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HIGHLY SECURED TRANSFORMER LOAD SHARING SYSTEM USING MICROCONTROLLER

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Abstract-The transformer is a static device, which converts power from one level to another level. The aim of the paper 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 microcontroller 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 microcontroller 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 paper 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.

Key Word: Transformer, Load Sharing, Microcontroller, Relay Driver

1. 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 disruption due to the sudden unexpected failure. 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 needs, the 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. It takes a lot of time to repair and involves a lot of expenditure. 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 ageing 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 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.

2. OBJECTIVE

The main objective 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. In the proposed system, 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 pins. Here the load is directly connected to the secondary of the main transformer as well as backup transformer. The two transformers are connected through the relay circuits. In the suggested approach second transformer will share the load, when the load on the first transformer will rise above its rated capacity.

3. LITERATURE REVIEW

- First method for parallel operation as obtains from the switch. And checking the polarity and frequency by the manpower.
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Following methods are followed for load sharing of transformer without microcontroller

Comparator based transformer load sharing

Here there are three transformer are used. Transformer T1 is main transformer and transformer T2 and T3 is called slave transformer. In normal operating condition transformer T1 is fulfil load demand. Suppose condition occurs that load on consumer side is increase above the capacity of main transformer. If there is no such arrangement to full fill the load chance of the damage of the transformer should be there. So in this condition parallel operation of transformer is used. In this scheme comparator is used to compare reference voltage and system voltage and in condition of load increase signal is given to the relay driver circuit. Relay driver gives the signal to the changeover relay. Change over relay closes its contact when load on the main transformer is more than its rated capacity and the transformer T2 is directly connected with main transformer in parallel. If load is increase beyond the both transformer capacity than transformer T3 is connected with both transformer.

GSM based transformer load sharing

Here the transformer load sharing is archived by the simple operation of microcontroller and GSM technique. For this configuration of the program through GSM module is done. Here two transformer is used one is main transformer and second is sharing transformer which is used to share the load .Here in normal condition the load is supply by main transformer. Condition occur that load on main transformer is increases above the rating of the main transformer capacity. Here when load is increase the relay will be connect sharing transformer with the main transformer. And this relay will be operating with the micro controller. To check the exceeding limit micro controller takes digital current value from the line. If condition is occurring that load increase that micro controller checks the instruction and give command to the GSM. From GSM module the SMS will be sending to the respected engineers.

Transformer load sharing with power factor improvement technique

In overload condition there is stress created on the winding of transformer. Due to this the temperature of transformer is get increase and these indicate overloading. In this scheme the protection of the over loading, over temperature of transformer is archived by the perfect load sharing and also scheme involves the power factor improvement technique. In most cases the load side power factor is lagging. Here automatic load sharing module also consist the automatic power factor correction circuit. Loads are inductive in nature so the power factor is lagging in nature. So to improve power factor nearer to the 1.0 capacitor or inductors banks are used.

4. PROBLEM STATEMENT

In literature review we can say that in the old project they do not uses the microcontroller the man power is required for load transferring and on transformer due to this the continuity of supply is not maintained.

5. PROPOSED METHODOLOGY

The present system is designed around two transformers. One transformer (TF1) is used as the main supply and the other transformer (TF2) is used in the place of the generator (for demo purpose). These two transformers are connected with the relay which is controlled by the embedded controller.

The loads are connected to the main line (TF1) and as well as to the TF2. Initially TF1 is connected to the load, the loads run with this power. Due to any reason this power is interrupted or over loaded, then it is identified by the controller and it immediately switches ON to the TF2 through the relay. The controller continuously monitors the TF1 (main line).

The project is all about protecting the transformer under overload condition. This can be done by connecting another transformer in 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.

6. 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 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

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capacity of main transformer the slave transformer is connected in parallel automatically and shares the load.

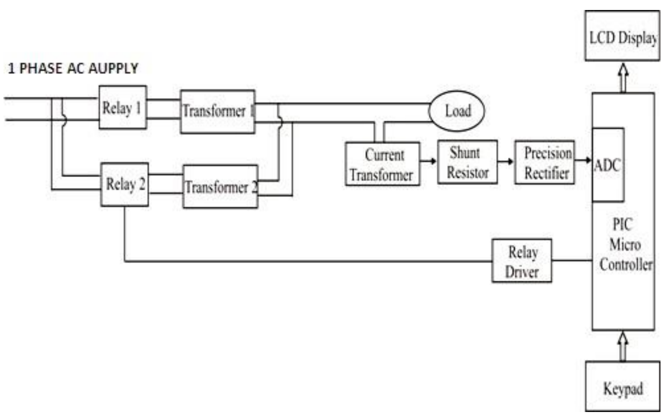
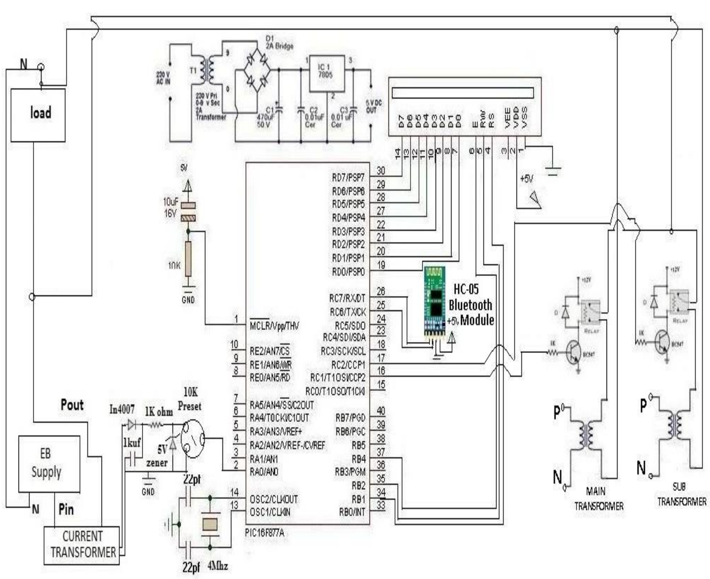


