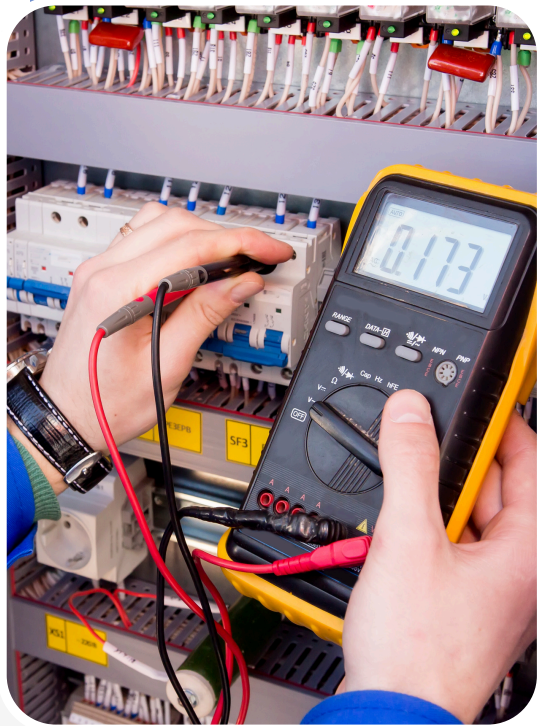


ELECTRICAL ENGINEERING DEPARTMENT



MEASUREMENT DEVICES

**ELECTRICAL ENGINEERING CAREER
STARTS FROM HERE**

KHAIROL NAPISHAM ABD RAZAK
MARIANA ROSDI

MEASUREMENT DEVICES

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STARTS FROM HERE**

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MEASUREMENT DEVICES : ELECTRICAL ENGINEERING CAREER STARTS FROM HERE

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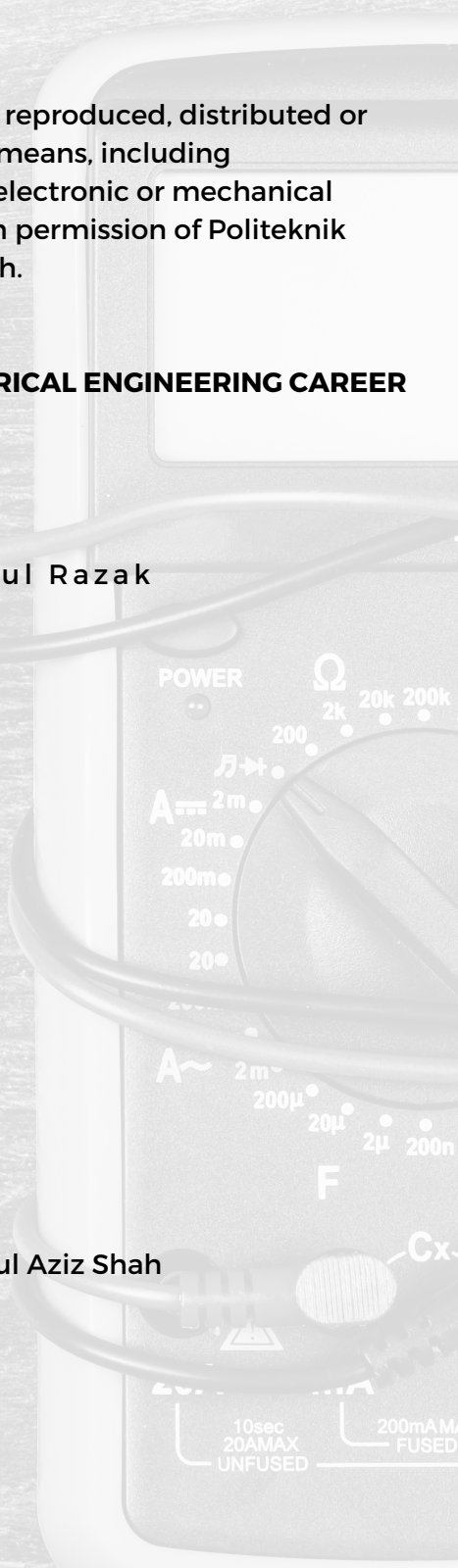
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PREFACE

In the rapidly evolving field of electronics, precise and reliable measurement is crucial for the development, testing, and maintenance of electronic systems. Whether you are a student, a hobbyist, or a professional engineer, understanding the principles and techniques of electronic measurement is essential for achieving accuracy and efficiency in your work. This eBook, **“MEASUREMENT DEVICES: ELECTRICAL ENGINEERING CAREER STARTS FROM HERE”** aims to provide a thorough and accessible introduction to the world of electronic measurement devices. It covers fundamental concepts, explores various types of measurements, and delves into the use of different instruments and techniques. Our goal is to equip readers with the knowledge and skills necessary to confidently perform measurements and interpret results in diverse electronic applications.

Key Features of This eBook:

1. **Comprehensive Coverage:** We begin with the basic principles of measurement, discussing units, standards, and types of errors. From there, we move on to detailed explanations of various measurement techniques, including voltage, current, resistance, capacitance, and more.
2. **Instrument Overview:** A significant portion of this eBook is dedicated to familiarizing readers with essential electronic measurement instruments. We cover multimeters, oscilloscopes, function generators, spectrum analyzers, and other tools, explaining their functions, features, and proper usage.
3. **Practical Examples and Applications:** Theory is complemented with practical examples and case studies that demonstrate real-world applications of electronic measurement. These examples help bridge the gap between theoretical knowledge and practical implementation.
4. **Advanced Topics:** For readers seeking to deepen their expertise, we explore advanced topics such as automated measurement systems, data acquisition, and emerging technologies in electronic measurement.
5. **User-Friendly Approach:** Written in a clear and concise manner, this eBook is designed to be user-friendly. Technical terms are explained, and complex concepts are broken down into manageable sections. Diagrams, tables, and illustrations are used to enhance understanding.

Thank you for choosing this eBook as your guide to electronic measurement devices. We are confident that it will be a beneficial addition to your technical library and a helpful companion in your journey through the fascinating world of electronics.

Happy measuring!

C O N T E N T S



C H A P T E R 1

INTRODUCTION TO	01
MEASUREMENT DEVICE	

C H A P T E R 2

MEASURING INSTRUMENT	07
MULTIMETER	

C H A P T E R 3

MEASURE CURRENT AND	18
VOLTAGE IN SERIES CIRCUIT	

C H A P T E R 4

MEASURE CURRENT AND	23
VOLTAGE IN PARALLEL CIRCUIT	

C H A P T E R 5

MEASURE CURRENT AND	28
VOLTAGE IN SERIES PARALLEL	
CIRCUIT	

C O N T E N T S



C H A P T E R 6

INTRODUCTION TO	33
OSCILLOSCOPE	

C H A P T E R 7

INTRODUCTION TO	41
FUNCTION GENERATOR	

C H A P T E R 8

ELECTRICAL	47
ENGINEERING CAREER	

R E F F E R E N C E S

48

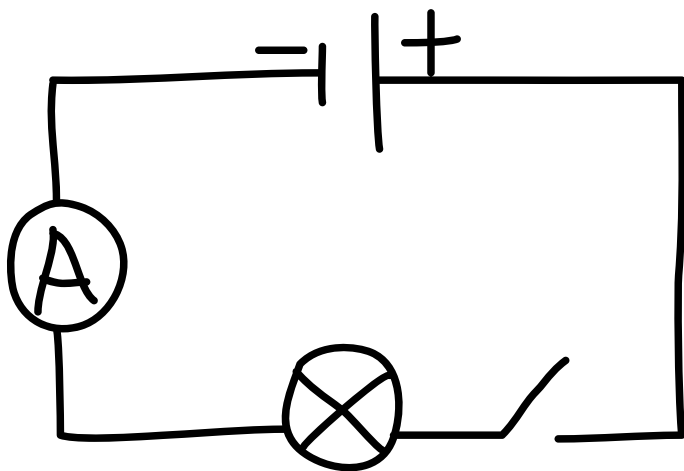
CHAPTER 1

INTRODUCTION TO MEASUREMENT DEVICE



What is a Measurement Device?

