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DESIGNING AN AUTOMATED TRANSFORMER TESTING UNIT

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ABSTRACT

When the transformer testing process is a manual system that consumes more time and labour. Labour is the most precious resources of a company. When the labour is handled efficiently, the company will be benefited. In rapidly growing industry, undesired and unexpected costs should be cut down and productivity should be increased to sustain in the competitiveness. This study reports the development of an automated transformer testing unit. Using this unit transformers can be checked efficiently and quickly. Results of the manual system in the company and designed system gave same values. This proved that the designed system is working accurately. It is possible to perform transformer testing on a production line where by improve the productivity.

Keywords: Transformer, Isolation, Microcontroller, Printed Circuit Board

1.0 INTRODUCTION

A transformer is an electrical device that transfers electrical energy between two or more circuits through electromagnetic induction[1]. However electromagnetic induction produces an electromotive force across a conductor which is exposed to time varying magnetic fields. The working principle of transformer depends upon Faraday's law of electromagnetic induction. Mutual induction between two or more winding is responsible for transformation action in an electrical transformer[2]. A reputed company in Sri Lanka currently manufacturing transformers for various products. There the transformer testing process is carried out by manual process in the production line[3]. Due to that many problems such as, more time consumption, surge problems etc occur frequently.

As a solution for this problem, an automated, transformer testing unit was developed. This system can be divided in to four basic parts, isolation test, open circuit test, short circuit test and load test. Isolation test observe whether the transformer is isolated or not. Open circuit test observe the core losses of transformer and shunt parameters of the equivalent circuit. Short

circuit test was carried to estimate the copper losses of transformer and approximate the equivalent resistance and reactance of the transformer[4]. Load test was done to measure the voltage, when the external load is supplied. By introducing this unit, company will be benefited less time consumption, reduction in electricity usage and using the unit as a surge protector too.

2.0 EXPERIMENTAL

2.1 Technologies used in the System

Atmega 16 microcontroller was used to develop the system, which handle data processing and produce desired outputs. Printed circuit boards (PCBs) were designed using PROTEUS version 7.6 software and PCBs were etched using Ferric Chloride ($FeCl_3$) chemical etching process.

2.2 Circuit development

Necessary programs were coded step by step. Then the necessary circuits lay outs were designed and they were printed using injected printer on to the shiny sides of sticker papers. Those were transferred on to well cleaned copper boards using an electrical iron. Thereafter paper was removed from the copper board and copper board was washed carefully. Ferric Chloride ($FeCl_3$) solution was used to etch the design. Then the unwanted areas of the copper board were dissolved in the $FeCl_3$ solution completely. The PCBs were taken out from the solution and washed with soap. Etched PCBs were checked for desired connectivity and functionalities using the multimeter. Finally developed programs were uploaded to the Atmega microcontroller and circuits were completed to develop the system.

2.3 Project design

The basic functions of the transformer testing unit is shown in figure 1.0 below.

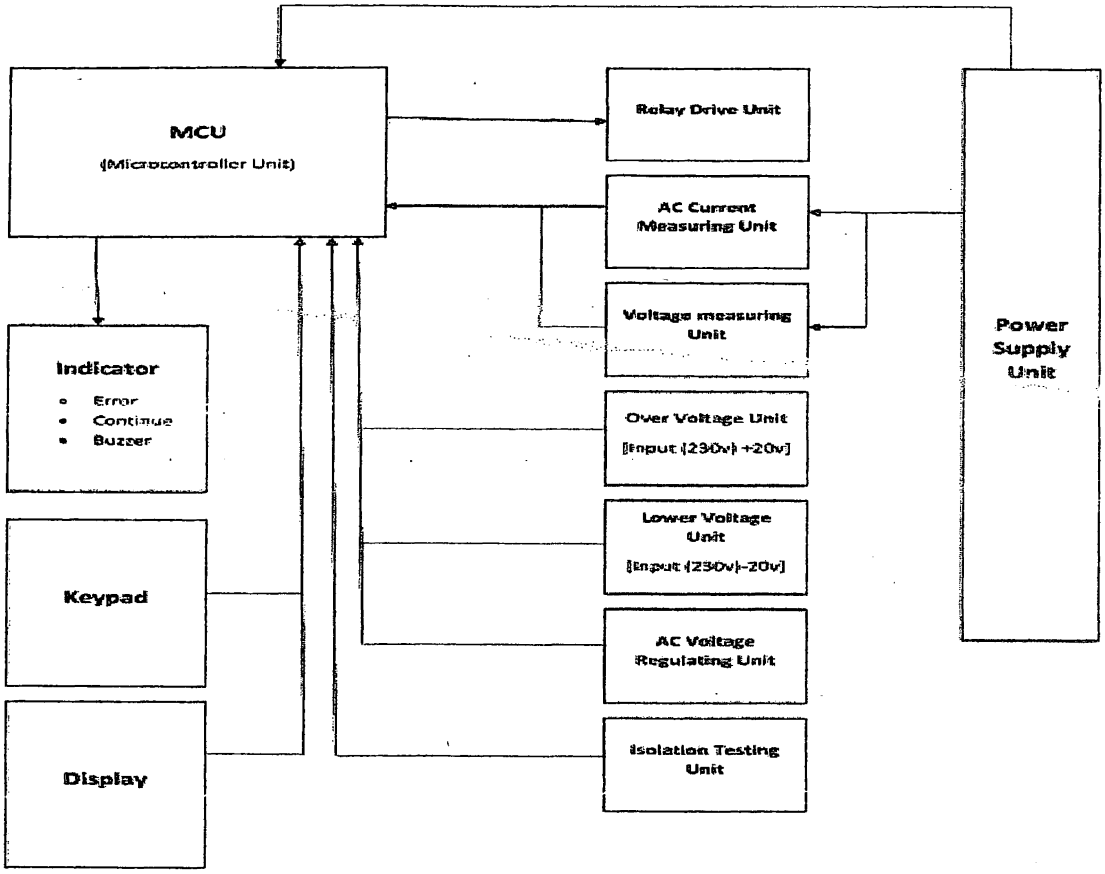

Figure 1: Block diagram of the designed transformer testing unit

Figure 2 shows the schematic circuit diagram of the designed transformer testing unit.

