Radio Mechanics
Fourth Year

Module 4
Small But Terrible
Electronic Components

What this module is about

This module is about small electronic parts which are the building blocks of electronic equipment and appliances. These electronic equipment and appliances are made up of circuits. Circuits are made up of electronic components. Components and their interconnections are represented in diagrams by their schematic symbols. Technician always refer to schematic diagrams when troubleshooting and repairing equipment. We cannot read and interpret diagrams without knowing component symbols. As electronic students and would-be technicians, it is a must for you to learn the symbols and functions of the basic electronic components.

After going through this module, you are expected to do the following:

1. Identify the different electronic components, their functions and uses.
2. Determine the resistance values of carbon and film-filled resistors through color codes.
3. Calculate the maximum and minimum value of resistors through color codes.
4. Draw schematic symbols of electronic components.
5. Test and measure effective and defective electronic components.

How to learn from this module

For maximum benefit from this module, you have to follow strictly the instructions.

1. You must work on this module in the sequence its contents are presented.
2. After reading the objectives, answer all the questions in the pretest as honestly as you can.
3. Check your answers by comparing these with the key to answers in the last part of this module. Ask your teacher the test results.
4. Read and understand every lesson as much as you can. Try to do the given activities and do the self-check to determine whether you understood what you have read.
5. Answer the posttest and compare your answers with the key to answers. You must get a score of at least 80% in order to move on to the next module. If you get less, you have to go through the module again.

Reminder:

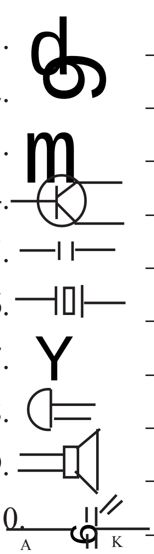
Be honest in answering and checking the pretest. Remember, you are studying by yourself. Your learning depends totally in you.

PRETEST

I. Directions: Give the component and its function or use as required.

Component	Function / Use
1. Switch	____________________
2.____________________	Converts electrical energy to sound energy.
3.____________________	Generates and amplifies signals.
4. Transformer	____________________
5. Inductor	____________________
6. ____________________	Stores charge in its dielectric.
7. Diode	____________________
8. ____________________	Regulates the flow of electric current.
9.____________________	Protects the circuit from overload.
10. Integrated circuit	____________________

II. Directions: Write the name of the following electronic components illustrated in schematic symbols.



1. ____________________
2. ____________________
3. ____________________
4. ____________________
5. ____________________
6. ____________________
7. ____________________
8. ____________________
9. ____________________
10. ____________________

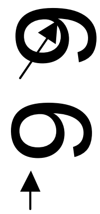
Lesson 1

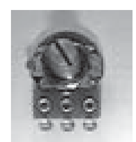
Schematic Symbols of Electronic Components

As previously stated, electronic components are the building blocks of all electronics equipment and appliances. These equipment and appliances were illustrated in schematic diagrams. You can interpret schematic diagrams easily if you know the schematic symbols of electronic components.

Considering the many applications of electronics, only a few of the basic types of components are used to represent all kinds of equipment and appliances. Each type has a specific function and use. Following are some of these electronic components and their uses and symbols.

1. **Resistor** (R) is an electronic component that regulates the flow of electronic current and produces specific voltage drop in circuit. It is used in bias circuits, coupling circuits, load circuits, tone control and volume control.



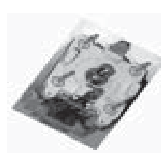


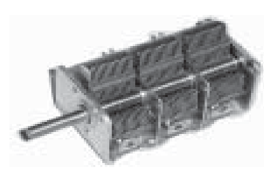
2. **Capacitor** (C) is an electronic component that stores charge in its dielectric. It blocks DC and allows AC to pass through. It is used in coupling, filtering, and tuning circuits.

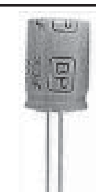

non polar


polarized


Tuning Capacitor

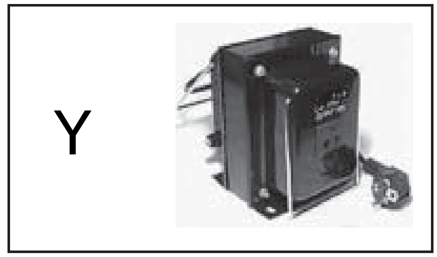

Trimmer Capacitor


Variable Capacitor

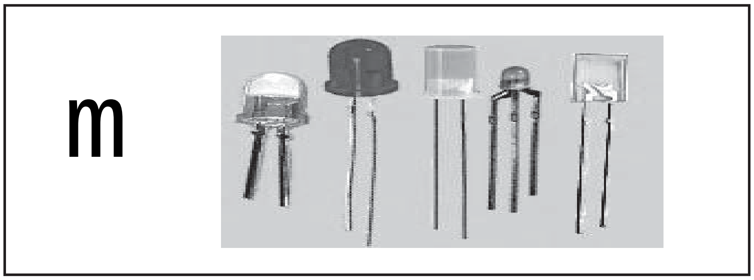

Vertical Capacitor

3. **Inductor or Coil** (L) stores energy in its magnetic field. It blocks AC and passes DC. It is also used in filtering, coupling and tuning circuits.