A measurement device, also known as a measuring instrument or measurement instrument, is a tool or instrument used to determine the size, amount, or degree of an object or phenomenon. In the context of electronics, measurement devices are essential for assessing various electrical parameters, such as voltage, current, resistance, capacitance, frequency, and power. These devices enable engineers, technicians, and hobbyists to ensure that electronic components and systems operate correctly and efficiently.



Importance of Measurement Devices in Electronics

Measurement devices are vital for several reasons:

Design and Development:

Ensuring that circuits and systems meet design specifications.

Testing and Debugging:

Identifying and fixing issues in electronic systems.

Quality Control:


Verifying that products meet industry standards and performance criteria.

Safety:

Detecting faults that could lead to hazardous conditions.

Maintenance and Repair:

Keeping electronic systems in good working order and extending their lifespan.



Measurement devices are the backbone of electronic testing and analysis. Understanding their functions, applications, and features is crucial for anyone involved in the design, testing, and maintenance of electronic systems.



Key Features to Consider

When selecting a measurement device, consider the following features:

Accuracy and Precision:

The degree to which the measurement conforms to the true value and the repeatability of the measurement.

Range and Resolution:

The span of values the device can measure and the smallest change it can detect.

Usability:

Ease of use, including interface design, portability, and connectivity options.

Compatibility:

Ability to integrate with other equipment and software.

Cost:

Balancing the device's capabilities with your budget.



Types of Electronic Measurement Devices

Here are some common types of electronic measurement devices:

Multimeter:

Function: Measures voltage, current, and resistance.

Types: Analog and digital.

Use Case: General-purpose testing and troubleshooting in electronic circuits.

Oscilloscope:

Function: Displays and analyzes the waveform of electronic signals.

Types: Analog and digital storage oscilloscopes (DSOs).

Use Case: Observing signal behavior over time, identifying signal anomalies.

Function Generator:

Function: Produces various types of electrical waveforms over a range of frequencies.

Use Case: Testing and designing circuits by providing a test signal.

Spectrum Analyzer:

Function: Measures the magnitude of an input signal versus frequency within the full frequency range of the instrument.

Use Case: Analyzing the spectral composition of signals, identifying frequency components.



Types of Electronic Measurement Devices

Here are some common types of electronic measurement devices:

Power Meter:

Function: Measures the power of an electrical signal.

Use Case: Assessing the power consumption of circuits and systems.

LCR Meter:

Function: Measures inductance (L), capacitance (C), and resistance (R).

Use Case: Evaluating the properties of inductors, capacitors, and resistors.

Logic Analyzer:

Function: Captures and displays multiple signals from a digital system or circuit.

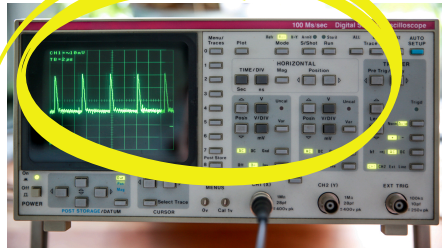
Use Case: Debugging and verifying the operation of digital circuits.

Network Analyzer:

Function: Measures the network parameters of electrical networks.

Use Case: Characterizing high-frequency network parameters like impedance, return loss, and signal integrity.

Do you recognize the measurement device?



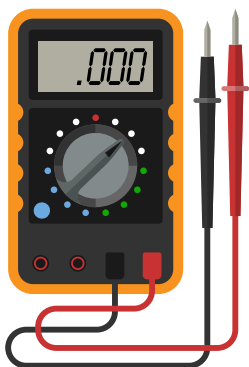
CHAPTER 2

MEASURING INSTRUMENT MULTIMETER



BACKGROUND

Electrical quantity such as in resistance, current, voltage, power and energy can be measured using meter. These meters can be categorised into two: analogue meters and digital meters.



LCD – Liquid Crystal Display
digital multimeters



Analogue Multimeter Scale
analogue multimeters

A multimeter is called a “multimeter” because it combines multiple measurement functions into a single instrument. The term “multi” indicates that the device can perform various types of measurements, which is a significant advantage for users who need a versatile tool for a wide range of tasks in electronics and electrical engineering. Here are the primary functions typically included in a multimeter:

Example Scenario



Consider a technician working on troubleshooting an electronic circuit. Instead of carrying separate tools for measuring voltage, current, and resistance, the technician can use a multimeter to perform all these measurements. This versatility and efficiency are why the term “multi” is used in the name “multimeter.”

Primary Functions of a Multimeter

Voltage Measurement (Voltmeter)

DC Voltage: Measures direct current voltage, such as from batteries or DC power supplies.

AC Voltage: Measures alternating current voltage, such as household electrical outlets.

Current Measurement (Ammeter)

DC Current: Measures direct current flow in a circuit.

AC Current: Measures alternating current flow in a circuit.

Resistance Measurement (Ohmmeter)

Measures the resistance of electrical components or circuits, helping to identify issues like open circuits or short circuits.



Additional Functions

Many modern multimeters also offer additional measurement capabilities, including but not limited to:

Continuity Testing:

Checks if there is a complete path for current flow, indicating a good connection.

Capacitance Measurement:

Measures the capacitance of capacitors.

Frequency Measurement:

Measures the frequency of an AC signal.

Temperature Measurement:

Uses a thermocouple to measure temperature.

Diode Testing:

Checks the functionality of diodes by measuring the voltage drop across them.



Advantages of a Multimeter

Convenience:

Combines multiple measurement tools in one device, reducing the need to carry several instruments.

Cost-Effective:

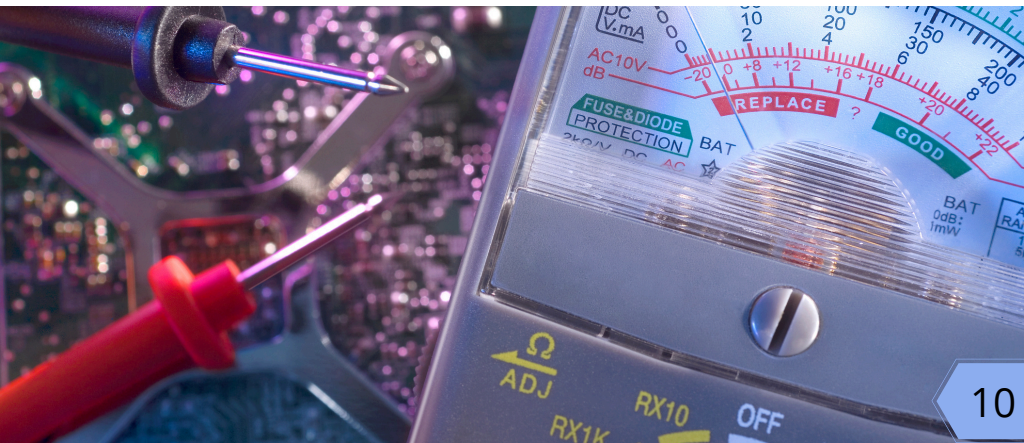
More economical than purchasing separate instruments for each measurement function.

