Prioritised Hybrid Automatic Transfer Switch with Two Generators Shift

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Abstract— *Due to epileptic availability of electrical power supply for industrial or domestic use, especially in developing countries, the need for continuity of electricity supply is inevitable, for this reason, this Microcontroller Based Prioritized Automatic Transfer Switching system is designed to use four sources namely; public utility, solar, generator1 and generator2, to change from one of them to another with priority given. Utility is given the top priority followed by solar and then generator1 will run for six hours while checking other sources, if any of them is returned, then it will be disconnected and switched off, then the load is reconnected to the existing source, otherwise if the hours elapsed and no return of power from the other sources, then generator2 is connected for the next six hours as in the case of generator1. The cycle will be repeated continuously. The manual method used for the switching system is a major setback and can make the entire process vulnerable to fire outbreak, inefficiency and wastage of time. In this paper, the proposed design will bring an improvement and eliminates potential dangers, risk associated with ordinary manual transfer switching system, continuity of supply and hence greater transformation in technological advancement of the switching system. A pic16F877A microcontroller is used to coordinate the activities of voltage sensing circuitry (for utility, solar and generators respectively), LED indicators and relay driver. A proposed block diagram of the system and flow chart were developed, the programming for the microcontroller is carried out using pickit2 programmer (in C++ programming language). Proteus suit software was used to simulate the system. The workability of the system designed was proved successful from the simulation result and the duration it takes for the system design to operate is about less than a second unless for generators where delay of about twenty seconds is observed for switching and stability.*

Keywords**:** Automatic Transfer Switching (ATS) System; Generator; Microcontroller; Solar; Utility,

1 INTRODUCTION

Generally organization`s development is distracted by intermittent power failure or constant outage. In countries where there is instability of power, investment does not easily succeed, industrial transformation cannot be easily sped up, however a heavy loss may result when some processes are interrupted such as surgery in health care organization and some online financial proceedings in government and private agencies [1].

To avoid these inconveniences, secondary source of power is mostly introduced to cushion undesirable effect of any unprecedented power failure. The transition can be achieved by means of an ATS.

A load can be switched from many sources of power (conventionally two) by means of an ATS. It ensures that a minimum gap between the power failure and load reconnection to secondary source of power is maintained. The ATS comes in between the power sources and the load to be connected in order to disconnect the load from the utility supply when there is no electricity and transfer it to secondary supply for sustainability of load operation, it then connects it back to the original supply upon restoration of power [2].

In the system existing, power failure can be easily detected from the four switches connected to different power sources and hence the four inputs signals are connected to the plc. If any of the four sources (solar, inverter, mains and generator), back up would be provided automatically provided from the other sources and the load is shared [3]. The need here is to design a sophisticated Transfer Switching system that can take renewable energy source (solar energy) into consideration and two generators that will be shifting from one to another after every six hours during state of redundancy from other sources. Utility is given the top priority followed by solar and then finally generators. When the power is restored in any of the prioritised sources, then the working generator would be instantly shorted down and the load is transferred from that generator to the existing load based on the priority stated previously.

2 LITERATURE REVIEW

In [4], an ATS with an enhanced design including both software and hardware modules were discussed. The generator is controlled and monitored from a remotely located computer system which can as well supervise other parameters and generator `s on and off.

In [5], the ATS includes a digital multimeter using microcontroller (PIC16F877A), and Liquid Crystal Display was also used to display A.C current and voltage.

In [6], a simple changeover was designed to automatically transfer the load from utility energy to standby generator

whenever there is power outage. Microcontroller was not used in this design.

In [7], various tasks such as programming crank timer, warm up timer and mains stability switch were accomplished by means of microcontroller, and a circuit for overvoltage protection using comparator, 555 timer IC for the delay needed, were also included.

In [**3**], an automatic switching system designed to be multi source was implemented were the transfer of load to any source (namely solar, mains, wind and generator) is based on priority such that if any one of the sources fails, then the load would be shifted to the source next to it.

3 WORKING PRINCIPLE

The system constitutes of four sensor (which is a 5V power supply) from the respective sources namely; utility, solar, generator1 and generator2. If utility is available, it is given the top priority, and then utility relay signal would be sent from the microcontroller through the relay driver to connect load. If the mains source is absent, then solar source would automatically be connected while all other sources are deactivated and the system is busy checking for the return of the mains supply. In the absence of solar and utility source, generator1 would be started and allowed to settle for an overall delay of approximately 20s, it will then be connected to the load for 6H while checking for availability of mains or solar source. If the time scheduled for the operation of the generator1 is exhausted without having the other sources` return, then it would be disconnected and switched off while generator 2 would pick up and is connected to the load within a time delay of 20s, it will keep up working and checking for the return of other sources until 6H elapsed, if before the end of the time, there is return of power from either utility or solar, the generator2 would be disconnected and switched off while the load is transferred to the existing source, otherwise generator 1 will take over from generator2. This cycle will keep on repeating as long as the microcontroller is active. The system is made in such a way that if generator1 is working, generator 2 will never come up and vice versa.

