Automatic Load Sharing of Transformer using Arduino and Microcontroller with their Comparison

Akshata Desai, Deepa Patted, Manjunath Vaggar, Pavangouda Jakkanagoudar, Kandagal S.S

Abstract— **Transformer is a static device, which converts power from one level to another level. The aim of the proposed work is to protect the transformer under overload condition by load sharing. Due to over load on transformer, the efficiency drops and winding 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 microcontroller on the other hand through the Arduino. The both controllers compare the load on the first transformer with the reference value. When the load exceeds the reference value, the second transformer will share the remaining load. If the load exceeds the rating of both transformers, then system is going to be shut down. Whenever the sharing of load on transformer occurs, the operator gets message through the GSM. An IOT is also used to inform the control station about sharing load. This arrangement will provide proper maintenance facility for both transformers. Hence, temperature of both transformers, load shared to another transformer along with timing are recorded. These can fetch about a year of records. All these make system very efficient and reliable.**

Index Terms— **Arduino, GSM Module, IOT, Microcontroller**

I. INTRODUCTION

Transformer is a static device which converts energy at one voltage level to another voltage level. It is an electrically isolated inductively coupled device which changes voltage level without change in frequency. Transformer transfers ac voltage from one electrical circuit to another by the principle of ***mutual induction***. Distribution transformers are one of the most important equipment in power system and are also known as the ***heart of the power system***. The reliable operation of a power system depends upon the effective functioning of the distribution transformer. Therefore, monitoring and controlling of key parameters like voltage and current are necessary for evaluating the performance of the distribution transformer. Thus, it helps in avoiding or reducing the disturbance due to the sudden unexpected failure [1].

Transformers being one of the most significant equipment in the electric power system, needs protection as a part of the general system protection approach. Moreover, the increasing population and their unavoidable demands have led to an increasing demand on electrical power. With this increased need, existing systems have become ***overloaded.*** The overloading at the consumer end appears at the transformer terminals which can affect its ***efficiency and protection*** systems. Due to overload on the transformer, the efficiency drops and the windings gets ***over heated*** and may get burnt. Transformers are occasionally loaded beyond nameplate ratings because of existing possible contingencies on the transmission lines, any failure or fault in power systems, or economic considerations. One of the reported damage or tripping of the distribution transformer is due to ***thermal overload***. To eliminate the damaging of transformers due to overloading from consumer end, it involves the control against over current tripping of distribution transformer. Rise in operating temperature of the transformer due to overloading has an influence on aging of transformers. 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 proposed work all about protecting the transformer under overload condition.This can be done by connecting another transformer in ***parallel*** through a microcontroller (IOT) as well as Arduino and relay which shares the excess load of the first transformer. 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].