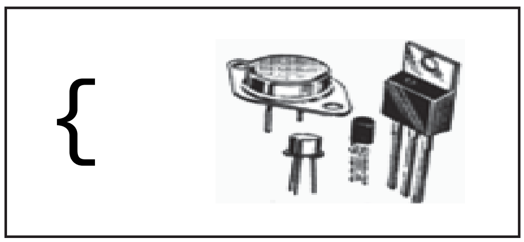
4. **Transformer** (T) is an electronic component that transfers power or signals from the primary to the secondary circuit by means of induction. It is used in power supplies, power isolation, stepping up or down voltages and as coupling between the stages of amplifiers.



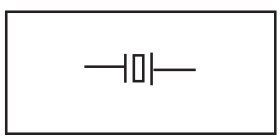
5. **Diode** (D) is an electronic component that conducts current only in one direction. It is used as rectifier in power supplies, detector in radio receivers, in switching circuits and as indicator.



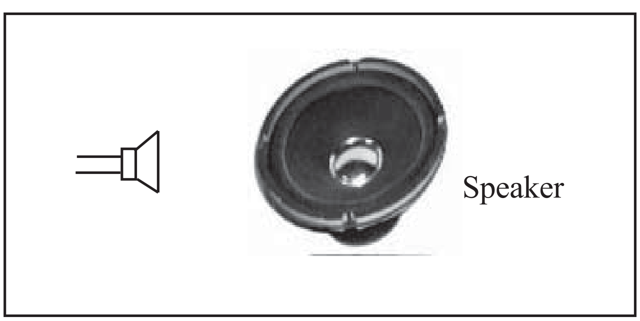
6. **Transistor** (T) is an active electronic component that generates and enlarges (amplify) signals. It is used as an oscillator, amplifier and switch in switching circuits.



7. **Crystal** (Y) is an electronic component that produces electromotive force (EMF) when made to vibrate and vice versa. It is used as oscillator in radio transmitters and radio receivers, among others.

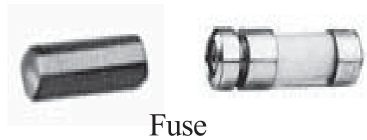


8. The **loudspeaker** converts electrical signals or sound signals or energy. It is used in all sound producing systems such as the radio, TV receivers and stereo amplifiers, among others.



9. The **fuse** (F) protects the circuit from overload or excessive current. It is used practically in all equipment and appliances. It is also used in wiring installations.

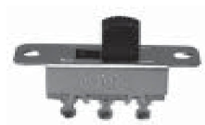
d



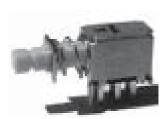
Fuse

10. **Switch** (SW) is used to open and close the circuit. With the switch we can convenietly connect or disconnect our appliances to or from the voltage source without disconnecting the plug from the voltage source.

Rotary switch



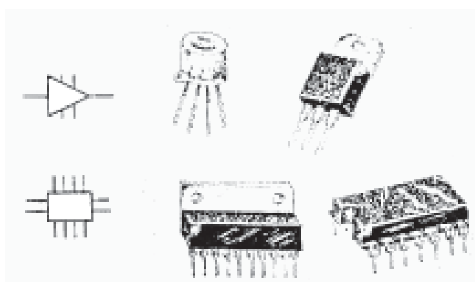
Slide switch



Push button switch

Toggle switch

11. **Integrated Circuit** (IC) is an active electronic component that is used as amplifier, oscillator, modulator, demodulator and regulator in digital circuits.



Activity 1

Make a compilation of the schematic symbols of other electronic components not included in this module. Draw them in a short bond paper and place them in a short folder. Use separate bond paper for each component. Follow the arrangement of components listed below.

Components
1. resistors
2. capacitors

3. inductors
4. transformers
5. diodes
6. transistors
7. switches
8. logic gates
9. electronic instruments or meters
10. others - those not included in the list

Self-check:

Draw the schematic symbols of the following electronic components with their corresponding letter symbols.

1. fuse
2. diode
3. resistor
4. capacitor
5. inductor
6. switch
7. transistor
8. transformer
9. integrated circuit
10. crystal

Lesson 2

Resistor Color Codes

The characteristics of a resistor of opposing the flow of electric current is its resistance, represented by letter (R). Resistance is measured in ohms **Ω**, named after George Simon Ohm, a German Physicist.

Resistance values of resistors are printed on their sides in numerals in color codes. In wire-wound resistors, resistance values are oftentimes printed on their sides in numeral. Resistance values of carbon-composition resistors as well as film-filled resistors, are printed as color bands around their circular bodies as color codes.

Resistor Color Codes

Color code is the system of using different colors to indicate the resistance values of resistors.

Table 1
Colors Used in Resistors and their Values

Color	First Significant Figure	Second Significant Figure	Decimal Multiplier	Tolerance
Black	0	0	1	20
Brown	1	1	10	1
Red	2	2	10^2	2
Orange	3	3	10^3	4
Yellow	4	4	10^4	4
Green	5	5	10^5	5
Blue	6	6	10^6	6
Violet	7	7	10^7	7
Gray	8	8	10^8	8
White	9	9	10^9	9
Gold			0.1	5
Silver			0.01	10
No Color				20

Table II

Memory Guide	Color Equivalent	Numerical Equivalent
Bold	Black	0
Boys	Brown	1
Rave	Red	2
Over	Orange	3
Young	Yellow	4
Girls	Green	5
But	Blue	6
Vilma	Violet	7
Gives	Gray	8
Willingly	White	9

In Table II, color codes are simplified for easy learning . The memory guide should be memorized.