Figure 6.1 Block diagram of transformer load sharing

In the power system transformers may be loaded beyond their nameplate ratings due to a fault or some emergency conditions. This type of overloading can cause either short term failures or long term failures. Increase in hot spot temperature would also lead to the accelerated ageing of the transformers resulting in transformer overload. So in order to keep the body temperature of the transformer within its nameplate rating, the transformer must be loaded efficiently in a controlled manner. Our system aims at load sharing of transformers and priority based load shedding.



procedure of load sharing is summarized below.

- Loads are supplied from a single transformer under normal condition and a standby transformer is connected in parallel through a relay.
- 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 energizes the relay coil. The relay coil thus sends a tripping signal to the relay 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 is informed to the controller by a GSM and the load parameters are continuously displayed in the LCD. This algorithm is followed whenever the transformer is working and the program is executed in a loop function so that the algorithm repeats itself.

7. PIC START PLUS PROGRAMMER:

A program written in the high level language called C; which will be converted into PICmicro MCU machine code by a compiler. Machine code is suitable for use by a PICmicro MCU or Microchip development system product like MPLAB IDE. The PIC start plus development system from microchip technology provides the product development engineer with a highly flexible low cost microcontroller design tool set for all microchip PIC micro devices. The **pic** start plus development system includes PIC start plus development programmer and MPLAB IDE. The PIC start plus programmer gives the product developer ability to program user software in to any of the supported microcontrollers. The PIC start plus software running under MPLAB provides for full interactive control over the programmer.

