AUTOMATED TEST JIG FOR TRANSFORMER TESTING USING LABVIEW

A PROJECT REPORT

Submitted by

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BONAFIDE CERTIFICATE

Certified that this project report **"AUTOMATED TEST JIG FOR TRANSFORMER TESTING USING LABVIEW"** is the bonafide work of **"THINESH MATHU.M(715517105051), YOGABHARATHI.K(715517105058), KAMAL.K(715517105302), PRADEEP KUMAR.L(715517105304)"** who carried out the project under my supervision.
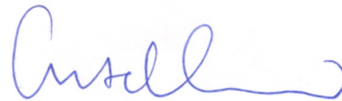

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ABSTRACT

Transformer is an essential component in electrical power system. Since it is working for 365 days in a year, its efficiency is a major factor. For confirming the specifications and performances of an electrical power transformer it has to go through a number of testing procedures. Some tests are done at a transformer manufacturer premises before delivering the transformer. To prove that the transformer meets customer's specifications and design expectations, the transformer has to go through different testing procedures in manufacturer premises. Some transformer tests are carried out for confirming the basic design expectation of that transformer.

These tests consume lot of time and the data logging is a complicated task. This project focus on development of test jig using Lab view to perform SC and OC test. This Virtual Jig can log the data (Plug and Play) and analyze the reading to meet customer and manufacturer specification.   This technique provide, better data handling and data storage.

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LIST OF SYMBOLS AND ABBREVATIONS

AC	Alternating current
A	Ammeter
ADC	Analog to Digital Converter
CT	Current Transformer
DAQ	Data Acquisition
DUT	Device Under Test
DNL	Differential Non-Linearity
DSP	Digital Signal Processing
DC	Direct current
DVDF	Double Voltage Double Frequency
DIO	Dual Input Output
GUI	Graphic User Interface
HV	High Voltage
I_m	Magnetizing current
INL	Integral Non-Linearity
I_c	Iron loss current
Lab VIEW	Laboratory Virtual Instrument Engineering Workbench
LED	Light Emitting Diode
LV	Low Voltage
MATLAB	Matrix Laboratory
MBT	Magnetic Balance Test
NI	National Instruments
I_{oc}	Open circuit current
X_{oc}	Open circuit reactance

R_{oc}	Open circuit resistance
V_{oc}	Open circuit voltage
PC	Personal Computer
PDA	Personal Digital Assistant
$\cos\emptyset$	Power Factor
$\emptyset$	Power Factor Angle
PT	Potential Transformer
PID	Proportional Integral Differential
PLC	Programmable Logic Controller
I_{sc}	Short circuit current
Z_{sc}	Short circuit impedance
X_{sc}	Short circuit reactance
R_{sc}	Short circuit resistance
V_{sc}	Short circuit voltage
SCADA	Supervisory Control and Data Acquisition
UI	User Interface
USB	Universal Serial Bus
VI	Virtual Instrument
VR	Voltage Ratio
V	Voltmeter
W	Wattmeter

CHAPTER 1
INTRODUCTION

Testing process of the transformers is being left unnoticed or not greatly improvised for a long time. From the start testing process requires a large no of equipments and man power and consuming a great time in the testing process. It requires a large area to handle the equipments and the probability of error in manual testing is much larger. To prove that the transformer meets customer's specifications and design expectations, the transformer has to go through different testing procedures in manufacturer premises. Some transformer tests are carried out for confirming the basic design expectation of that transformer. The most of the routine test performed in the manufacturing and initialization premises are transformer ratio test, open circuit and short circuit test, vector group test, winding resistance test and related to these. These tests consume lot of time and the data logging is a complicated task. This project focuses on development of virtual test jig using Lab VIEW to perform those routine tests. This Virtual Jig can log the data (Plug and Play) and analyze the reading to meet customer and manufacturer specification. This provide, better data handling and data storage. Thus it reduces the human effort and errors and provides a better way of testing the transformers.

1.1   OPEN CIRCUIT TEST

Open and short circuit tests are performed on a transformer to determine the:

1. Equivalent circuit of transformers
2. Voltage Regulation of Transformers

3. Efficiency of transformer

The power required for open circuit tests and short circuit tests on a transformer is equal to the power loss occurring in the transformer.

The connection diagram for open circuit test on transformer is shown in the fig 1.1. A voltmeter, wattmeter, and an ammeter are connected in LV side of the transformer as shown. The voltage at rated frequency is applied to that LV side with the help of a variac of variable ratio auto transformer.

The HV side of the transformer is kept open. Now with the help of variac, applied voltage gets slowly increased until the voltmeter gives reading equal to the rated voltage of the LV side. After reaching rated LV side voltage, record all the three instruments reading (Voltmeter, Ammeter and Wattmeter readings). Experimental setup for open circuit test is shown in fig 1.1.

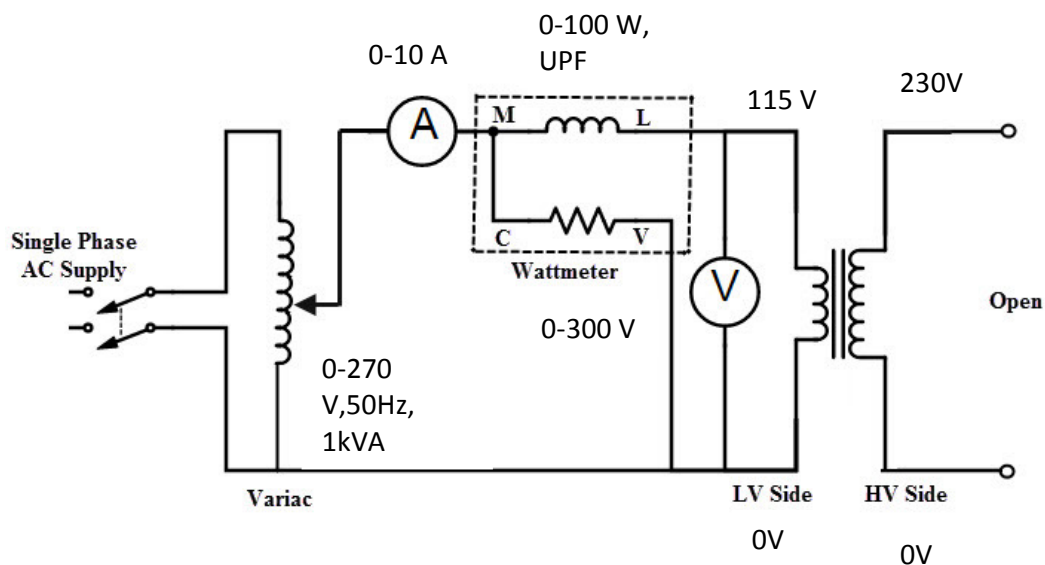**Fig 1.1 Open circuit test on transformer**

The ammeter reading gives the no load current I_e. As no load current I_e is quite small compared to rated current of the transformer, the voltage drops due to this current that can be taken as negligible.

Since voltmeter reading V_1 can be considered equal to the secondary induced voltage of the transformer, wattmeter reading indicates the input power during the test. As the transformer is open circuited, there is no output, hence the input power here consists of core losses in transformers and copper loss in transformer during no load condition. But as said earlier, the no-load current in the transformer is quite small compared to the full load current so, neglect the copper loss due to the no-load current. Hence, can take the wattmeter reading as equal to the core losses in the transformer.

Let us consider wattmeter reading is P_o.

$$P_O = \frac{V_1{}^2}{R_m} \tag{1.1}$$

Where, R_m is shunt branch resistance of transformer.

If, Z_m is shunt branch impedance of transformer.