" Bold Boys Rave Over Young Girls, But Vilma Gives Willingly."

How to Read the Color Codes of Resistors

When reading the colors of a resistor, always start reading from the first color nearest to the end of the resistor, and continue as indicated by the arrow. See the figure below.

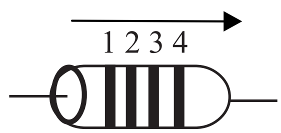


Figure 1

Interpreting the Color Codes of Resistors

When using the simplified color code (Table 1), first, memorize the Memory Guide (Table II). Pair each word with its color equivalent and then its numerical equivalent (Table II).

In interpreting the colors of a resistor, the first color nearest the end of the resistor is the first digit, the second color is the second digit, the third color is the multiplier or the number of zeroes to be added to the first and second digits, and fourth color is the tolerance. See the figure below.

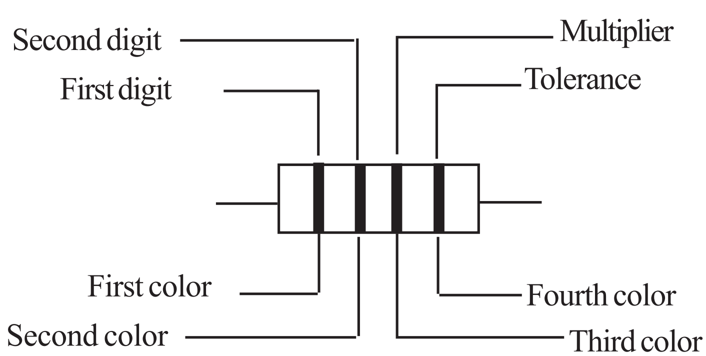


Figure 2

In the example that follows, we will disregard the fourth color (tolerance color) for a while. This is for simplicity and for easy learning. However, it will be discussed later.

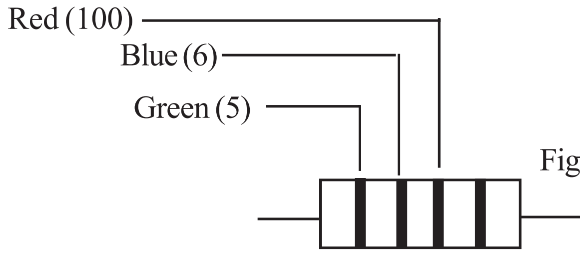


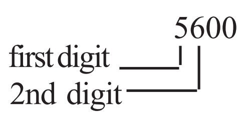
Figure 3

To determine the resistance value of the resistor in Figure 3, its colors are interpreted as follows: (See Table 1).

Green, being the first color band, has a numerical value of 5 in the first significant figure. So, write 5 as your first digit. Blue being the second color band, write 6 as your second digit. The number formed is 56. Red, the third color band and serving as your multiplier, has a numerical value of 10^2 or 100. Multiplying the first and second digits (56) by 100 gives you an answer of 5,600. Hence, the value of the resistor is 5,600 ohms.

$$56 \times 100 = 5,600$$

In another way, simply write 2 zeroes after the first and second digits and you get the same answer. Multiplying a number by 100 is the same as adding two zeroes to the right of the number.



When the third color band is black, it simply means that you are to multiply the first two digits by one (1). See Figure 4.

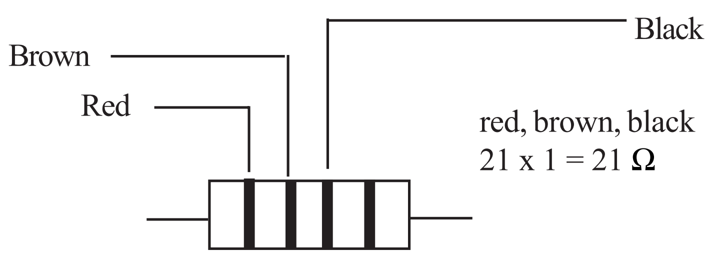


Figure 4

When the third color band is gold, it simply means that you multiply the first two digits by point one (0.1). See Figure 5.

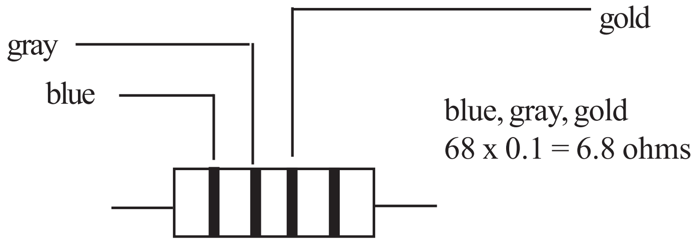


Figure 5

When the third color band is silver, multiply the first two digits by point zero (0.01). See Figure 6.

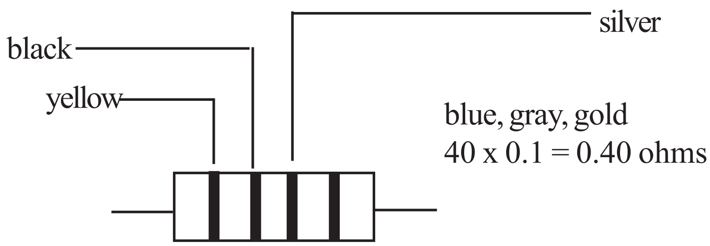


Figure 6

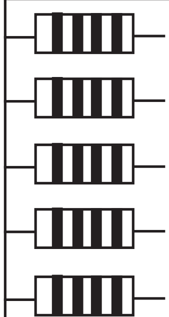
Self-check:

Give the values of the following resistors:
Note: The fourth color is disregarded.

