

Automatic Transformer Distribution and Load Sharing Using Microcontroller

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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 slave transformers will share the load when the load on the main transformer will rise above its rated capacity. The main aim of the work is to provide an un-interrupted 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.

Keywords: Capacity, Interruption, Load; System, Transformer, Microcontroller.

1. INTRODUCTION

Transformer is the vital component in the electric power transmission and distribution system. The problems of overloading, voltage variation and heating effects are very common. It takes a lot of time for its repair and also involves lot of expenditure. This work is all about protecting the transformer under overload condition. Due to overload the efficiency drops 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 microcontroller and change over relay. The microcontroller compares the load on the first transformer with a reference value. When the load exceeds the reference value, the slave transformer will automatically be connected in parallel with first transformer and share the extra load. Therefore, a number of transformers work efficiently under overload condition and the damage can be prevented.

In this work, the slave transformers share the load of master transformer in the case of over load and over temperature conditions. A sensor circuit containing microcontroller, current transformer etc. 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. The microcontroller monitor's the load current and temperature of transformer and displays the values on LCD. Whenever loads are added to the secondary side of the transformer, the current at the secondary side rise. As the load current exceeds the rated current rating of the transformer, the temperature of the secondary winding rises, therefore the microcontroller will send a trip signal to the relay, thereby turning on the slave transformers. 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 project three modules are used to control the load current. The first module is the sensing unit, which is used to sense the current of the load; the second module is control unit in which relay plays the main role, and its function is to

change the position with respect to the control signal and last module is microcontroller. It will read the digital signal and perform some calculation and finally gives control signal to the relay. For monitoring the load current continuously, current transformer is used and the output of current transformer is fed to micro-controller through A-D converter. Similarly for monitoring transformer body temperature operational amplifiers are used with suitable temperature transducer.

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 relays. 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.

2. 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 are auxiliary transformers and we called them as slave transformers. 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.

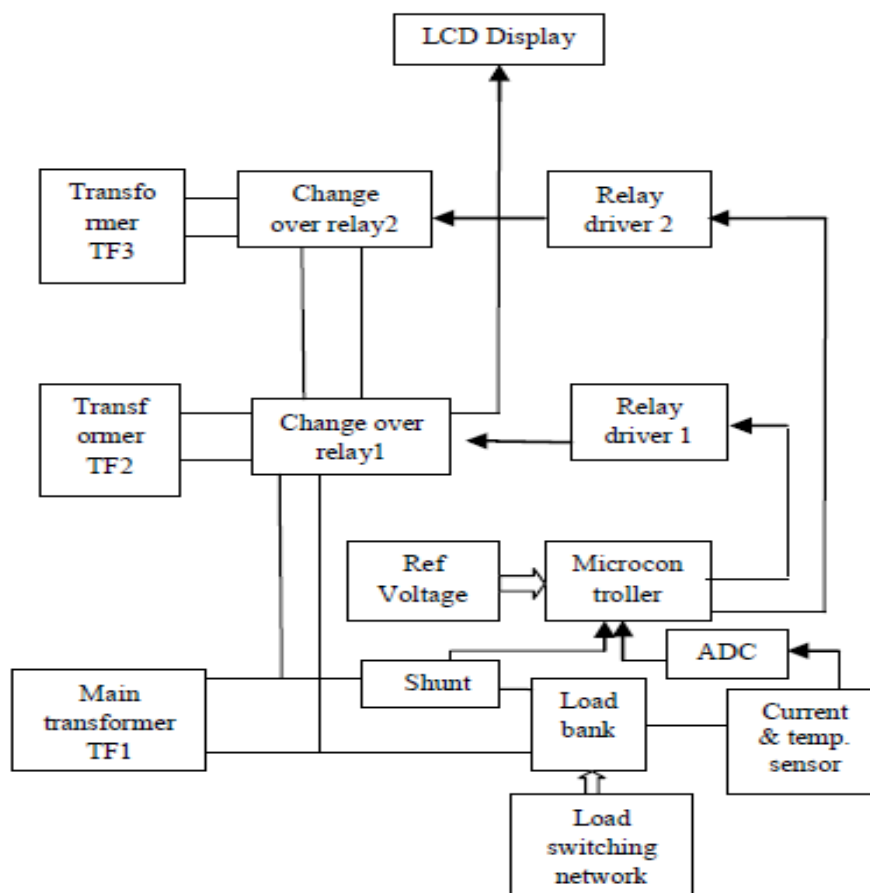


Fig.1 Simplified Block Diagram of System

Reference voltage is set by the user. Comparator (microcontroller) 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 it's 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 a 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 un-interruption of supply is gets eliminated by this arrangement. The visual indicator contains the LED's which shows the ON/OFF status of the all transformers.

3. CIRCUIT DIAGRAM AND DESCRIPTION

Firstly, the required operating voltage for Microcontroller 89C51 is 5V. Hence the 5V D.C. power supply is needed by the same. This regulated 5V is generated by first stepping down the 230V to 18V and 12 V operating voltage for relays. Hence another supply is required to generate 12V.

