OC, UV, OV Protected advanced automatic phase selector with inverter support

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Abstract— The distribution system is three phase whereas majority of all house hold electrical loads are single phase loads. The improper allocation of these single-phase loads in three phase system will lead to current imbalances of the power system. The unbalanced system will increase the power quality issues. Almost all houses now require to use inverter. If an equipment is starting, then the to which phase it is to be connected can be determined and this idea is the key point to this paper. This can also protect the whole system from open circuit, under voltage and over voltage problems which may lead to brown out or a complete black out.

Index Terms— Phase selector, Protection, power quality.

I.INTRODUCTION

Power instability and phase failure has posed serious threat to the economic growth of developing countries. It is noticed that power interruption in distribution system is about 70% due to single phase faults when the other two phases are in normal condition. Most companies; industrial, commercial and even domestic are dependent on public power supply which have erratic supply such as phase failure, phase imbalances or total power failure due to one or more technical problem in power generation, transmission or distribution. This creates a need for automation of electrical power generation or alternative sources of power to back up the utility supply. This automation is required as the rate of power outage becomes predominantly high. Hence, there is need for automation of phase change during phase failure or total power failure in order to safe guard consumer appliances from epileptic power supply. If the processes of change-over are manual, serious time is not only wasted but also creates device or machine damage from human error during the change-over connections, which could bring massive losses. Industries require three phases power to run their machinery. Some of them require continuous or uninterrupted power to maintain their data.

In most cases, many manufacturing companies, be it domestic or industrial, which employ single phase equipment for its operation sometimes experience challenges during unbalance voltages, overloads and under-voltages, in power supply, much time would be required in the process of manual change over. This means that time and the process needed for the phase change may cause serious damages to machines and even the products, hence, there is need for automatic phase switching system.

The importance and advancement of control system in engineering have created different ways in which automatic switching systems can solve domestic and industrial problems especially in the developing countries. The importance attached to cases of operation in hospitals and air ports in order to save life from generator as fast as possible makes it important for the design and construction of an automatic change-over switch which would solve the problem of manpower and the danger likely to be encountered changeover.

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 [1].

We introduce auto phase selector unit for that equipment whose supply is single phase. The single-phase supply is selected automatically from three phases supply. The objective of the APS is to ensure that there is continued commercial power supplied to the site at all times.

Whenever the supply of one or two phases of a three-phase electrical line goes off, the APS system automatically distributes the electrical supply from the active phase to the failed phases. This ensures continuous power supply through all the three phases even if one phase is active.

Automatic Phase Selector is used to sustain energy consumption in the time of phase trip [2].

The intelligent phase selector is a system that is capable of comparing three phases and switching automatically to any of the three phases.

The project is designed to provide uninterrupted AC mains supply i.e., 230 volts 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.

To develop a simple low cost device aimed at easing the prevalent burden faced by delicate offices, parastatals and institutions who need very low but constant power supply. Since supply is always on along the distribution lines that supply such sites, what pesters on the progress of work thereof is always the unwarranted trip of phases due to power usage from neighboring consumers. The automatic phase selector therefore, erases this setback form the face of progress of work in such offices.

Auto Phase Selector introduces an automatic solution to overcome power fluctuation or phase interruption by selecting next most healthy available phase to feed the equipment.

II. SYSTEM FEATURES AND DESCRIPTION

Now days in most of the office buildings, hostel etc., phase selectors are most commonly available. From the available 3 phases, this phase selectors will switch the loads to required phase. But while considering the entire system, it will create some sort of phase imbalance. We can also use phase selectors to redistribute the loads in order to balance the three-phase load current. In the case of automatic phase selectors, they are also commonly available in many buildings all over India. When power in one phase is not available it can switch or automatically switch to another phase where power is available there by maintaining the continuity of the supply. It finds wide application in the many fields. The major advantage is the automatic switching, where the human interference or involvement is not at all necessary. And the serious issue is that it is not offering any safety to the user end or consumer end equipment's, also if all the three phases are lacking of power, it cannot maintain the continuity and reliability of the supply system. But in this system, we are incorporating under voltage protection, over voltage protection and also an inverter package to ensure the continuity, safety and reliability of the supply [3]. Algorithm proposed in this paper will ensures further protection and ensures the safe and smooth operation of this system.

Hence main features of this system can be listed as:

1. Automatic phase selection (Among 3 phases).
2. Inverter backup.
3. Overvoltage protection.
4. Under voltage Protection
5. Over current Protection

During the normal operation, Phase A is given priority and is connected to the load side which feeds the load. Second priority is given to Phase B, then C and then to the inverter respectively if all the 3 phases will fail together due to outage of the power system. For over current protection, the load current is continuously monitored by a CT and if at any instance, it overcomes the specific limit, the relay will drop out and the load circuit is isolated.