Then,

$$Z_m = \frac{V_1}{I_e} \tag{1.2}$$

Therefore, if shunt branch reactance of transformer is X_m,

$$\left(\frac{1}{X_m}\right)^2 = \left(\frac{1}{Z_m}\right)^2 - \left(\frac{1}{R_m}\right)^2 \tag{1.3}$$
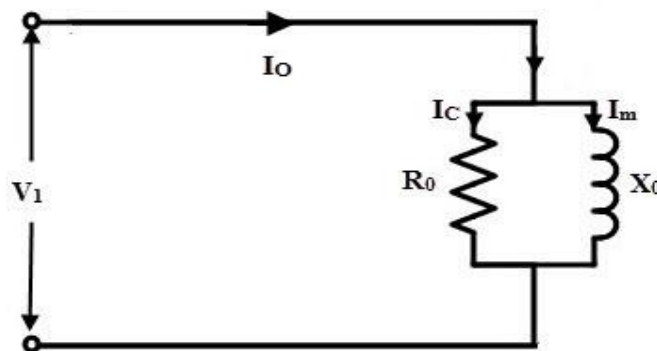

Fig 1.2 Equivalent circuit of transformer - open circuit test

These values are referred to the LV side of the transformer due to the tests being conducted on the LV side of transformer. These values could easily be referred to HV side by multiplying these values with square of transformation ratio.

Therefore it is seen that the open circuit test on transformer is used to determine core losses in transformer and parameters of the shunt branch of the equivalent circuit of the transformer.Equivalent circuit of transformer in open circuit is shown in fig 1.2.

1.2 SHORT CIRCUIT TEST

The connection diagram for the short circuit test on the **transformer** is shown in the fig1.3 below. A voltmeter, wattmeter, and an ammeter are connected in HV side of the transformer as shown. A low voltage of around 5-10% is applied to that HV side with the help of a variac (i.e. a variable ratio auto transformer). Short-circuit the LV side of the transformer. Now with the help of variac applied voltage is slowly increased until the wattmeter and an ammeter gives reading equal to the rated current of the HV side.

After reaching the rated current of the HV side, record all the three instrument readings (voltmeter, Ammeter and Watt-meter readings). The ammeter reading gives the primary equivalent of full load current IL. As the voltage applied for full load current in a short circuit test on the transformer is quite small compared to the rated primary voltage of the transformer, the core losses in transformer can be taken as negligible here. Experimental connection for short circuit test is shown in fig 1.3.
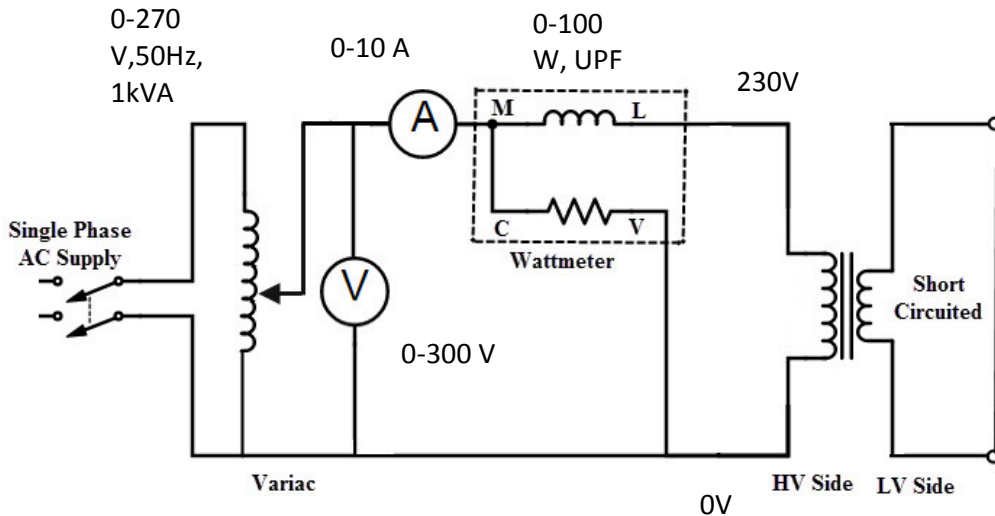
Fig 1.3 Short circuit test on transformer

Let's say, voltmeter reading is V_{sc}. The watt-meter reading indicates the input power during the test. As the transformer is short circuited , there is no output; hence the input power here consists of copper losses in the transformer. Since the applied voltage V_{sc} is short circuit voltage in the transformer and hence it is quite small compared to the rated voltage, so, neglect the core loss due to the small applied voltage. Hence the wattmeter reading can be taken as equal to copper losses in the transformer. Let us consider wattmeter reading is P_{sc}.

$$P_{sc} = R_{sc}I_L{}^2 \qquad (1.4)$$

Where, R_e is equivalent resistance of transformer

If, Z_{sc} is equivalent impedance of transformer.

$$Z_{sc} = \frac{V_{sc}}{I_L} \qquad (1.5)$$

Therefore, if equivalent reactance of transformer is X_e.

$$X_e{}^2 = Z_e{}^2 - R_e{}^2 \qquad (1.6)$$

These values are referred to the HV side of the transformer as the test is conducted on the HV side of the transformer. These values could easily

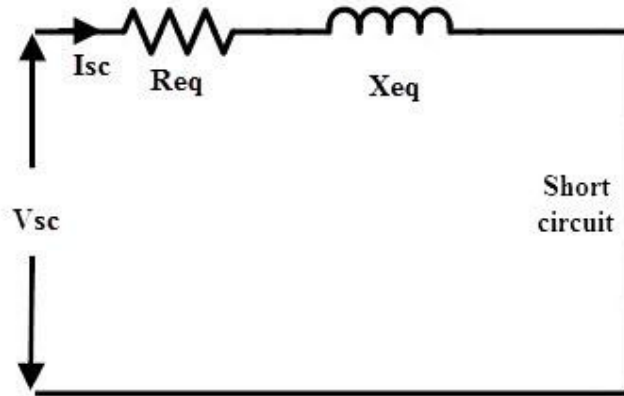be converted to the LV side by dividing these values with the square of transformation ratio.

Fig 1.4 Equivalent circuit of transformer – short circuit test

Hence the short-circuit test of a transformer is used to determine copper losses in the transformer at full load. It is also used to obtain the parameters to approximate the equivalent transformer.Equivalent circuit of Transformer in short circuit test is shown in fig 1.4.

CHAPTER 2
LITERATURE SURVEY

Ben E. Franklin, Cajetan M. Akujuobi, Warsame Ali Prairie View A&M University, Texas(2008) their focus is to implement automated test algorithms for testing analog-todigital converters using LabView software. With the increase in bandwidth hungry applications the need for high speed and high resolution ADCs are needed on the front ends of the new systems that are being implemented today. As the designs become more complex, the ability to test these fast and high resolution ADCs becomes even more important. LabView allows the test engineer to interact with the device under test (DUT) through means of data acquisition and instrument control. Developing custom tests in LabView can result in reduced test time, which in turn will help reduce costs in testing. A linearity test will be presented for testing ADC static parameters in LabView, which include Differential Non-Linearity (DNL) and Integral Non-Linearity (INL)

Kunal B. Chavhanl and R.T. Ugale,(2010) stated that the testing of electrical machines is necessary for validating the design of a machine. Induction Motor (IM) is widely used in the industrial applications. More than 90% motors used are of squirrel cage type in the industry. With the development of sensors and various automation components, the testing process can be automated using software such as LabVIEW, Programmable Logic Controller (PLC), Supervisory Control and Data Acquisition (SCADA) etc. LabVIEW is a graphical programming language which is widely used throughout the industry, as well as research and academic labs, for data acquisition and as an instrument control software. LabVIEW is compatible with Windows, Mac OS X, and Linux. The traditional motor testing method possesses many disadvantages such as more time

requirement, lack of reliability, and stability of measuring instruments in the production environment. They aims at development of an automated test bench for Induction Motor using data acquisition and controlling of the motor by developing suitable Graphic User Interface (GUI) and integration of sensing components into the system

The authors S P Zhu, J Shi and Y S Lim(2000) describes about an on-line testing and analysis prototype, called TXWIN, for distribution power transformers is presented in this paper. TXWIN allows the user to perform no-load test, load-loss test, and ratio test automatically via Windows Graphic User Interfaces (GUI). It also contains other transformer performance tests: DC resistance measurement test, high tension test, and insulation test. The prototype also has the funct ions to analyze test results, generate customized reports, and store transformer data in database.

