Digital Testing Kit for Three Phase Distribution Transformer

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Abstract-*The aim of the project is to design a Digital Testing Kit for Three Phase Distribution Transformer. This kit performs necessary tests on the repaired transformer using microcontroller based programming. After this testing transformer is ready to use and perform healthy operations. When transformer is repaired there are many chances of loose connections and insulation failure. To avoid the faulty condition or improper operation of transformer testing is important.*

For this purpose testing kit is designed in which various tests are performed. This testing kit consist of components such as current transformer to step down current, voltage transformer to step down voltage, zero crossing detector to measure phase difference between the voltage and current, with the help of microcontroller the final output is given to LCD to display the required outputs. In this kit PIC microcontroller is used to process on the output obtained from ZCD with the help of the microcontroller programming. For microcontroller programming language used is embedded C. Hence the output voltage, current and power factor is displayed on the LCD display.

On the basis of results obtained from testing it can be concluded that the transformer is ready to use or not. Efficiency is one of the most important factor in the result analysis. If the efficiency of the transformer after testing is below the desired value then the transformer should be repaired again.

Key Words: **CT, PT, ZCD, PIC microcontroller**

1. INTRODUCTION

Digital Testing Kit for Three Phase Distribution Transformer performs necessary tests on the repaired transformer using microcontroller based programming. After this testing transformer is ready to use and perform healthy operations. When transformer is repaired there are many chances of loose connections and insulation failure. To avoid the faulty condition or improper operation of transformer testing is important. In this research paper focus is given on the tests of transformer to find out its efficiency. The parameters to be displayed to find out the efficiency of the transformer are: Line voltages, Line currents, Phase voltages, Phase currents, Power factor, Losses

2. OBJECTIVE

Transformers play an important role in the power system. They help to convert power to appropriate levels which other components can safely use. They are often in operation for a long time and only stop working during power interruptions and maintenance. It is important to regularly assess their functions to ensure continuous service, so the testing of the transformer is important factor. On the basis of efficiency it can be determined that transformer can be reused or not.

The main objective of this Digital Testing Kit is to minimize the time consumption and increase the efficiency. It works for the measurement of all parameters required for testing of transformer such as phase voltage, phase current, line voltage, line current, power factor, active power, reactive power and apparent power. For testing of the transformer two-wattmeter method is also used but preference is given to the digital testing kit because of its desirable features.

3. HARDWARE IMPLEMENTATION

3.1. Block Diagram of Proposed Work

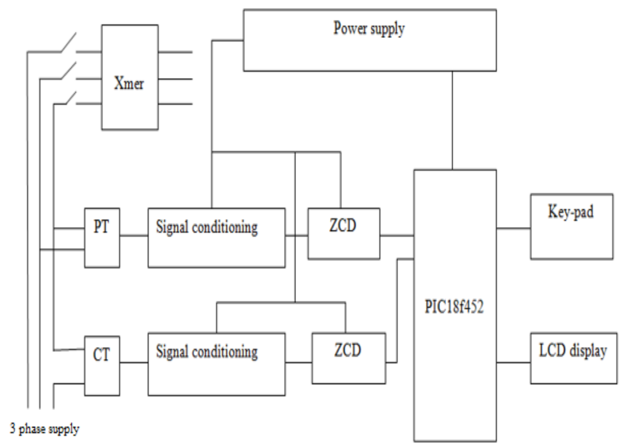

Fig3.1 Block diagram of hardware

4. BLOCK DIAGRAM DESCRIPTION

4.1. Current Transformer:

Current transformer is used to step down current of power system to lower level to make it feasible to be measured by small rating ammeter. Secondary current is proportional to primary current. Secondary voltage depends upon the current as well as load resistance. Secondary can be short circuited. Open secondary may result in failure of the transformer.
Rating: 30A/100mA

4.2. Potential Transformer

A potential transformer is high ratio transformer that is used to measure voltage in high voltage line. Secondary voltage is proportional to Primary voltage. Secondary current depends upon the voltage as well as load resistance. Secondary can be open circuited. Short secondary may result in failure of the transformer.

