DESIGN, CONSTRUCTION AND PERFORMANCE EVALUATION OF A NON-CONTACT AC VOLTAGE DETECTOR

By

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THIS FINAL YEAR PROJECT REPORT IS SUBMITTED TO THE DEPARTMENT OF PHYSICS IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF THE DEGREE OF BACHELOR OF SCIENCE AND EDUCATION OF BUSITEMA UNIVERSITY.

MAY, 2026

Declaration

I, **Mande Emmanuel,** do declare that this project report is my original work and has not been submitted to any other institution of higher learning for any academic award.

Signature: ..... Date: 4th June 2026

Mande Emmanuel

BU/UP/2023/0821

Approval

This is to certify that this research project report by **Mande Emmanuel** (BU/UP/2023/0821), was carried out under my supervision and is now ready for submission to the Department of Physics, Busitema University, for examination.

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Signature.....

Date.....04/06/2026.....

Dedication

This work is dedicated to my beloved parents, Mr. Adyema Simon and Mrs. Chemutai Judith, for their unwavering support, sacrifices, and encouragement throughout my academic journey. I pray that the good Lord always grants your heart's desires and may He increase your faith, love and hope in Him in your old age

Acknowledgement

I would like to express my sincere gratitude to the Almighty God for granting me good health, wisdom, and strength throughout the course of this project. I extend my deepest appreciation to my supervisor, Dr. Richard Cliffe Ssenyunzi, for his invaluable guidance, support, and constructive advice during the entire research process. I am also grateful to my family members for their spiritual, moral, and financial support throughout my studies.

Special thanks go to my friends and colleagues for their encouragement, cooperation, and the useful ideas they contributed, which greatly supported the completion of this project.

Abstract

This study presents the design and construction of a non-contact AC detector capable of identifying live conductors without physical contact. The device operates on the principle of electromagnetic induction whereby a varying electric field around an energized conductor induces a small signal in a sensing probe. The induced signal is amplified using a transistor-based circuit to activate visual and audio indicators (LED and buzzer). The detector was constructed using discrete components and tested at various distances from AC conductors within the range of 110–220 V. Experimental results showed that the device successfully detected AC voltage up to 14 cm with output voltage ranging from 0.03 V to 0.24 V from a live Ac carrying conductor demonstrating its usefulness as a low-cost safety tool for electrical maintenance.

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List of acronyms

AC: Alternating Current

BJT: Light Emitting Diode

BJT: Bipolar Junction Transistor

FET: Field Effect Transistor

CHAPTER ONE: INTRODUCTION

1.0 Introduction

This study focuses on the design, construction, and testing of a non-contact AC voltage detector capable of identifying live electrical conductors without physical contact. The development of such devices is essential for improving safety and efficiency in electrical systems. This chapter presents the background to the study, problem statement, aim and objectives, as well as the scope and significance of the study.

1.1 Background of the Study

The detection of alternating current (AC) in electrical conductors is an important practice in electrical installation, maintenance, and safety verification. Electrical wiring systems in residential, industrial, and laboratory environments often develop faults such as broken conductors, loose connections, or insulation deterioration. These faults can interrupt current flow and create hazardous conditions including electric shock, equipment damage, and electrical fires if not identified early (Mullen & Wade, 2020 ; Zhou et al., 2024)

Traditionally, electricians used direct-contact devices such as test lamps, neon testers, and digital Multimeters to determine the presence of voltage. Although these instruments provide accurate measurements, they require physical contact with the conductor, which may expose technicians to electrical hazards. Advances in semiconductor electronics have led to the development of non-contact AC detectors that allow the presence of voltage to be identified without touching the conductor, thereby improving operational safety (Hayes, 2015; Zhou et al., 2024)

The operation of a non-contact AC detector is based on electromagnetic principles. When an alternating voltage is applied to a conductor, it produces a varying electric field around the wire. This field can induce a small signal in a nearby sensing probe through capacitive coupling. The weak signal is then amplified using electronic components such as transistors until it activates an indicator like a light-emitting diode (Floyd, 2022) .

Therefore, designing and constructing a non-contact AC detector provides an effective approach to improving electrical safety while also offering practical learning opportunities

in electronic circuit design. Non-contact AC detectors are widely used by electricians, technicians, and laboratory personnel to identify live conductors safely during installation and maintenance of electrical systems.

