

Automatic Power Transformer Tester

**Dr .D .Sivaraj¹, Akash. S², Gokulraj. N³,
Khaja moideen. S⁴, Loganathan. S⁵**

¹Assistant Professor, Department of Electrical and Electronic Engineering,
Sri Manakula Vinayagar Engineering College, Puducherry, India.

^{2,3,4,5}Students, Department of Electrical and Electronics Engineering, SMVEC, Puducherry, India

Abstract

An essential step in the production of transformers is the quality testing of the devices. Transformers with normal operation have a lower failure rate and longer lifespan. When done manually, checking the transformer in its whole is a time-consuming and laborious task. Using the software platform LabVIEW (Laboratory Virtual Instrumentation Engineering Workbench), the testing method is automated and can save the time. The test platform is made to conduct tests with high voltage and zero load voltage test. A comprehensive design, simulation, and visualisation environment is provided by the LABVIEW software platform. The programme is built on cutting-edge. Computing techniques making it possible to calculate the ideal transformer active and mechanical part configuration.

Index terms: Automation, power transformer, high voltage test, no-load voltage test, and quality testing (Key words)

I. INTRODUCTION

An electrical distribution system's major component is the transformer. Failure of the transformer may result from electrical overvoltage conditions, lighting, switching surges, partial discharge, static electrification, mechanical deformation of the transformer's windings, which causes abrasions or rupturing of the paper insulation, or thermal deformation, which occurs when the paper insulation loses its physical strength to the point where it can no longer withstand the mechanical movement or overloading the transformer for an extended period of time. Meeting client requirements, enhancing operational accuracy, accelerating troubleshooting, and lowering total failure risk are other justifications. Because of this, it's crucial to put the transformer through a number of testing processes. In a mass-producing enterprise, manual transformer testing costs money, labour, and time. Thus, automating the testing procedure will be useful.

Transformer Mounted on a PCB

The power transformer testing procedures vary depending on the kind of transformer. This document discusses the testing procedures for PCB mountable toroidal type power transformers. The following are the components of the PCB mountable toroidal transformer.

Core CRGO: When silicon is added to iron in the precise amounts and through a certain manufacturing method, iron's magnetic and electrical characteristics are found to dramatically enhance. The modern name for this is silicon steel. Along with lowering eddy current losses, this metal combination also greatly increased the steel's magnetic permeability. Due to this finding, high-grade steel known as Cold Rolled Grain Oriented (CRGO) steel was created [1].

Tape toroidal cores are made by winding magnetic material around a mandrel in the shape of a pre-slit tape, much as tape C cores. All iron alloys and amorphous materials are available for this tape. The cased

and encapsulated versions of the tape toroid are both available. Superior electrical characteristics and winding stress prevention are provided by the cased toroid. When some of the precise magnetic qualities are not crucial to the design, such as in power transformers [2], the enclosed cores are employed.

Windings: Copper windings are chosen over aluminium windings in power transformers because they can carry nearly twice as much current and have a higher short circuit resistance. The secondary windings experience an induced emf as a result of these stationary windings' variable flux. Various transformers have different copper winding grades.

II.METHODOLOGY

PCB toroidal transformer production

Power transformer quality testing is included as a last stage in the production process. Consequently, it is crucial to comprehend the complete production process. The choice of insulation and the core (encapsulated) is the first step in the production of a power transformer. The secondary windings are wound next, which is followed by the primary windings, which are separated by insulation. There could be several secondary windings in the PCB toroidal transformer. Insulation separates the windings as they are coiled one on top of the other. Over the finished windings, the casing is fastened. The power transformer enters intermediate testing after being partly finished. The preliminary test is another name for the intermediate test. The transformer is potted after passing the testing. The purpose of potting is to guarantee that the device can withstand stress, vibration, and to keep out moisture, water, and/or corrosive substances. A potted PCB toroidal transformer is looks as shown in Figure 1.

