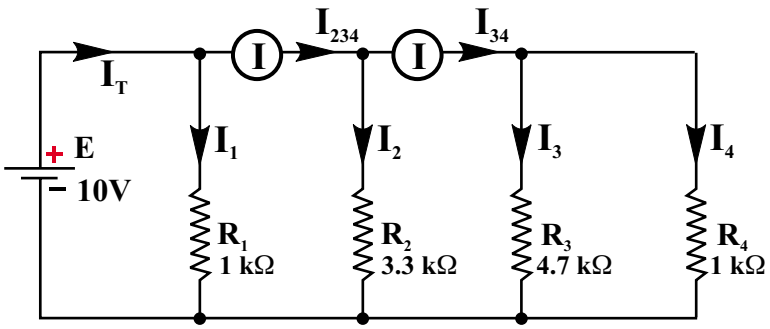


Fig 5 Measuring multiple branch currents

Procedure - Measurements

Open Circuits

6) Insert an open into the circuit as shown in Figure 6. Measure and record the voltage across the open circuit.

V_{OC} _____

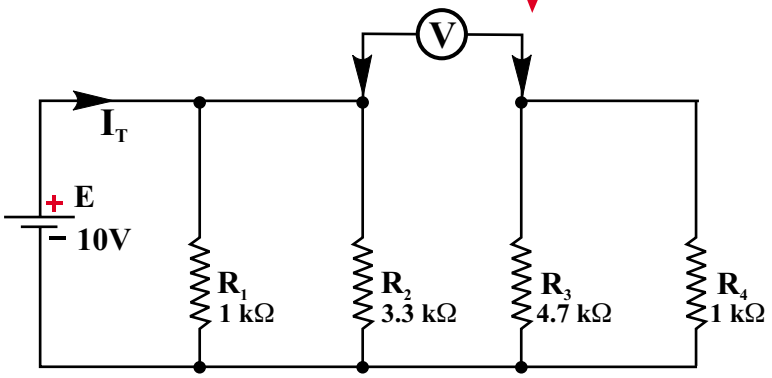


Fig 6 Insert and measure across an open circuit

7) Leave the open circuit between R_2 and R_3. See Figure 7. Use the DMM as an ammeter to measure and record the currents required to complete Table 5.

Write the simplified equation for the total current in terms of the branch currents.

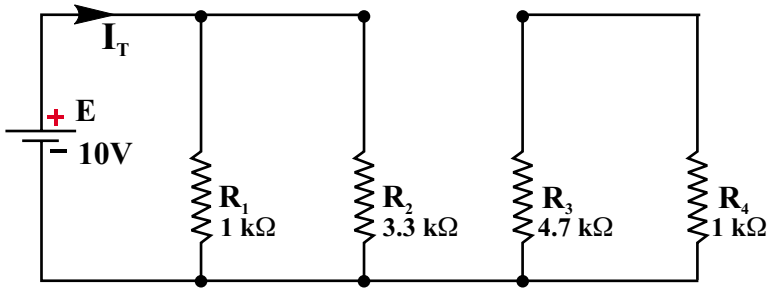


Fig 7 Measure and record the currents

Current
I_1 =
I_2 =
I_3 =
I_4 =
I_T =

Table 5
Measured Current in each branch.

Simplified equation R_T = _____

Electronic Workbench

1) Use Electronics Workbench to build the circuit shown in Figure 4. Install five ammeters in the circuit to measure the total circuit current and each of the individual circuit currents. Modify the circuit description to show your name and section number.

Activate the circuit and make a printout that shows the circuit with the ammeter readings (the circuit description should also be included in the print out).

The printout must be stapled as the last page of the lab and handed in.

Note When printing using Electronic Workbench 4.0 be sure to have your circuit in the upper left hand corner of the page.