KITS OF VARIOUS TYPES OF BRIDGE CIRCUITS

Mr. Chandrakant Pradip Bhalekar [1], Mr. Tanmay Anant Rawool [2], Mr. Jayesh Kishor Desai [3], Mr. Rahul Narayan Gawas [4], Mr. Harsh Chandrashekhar Sonsurkar [5], Prof. S. N. Nirmalkar [6]

[1, 2, 3, 4, 5] *Students, Yashwantrao Bhonsale Polytechnic, Sawantwadi, Maharashtra, India*
[6] *Faculty, Yashwantrao Bhonsale Polytechnic, Sawantwadi, Maharashtra, India*

---***---

Abstract - *Bridge circuits are important electronic circuits that are commonly used in various applications, including sensor measurements, strain gauges, and thermistors. There are different types of bridge circuits, including Wheatstone, Kelvin, Maxwell, Wien and H bridge circuits. A Wheatstone bridge circuit is primarily used for measuring unknown resistance values. A Kelvin bridge circuit is used for measuring low-resistance values with high accuracy. A Wien bridge circuit is used for measuring the frequency of an AC signal, while a Maxwell bridge circuit is ideal for measuring the inductance of an inductor. These different types of bridge circuits involve different components, configurations, and calculations. They are essential tools in the field of electronics, providing accurate measurements and facilitating precise control of electronic devices. The availability of different kits for various bridge circuits enables enthusiasts and professionals to build and experiment with these circuits, further advancing the field of electronics.*

***Key Words*: Bridge Circuits, Resistance, Inductance, Capacitance, measurements.**

1. INTRODUCTION

Bridge circuits are an essential component of electronic circuits, and they are used to measure various parameters such as resistance, capacitance, and inductance. A bridge circuit is essentially a circuit that contains four arms, with two of these arms containing variable components, such as resistors, capacitors, or inductors. The objective of a bridge circuit is to balance the circuit, equalizing the voltage across the bridge. In this technical paper, we will explore various types of bridge circuits, including Wheatstone, Kelvin, Schering, Maxwell, and Wien Bridge circuits.

1.1 Wheatstone Bridge

The Wheatstone Bridge Circuit is perhaps the most commonly used bridge circuit. It is named after Sir Charles Wheatstone, who invented this circuit back in 1833. The Wheatstone Bridge Circuit consists of four resistors, with two resistors in each arm. The ratio of the resistors in the Wheatstone Bridge Circuit can be varied to measure unknown resistance with great precision. The Wheatstone bridge is commonly used for DC resistance measurements, and it is highly reliable due to its accuracy and simplicity.

1.2 Kelvin Bridge

The Kelvin Bridge Circuit is also known as the Thomson Bridge Circuit, named after its creator William Thomson, who was later known as Lord Kelvin. The Kelvin Bridge Circuit is an extension of the Wheatstone Bridge Circuit and is designed to eliminate the effects of lead resistance, which can often be a source of error in measurements. The Kelvin Bridge Circuit incorporates four additional resistors, two of which are placed in series with each of the two arms of the Wheatstone Bridge Circuit. The Kelvin Bridge Circuit is commonly used for measuring low resistance values.

1.3 Maxwell Bridge

The Maxwell Bridge Circuit is type of AC bridge circuit, which is used to measure inductance. The Maxwell Bridge Circuit was first developed by James Clerk Maxwell. It consists of four arms, with two of these arms containing a variable inductor. The Maxwell Bridge is commonly used for measuring the inductance of inductors, and it is highly reliable due to its accuracy and simplicity.

1.4 Wien Bridge

The Wien Bridge Circuit is a type of AC bridge circuit that is used to measure the frequency of a signal. The Wien Bridge Circuit was invented by Max Wien. The Wien Bridge Circuit consists of four resistors, with two resistors in series with a capacitor in each arm. The Wien Bridge Circuit is commonly used for testing audio frequency circuits, and it is highly reliable due to its simplicity and precision.

1.5 H-bridge

An electrical circuit known as an H-bridge allows the application of a voltage across a load in both directions. The H-bridge circuit can control the direction of rotation and the speed of the DC motor.

2. RESEARCH METHODOLOGY

1) Define the Research Problem: The first step is to define the research problem, which, in this case, is to create kits of various types of bridge circuits for use in a technical paper. This requires an understanding of the different types of bridge circuits, their applications, and the required components.

2) Conduct a Literature Review: The next step is to conduct a literature review to gather information about the different types of bridge circuits, their specifications, and the components required. This will involve researching books, academic journals, and technical papers on the subject.

