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Automatic Load Sharing of Transformer with Monitoring System

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Abstract-
The transformer is a static device, which transfer power from one level to another level. The aim of the project is to protect the transformer under overload condition by load sharing. Due to overload on transformer, the efficiency drops and windings get overheated and may get burnt. Thus by sharing load on transformer, the transformer is protected. This will be done by connecting another transformer in parallel through a micro-controller. The micro controller compares the load on the first transformer with a reference value. When the load exceeds the reference value, the second transformer will share the extra load. Therefore, the two transformer work efficiently and damage is prevented. Also smart health monitoring of transformer with all main parameters of Load share information using IOT features.

Keywords—: Transformer , parallel load sharing , IOT Module, Arduino Uno Controller etc.

1. Introduction

The accelerated aging is one of the main consequences of overloading power transformers. Thus load limitations must be implemented to operate the transformers within safe limits. Moreover on overloading the transformers voltage regulation may increase and power factor drops. The project is all about protecting the transformer under overload condition. This can be done by connecting another transformer in parallel through a microcontroller and a relay which shares the excess load of the first transformer. The transformers are switched alternatively to avoid thermal overloading. Therefore, two transformers work efficiently under overload condition and damage can be prevented. If there is a further increase in load beyond the capacity of two transformers there will be a priority based load shedding of consumers which will provide un-interrupted power supply for the hospitals, industries etc [1][2].

In this project "Automatic Load Sharing Of Transformers" we are using two transformers, one is main transformer (TF1) and the next is backup transformer (TF2). Here the load is directly connected to the secondary of the main transformer as well as backup transformer; here two transformers are connected through the relay. The transfers switch senses when utility power is interrupted, and starts up the transformer TF2 which acts as a backup transformer [3]. If the utility power remains absent, the transfer switch disconnects the load from the utility and connects it to the Transformer TF2, restoring electricity to the load. The transfer switch continues to monitor utility power, and when it is restored, switches the load from the Transformer TF2 back to the Main transformer TF1. Once the Transformer TF2 is disconnected, it goes through a cool-down routine and is automatically shut down.[4][5].

In this project three modules are used to control the load currents. The first module is a sensing unit, which is used to sense the current of the load and the second module is a control unit. The last module is micro-controller unit and it will read the analogue signal and perform some calculation and finally gives control signal to a relay. A IOT Module is also used to show all information and parameters of transformer. The advantages of the project are transformer protection, uninterrupted power supply, and short circuit protection. When designing low-voltage power system to the supply large load currents, paralleled lower-current modules are often preferred over a single, large power converter for several reasons. These include the efficiency of designing and manufacturing standard modular converters which can be combined in any number necessary to meet a given load requirement and the enhanced reliability gained through redundancy [6][7].

2. Literature Review

- *Haibo Liu and Chengxiong Mao presented* paper ,"Parallel Operation of Electronic Power Transformer and Conventional Transformer", is proposed that the secondary voltage of conventional transformer is selected as the reference voltage of Electronic power transformers output voltage on the base of the analysis of parallel principle of one EPT and one conventional transformer, also a novel parallel control scheme based on the proposed idea is proposed and its control performance is analyzed in detail.

- *Jardini J.A. and et Alli* presented paper on the results of the study carried out for the "Determination Of The Residential Area Based on Field Measurements", commercial and industrial consumers daily load curves based on field

measurements performed by the Utilities of Electric Energy of Sao Paulo State, Brazil. A methodology for the aggregation of these loads to determine the expected loading in equipment or in a preset part of the distribution network by using the representative daily curves of each consumer's activity and the monthly energy consumption of the connected consumers is also presented. The paper proposes that customers representative daily load curves are defined statistically form by the mean and standard deviation curves.

- *T.Venkata Sai Kalyani* , in this paper to protect the transformer under overload condition by load sharing. Due to overload on transformer, the efficiency drops and windings get overheated and may get burnt. Thus by sharing load on transformer, the transformer is protected. This will be done by connecting another transformer in parallel through a micro-controller. The micro controller compares the load on the first transformer with a reference value. When the load exceeds the reference value, the second transformer will share the extra load. Therefore, the two transformer work efficiently and damage is prevented. In this project three modules are used to control the load currents. The first module is a sensing unit, which is used to sense the current of the load and the second module is a control unit. The last module is micro-controller unit and it will read the analogue signal and perform some calculation and finally gives control signal to a relay. A GSM modem is also used to inform the control station about switching. The advantages of the project are transformer protection, uninterrupted power supply, and short circuit protection. When designing low-voltage power system to the supply large load currents, paralleled lower-current modules are often preferred over a single, large power converter for several reasons. These include the efficiency of designing and manufacturing standard modular converters which can be combined in any number necessary to meet a given load requirement and the enhanced reliability gained through redundancy.