The block diagram and flow chart of the overall system are shown in figure 1 and figure 3 respectively. Figure 2 provides the overall circuit simulation.

The Table 1 below shows the various conditions that exist and the corresponding output signals, where 0 stands for no input or output, 1 stands for there is input or output and x stands for don't care condition.

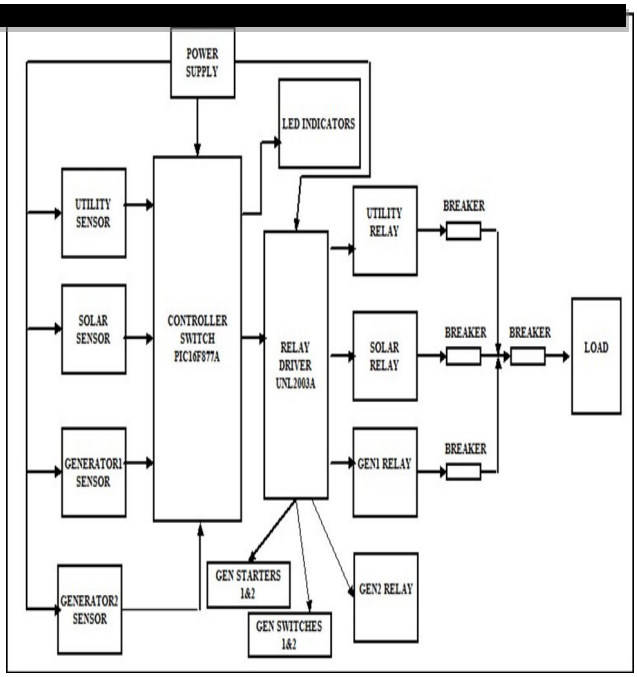

Figure 1: Block Diagram

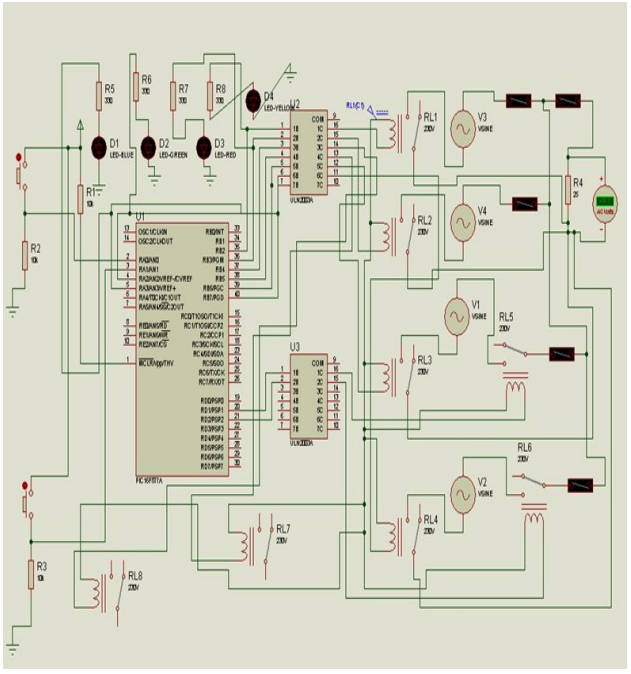

Figure 2: Simulation Circuit

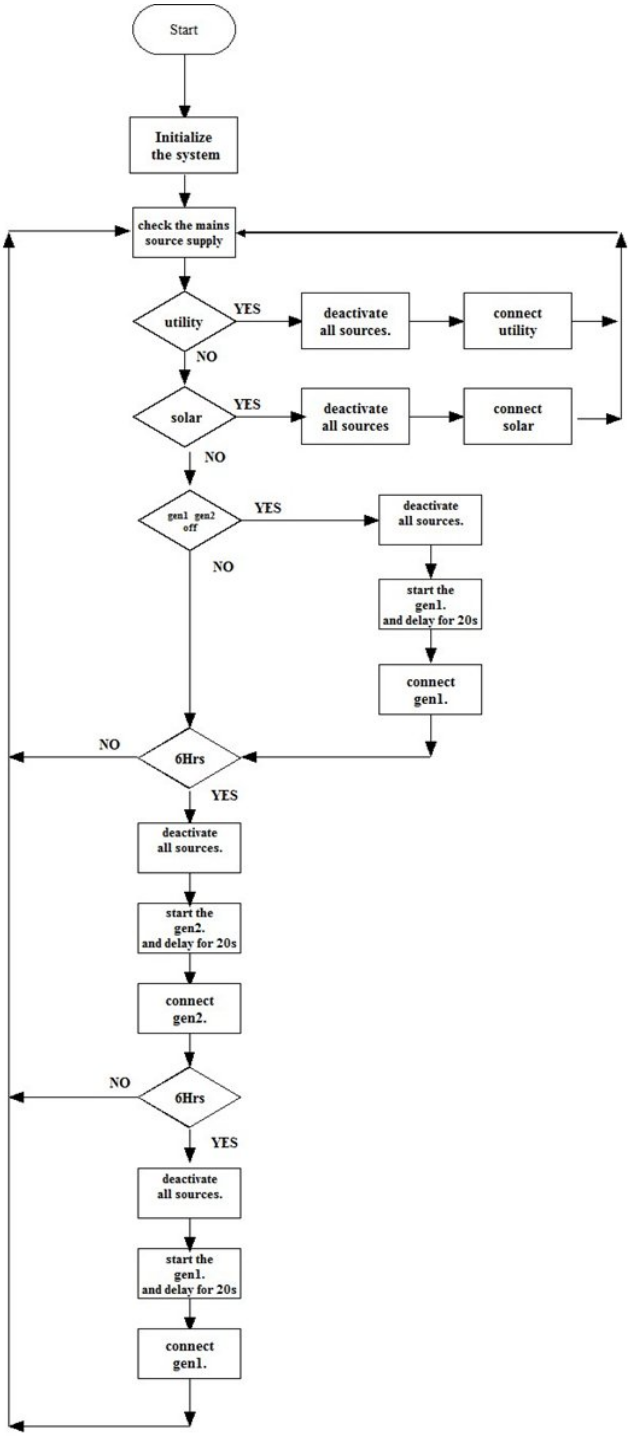

Figure 3: Flow Chart

Table 1: Proposed Power Selection Table

	INPUT			OUTPUT			
UTILITY SOURCE	SOLAR SOURCE	GENERATOR 1 SOURCE FIRST 6 HOURS	GENERATOR 2 SOURCE NEXT 6 HOURS	UTILITY SIGNAL	SOLAR SIGNAL	GENERATOR 1 SIGNAL	GENERATOR 2 SIGNAL
1	x	x	x	1	0	0	0
0	1	x	x	0	1	0	0
0	0	1	x	0	0	1	0
0	0	x	1	0	0	0	1
0	0	0	0	0	0	0	0

4 RESULT AND DISCUSSION

The result obtained from the simulation is summarised in Table 2 below where 0 stands for presence of power while 1 stands for absence of power, and it shows that utility is given the highest priority because whenever the utility source is available, it will be selected regardless of whichever source is present (from row 9 to 16). The table also shows that solar is given the next priority after utility (from row 5 to 8), then followed by generator1 which operates for six hours and then generator2 takes over, it was observed from the simulation that exchange of operation is repeated for every six hours between the two generators. If it happened that during the exchange