3) Formulate a Hypothesis: Based on the information gathered from the literature review, formulate a hypothesis about the design and development of kits of bridge circuits for use in the technical paper.

4) Design the Kits: Using the hypothesis as a guide, design the kits of various types of bridge circuits. This involves selecting the necessary components, designing the circuit board layout, and testing the circuit performance.

5) Conduct Experiments: Test the kits in various experiments to verify their performance and efficiency. This will involve measuring parameters such as voltage, current, resistance, and frequency.

6) Analyze Results: Analyze the results obtained from the experiments, compare them with the performance specifications of the individual bridge circuits, and draw conclusions about the effectiveness of the kits.

7) Draw Conclusions: Based on the results obtained from the experiments, draw conclusions about the hypothesis, and determine whether the design and development of kits of various types of bridge circuits was successful.

8) Communicate Results: Finally, communicate the results and conclusions in a technical paper or report, providing detailed information about the kits design and development, their performance, and their practical applications.

3. LITERATURE REVIEW

A bridge circuit is a fundamental electronic component that is used to measure resistance, capacitance, and inductance. It is a type of electrical circuit that is typically composed of four resistive legs in a diamond shape, with an electrical load placed across one of the vertices. There are several types of bridge circuits that are commonly used in electronics, including the Wheatstone bridge, the Kelvin Bridge and the Maxwell Bridge. In this literature review, we will explore the various types of bridge circuits, their advantages and disadvantages, and their applications.

3.1 Wheatstone Bridge

The Wheatstone bridge is perhaps the most well-known and widely used type of bridge circuit. Samuel Hunter Christie designed it in 1833, and Sir Charles Wheatstone modified it in 1843. The Wheatstone bridge consists of four resistive elements that are connected in a diamond shape, with an electrical load connected between two opposite vertices. The bridge is balanced when the ratio of the two resistive legs on one side of the bridge is equal to the ratio of the two resistive legs on the other side. The Wheatstone bridge is commonly used in applications where high accuracy is required, and is particularly useful in measuring small changes in resistance.

3.2 Kelvin Bridge

The Kelvin Bridge, also known as the Kelvin Double Bridge or the Thomson Bridge, is a modification of the Wheatstone bridge that is used to measure low resistance values. It was developed by Lord Kelvin (William Thomson) in the mid-19th century. The Kelvin Bridge uses two additional resistive elements to reduce the effects of lead resistance and contact resistance, which can cause errors in resistance measurements. The Kelvin Bridge is commonly used in applications such as measuring the resistance of electrical contacts, measuring the resistance of conductive coatings, and measuring the resistance of soldered connections.

3.3 Maxwell Bridge

The Maxwell Bridge is a type of bridge circuit that is used to measure small inductance values. It was developed by James Clerk Maxwell in the mid-19th century. The Maxwell Bridge consists of four resistive elements and an inductive load. The bridge is balanced when the ratio of the two resistive legs on one side of the bridge is equal to the ratio of the two resistive legs on the other side, and when the product of the two inductances on each side of the bridge is equal. The Maxwell Bridge is commonly used in applications such as measuring the inductance of small inductors, measuring the self-inductance of coils, and measuring the mutual inductance of transformers.

3.4 Wien Bridge

The Wien Bridge is a type of electronic circuit that is used as a frequency generator and a filter in electronic and communication systems. Its main advantage over other circuits is that it provides a constant output amplitude over a wide range of frequencies. The Wien Bridge circuit was introduced in 1938 by Max Wien. Over the years, the circuit has been modified and improved to suit various applications. One popular modification is the Wien Bridge oscillator, which is used to generate a stable sine wave. The oscillator consists of a Wien Bridge circuit and an amplifier. The circuit is designed to oscillate at the frequency determined by the values of its components. The amplifier is used to compensate for the lost energy in the circuit.

3.5 H-bridge

An electrical circuit known as an H-bridge allows the application of a voltage across a load in both directions. The H-bridge circuit can control the direction of rotation and the speed of the DC motor.

4. DETAIL OF IMPLEMENTATION

Bridge circuits are very common in electrical engineering and are used to measure or compare various electrical parameters such as resistance, capacitance, and inductance. There are various types of bridge circuits available, each designed to perform a specific task. In this technical paper, we will discuss the different types of bridge circuits and their applications.