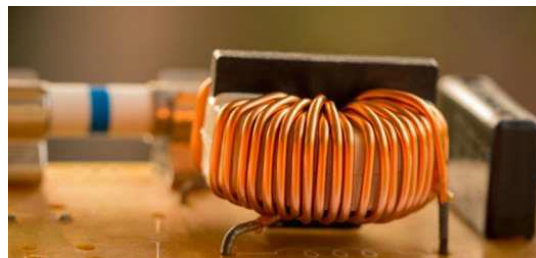


Figure: 1 Toroidal Winding around core

Because it is difficult to repair the transformer after it fails the intermediate test, the prior potting test is performed before potting. The transformer goes through screen print branding and visual inspection after being potted. The transformer is next subjected to the last test, known as Final Quality Control (FQC). The FQC is less rigorous than the intermediate test. Transformers that have passed testing are then submitted for packaging.

According on the kind of transformer used, a different intermediate test is used. Two tests are conducted on the PCB mountable toroidal transformer. both the No Load Voltage Test and the High Voltage (HV) Test.

1.High Voltage test

When operating, electrical equipment must be able to tolerate overvoltage. The dielectric withstand test is another name for this test. In that it will ensure no current flows from one location to another, it is the reverse of a continuity test. In order to perform the high voltage test, the transformer's primary windings are exposed to a very high voltage, such as 500 v, and the output voltage across the secondary winding is measured. A big voltage differential applied between two conductors separated by an insulator would result in a relatively little current flowing because the high voltage assures good insulation between the windings.

Although this tiny current is permissible, the insulation cannot break down.

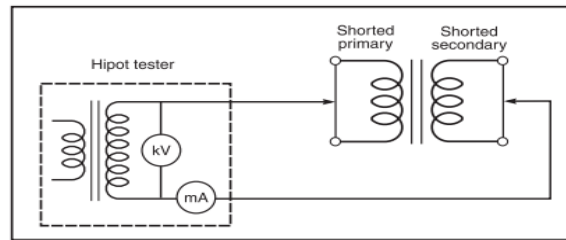


Figure: 2 overall diagrams of Hipot test

Portable insulation resistance testers and megohmmeters are designed to help prevent hazards such as electric shock and short-circuits caused when the insulation in electrical devices, parts, and equipment used in industrial plants, buildings, and other settings degrades over long periods of use. The overall Diagram of Hipot test as shown in figure 2.

2.No Load Voltage Test

In order to calculate the no load current, the no load voltage must first be measured. The transformer's main windings are tested while the secondary windings are in a no-load state, with the rated voltage being applied to both. Therefore, only the transformer's main side receives current flow. The core is nonetheless excited by this current, which results in iron loss in the core. For this, it takes into account variables like input voltage, voltage across secondary windings, total output voltage, and no-load current at various input voltages.

III.HARDWARE USED

The integration of numerous hardware components with the testing platform built using Lab VIEW software is necessary to automate and implement the aforementioned testing procedures for PCB mountable toroidal transformer. Hardware parts are listed with a brief description

Relays: Switches with electromechanical or electrical operation are relays. In a control circuit, they are typically used to switch currents. Between testing, the point of contact is switched using relays. figure 3



Figure:3 Relay Variants

Connector Wires: Data is sent from an HV tester and a digital multimeter to a computer using converter cables. One USB port and a common RS-232 serial port is connected via the USB to serial converter, which functions as a bridge.

Arduino: Open-source electronics platform based on easy-to-use hardware and software Arduino boards read inputs light on a sensor, a finger on a button and turn it into an output activating a motor, turnin on an LED.

High voltage tester: The high voltage test is performed using a High Voltage (HV) tester. A recommended option is the Chroma Hipot Tester 19050 series [3].

DAQ Meter: The process of measuring an electrical or physical phenomena, such as voltage, current, temperature, pressure, or sound, is known as data acquisition (DAQ). Sensors, DAQ measuring gear, and a computer with programmable software make up a DAQ system.

The procedure of sampling signals that measure actual physical occurrences and transforming them into a digital format that can be altered by a computer and software is known as data acquisition and storage, or DAQ or DAS.

Digital multimeter: Instruments for measuring things like voltage, current, and resistance include digital multimeters. Digital displays make it possible for even novice users to interpret measured values quickly and simply.

Multimeter: A volt/ohm metre, commonly referred to as a multimeter or multitester, is an electronic measuring device that integrates many measurement capabilities into a single unit. A standard multimeter could include capabilities to measure voltage, current, and resistance, among other things.

