Lesson 07

Title of the Experiment: Identification of few passive devices used in Technological Electronics
(Activity number of the GCE Advanced Level practical Guide –20)

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Introduction

Consider the circuit shown in Figure 1 having a battery as a voltage source V and a resistor R. The current I passes through the circuit until the source is disconnected.

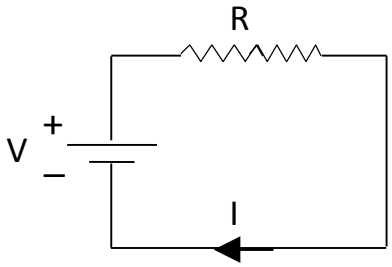


Figure 1: Simple circuit of a voltage source and a resistor

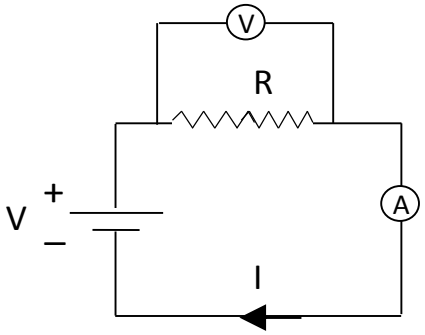


Figure 2: The voltage and the current measurements of a resistor

If the resistor is changed by another resistor which has a higher value or a lower value then the current passing through the circuit changes accordingly. In another words, R controls the current passing through the circuit.

In this circuit, voltage source is an active component and the resistor is the passive component. Active components provide power to the electrical circuits whereas the passive components do not generate power, but instead dissipates, stores, or releases power. Each circuit is an arrangement of active and passive elements designed to perform specific functions.

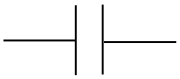
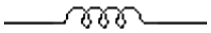
The current passing through any branch of a circuit is invisible. Apart from a power source, the voltage generated across each component is also invisible. Those can be visible and measured by using specific meters which should be connected properly. The voltage can be measured by using a voltmeter which is connected in parallel to the measured elemental voltage whereas the current can be measured by using an ammeter which is connected in series to the measured element. Nowadays, both the voltage and the current can be measured using a single meter known as a multimeter.

The voltage across the resistor and the current passing through the circuit can be measured using the voltmeter and the ammeter as shown in Figure 2.

Passive devices

Resistors, capacitors and inductors are basic passive components commonly used in electronic circuits. Details of these commonly used passive component are given in Table 1.

Table 1: Details of a resistor, capacitor and an inductor

Passive component	Name of the value	Symbol used in a circuit	Unit
Resistor	Resistance		Ohm (Ω) (typical values in Ω, kΩ and MΩ)
Capacitor	Capacitance		Farad (F) (typical values in μF and pF)
Inductor	Inductance		Henry (H) (typical values in mH and μH)

Resistors, capacitors and inductors have their unique properties. The features and the applications of these passive components in electronics circuits are given in Table 2.

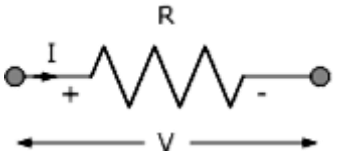
Table 2: Main features and applications of the passive components given above

Passive component	Features	Applications
Resistor	- To resist or oppose the flow of current passing through a resistor - The current passing through a resistor is directly proportional to the voltage	- To provide proper values of the circuit voltages when required - To limit the current - To provide load
Capacitor	- The current passing through a capacitor is directly proportional to the rate of change of the voltage	- Ability to store and deliver charges - To block the direct currents (i.e. currents not varies with time) - To oppose any change in voltage
Inductor	- The induced voltage is directly proportional to the rate of change of the current passing through an inductor	- Ability to store and deliver energy - Induce voltage whenever current passing through the inductor changes - To block the alternative currents (i.e. opposes any change in currents)

Theory:

Resistor

Ohm's law states that when a current passes through a resistor, the voltage across the resistor and the current through it are directly proportional to each other.



$$V \propto I$$

$$V = IR$$

R is the proportionality constant known as the resistance.

The power absorbed by a resistor is represented by

$$P = V.I = \frac{V^2}{R} = I^2R \text{ watts}$$

Capacitor

The charge stored in a capacitor Q is directly proportional to the voltage V across the capacitor.

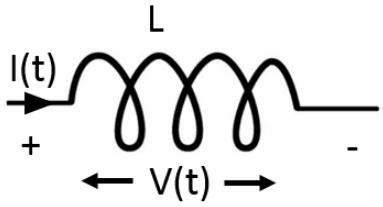
$$Q \propto V$$

$$Q = CV$$

C is the proportionality constant known as the capacitance.

Inductor

An induced voltage V(t) across the inductor is generated when the current passes through the inductor changes with time.



$$V(t) = L.\frac{dI(t)}{dt}$$

L is known as the inductance.

Learning outcomes:

After completing this practical, students will be able to

- identify the passive components used in electronic circuits and measure their values using appropriate instruments
- understand the importance of passive components in electronic circuits.