1.2 Problem statement

The widespread use of alternating current (AC) electrical systems in residential, laboratory, and industrial environments exposes technicians and users to potential electrical hazards. Conventional voltage detection methods, such as multimeters, test lamps, and voltage probes, require direct contact with electrical conductors, thereby increasing the risk of electric shock and equipment damage. Although non-contact voltage detectors provide a safer alternative, many commercially available devices are relatively expensive and not readily accessible for educational and low-cost applications. In addition, there is limited availability of locally developed systems that demonstrate the practical implementation of non-contact voltage detection principles. Therefore, there is a need to design, construct, and evaluate a cost-effective non-contact AC voltage detector that can safely identify live electrical conductors without physical contact, while also serving as a practical tool for learning and application in electrical and electronic systems.

1.3 Aim of the study

To design, construct, and test a non-contact AC Voltage detector capable of identifying live electrical conductors without physical contact.

1.4 Specific objectives

a) To design a transistor-based non-contact AC detection circuit.
b) To construct the detector using discrete electronic components.
c) To integrate visual (LED) and audible (buzzer) indicators.
d) To evaluate the detector’s sensitivity and performance at different distances from a live conductor.
e) To analyze the relationship between distance and the induced signal parameters (output voltage and current).

1.5 Purpose of the study

The purpose of this study is to develop a safe, cost-effective, and practical method for detecting live electrical conductors without physical contact. The study aims to enhance electrical safety during installation, maintenance, and troubleshooting by reducing the risk of electric shock associated with direct-contact voltage detection methods.

1.6 Scope of the study

This study focuses on the design and construction of a cost-effective non-contact AC voltage detector using discrete electronic components. The device is designed to detect alternating current in conductors within the voltage range of 110 V to 220 V. The study involves the design of the detection circuit, construction of the prototype, and experimental evaluation of the detector's performance. Performance is assessed based on sensitivity, output response, and detection distance from a live conductor. All experimental work was conducted in the Physics Laboratory at Busitema University, Nagongera Campus. The study is limited to low-voltage AC detection and does not cover high-voltage or industrial-scale applications.

CHAPTER 2: LITERATURE REVIEW

2.0 Introduction

This section takes a survey of related works, research gaps and theoretical foundation of non-contact AC voltage detectors

2.1.0 Review of related studies.

Li. et.al (2011) developed a non-contact AC voltage detection system based on the electric field sensing principle. When alternating current flows through a conductor, a time-varying electric field is produced around it, which induces a small voltage signal in a nearby sensing probe without direct contact. In this design, a Field Effect Transistor (FET) sensor was used to detect variations in the electric field surrounding energized conductors. The induced signal was amplified and processed to produce a measurable output indicating the presence of voltage. Results obtained showed that the system could reliably identify live conductors while maintaining complete electrical isolation from the power source. However, the system exhibited low sensitivity in weak electric field conditions and required improved signal amplification and noise filtering for better performance.

Wei et al. (2011) investigated capacitive electric-field coupling for non-contact voltage detection. The electric field produced by an energized conductor interacts with a nearby sensing electrode through capacitive coupling, thereby inducing a voltage proportional to the field intensity. Experimental results showed that the sensing probe could effectively detect alternating voltage under controlled laboratory conditions. J. Wang et al., (2013) Similarly confirmed that capacitive sensing improves detection capability compared to earlier electric-field methods. However, Zhou et al., (2024) noted that system accuracy is affected by factors such as probe distance, insulation thickness, and electromagnetic interference. It was therefore suggested that shielding and calibration techniques be incorporated to improve performance in practical environments.

Gujja, (2016) designed and analyzed a digital electric field strength detector for sensing electromagnetic fields generated by AC electrical systems. Energized conductors were observed to produce weak electric and electromagnetic fields which induce signals in nearby detection circuits. Amplification stages and signal conditioning units were

incorporated to process these signals and determine the presence of electrical energy. Experimental results showed that the detector could successfully identify energized conductors without direct contact. Patel & Gopi,(2015) emphasized the role of digital signal processing in improving detection accuracy, while Zhou et al., (2024) highlighted the importance of proper circuit design in minimizing noise interference. However, increased system complexity resulted in higher power consumption and cost, thus the need for low-power optimized designs was recommended.

G. Wang et al.,(2015) proposed a MEMS-based electric field sensor for non-contact voltage detection, particularly for high-voltage transmission lines. The system utilized micro-electromechanical sensors to measure electric field intensity with high sensitivity and precision and determined the presence of voltage by comparing the measured field strength with a predefined threshold. Experimental findings showed that electric field strengths of approximately 25 kV/m could be detected near ultra-high-voltage transmission lines. G. Wang et al.(2017) and Oh et al. (2018) also reported improved accuracy and reliability using MEMS technology. Despite these advantages, high fabrication complexity and cost limit their application in low-cost systems, hence the need for simplified and cost-effective designs.