1. Red, Violet, Brown, Gold
2. Orange, Red, Black, Silver
3. Gray, Red, Gold, Gold
4. Orange, White, Red, Silver
5. Yellow, Violet, Black, Gold

Activity 2

Get five (5) resistors (1 watt each) with different color codes. Attach them to a short folder and compute their color code value. See the following example.

Resistor	Colors	Color Coded Value	Maximum Tolerance Value	Minimum Tolerance Value
	orange, red, brown, gold	320 Ω	336 Ω	304 Ω

Note: Prepare your folder in the same manner as the given example. Start your measurements from the center in order that all the outer lines are equally distant from the edge of the folder.

Lesson 3

Tolerance of Resistors

The fourth color band of the resistor represents its tolerance value. Tolerance indicates the permissible minimum values a particular resistor can deviate from its original color coded value when the said resistor is used in the circuit.

There are three colors used to indicate tolerance. They are gold, silver, and body color (no color used).

Rules to Determine Tolerance of Resistors

1. When the fourth color band is gold, it simply means that tolerance is 5% above and below its color coded value. In the other words, if this particular resistor is good, the measured value should be within 5% plus or minus its color coded value.

2. When the fourth color band is silver, it simply means that tolerance is 10 % above and below its color coded value.

3. When there is no fourth color band, it simply means tolerance is 20 % above and below its color coded value. Actually, this type of resistor has only three color bands. The fourth, indicating its tolerance is the same as its body color.

How to Calculate the Value of Resistors Considering their Tolerance

1. Write down the value of the resistor based on its color code in ohm.
2. Compute the tolerance value (in percent) of the color coded value.
3. Add the extracted tolerance value to the color coded value. The sum represents the maximum value.
4. Subtract the extracted tolerance value from the color coded value. The difference represents the minimum value.

For example, calculate the value of the given resistor considering its tolerance. See Figure 7.

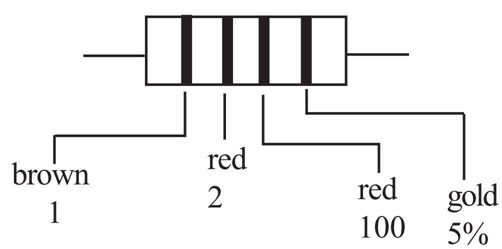


Figure 7 - Resistor with gold as its tolerance color.

The color coded value is:

  12
x 100
  1,200 ohms

Compute 5 % of 1,200 ohms (converting 5 % into decimals gives you .05)

  1,200
x .05
  60 ohms - extracted tolerance value

Add the extracted tolerance value to the color coded value:
60 ohms + 1,200 ohms = 1,260 ohms - maximum value

Add the extracted tolerance value from the color coded value;
1,200 ohms - 60 ohms = 1,140 ohms - minimum value

Interpreting the Computed Maximum and Minimum Tolerance Value

The value of the resistor, one color code of which is brown, red, gold, is between 1,140 amd 1,260 ohms or above 1, 260 ohms considering its tolerance value. If the resistor measured value is between 1,140 and 1,260 ohms or above 1,260, the resistor is defective and should therefore be replaced. But if the measured resistance value is within or between 1,140 ohms and 1,260 ohms, the resistor is good.

Self-check

Directions: Calculate the maximum and minimum tolerance value of the following resistors the color codes of which are as follows:

1. Brown, Green, Green, No Color
2. Gray, Violet, Black, Gold
3. Orange, White, Brown, Silver
4. Red, Red, Orange, Gold
5. Brown, Gray, Brown, Silver

Activity 3

Using the same folder and set of resistors in the activity you did in Lesson 2, compute the maximum and minimum tolerance value of the attached resistors. See the given example in Lesson 2 (Activity 2).

Lesson 4

Testing Good and Defective Electronic Components

Electronic components may become defective due to continued use. Some of these defects may occur accidentally while others due to overcurrent flowing through the circuit. An efficient electronic technician must be proficient in testing electronic components. Electronic components develop various troubles, thus requiring different approaches to test electronic components. Use the VOM (Volt-Ohm-Milliammeter).

Testing Resistors with an Ohmmeter of VOM

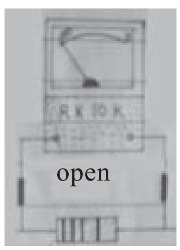
Resistors may develop troubles such as open resistors, increased resistance values and decreased resistance values. Before testing any resistor in the circuit, do the following:

1. Switch off the device or appliance.

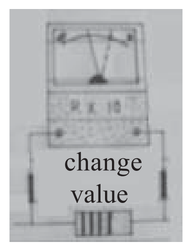
2. Disconnect or desolder one terminal of the resistor you desire to check from the printed circuit board (PCB). Be careful when disconnecting the resistor from the circuit. Carelessness may result in breaking the printed circuit foil.

3. Set your ohmmeter to the appropriate range. When checking resistors of high resistance value, adjust the ohmmeter to the highest range.

Test Results of Defective Resistors



The ohmmeter does not deflect or reads infinitely even at the highest range.



