DESIGN AND DEVELOPMENT OF INTELLIGENT 3 PHASE CHANGER

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Abstract: In the present scenario of 3 phase applications, if low voltage is available in any one of the three phases and needs equipment to work in normal voltage, then the phase contacts must be changed manually. The product developed will solve the problems related to 3 phase applications. The main aim of this product is to provide uninterrupted power supply for three phase loads even in the failure of a phase in a three phase system. The product is very useful in those industries, factories, home spaces and offices where continuous supply of electricity is needed. Normally in a three phase supply if one or two phase fails , power will not be there in the gadget connected to that particular failed phase(s), to avoid these failures , we bring Intelligent three Phase changer with PLC, which shifts power from alive phase to the failed phase(s) instantaneously, thus keeps all the circuits alive.

Keywords: 3 phase, low voltage, phase changer, PLC based, phase failure.

1. INTRODUCTION

The product consists of 3 pairs of contactors, where each pair is inter-connected by means of a mechanical switch, and a Programmable Logic Controller (PLC) to make the switchover between the contactors. The use of mechanical switch is to avoid two phases in a single line. The 3 phases (R Y B) is given to three pairs of contactors as RY YB and BR phases respectively, where in RY, R is primary phase and Y is secondary phase. If primary phase is not available then the secondary phase will be switched by the PLC. The PLC used here is SIEMENS LOGO 230 RC.

The next part of the product is the critical portion of the system, powering the PLC with the same 3 phase supply. During the presence of single phase supply, phase changeover is not required, but in the presence of two phases, phase changeover must take place, hence the PLC must be ON in the presence of any two phases. The output from any pair of contactors is given as power supply to PLC and thereby solving the above problem. Also 3 Normally Closed (NC) switches are connected to three pairs of contactors respectively so as to provide two phase supply when single phase is available.

The advantages of the product are, 3 phase supply is available to the user even if the PLC fails, the switchover takes place so fast and it is unnoticeable practically, human intervention for phase change over during phase loss in incoming 3 phase supply is eliminated, increases production in industries by providing continuous supply. Since the product is intelligent due to the use of PLC, it serves automation operations.

1.1 Related Work

Most industrial and commercial processes are dependent on power supply and 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. (Atlas, A. Sharaf, 2008).

The starting of the generator is done by a relay which switches the battery voltage to ignition coil of the generator while the main power relay switches the load to either public supply or generator. The approach used in this work is the modular approach where the overall design was first broken into functional block diagrams, where each block in the diagram represents a section of the circuit that carries out a specific function. (Sharaf, R. Chhetri , Canada 2006).

A manual change-over switch consists of a manual change-over switch box, switch gear box and cut-out fuse or the connector fuse as described by Rocks and Mazur (1993). This change-over switch box separate the source between the generator and public supply, when there is power supply outage from public supply, someone has to go and change the line to generator. Thus when power supply is restored, someone has to put OFF the generator and then change the source line from generator to public supply. (X. Yaosuo, C. Liuchen, B. K. Kjaer, J. Bordonau and T. Shimizu, Sep. 2004)

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. The electronic control monitors the incoming public supply voltage and detects when the voltage drops below a level that electrical or electronic gadgets can function depending on the utility. (Jason Hsu, Sep 2007)

1.2 Organization of paper

The work in this paper is divided in three stages. 1) Design of intelligent three phase changer 2) Programming the PLC and its simulation 3) Real-time hardware implementation. Design is done by optimal usage of resources, for the purpose of making it cost efficient. Thereafter, Programming is done using logo! Software provided by Siemens ltd. Finally, Real-time implementation is done and tested.

Paper is organized as follows. Section II describes the design of the intelligent three phase changer. The flow diagram represents the step of the algorithm. Simulation results for the program in PLC are given in Section III. Section IV presents real-time results showing the model tested. Finally, Section V presents conclusion.

2. DESIGN OF INTELLIGENT 3 PHASE CHANGER

The basic wiring diagram contains 1 LOGO! 230RC PLC, 3 pairs of Air Break Power Contactors, 3 Auxiliary NC blocks, 3 Mechanical Interlocks and 4-core connecting wires.

