ABSTRACT

For analyzing the performance of any electrical circuit we have to measure various quantities such as voltage, current, power, power factor, etc. For this purpose we require a measuring instrument like ammeter, voltmeter, etc for measuring all this values.

But the problem with these measuring instruments is that while using it various errors are induces and due to these errors the accurate measurements is not possible and we were unable to analyze the system properly.

So our project aims to make such a kind of arrangement in a circuit which includes the Current and Voltage sensor which helps to measure all the above mentioned parameters. For that purpose we designed a PCB which includes current and voltage sensor along with the signal conditioning circuit which conditions the sensors output. This conditioning circuit plays important role while interfacing the sensors with the microprocessor and LCD display.

The detailed design of transducer circuit, signal conditioning circuit and power supply circuit are presented. The experimental studies are carried out and the results are discussed.

CONTENTS

CHAPTER 1

INTRODUCTION AND BACKGROUND OF THE PROJECT

For analyzing the performance of any electrical circuit we have to measure various quantities such as voltage , current , power , power factor , etc. For this purpose we require a measuring instruments like ammeter , voltmeter , etc for measuring all this values .

But the problem with these measuring instruments is that while using it various errors are induces and due to these errors the accurate measurements is not possible and we were unable to analyze the system properly. The various errors are:

1. Drift Error
2. Observational Error
3. Instrumental Error
4. Environmental Error

So to avoid this errors and to analyze the system Properly we are going to make such kind of circuit which will be able for measuring the accurate values and display it on the LCD Display for this purpose we are using the following components in our circuit

1. Voltage Sensor for measuring voltage
2. Current Sensor for measuring current
3. Signal Conditioning Circuit to convert the signal

So for measuring the voltage and current by using sensors we have to convert the high voltage in the range of ±600 V and the high current in the range of ±15 A.

Conversion of power quantities to low level signals is achieved by using Hall Effect voltage and current transducers. The Swiss make Hall Effect voltage sensor LEM LV 25-P and current sensor LEM LA 25-P are used to convert power level voltage and current quantities in to low level signals in the range of ±5 V.

The Hall Effect transducers provide the isolation between the high power network and the electronic circuits. For both voltage and current measurements the output voltage is obtained across an external resistance Ro. In this application, three voltage sensors (three for three phase voltages) and three current sensors (three for three-phase load currents) are used. The system voltages in the range of ± 600 V are converted to ±5 V. The currents of values ±15 A are converted to ±5 V

CHAPTER 2

LITERATURE SURVEY

- **Literature Survey:**

The Hall Effect voltage and current sensor are employed in project for sensing voltage and current in the circuit.

2.1 Transducer Circuit:

Conversion of power quantities to low level signals is achieved by using Hall Effect voltage and current transducers. The Swiss make Hall Effect voltage sensor LEM LV 25-P and current sensor LEM LA 25-P are used to convert power level voltage and current quantities in to low level signals in the range of ±5 V. The Hall effect transducers provide the isolation between the high power network and the electronic circuits. For both voltage and current measurements the output voltage is obtained across an external resistance Ro. In this application, three voltage sensors (three for three phase voltages) and three current sensors (three for three-phase load currents) are used. The system voltages in the range of ±600 V are converted to ±5 V. The currents of values ±15 A are converted to ±5 V.

Conversion of power quantities to low level signals is achieved by using Hall Effect in sensor.

The Swiss make Hall effect voltage sensor **LEM LV 25-P** are used to convert power level voltage quantities in to low level signals in the range of ±5 V. The system voltages in the range of ±600 V are converted to ±5 V. In the experimental set-up, the power voltage is scaled down to 1/100 scale. The input resistance R_{vi} is taken as 78 kΩ./ 6 W For 600 V peak, the input current I_i is limited to The output current i_o is given as,

$$I_1 = 600/78000 = 7.69 \text{ mA}$$

$I_o = I_1 \times \text{conversion ratio} = 7.69 \times 2.5 = 19.23 \text{ mA}$

The output measuring resistance is taken as R_{vo} =260 Ω.

Therefore the output voltage is given as,

$V_o = I_o \times R_{vo} = 20 \times 260 = 4999.8$ mV= 5 V

Thus a power level voltage signal of ±600 V transduced to ±5 V with isolation.

The Swiss make Hall effect voltage sensor **LEM LA 25-P** are used to convert power level current quantities in to low level signals in the range of ±5 V.

The currents of values ±15 A are converted to ±5 V.

In the experimental set-up, the power level current of ±15 A is transduced to ±5 V. The 3 turns are wound to carry a 30 AT mmf in the primary.

Let the input current be i_i. The number of turns on the primary side is 3. Thus ampere turns on the primary side is 3. With the conversion ratio of 1:1000, the secondary output current is given as

$$I_o = I_1 * 3/1000 = 0.003\, I_1$$

This output current is producing an output voltage v_o across 110 Ω, according to the following equation.

$$V_o = I_o \times Ro = 0.003\, I_1 \times 110 = 0.33\, I_1 V$$

Thus, ±15 A input current is transduced into ±5 V with isolation. The printed circuit board (PCB) for Hall effect voltage and current transducers are developed.

2.2 Signal Conditioning Circuit:

The low level bipolar voltage signals in the range of ±5 V are now converted to 0-3 V range as the DSP 2812 accepts the input data range of 0-3 V. The following circuit using operational amplifiers (OPAMP) is used to achieve the above requirement of signal conversion.

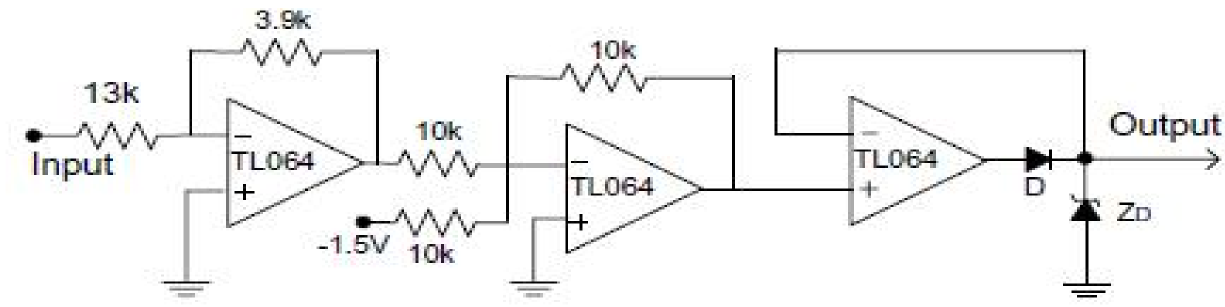


Fig. A - Signal Conditioning Circuit

DC Supply Requirement

Set up Module	**DC supply requirement**
Hall effect transducer	± 15 V DC Supply
Signal Conditioning Circuit	± 15 V DC Supply and -1.5 DC Supply

To have good reliability of supply units, a number of modular step-down transformers are used. A general schematic for DC voltage regulated supply is given in . In specific, to generate ±15 VDC regulated supply, 230/18-0-18 center tapped step down transformer of 2 A rating is used. Full bridge diode rectifier is used to convert AC to DC. The two identical DC electrolytic storage capacitors are employed to make output voltage smooth. The center point of secondary of transformer is connected to the center point of the dc capacitors and it will act as a local ground. The unregulated DC voltage is given as input to the voltage regulator ICs, 7815 and 7915 to produce regulated DC output voltage of +15 V and -15 V respectively. Two such units are used. One for supplying Hall effect sensors and another for signal conditioning circuit. The signal conditioning circuit also needs -

1.5 VDC regulated supply. This is achieved by on board variable negative voltage regulator (IC LM337). The input to this is given from -15V regulated supply.