Tan et al., (2023) developed a non-contact AC voltage sensor based on capacitive electric-field coupling principles. The sensing structure was modeled as a capacitive voltage divider to establish a relationship between electric field strength and the induced signal. Experimental testing showed that the sensor achieved an error margin of less than ±3%, indicating high accuracy and reliability. J. Wang et al., (2013) also reported improvements in sensitivity and signal processing techniques. However, environmental factors such as electromagnetic interference and sensor positioning were found to affect system performance. It was therefore recommended that advanced filtering and calibration techniques be incorporated to enhance reliability. Overall, capacitive electric-field coupling remains one of the most effective approaches for modern non-contact voltage detection systems.

Despite the advancements in non-contact voltage detection technologies, there remains a need for simple, low-cost, and portable detection systems that can be easily constructed

using basic electronic components. Therefore, this project aims to design and construct a simple non-contact AC voltage detector using transistors, resistors, an LED, and a buzzer, providing a practical and affordable solution for detecting live electrical conductors in laboratory and educational environments.

2.2.0 Theoretical foundation

2.2.1 AC Signal Induction

Signal induction is a fundamental electromagnetic principle that enables the detection of alternating current (AC) without direct electrical contact with the conductor. When an AC voltage is applied to a conductor, the current flowing through the wire varies continuously with time, typically at frequencies of 50 Hz or 60 Hz in power distribution systems. This time-varying current produces a changing electromagnetic field around the conductor. When a sensing probe is brought near this field, a small electrical signal is induced in the sensing element due to electromagnetic interaction. This induced signal can then be amplified and used to activate indicators such as a light emitting diode (LED) or buzzer in a non-contact AC detector.

2.2.2 Alternating Current and Time-Varying Fields

In an AC system, voltage and current vary sinusoidaly with time. The instantaneous voltage in an AC circuit can be represented as:

$$V(t) = V_{Max} \sin(2\pi ft) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 2.1$$

Where:

V(t) = instantaneous voltage

V_{Max} = maximum (peak) voltage

f = frequency of the AC supply

t = time

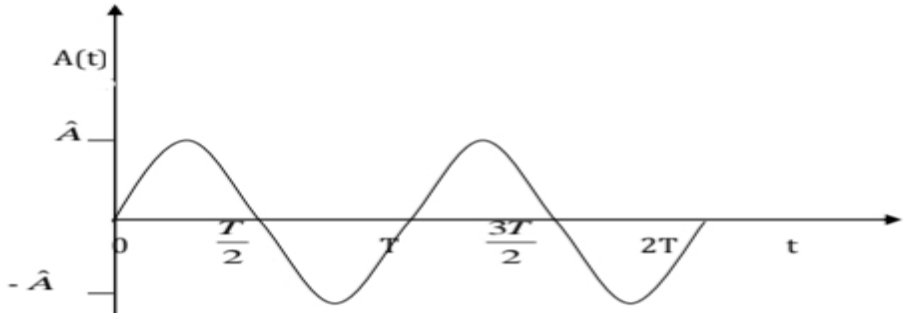


Figure 2. 1: Sinusoidal wave signal

The alternating nature of voltage produces a surrounding electric field that expands and collapses continuously with time. This varying field extends into the space around the conductor and becomes the basis for non-contact detection.

2.2.3 Factors Affecting Signal Induction.

The magnitude of the induced signal in a non-contact AC detector depends on several important parameters:

The magnitude of the AC voltage in the conductor.

The distance between the sensing probe and the live wire.

The frequency of the alternating current supply.

Environmental electrical noise and nearby conductive materials

2.2.4 Bipolar Junction Transistor (BJT) Structure

The BJT is constructed with three doped semiconductor regions separated by two PN junctions. The three regions are called emitter, base, and Collector the PN junction joining the base region and the emitter region is called the base-emitter junction. The PN junction joining the base region and the collector region is called the base-collector junction. A wire lead connects to each of the three regions. These leads are labeled E for emitter, B for base and C for collector. The base region is lightly doped and very thin compared to the heavily doped emitter and the moderately doped collector regions

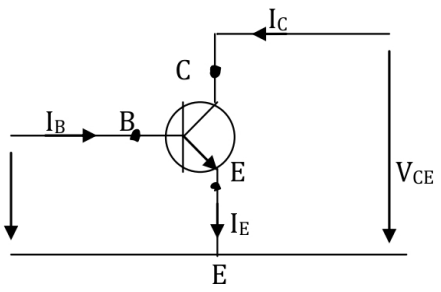


Figure 2. 2: BJT Structure

The current I_B entering the base is called the base current. The current I_C entering the collector is called the collector current, and I_E is the emitter current. The potential difference VBE between the base and the emitter is called the base-emitter voltage, and V_{CE} is the collector-emitter voltage.