Space-Saving:

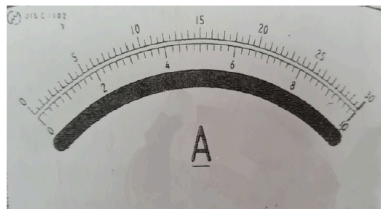
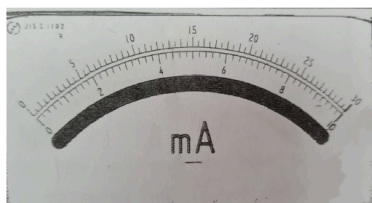
Saves workspace by eliminating the need for multiple single-function tools.

Efficiency:

Simplifies the process of switching between different types of measurements, saving time and effort.



An Analogue meter uses the principle of magnetism in the movement of the indicator needle. The indicator needle moves across the scales in the front of the meter. The deflection of the indication needle is proportional to the magnitude of the quantity measured. The diagram below shows a unit for measuring the current of mA and A



This meter is used to measure current flowing through the load. This meter is connected in series with the load. Zero scale for the ammeter is located on the left side of the panel.

WHAT DO METERS MEASURE?

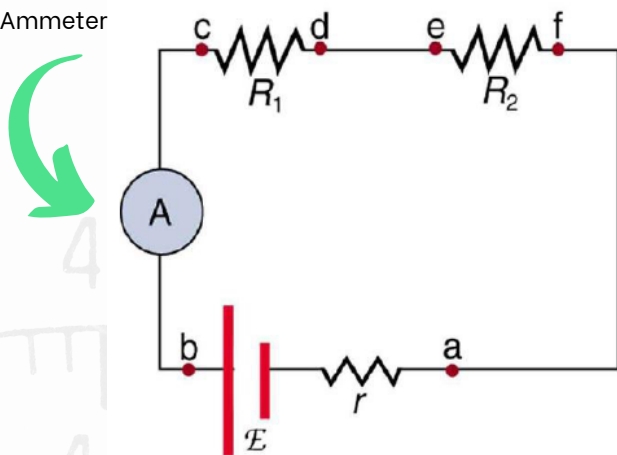
An Ammeter is a measuring device that is used to measure the flow of electricity in the form of **current** in a circuit. Electrical currents are then measured in the form of amperes, hence the name, “ammeter”.

The term “ammeter” is sometimes used incorrectly as “ampmeter”. Ammeters are designed, (as well as ohmmeters and voltmeters), to be used with the use of a sensitive current detector such as a moving coil in a galvanometer.

In order to measure the electric current flow through it, an ammeter is placed in **series** with a circuit element.

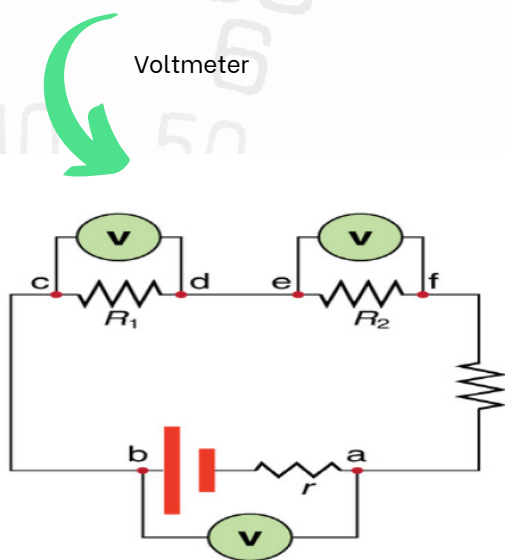
The ammeter is designed to offer very low resistance to the current, so that it does not appreciably change the circuit it is measuring. To do this, a small resistor is placed in parallel with the galvanometer to shunt most of the current around the galvanometer. Its value is chosen so that when the design current flows through the meter it will deflect to its full-scale reading. A galvanometer full-scale current is very small: on the order of milliamperes

Ammeter

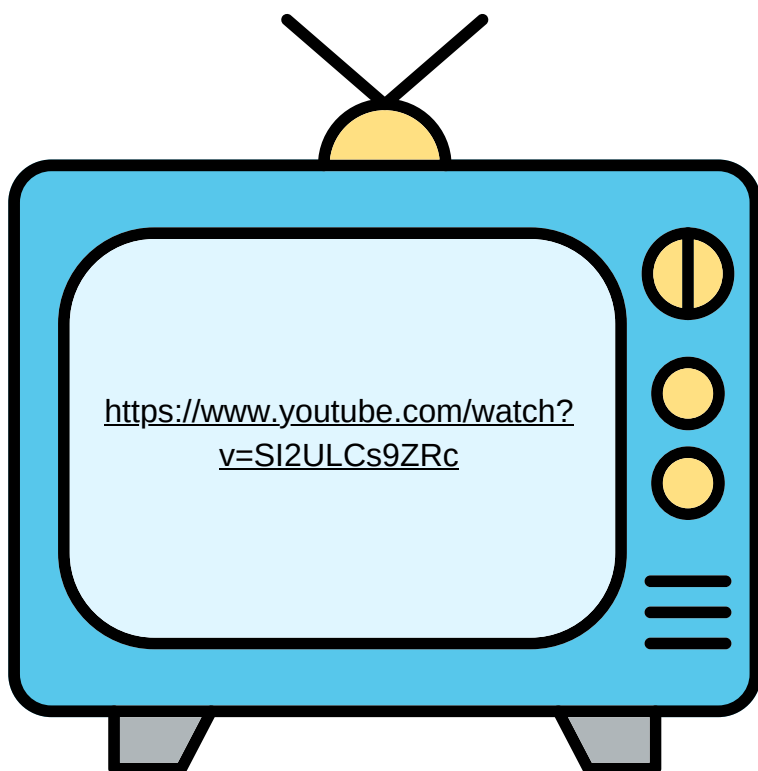


A “Voltmeter” is an instrument used for measuring **voltage** (V), that is the potential difference present between any two points within a circuit. To measure a voltage (potential difference), a voltmeter must be connected in **parallel** with the component whose voltage you wish to measure.