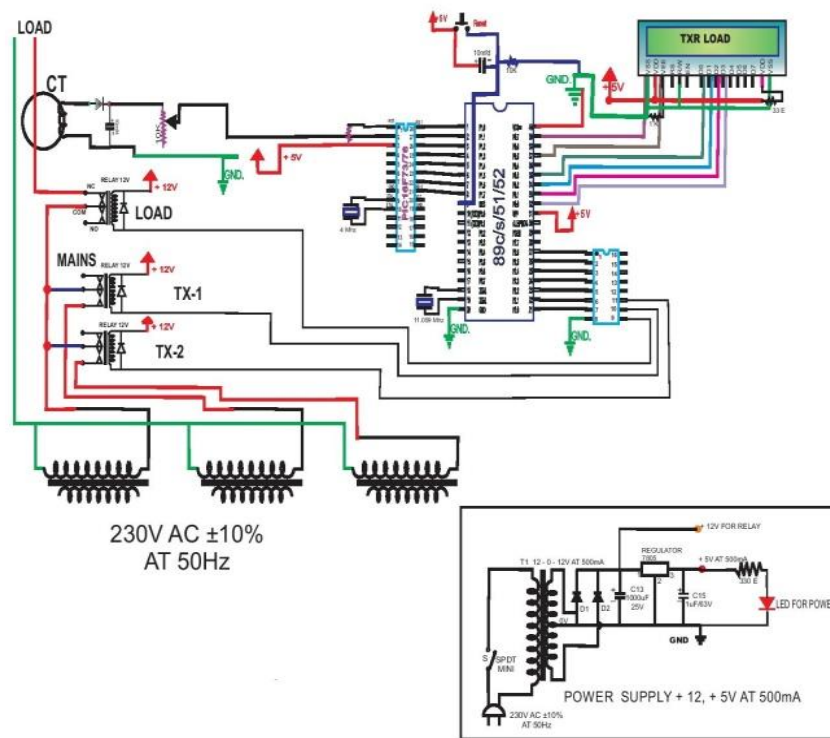


Fig.2 Circuit Diagram of System

The step downed a.c. voltage is being rectified by the Bridge Rectifier. The diodes used are 1N4007. The rectified a.c. voltage is now filtered using a 'C' filter. Now the rectified, filtered D.C. voltage is fed to the Voltage Regulator. This voltage regulator allows us to have a Regulated Voltage which is +5V. We are using two voltage regulators i.e., 7805 and 7812. These voltage regulators regulate 5v for microcontroller and 12v for relays. The rectified, filtered and regulated voltage is again filtered for ripples using an electrolytic capacitor 100µF. Now the output from this section is fed to 40th pin of 89c51 microcontroller to supply operating voltage.

The microcontroller 89C51 with Pull up resistors at Port0 and crystal oscillator of 11.0592 MHz crystal in conjunction with couple of capacitors of is placed at 18th & 19th pins of 89c51 to make it work (execute) properly. The LCD is interfaced to Microcontroller. The data pins of LCD are connected to Port 0. The control pins of LCD are connected to Port 2 as shown in schematic.

One of the port 3 pin is connected to the secondary side of transformer one through bridge rectifier and regulator to check the status of the transformer one i.e. whether the power supply is on or off to the transformer one through relay. Relay is used to on & off the transformer occurred it is connected to P2.0 microcontroller.

The data pins of ADC are connected to the port 1 of microcontroller. Whatever the data in ADC from C.T (current transformer) will be converted from analog to digital and fed it to the microcontroller.

Reference value is set in the preset which is continuously compared with feedback signal in the controller. Three relays are connected to controller through relay driver. The phase of transformers T1, T2 & T3 are connected to the relay contactor while the neutral is given separately from the single phase supply.

100W bulbs are used as loads which is connected to the secondary side of main transformer T1. Another n-p-n transistor of controller is used for providing the feedback signal and to make the system automatic.

Initially, when we switched ON the supply then main transformer T1 is ON and shares the load up to its rated capacity. Now, we gradually vary the load on the transformer T1 by turning on the bulbs. This variation of the load is given to the microcontroller 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 controller 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.

TEMPERATURE MONITORING AND CONTROL:

The circuit design consists of a basic transducer, which converts temperature in to equivalent voltage. For this, transistor "SL10" is used as a sensor. The transistor junction (Base & emitter or Base & collector) characteristics depend upon the temperature. For a transistor, the maximum average power that it can dissipate is limited by the temperature that collector - base junction can with stand. Therefore, maximum allowable junction temperature should not be exceeded. The average power dissipated in collector circuit is given by the average of the product of the collector current and collector base voltage. At any other temperature the de-rating curves are supplied by the manufacturer to calculate maximum allowable power (Pj). Where TC is case temperature, Tj is junction temperature and Qj is the thermal resistance. The entire circuit design of the temperature sensing circuit is illustrated in Fig.3. With the help of 2K preset (variable resistor) connected at the input of first stage, the initial room temperature corresponding output voltage can be adjusted for the easy calibration. The output of the second stage is clamped with 5V zener and the same output is fed to the A/D converter.