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The main aim of this system is to provide uninterruptable power supply for three phase loads even in the failure of a phase in a three phase system. Then build the prototype and verify it. Specifically, the aims accomplished are listed in the following:

- Study of SIEMENS LOGO! PLC and LOGO! Soft Comfort and designing a circuit to control the phase change-over.
- Optimizing the cost of the system according to the specifications required.
- Building a ladder diagram of the intelligent three phase changer and simulating it.
- Implementing, testing and analyzing the system on the real-time hardware.

If primary phase is not available then the secondary phase will be switched by the PLC. The PLC used here is SIEMENS LOGO 230 RC. The next part of the product is the critical portion of the system, powering the PLC with the same 3 phase supply. During the presence of single phase supply, phase changeover is not required, but in the presence of two phases, phase changeover must take place, hence the PLC must be ON in the presence of any two phases.

2.1 Flowchart

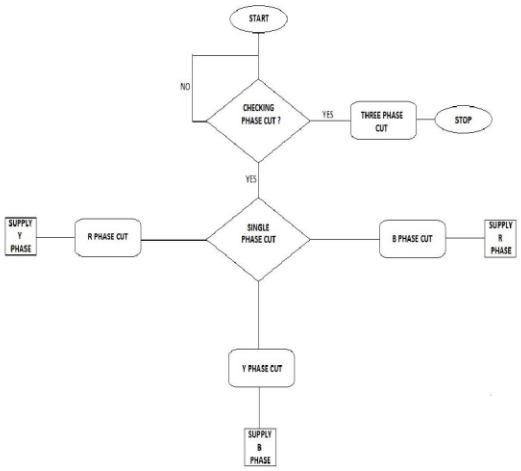

Figure 1: Flow diagram of phase changer operation

3. SIMULATION

3.1 Simulation Using Soft Comfort

The software used for simulation is LOGO! Soft Comfort V7.0.30. It is a licensed product from Siemens Ltd. LOGO! supports a new text display module. This LOGO! TD module extends the display and user interface capabilities of a LOGO! Base Module.LOGO!Soft Comfort provides configuration of the following LOGO! TD features:

- Power-on screen
- Function keys
- Message texts
- Backlight function

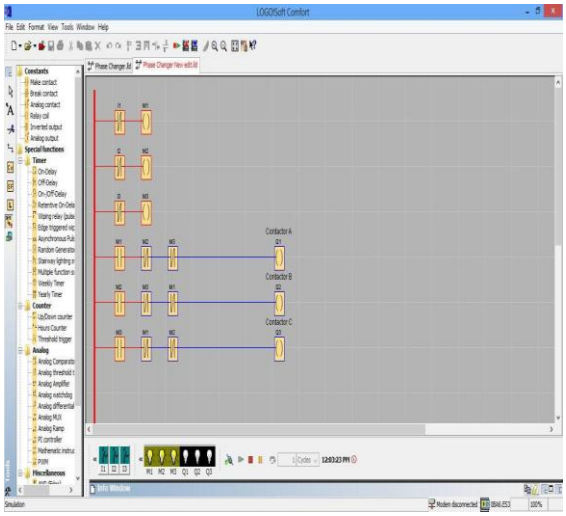

Figure 2: Phase Changer Simulation

The above image is the simulation of phase changer working. Here I1,I2, I3 are the inputs which represent R,Y and B phases respectively. M1, M2 and M3 are temporary coils used for defining the operation of the circuit. If either of the input is not working then the corresponding outputs Q1, Q2 and Q3 will be switched ON respectively according to the program.

3.2 Simulation for Timing Operation

Timing is an important operation in automation. Timing operation in Intelligent Three Phase Changer has wide variety of applications, some of which includes the automatic shutdown of power in offices and industries when not in use, also for timing control, automatic On/Off control of machines in factories.

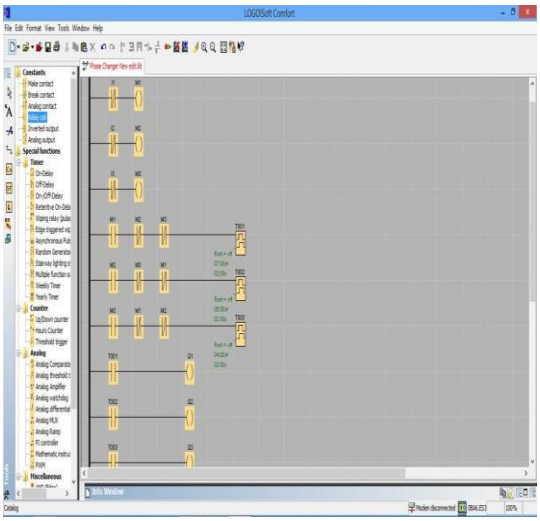

Figure 3: Timing Control Simulation

The above figure shows the timing control simulation for Intelligent three phase changer, where T001, T002, and T003 are ON/OFF Timers used for controlling delay of the output phases. Each timer was been provided with its own delay and simulated.