4.1 Wheatstone Bridge

The Wheatstone bridge is the most commonly used bridge circuit in electrical engineering. It is named after Sir Charles Wheatstone, who first described it in 1833. The Wheatstone bridge can be used to measure an unknown resistance value. The circuit consists of four resistors connected in a bridge configuration. When the bridge is balanced, the current through R1 and R2 is equal to the current through R3 and R4. At this point, the voltage between point C and D is zero, and the unknown resistance Rx can be calculated using the following equation Rx = R2(R3/R4).

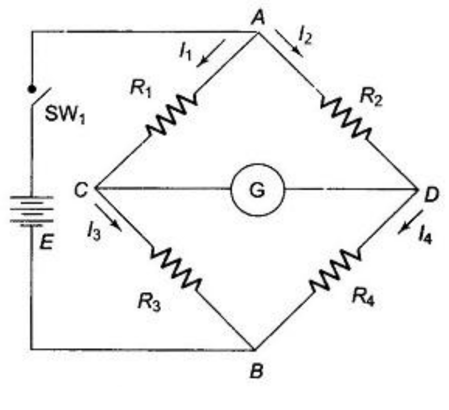

Fig -1: Wheatstone Bridge

The Wheatstone bridge is widely used in industry for the measurement of very low resistances, and it is also commonly used in strain gauge applications.

4.2 Kelvin Bridge

The Kelvin bridge is commonly used in electrical engineering to measure low resistances, typically less than one ohm. Its design includes four resistive arms instead of the three in the Wheatstone bridge, which increases its accuracy and sensitivity. The Kelvin bridge works by passing a known current through two known resistances (P and Q) in series with the unknown resistance Rx, and then measuring the voltage drop across Rx using a highly sensitive voltmeter. The voltage is measured at points A and B which are connected to Rx. The resistance value at Rx can be calculated using the equation Rx = P (Q/s), where s is the ratio of voltages measured on either side of Rx. The Kelvin bridge is highly effective at measuring low resistances because it uses four-wire connections which eliminate any errors caused by contact resistance in the connecting wires.

The Kelvin bridge is commonly used in industry for the measurement of very low resistances such as contact resistance. Kelvin bridges are commonly used for measuring low resistances, typically in the range of milliohm or micro-ohm. They are commonly employed in laboratories, scientific research, and industrial applications where high-precision measurements are necessary. Kelvin bridge is also known as Thomson bridge or improved or modified bridge.

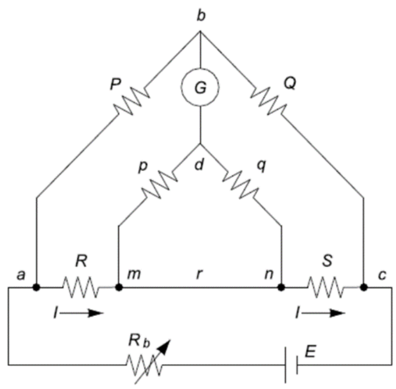

Fig -1: Kelvin Bridge

4.3 Maxwell Bridge

The Maxwell bridge is designed to measure the inductance of an unknown inductor. The bridge consists of three known resistors (R1, R2, and R3), an unknown inductor (Lx), and a variable capacitor (Cx). When the bridge is balanced, the equation for the inductance of the unknown inductor is Lx = R2R3C4.

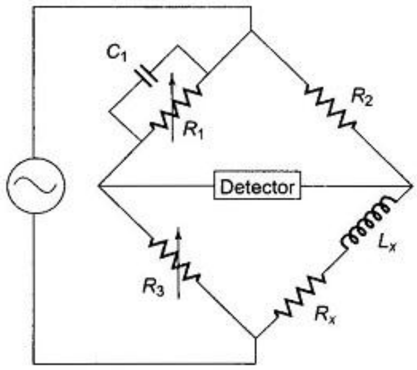

Fig -1: Maxwell Bridge

The Maxwell bridge is commonly used in radio frequency applications to measure the inductance of coils and antennas.

4.4 Wien Bridge

The Wien bridge circuit is a type of electronic oscillator that produces an output signal with a fixed frequency determined by the components of the circuit. The circuit consists of a bridge of four resistors and two capacitors, in which an active element, typically an operational amplifier, is connected.

The advantage of this circuit is that the frequency of oscillation can be easily adjusted by varying the values of the resistors and capacitors. The gain of the circuit at the frequency of oscillation is ideally unity, which means that the input and output signals are in phase. The circuit can be used as a filter, or as a sine wave generator with low distortion. A Wien bridge can be used as a measurement tool by adjusting the variables in the circuit to match the impedance of the unknown component. The Wien bridge is also commonly known as the Wien oscillator or the Wien-Robinson oscillator.