CHAPTER 3

SCOPE OF PROJECT

Majority of faults, incidents, and accidents associated with electrical equipment and systems are as a result of under voltage and overvoltage. It is important to know the exact amount of current and voltage is a particular system and application as it enables the engineer or technician to make and implement safety-critical decisions.

In addition, knowing the amount of current or voltage in a system allows one to guess the performance of the various subcomponents in a system.

We can use the voltage sensors for the following applications,

1. In Educational Laboratory
   To measure per phase voltage and current in the three phase circuits to determine the various parameters such as impedence, resistance, reactance, etc.

2. Linear and switch-mode power supplies monitoring
   To check the magnitude of voltage and current whether it is within rated values or not so further changes can be implemented to bring up values of voltage and current to the rated values.

3. Motor Control
   To control the motor by monitoring the values of voltage and current.

4. Overload Protection
   As in case of overload condition the currents exceeds the rated amount which can be monitor by current sensor and voltage sensor which gives real time values without any delay.

5. Over Current Protection
   To give over current protection to any electrical machine we have to continuously monitor the current so for that purpose current sensors are used.

6. Ground Fault Detection

7. AC variable speed drives and servo motor drives

8. Static converters for DC motor drives

9. Battery supplied applications

10. Uninterruptible Power Supplies (UPS)

11. Power supplies for welding applications.

12. Power Quality Measurement

13. Switchgear Optimization

14. Earth Fault Measurement

CHAPTER 4

METHODOLOGY

There are two types of current sensing: direct and indirect. Direct sensing is based on Ohm's law , while indirect sensing is based on Faraday's and hall effect . Direct sensing involves measuring the voltage drop associated with the current passing through passive electrical components.

From the indirect sensing we have chosen the Hall Effect sensor for sensing the voltages and currents.

4.1 Hall Effect

A Hall effect sensor is a device that is used to measure the magnitude of a magnetic field. Its output voltage is directly proportional to the magnetic field strength through it.

In a Hall effect sensor, a thin strip of metal has a current applied along it. In the presence of a magnetic field, the electrons in the metal strip are deflected toward one edge, producing a voltage gradient across the short side of the strip (perpendicular to the feed current). Hall effect sensors have an advantage over inductive sensors in that, while inductive sensors respond to a changing magnetic field which induces current in a coil of wire and produces voltage at its output, Hall effect sensors can detect static (non-changing) magnetic fields.

In its simplest form, the sensor operates as an analog transducer, directly returning a voltage.

In electrical engineering, current sensing and voltage sensing is any one of several techniques used to measure electric current and voltage. The measurement of current and voltage ranges from picoamps to tens of thousands of amperes and volts also. The selection of a current and voltage sensing method depends on requirements such as magnitude, accuracy, bandwidth, robustness, cost, isolation or size. The current and voltage value may be directly displayed by an instrument, or converted to digital form for use by a monitoring or control system

- Current and voltage sensing technologies must fulfill various requirements, for various applications. Generally, the common requirements are:

- High sensitivity
- High accuracy and linearity
- Wide bandwidth
- DC and AC measurement
- Low temperature drift
- Interference rejection
- IC packaging
- Low power consumption
- Low price

- There are various sensing equipments present for current and voltage sensing. The measurement of the electric current and voltage can be classified depending upon the underlying fundamental physical principles such as,

- Ohm's Law
- Faraday's Law of Induction
- Magnetic field sensors
- Faraday Effect

- Which further includes…

1. Shunt and series resistor
2. Current transformer
3. Voltage transformer
4. Rogowski coil
5. Hall effect
6. Flux gate sensors
7. Magneto-resistive current sensor

4.2 Reason for using Hall effect

The reasons for using a particular technology or sensor vary according to the application.

Cost, performance and availability are always considerations.

The features and benefits of a given technology are factors that should be weighed along with the specific requirements of the application in making this decision.

General features of Hall effect based sensing devices are:

- True solid state
- Long life (30 billion operations in a continuing keyboard module test program)
- High speed operation - over 100 kHz possible
- Operates with stationary input (zero speed)
- No moving parts
- Logic compatible input and output
- Broad temperature range (-40 to +150°C)
- Highly repeatable operation

There are many advantages of Hall effect sensors over other sensing method Some of this are

Hall Effect sensors are a type of non-contacting position sensor. They can be either rotary or linear and because they are non-contacting, they are wear free and have virtually infinite life.

Hall Effect sensors are a type of non-contacting position sensor. They can be either rotary or linear and because they are non-contacting, they are wear free and have virtually infinite life.

In simple terms, hall effect sensors work whereby a magnet is centrally aligned with the hall sensor electronics. When the magnet is rotated the magnetic field changes and the electronics convert this into a relative positional output. In the case of a linear hall, the stroke is restricted due to this principle but the function is basically the same.

Hall Effect sensors are available with either an analogue or digital outputs depending on the application they are required for.

4.3 Advantages of Hall Effect sensors

Although Hall Effect sensors are often seen as more expensive than standard linear or rotary sensors this is not always necessarily the case and they are frequently selected because of their advantages;

They are suitable for harsh environments with high IP ratings to IP68/69K.

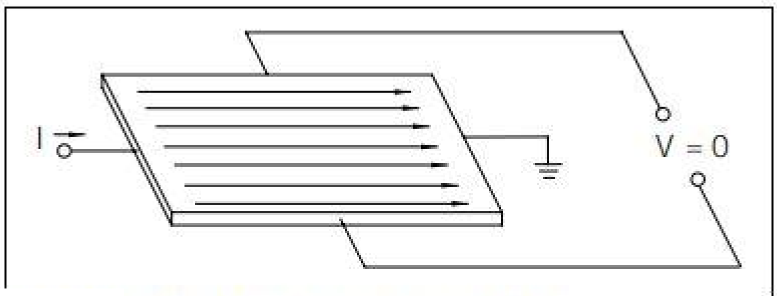
Hall Effect sensors do not wear so have a long life and in case of two-part technology, meaning they have a virtually unlimited life.

- They are highly reliable.
- Offer pre-programmable electrical angles and outputs.
- Offer high-speed operation.
- The ability to work in a wide temperature range.

Something to take into consideration when selecting a Hall Effect sensor is the surrounding area of the application as these sensors can be affected by external factors interfering with the magnetic field.

4.4 Introduction

The Hall effect was discovered by Dr. Edwin Hall in 1879 while he was a doctoral candidate at Johns Hopkins University in Baltimore. Hall was attempting to verify the theory of electron flow proposed by Kelvin some 30 years earlier. Dr. Hall found when a magnet was placed so that its field was perpendicular to one face of a thin rectangle of gold through which current was flowing, a difference in potential appeared at the opposite edges. He found that this voltage was proportional to the current flowing through the conductor, and the flux density or magnetic induction perpendicular to the conductor. Although Hall's experiments were successful and well received at the time, no applications outside of the realm of theoretical physics were found for over 70 years. With the advent of semiconducting materials in the 1950s, the Hall effect found its first applications. However, these were severely limited by cost. In 1965, Everett Vorthmann and Joe Maupin, MICRO SWITCH Sensing and Control senior development engineers, teamed up to find a practical, low-cost solid state sensor. Many different concepts were examined, but they chose the Hall effect for one basic reason: it could be entirely integrated on a single silicon chip. This breakthrough resulted in the first low-cost, high-volume application of the Hall effect, truly solid state keyboards. MICRO SWITCH Sensing and Control has produced and delivered nearly a billion Hall effect devices in keyboards and sensor products.