For a BJT to operate properly as an amplifier, the two PN junctions must be correctly biased with external dc voltages. The base-emitter V_{BE} junction is forward-biased and the base-collector V_{BC} junction is reverse-bias

2.2.5 Regions of BJT operation

Cut-off region:

The transistor is off. There is no conduction between the collector and the emitter (I_B = 0, therefore, I_C = 0). It implies that no signal is detected.

Active region:

The transistor is on. The collector current is proportional to and controlled by the base current.

i.e. $I_C \propto I_B$

$$I_C = \beta I_B \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 2.1$$

And relatively insensitive toV_{CE}. In this region, the transistor can be an amplifier.

Saturation region:

The transistor is on. The Collector current varies little with a change in the base current in the saturation region. The V_{CE} is small, a few tenths of volts. The collector current is

strongly dependent on V_{CE} unlike in the active region. It is desirable to operate transistor switches in or near the saturation region when in them on state.

Basic equations of BJT

For NPN $V_B > V_E + 0.6V$

For PNP $V_B < V_E - 0.6V$

For both NPN and PNP anytime $I_E = I_B + I_C$ ……. 2.2

For both NPN and PNP only in the active region, $I_C \propto I_B$

$$I_C = h_{fE} I_B = \beta I_B \text{ ……. 2.3}$$

Where β is the DC current gain of the device

Substituting equation **2.1** into **equation 2.2**

$$\therefore I_E = I_B + \beta I_B \text{……2.4}$$

$$I_E = (1 + \beta) I_B \approx \beta I_B$$

($\beta \approx 100$ *unless otherwise specialized*)

Also, the current gain from the Emitter to the Collector terminal i.e. $\alpha = \frac{I_C}{I_E}$

Since $I_E = I_B + I_C$ $V_{CE} = V_{CB} + V_{BE}$

The multi-stage transistor configuration in the non-contact ac voltage detector provides sufficient amplification of the weak signals

CHAPTER 3: MATERIALS AND METHODS

3.1 Introduction

This section mainly involves description of components, mathematical modeling, operation units and the design procedures.

3.2 Materials

- B547 transistors
- Green led bulb
- 3.7 V source
- inductor
- 100k Ω,10k Ω and 100 Ω resistors
- Buzzer and
- switch.

Transistor

A transistor is an electronic component that is used in circuits to either amplify or switch electrical signals or power, allowing it to be used in a wide array of electronic devices. A transistor consists of two PN diodes connected back-to-back. It has three terminals namely emitter, base and collector

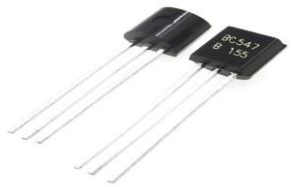


Figure 3. 1: Transistor

Resistor

A resistor is an electrical component that limits or regulates the flow of electrical current in an electronic circuit. Resistors can also be used to provide a specific voltage for an active device such as a transistor



Figure 3. 2: Resistor

Buzzer

An electric signaling device that makes a buzzing sound. It can convert audio signals into sound signals. It is widely used on alarms, computers, printers and other electronic products as sound devices.



Figure 3. 3: Buzzer

LED

A light-emitting diode (LED) is a semiconductor device that emits light when an electric current flows through it



Figure 3. 4: LED

Battery

A battery is an electrochemical device consisting of one or more cells that convert stored chemical energy into electrical energy.



Figure 3. 5: Battery

Inductor Coil

An inductor is a passive electrical component that opposes sudden changes in current. They slow down current surges by temporarily storing energy in an electro-magnetic field and then releasing it back into the circuit.



Figure 3. 6: Inductor Coil

3.3 Organization of components

The design and performance evaluation of this Non-contact AC voltage detector included an antenna (inductor coil), NPN transistors (BC547), resistors (100k Ω,10k Ω and 100 Ω), and an LED, and a 3.7V DC battery. The circuit was constructed on a compact breadboard, with components fitted to ensure portability and sensitivity to electromagnetic fields. The antenna was positioned to capture the stray electric field from live AC wires, while the transistors were arranged in a high-gain Darlington pair configuration to amplify the minute signals. This setup ensures that the frame provides enough rigidity for the probe while maintaining high sensitivity.

