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Automatic Three Phase Selector with Power Factor Improvement

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Abstract - *Automatic three phase selector with power factor improvement is designed for automation of phase change during phase failure or total power failure in any of three phases in order to safe guard consumer appliances from epileptic power supply and to improve power factor automatically whenever power factor falls below a certain level. In most cases, many manufacturing companies, whether they are domestic or industrial, which employs single phase equipment for its operation sometimes experience challenges during failures in power supply. And also we know that inductive loads are main reason for low power factor in power system. By improving power factor of power system automatically using capacitor banks, power system efficiency can be improved. Automated system is developed using PIC microcontroller to solve these issues.*

***Key Words*: Capacitor Banks, Power Factor, PIC Microcontroller, Phase Changer, Single Phase Load.**

1. INTRODUCTION

It is often noticed that power interruption in distribution system is about 70 % for single phase faults while other two phases are in normal condition. Thus, in any commercial or domestic power supply system where 3 phase is available, it is advisable to have an automatic changeover system for uninterrupted power to critical loads in the event of missing phase. Automatic Three Phase Selector with Power Factor Improvement is designed to solve these two issues so efficiently. And also power factor is the key factor to evaluate how effectively electric power in a power system is being used. If the power factor is high (unity), then the effectiveness of usage of electric power in a power system is more. As the power factor reduces, the less effectively electric power is being used in power system. The first part is designed to provide uninterrupted AC mains supply i.e., 230 volt to a single phase load. This is achieved by automatic changeover of the load from the missing phase to the next available phase in a 3 phase system. In this system auto selection is achieved by using a set of relays interconnected in such a way that if one of the relay feeding to the load remains energized always. Under the phase failure condition the logic gates comprising of AND & OR switch on the next relay and that delivers the power to the load. The second part is designed to minimize penalty for industrial units using automatic power factor correction unit. In this proposed system, two zero crossing detectors are used for detecting zero crossing of voltage and current. The time lag between the zero-voltage pulse and zero-current pulse is duly generated by suitable operational amplifier circuits in comparator mode is fed to two interrupt pins of a microcontroller. The program takes over to actuate appropriate number of relays from its output to bring shunt capacitors into load circuit to get the power factor till it reaches near unity. The capacitor bank and relays are interfaced to the microcontroller using a relay driver. The microcontroller used belongs to PIC family. LCD display provided displays the active phase and the measured power factor in the beginning. when the capacitor banks are connected it shows the improved power factor.

2. BLOCK DIAGRAM REPRESENTATION

The block diagram mainly consists of

- Single phase sensing unit
- Voltage & Current transformers
- Zero crossing detectors
- Pic-microcontroller chip
- Relay circuit
- Capacitor
- Inductive load
- Liquid crystal display

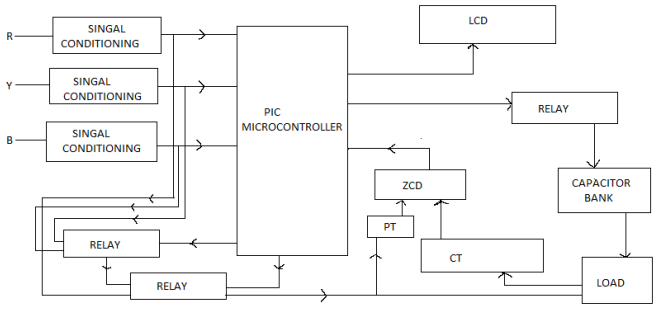

Fig -1: Block Diagram

According to block diagram a 50 Hz Ac supply is connectedtothelampandinductiveload.Currenttransformeran dpotentialtransformerareusedtoreducecurrent and voltage levels for zero crossing detector. The zero crossing detectors is a device for detecting the point where the voltage crosses zero in either direction. The measured voltage and current signal are given to input pin of pic microcontroller. Pic microcontroller converts the analog output of the zero

crossing detectors into digital signal. Pic microcontroller calculate the power factor of measured values, depends upon error it will send signal to relay. Pic microcontroller also monitors the three phase line voltage to find whether the line voltages are present or not. If any one line voltage is zero due to some other reason then it will indicate to corresponding circuit. LCD display is used to display power factor value and active phase of the line continuously. When relay energized by PIC microcontroller it connect capacitor parallel with load, when relay de energized it disconnect the capacitor from the line.

3. OPERATION

Three phase line voltages such as R, Y and B are monitored by the potential transformers. The potential transformer will convert the mains supply voltage to low voltage AC. That AC voltage will be rectified with the help of a bridge rectifier. Then the rectified output is filtered through the capacitor. Then the voltage is given to base of the BC547 switching transistor. Now the transistor is conducting, due to that collector and emitter terminal is shorted. The 40106 Schmitt trigger inverter is connected in the collector terminal. So zero voltage is given to inverter input and +5v is taken in the inverter output which is given as input to 7410 AND gate. If three line voltage is present, all inputs in the AND gate are high so the output of the AND gate is high which is given to microcontroller or other interfacing circuits. If any one line voltage is zero, the output of the AND gate also zero. In microcontroller or PC we can find the single phase fault with the help of software.