Hall effect principle, no magnetic field

Fig B

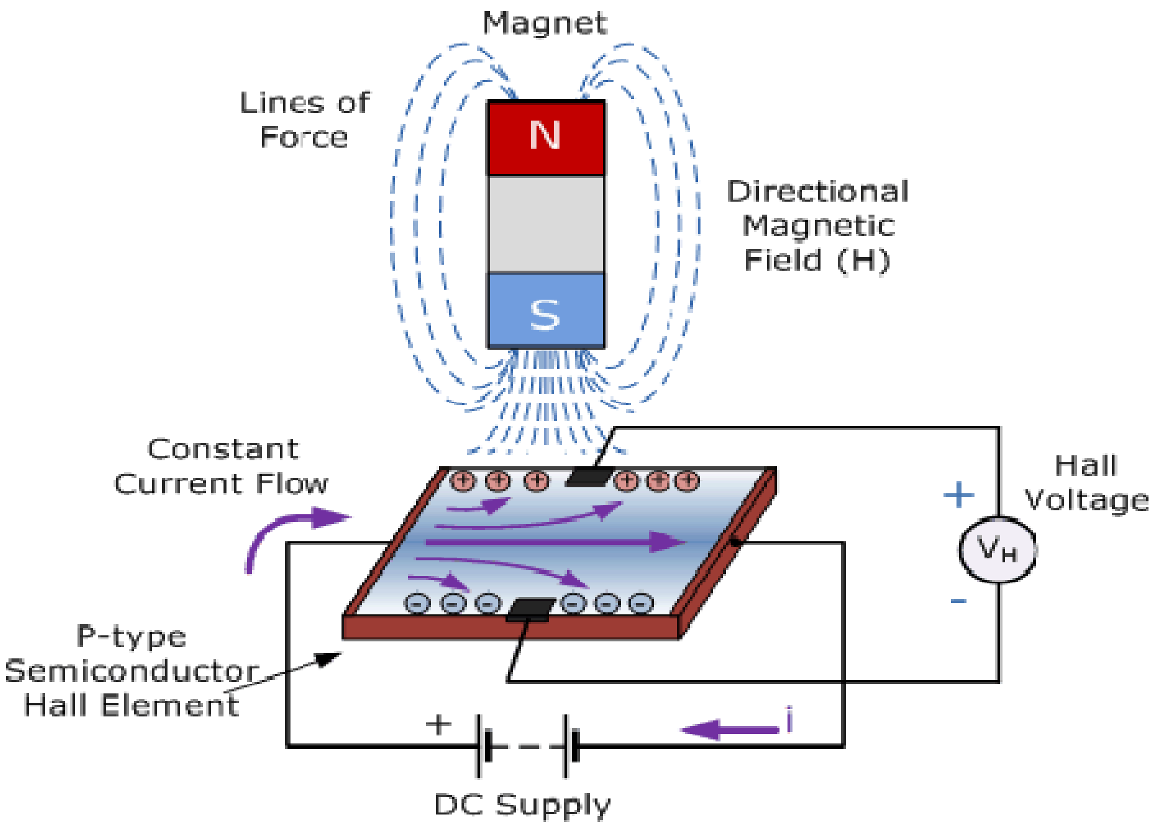


Fig C

4.5 Theory of the Hall Effect

When a current-carrying conductor is placed into a magnetic field, a voltage will be generated perpendicular to both the current and the field. This principle is known as the Hall effect. Illustrates the basic principle of the Hall effect. It shows a thin sheet of semiconducting material (Hall element) through which a current is passed. The output connections are perpendicular to the direction of current. When no magnetic field is present (Figure 2-1), current distribution is uniform and no potential difference is seen across the output.

When a perpendicular magnetic field is present, as shown in Figure 2-2, a Lorentz force is exerted on the current. This force disturbs the current distribution, resulting in a potential difference (voltage) across the output. This voltage is the Hall voltage (VH). The interaction of the magnetic field and the current is shown in equation form as equation 2-1.

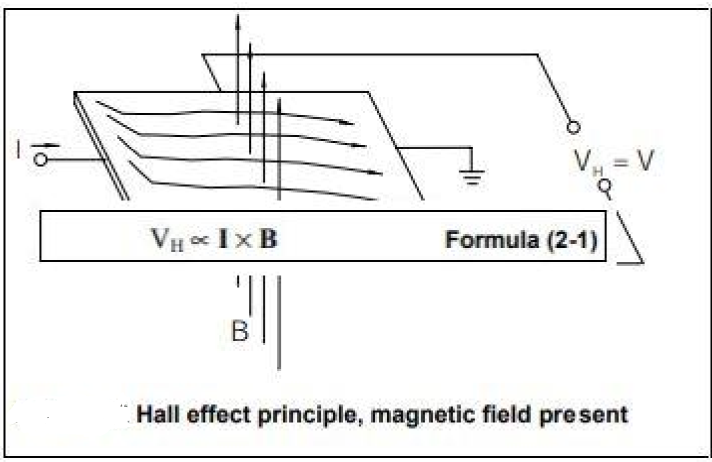


Fig D

Hall effect sensors can be applied in many types of sensing devices. If the quantity (parameter) to be sensed incorporates or can incorporate a magnetic field, a Hall sensor will perform the task.

The Hall voltage is proportional to the vector cross product of the current (I) and the magnetic field (B). It is on the order of 7 µv/Vs/gauss in silicon and thus requires amplification for practical applications. Silicon exhibits the piezo resistance effect, a change in electrical resistance proportional to strain. It is desirable to minimize this effect in a Hall sensor. This is accomplished by orienting the Hall element on the IC to minimize the effect of stress and by using multiple Hall elements. Figure 2-3 shows two Hall elements located in close proximity on an IC. They are positioned in this manner so that they may both experience the same packaging stress, represented by Δ R. The first Hall element has its excitation applied along the vertical axis and the second along the horizontal axis. Summing the two outputs eliminates the signal due to stress. MICRO SWITCH Hall ICs use two or four elements.

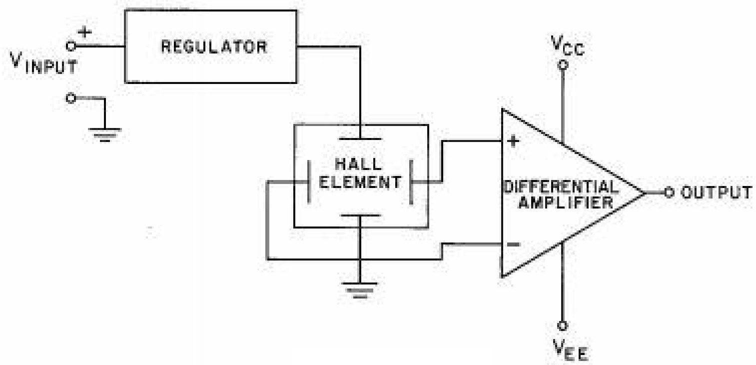


Fig E

4.6 Applications of Hall Effect sensors

Hall Effect sensors have a wide range of applications. They are used in many industries, we see a high demand for them in the Motorsport industry where they are used on sequential gearboxes, throttle measurement where the non-contacting, wear free principle, is very prominent. Some other applications for Hall Effect sensors include;

- Automation equipment
- Mobile vehicle
- Marine
- Handling equipment
- Agricultural machinery
- Process and packaging machines
- Slitting & rewinding machines

CHAPTER 5

DETAILS OF DESIGNS, WORKING AND PROCESS

5.1 Details of Design

5.1.1 Selection of Voltage Sensor

Voltage Range : ± 600 V

Fig F

So we selected the voltage sensor LEM LV 25P which having following specifications :

I_{PN} : 10 mA

V_{PN} : 10..500 V

5.1.2 Selection of Current Sensor

Current Range : ± 15 A

Fig G

So we selected the current sensor LEM LA 25P which having following specification :