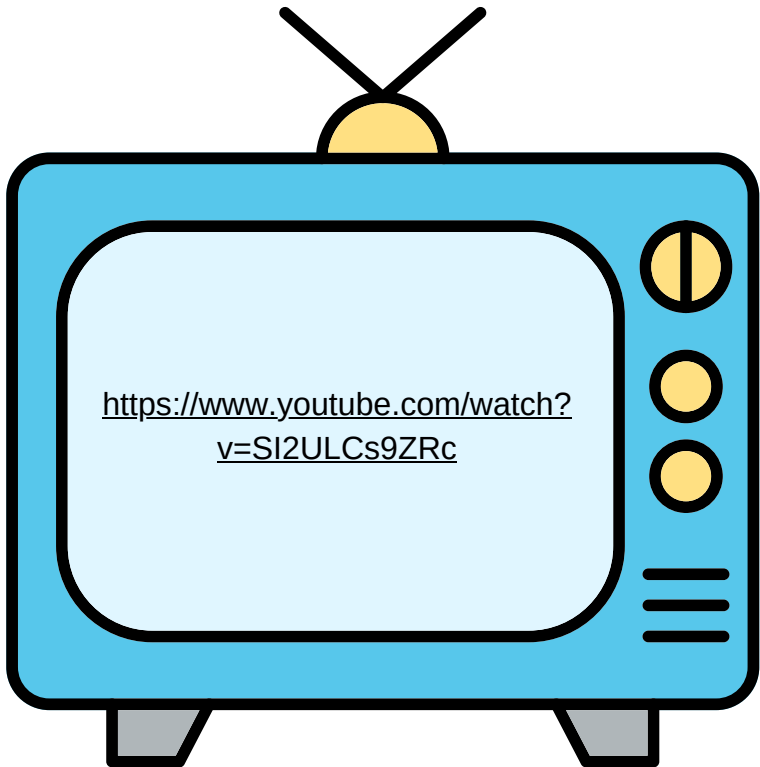
Voltmeters can be used to measure the voltage drop across a single component or supply, or they can be used to measure the sum of voltage drops across two or more points or components within a circuit.



Video How To Use Analog Multimeter



**Video To how to check DC voltage
with analog multimeter**

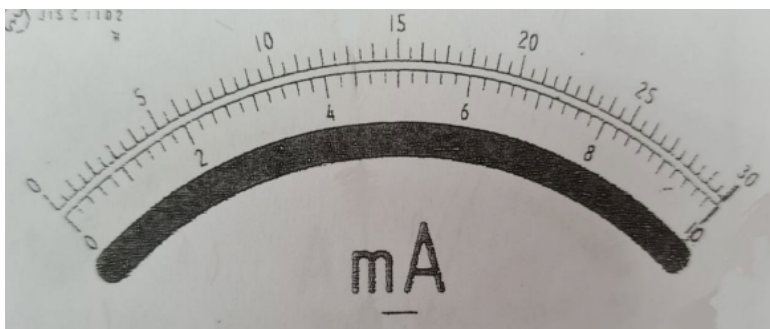




PRACTICAL WORK 1

PROCEDURES:

1. Indicate and draw the pointer of the meter based on the value given.
2. The pointer need to draw clearly and correctly by using a pencil.



- | | |
|---------------------------------|---------------------------------|
| ● Range: 0.3mA
Value: 0.27mA | ● Range: 3.0mA
Value: 1.5mA |
| ● Range: 1.0mA
Value: 0.8mA | ● Range: 10mA
Value: 4.4mA |
| ● Range: 3.0mA
Value: 1.5mA | ● Range: 30mA
Value: 21mA |
| ● Range: 10mA
Value: 6.6mA | ● Range: 0.3mA
Value: 0.13mA |
| ● Range: 30mA
Value: 17mA | ● Range: 1.0mA
Value: 0.26mA |
| ● Range: 1.0mA
Value: 0.3mA | ● Range: 3.0mA
Value: 1.45mA |

QUIZ

1

Explain the steps required to measure the current by using DC Ammeter

2

Draw the front panel of the Ammeter

*Good!
Luck!*

CHAPTER 3

MEASURE CURRENT AND VOLTAGE IN SERIES CIRCUIT



BACKGROUND:

In electronics, components of an electronic circuit can be connected in series or in parallel as shown in Figure 1. Components connected in series are connected along a single path, so the same current flows through all of the components. Components connected in parallel are connected so the same voltage is applied to each component.

In a series circuit, the current through each of the components is the same, and the voltage across the components is the sum of the voltages across all the components. In a parallel circuit, the voltage across each of the components is the same, and the total current is the sum of the current through all the components. Therefore from the Figure 1 we can calculate

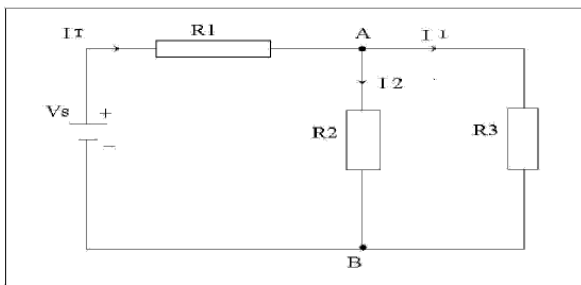
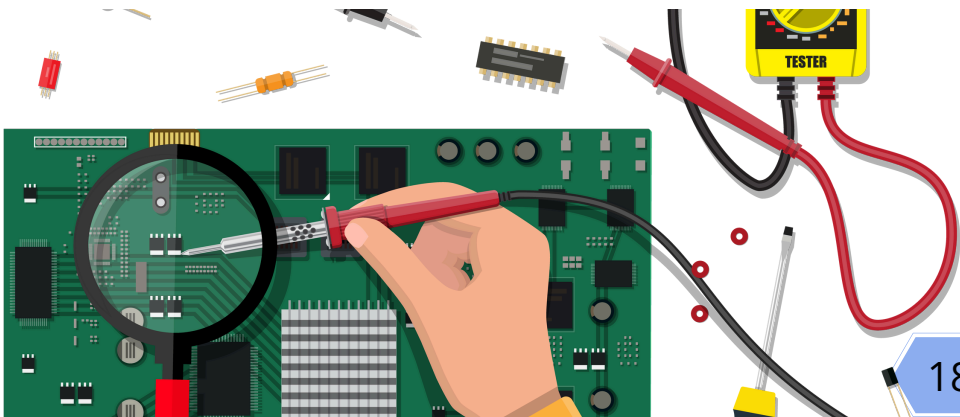


Figure 1



Error is defined as the difference between the measured value (X_m) and the true value (X_{true})

$$\text{Error} = X_m - X_{true}$$

Therefore the percentage of error is:

$$\% \text{ error} = \left| \frac{\text{true value} - \text{measured value}}{\text{true value}} \right| \times 100\%$$

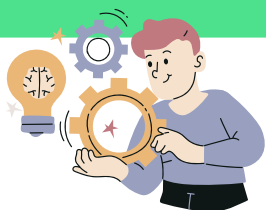
There are several types of error such as systematic error, random error and non linear error. Systematic errors occur in a repeatable way every time a measurement occurs under similar conditions. They are also known as 'bias' errors.

Nonlinear errors can result from poor design or from inappropriate system use. Many components and systems of components are designed to produce linear output from linear input. However, if those components are improperly used, either by the designer or the end user, nonlinear can results. Random errors are different for every measurement event. The defining characteristics for random errors is that they have an average value of zero. As a result, it's often possible to reduce random error in measurement by repeating the measurement and then averaging the outcomes.

ERROR

How to Measure DC Voltage and Current in a Series Resistor Circuit.





PRACTICAL WORK 2

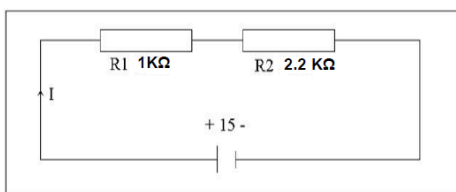


Figure 2

APPARATUS:

- i. Resistor
- ii. Ammeter
- iii. Voltmeter
- iv. Power supply
- v. Multi meter
- vi. Wires

PROCEDURES:

1. Connect the circuit as shown in Figure 2.
2. Make sure the voltmeter is connected in parallel with resistors and ammeter is connected in series.
3. Adjust the power supply to 15V and measure the voltage and current across every resistor.
4. Record the measured value

Resistor R1

- Current (theory), I_t
- Current (experiment), I_e
- Error, e

Resistor R2

- Current (theory), I_t
- Current (experiment), I_e
- Error, e

QUIZ

1

What is an error?