PROGRAM:

```
sbit rs at RB1_bit;
sbit rw at RB2_bit;
sbit e at RB4_bit;
sbit relay1 at RC0_bit; sbit
relay2 at RC1_bit;
sbit rs_Direction at TRISB1_bit; sbit
rw_Direction at TRISB2_bit; sbit
e_Direction at TRISB4_bit;
sbit relay1_Direction at TRISC0_bit;
sbit relay2_Direction at TRISC1_bit;
unsigned int
adc_rd=0,adc_rd1=0,adc_rd2=0,adc_rd3=0; char
uart_rd,uart_rd1;
```

```
unsigned char tt1,jj=0,AA;
void delay(unsigned int msec ); void
lcd_cmd22(unsigned char AA); void
lcd_data(unsigned char item);
void lcd_data_string(unsigned char *str); void
ini();
void conv(unsigned int count); void
lcd_cmd22(unsigned char AA)
{
PORTD = AA;
rs=     0;
rw=0;
e=1;
delay(1); e=0;
return;
}
void ini()
{
lcd_cmd22(0x38);
lcd_cmd22(0x0c);
lcd_cmd22(0x01);
lcd_cmd22(0x80);
}
void delay(unsigned int msec )
{
int i ,j ; for(i=0;i<msec;i++)
for(j=0; j<1275; j++);
}
void lcd_data(unsigned char item)
{
PORTD = item; rs=
1;
rw=0;
e=1;
delay(1); e=0;
return;
}
void lcd_data_string(unsigned char *str)
{
int i=0; while(str[i]!='\0')
{
lcd_data(str[i]); i++;
delay(1);
}
return;
}
void conv(unsigned int count)
{
unsigned int dig1,dig2,dig3,temp;
dig1=count/100; dig1=dig1+=0x30;
temp=count%100;
dig2=temp/10; dig2=dig2+0x30;
dig3=count%10; dig3=dig3+0x30;
lcd_data(dig1); lcd_data(dig2);
lcd_data(dig3);
}
void main()
{
TRISA = 0xff; TRISB = 0x00;
TRISC = 0x00; TRISD = 0x00;
ADCON1 = 0x00;
UART1_Init(9600);
ini(); relay1=1; relay2=0;
while (1)
{
adc_rd1=0;
adc_rd1 = ADC_Read(0);
adc_rd1=(adc_rd1*1.25)/5;
// lcd_cmd22(0x80);
//lcd_data_string("watts:");
// conv(adc_rd1);
// lcd_cmd22(0xc0);
//  lcd_data_string("Load Sharing Sys"); if(adc_rd1<=1)
{
relay2=0; lcd_cmd22(0x80);
lcd_data_string("T1:000W  T2:000W");
//lcd_cmd22(0xC0);
//lcd_data_string("TW:000W"); UART1_Write_Text("T:0  T2:0");
}
if(adc_rd1>=2 && adc_rd1<=5)
{
relay2=0; lcd_cmd22(0x80);
lcd_data_string("T1:040W  T2:000W");
//lcd_cmd22(0xC0);
//lcd_data_string("TW:040W"); UART1_Write_Text("T:40
T2:0");
}
if(adc_rd1>=6 && adc_rd1<=19)
{
//lcd_cmd22(0x01); relay2=0; lcd_cmd22(0x80);
lcd_data_string("T1:060W  T2:000W");
//lcd_cmd22(0xC0);
//lcd_data_string("TW:060W"); UART1_Write_Text("T:60
T2:0");
}
```

```
if(adc_rd1>=20 && adc_rd1<=31)
{
relay2=1;
lcd_cmd22(0x80);
lcd_data_string("T1:060W  T2:020W");
// lcd_cmd22(0xC0);
//
lcd_data_string("TW:080W");
UART1_Write_Text("T:60
T2:20");
}
if(adc_rd1>=32 && adc_rd1<=40)
{
relay2=1;
lcd_cmd22(0x80);
lcd_data_string("T1:060W  T2:040W");
// lcd_cmd22(0xC0);
// lcd_data_string("TW:100W");
UART1_Write_Text("T:60
T2:40");
}
if(adc_rd1>=41 && adc_rd1<=50)
{
relay2=1; lcd_cmd22(0x80);
lcd_data_string("T1:060W  T2:060W");
//lcd_cmd22(0xC0);
//lcd_data_string("TW:120W");
UART1_Write_Text("T:60 T2:60");
}
if(adc_rd1>=51)
{
lcd_cmd22(0x01);
relay2=1;
lcd_cmd22(0x80);
lcd_data_string("HIGH  WATTS");
// lcd_cmd22(0xC0);
// lcd_data_string("WATTS"); UART1_Write_Text("HIGH WATTS ");
}
delay(50); UART1_Write(10);
UART1_Write(13);

}
}
```

8. OBSERVATION

In this project, 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 "Highly Secured Automatic Load Sharing of Transformers using Microcontroller" 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.

Analysis of load sharing with various Loads

Figure 8.1 When Load 60 Watts

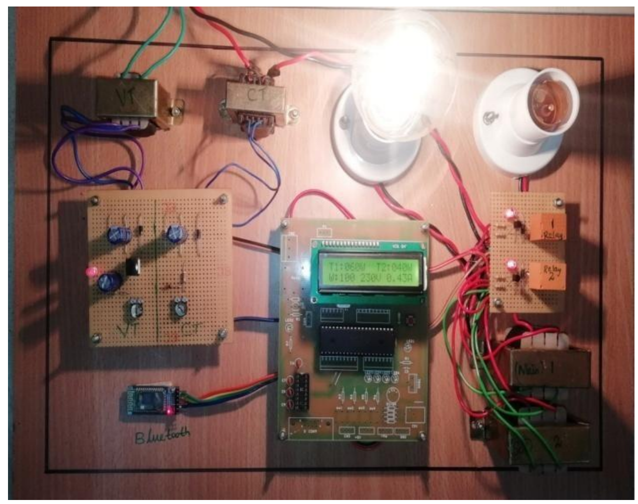


Figure 8.2 When Load 100 Watts

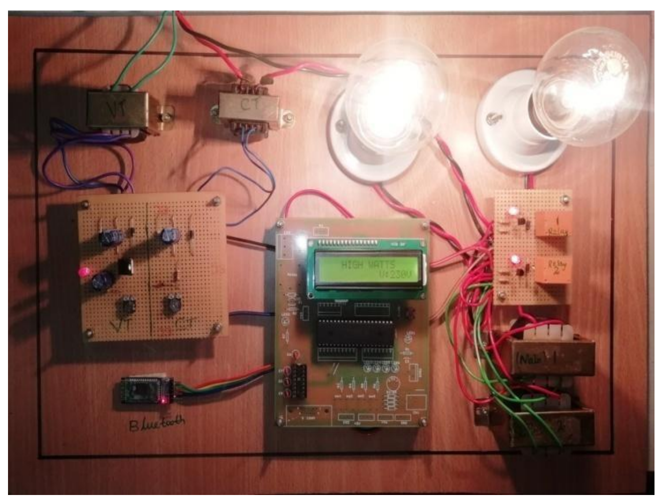


Figure 8.3 When Load 160 Watts (High Watts)

CONCLUSION

The project concludes that 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.

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