Motor driver IC: To drive high current loads using digital logic circuits, a driver IC is required. The necessary power cannot be supplied via the Arduino I/O. You can utilise the ULN2003 motor driver IC. The relay modules are driven by this.

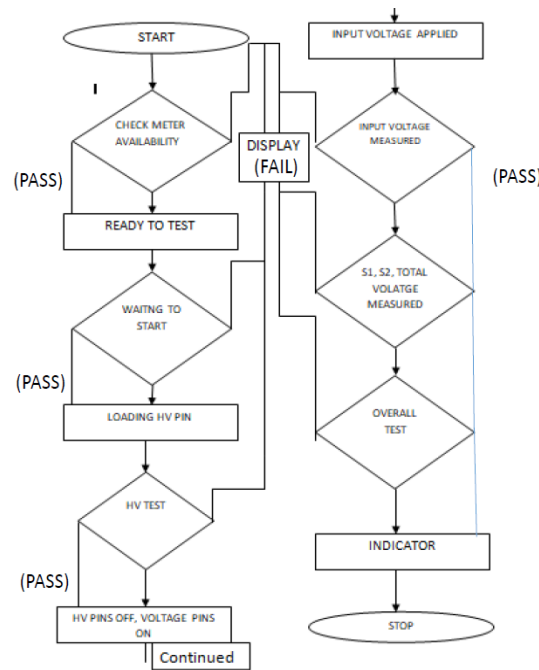
Personal computer: Powerful and effective computer hardware is needed to execute a programme consistently for a long time. The Lenovo ThinkCentre Tiny desktop offers robust corporate performance that is both easy to use and energy-efficient.

Power source: To test the output voltage of the secondary windings, the transformer's primary windings must be powered by a 230 v AC power source. The programmable power source IRDC CF-500 offers this kind of power source. This has been entirely digitalized and may be measured using digital sampling [4].

IV.ALGORITHM (TESTING)

- 1.Start the program for meter initialization
- 2.Check for connections, if pass go to next step else go to start
- 3.Check for meter availability, if pass go to next step else start from beginning till meter is available
- 4.Display meter is ready for test
- 5.Check for start command, if yes load HV pins and display yes else go to previous step
- 6.Check for HV test result, if pass go to next step else display and stop the process
- 7.If pass display operation HV pins off and voltage pins on
- 8.Follow steps 6 and 7 for voltage pins, to measure current (Io-no load current), S1 voltage, S2 voltage, total voltage. If pass keep going to next steps, else display rework and go to stop
- 9.Follow steps 6 and 7 for overall test
- 10.Stop the program and check for storage of results

FLOW CHART(TESTING)



V.RESULTS

Software

To assess the quality of the power transformer, a number of tests must be conducted. Testing each parameter independently costs time and money. The solution to this is to create an integrated testing setup that utilises the hardware tools already in existence and a software programme that aids in creating a continuous testing procedure to ascertain the different power transformer characteristics [5]. The National Instruments platform and development environment for a visual programming language is called Lab VIEW (Laboratory Virtual Instrumentation Engineering Workbench). The name of the graphical language is "G." Lab VIEW is frequently used for data collecting, instrument control, and industrial automation on a number of platforms. It was first made available for the Apple Macintosh in 1986.

Its graphical representation, similar to a process flow diagram, was created to provide an intuitive programming environment for scientists and engineers. The language has matured over the last 20 years to become a general-purpose programming environment. LabVIEW has several key features which make it a good choice in an automation environment. These include simple network communication, turnkey implementation of common communication protocols (RS232, GPIB, etc.), powerful toolsets for process control and data fitting, fast and easy user interface construction, and an efficient code execution environment. We discuss the merits of the language and provide an example application suite written in-house which is used in integrating and controlling automation platforms.