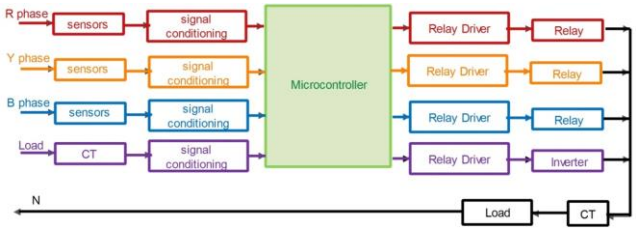

Figure 1: Block Diagram of the proposed technique

As per IS distribution system standards, the maximum permissible voltage deviation is 6% from the nominal value. Technically speaking, an over/under voltage condition is reached when the voltage exceeds/lags the nominal voltage by 10% for more than 1 minute. Both of these conditions result in voltage that falls outside the acceptable power envelope. Overvoltage can cause damage to components connected to the power supply and lead to insulation failure, damage to electronic components, heating, flashovers, etc. The life of the electromechanical equipment can be drastically reduced on operating in under voltage conditions and lead to premature failure [4,5].

Figure 1 represents the block diagram of the proposed system. Each phase is connected to a step-down transformer, 230/6V as shown in the figure. It is rectified and filtered to feed positive input of an op-amp comparator.

Transformer voltage ratio	=230/6V
Allowed variation in primary	=216.2V to 233.8V
Allowed variation in secondary	=5.64V to 6.36V
OVref	=7V DC
UVref	=6V DC

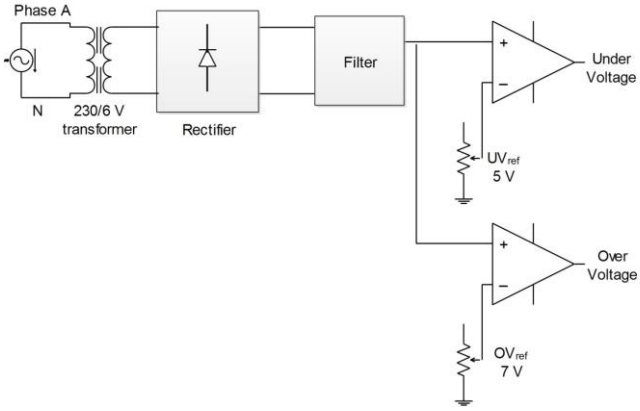

Figure 2: UV and OV Protection schemes

At the output side the output given by the microcontroller is amplified by the driver circuit and it further switches the relay to connect corresponding phase or inverter to the load. Output pulse is initiated only in the case unless over current is detected. Otherwise the load will be isolated. The over current setting depends upon the load value and it varies from circuit to circuit. But in real system these 6% variation is most common so in the design we are selecting the upper and lower limits of voltages as 5V to 7V, where the DC side voltages below 5

volts is treated as an under-voltage case and the DC side voltage above 7V is taken as overvoltage. Similarly, all the 3 phases are measured to be within the range mentioned above. The conditioned signals are fed to the microcontroller. Figure 2 represents the under voltage and over voltage protection schemes of the system.

III. SYSTEM OPERATION & FLOWCHART

In ordinary automatic phase selectors input will be coming from three phases and the output load will be fed to single phase loads. Normally it will be switched to any one of the active phase. If power in any of the phase turns off, automatically the phase selector will select second phase which is active. When again the second become inactive, third phase is to be switched on. But what happens in the case when three phases are facing turn off? At that situation, the automatic phase selector presented in this paper will select the inverter and the loads get connected to the inverter and it will be fed by the inverter.

And for over current protection we are providing a CT which will monitor the load current. if any over current occurs or if any fault occurs in the system the over current protection will act and the load gets tripped off. At that situation, even the inverter is also prevented from feeding the load as fault persists, the load must be completely isolated to ensure the safety of the system. For under voltage protection the voltage of the incoming circuit is being sensed in the load side and if the voltage is drops beyond a particular value that phase is switched off and alternate phase is checked for proper voltage. If alternate phase is also having less voltage then that will be also prevented from feeding the load and finally it is switched to inverter. Similarly, for over voltage also if any phase is experiencing over voltage automatically this will switches to inverter load.

Figure 3 shows the Flow chart of the proposed method. Flow of work is such that system initially when started, controller will read the value of phase A voltage and it is compared with over voltage reference and under voltage reference if the voltage of phase A comes in between over voltage reference and under voltage reference load is switched to phase A and it will always check that if there any over current persist. If any over voltage, under voltage, over current is there or any fault is there in the circuit or phase, automatically the circuit is tripped. Again, if only the voltage limit is violated, then automatically controller will sense the input of phase B and it is also compared with over voltage and under voltage reference.