I_{PN} : 25 A

5.1.3 Selection of Values of Resistors used for sensors

For voltage sensor

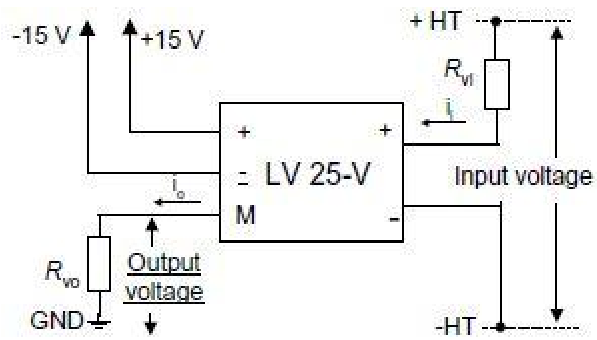


Fig H

- In the experimental set-up, the power voltage is scaled down to 1/100 scale. The input resistance R_{vi} is taken as 78 kΩ./ 6 W
- For 600 V peak, the input current I_1 is limited to $I_1 = 600/78000 = 7.692$ mA
- $I_o = I_i \times$conversion ratio $= 7.692\times 2.5 = 19.23$ mA
- The output measuring resistance is taken as R_{vo}=260 Ω.
- Therefore the output voltage is given as,

$$V_o = I_o \times R_{vo} = 19.23\times 260=4999.8 \text{ mV}= 5 \text{ V}$$

- Thus a power level voltage signal of ±600 V transduced to ±5 V with isolation.

For Current Sensor

- The currents of values ±15 A are converted to ±5 V.
- In the experimental set-up, the power level current of ±15 A is transduced to ±5 V. The 3 turns are wound to carry a 45 AT mmf in the primary.

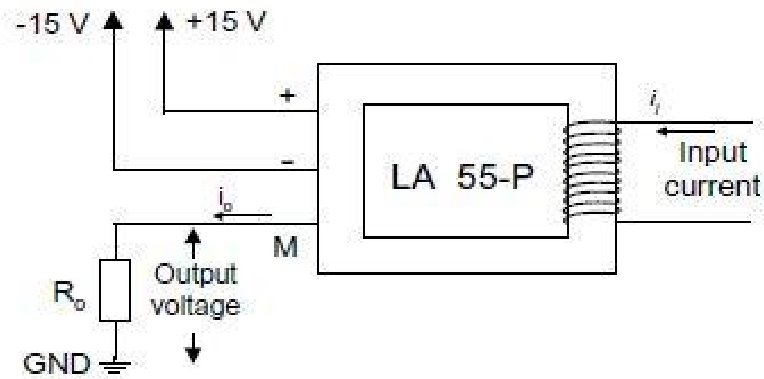


Fig I

- Let the input current be I_1. The number of turns on the primary side is 3. Thus ampere turns on the primary side is 3 I_1. With the conversion ratio of 1:1000, the secondary output current is given as
  $I_0 = I_1 * 3/1000 = 0.003\ I_1$
  This output current is producing an output voltage Vo across 110 Ω, according to the following equation.

$$V_o = I_o \times R_0 = 0.003\ I_1 \times 110 = 0.33\ I_1 \ldots V$$

5.1.4 Wattage Rating of Resistors

- For Voltage Sensor

Wattage rating for R_{VI} is calculated as follows ,

Power rating = (Current through R_{VI} $)^2$ * Resistor value
= $(8mA)^2$ * 78 KΩ
= 4.992 …W

So we selected the resistor having power rating of 6 W .

Wattage rating for R_O is calculated as follows ,

Power rating = (Current through R_O $)^2$ * Resistor value
= $(19.23\ mA)^2$ * 260 Ω
= 0.0961 …W

So we selected the resistor having power rating of 0.25 W .

- For Current Sensor

Wattage rating for R_O is calculated as follows ,

Power rating = (Current through R_O $)^2$ * Resistor value

= $(45\ mA)^2 * 110\ \Omega$

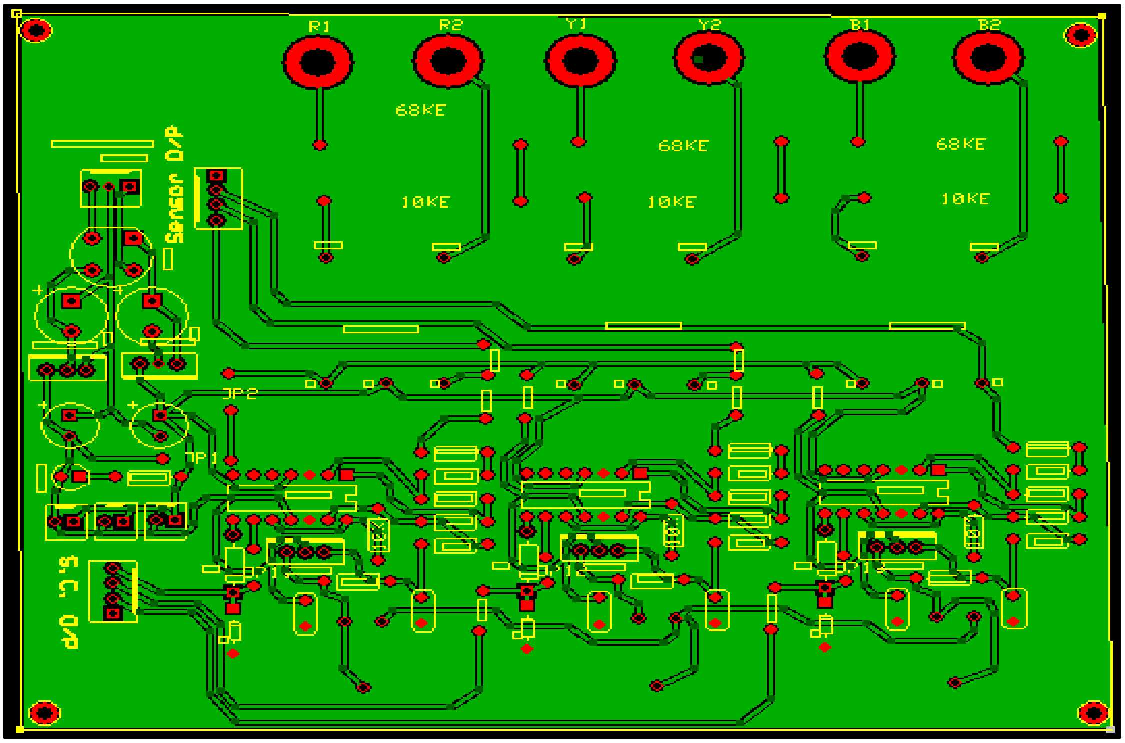
= 0.2227 …W

So we selected the resistor having power rating of 0.25 W .