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II. BLOCK DIAGRAM

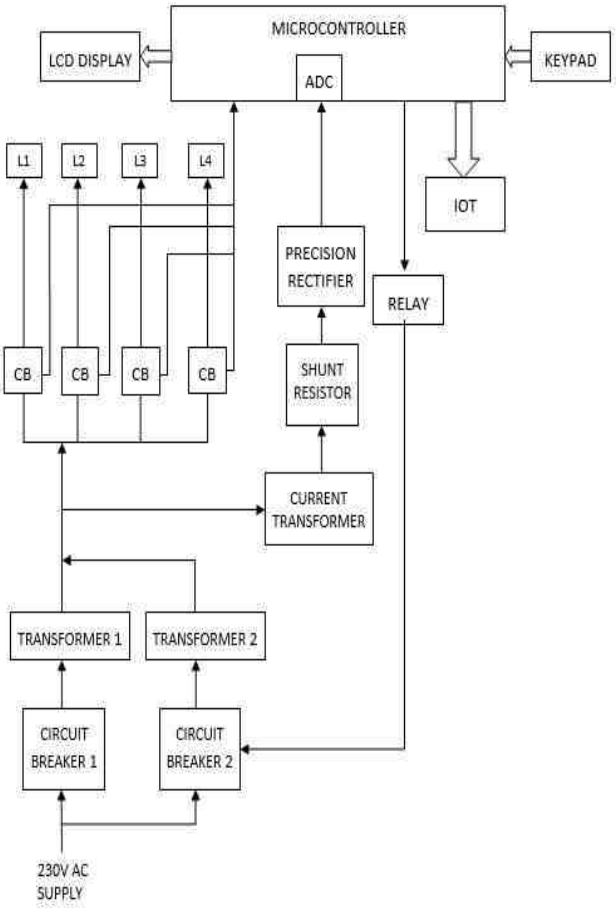

Figure 1: Block Diagram of load sharing using Microcontroller

In the proposed system (figure 1) only one transformer is operating to feed the loads. A standby transformer is connected in parallel through a circuit breaker and relay. The current transformer continuously measures the load current and feeds it to the Microcontroller ADC pin. The reference value or the maximum load limit is entered by the user and priority level of the load is also set by the user or concern authority. As the load demand increase during peak hours, a single transformer would not be able feed all the load. During this condition, when the load demand exceeds the reference value, Microcontroller will give a control signal to energize the relay coil. Thus, the standby transformer will be connected in parallel and share the load equally. Since the transformers are of the same ratings. Thus, all the loads are fed efficiently providing un-interrupted power supply. When the load increases to further to a value which is greater than the capacity of the two transformers, priority-based load shedding will be implemented. The loads which have the lowest priority will be shut down by opening the respective circuit breaker [1]. When the load decreases, and comes to normal working condition, first transformer will be shut down in order to avoid thermal loading. This is done because the first transformer operates for a longer time interval than standby transformer and its body temperature rises. This will display on the LCD display.

In this technique an *IOT* is implemented, which stores the data about the Load Current, Time, Date and temperature of both transformers. It will be stored in *THINGSPEAK* (From this a user id and password had generated. By login, data can fetch). This data can extract for *every 20seconds* and can store about a year of data. Similarly, it is done for standby or secondary or second transformer. By seeing this data, there should be an eye on load limit on transformer as well as duration of load on transformer. This prevents overheating and overloading of transformer. Hence, the transformer will work efficiently. This will be a real time proposed work.

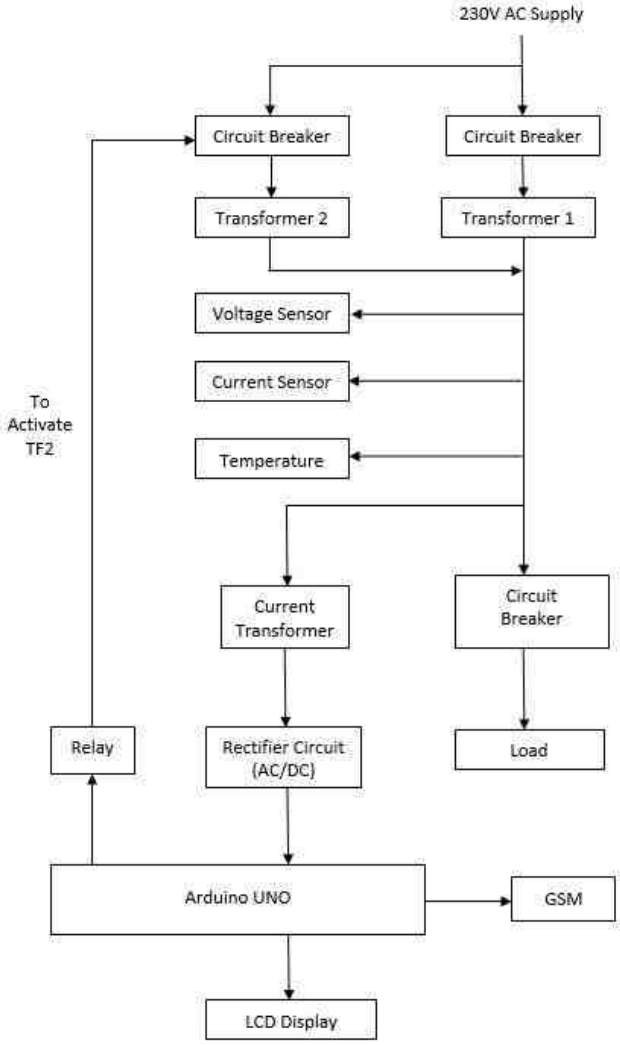

Figure 2: Block Diagram of load sharing using Arduino

The figure 2 shows load sharing of transformer using Arduino, only one transformer is operating to feed the loads. A standby transformer is connected in parallel through a circuit breaker and relay. The current transformer continuously measures the load current and feeds it to the Arduino. The reference value or the maximum load limit is entered by the user and priority level of the load is also set by the user or concerned authority. As the load demand increase during peak hours, a single transformer would not be able feed all the load. During this condition, when the load demand exceeds the reference value, an Arduino will give a control signal to energize the relay coil. Thus, the standby transformer will be connected in parallel and will share the load equally since the transformers are of the same ratings. Thus, all the loads are fed efficiently providing un-interrupted power supply. The *GSM modem* will send a message to the control room about the load sharing and a display will be shown in the LCD display. When the load increases further to a value which is greater than the capacity of the two transformers, *priority-based* load shedding will be implemented. The loads

which have the lowest priority will be shut down by opening the respective circuit breakers. This message is also sent to the control room. When the load decreases, and comes to normal working condition, first transformer will be shut down in order to avoid thermal overloading. This is done because the first transformer operates for a longer time interval than standby transformer and its body temperature rises. By providing alternative switching, the transformers can be cooled by natural methods. Each time the GSM will send message about the active transformer thus making load sharing and load shedding efficient [2].