2

Calculate the percentage of error for each resistor

*Good!
Luck!*

CHAPTER 4

MEASURE CURRENT AND VOLTAGE IN PARALLEL CIRCUIT



BACKGROUND:

In electronics, components of an electronic circuit can be connected in series or in parallel as shown in Figure 1. Components connected in series are connected along a single path, so the same current flows through all of the components. Components connected in parallel are connected so the same voltage is applied to each component.

In a series circuit, the current through each of the components is the same, and the voltage across the components is the sum of the voltages across all the components. In a parallel circuit, the voltage across each of the components is the same, and the total current is the sum of the current through all the components. Therefore from the Figure 1 we can calculate

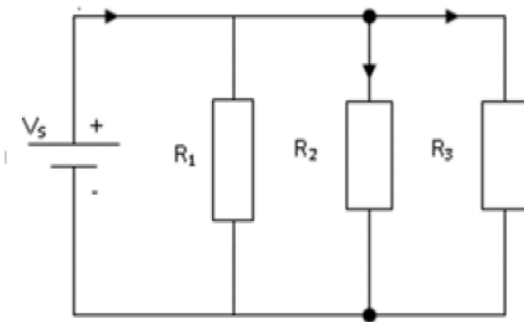
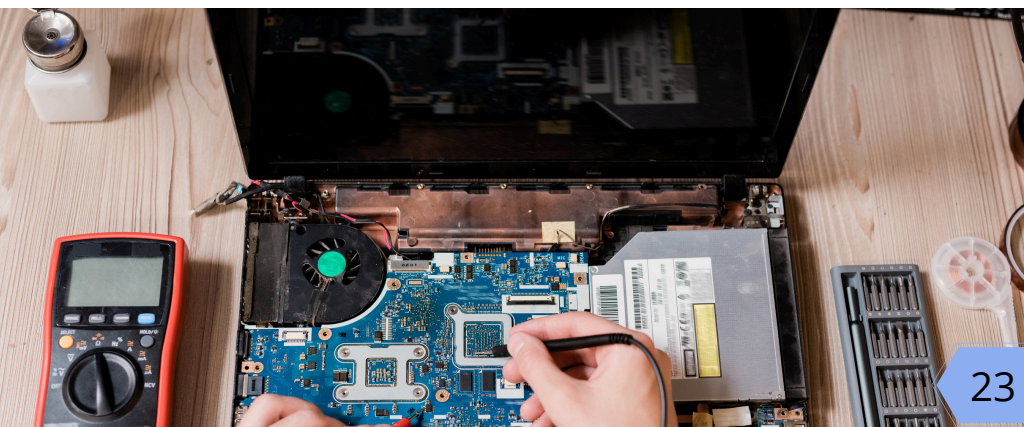


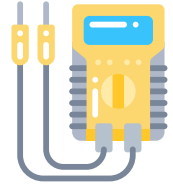
Figure 1



Error is defined as the difference between the measured value (X_m) and the true value (X_{true})

$$\text{Error} = X_m - X_{true}$$

Therefore the percentage of error is:



$$\% \text{ error} = \left| \frac{\text{true value} - \text{measured value}}{\text{true value}} \right| \times 100\%$$

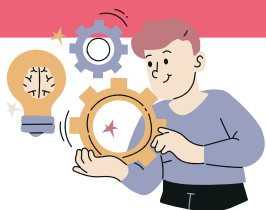
There are several types of error such as systematic error, random error and non linear error. Systematic errors occur in a repeatable way every time a measurement occurs under similar conditions. They are also known as 'bias' errors.

Nonlinear errors can result from poor design or from inappropriate system use. Many components and systems of components are designed to produce linear output from linear input. However, if those components are improperly used, either by the designer or the end user, nonlinear can results. Random errors are different for every measurement event. The defining characteristics for random errors is that they have an average value of zero. As a result, it's often possible to reduce random error in measurement by repeating the measurement and then averaging the outcomes.

ERROR

How to Measure DC Voltage and Current in a Parallel Resistor Circuit





PRACTICAL WORK 3

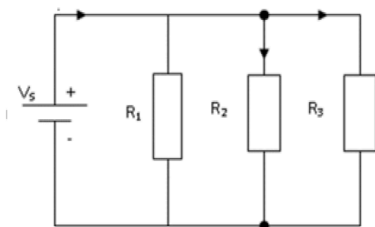


Figure 2

APPARATUS:

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- iii. Voltmeter
- iv. Power supply
- v. Multi meter
- vi. Wires

PROCEDURES:

1. Connect the circuit as shown in Figure 2.
2. Make sure the voltmeter is connected in parallel with resistors and ammeter is connected in series.
3. Adjust the power supply to 15V and measure the voltage and current across every resistor. ($R_1 = 1\text{K}\Omega$; $R_2 = 2.2\text{K}\Omega$; $R_3 = 3.3\text{K}\Omega$)
4. Record the measured the value

Resistor R1

- Current (theory), I_t
- Current (experiment), I_e
- Voltage (theory)
- Voltage (experiment)
- Error, e

Resistor R2

- Current (theory), I_t
- Current (experiment), I_e
- Voltage (theory)
- Voltage (experiment)
- Error, e

Resistor R3

- Current (theory), I_t
- Current (experiment), I_e
- Voltage (theory)
- Voltage (experiment)
- Error, e



QUIZ

1

What is an error?

2

Calculate the percentage of error for each resistor

*Good!
Luck!*

CHAPTER 5

MEASURE CURRENT AND VOLTAGE IN SERIES PARALLEL CIRCUIT



BACKGROUND:

In electronics, components of an electronic circuit can be connected in series or in parallel as shown in Figure 1. Components connected in series are connected along a single path, so the same current flows through all of the components. Components connected in parallel are connected so the same voltage is applied to each component.

In a series circuit, the current through each of the components is the same, and the voltage across the components is the sum of the voltages across all the components. In a parallel circuit, the voltage across each of the components is the same, and the total current is the sum of the current through all the components. Therefore from the Figure 1 we can calculate

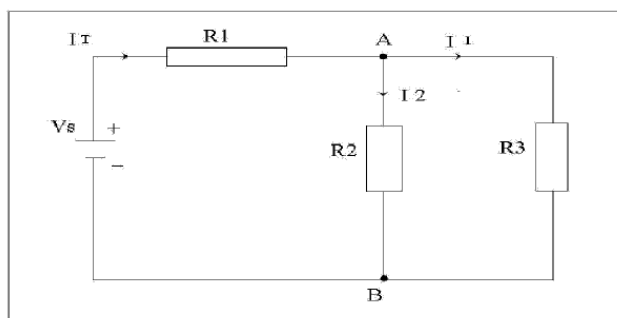


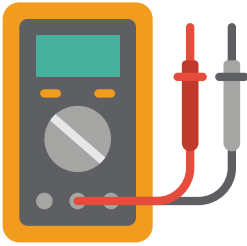
Figure 1



Error is defined as the difference between the measured value (X_m) and the true value (X_{true})

$$\text{Error} = X_m - X_{true}$$

Therefore the percentage of error is:



$$\% \text{ error} = \left| \frac{\text{true value} - \text{measured value}}{\text{true value}} \right| \times 100\%$$

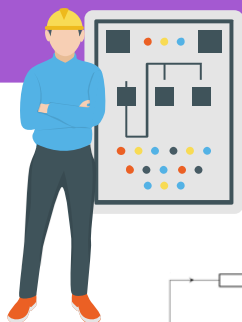
There are several types of error such as systematic error, random error and non linear error. Systematic errors occur in a repeatable way every time a measurement occurs under similar conditions. They are also known as 'bias' errors.