period, the two generators are working simultaneously due possibly faulty relays, the system failed to switch one of them off, priority is given to generator 1 while keeping generator 2 disconnected. If more than one source are still giving out power, then the exterternal circuit breakers or fuses (either between the sources or between the sources and the load) instantly disconnect the sources from each other or from the load until maintenance is carried out.

Table2: Power Selection Table

		INPUT			OUTPUT			
SERIAL NUMBER	UTILITY SOURCE	SOLAR SOURCE	GENERATOR1 SOURCE FIRST 6 HOURS	GENERATOR2 SOURCE NEXT 6 HOURS	UTILITY SIGNAL	SOLAR SIGNAL	GENERATOR1 SIGNAL	GENERATOR2 SIGNAL
1	0	0	0	0	0	0	1	0
2	0	0	0	1	0	0	0	1
3	0	0	1	0	0	0	1	0
4	0	0	1	1	0	0	1	0
5	0	1	0	0	0	1	0	0
6	0	1	0	1	0	1	0	0
7	0	1	1	0	0	1	0	0
8	0	1	1	1	0	1	0	0
9	1	0	0	0	1	0	0	0
10	1	0	0	1	1	0	0	0
11	1	0	1	0	1	0	0	0
12	1	0	1	1	1	0	0	0
13	1	1	0	0	1	0	0	0
14	1	1	0	1	1	0	0	0
15	1	1	1	0	1	0	0	0
16	1	1	1	1	1	0	0	0

5 CONCLUSION

The system was simulated and works satisfactorily as expected, it would be of high importance if it would be used where interruption of power is a critical issue such as banks, industries and hospitals. It is designed to have a minimum delay of 1s unless during transition to generators where the delay is up to 20s for generators' stability.

6 FUTURE WORK

A backup supply should be incorporated to compensate for the delay of 20s and also a comparator design approach should be used to detect under and overvoltage.

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