Reliable ADC testing using LabVIEW are Vilmos Pálfi and István Kollár,(2012) here thy are talking about the sinewave histogram test which is a commonly used method to characterize nonlinear behaviour of A/D converters. Accurate test results require wise choice of the test settings and signal parameters. However, standard methods do not support the recognition of bad parameter settings. In addition, those may provide inaccurate results even when the signal settings are optimal for the histogram test. In their paper they presents a software which helps handling above problems and deficiencies to guarantee the quality of the test results.

The journal paper Computer Simulation Analysis of Power Transformer Test Design Technology written by Yongsheng Duan and Kaiping Li(2003) talks about Transformer is an extremely important electrical equipment in power system. The quality of transformer

test directly affects the safety and reliability of industry, agriculture and household power supply. Therefore, power transformer plays a very important role in the power system. Before putting into operation, carry out handover test, which will check the correctness of manufacturing. Through the simulation analysis, better verify the rationality of the function and performance design of the power transformer, which will ensure the safe, reliable and stable operation of the transformer during the test. Through the simulation experiment, determine whether the function of power transformer can meet the demand in advance, which will avoid the cost of direct test verification. TRT is an important test item in transformer test, which needs computer simulation at the same time. Therefore, this paper takes the temperature rise test (hereinafter referred to as TRT) as an example. Firstly, this paper lists the experimental items of transformer. Then, the TRT is selected as the verification item. Based on the analysis of the design of automatic control system for TRT, the computer simulation analysis is carried out in this paper. By this it is understood the way how computer simulation analysis are being carried out.

The physical test jig structures whereas the conductivity test jig includes: a jig main body; a holding member; a conductivity test unit; a conductivity member; an air cylinder; a jig main body; and a second air cylinder. The jig main body has a hole for receiving the connector. The holding member holds the connector in the hole. The conductivity test unit is detachably attached to the connector. When the conductivity test unit moves close to the connector, the conductivity member is electrically connected to the terminals of the connector. The air cylinder makes the conductivity test unit contact the connector and removes the conductivity test unit from the connector. The push-out member is interposed between

the connector and the jig main body in an insertion direction of the connector in the hole. The second air cylinder moves the push-out member in the insertion direction.

Kalkman, C. J.(2011) experimented a Computer-based data acquisition systems play an important role in clinical monitoring and in the development of new monitoring tools. LabVIEW (National Instruments, Austin, TX) is a data acquisition and programming environment that allows flexible acquisition and processing of analog and digital data. The main feature that distinguishes LabVIEW from other data acquisition programs is its highly modular graphical programming language, "G," and a large library of mathematical and statistical functions. The advantage of graphical programming is that the code is flexible, reusable, and self-documenting. Subroutines can be saved in a library and reused without modification in other programs. This dramatically reduces development time and enables researchers to develop or modify their own programs. LabVIEW uses a large amount of processing power and computer memory, thus requiring a powerful computer. A large-screen monitor is desirable when developing larger applications. LabVIEW is excellently suited by testing new monitoring paradigms, analysis algorithms, or user interfaces. The typical LabVIEW user is the researcher who wants to develop a new monitoring technique, a set of new (derived) variables by integrating signals from several existing patient monitors, closed-loop control of a physiological variable, or a physiological simulator.

CHAPTER 3
HARDWARE DESCRIPTION

3.1 AUTOTRANSFORMER

3.1.1 INTRODUCTION

An **autotransformer** is an electrical transformer with only one winding . The "auto" (Greek for "self") prefix refers to the single coil acting alone, not to any kind of automatic mechanism. In an autotransformer, portions of the same winding act as both the primary winding and secondary winding sides of the transformer. In contrast, an ordinary transformer has separate primary and secondary windings which have no metallic conducting path between them.The autotransformer winding has at least three taps where electrical connections are made. Since part of the winding does "double duty", autotransformers have the advantages of often being smaller, lighter, and cheaper than typical dual-winding transformers, but the disadvantage of not providing electrical isolation between primary and secondary circuits. Other advantages of autotransformers include lower leakage reactance, lower losses, lower excitation current, and increased VA rating for a given size and mass. Autotransformer is shown in the fig 3.1.

Fig 3.1 Auto transformer

3.1.2 APPLICATION:

1. Power transmission and distribution .
2. Audio System .
3. Railways .
4. Starter (for motor) .

3.2 SINGLE PHASE TRANSFORMER

3.2.1 INTRODUCTION

A **transformer** is a passive electrical device that transfers electrical energy from one electrical circuit to another, or multiple circuits. fig 3.2 shows the single phase transformer. A varying current in any one coil of the transformer produces a varying magnetic flux in the transformer's core, which induces a varying electromotive force across any other coils wound around

the same core. Electrical energy can be transferred between separate coils without a metallic (conductive) connection between the two circuits. Faraday's law of induction, discovered in 1831, describes the induced voltage effect in any coil due to a changing magnetic flux encircled by the coil.

Transformers are most commonly used for increasing low AC voltages at high current (a step-up transformer) or decreasing high AC voltages at low current (a step-down transformer) in electric power applications, and for coupling the stages of signal-processing circuits. Transformers can also be used for isolation, where the voltage in equals the voltage out, with separate coils not electrically bonded to one another.

Fig 3.2 Single phase transformer

3.2.2 APPLICATION

1. Distribution System .
2. In generating stations .
3. In most of power circuits .

3.3 DAQ (NI myDAQ)

3.3.1 INTRODUCTION

Combines a comprehensive set of plug-and-play computer-based lab instruments with portability for hands-on student learning in or outside the lab. myDAQ Student Data Acquisition Devices feature eight commonly used plug-and-play computer-based lab instruments based on LabVIEW, including a digital multimeter (DMM), oscilloscope, and function generator. Students can access all the ready-to-run software instruments to perform experiments and exercises with the Bode analyzer, arbitrary waveform generator, dynamic signal analyzer (fast Fourier transform), digital input, and digital output. These affordable devices allow for real engineering and, when combined with LabVIEW and NI Multisim software, give students the power to prototype systems and analyze circuits outside traditional lectures and labs. NI myDAQ is shown in fig 3.3.

