Automatic Load Sharing of Transformers
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Abstract— 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. It is same like parallel operation of transformers where the number of transformers shares the system load. In the suggested approach second transformer will share the load when the load on the first transformer will rise above its rated capacity. The main aim of the work is to provide an uninterrupted power supply to the energy consumers. By implementation of this scheme the problem of interruption of supply due to transformer overloading or overheating can be avoided.

Key words: Capacity, Interruption, Load, System, Transformer

I. INTRODUCTION
Transformer is the vital component in the electric power transmission and distribution system. The problem of overloads, voltage variation and heating effects is very common. It takes lot of time to its repair and also involves a lot of expenditure. This work is all about protecting the transformer under overload condition. Due to overload the efficiency gets reduced and the secondary winding gets overheated or it may be burnt. So, by reducing the extra load, the transformer can be protected. This can be done by operating another transformer in parallel with main transformer through comparator and change over relay. The comparator compares the load on the first transformer with a reference value. When the load exceeds the reference value, the second transformer will automatically be connected in parallel with first transformer and share the extra load. Therefore, two transformers work efficiently under overload condition and the damage can be prevented.

For home appliances, commercial and industrial loads, the transmitted voltage must be steeped down to a distribution level. This may happen in several phases. In sub-stations the voltage gets stepped down from transmission level (in the tens or hundreds of thousands of volts range) to the distribution level (typically less than 10,000 volts).

In this work, a slave transformer shares the load of master transformer in the case of overload 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.

Here, we used regulated 12V, 500mA power supply, 7805 three terminal voltage regulator is used for voltage regulation. Bridge type full wave rectifier is used to rectify the AC output of secondary of 230/12V step-down transformer.

The concept of automatic load sharing of transformer or overload protection of transformer is done by various means like by using microprocessors, by using GSM technology, and by using relay’s. 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. While operating the number of transformers in parallel we have to follow some conditions like same voltage ratio, same X/R ratio, same KVA ratings, same polarity etc. i.e. we have to operate identical transformers in parallel.

II. BLOCK DIAGRAM

In this project we are using the three identical transformers which are connected in parallel through change over relay. Transformer-T1 is a main transformer we called it a master transformer and transformer-T2 and T3 is a auxiliary transformer and we called it a slave transformer. Each transformer has its own load handling capacity. In case of a normal operation the master transformer shares 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.

Load switching network is provided to ON/OFF the load on the transformers which is connected to load bank. Shunt is used to distribute the current to all the sections of the circuit. Comparator is having two inputs one is from shunt and the second is from the reference voltage.

Fig. 2.1: Block Diagram
Reference voltage is set by the user. Comparator compares the reference voltage and system voltage continuously and the output signal is given to the relay driver circuit. Relay driver circuit consists of NPN transistor to drive the relay. Relay driver gives the signal to the changeover relay in case of overload conditions. Change over relay closes its contact when load on the master transformer is more than its rated capacity and the transformer-T2 i.e. slave transformer is automatically connected in parallel with the main transformer and if the load is increased to such an amount that can’t be handled with the two transformers then the third transformer T3 is automatically connected in parallel with T1 & T2 and shares the load. Due to which the transformer-T1 is not overloaded and the problem like overheating, burning of winding of transformer and uninterrupted supply is gets eliminated by this arrangement. The visual indicator contains the LED’s which shows the ON/OFF status of the all transformers.

III. CIRCUIT DIAGRAM AND DESCRIPTION

Firstly, the 230V single phase AC supply is given to the primary of 230/12V stepped down transformer and the 12V is obtained at secondary winding of transformer. This 12V output is given to the bridge rectifier. Bridge rectifier converts AC into DC. Electronics devices will works properly when they get regulated constant DC power supply for that purpose regulator 7805 is used. The 5V DC regulated supply is given to the transistor’s collector & base (Tr1). The emitter of n-p-n transistor is connected to the pin number-2 (V-) of the LM-3914 comparator IC. Reference value is set in the preset which is continuously compared with feedback signal. Preset is connected to the pin number 4 & 3 of comparator IC. The MCT-2E is used as a octocoupler. It is a component that transfers electrical signals between two isolated circuits by using light. Octocoupler prevents high voltages from affecting the system receiving the signal. Octocoupler connects the two IC’s (i.e. LM3914 comparator IC and ULN 2803 relay driver IC) with each other. Three relays are connected to the pin no. 11, 17 & 18 of ULN2803. The phase of transformers T1, T2 & T3 are connected to the contactor while the neutral is given separately from the single phase supply.

Potentiometer of 100K is used as a load which is connected to the secondary side of main transformer T1. Another n-p-n transistor Tr-2 is used for providing the feedback signal to the Tr-1 and to make the system automatic. Base of Tr-2 is connected to the potentiometer and the emitter of Tr-2 is connected to the base of transistor Tr-1 which is then further applied to the comparator IC LM3914.

Initially, when we switched ON the supply then main transformer T1 is ON and shares the load upto its rated capacity. Now, we gradually vary the load on the transformer T1 by varying the potentiometer. This variation of the load is given to the comparator IC LM3914 continuously by feedback circuit. As the load is increased to such an extent that can’t be handled by transformer T1 then this value is compared with the reference or set value by the comparator IC and signal is fed to the relay driver IC ULN2803 for closing of relay contacts. In normal condition the relay contacts are open that’s why the transformer T2 & T3 are in OFF condition or in other ways they are not part of sharing the load. As the relay-2 closes its contacts the auxiliary transformer T2 is connected in parallel with transformer T1 and shares its load automatically. When the load is increased and increased to such an extent that can’t be handled by two transformers, then again comparator IC gives the signal to the relay driver IC for closing the contacts of relay-3. As the relay-3 closes its contacts the transformer T3 is connected automatically in parallel with transformer T1& T2 and shares the increased load on the system. In this way the automatic load sharing between number of transformers is done and the protection of transformers against overload is achieved.

IV. SPECIFICATION OF COMPONENT USED

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Component Used</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>01.</td>
<td>Transformer</td>
<td>230/12 V</td>
</tr>
<tr>
<td>02.</td>
<td>Capacitor</td>
<td>2200uf, 1000uf, 220uf</td>
</tr>
<tr>
<td>03.</td>
<td>Comparator IC 3914</td>
<td>Upto 35volt</td>
</tr>
<tr>
<td>04.</td>
<td>7805 Regulator IC</td>
<td>-</td>
</tr>
<tr>
<td>05.</td>
<td>Relay Driver IC-ULN2803</td>
<td>Upto 30volt</td>
</tr>
<tr>
<td>06.</td>
<td>Relay (SPDT)</td>
<td>30V DC, 1Amp</td>
</tr>
<tr>
<td>07.</td>
<td>Resistors</td>
<td>56KΩ, 1.6KΩ, 18KΩ</td>
</tr>
<tr>
<td>08.</td>
<td>Potentiometer</td>
<td>100K</td>
</tr>
<tr>
<td>09.</td>
<td>Diode (P-N junction)</td>
<td>IN4004</td>
</tr>
</tbody>
</table>

Table 4.1: Specification of Component Used
V. ADVANTAGES
1) The load is shared by transformers is automatically.
2) No manual errors are taking place.
3) It prevents the main transformer from damage due to the problems like overload and overheat.
4) Un-interrupted power supply to the consumers is supplied.

VI. CONCLUSION
The work on “Automatic load sharing of transformers” is successfully designed, tested and a demo unit is fabricated for operating three transformers in parallel to share the load automatically with the help of change over relay and relay driver circuit. Also to protect the transformers from overloading and thus providing un-interrupted power supply to the customers.

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REFERENCES