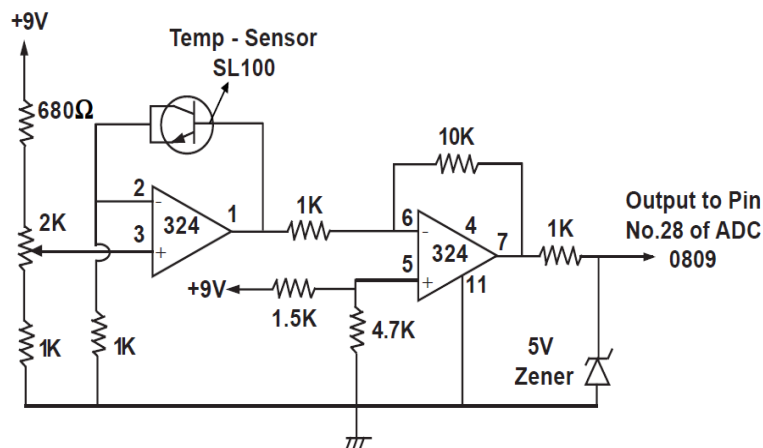


Fig.3 Temperature Monitoring and control circuit

4. SPECIFICATION OF COMPONENT USED

Table 1: Specification of Component Used

Sr. No.	Component Used	Rating
01.	Transformer	230/12 V
02.	Capacitor	2200uf, 1000uf, 220uf
03.	7805 Regulator IC & CT	-
04.	Relay Driver IC- ULN2003	Up to 30volt
05.	Relay (SPDT)	30V DC, 1Amp
06.	Resistors	56K Ω , 1.6K Ω , 18K Ω
07.	Diode (P-N junction)	IN4004
08.	Bulbs	100W
09.	ADC	0508 G
10.	16 x 2 Character LCD	5V
11.	AT89S52 microcontroller	5V

5. OBSERVATION AND CONCLUSION

In this project we observed that if load on one transformer is increases then the relay will sense the change in current & microcontroller operates & slave transformers comes automatically in operation to share the load.

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 and also to protect the transformers from overloading and thus providing an uninterrupted power supply to the customers.

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 overheats.
- 4) Un-interrupted power supply to the consumers is supplied.

6. IMPLEMENTATION, TESTING AND SNAPSHOT

- Check that the whole setup is in OFF condition first
- Now turn on the supply and see that only one bulb is turned ON this indicates that the load is low and the current and voltage is displayed on the LCD.
- Now for this condition only one LED of Master transformer is turned on, this shows that the load is only through master transformer.
- After this,turn on the second bulb too , this indicates that the load is high and the current is displayed on the LCD
- Now as the load is high the microcontroller trips on the first relay and the load is shared by the two transformers
- Now both the LED’s of transformers start glowing which indicates the load is being shared by both the transformers
- After this , turn on the third bulb too , this indicates that the load is again increased and the current is displayed on the LCD
- Now as the load is increased the microcontroller trips on the second relay and the load is shared by three transformers
- Now all the LED’s of transformers start glowing which indicates the load is being shared by all the transformers
- After this , turn on the last bulb too , this indicates that the load is again increased and the current is displayed on the LCD

- Now as the load is increased the microcontroller trips on the last relay too and the entire load is cut as all the transformers are fully loaded.

Thus the project is tested.

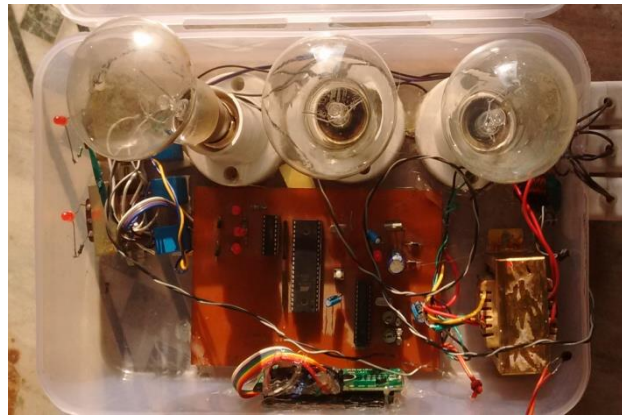


Fig.4 Snapshot of model

7. FUTURE SCOPE

The project describes about how to use power supply intelligently under peak loads. The project automatically connects and disconnects the transformer thus protecting transformer from overload. Sensing unit, i.e. Current transformer plays an important role by sensing the current through the load and sending feedback signal to the microcontroller. PIC Microcontroller is so programmed that as soon as the load exceeds a particular current limit it will soon generate a control signal that would be amplified by the driver unit and finally control signal is fed to the relay. The switching process occurs in the Relay which automatically connects the transformer in parallel in accordance to the load sensed by the CT. The future scope of our project is particularly in Substation. In substations particularly during the peak hours there is a need for the operation of additional transformer to supply the additional load requirement. Our project automatically connects the transformer under critical loads. Thus there is no need to operate both transformers under normal loads, particularly during off peak hours. Thus power is shared intelligently with the transformers in parallel.

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