The design of the non-contact AC voltage detector includes four basic units: The Detection Unit, the Amplification Unit, the output Indication Unit, and the Power Supply Unit. The Detection Unit includes an inductor or copper coil which is used for the initial detection of the electromagnetic field produced by AC current. The Amplification Unit, consisting of multiple transistors, converts the weak induced signal into a stronger current capable of driving the output. The block diagram describing the component and circuit arrangement of the system is shown below



Figure 3. 7: Block Diagram

Similarly, the output Unit distinguishes this detector from standard contact-based testers. This unit's use of an LED and a limiting resistor is responsible for providing a visual alert when voltage is detected.

3.4 component units

3.4.1 Power supply unit

The power supply unit consists of a 3.7V Lithium-ion DC. It provides the required biasing voltage for the three cascaded BC547 transistors, ensuring that the minuscule induced current from the sensing probe can be amplified to drive the LED and buzzer.

3.4.2 Detection unit

The sensing probe (inductor) detects the electric field surrounding a live AC conductor. A weak induced signal is generated at the base of the first transistor Q1.

3.4.3 Amplification unit

Three BC547 transistors are connected in a cascaded configuration to amplify the weak induced signal. The high-value resistor (100 kΩ) increases sensitivity by allowing small currents to influence the base of the transistor.

3.4.4 Output unit

The amplified signal drives an LED and buzzer connected to the collector of the final transistor Q3. When sufficient signal is detected, both indicators are activated.

3.5 Non-contact AC voltage detector circuit diagram

The circuit diagram in Figure **3.8** shows the schematic layout of the design. This enables proper circuit simulation to ensure a proper connection and reliable detection of live AC lines without physical contact.

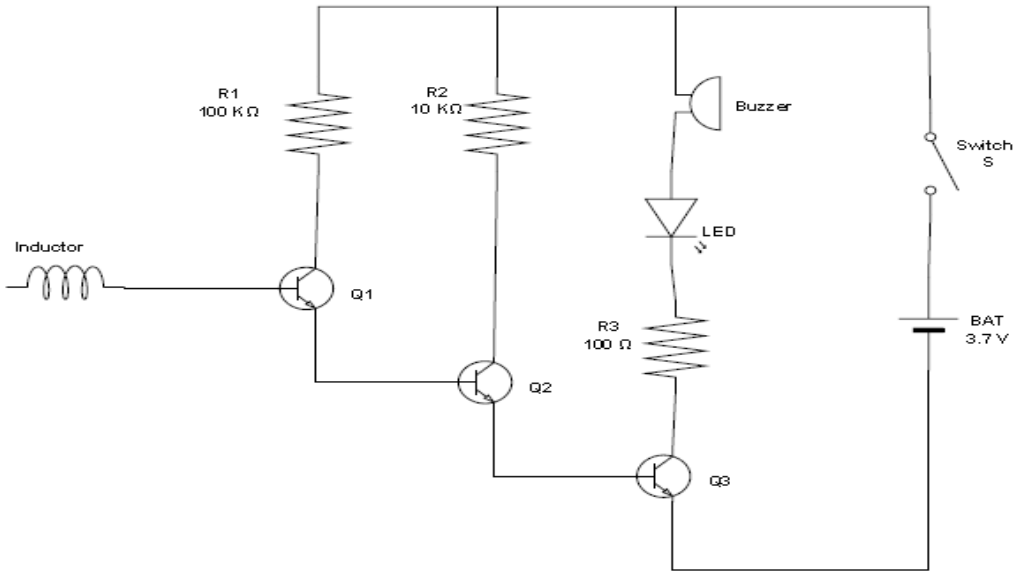


Figure 3.8: Non-contact AC voltage detector circuit diagram

3.5.1 Construction process

Step 1: The perforated hardboard is positioned on a flat stable platform to securely mount all components at ease**.**

Step 2: The B547 transistors Q_1, Q_2 and Q_3 are mounted on the perforated hardboard in cascaded form.

Step 3: 100kΩ and 10k Ω resistors are connected to the collectors of $Q_1$and Q_2 respectively and 100Ω resistor in series with LED and Buzzer are connected to the collector

of Q_3 .The high-value resistor (100kΩ) increases sensitivity by allowing detection of weak induced signals, while the multi-stage transistor configuration provides sufficient amplification

Step 4: The inductor is connected to the base of transistor Q_1

Step 5: Power source (3.7V) with the switch along the positive terminal to the positive of the buzzer is installed.

Step 6: The mounted components on perforated hardboard are fitted by soldering.