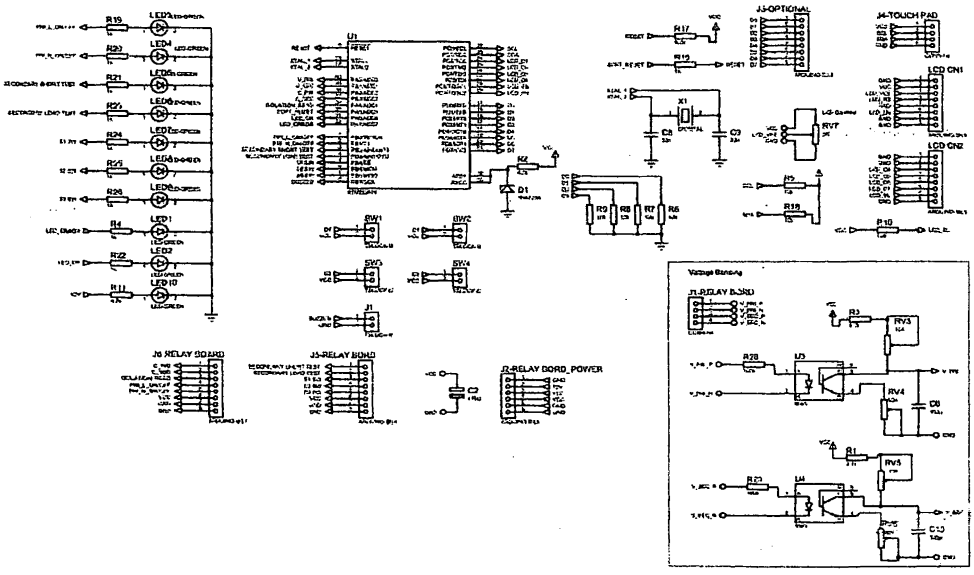

Figure 2: Schematic circuit diagram of the testing unit

Four tests are carried out by transformer testing unit namely Isolation test, Short Circuit Test, Open Circuit Test and Load Test.

Isolation test

In this testing, the circuit is connected to neon bulb which is active above 110V. The brightness of the neon bulb is depend on the resistor of the LDR in the circuit. Due to the variation of the LDR resistance value, microcontroller analog reading values also varies. The neon bulb will respond as relevant. Then the If the transformer is not isolated, the neon bulb doesn't switch on.

Open circuit test

Under this test, when the relay RL07 and RL06 are switched on and all the other relays are switched off, output voltage and input current are measured.

Short circuit test

Under this test, when relay RL06 switched on, the output voltage will be short circuited. Then varying the input voltage, output current and input current are measured.

Load test

The values of output voltage, output current and input current are measured by making relay RL 04 on and by connecting output to resistance load.

The designed transformer testing unit was checked with manual testing method for transformer of 10Amp power guards, 30Amp power guards and boosters.

3.0 RESULTS AND DISCUSSION

Results were obtained using the developed transformer testing unit and also with the manual system.

Tables 1-3 show the comparison of testing results for the three types of the transformers by designed system and manual method.

Table 1: Transformer testing values of Power Guard 10Amp

Primary				Secondary				
Voltage (V)	Current (mA)			Voltage (V)		Current (mA)		Manual system
	Open	Short	Load	Open	Load	Short	Load	
210	1.60	40.8	16.6	35	21.5	222	88	Same value
230	1.81	43.2	18.2	39	23.3	236	98	Same value
250	2.16	47.5	19.9	42	25.8	254	106	Same value

Table 2: Transformer testing values of Power Guard 30Amp

Primary				Secondary				
Voltage (V)	Current (mA)			Voltage (V)		Current (mA)		Manual system
	Open	Short	Load	Open	Load	Short	Load	
210	2.92	58.4	16.2	21.5	28.7	371.2	97.9	Same value
230	3.57	63.4	18.0	31.7	23.5	411.1	103.5	Same value
250	4.33	69.0	19.5	35.2	25.9	449.2	114.5	Same value

Table 3: Transformer testing values of Booster

Primary				Secondary				
Voltage (V)	Current (mA)			Voltage (V)		Current (mA)		Manual System
	Open	Short	Load	Open	Load	Short	Load	
210	2.80	43.2	7.1	15.2	13.4	530	0.59	Same value
230	4.12	48.0	8.2	16.8	14.9	586	0.66	Same value
250	5.14	52.1	9.2	18.3	16.2	629	0.72	Same value

Results showed that both systems gave same values. This proved that the designed system is working accurately.

Strengths of the designed system,

- Less time consuming when testing the transformers
- It consists of a surge protection unit (Isolation unit)
- Cost effective
- Help to improve productivity
- Ease of use

Limitations of designed system,

- Can check only law frequency transformers.
- Can only be used in step down transformers with 100V or below.

4.0 CONCLUSION

The designed transformer testing unit is a cost effective and efficient testing process. By using this transformer testing unit on a production line productivity can be improved. This system is iess time consuming and also protects the workers from the surge sparks. By applying this solution, the company will be able to increase the efficiency of the workers who are engaging in transformer testing process.

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