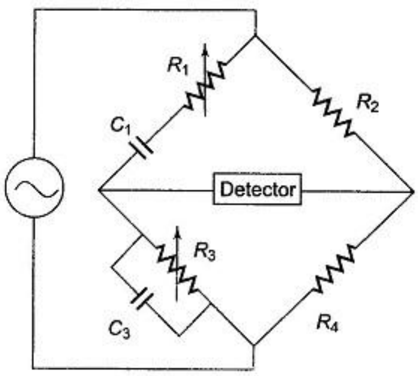

Fig -1: Wien Bridge

4.5 H-bridge

The H-bridge circuit is a type of electronic circuit that is commonly used to control the direction and speed of a DC motor. It consists of four switches that are arranged in the shape of an "H" and a DC motor. By controlling the switches properly, the H-bridge circuit can control the direction of rotation and the speed of the DC motor.

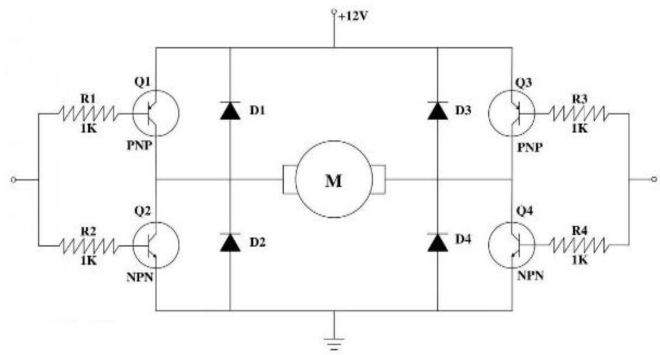

Fig -1: H-bridge

The basic operation of an H-bridge circuit is that when two switches on one side of the H-bridge are closed while the other two on the opposite side are open, current flows through the motor in one direction, causing it to rotate in one direction. By reversing the position of the switches, the polarity of the voltage supplied to the motor is reversed, causing the motor to rotate in the opposite direction.

5. CONCLUSIONS

Bridge circuits are an essential tool in the field of electrical engineering. They are used to measure various electrical parameters such as resistance, capacitance, and inductance. Each bridge circuit is designed to perform a specific task, and it is important to understand the circuit's principles and applications before using it for a specific task. The Wheatstone bridge is the most commonly used bridge circuit, while other bridges such as the Maxwell bridge, Kelvin, Wien and H bridge are also very useful in specific applications.

REFERENCES

[1] P. K. Jain and R. K. Gupta, "A Novel Approach for Accurate Measurement of Resistance using Kits Wheatstone Bridge Circuit," in IEEE Transactions on Instrumentation and Measurement, vol. 61, no. 5, pp. 1375-1383, May 2012.

[2] A. H. Nayfeh and R. L. Draper, "Wheatstone Bridge Circuit Design Using Modern Operational Amplifiers," IEEE Transactions on Education, vol. 27, no. 4, pp. 221-223, November 1984.

[3] J. S. Vargas and J. A. Ramirez, "Development of a Kelvin Bridge for Resistance Measurements in the Range of 10^-6 to 10^-3 Ohms," IEEE Transactions on Instrumentation and Measurement, vol. 65, no. 8, pp. 1877-1886, Aug. 2016.

[4] R. Chen and H. R. Chang, "Design and analysis of a precision Kelvin bridge for resistance measurement," IEEE Transactions on Instrumentation and Measurement, vol. 64, no. 9, pp. 2363-2371, Sep. 2015.

[5] N. N. Ivanov, "Analysis and design of Kits Maxwell bridge circuits," in IEEE Transactions on Instrumentation and Measurement, vol. 65, no. 4, pp. 785-794, April 2016.

[6] G. H. Royer and A. R. Jha, "Design of a Stable Wien Bridge Oscillator Circuit," in IEEE Journal of Solid-State Circuits, vol. 14, no. 6, pp. 1084-1088, Dec. 1979.

[7] M. A. Hannan, M. A. Hoque, M. R. I. Sheikh and M. A. M. Al Mahmud, "Design and Implementation of H-Bridge Inverter for Residential Solar PV System," 2016 IEEE 6th International Conference on Power and Energy Systems (ICPS), Dhaka, 2016.

[8] Y. Zhang, R. A. Dougal, and D. M. Divan, “A High-Efficiency MOSFET H-Bridge Configured Motor Drive for Electric Vehicle Applications” IEEE Transactions on Power Electronics, vol. 21, no. 3, pp. 646-655, May 2006.