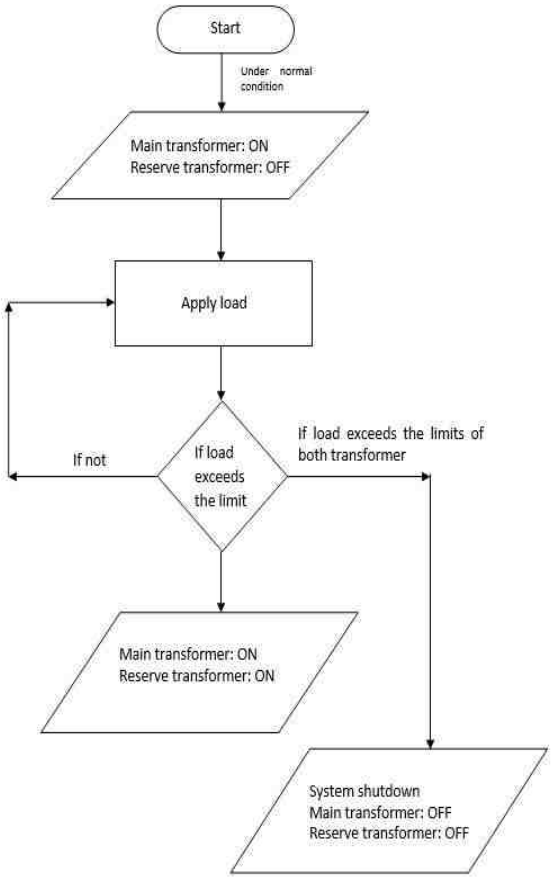

Figure 3: Generalized flow chart of load sharing of transformer

The figure 3 shows generalized flow chart of load sharing of transformer. Automatic load sharing of transformer using Microcontroller and Arduino. The two identical transformers are using which are connected in parallel thought change over relay. Transformer 1 is a main transformer, which is called a master transformer and Transformer 2 is an auxiliary transformer which is called as slave transformer. Each transformer has its own load handling capacity. In case of a normal operation the master transformer shears the load but as the load is beyond the rated capacity of main transformer the slave transformer is connected in parallel automatically and shares the load. There are different conditions would apply while connecting the load which are discussed below.

- **Under normal condition**

In the proposed system only one transformer is operating to feed the loads. A standby transformer is connected in parallel a circuit breaker and relay. The current transformer continuously measures the load current and feeds it to the comparator. Under normal condition the main transformer is in ON condition and the reserve transformer is in OFF condition. Apply the load, the reference value or maximum load limit is entered by the user and priority level of the load is also set by the user or concerned authority. During the normal the single transformer can able to feed the entire load.

- **Under abnormal condition**

As the load demand increases during peak, a single transformer would not be able to feed the entire load. During this condition, when the load demand exceeds the reference value, The Microcontroller on the other hand the Arduino will give a control signal to energize the relay coil. Thus, the standby transformer will be connected in parallel and will share the load equally since the transformers are of the same ratings. Thus, all the loads are feed efficiently providing un-interrupted power supply. The GSM modem will send the message to the control room about the load sharing and a display will be shown in the LCD display. If load limits exceed the main transformer is in ON condition and the reserve transformer is in ON condition.

When the load increases further to a value which is greater that the capacity of the two transforms, priority-based load shading will be implemented. The loads which have the lowest priority will be shut down by opening the respective circuit breakers. If the load limit exceeds the both the transformer. The main transformer and the reserve transformer will be in OFF condition.