Ohmmeter reading differs much beyond the tolerance value.

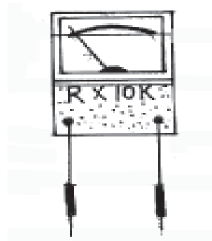
Testing the Capacitor with an Ohmmeter or VOM

A capacitor may develop trouble like open shorted and weak or leaky. Following are rules to follow in testing capacitors:

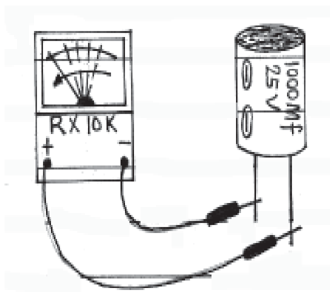
1. Switch off the power supply.
2. To be safe and to protect your ohmmeter from damage, discharge the capacitor before testing. Do this by shortening its two terminals with a screwdriver. Make sure you are handling the screwdriver on its insulated handle.

3. Disconnect one terminal lead of the capacitor from the circuit before testing.

4. Adjust your ohmmeter to a higher range such as R x 10 K or R x 1 meg.

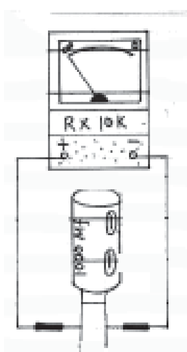


Test Results of a Good Capacitor

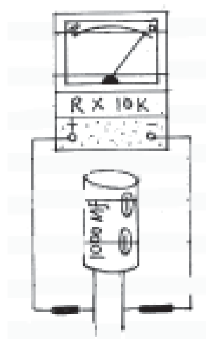


The pointer deflects to the right and goes back slowly to infinity or the original position.

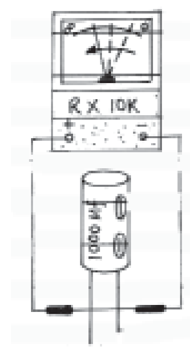
Test Results of Defective Capacitors



Ohmmeter reading needs infinity even at the highest range.
The pointer does not move to the right.



Ohmmeter reads zero even at a lower range.
The pointer deflects to the right and stays there.

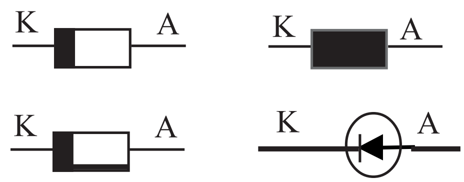


The ohmmeter indicates resistance to reading.
The pointer deflects to the right and does not return to infinity.

Testing Diode with an Ohmmeter or VOM

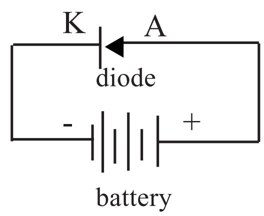
Before attempting to test a good or defective diode, one thing very important to consider is knowing its terminals or electrodes. These electrodes are anode (A), positive current-carrier and cathode (K), negative current-carrier. Following are some points to consider in determining the electrodes of a diode.

1. Cathode and anode markings are displayed on the body of the diode, as shown in the illustrations.

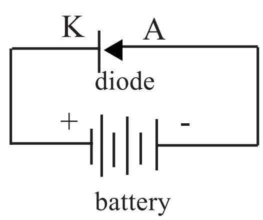


2. Sometimes, markings are worn out, hence use a VOM to determine the electrodes. The battery inside the VOM is used to apply forward and reverse bias.

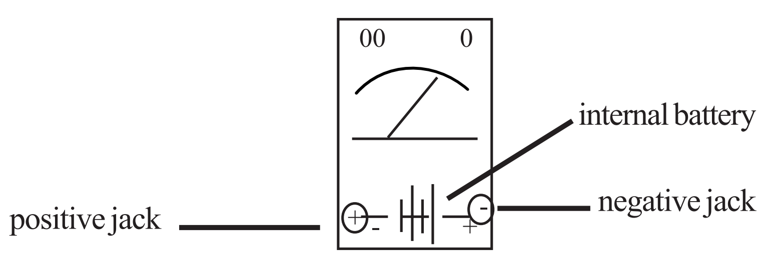
In the forward bias, the positive post of the battery is connected to the anode, and the negative post is connected to the cathode.



Reverse bias - the positive post of the battery is connected to the cathode and the negative post is connected to the anode.

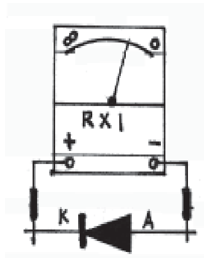


3. Knowing the correct polarity of the VOM is a "must". The polarity of the internal batteries of Asian VOMs such as Standard and Sanwa are opposite to the markings of its test prod sockets. The negative terminal of the battery is actually connected to the positive (+) output jack. The positive terminal is connected to the negative (-) common jack.

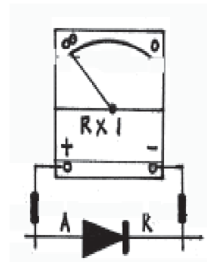


Test Results of a Good Diode

Note: The VOM we are going to use has reversed polarity.