Selection page:

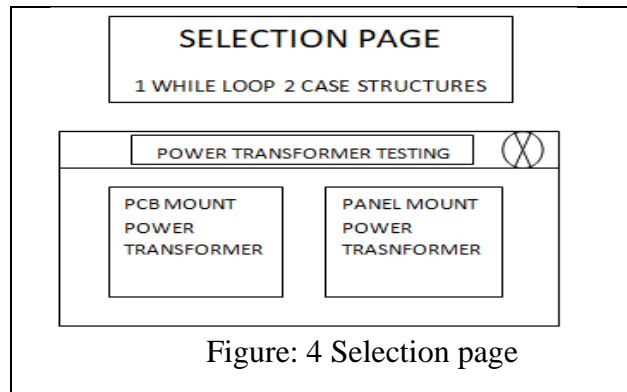


Figure: 4 Selection page

When the application is opened, the selection page is the first screen to show up. It should contain the various power transformer types that will be evaluated. The operator can choose the type of transformers to be tested from this. Figure 2 depicts the selection panel created using Lab VIEW. There are two different transformer types shown in the illustration for your consideration. The PCB mountable power transformer and the panel mount transformer are the two types [6].

Interfaces:

Options such as start, create, and modify have should be available on the testing application's home page. The testing platform is opened when the start option is selected, allowing testing to be done on the power transformer of your choice. When testing a new power transformer, the create option is used to enter the required data. To modify the default settings, use the edit option [7]. The Lab VIEW software's main screen is seen in Figure 5.

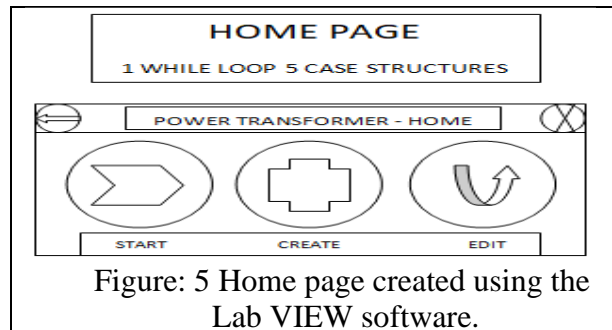


Figure: 5 Home page created using the Lab VIEW software.

Test Page:



Figure: 6 User Interface

The testing page is where the quality of the power transformer is assessed through all of the tests. The operator must press READY TO TEST once the test transformer has been mounted on the fixture before testing may start. Testing results are reported as PASS if the measured values fall within the defined range. The outcome is published as FAIL [8–10] if any one of the parameters veers outside of the range.

VI. DISCUSSION AND CONCLUSION

To execute VIs, Lab VIEW uses a dataflow concept. When a node finish running its programme, it sends the output data to its output terminals and moves on to the following node in the dataflow pipeline. Case structures are being used in this application. One or more sub-diagrams, or cases, make up a case structure; only one of these cases actually executes when the structure is put to use.

Adding or removing cases requires a right-click on the structure's edge. The labelling tool may be used to customize the values handled by each case as well as enter values in the case selector label. Lab VIEW software is used to programmed the test panel. On the destination PC, which does the testing, this software is installed.

Because the test panel has numerous Sub VIs, data collecting with Lab VIEW is simpler than with other programming environments. the outcomes of testing a power transformer that can be mounted on a PCB before potting. The displays the test panel along with the measurements made for each parameter. Each parameter may be shown to be within the predetermined standard limits. As a result, the transformer is deemed to pass. An excel sheet is used to keep the outcomes that were seen for all of the goods. This page lists all the data obtained using various parameters and indicates whether or not the product passed the quality testing. The value connected to the selector terminal, which may be of the Boolean, string, integer, or enumerated type, selects which case to run.

- A summary of the business and processes examined
- Project overview and methodology, with a completed implementation plan
- Created the necessary strategy for carrying out the problem-solving component of the problem statement.

- Hardware that passed testing without issue
- Developed and coded LabVIEW testing platform
- The developed platform offers dependable datasets and repeatable outcomes.
- Complete integration of all processes into a single unit.
- Experiments using various transformers
- Report creation may be customized to meet individual needs.
- Data may be exported to other platforms and is replicable and verified.
- Has more accurate data that may be utilised for additional analysis, such as MSA, histogram, and pareto charts.
- Using KNIME and POWER BI, additional processes for various instruments or measuring apparatus may be integrated into the platform.

VII. REFERENCES

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