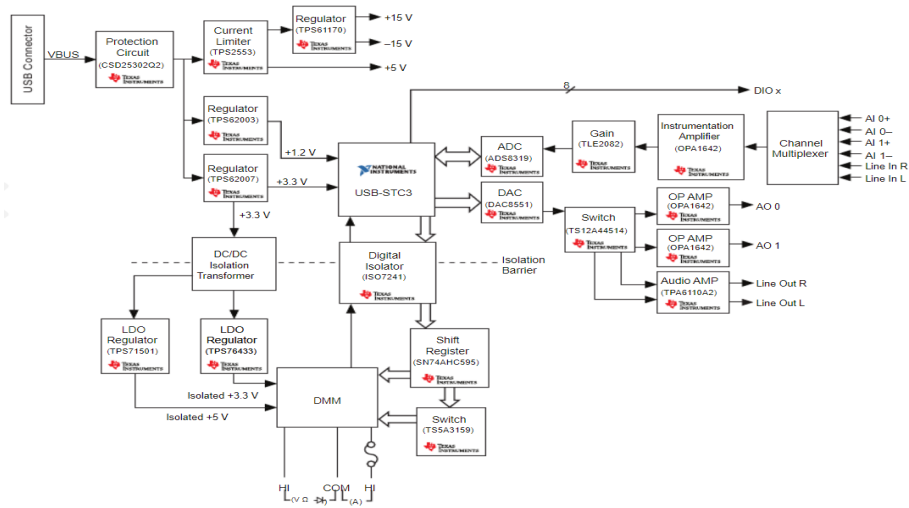**Fig 3.3 NI myDAQ**

3.3.2 HARDWARE BLOCK DIAGRAM

Fig 3.4 Hardware block diagram of NI myDAQ
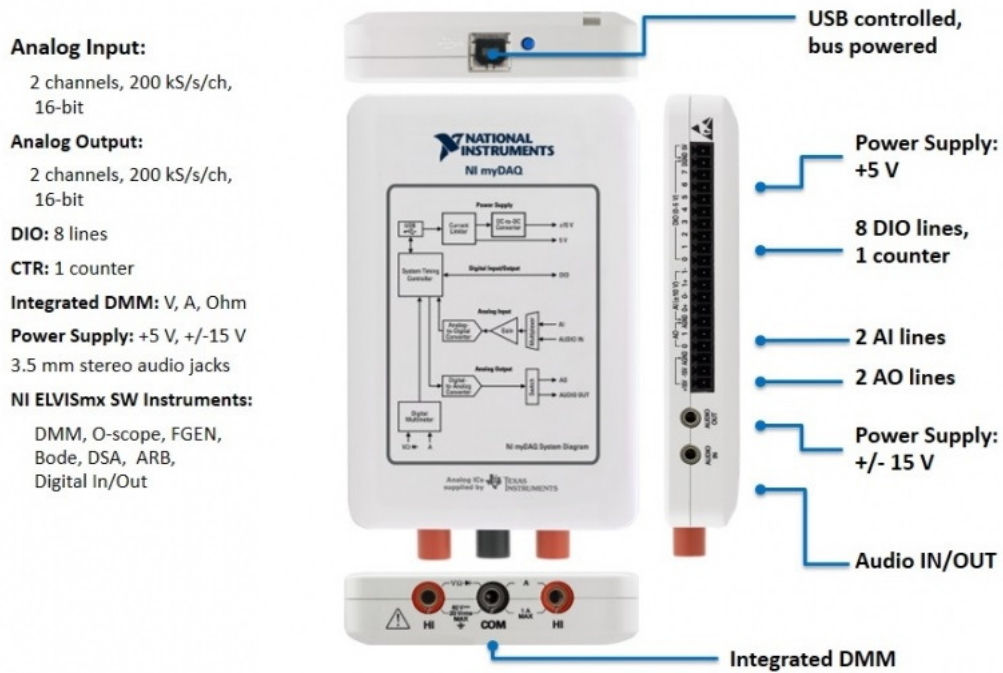
3.3.3 PIN OUT CONFIGURATION

Fig 3.5 Pin out configuration of DAQ(NI myDAQ)

3.4 POTENTIAL TRANSFORMER

3.4.1 INTRODUCTION

Potential transformers or voltage transformers are used for stepping down the voltage to a lower value so that it can be measured safely and easily.It is similar to a general purpose step down transformer. The primary side is connected to the phase and ground of the high voltage source. It has lower number of turns in the secondary side than in the primary side. A voltage proportional to the primary voltage is obtained in the secondary. Generally the primary of the potential transformer is connected parallel to the voltage to be measured. The secondary terminal can be connected to the measuring equipment.The symbolic representation of potential transformer is shown in fig 3.6.

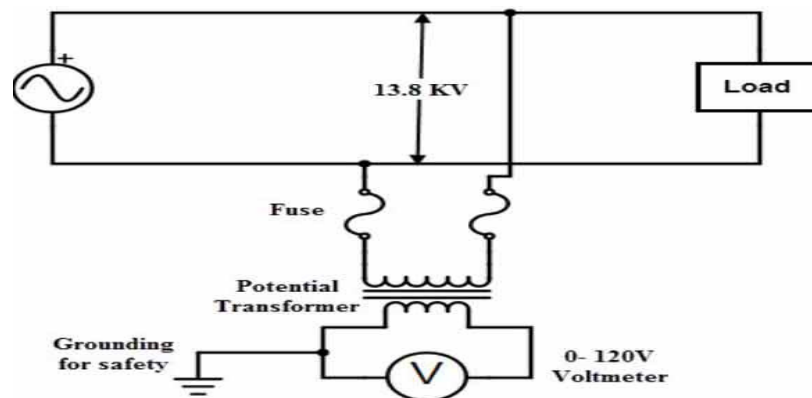

Fig 3.6 Symbolic representation of potential transformer

3.4.2 BURDEN OF POTENTIAL TRANSFORMER

The burden is the total external volt-amp load on the secondary at rated secondary voltage. The rated burden of a PT is a

VA burden which must not be exceeded if the transformer is to operate with its stated accuracy. The maximum burden is the greatest VA load at which the potential transformer will operate continuously without overheating its winding beyond the permissible limits. This burden is several times greater than the rated burden. The burden or load connected on the secondary should be within the limits for effective and efficient operation of the transformer.

3.5 CURRENT TRANSFORMER

3.5.1 INTRODUCTION

Current transformer belongs to the category of instrument transformers which is used for measuring electrical parameters such as voltage and current. The current is induced in the secondary of current transformer proportional to the current in the primary. The current transformer is mainly used for the measurement of high magnitude current. Thus affirming the safety of the measuring instruments such as ammeter, voltmeter and watt-meter etc. The principle of operation of current transformer is different from widely used voltage transformer. The symbolic representation of current transformer is shown in fig 3.7 .
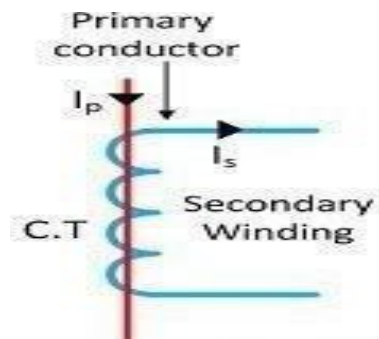

Fig 3.7 Symbolic representation of current transformer .

3.6 RELAY

A **relay** is an electrically operated switch. It consists of a set of input terminals for a single or multiple control signals, and a set of operating contact terminals. The switch may have any number of contacts in multiple contact forms, such as make contacts, break contacts, or combinations thereof. Relays are used where it is necessary to control a circuit by an independent low-power signal, or where several circuits must be controlled by one signal. Relays were first used in long-distance telegraph circuits as signal repeaters: they refresh the signal coming in from one circuit by transmitting it on another circuit. Relays were used extensively in telephone exchanges and early computers to perform logical operations.Relay module is shown in fig 3.8.

The traditional form of a relay uses an electromagnet to close or open the contacts, but other operating principles have been invented, such as in solid-state relay which use semiconductor properties for control without relying on moving parts. Relays with calibrated operating characteristics and sometimes multiple operating coils are used to protect electrical circuits from overload or faults; in modern electric power systems these functions are performed by digital instruments still called protective relay.
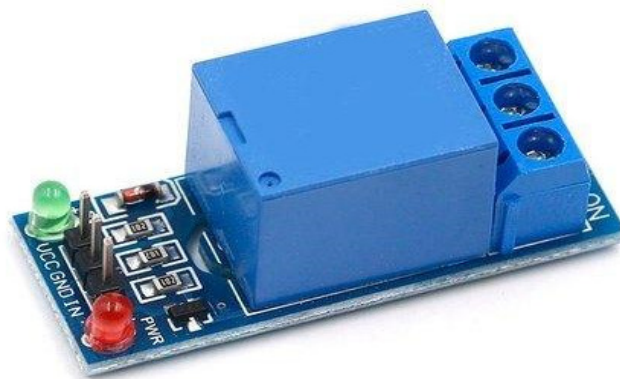

Fig 3.8 Relay module

CHAPTER 4
SOFTWARE DESCRIPTION

Computer based data acquisition systems play an important role in clinical monitoring and in the development of new monitoring tools. LabVIEW (National Instruments, Austin, TX) is a data acquisition and programming environment that allows flexible acquisition and processing of analog and digital data. The main feature that distinguishes LabVIEW from other data acquisition programs is its highly modular graphical programming language, "G," and a large library of mathematical and statistical functions. The advantage of graphical programming is that the code is flexible, reusable, and self documenting. Subroutines can be saved in a library and reused without modification in other programs. This dramatically reduces development time and enables researchers to develop or modify their own programs. LabVIEW uses a large amount of processing power and computer memory, thus requiring a powerful computer. A large screen monitor is desirable when developing larger applications. LabVIEW is excellently suited by testing new monitoring paradigms, analysis algorithms, or user interfaces. The typical LabVIEW user is the researcher who wants to develop a new monitoring technique, a set of new (derived) variables by integrating signals from several existing patient monitors, closed loop control of a physiological variable, or a physiological simulator.