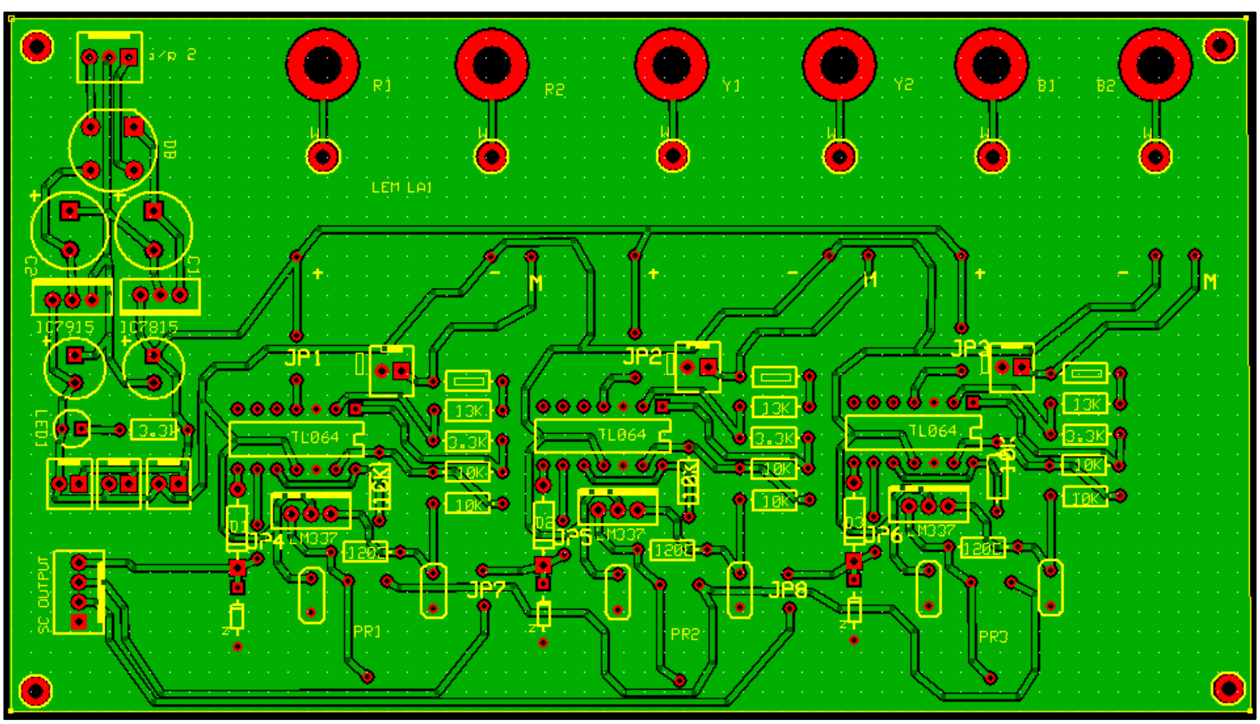
5.1.5 Resistors used for signal conditioning are of 0.25 W as very few mA current flows through them.

5.1.6 PCB design in ExpressPCB

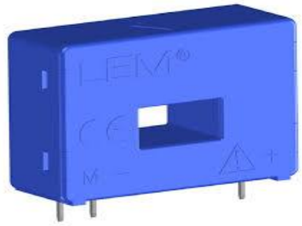
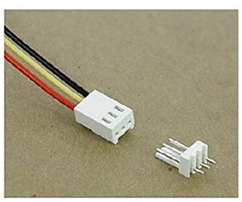
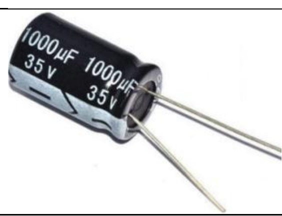
1. **Voltage Sensor**

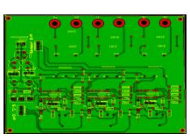
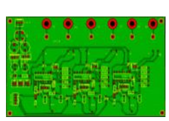


2. **Current Sensor**



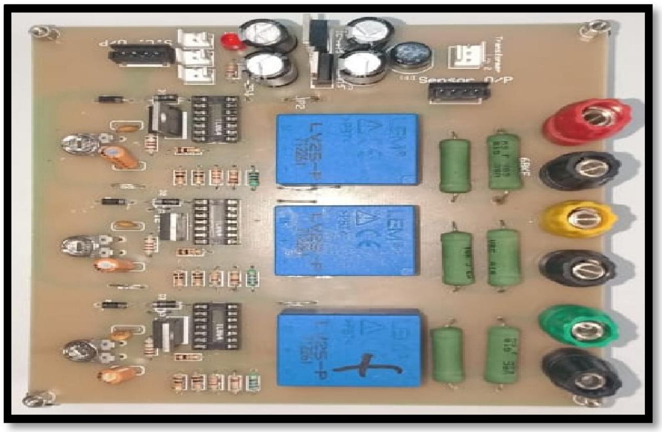
Components Used and Expenditure for Capstone Project

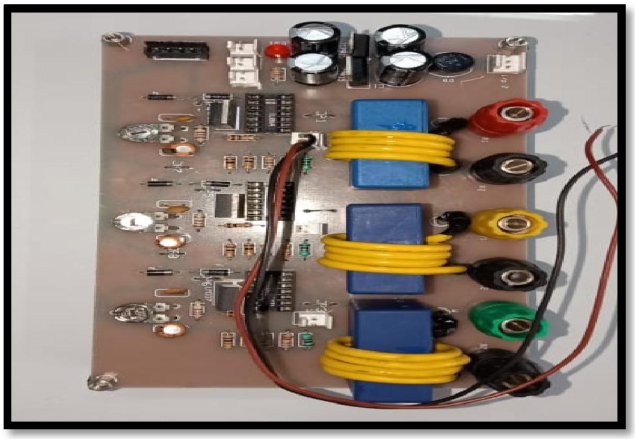
Sr No	Components Used	Specification	Qty.	Cost	Expenditure
1.		LEM LA 25 P Current Sensor	03	1200	3600
2.		LEM LV 25 P Voltage Sensor	03	1300	3900
3.		Reliment Pin	2 pin 3 pin 4 pin	50	50
4.		Diode Bridge 1.5 A	02	25	50
5.		Capacitor 1000 uF 35 V	08	8	64
6.		Regulator IC IC 7815 Provide +15 V	02	15	30

7.		Regulator IC IC 7915 Provide -15 V	02	15	30
8.		LED RED Colored	02	3	06
9.		Resistors 110Ω 120 Ω 10k Ω 3.3k Ω 13 k Ω 250 Ω 68 k Ω 10 k Ω	 03 06 18 06 06 03 03 03	 1 2 3 3 3 2 10 10	175
10.		OPAMP IC IC TL064	06	15	90
11.		Preset Adjustable Resistor 100 Ω	06	10	60
12.		Adjustable Negative Voltage Regulator IC IC LM337	06	20	120
13.	 	Designed circuit on PCB plate And Printing Cost	Each 1	1850	1850
14.		Capacitor 1 uF	12	1	12

15.		14 Pin IC base	06	5	30
16.		Transformer 230 V/ 18-0-18 V	180	2	360
17.		Banana Terminals Red, yellow, Blue and Black	6 Pairs	50	300
18		PCB standoff Spacers	08	3	24
19.		Diode 1N4007	06	5	30
20.		Zener Diode 3.3 V	06	5	30
21	Other Expenditures	-	-	-	1200
					Total- Rs 12000

Testing setup:





5.2 Working and Process of Circuit

The first stage includes the conversion of power quantities i.e., 3-phase source voltages, dc link capacitor voltage, load currents and filter currents using Hall effect voltage and current transducers to low level signals preferably within the range of ±5 V. These signals from Hall effect sensors are further conditioned using signal conditioning circuit to the range of 0-3 V, which is compatible with DSP 2812.

(a) Conversion of power quantities in the power distribution network, i.e. voltages and currents to the low level signal preferably within the range of ±5 V.

(b) Conversion of bipolar low level signals representing voltage and currents at power level to unipolar 0-3 V compatible for DSP.

Transducer Circuit: Conversion of power quantities to low level signals is achieved by using Hall effect voltage and current transducers. The Swiss make Hall effect voltage sensor LEM LV 25-P and current sensor LEM LA 55-P are used to convert power level voltage and current quantities in to low level signals in the range of ±5 V. The Hall effect transducers provide the isolation between the high power network and the electronic circuits. For both voltage and current measurements the output voltage is obtained across an external resistance R o. In this application, four voltage sensors (three for three phase voltages and one for DC link voltage) and seven current sensors (three for three-phase load currents and three for three-phase compensator currents and one for monitoring the neutral current) are used. The system voltages in the range of ±500 V are converted to ±5 V. The currents of values ±10 A are converted to ±5 V. The circuit and design details for Hall effect voltage and current transducers .