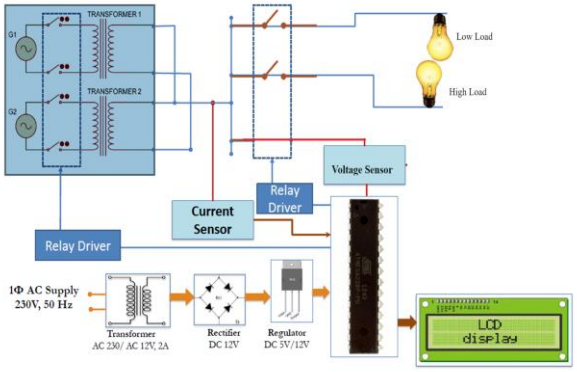
- *Mohammad A. Lakdawala* **,** The transformer is a very bulky and costly equipment of electrical power system that steps up/down the level of power of the system. The transformer operates throughout the day in the supply system which makes it one of the most important part of the electrical power system. Many of the times the condition occurs in the system when the load on the transformer fluctuates outside the normal operating range which may lead to the overload condition and damage of the insulation of windings resulting the failure in operation of the transformer, thus causing interruption of the supply. One of the main reasons of overloading is the improper load sharing of the transformers. One of the best solutions to avoid the overloading is to operate the number of transformers in parallel. It is same like parallel operation of transformers where the number of transformers shares the system load. The transformers work efficiently and thus damage is prevented. The outcome of this project is based on reliable power supply and safety of transformer. By implementation of this scheme, the problem of interruption of supply due to transformer overloading or overheating can be avoided.

- *Rekha.T, BinduPrakash, Asna.S,Dinesh. Sand Nandana. S.Prasad (2015),* Distribution transformers are an important part of power system which distributes power to the low-voltage users directly, and its operation condition is important for the entire distribution network operation. However, their life is significantly reduced if they are subjected to overloading and over temperature resulting in unexpected failures and loss of supply to a large number of customers thus effecting system reliability. Protection against fault in power systems is very essential and vital for its reliable performance. This project is a simplified approach to protect the transformers from unusual conditions. For this purpose two similar types of distribution transformers are used so that, if any one transformer fails, then immediately another transformer is brought into the circuit during over loading, over temperatures, input voltage variations and provides conventional 230V supply to the consumers without burning of transformers. Most of the loads (e.g. Induction motors, arc lamps) are inductive in nature and hence have low lagging power factor. The low power factor is highly undesirable as it causes an increase in current, resulting in additional losses of active power in all the elements of power system from power station generator down to the utilization devices. So in this paper an automatic power factor correction circuit is also incorporated with the load sharing module.

- *Ashish R. Ambalkar, Nitesh M. Bhoyar, Vivek V. Badarkhe and Vivek B. Bathe (2015),* The transformer is very costly and bulky equipment of power system. It operates for 24 hours of a day and feeds the load. Sometimes the situation may occur when the load on the transformer is suddenly increased above its rated capacity. When this situation occurs, the transformer will be overloaded and overheated and damage the insulation of transformer resulting in interruption of supply. The best solution to avoid the overloading is to operate the number of transformers in parallel. In this work, a slave transformer shares the load of master transformer in the case of over load and over temperature. A sensor circuit is designed to log the data from master transformer and if it is found to be in overload condition, immediately the slave transformer will be

connected in the parallel to the master transformer and the load is shared. Initially when we switched ON the load that load will be shared by the first transformer. Once load has been increased on first transformer above its rated capacity then the stand by transformer (second) will share the load automatically. In this work we are used a relay and comparator IC's for automatic load sharing between three transformers. The number of transformers to be operated in parallel can also be increased according to demand of a particular area.

3. Block Diagram



Fig,1. Block Diagram

- 1. Loads are supplied from a single transformer under normal condition and a standby transformer is connected in parallel through a circuit breaker.
- A current transformer measures the load current continuously and feeds it to the controller by converting it to a corresponding D.C value in order to compare with the reference value set by the user.
- Whenever the load current exceeds reference value, the controller sends a high signal to the relay which energies the relay coil. The relay coil thus sends a tripping signal to the circuit breaker of the standby transformer.
- Thus the load is shared by the transformers equally as the transformers are identical. The current transformer still measures the load current and compares it with the reference value.
- Whenever the load current falls below reference value one transformer is shut down and this is done in an alternative manner to avoid thermal overloading.
- If the load value increases further beyond the capacity of two transformers, load will be cut-off from the main supply based on the priority level set by the user. This is done to provide un-interrupted power supply to higher priority loads.
- . Each of the process and all parameters of transformer is informed to the controller by a IOT and the load parameters are continuously displayed in the LCD..

