

# Measurement of Unknown Inductance and Capacitance by A.C. Bridge

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**Abstract:** Alternating current bridge methods are of outstanding importance for measurement of electrical quantities. Measurement of inductance, capacitance, storage factor, loss factor may be made conveniently and accurately by employing a.c. bridge network. The purpose of this paper is to measure unknown inductance and capacitance by using single a.c. bridge with the help of switching network. The bridge is a combination of Maxwell's inductance capacitance bridge use to measure inductance of inductor and Schering bridge use for measurement of capacitance of capacitor. The methodology use for the measurement is to observe no sound from the detector i.e. making the bridge in balance condition and then applying the balance condition.

**Keywords:** Inductance, A.C. Bridge, Capacitance.

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## I. INTRODUCTION

The a.c. bridge is a natural outgrowth of the wheatstone bridge. An a.c. bridge, in its basic form, consists of four arms, a source of excitation, and a balance detector. In an a.c. bridge each of four arm is an impedance, and the battery and galvanometer are replaced by an a.c. source and a detector sensitive to small alternating potential difference.

The usefulness of a.c. bridge circuits is not restricted to the measurement of unknown impedances and associated parameters like inductance, capacitance, storage factor, dissipation factor etc. this circuits find other application in communication systems and complex electronic circuit. Alternating current bridge circuit are commonly used for phase shifting, providing feedback paths for oscillator and amplifier, filtering out undesirable signals and measuring the frequency of audio signals.

The purpose of selecting this project is the cost effectiveness, by combining the two bridges we are reducing the cost of case and components, The motive behind choosing the Maxwell's inductance capacitance bridge and Schering bridge for the manufacturing of this generalized a.c. bridge is the maximum number of common arms i.e. we directly get two common arms out of four arms.

## II. METHODOLOGY

### A. A.C. BRIDGES:

This paper mainly includes two bridges:

#### 1. Maxwell inductance capacitance bridge:

James Clerk Maxwell(13 June 1831- 5 November 1879) proposed Maxwell bridge (in long form, a Maxwell-Wien bridge) is a type of Wheatstone bridge used to measure an unknown inductance (usually of low Q value) in terms of calibrated resistance and capacitance. It is a real product bridge.

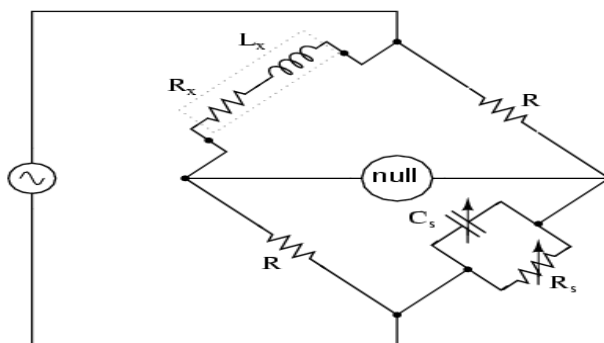


Fig. 1 : Maxwell's inductance capacitance bridge

To avoid the difficulties associated with determining the precise value of a variable capacitance, sometimes a fixed-value capacitor will be installed and more than one resistor will be made variable.

The additional complexity of using a Maxwell bridge over simpler bridge types is warranted in circumstances where either the mutual inductance between the load and the known bridge entities, or stray electromagnetic interference, distorts the measurement results. The capacitive reactance in the bridge will exactly oppose the inductive reactance of the load when the bridge is balanced, allowing the load's resistance and reactance to be reliably determined.

**2. Schering bridge:**

Harald Schering (November 25, 1880 - April 10, 1959) Schering is remembered for invention of the "Schering bridge", which is an AC bridge circuit used to measure capacitance and the dissipation factor of capacitors.

A Schering Bridge is a bridge circuit used for measuring an unknown electrical capacitance and its dissipation factor. The dissipation factor of a capacitor is the ratio of its resistance to its capacitive reactance. The Schering Bridge is basically a four-arm alternating-current (AC) bridge circuit whose measurement depends on balancing the loads on its arms.

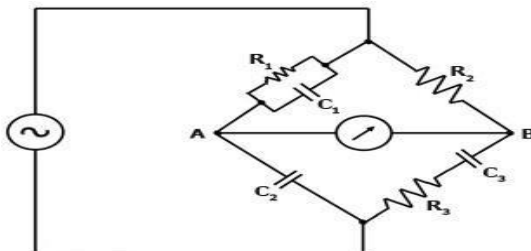


Fig 2. Schering bridge

**B. WORKING:**

The 230v supply is given to stepdown transformer, which stepdown supply voltage to 23v. then, this supply is fed to bridge rectifier which rectifies the supply in d.c. the output of bridge rectifier is given to voltage regulated IC (LM7815) which produce a fixed voltage of 15v d.c. now, this supply is fed to a.f oscillator which produces output at 10KHz supplied to a.c bridge.