Design Example of Hall Effect Voltage Transducer:

- In the experimental set-up, the power voltage is scaled down to 1/100 scale. The input resistance R_{vi} is taken as 75 kΩ./ 5 W
- For 600 V peak, the input current I_1 is limited to $I_1 = 600/78000 = 7.69$ mA
- $io = ii \times$ conversion ratio $= 7.69 \times 2.5 = 19.23$ mA
- The output measuring resistance is taken as R_{vo}=260 Ω.
- Therefore the output voltage is given as,
- $vo = io \times Rvo = 19.23 \times 260 = 4999.8$ mV= 4.9V
- Thus a power level voltage signal of ±600 V transduced to ±5 V with isolation.

Design Example of Hall Effect Current Transducer:

The circuit connection for the Hall effect current transducer. In the experimental set-up, the power level current of ±15 A is transduced to ±5 V. The 3 turns are wound to carry a 30 AT mmf in the primary. Let the input current be I_i . The number of turns on the primary side is 3. Thus ampere turns on the primary side is 3 I_i. With the conversion ratio of 1:1000, the secondary output current is given as

$I_0 = I_1 * 3/1000 = 0.003\, I_1$

This output current is producing an output voltage V_o across 110 Ω, according to the following equation.

- $Vo = I_0 \times R_0 = 0.003\, I_1 \times 110 = 0.33\, I_1$ V
- Let the input current be I_1. The number of turns on the primary side is 3. Thus ampere turns on the primary side is 3 I1. With the conversion ratio of 1:1000, the secondary output current is given as

  $I_0 = I_1 * 3/1000 = 0.003\, I_1$

  This output current is producing an output voltage Vo across 110 Ω, according to the following equation.

  $V_o = I_0 \times R_0 = 0.003\, I_1 \times 110 = 0.33\, I_1$ V

Signal Conditioning Circuit: The low level bipolar voltage signals in the range of ±5 V are now converted to 0-3 V range as the DSP 2812 accepts the input data range of 0-3 V.

The following circuit using operational amplifiers (OPAMP) is used to achieve the above requirement of signal conversion. The circuit detail is shown in Fig.

DC Power Supply Requirement

Set up Module	**DC supply requirement**
Hall effect transducer	-+ 15 V DC Supply
Signal Conditioning Circuit	-+15 V DC Supply and -1.5 DC Supply

The signal of ±5 V is given to first stage. The first stage is an attenuator with attenuation factor of 0.3. Therefore, output of first amplifier is within the range of ±1.5 V. In the second stage, the bipolar signal of ±1.5 V is shifted by +1.5 V. Thus, the output of second stage amplifier is 0-3 V. Third stage is precision rectifier and is used to prevent any excursions of negative voltage (below 0 V). The zener diode ZD at the output stage prevents over voltage (above 3.3 V). The reference of -1.5 V is generated using an adjustable negative voltage regulator (LM337). The input to this regulator is -15 V, which is drawn from the supply of OPAMPs (±15 V). Sixteen such circuits are required for 16 input channels of DSP 2812. The two identical PCBs are designed each with eight such generic circuits.

To have good reliability of supply units, a number of modular step-down transformers are used. A general schematic for DC voltage regulated supply is given in Fig. 8. In specific, to generate ±15 VDC regulated supply, 230/18-0-18 center tapped step down transformer of 2 A rating is used as shown in Fig. . A full bridge diode rectifier is used to convert AC to DC. The two identical DC electrolytic storage capacitors are employed to make output voltage smooth. The center point of secondary of transformer is connected to the center point of the dc capacitors and it will act as a local ground. The unregulated

DC voltage is given as input to the voltage regulator ICs, 7815 and 7915 to produce regulated DC output voltage of +15 V and -15 V respectively. One such units are used. One for supplying Hall effect sensors and for signal conditioning circuit. The signal conditioning circuit also needs -1.5 VDC regulated supply. This is achieved by on board variable negative voltage regulator (IC LM337). The input to this is given from -15V regulated supply.