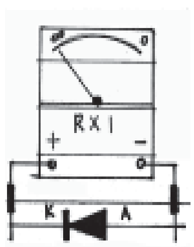


VOM indicates low resistance reading (forward bias)

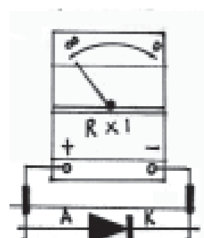


In reversing the leads, VOM shows very high resistance or infinity (reverse bias)

Test Results of an Open Diode



forward bias

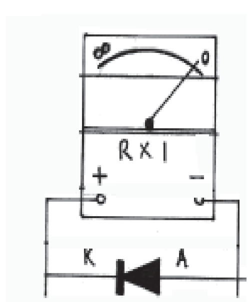


reverse bias

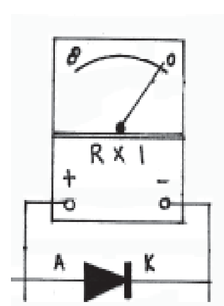
VOM indicates infinity or high resistance in all ranges.

Reversing the lead-VOM still indicates infinity or high resistance

Test Results of a Shorted Diode



forward bias



reverse bias

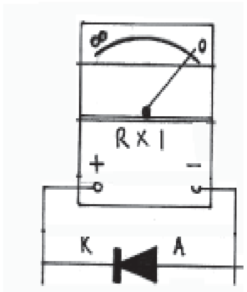
VOM reads zero resistance in all ranges

The pointer deflects to the right and stays there.

Reversing the leads, does not alter the indication .

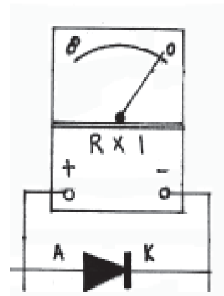
VOM still indicates zero resistance

Test Results of a Leaky Diode



forward bias

VOM indicates resistance reading

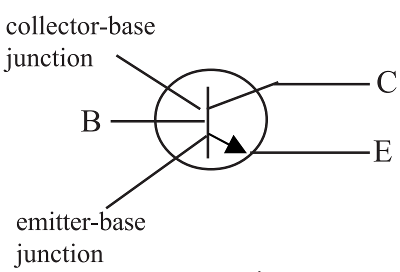


reverse bias

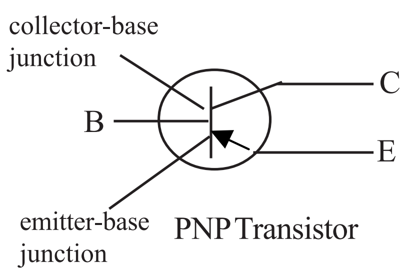
Reversing the leads, VOM still indicates resistance reading

Testing Transistors with an Ohmmeter or VOM

Practically all electronic equipment and appliances contain transistors. Most of the common troubles of electronic equipment and appliances are caused by faulty transistors. Transistors have three (3) electrodes or terminals; the *base* (B), the *emitter* (E) and the *collector* (C). They are grouped into two types; negative-positive-negative (NPN) and the positive-negative-positive (PNP). Transistors have two junctions between their electrodes - the emitter-base junction and collector-base junction. The symbols below indicate the type of transistors with their electrodes and junctions.



NPN Transistor



PNP Transistor

Transistors may develop troubles such as shorted emitter-base, open emitter-base, shorted collector-base, open collector-base, shorted collector-emitter, and leaky collector-emitter.

Below are transistors with identification and leads bearing levels.


Figure E-1

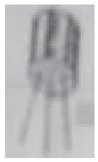


Figure E-2

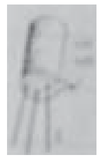


Figure E-3


Figure E-4


Figure E-5


Figure E-6

The labels are interpreted as follows:

Figure E-1	The base and emitter leads are identified through letters. The collector is the transistor body.
Figure E-2	The lead nearest to the dot on the transistor body is the collector. The lead next to the body is the base.
Figure E-3	The lead nearest to the flat portion of the body is the emitter.
Figure E-4	The lead nearest to the tab is the emitter.
Figure E-5	The left pin is the base, and the right pin, the emitter. The transistor body is the collector.
Figure E-6	The center lead is the collector which is connected internally to the metal tab.
Figure E-7	The angular lead is the base.

Test of Good Transistors

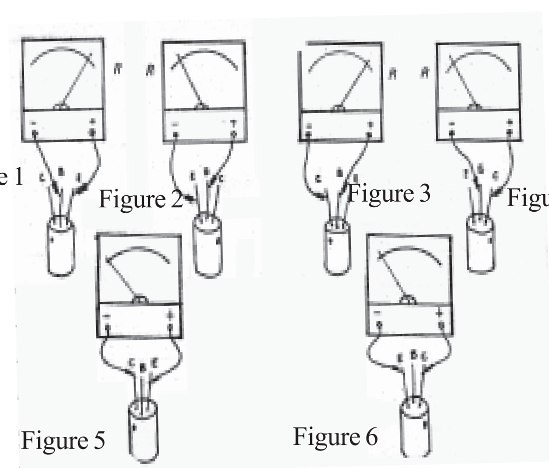


Figure 1 Figure 2 Figure 3 Figure 4 Figure 5 Figure 6

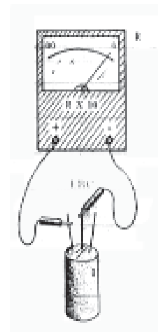
The illustrations above are interpreted as follows:

Figure 1 - VOM indicates resistance reading (forward bias).
Figure 2 - Reversing the leads, VOM indicates infinity or high resistance (reverse bias).