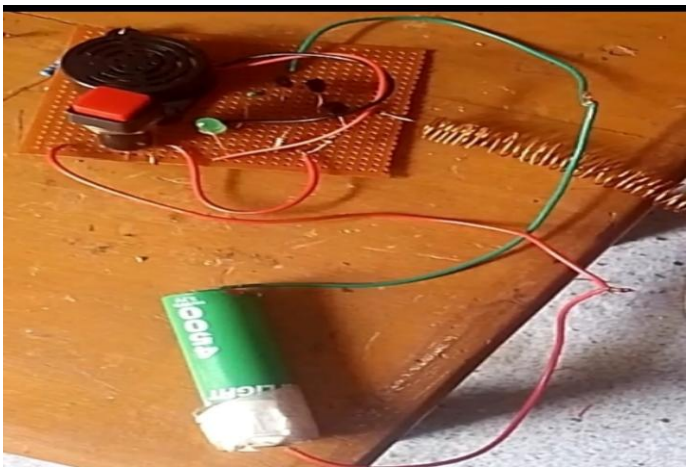


Figure 3.9: Constructed Non -Contact AC voltage Detector

3.5.2 Experimental Procedures

The following steps were undertaken to evaluate the performance and reliability of the non-contact AC detector:

a) The non-contact detector was positioned near the AC conductor under test.
b) The device was powered on, and the activation of both status indicators was verified to ensure system readiness.
c) The orientation and physical placement of the monitored wire were systematically varied. This was done to investigate the detector's ability to maintain consistent sensitivity and functional stability under different conditions.

3.6 Circuit Analysis and Amplification Mechanism

The non-contact AC voltage detector operated based on the electric field produced around an energized conductor. When an alternating voltage was applied to a conductor, a time-varying electric field was established around it. This field induced a small voltage in the sensing probe through capacitive coupling.

The induced voltage IS directly proportional to the electric field strength;

$$V_{in} \propto \mathbf{E} \quad \text{..... (3.1)}$$

Since the electric field around a conductor depended on the applied voltage and the distance from the conductor;

$$\mathbf{E} \propto \frac{V_a}{d} \quad \text{..... (3.2)}$$

Combining equations (3.1) and (3.2) results into;

$$V_{in} \propto \frac{V_a}{d} \quad \text{.....(3.3)}$$

This implied that the induced voltage increases as the sensing probe approaches the energized conductor.

3.6.1 Voltage Gain and multi-stage Amplification

The induced signal was very weak and required amplification. The voltage gain of a single amplifier stage is defined as;

$$A_V = V_{out} / V_{in} \quad \text{..... (3.4)}$$

To achieve sufficient amplification, multiple transistor stages were connected in cascade. Hence, the total gain was given by;

$$A_T = A_1 \times A_2 \times A_3 \quad \text{..... (3.5)}$$

since the three stages had equal gain;

$$A_T = (A_V)^3 \quad \text{..... (3.6)}$$

Therefore, the output voltage became;

$$V_{out} = A_T \times V_{in}$$ ..... (3.7)

This showed that a very small, induced voltage was amplified to a measurable level.

3.6.2 Current Gain (β) and Signal Amplification

The transistor also amplified current according to;

$$I_C = \beta I_B$$ ..... (3.8)

Where $I_E = I_C + I_B$

Since the base current is very small; $I_E \approx I_C$

For cascaded transistor stages, the current gain becomes;

$$I_{out} \approx (\beta)^3 \times I_{in}$$ ..... (3.9)

This enabled very small input currents to be amplified sufficiently to drive output devices. That's to say the LED and Buzzer

3.6.3 Transistor Biasing and Switching Condition

For proper operation of the transistor, the base-emitter junction is forward biased;

i.e. $V_{BE} \approx 0.7$ V

For the transistor to operate in the active region, $V_{CE} > V_{BE}$

When the amplified signal reaches a sufficient level ($V_{out} \geq 0.7$ V), the transistor is switched ON, allowing collector current to flow and activating the output stage.

The power delivered to the output components was given by;

$$P = VI$$ ..... (3.10)

For the light-emitting diode (LED);

$$P_{LED} = V_{LED} \times I_{LED}$$ ..... (3.11)

For the buzzer;

$$P_{BZ1} = V \times I \quad \text{..... (3.12)}$$

These relationships (Equations 3.1 -3.12) formed the basis for the design and construction of the circuit, ensuring effective detection, amplification, and indication of AC voltage without direct contact.

CHAPTER 4: RESULTS AND DISCUSSION

4.0 Introduction

This chapter explores the process through which the measurements were conducted and the analysis of the results.

4.1 Presentation of results

Measurements were taken at the input stage of the circuit to evaluate the magnitude of the induced signal before amplification. This was necessary to confirm the effectiveness of the sensing mechanism. However, the activation of the LED and buzzer depends on the amplified signal at the final stage, which exceeds the transistor threshold voltage of approximately 0.7 V.