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ERROR

How to measuring a series parallel circuit





PRACTICAL WORK 4

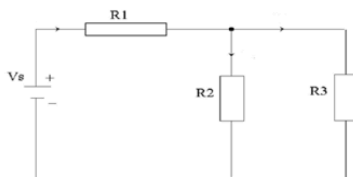


Figure 2

APPARATUS:

- i. Resistor
- ii. Ammeter
- iii. Voltmeter
- iv. Power supply
- v. Multi meter
- vi. Wires

PROCEDURES:

1. Connect the circuit as shown in Figure 2.
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3. Adjust the power supply to 15V and measure the voltage and current across every resistor.
($R_1 = 1K\Omega$; $R_2 = 2.2K\Omega$; $R_3 = 3.3K\Omega$)
4. Record the measured value

Resistor R1

- Current (theory), I_t
- Current (experiment), I_e
- Voltage (theory)
- Voltage (experiment)
- Error, e

Resistor R2

- Current (theory), I_t
- Current (experiment), I_e
- Voltage (theory)
- Voltage (experiment)
- Error, e

Resistor R3

- Current (theory), I_t
- Current (experiment), I_e
- Voltage (theory)
- Voltage (experiment)
- Error, e



QUIZ

1

What is an error?

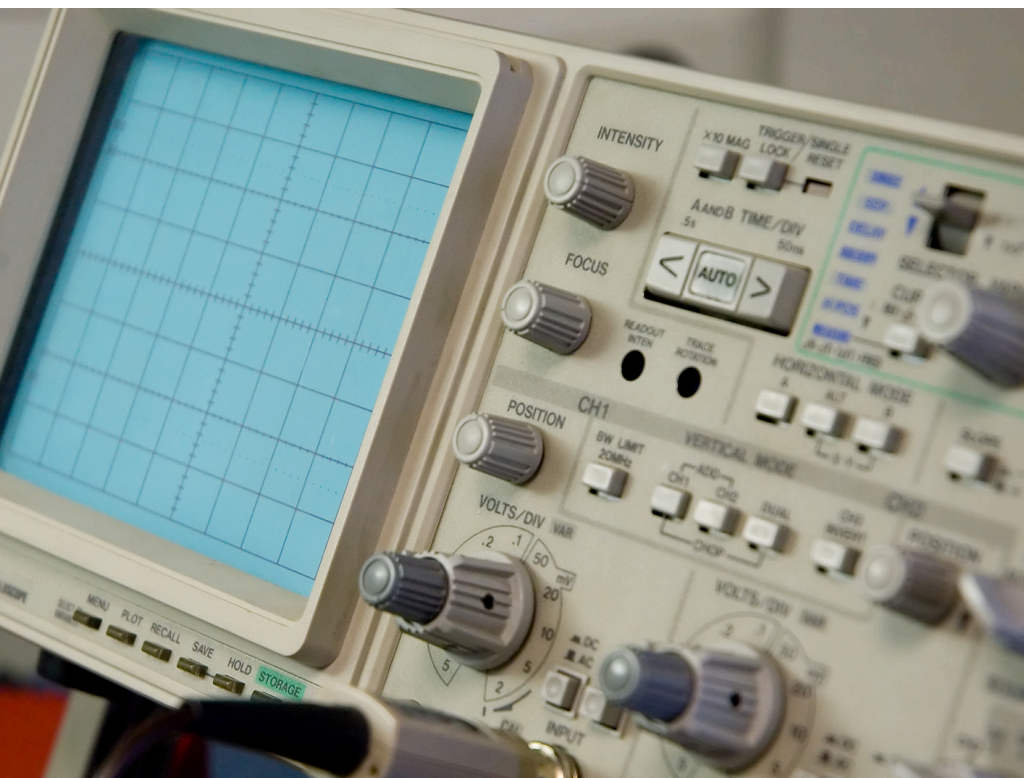
2

Calculate the percentage of error for each resistor

*Good!
Luck!*

CHAPTER 6

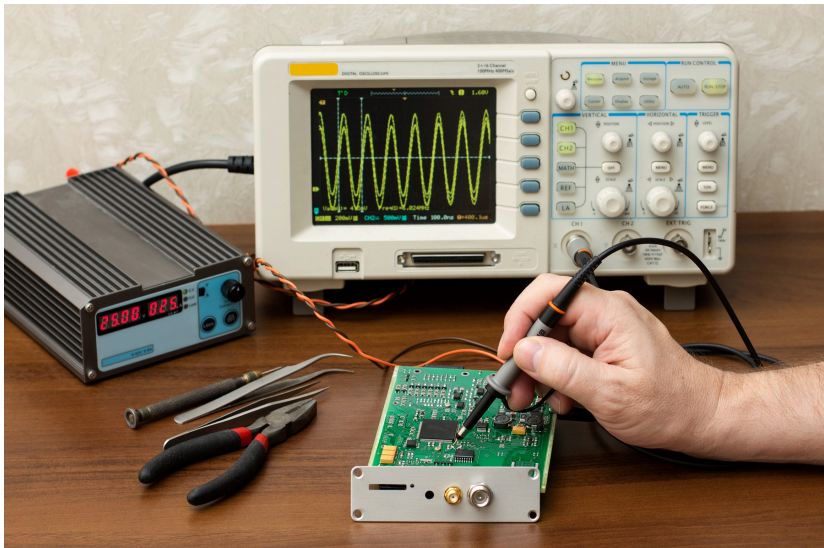
INTRODUCTION TO OSCILLOSCOPE



BACKGROUND:

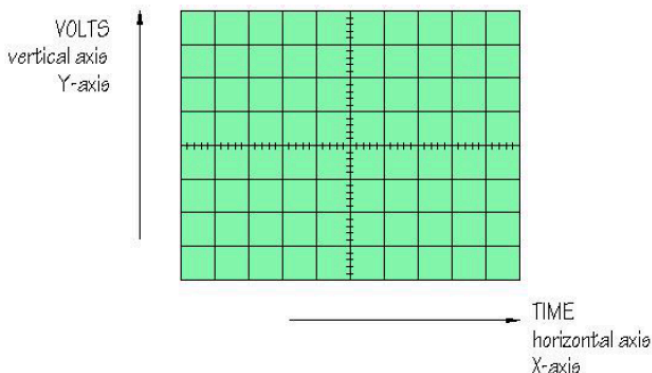
What does an oscilloscope do?

An oscilloscope is easily the most useful instrument available for testing circuits because it allows you to see the signals at different points in the circuit. The best way of investigating an electronic system is to monitor signals at the input and output of each system block, checking that each block is operating as expected and is correctly linked to the next. With a little practice, you will be able to find and correct faults quickly and accurately.