Figure 3 - VOM indicates resistance reading (forward bias).
Figure 4 - Reversing the leads, VOM reads infinity or high resistance (reverse bias).
Figure 5 - VOM reads infinity or high resistance.
Figure 6 - Reversing the leads, VOM still indicates infinity or high resistance.

Test Results of Defective Transistors

Figure 1



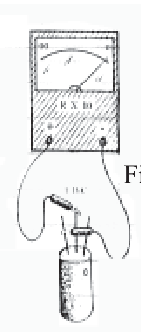


Figure 2

1. Shorted emitter-base

Interpretation of the illustrations

Figure 1 - VOM indicates zero resistance.
Figure 2 - Reversing the test leads VOM still indicates zero resistance.

2. Open emitter-base

Interpretations:

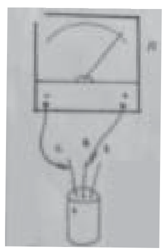


Figure 3

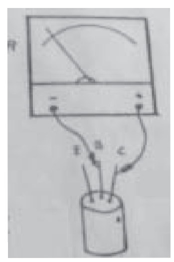


Figure 4

Figure 3 - VOM reads infinity or high resistance.
Figure 4 - Reversing the test leads. VOM still reads infinity.

3. Shorted collector-base

Interpretations:

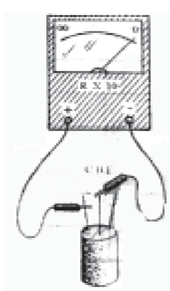


Figure 5 -VOM indicates zero resistance.

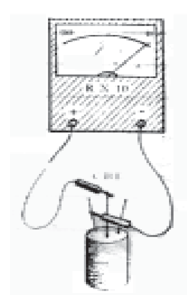


Figure 6 - Reversing the test leads, VOM still indicates zero resistance.

4. Open collector-base

Interpretations:

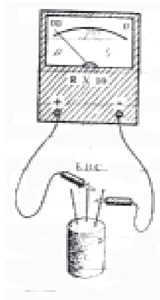


Figure 7 - VOM reads infinity

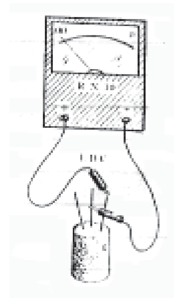


Figure 8 - Reversing the test leads, VOM still reads infinity.

5. Shorted emitter-collector

Interpretations:

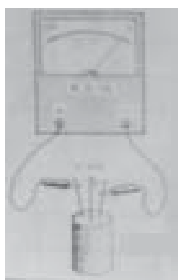


Figure 9 - VOM indicates zero reading.

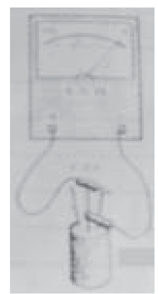


Figure 10 - Reversing the test leads, VOM still reads zero.

6. Leaky emitter-collector

Interpretations:

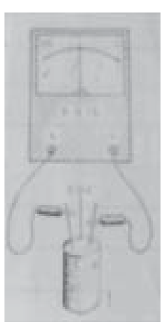


Figure 11 - VOM indicates resistance reading.

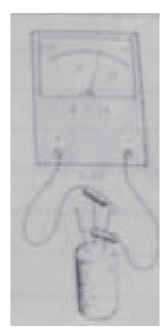


Figure 12 - Reversing the test leads, VOM still indicates resistance reading.

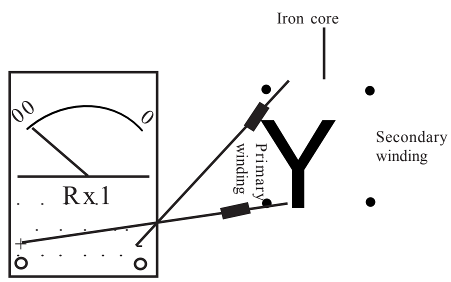
Testing the Transformer with an Ohmmeter or VOM

The transformer is an alternating current and voltage changing device through which voltage can be received and delivered at either higher or lower value. It has two windings, primary and secondary. These two separate windings are wound in an iron core. The primary winding receives the energy or voltage, while the secondary winding delivers the energy or voltage.

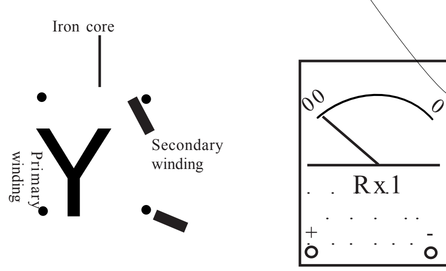
Transformers also become defective. Some of these defects are open primary winding, open secondary winding, shorted primary and secondary winding and shorted iron core and windings.

Test Results of Defective Transformers

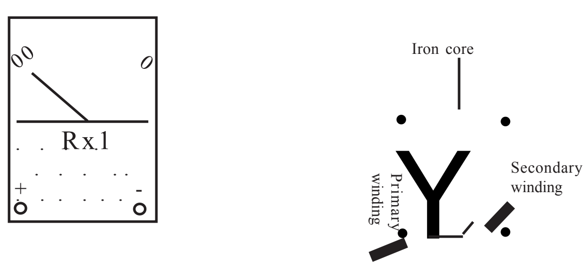
1. Open primary winding.
   VOM reads infinity or high resistance in all ranges.