4.1 Lab VIEW INTRODUCTION

The LabVIEW program development environment is different from standard C or Java development systems in one important respect: While other programming systems use text-based languages to create lines of code, LabVIEW uses a graphical programming language, often called "G," to create programs in a pictorial form called a block diagram.

Graphical programming eliminates a lot of the syntactical details associated with text-based languages, such as where to put semicolons and curly braces. Graphical programming allows the user to concentrate on the flow of data within the application, because its simple syntax doesn't obscure what the program is doing. Figures 4.1 and 4.2 show a simple LabVIEW user interface
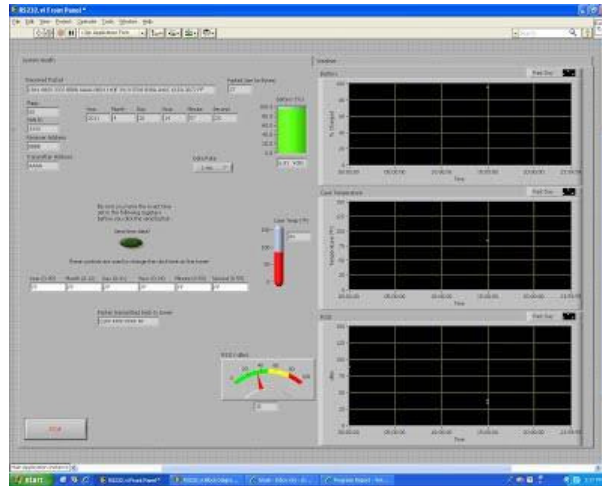

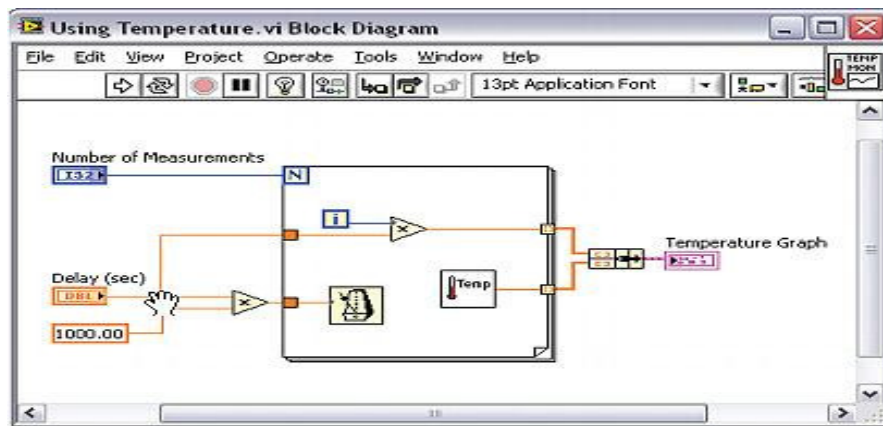
Fig 4.1 User interface

Fig 4.2 Graphical code

and the code behind it. LabVIEW uses terminology, icons, and ideas familiar to scientists and engineers. It relies on graphical symbols rather than textual language to define a program's actions. Its execution is based

on the principle of dataflow, in which functions exe cute only after receiving the necessary data. Because of these features, user can learn LabVIEW even if user have little or no programming experience. However, user will find that a knowledge of programming fundamentals is very helpful.

4.2 The Lab VIEW System

The Lab VIEW System the LabVIEW system is a software environment for data acquisition and control, originally conceived and developed on a Macintosh computer (Apple Computer, Cupertino, CA), and introduced in 1986. LabVIEW is an acronym for Laboratory Virtual Instrument Engineering Workbench. It has evolved from a program that could send, receive, and integrate data to and from laboratory instruments equipped with a GPIB (general purpose interface bus, conforming to the IEEE-488 standard) into a system that can accept data in both analog and digital formats, and perform data analysis and instrument control. It was the first software program to include graphical, iconic programming techniques, which make the form of programming more transparent, and the sequence of processing visible to the user. The latest release of LabVIEW (version 3.0) is available on three computing platforms: Apple Macintosh, DOS/Windows 3.1, and Sun workstations. Applications developed on one of these platforms can run on another platform with no or only minor modifications. The main feature that distinguishes LabVIEW from other data acquisition programs is the graphical programming language ("G"). It comes with a huge library of mathematical, statistical, and digital signal processing (DSP) functions. Graphical programming means that statements, variables and functions are represented by on screen icons and "wires," rather than by lines of text. In a LabVIEW program, execution is not controlled by the order in

which the statements were written in the source code (line-oriented programming), but, rather, by the data that are generated (data flow oriented). For example, subroutines that use data originating from an A/D conversion board as input do not execute until the data have been acquired. The developers of LabVIEW have consistently used the metaphor of a VIRTUAL INSTRUMENT (VI), mimicking real world measurement instruments. A LabVIEW virtual instrument consists of a front panel (the user interface) that can both accept input from the user (sliders, knobs, values entered from the keyboard, push buttons, selector switches) and present output to the user (indicators, LEDs, graphs, strip charts, sounds). A LabVIEW program (called diagram) somewhat resembles the schematic for an electronic circuit. Wires represent variables that hold data. The various processes that act on these variables are represented by icons (small graphic objects that suggest the operation they perform). All basic elements of conventional programming languages are implemented. For example, CONDITIONAL BRANCHING (IF . . . THEN . . . ELSE) is represented by a CASE structure. Repetitive operations can be put into FOR... NEXT or WHILE loops. In LabVIEW, this literally means moving all the relevant statements within the screen boundaries of a graphic element that represents the loop.

4.3 Creating a Lab VIEW Program

The creation of a LabVIEW program (virtual instrument or VI) starts with determining which variables will serve as inputs, and placing them on the front panel as controls. A wide selection of customizable graphic elements is available to represent numeric controls, text (string) controls, pop up menu controls, picture "ring" controls, or picture Boolean controls. Similarly, the outputs from the program are placed on

the front panel. Again, the output may be in numerical, textual, or graphical form. The programmer then switches to the underlying diagram, where the newly placed front panel controls and indicators are represented as rectangular boxes. Color and a number inside the box denote data type and precision (INTEGER or FLOATING POINT). The programmer selects functions or subroutines (SUBVIS) from pull down menus and connects input and output terminals with the functions using a special cursor, the wiring tool. Colour and line thickness of the wires provides information on the data type. Wires representing integer numbers are represented in blue, while FLOATING POINT NUMBERS are represented in orange. Arrays are represented by thicker wires; parallel wires represent multidimensional arrays. Repetitive operations are placed inside a WHILE or FOR NEXT loop as appropriate. Conditional branching is achieved with the CASE structure, by wiring the condition (either a Boolean TRUE or FALSE, or an integer number) to the condition terminal, a green question mark. Inside the CASE structure, each of the CASEs can be filled with the appropriate actions or subroutines (sub-VI's). Since it is not possible to have all the cases visible at the same time, a control at the top border of the CASE structure allows the programmer to step through and inspect the contents of the various case alternatives. When printing a diagram for documentation, the contents of each case can be printed separately. DEBUGGING is facilitated by the fact that each VI or sub VI is a separate program that can be run independently from the calling (main program) by setting the front panel controls and inspecting the results. Rearranging screen objects can be easily accomplished and connecting wires will try to adapt in a logical way. The programmer can improve diagram legibility by minimizing screen clutter and by avoiding crossing of wires or wires that cross under, rather than terminate, in functions or sub-VIs. Some drawing

tools, like alignment and distribution, are available to help " streamline the appearance of diagrams and front panels.