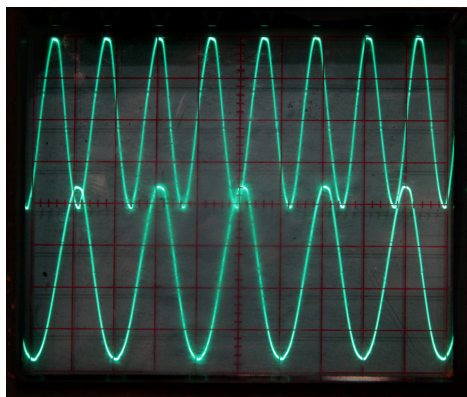


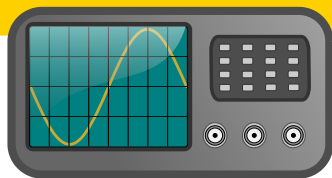
The function of an oscilloscope is extremely simple :

it draws V/t graph, a graph of voltage against time, voltage on the vertical or Y-axis, and time on the horizontal or X-axis.



Many of the controls of the oscilloscope allow you to change the vertical or horizontal scales of the V/t graph, so that you can display a clear picture of the signal you want to investigate. 'Dual trace' oscilloscopes display two V/t graphs at the same time, so that simultaneous signals from different parts of an electronic system can be compared.





PRACTICAL WORK 5

PROCEDURES:

To get the line on the screen, follow the instruction below:

1. Ensure the POWER is OFF.
2. Set INTENSITY to clockwise (3 o'clock).
3. FOCUS-Middle position.
4. Vertical Mode – CH 1.
5. CHOP-released.
6. CH 2 INV-released.
7. POSITION-Middle position.
8. Set VOLT/DIV- 1V/DIV.
9. Variable-CAL (clockwise).
10. Set AC-DC-GND to GND.
11. SOURCE-set to CH 1.
12. COUPLING-AC.
13. Set SLOPE to positive.
14. TRIG ALT-released.
15. Level LOCK-push.
16. HOLD OFF-minimum (anticlockwise).
17. TRIGGER Mode-auto.
18. SWP UNCL-released.
19. TIME/DIV- 0.2 mSec/Div.
20. POSITION-Mid Position.
21. X10MAG-released.
22. X-Y-released.
23. ON the oscilloscope and the get the line on the screen.
24. By using the VERTICAL/HORIZONTAL controller, adjust the line position.
25. Tune the INTENSITY/BRIGHTNESS and FOCUS to obtain sharp and suitable trace.
26. Turn/Press each control button on the oscilloscope and observe the effect and briefly explain.

APPARATUS:

- i. Oscilloscope
- ii. Probe

Introduction To The Oscilloscope





To CALIBRATE the oscilloscope, follow the instruction below:

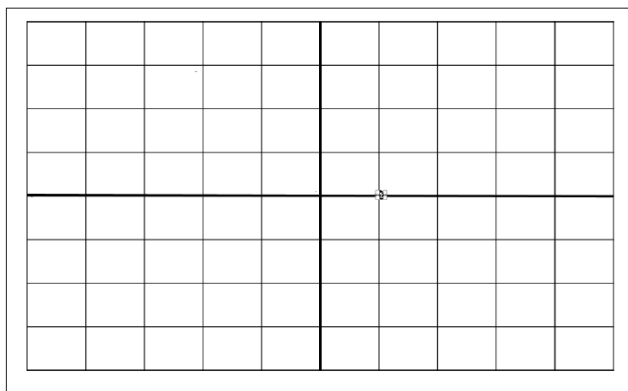
1. Connect probe to CH 1 socket. Set the probe switch to X1.
2. Connect probe to the CAL.....2 Vpp 1 kHz.
3. Observe the square waveform on the screen.
4. Determine the total (DIV) in one cycle at X axis to get the frequency and Y axis to get peak to peak voltage.
5. Draw the waveform on the graph paper and calculate peak to peak voltage and frequency

$$V_{pp} = (\text{total div of Y axis}) \times (\text{volt/div})$$

$$f = 1 / [(\text{total div of X axis}) \times (\text{time/div range})]$$

*div = division

RESULTS: CALIBRATION



CALIBRATION OSCILLOSCOPE



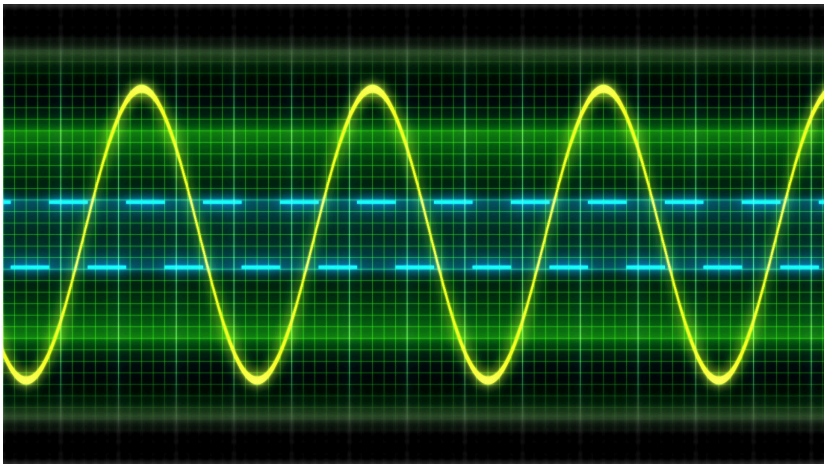


Given the $V/D = 1\text{ V}$; $T/D = 0.2\text{mS}$, calculate:

1. $V_P - P =$

2. $T =$

3. $F = 1/T$



QUIZ

1

What can be observed by using an oscilloscope if you change volt/div? Give an example

2

What can be observed by using an oscilloscope if you change time/div. Give an example

*Good!
Luck!*

CHAPTER 7

INTRODUCTION TO FUNCTION GENERATOR



BACKGROUND:

A function generator is a device that can produce various patterns of voltage at a variety of frequencies and amplitudes. It is used to test the response of circuits to common input signals. The electrical leads from the device are attached to the ground and signal input terminals of the device under test.

Most function generators allow the user to choose the shape of the output from a small number of options. A function generator produces different waveforms [produce alternating current (ac)] of adjustable frequency.

The common output waveforms are the sine, square, triangular and saw tooth waves. Square wave - The signal goes directly from high to low voltage. Sine wave - The signal curves like a sinusoid from high to low voltage. Triangle wave - The signal goes from high to low voltage at a fixed rate.



Front panel of a signal generator as shown in figure 1

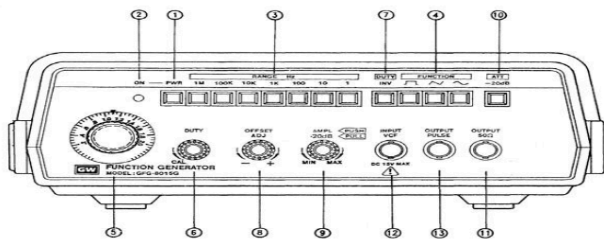


Figure 1



The connection between the oscilloscope and signal generator is simple as shown in Figure 2

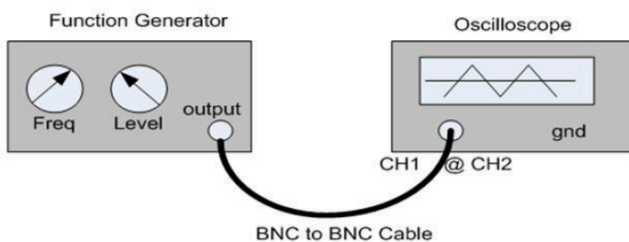


Figure 2

Function Generator Tutorial: What is a Signal Generator / Function Generator?