Although the measured voltages were below 0.7 V, the multi-stage transistor amplifier increased the signal to a level sufficient to drive the LED and buzzer.

Table 4.1: showing the variation of distance against the signal voltage output

Distance (cm)	Voltage output (V)
14.0	0.03
12.0	0.05
10.0	0.07
8.0	0.12
6.0	0.18
4.0	0.21
2.0	0.24

Table 4.2: showing the variation of distance against current output

Distance (cm)	Current output (mA)
14.0	0.36
12.0	0.61
10.0	0.87
8.0	1.21
6.0	1.77
4.0	2.20
2.0	2.56

Table 4.3: LED and Buzzer response against distance

Distance from the wire (cm)	LED response	Buzzer response	Response strength
2 – 6	ON	ON	strong
10 - 14.6	ON	ON	Weak
>14.6	OFF	OFF	OFF

Graphical representation of results

The graphs were extracted using XSS tool

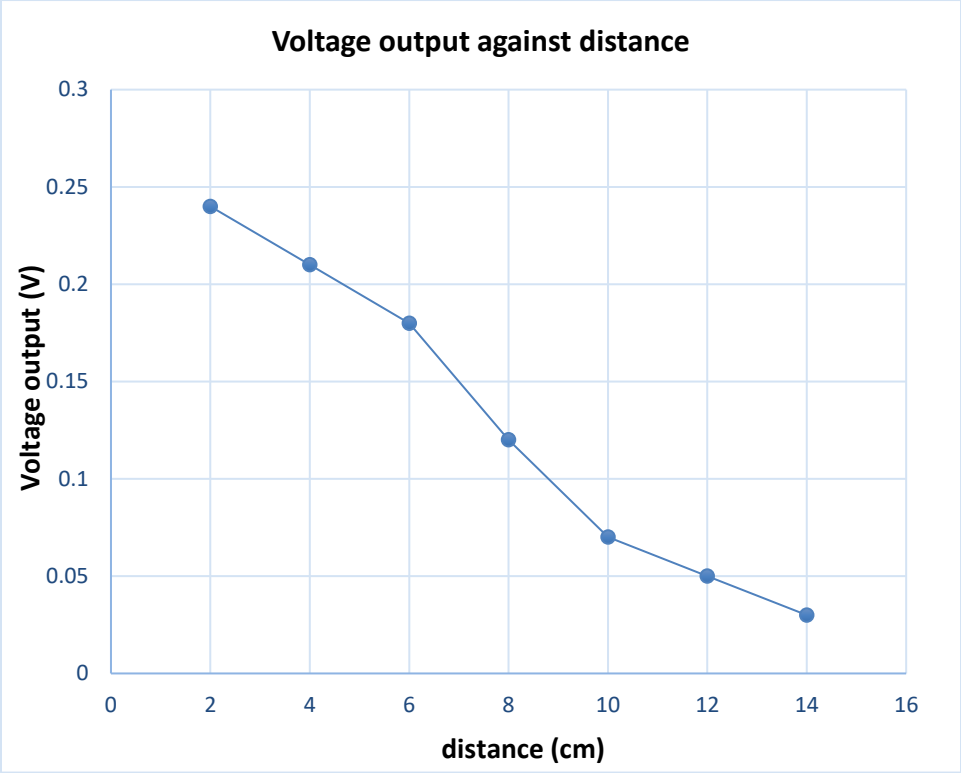


Figure 4.1: variation of distance with Voltage output

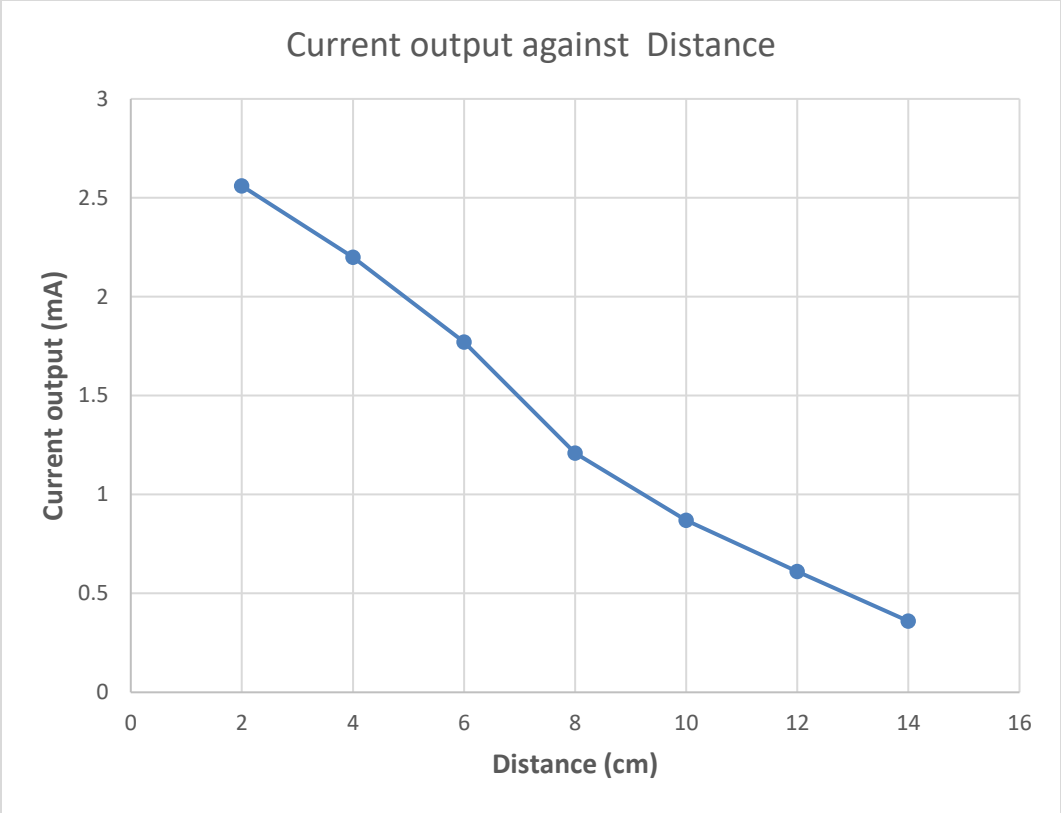


Figure 4.2: variation of current output with distance

4.2 Discussion of results.

The results obtained demonstrate that the non-contact AC detector successfully detects the presence of alternating current without physical contact. The output voltage and current were observed to increase as the distance between the detector and the live conductor decreased.

From **Table 4.1**, the output voltage increased from 0.03 V at 14 cm to 0.24 V at 2 cm. Similarly, Table 4.2 shows that the output current increased from 0.36 mA to 2.56 mA over the same distance range. This indicates a clear inverse relationship between distance and signal strength.

This behavior can be explained by the principle of capacitive coupling. As the detector moves closer to the conductor, the strength of the electric field interacting with the sensing probe increases, resulting in a stronger induced signal. Consequently, both the voltage and current outputs increase.

The results also confirm that the detector is more sensitive at shorter distances, where the electric field is strongest. At larger distances, the signal becomes weaker, which may limit detection capability. This explains why the device performs best within close proximity to the conductor.

Additionally, the consistent increase in both voltage and current suggests that the amplification stage using transistors is functioning effectively. The transistor configuration successfully amplifies the weak induced signal to a measurable level capable of activating the LED and buzzer.