4.4 Lab VIEW Libraries

Extensive libraries of functions are available that aid in the acquisition of data using either the serial ports or one of the National Instruments analog or digital input boards. Many of these library VIs contains source code (diagrams) that can be modified by the user. Various windowing functions, spectral analysis, and a large set of digital filters are available to inspect or to alter the frequency content of acquired waveform data. In addition, a large library of statistical functions is available for basic statistics, hypothesis testing, and curve fitting. Manipulation of character strings is supported to facilitate communication with devices via RS-232 or IEEE488. To aid user interaction with a Lab VIEW program, a large number of on-screen controls and indicators are available from a pull-down menu. These controls and indicators include numeric controls to display or to alter numbers, sliders, knobs, gauges, dials, pointers, and thermometers. Most of these graphic elements can be set to be either a control or an indicator. Boolean controls and indicators available are buttons, knobs, switches, and LEDs. Display of data in graphical form has been made straightforward by the inclusion of resizable graphs that can be positioned anywhere on the screen. The visibility, scaling, labeling, gridlines, colors, and behavior of cursors on these graphs can be set from within the program using attribute nodes.NI and many third-party vendors provide a variety of Lab VIEW toolsets for advanced data acquisition, data analysis, system control (PID, fuzzy logic, system design, IMAQ-Image Analysis), database connectivity, etc. Each of these toolsets/libraries provides advanced functions that can be easily incorporated into applications. Users can also build and deploy toolsets.

Built-in control structures such as Math-Script allow embedding MATLAB (Math Works, Natick, MA) scripts within Lab VIEW code for complex mathematical analysis. Lab VIEW also provides functions to embed text-based code into the block diagram. NI provides the personal digital assistant (PDA) module extension for Lab VIEW that allows applications to be developed and deployed onto PDAs for remote monitoring and control. Lab VIEW provides tools such as the Real-Time Module and the field-programmable gate array Module to develop deterministic applications that can be run stand-alone, in a distributed fashion, or downloaded to a dedicated target to run independently.The inherent parallel environment of Lab VIEW is extremely useful in the control of laboratory equipment. Functions can have multiple continuous While Loops where one loop is acquiring data rapidly and the other loop processes the data at a much slower rate. Implementing such a paradigm in other languages requires triggering an independent function thread for each process and developing logic to manage synchronization. Through timed While Loops, multiple independent While Loops can be easily synchronized to process at a desired period and phase relative to one another. Lab VIEW allows invoking multiple instances of the same function with each maintaining its own data space. For instance, drag many instances of the Mean sub-VI onto the block diagram and they would all run in parallel, independent of one another. To synchronize or enforce control flow within the dataflow environment, Lab VIEW also provides functions such as queues, semaphores, and notification functions.

4.5 DAQ Assistance

DAQ Assistant is used to quickly develop and deploy a data acquisition (DAQ) application in Lab Windows/CVI. The DAQ Assistant

is an easy-to-use graphical interface for configuring measurement tasks and channels and for customizing timing, triggering, and scales without programming. Using the DAQ Assistant, user can configure a measurement task for all of the DAQ applications and then generate code to configure and use the task in the application program . DAQ package in LabVIEW is shown in fig 4.3.
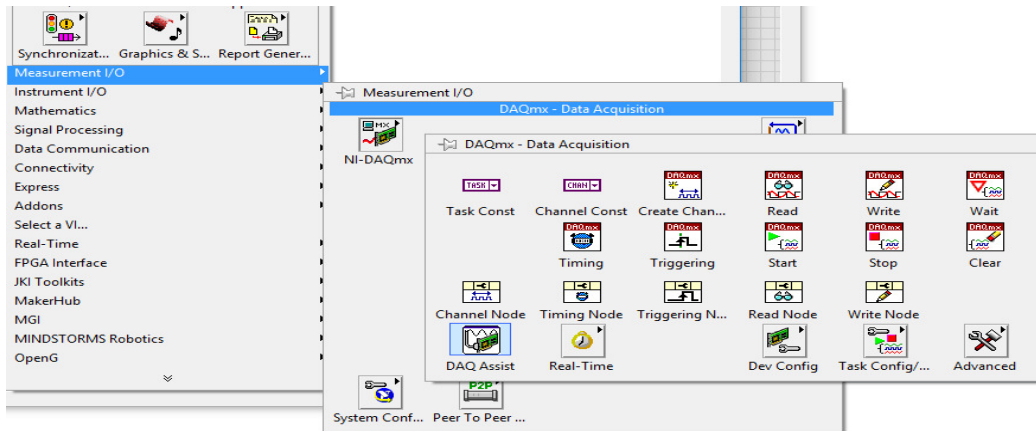

Fig 4.3 DAQ package

Once user have a DAQmx Task Name (Task Constant), right click the Task Constant and hover over Generate Code. User have the following options: Example, Configuration, Example and Configuration, and Convert to Express VI.

CHAPTER 5

RESULTS AND DISCUSSION

The project was carried out successfully and tested in the laboratory. The results were obtained as expected and the following observations were made.

5.1 EXECUTION OF PROGRAM

The program written in Lab VIEW was executed in PC/Laptop , which is connected with the DAQ (NI myDAQ) . It transfers the analog data form PT and CT to PC/Laptop. LabVIEW program for open circuit test is shown in fig 5.1. LabVIEW program for short circuit test is shown in fig 5.2.
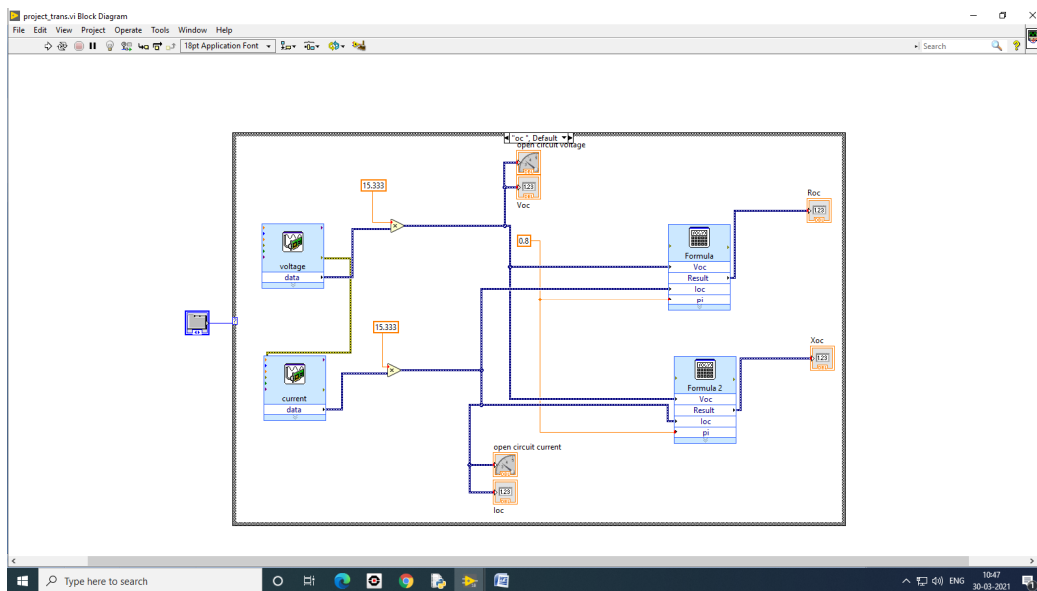