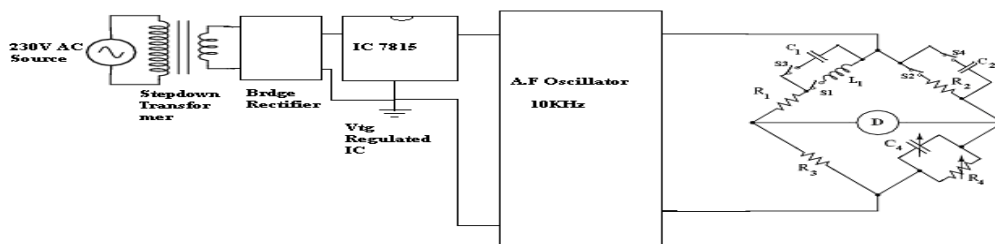
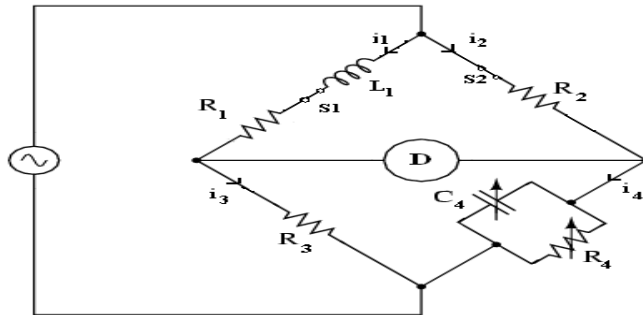


Fig. 3 Experimental setup

The working of a.c. bridge can be easily explain on the basis of two modes given as follows;

**Mode-1(Measurement of Inductance):**



**Fig. 4: Maxwell's inductance capacitance bridge**

If we close the switch(S1) and switch(S2), the circuit diagram can be drawn as shown . Now we get Maxwell's inductance capacitance bridge, where

Arm1 consist of inductor in series with resistor

Arm2 consist of non inductive resistor

Arm3 consist of non inductive resistor

Arm4 consist of variable resistor in parallel with variable capacitor

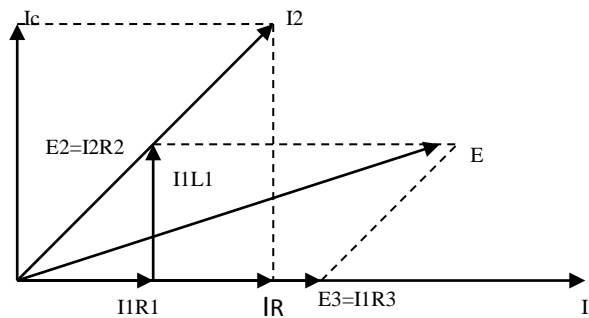
**Derivation and Phasor Diagram:**

$$(R_1 + j\omega L_1) (R_4) (1 + j\omega C_4 R_4) = R_2 R_3$$

$$R_1 R_4 + j\omega L_1 R_4 = R_2 R_3 + j\omega R_2 R_3 C_4 R_4$$

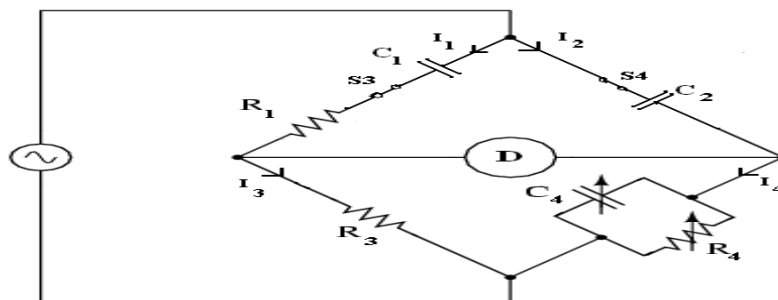
Separating real & imaginary terms

$$L_1 = R_2 R_3 C_4$$



**Fig. 5: Phasor Diagram Of Maxwell's Inductance Capacitance Bridge.**

**Mode-2(Measurement of capacitance):**



**Fig. 6: Schering Bridge**

In this case switch (S3) and switch (S4) are close, and switch (S1) and switch (S2) are closed therefore we get circuit diagram of Schering bridge, where;

Arm1 consist of capacitor (C1) in series with resistor (R1)

Arm2 consist of capacitor (C2)

Arm3 consist of non inductive resistor (R3)

Arm4 consist of variable capacitor (C4) in parallel with variable resistor (R4)

**Derivation and Phasor Diagram:**

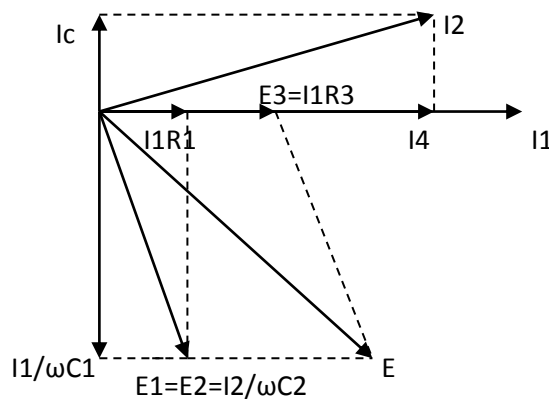
$$(R1 + 1/j\omega C1)(R4 / (1 + j\omega C4 R4)) = R3 / (j\omega C2)$$

$$(R1 + 1/j\omega C1)R4 = (R3 / j\omega C2)(1 + j\omega C4 R4)$$

$$R1 R4 - (j R4 / C1) = -j(R3 / C2) + (R3 R4 C4 / C2)$$

Equating the imaginary term, we get

$$C1 = C2 * (R4 / R3)$$



**Fig. 7: Phasor Diagram of Schering Bridge**

By using a single bridge instead of using two bridges for the measurement of inductance & capacitance there is reduction in the hardware thus reducing the cost. The frequency is not appear in any of the two equation. It can be used to study the measurement of inductance and capacitance in laboratory. It can be used in communication systems and complex electronic circuits.

**III. COCLUSION**

Hence from this paper the inference drawn is that the by using a single bridge we can measure unknown inductance and capacitance. This reduces the hardware that is used in Maxwell’s inductance capacitance bridge and Schering bridge, which ultimately reduces the cost. The Q-factor can be improved by using high quality of inductor and capacitor and by increasing the value of resistors.

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