However, slight limitations arise due to environmental interference, insulation thickness, and orientation of the detector. These factors can affect the strength of the induced signal and lead to variations in output.

The results confirm that the constructed device meets its intended purpose of detecting AC voltage safely and effectively, although its performance is dependent on distance and surrounding conditions.

CHAPTER 5: CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion.

This study successfully achieved its objective of designing, constructing, and testing a non-contact AC detector. The device was able to detect the presence of alternating current in electrical conductors without physical contact, thereby enhancing user safety.

The detector operated based on capacitive coupling, where a time-varying electric field around a live conductor induced a small signal in the sensing probe. This signal was effectively amplified using a transistor-based circuit to produce a measurable output in the form of voltage, current, and activation of visual and audio indicators. The observed results are consistent with findings by Zhang et al. (2012), who reported that induced signal strength decreases with distance due to reduced electric field intensity.

The successful amplification of weak signals in this study confirms that transistor-based systems can provide a viable alternative to more complex detection circuits. Experimental results showed that the detector's output voltage and current increased as the distance between the detector and the conductor decreased. The device demonstrated reliable performance within short distances, confirming its effectiveness as a practical tool for electrical safety and fault detection.

Although the detector is limited by distance and environmental factors, it provides a simple, low-cost, and efficient solution for identifying live conductors in laboratory and maintenance environments.

5.2 Recommendations

For better results in the study;

Future designs should incorporate operational amplifiers to enhance signal amplification and extend detection range, Shielding and filtering techniques should be introduced to minimize the effects of external electromagnetic interference, The use of integrated circuits or microcontrollers can improve accuracy and provide more stable output readings, The detector should be enclosed in a well-insulated casing to improve

durability and user safety. Additional tests should be conducted under varying environmental conditions, different voltage levels, and different conductor types.

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