III. COMPONENT DETAILS

Table 1: Electrical components specification of working model

Sl.no	Components	Specification
1	Transformer (1:1)	230/230V, 250mA
2	Capacitor	2200uf
3	Voltage regulator	7805
4	Transformer	230/9V, 500mA
5	ATmega324 Microcontroller	5V
6	Relay driver (12V DC)	Operating voltage upto 7V
7	Diode (P-N junction)	1N4007
8	LCD display	16x2
9	Current sensor	ACS712, 20A
10	Lamp load	40W, 60W

IV. RESULT AND DISCUSSIONS

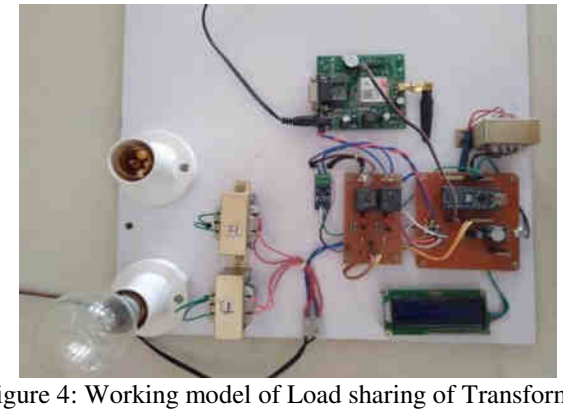

Figure 4: Working model of Load sharing of Transformer

In this proposed work it has been observed that if the load on main transformer exceeds more than reference value then relay will sense the change in load current value. Thus, Arduino will operate and slave transformer will come into action automatically to share the load.

Table 2: Experimentally determined data of load current using an IOT

Sl.no	Date	Time(hrs)	Load Current(A)
1	2020-07-12	09:00:34	0.09518
2	2020-07-12	09:00:56	0.09518
3	2020-07-12	09:01:16	0.04679
4	2020-07-12	09:01:40	0.14358
5	2020-07-12	09:02:01	0.04679
6	2020-07-12	09:02:22	0.11132
7	2020-07-12	09:02:42	0.12745
8	2020-07-12	09:03:07	0.06292
9	2020-07-12	09:03:29	0.32103
10	2020-07-12	09:03:52	0.43395
11	2020-07-12	09:04:15	0.35329
12	2020-07-12	09:04:37	0.33716
13	2020-07-12	09:04:59	0.33716
14	2020-07-12	09:05:22	0.43395
15	2020-07-12	09:05:45	0.33716

The table 2 shows an experimentally determined data of load current using an IOT. To extract these data *THINGSPEAK* software is utilized. It stores Date, Time and Load Current respectively. It records the data continuously every interval of time say about 22seconds. Even the graph is also recorded which is showed in the figure 5.

For particular time, at 9hr 34second, the transformer1 is shared the load, by this time load current is 0.09518A. similarly at 9hr 56second it is recoded load current. So, after every interval of 22seconds it will go on record the data.

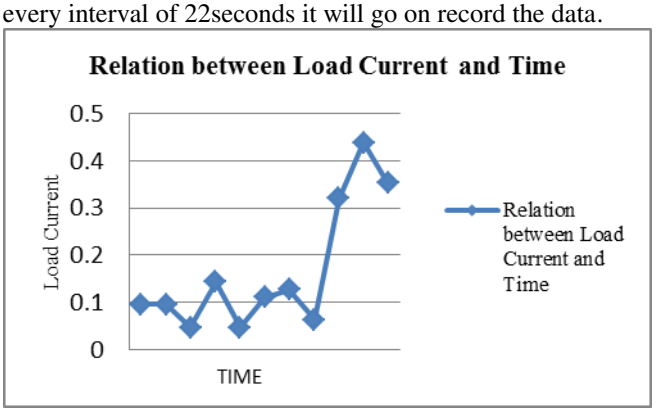

Figure 5: Relation between Load Current and Time

The figure 5 shows, Relation between Load Current and Time. This graph deals with Current in milliamps and Time in seconds. Constructed according to experimentally determined values which are tabulated in the table 2. The blue line shows load sharing of transformer using IOT are drawn by using an experimentally determined value.

ADVANTAGES

The advantages of load sharing of transformer using Microcontroller and Arduino are mentioned below

- The load is shared by transformer is automatically,
- No manual error is taking place,
- It prevents the main transformer from damage due to the problems like overloading as well as overheating and
- Un-interrupted power supply to consumer is supplied and short circuit protection.

CONCULSION

In this paper, observed that if load on one transformer is increases then the relay will sense the change in current. Both Microcontroller as well as Arduino operates and slave transformer comes automatically in operation to share the load.

The work on "Automatically load sharing of transformer using both Microcontroller (IOT) and Arduino" is successfully done and demonstrated. The demo is fabricated for operating two transformers in parallel to share the load automatically with help of change over relay and relay driver circuit. Thus, the two transformers are protected from overloading as well as overheating and providing an uninterrupted power supply to the customers.

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