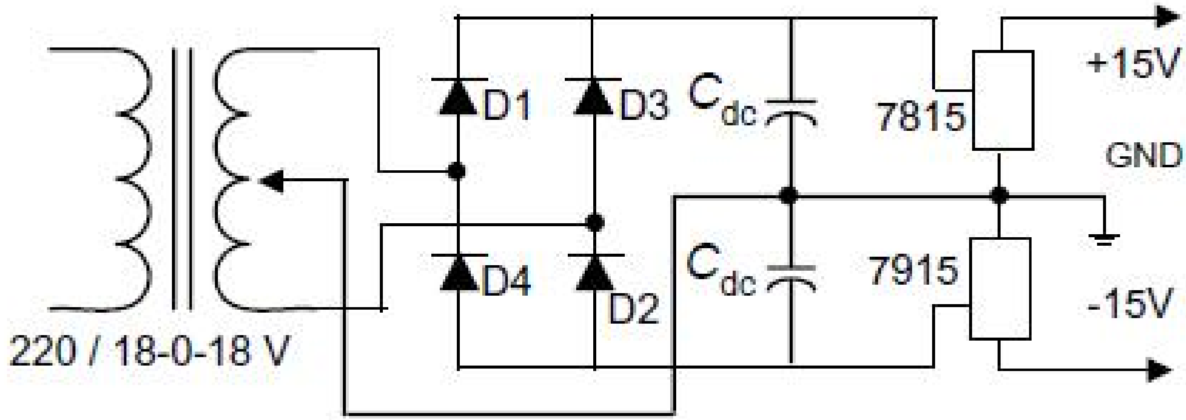


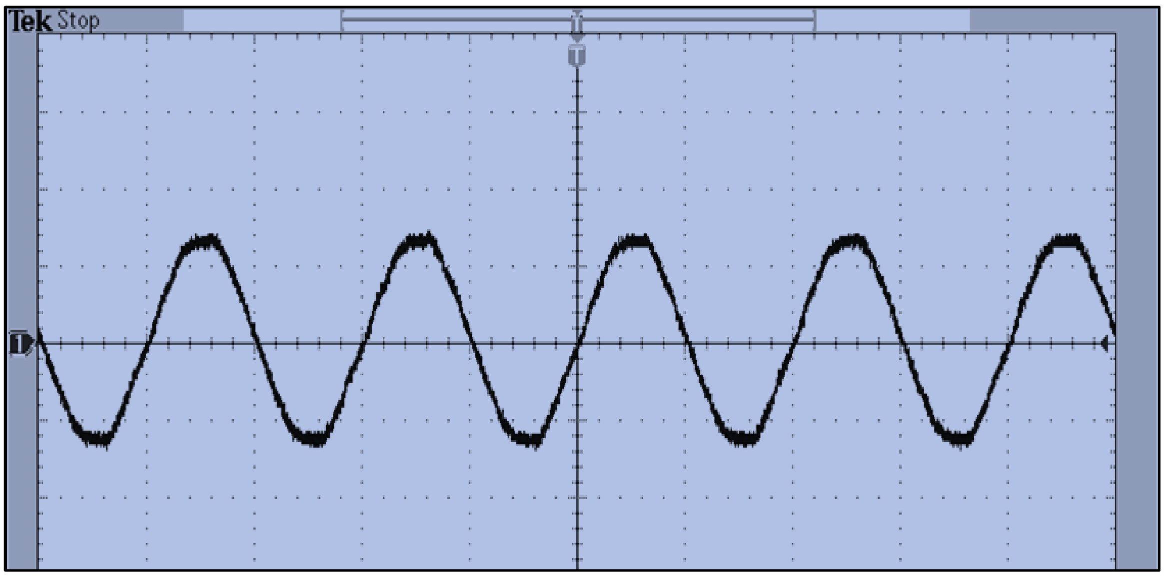
Fig. A full bridge diode rectifier

CHAPTER 6

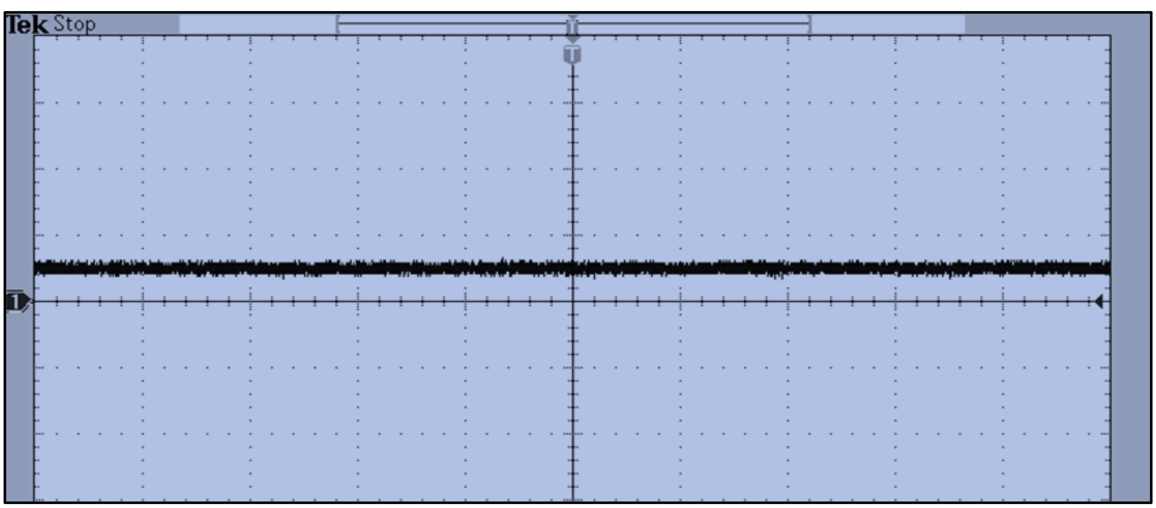
RESULTS AND APPLICATIONS

6.1 Results

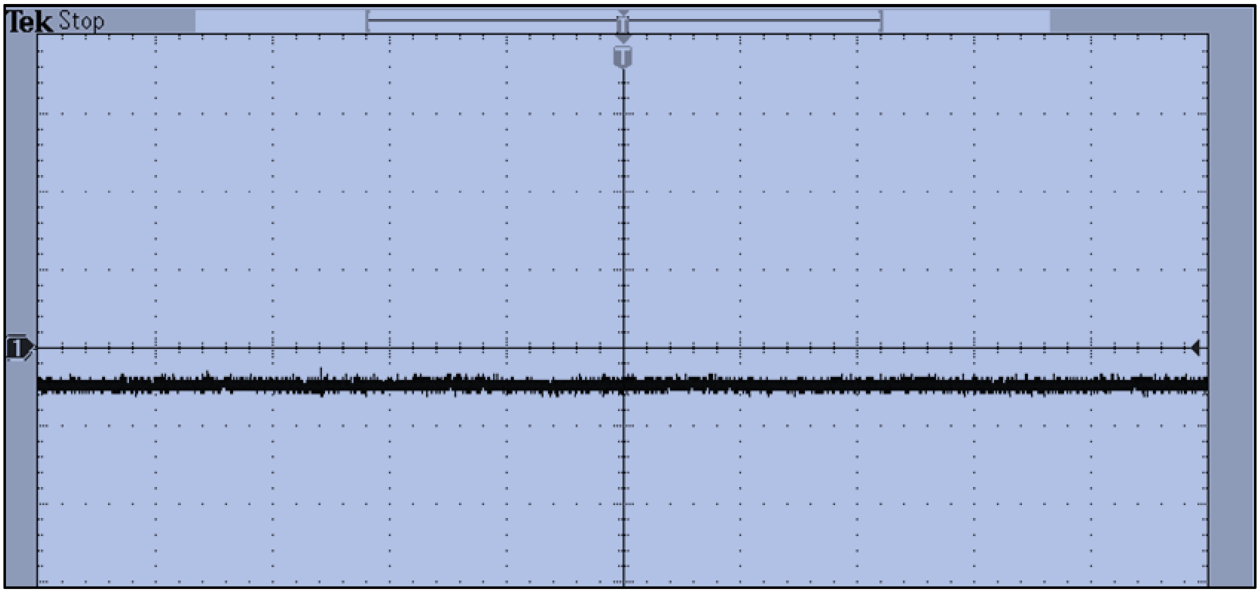
- **Input to the Rectifier Unit :**



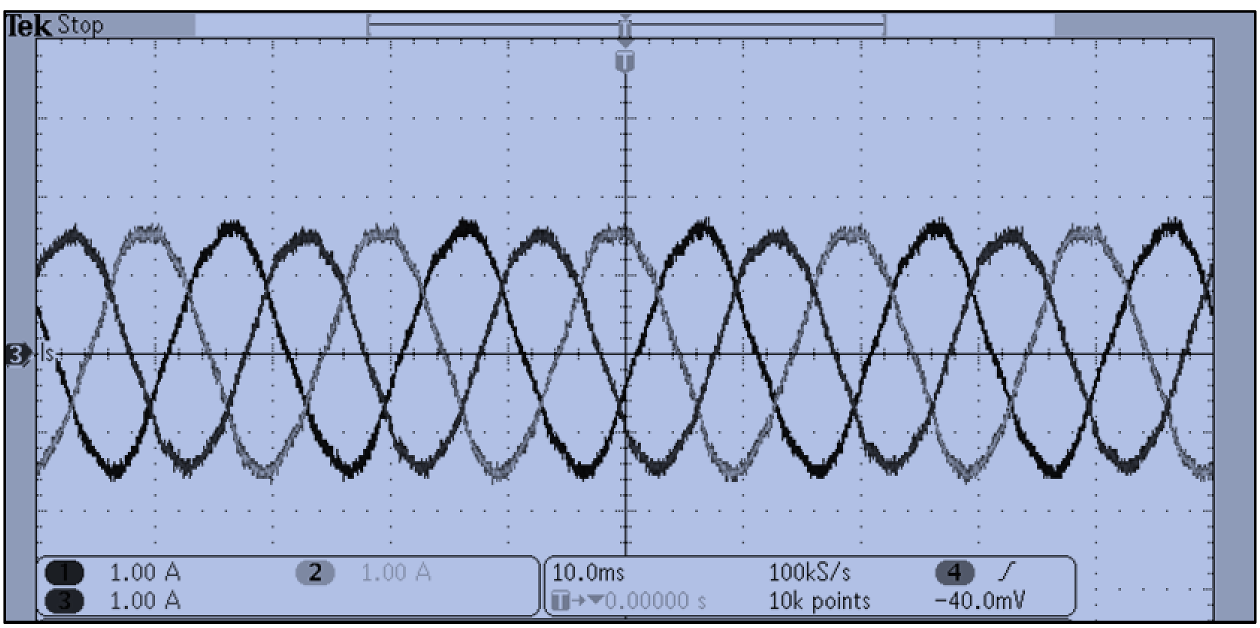
- **Output of Rectifier Unit (Output of IC 7815)**