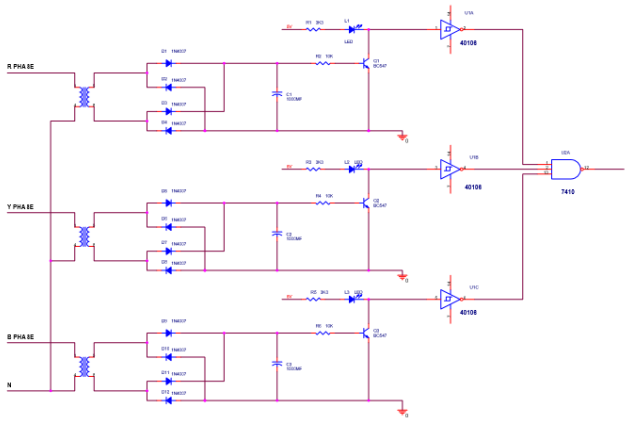

Fig -2: Single Phase Sensing Unit

The potential transformer is used to step down the mains supply voltage to low voltage level. The voltage level is from 440V AC to 6V AC. Then the output of the transformer is given to Zero Crossing Detector. The current consumed by the load is measured with the help of a current transformer. The current transformer will convert the load current in to lower values that current output will be converted in to voltage with the help of the shunt resistor. Then the corresponding the AC voltage is given to zero crossing detector. The Zero Crossing Detector is used to convert the sine wave to square wave signal. The zero crossing detectors are constructed by the operational amplier LM 741. The inverting and non- inverting input terminals are connected to the potential transformer and current transformer terminals respectively. So the input sine wave signal is converted in to square wave signals. The square signal is in the range of +12v to -12v level. Then the square wave signal is given to base of the BC 547 switching transistor in order to convert the TTL voltage 0 to 5v level. Then the both ZCDs outputs are given to logical XOR gate 74LS86 to find the phase angle difference between the voltage and current. The XOR gate output is then given to a microcontroller or PC and calculate the power factor with help of software.

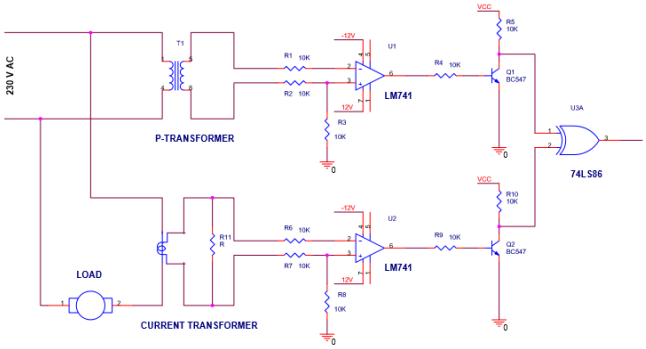

Fig -3: Power Factor Measurement Unit

4. EXPERIMENTAL SETUPS AND RESULT

A three active line is taken from an extension board as shown in Fig. 4.

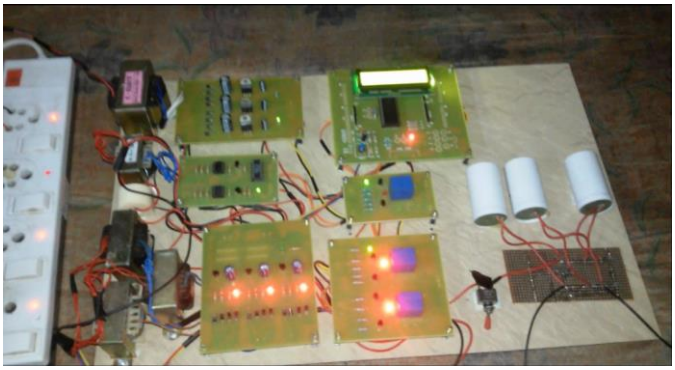

Fig -4: Experimental Setup of the Proposed System

At first all the three lines are active and circuit is completed through line R and LCD displays line which is active now i.e line R. Now cut the line R, the circuit is completed through line Y and active line indicated on LCD will be the line Y. similarly the LCD shows active line as B on display when line R and Y are cut o. In all the three cases power factor of the load is calculated and displayed on LCD. Capacitor banks are connected to the load through a switch to show the changes in power factor value. When capacitor banks are connected power factor is improved and the improved value is displayed on the LCD.

5. CONCLUSIONS

This proposed automatic three phase selector with power factor improvement investigated the influence of capacitor banks for improving the power factor of the inductive load. At the same time a three phase sensing circuit is used to monitor the available phases from the three phase system. So that continuity of supply to single phase load is maintained even if any one of the phases misses. The proposed system for power factor measurement is suitable if both current and voltage are purely sinusoidal. Further studies have showed that our proposed project can be improved by using synchronous condenser instead of capacitor bank because of long life and low maintenance cost.

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