PRACTICAL WORK 6

PROCEDURES:

To get waveform from Audio Generator.

1. Connect audio generator to Vin oscilloscope.
2. Set the button from audio generator following the table 1.
3. Get the waveform on the screen.
4. Draw the waveform on the graph paper with various Sweep Time Range and Volt/Div.

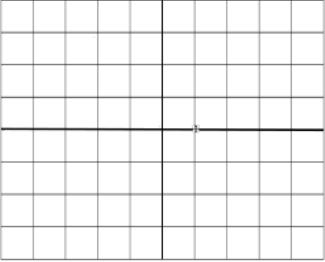
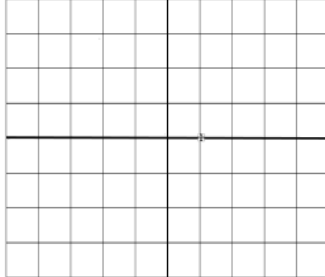
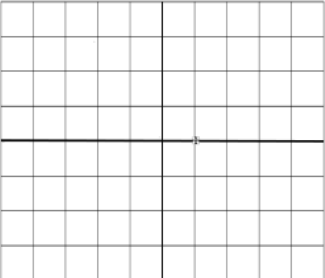
APPARATUS:

- i. Oscilloscope
- ii. Function generator
- iii. Probe

SETTING	
V peak to peak (V)	Frequency (f)
4 Vpp	2 kHz
10 Vpp	6 kHz
16 Vpp	10 kHz

Table 1

RESULTS:
WAVEFORM AND CALCULATION FROM AUDIO GENERATOR

SETTING	WAVEFORM	Vpp	FREQUENCY, f
4 Vpp 2 kHz			
10 Vpp 6 kHz			
16 Vpp 10 kHz			

DISCUSSION

1

(Discuss your observations from theoretical and practical result)

2

(Give a conclusion obtained from the experiment)

*Good!
Luck!*

CHAPTER 8

ELECTRICAL ENGINEERING CAREER



EXAMPLES OF MEASUREMENT DEVICE USE BY ELECTRICAL TECHNICIAN/ ENGINEERS

1. Design Engineers

Role: Develop and design new electronic circuits and systems.

Measurement Devices Used: Oscilloscopes, multimeters, signal generators, spectrum analyzers.

Example: A design engineer developing a new microcontroller-based circuit uses an oscilloscope to observe signal waveforms and verify the correct timing and operation of the circuit. A multimeter is used to measure voltage levels at different points in the circuit to ensure they are within specified ranges.

2. Test and Validation Engineers

Role: Ensure that electronic products meet specified performance criteria and standards.

Measurement Devices Used: Automated test equipment (ATE), multimeters, LCR meters, network analyzers.

Example: A test engineer uses automated test equipment to run a series of electrical tests on a batch of printed circuit boards (PCBs) to verify functionality and performance against design specifications. An LCR meter is used to measure the inductance, capacitance, and resistance of components on the board to ensure they meet the required tolerances.

3. Maintenance Engineers

Role: Maintain and repair electronic systems and equipment.

Measurement Devices Used: Multimeters, insulation testers, thermal cameras.

Example: A maintenance engineer troubleshooting a faulty industrial control system uses a multimeter to measure voltage and current levels to locate a malfunctioning component. An insulation tester checks the integrity of wiring insulation to prevent electrical hazards.

4. Field Service Engineers

Role: Provide on-site support and repair services for electronic equipment.

Measurement Devices Used: Portable oscilloscopes, handheld multimeters, clamp meters.

Example: A field service engineer repairing an automated teller machine (ATM) uses a handheld multimeter to check the power supply voltage levels and continuity of connections. A portable oscilloscope helps diagnose issues with the machine's communication signals.

EXAMPLES OF MEASUREMENT DEVICE USE BY ELECTRICAL TECHNICIAN/ ENGINEERS

5. Research and Development (R&D) Engineers

- Role: Conduct research to develop new technologies and improve existing products.
- Measurement Devices Used: Spectrum analyzers, network analyzers, precision multimeters, signal generators.
- Example: An R&D engineer working on a new wireless communication technology uses a spectrum analyzer to measure the frequency spectrum of transmitted signals and identify interference sources. A network analyzer characterizes the performance of antennas and RF components.

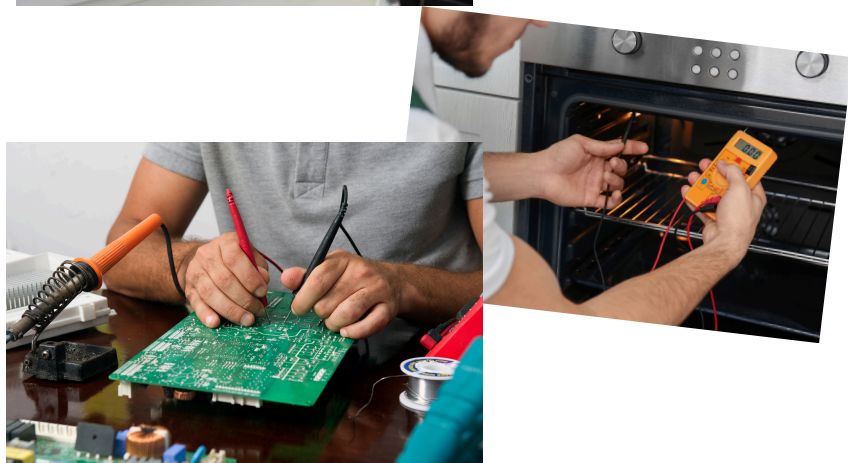
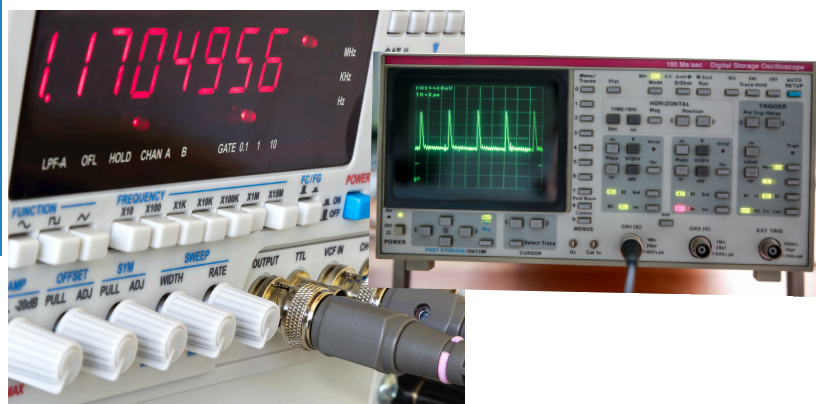
6. Quality Assurance Engineers

- Role: Ensure that products meet quality standards and specifications.
- Measurement Devices Used: Automated inspection systems, multimeters, functional testers.
- Example: A quality assurance engineer uses automated inspection systems to perform visual inspections of PCBs to detect manufacturing defects. Multimeters verify electrical connections and component values on the final product to ensure compliance with quality standards.

7. Power Engineers

- Role: Design, operate, and maintain electrical power systems.
- Measurement Devices Used: Power quality analyzers, clamp meters, insulation resistance testers.
- Example: A power engineer uses a power quality analyzer to monitor and analyze the power supply quality in a manufacturing plant, identifying issues such as voltage sags, swells, and harmonic distortions. A clamp meter measures the current flow in large conductors without interrupting the circuit.

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