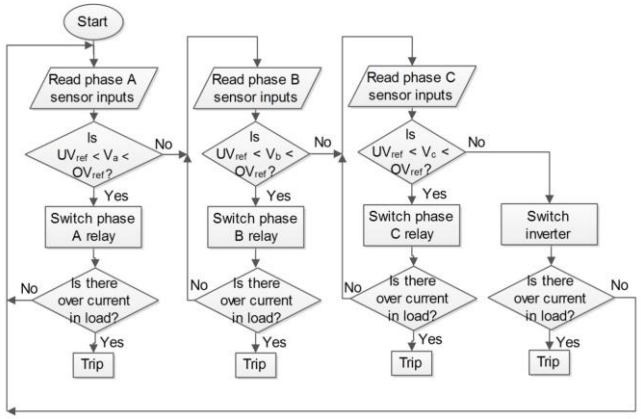

Figure 3: Flow chart of the proposed method

If it is coming within the reference it is switched to phase B and again controller will monitor whether fault is there or not is by sensing the current. If over current is there, again the system is tripped. Similarly, for phase C also it is switched whenever phase B is experiencing any under voltage or over voltage after validating all the conditions. If all the three phases are not available with proper supply, ie: the voltages are not within the range then automatically the controller will switch on to the inverter to feed the load and again for additional protection we are sensing whether over load is there. If over load is there inverter is also cut off from the load. Hence entire protection will be ensured by this circuit.

IV. CIRCUIT AND HARDWARE

Circuit and hardware details of major components are furnished in the table given below. Figure 4 shows the experimental setup associated with this system.

Table 1: Components of the project

N	Item	Nos
1	Step down transformer – 230/6V	3
2	Diode Bridge – W10	3
3	Opamp – LM324	2
4	Driver- L293D	1
5	Load-60W incandescent lamp	1
6	Microcontroller-AT89s51	1

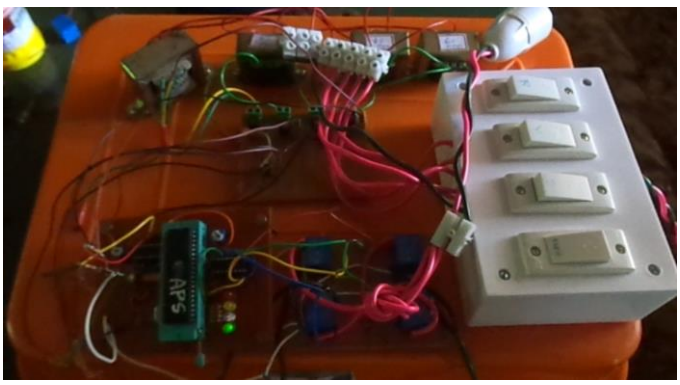

Figure 4: Experimental setup of the system

V.RESULTS

The results obtained from this are noted in the Table 2. From the observations, this is clear that if an under voltage or over voltage occurs in any phase, the load in that phase will be shifted to other phases. Thus the problem due to the under or over voltage is rectified.

Case	Voltages (V)			Load Current	Load status
	R	Y	B		
1	Normal	Normal	Normal	Normal	R phase
2	UV/OV	Normal	Normal	Normal	Y phase
3	UV/OV	UV/OV	Normal	Normal	B phase
4	UV/OV	UV/OV	UV/OV	Normal	Inverter
5	Normal	UV/OV	Normal	Normal	R phase
6	Normal	Normal	UV/OV	Normal	R phase
7	Normal	Normal	Normal	OC	Open
8	UV/OV	UV/OV	UV/OV	OC	Open

Table 2: Observations from the test

This system is very much useful for Residential, Commercial offices, Factories operating with 1 phase machineries and Hospitals/Banks/Institutions. It automatically supplies voltage in case of power failure or low voltage in up to 2 of the 3 incoming phases. Automatic Phase Changer automatically cuts supply during low voltage thus, protects equipment from the harmful effects of unhealthily low voltage.

There are many advantages for this system. It is more reliable than any other system. There is less moving part in the proposed scheme and so it requires less maintenance. As from the Table 1 it requires less number of components and also the components are cheaper. So as a whole the system will be cheaper. The life of an electrical equipment is determined by the proper usage of the system. The systems like projector will fail due to subsequent failure of power supply. This can be rectified by using this system by eliminating power Interruption during running of load. The system is very compact in size. It can be used for all single-phase loads irrespective of the nature of work it offers.

REFERENCES

[1]. “Design of an Automatic Power Phase Selector”, Uchechukwu Innocent Ezirim, Uchenna Bright Oweziem, Chinedu Cletus Obinwa and Solomon Okwuchukwu Ekwueme, International Journal of Engineering and Innovative Technology (IJEIT) Volume 5, Issue 2, August 2015

[2]. “Design and Construction of Automatic Three Phase Power System Selector”, F. U. Nweke and R. C. Iwu, IOSR Journal of Applied Physics (IOSR-JAP) e-ISSN: 2278-4861.Volume 7, Issue 6 Ver. I (Nov. - Dec. 2015), PP 11-14

[3]. “AUTOMATIC PHASE SELECTOR USING MICRO-CONTROLLER 89C52”, Mr.Lalit Patil, Shiwali Sonawane, Nisha Thakur and Komal Nagare, International Research Journal of Engineering and