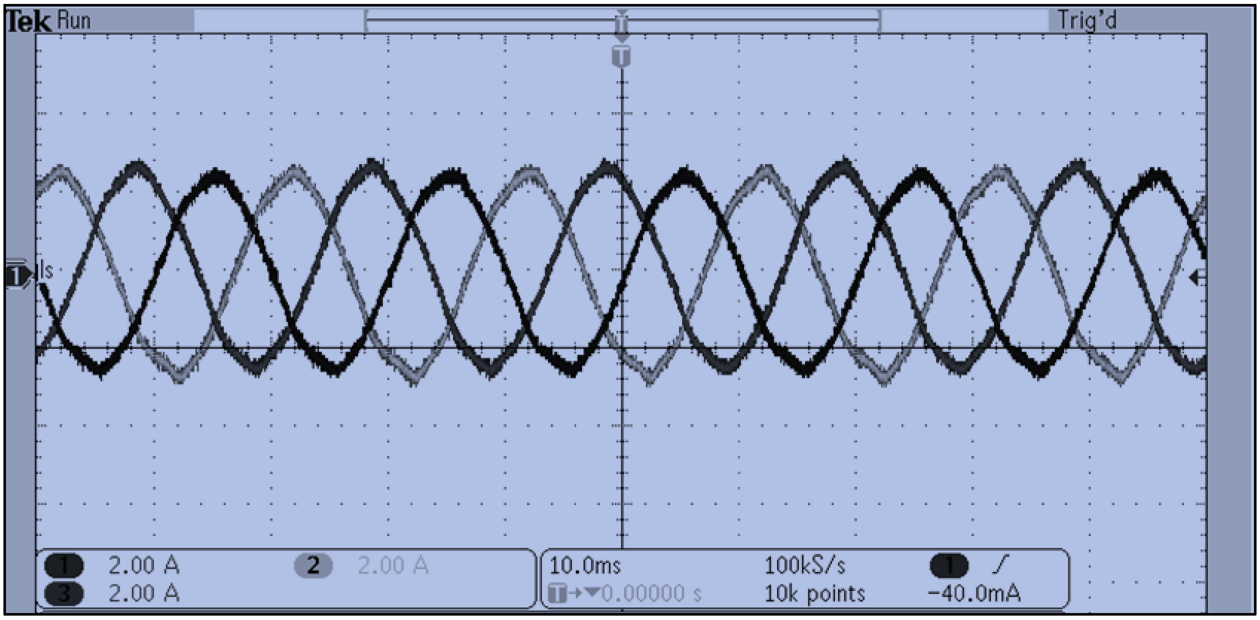
Output of Rectifier Unit (Output of IC 7915)



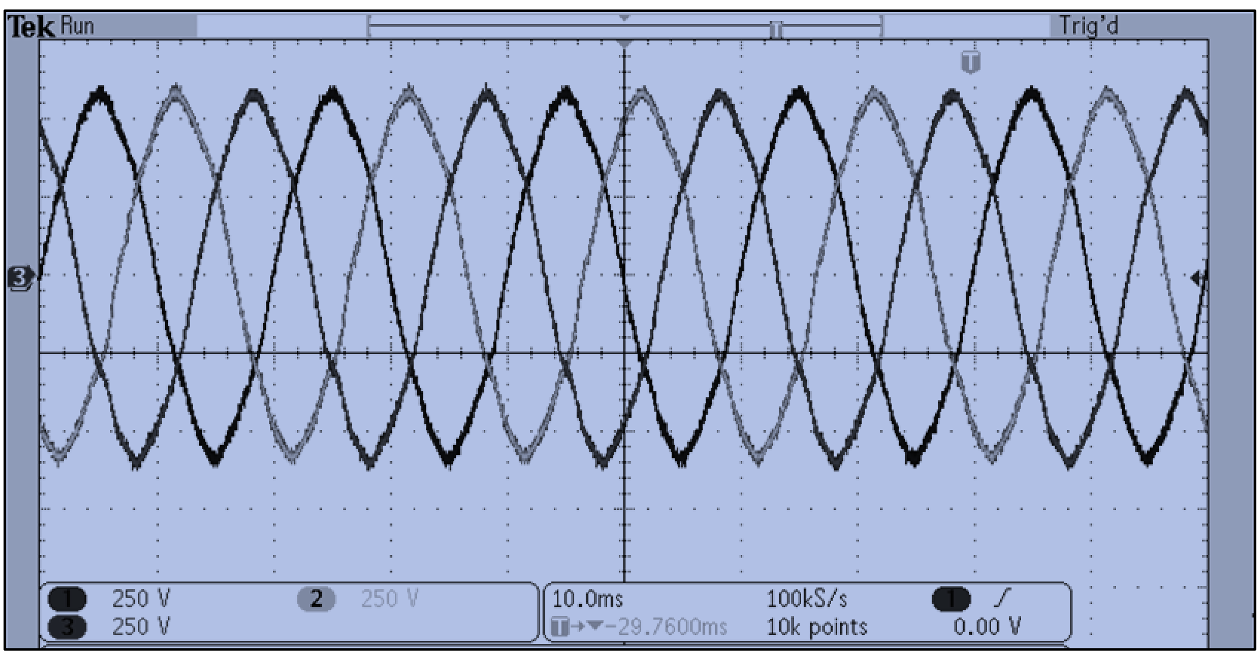
Output of Current Sensors (For 1 A)



Output of Current Sensors (For 2 A)



Output of Voltage Sensors



6.2 Application

- In Educational Laboratory
    - To measure the per phase voltage and current in the three phase circuits to determine the various parameters such as impedence , resistance , reactance ,etc.

- Linear and switch-mode power supplies monitoring
    - To check the magnitude of voltage and current whether it is within rated values or not so further changes can be implemented to brought up values of voltage and current to the rated values.

- Motor Control
    - To control the motor by monitoring the values of voltage and current .

- Overload Protection
    - As in case of overload condition the currents exceeds the rated amount which can be monitor by current sensor and voltage sensor which gives real time values without any delay.

- Over Current Protection
    - To give over current protection to any electrical machine we have to continuously monitor the current so for that purpose current sensors are used.

- Ground Fault Detection

- AC variable speed drives and servo motor drives

- Static converters for DC motor drives

- Battery supplied applications

- Uninterruptible Power Supplies (UPS)

- Power supplies for welding applications.
- Power Quality Measurement
- Switchgear Optimization
- Earth Fault Measurement

CHAPTER 7

CONCLUSION AND FUTURE SCOPE

7.1 CONCLUSION

The details of measurement of three phase voltage and current by using hall sensors are presented. The design of various building blocks such as transducer circuit, signal conditioning circuits, etc. are clearly illustrated and explained.

The results demonstrate the waveforms of input AC voltage, output of rectifier unit and sensors output. We got the satisfactory output waveforms of each block (input voltage, rectifier unit and sensors) The signal coming from the sensors can be conditioned with the help of signal conditioning circuit in order to be acquired by the microprocessor.

7.2 FUTURE SCOPE OF PROJECT

- At this present stage our circuit is able to measure only current and voltage in the three phase circuit. But it can be modified further by measuring not only current and voltage but also frequency of supply , power factor of the circuit , active power , reactive power , apparent power , harmonic content in the circuit along with its order , etc

- We are getting the readings on LCD display but in future it can be seen on android phone by making the arrangement of bluetooth connectivity and receiver thereby we are able to take readings from remote place als

- At the present stage it is not possible to see the waveform of voltage and current as there is no provision of DSO so in future we can make the in built provision of DSO in our circuit so along with values we are to see the nature of voltage and current waveform.

- We can replace the Bluetooth wireless communication system by Internet of Things (IOT) technology. This technology is used to connect the sensors and devices over the internet by allowing them to talk to us , work in applications , and interact with each other.

CHAPTER 8

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