- Voltage Ratio:440/36V
- Primary voltage:440V
- Secondary voltage:36V

4.3. Signal Conditioning Block

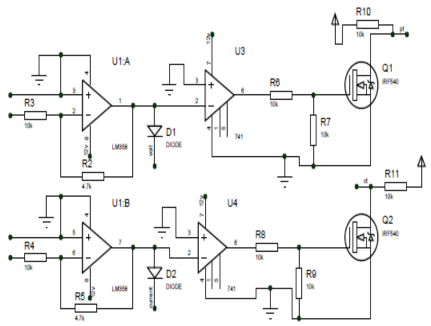

Fig.3.2 Signal conditioning block

36V supply is given to op-am LM358 through the transformer, this 36V supply will step down at next op-am IC741 which acts as zero crossing detector. Property of IC 741 is to convert the sinusoidal wave into square wave. The output of square wave is given to high level trigger MOSFET which will give signal to microcontroller. The microcontroller measures the angle and therefore power factor can be obtained by cosine of that angle.

4.4 Circuit Diagram of Power Supply:

The power supply used following sections:

- A step-down Transformer.
- Rectifier stage.
- Capacitor filter.
- A Voltage Regulator.

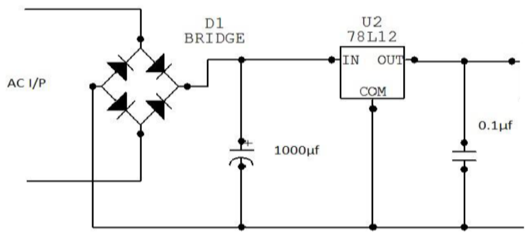

Fig.3.3 Circuit Diagram of Power Supply

Since, many electronic components like CMOS and TTL chips are very sensitive to the voltage variations and other power related factors. Any electronic circuit consisting of sensitive electronic components demands a stable, ripple free and highly regulated power supply for its proper operation. To obtain very high regulation, electronic voltage regulators are used. Electronic voltage regulators maintain a steady output voltage in spite of line voltage and load variations.

The circuit needs two different voltages, +5V & +12V, to work. These dual voltages are supplied by this specially designed power supply. The power supply, unsung hero of every electronic circuit, plays very important role in smooth running of the connected circuit. The main object of this "power supply" is, as the name itself implies, to deliver the required amount of stabilized and pure power to the circuit. Every typical power supply contains the following sections:

4.5. Zero Crossing Detector

ZCD is used to measure time difference between two waves we need to detect zero crossing of two waves. Basically a time difference between two waves is used to calculate power factor.

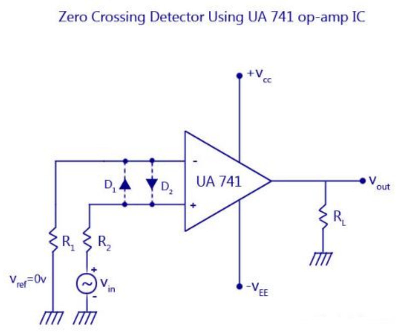

Fig.3.4 Zero Crossing Detector

4.6. PIC 18F452 Microcontroller

. The prime use of a microcontroller is to control the operation of a machine using a fixed program that is stored in ROM and does not change over the lifetime of the system. Here, PIC microcontroller is used for programming. The PIC program is more compact and will run faster to accomplish the tasks. Here, in this kit PIC 18F452 microcontroller is used because of its desirable features which are essential for the proper working of the digital testing kit.

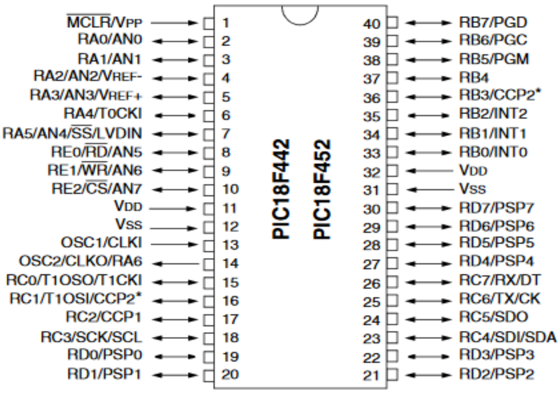

Fig.3.5 PIC Microcontroller

4.7. Connection Diagram

In the connection diagram, the interfacing of the signal conditioning block, power supply, crystal circuit, keypad, LCD is displayed. This connection diagram is prepared with help of the Proteus software. Connection of different components to PIC Microcontroller according to its configuration is as shown below:

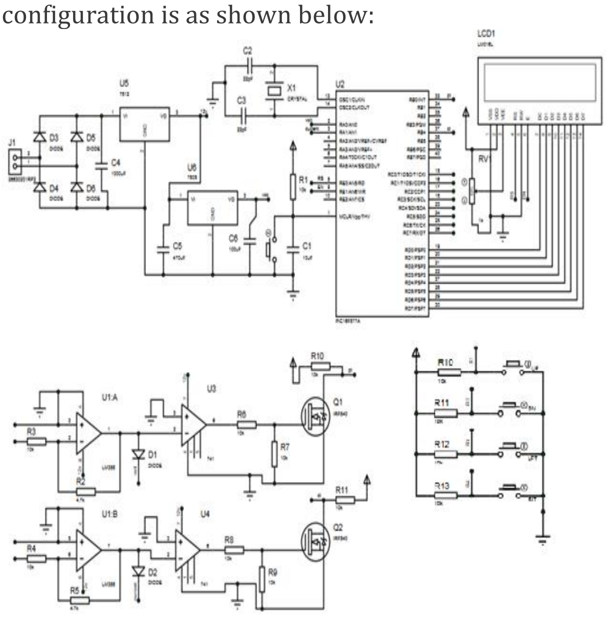

Fig.3.6 Connection diagram

Photograph No. 1 Complete hardware of Digital Testing Kit.

5. FLOW OF HARDWARE MODEL

Step1: Measure voltage and current flowing through the circuit at OC test and SC test by using PT and CT respectively. PT and CT step down the voltage and current.
Step2: Give the measured step down currents and voltages as input to Signal conditioning unit. The signal conditioning unit again steps down the voltage and current and gives input to the ADC port of PIC microcontroller and to ZCD. ZCD find out the angle difference between voltage and current for both test.
Step3: Output of Signal conditioning unit and ZCD is given to PIC microcontrollerPIC18F452. The process takes place in PIC microcontroller with the help of programming.
Step4: Interface microcontroller to LCD display
Step5: LCD displays output

6. HARDWARE RESULT

These tests are carried out on 5kVA, 440V/440V, Star-Delta 3phase transformer.

Photograph No. 2

A. Open Circuit Test:

Open circuit test is conducted at rated voltage i.e.440V and at rated frequency 50 Hz. From the open circuit test we get output power in terms of iron (core) losses.

Vph =250 V

Vl = √3*Vph = 432 V

Il = Iph = 0.2 A

Photograph No. 3

Phase angle between voltage and current = 115˚

Phase angle (α)=115= (180-115)= 65 ˚

Cosα=0.42

Photograph No. 4

P1 = √3*Vl*Il*cosα = 64 W

Photograph No. 5

B. Short Circuit Test:

Short circuit test is conducted at rated current i.e. 10A and at rated frequency 50Hz .From the short circuit test we get output power in terms of copper losses.

Vph= 20V

Vph = Vl =34 V

Iph =10 A

Rated current= 5000/440

= 11.36 A

(Rated current is 11.36A but the test transformer can sustain only 10A current)

Photograph No. 6

Phase angle between voltage and current=22 ˚

Phase angle (α) = 22 ˚

Cosα=0.92

Photograph No. 7

P2 = √3* Vl* Il* cosα = 546W

Photograph No. 8

Efficiency = kVA/ (kVA+P1+P2)*100

= 89 %

Photograph No. 9

Result analysis

Parameter	Observed values	Calculated values
P1	64	63.24
P2	546	546.01
Efficiency	89	89.13

7. CONCLUSIONS

Calculated and observed values are approximately same so the efficiency of kit about 90% to 95%. Kit reduces the human efforts.

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