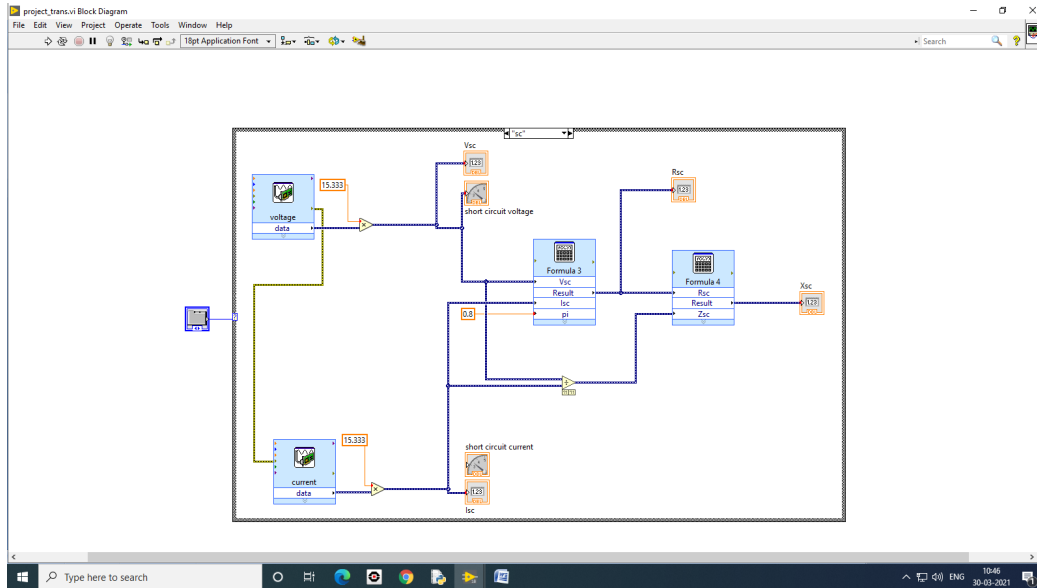**Fig 5.1 Code for open circuit test**

Fig 5.2 Code for short circuit test

5.2 CALCULATIONS INVOLVED

5.2.1 OPEN CIRCUIT TEST

$$P_{oc} = V_{oc}I_{oc}\cos\emptyset = 35W \tag{5.1}$$
$$I_c = I_{oc}\cos\emptyset = 0.152\ A \tag{5.2}$$
$$I_m = I_{oc}\sin\emptyset = 0.648\ A \tag{5.3}$$
$$R_o = \frac{V_{oc}}{I_c} = 0.15\ \text{ohm} \tag{5.4}$$
$$X_o = \frac{V_{oc}}{I_m} = 0.744\ \text{ohm} \tag{5.5}$$

5.2.2 SHORT CIRCUIT TEST

$$P_{sc} = I_{sc}{}^2 R_{sc} = 45\ \text{W} \tag{5.6}$$
$$R_{sc} = \frac{P_{sc}}{I_{sc}{}^2} = 2.858\ \text{ohm} \tag{5.7}$$
$$Z_{sc} = \frac{V_{sc}}{I_{sc}} = 4.033\ \text{ohm} \tag{5.8}$$
$$X_{sc} = \sqrt[2]{Z_{sc}{}^2 - R_{sc}{}^2} = 2.846\ \text{ohm} \tag{5.9}$$

5.3 DISPLAYING METER READINGS IN LABVIEW

All the values calculated during the test are displayed in Lab VIEW front panel and user can switch between both the tests (OC and SC test). Below shown fig 5.3 and fig 5.4 are the actually how the values will be shown in the front panel.
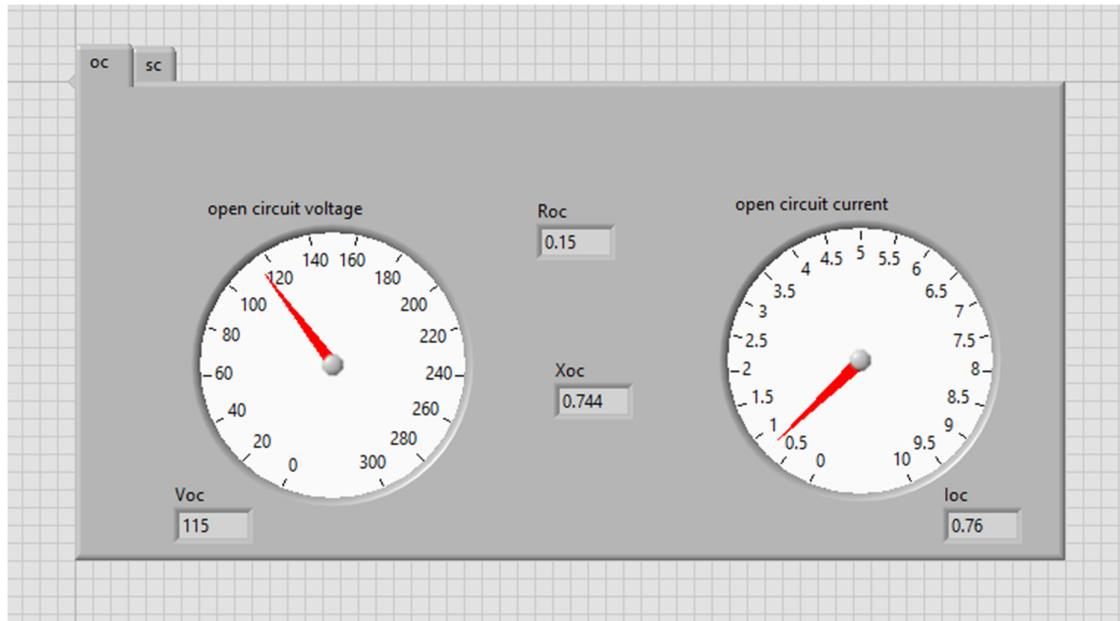

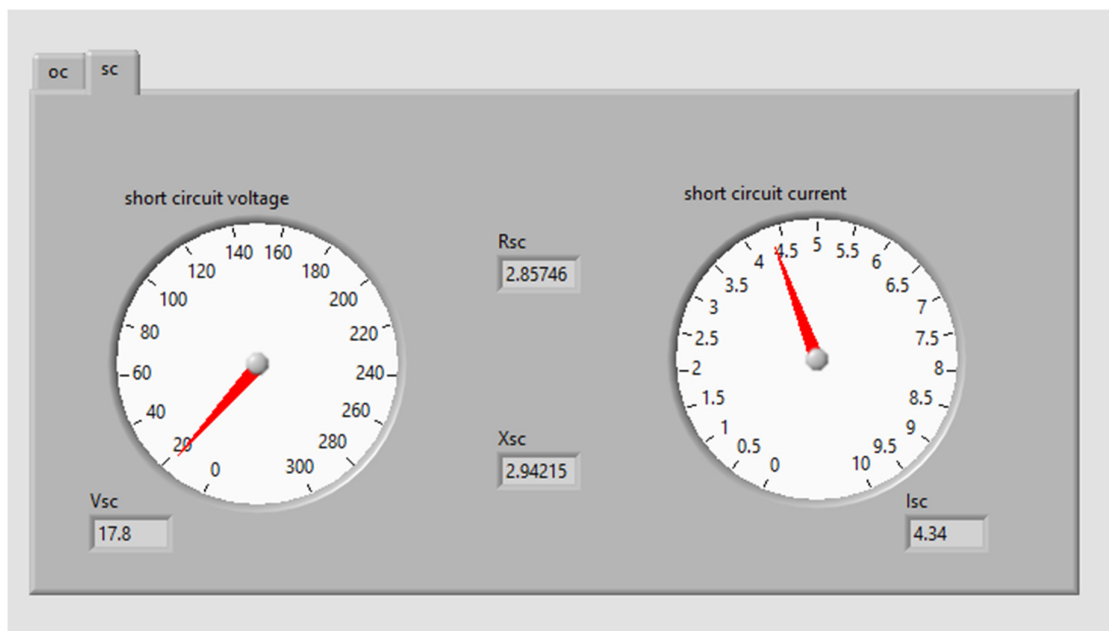**Fig 5.3 Output of OC test shown in front panel**