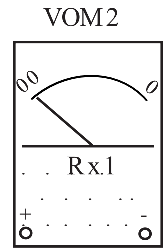
2. Open secondary winding.
   VOM reads infinity or high resistance in all ranges.

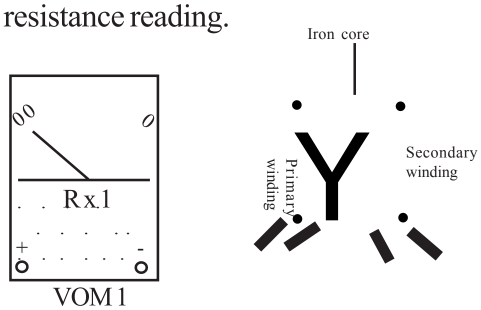


3. Shorted primary and secondary windings.
   VOM indicates zero resistance reading.



4. Shorted iron core and windings.
VOM indicates both zero resistance reading.





Activity 4

Report to your teacher in school for actual testing of electronic components. Borrow one (1) VOM from your teacher and get a data sheet to record your test results.

Self-check:

Directions: Read the statements carefully. Check (✓) if the statement is correct, and a cross (×) if it is wrong.

____ 1. It is good practice to discharge capacitors before testing.
____ 2. Resistance can be checked accurately in a circuit.
____ 3. Resistors may become shorted due to overcurrent.
____ 4. If a capacitor is open, the VOM reads infinity even at highest range.
____ 5. The battery inside the VOM applies forward or reverse bias to the diode.
____ 6. A shorted diode is indicated by a zero resistance reading in the VOM.
____ 7. An open-base emitter junction of a transistor is indicated by high resistance in the VOM on either forward or reverse bias.
____ 8. Secondary voltage can be measured through a transformer even if its primary winding is open.
____ 9. If the primary and secondary windings of a transformer are shorted, the VOM indicates zero resistance reading.
____ 10. A transistor is leaky if there is resistance reading between its emitter and collector.

LET'S SUMMARIZE

- Electronic components are the building blocks of electronic equipment and appliances. They are small but terrible because they can make even the biggest equipment or machine move or operate.

- Some common electronic components are the resistors, capacitors, inductors, transformers, diodes, transistors, crystals, fuses, loudspeakers, switches, integrated circuits and many others.

- These small but terrible electronic components may become defective due to overcurrent and long continued use. They may develop defects or troubles like, open, increased or decreased resistance values, shorted, leaky, weak and the like.

- These troubles or defects can be identified through voltage and resistance measurements. The volt-ohm-milliammeter (VOM) is the most commonly used instrument to test electronic components for defects.

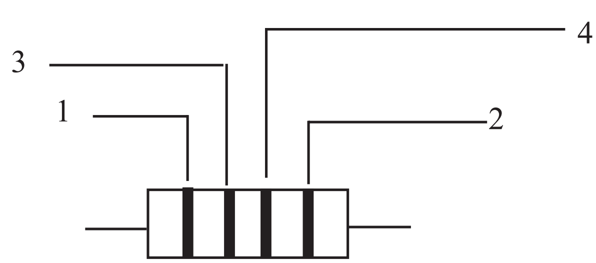
- Through resistance measurement, the condition of an electronic component can be easily determined by the behavior of the VOM's pointer. The pointer may indicate a resistance reading, a zero resistance reading and an infinity reading. Thus, a technician should be knowledgeable enough to interpret these readings.

POSTTEST

I. Directions: Fill in the empty boxes with the correct symbols, functions and uses of the indicated electronic components.

Component	Symbol	Functions	Uses
1. resistor			
2. capacitor			
3. inductor			
4. transformer			
5. diode			
6. transistor			
7. integrated circuit			
8. crystal			
9. fuse			
10. switch			

II. Below is a pictorial symbol of a resistor. Interpret the colors by labeling them.



KEY TO ANSWERS

Pretest

I.

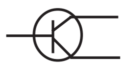
1. opens and closes the circuit
2. loudspeaker
3. transistor
4. transfer power from primary to secondary circuit by induction
5. blocks AC and passes DC
6. capacitor
7. used as rectifier in power supplies
8. resistor
9. fuse
10. used as amplifier, oscillator, demodulator, modulator and regulator.

II.

1. Fuse
2. resistor
3. diode
4. transistor
5. capacitor
6. crystal
7. transformer
8. microphone
9. loudspeaker
10. LED

Posttest

	Functions	Uses
1. 	Produces specific voltage drop	Used in bias, coupling, tone circuits
2. 	Stores electric charge in its dielectric	Used in coupling, filtering and tuning circuits.
3. 	Stores energy in its magnetic field	Blocks AC and passes DC.

4. Y	Transfers power from primary to secondary circuits	Used in power supply to step-up or step-down voltage
5. A m K	Conducts current in only one direction	As rectifier of power supplies.
6. 	Generates and enlarges signals.	As oscillator , amplifier and switch
7. 	Amplifies or enlarges signals.	Amplifier, oscillator and modulator
8. 	Produces emf when made to vibrate	Oscillator in radio transmitter and receiver
9. d	Protects the circuit from overload	Used practically in all electronic appliances and equipment
10. 	Opens and closes the circuit	For disconnecting electronic appliances from the voltage source.

II.

1. first digit
2. tolerance
3. second digit
4. multiplier