1. Materials/Equipment:

i) To identify the types of the passive components:

Several types of resistors; wire wound, standard and color coded resistors

Several types of capacitors; ceramic, electrolytic capacitors and color coded capacitors

Several types of inductors; relays, transformers

ii) To understand the different sizes of the passive components:

Several sizes of color coded resistors

Ceramic capacitors (for lower values) and electrolytic capacitors (for higher values)

iii) Multimeter

iv) Power supply

v) A tube light and a bulb

vi) Two way switches

vii) Connecting wires

2. Methodology/Procedure:

i) To identify the types of resistors and measure the values of resistors:

a) Identify the various resistors such as wire wound, standard, variable and color coded resistors.

b) Study the color code given for resistors.

c) Record the resistances of the color coded resistors using the color codes given below.

d) Measure the same resistors using multimeter/Ohm meter.

e) Compare the values in c) and d).

ii) To identify the types of capacitors and measure the values of capacitors:

a) Identify the various sizes of capacitors given; polythene, ceramic and electrolytic capacitors.

b) Study the chart given for capacitors.

c) Record the capacitance of the coded capacitors using the chart given below.

d) Measure the same capacitors using the multimeter.

e) Compare the values in c) and d).

iii) To identify the types of inductors and observe the features of the relay and transformer:

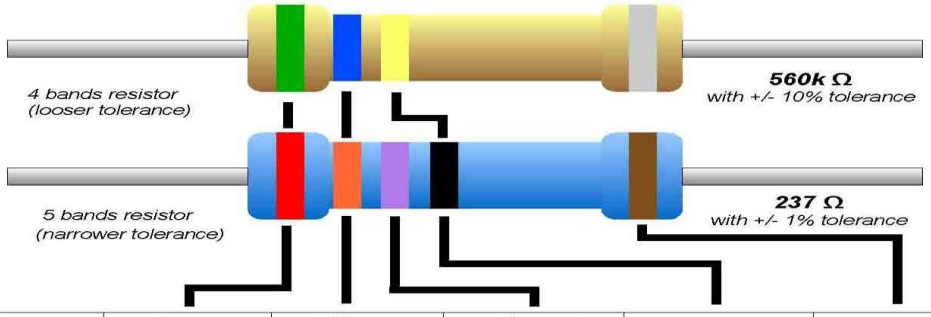
a) Identify the various inductors given; coils, relays and transformers.

b) Identify the terminals of a given relay using a multimeter.

c) Observe the function of the relay as a Switch.

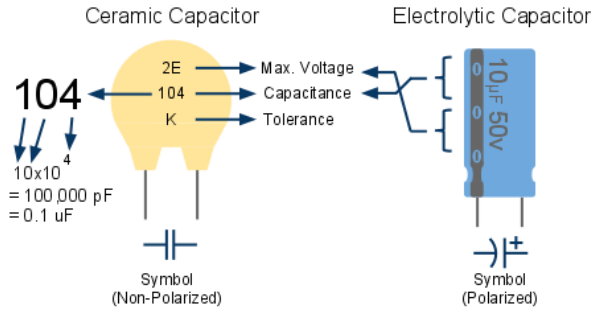
d) Measure the output voltage of a step down transformer connected to the main power.

Resistor Color Code



Color	1st Band	2nd Band	3rd Band	Multiplier	Tolerance
Black	0	0	0	x 1 Ω	
Brown	1	1	1	x 10 Ω	+/- 1%
Red	2	2	2	x 100 Ω	+/- 2%
Orange	3	3	3	x 1K Ω	
Yellow	4	4	4	x 10K Ω	
Green	5	5	5	x 100K Ω	+/- .5%
Blue	6	6	6	x 1M Ω	+/- .25%
Violet	7	7	7	x 10M Ω	+/- .1%
Grey	8	8	8		+/- .05%
White	9	9	9		
Gold				x .1 Ω	+/- 5%
Silver				x .01 Ω	+/- 10%

Capacitors



Capacitance Conversion Values

Microfarads (µF)	Nanofarads (nF)	Picofarads (pF)
0.000001 µF	0.001 nF	1 pF
0.00001 µF	0.01 nF	10 pF
0.0001 µF	0.1 nF	100 pF
0.001 µF	1 nF	1,000 pF
0.01 µF	10 nf	10,000 pF
0.1 µF	100 nF	100,000 pF
1 µF	1,000 nF	1,000,000 pF
10 µF	10,000 nF	10,000,000 pF
100 µF	100,000 nF	100,000,000 pF

Max. Operating Voltage

Code	Max. Voltage
1H	50V
2A	100V
2T	150V
2D	200V
2E	250V
2G	400V
2J	630V

Tolerance

Code	Percentage
B	± 0.1 pF
C	±0.25 pF
D	±0.5 pF
F	±1%
G	±2%
H	±3%
J	±5%
K	±10%
M	±20%
Z	+80%, -20%