Fig 5.4 Output of SC test shown in front panel

5.4 ACTUAL TEST SETUP

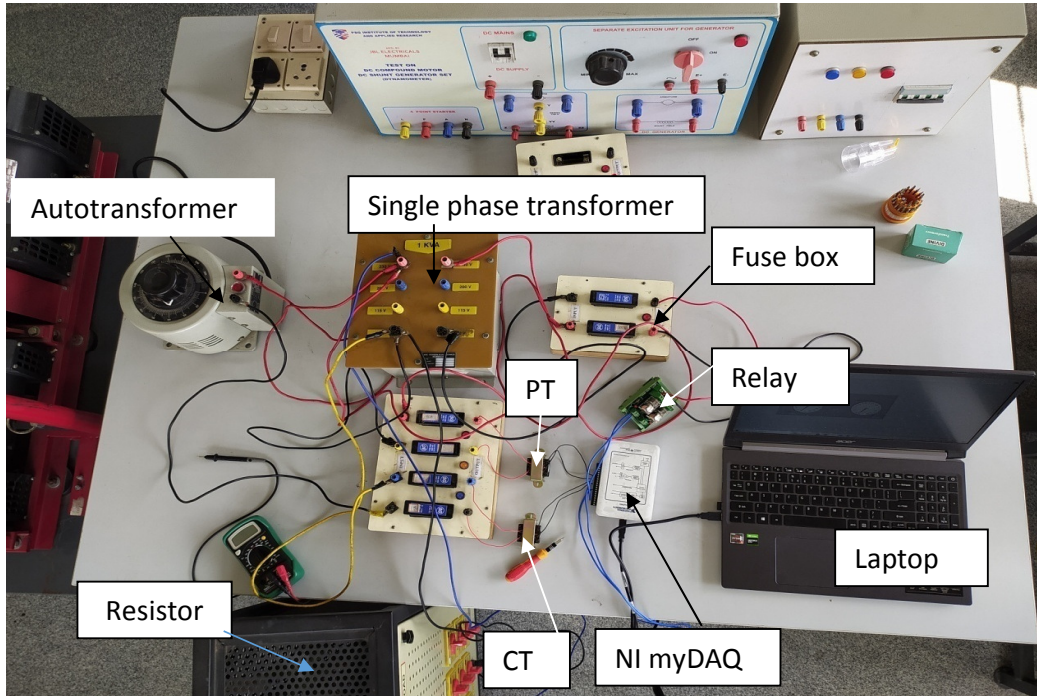All the apparatus are connected as per the connection shown below in fig 5.5 and fig 5.6.

Fig 5.5 Actual test setup top view
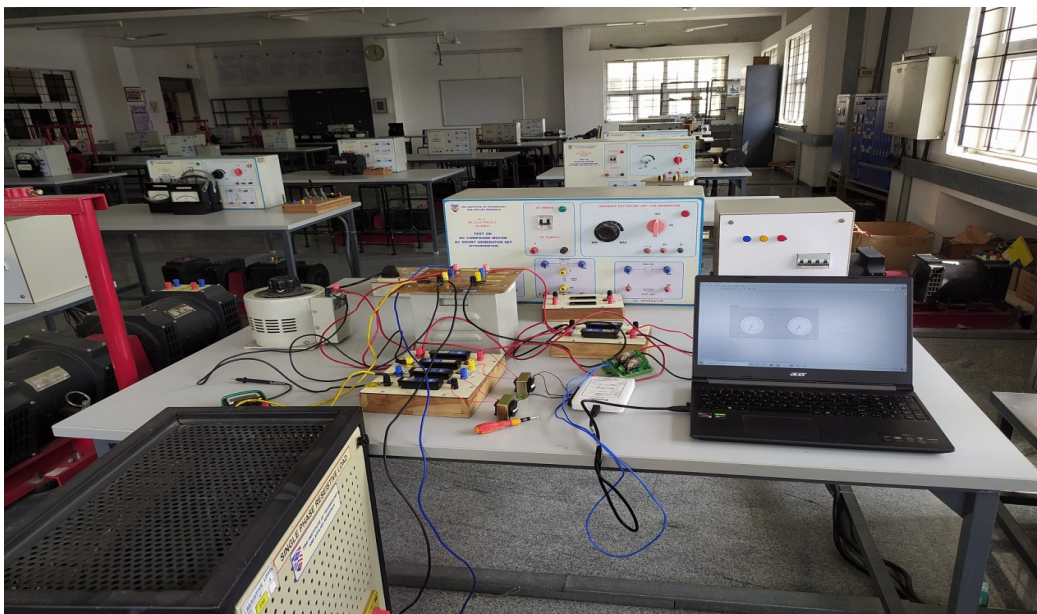
Fig 5.6 Actual setup front view

5.5 BLOCK DIAGRAM

This block diagram shows in fig 5.7 explains how the flow of the execution of the experiment.
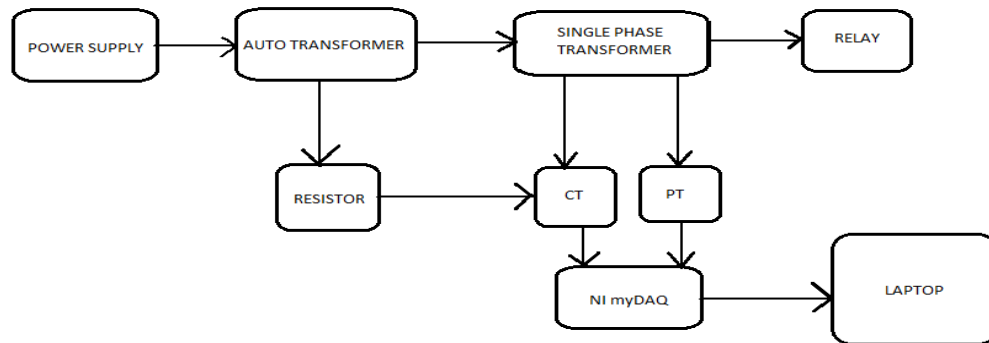
Fig 5.7 Block diagram

5.6 HARDWARE SPECIFICATION

Table 1.1 Hardware Specifications

S.NO	NAME	RATING	QUANTITY
1.	POWER SUPPLY	230V,50Hz	1
2.	AUTOTRANSFORMER	0-230V,50Hz	1
3.	SINGLE PHASE TRANSFORMER	230-230 V ,50 Hz,1kVA	1
4.	RELAY	0-230V AC,10A 0-20V DC	1
5.	NI myDAQ	-	1
6.	LAPTOP	WITH LABVIEW (2019)INSTALLED	1
7.	RESISTOR	230 ohm,230W	1

CHAPTER 6

CONCLUSION

The chapter concludes the project by summarizing the procedures that were carried out to execute the project .

6.1 SUMMARY OF THE PROJECT

The project work involves successful implementation of OC and SC tests and displaying the values in the front panel of Lab VIEW . The current and voltage readings are measured from CT and PT respectively. The analog values from both the transformers are read by DAQ and corresponding signal is sent to PC/Laptop. Then the values are displayed in the front panel .

6.2 FUTURE WORK

More complicated test like MBT, Vector group, TRT, etc., can be carried out using the same technique. Also logging data for future reference and analysis . These data can be transferred to cloud. One more improvement can be done is power factor measurement

APPENDIX

DEVICE SPECIFICATIONS

NI myDAQ Student Data Acquisition Device

Definitions

Warranted specifications describe the performance of a model under stated operating conditions and are covered by the model warranty.

The following characteristic specifications describe values that are relevant to the use of the model under stated operating conditions but are not covered by the model warranty.

- Typical specifications describe the performance met by a majority of models.

- Nominal specifications describe an attribute that is based on design, conformance testing, or supplemental testing.

Specifications are Typical unless otherwise noted.

Conditions

Specifications are valid at 25 °C unless otherwise noted.

Analog Input

Number of channels	2 differential or 1 stereo audio input
ADC resolution	16 bits
Maximum sampling rate	200 kS/s
Timing accuracy	100 ppm of sample rate
Timing resolution	10 ns

Range

Analog input	±10 V, ±2 V, DC-coupled

Audio input   ±2 V, AC-coupled

Passband   (-3 dB)

Analog input   DC to 400 kHz

Audio input   1.5 Hz to 400 kHz

Connector type

Analog input   Screw terminals

Audio input   3.5 mm stereo Jack

Input type (audio input)   Line-in or microp

Microphone excitation   5.25 V through 10 kΩ

Table 1.2 Absolute accuracy

Nominal Range		Typical at 23 °C (mV)	Maximum (18 to 28 °C) (mV)
Positive Full Scale	Negative Full Scale		
10	-10	22.8	38.9
2	-2	4.9	8.6

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