4. Hardware & Software

- Atmega328P microcontrollers (Arduino)
- LCD Display
- 7805 Voltage Regulator
- Rectifier
- Current Sensor
- 12 V Relay
- Bulb
- 12-0-12 Transformer
- IOT Module
- Crystal Oscillator
- Switches
- Wire
- Development Board
- Other

Software Specifications

- Arduino Compiler
- MC Programming Language: C

5. Circuit Diagram

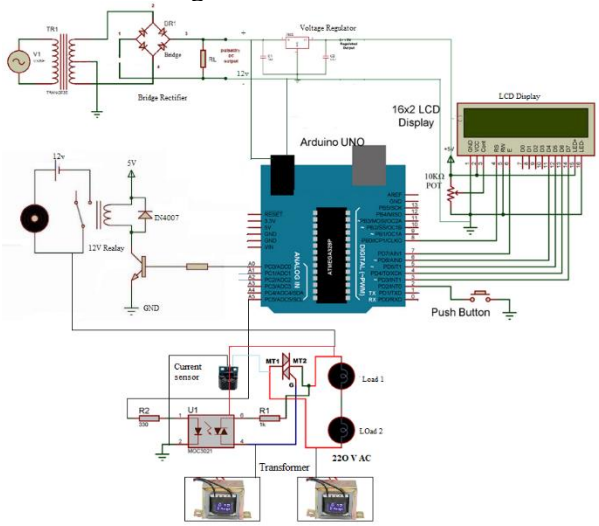


Fig.2.Circuit Diagram

6. Result

CASE 1 : Based On Load Current

CONDITION	TRANSFORMER T1	TRANSFORMER T2
Load current below 1.2A	ON	OFF
Load current above 2.4A	ON	ON

Case 2 : Based On Load Priorities
Feeder F1 = Hospitals and Government sectors
Feeder F2 = Commercials and Industrials
Feeder F3 = Residential and Agriculture

On the foundation of the field, the comprehensive power loss curve for transformers is drawn.It is simple to determine the economic operating interval for a transformer by computing the critical load apparent power between each pair of operation modes for a large number of transformers.

The distribution network reliability transformer operation economy and load balancing are the optimisation aims of the distribution transformer load distribution model that takes into account the economy of the parallel transformers.

In this project, we saw that when the load on a single transformer grows, the relay detects the change in current, the microcontroller activates, and the slave transformers switch on automatically to divide the load.
Three transformers are operated in parallel to automatically share the load with the aid of a changeover relay and relay driver circuit, as well as to protect the transformers from overloading and thereby provide customers with a consistent supply of power. The work on "Automatic load sharing of transformers" has successfully been designed, tested, and a demonstration unit is constructed.

- **Project Image**

CONDITION	Feeder F1	Feeder F2	Feeder F3
Load current below 2.4A	ON	ON	ON
Load current above 2.4A	ON	ON	OFF
Still load current goes on increasing continuously	ON	OFF	OFF

Fig.3. Project Image

7. Advantages
- Parallel operation of transformer Minimize The Transformer Losses.
- Automation of load sharing Reduce Human Interference.
- Increase Reliability Of Power System.

8. Disadvantages
- Initial cost of replacement is high
- Control and protection Is more complex

9. Application
- Power generation & distribution system
- Process Industry.
- Protection from overloading of transformers.
- Uninterrupted power supply

10. Conclusion

Transformers are one among the most generic and expensive piece of equipment of the transmission and distribution system. It is known as the heart of the power system. Due to its high cost, the protection and maintenance of the transformer is crucial. With increase in load demand day by day and with existing transformers the load demand is to be satisfied and it may lead to increase in load of each transformer. One of the best solutions of overcoming this is by connecting transformers in parallel. In this project of Automatic Load Sharing of Transformers Using Microcontroller, a technology is implemented to share the load on the transformers. This provides un-interrupted power supply and avoids blackout in particular areas where there is varying loads. With the advancement of communication technology, now it is possible to receive overload condition of transformer through LCD display to the control room. During overload condition exceeding specified limits information is immediately communicated through display technology to the concerned authority for possible remedial actions. Hence the transformer is protected from the overload condition and uninterrupted power supply is available to the consumers.

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