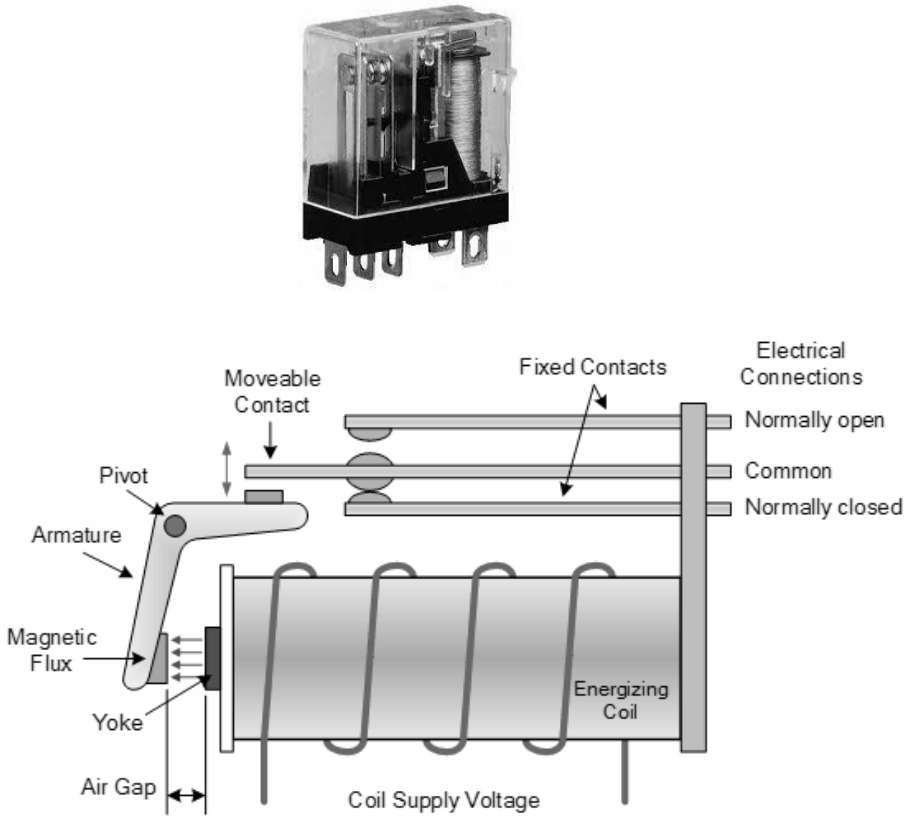


Figure 3: Relay and its function

3. Readings/Observations:

i) Resistor measurements:

Resistance (Ω)	
Color code value	Measured value

ii) Capacitor measurements:

Capacitance (F)	
Coded value	Measured value

iii) Transformer measurements:

The output voltage of the step down transformer = …… V

iv) Function of a relay as a switch

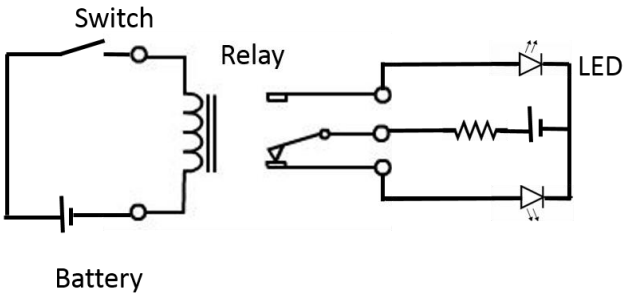


Figure 4: Circuit to show a relay as a Switch

Observations;

Identify the terminals of the relay.
Observe the function of the switch using the LEDs

v) Demonstrate the energy stored in an inductor

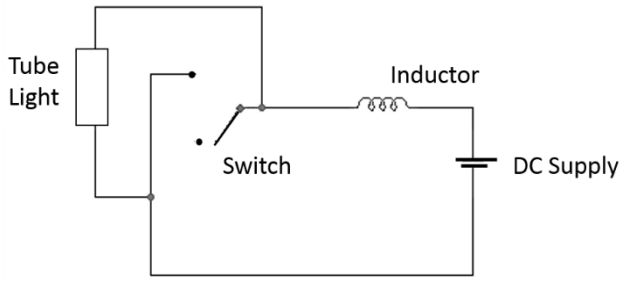


Figure 5: Circuit to show a energy storage of an inductor

Observations;

Identify the illumination of the tube light due to energy stored in an inductor.

vi) Demonstrate the energy stored in a capacitor

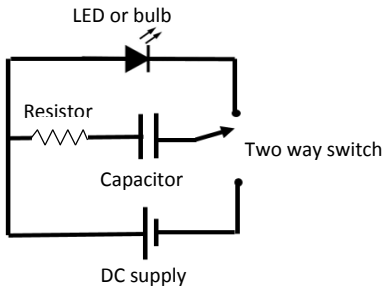


Figure 6: Circuit to show an energy storage of a capacitor

Observations;

Identify the charging of the capacitor while measuring the voltage across it when the capacitor is connected to the DC power supply.

Observe the illumination of the blub when the circuit with the blub is connected.

Measure the voltage across the capacitor after the illumination of the bulb.

Discussions:

Conclusions:

References:

Basic electronics (1988 - Third edition), B.L. Theraja, Chand & Company (Pvt) LTD