4. REAL-TIME IMPLEMENTATION

4.1 IMPLEMENTATION OF PROJECT

The project is implemented in real-time using three pairs of contactors, where each pair is inter-connected by means of a mechanical switch, and a Programmable Logic Controller (PLC) to make the switchover between the contactors. The use of mechanical switch is to avoid two phases in a single line. The 3 phases (R Y B) is given to three pairs of contactors as RY YB and BR phases respectively, where in RY, R is primary phase and Y is secondary phase.

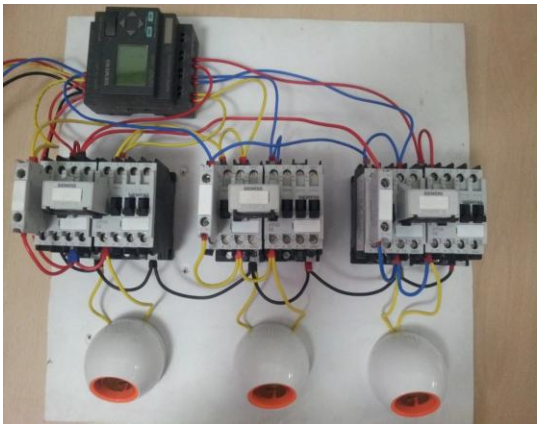

Figure 4: Intelligent Three Phase Changer

If primary phase is not available then the secondary phase will be switched by the PLC. The PLC used here is SIEMENS LOGO 230 RC. The next part of the product is the critical portion of the system, powering the PLC with the same 3 phase supply. During the presence of single phase supply, phase changeover is not required, but in the presence of two phases, phase changeover must take place, hence the PLC must be ON in the presence of any two phases. The output from any pair of contactors is given as power supply to PLC and thereby solving the above problem. Also 3 Normally Closed (NC) switches are connected to three pairs of contactors respectively so as to provide two phase supply when single phase is available.

4.2 ADVANTAGES OVER CONVENTIONAL SYSTEM

- 3 phase supply is available to the user even if the PLC fails
- The switchover takes place so fast and it is unnoticeable practically
- Human intervention for phase change over during phase loss in incoming 3 phase supply is eliminated
- It serves automation operations
- When supply resumes it restores to the normal position automatically
- Fully automatic solid state transfer circuit
- Need not monitor for switch back
- Timing control
- Automatic ON/OFF control
- Cost efficient
- Highly reliable and robust

4.3 BENEFITS AND FEATURES OF THE SYSTEM

Fully automatic & No manual intervention Provides continuous two phase supply even with one phase Compact in size and easy serviceability. Shifts instantly within a second Instant automatic phase change when any phase fails can get electric supply in all three phase lines automatically changes from low voltage line to proper voltage line Avoids physical operation and suffering Quality components are used to provide 100% efficiency

5. CONCLUSION

The motto is to help the society and bring automation in real life. The idea to make Intelligent Three Phase Changer struck when we encountered a problem, where a man was shifting regulator to change a phase in its absence. The idea was brought forward to the Siemens Executive, and they were pleased to provide us with components to proceed for the same. The idea is implemented in real time and all the circuits were designed and implemented. Programming was simulated using LOGO Soft Comfort and implemented in real time by downloading into LOGO 230RC Programmable Logic Controller (PLC) and expected output is obtained that could be used in Homes, Industries and Offices where continuous three phase supply is needed. Thus the product developed is robust and stable. Three phase supply is available to the user even if the PLC fails. The switchover takes place so fast and it is unnoticeable practically. Human intervention for phase change over during phase loss in incoming three phase supply is eliminated. It increases production in industries by providing continuous supply. Since the product is intelligent due to the use of PLC, it serves automation operations such as

- Switching ON the alternate power supply (diesel generator, UPS, etc.,) when all three phases are not available.
- Automatic ON/OFF control of phases according to our desire.
- Timing control of phases, most useful in Offices and Industries.
- Simple programming code is enough for future improvements.

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REFERENCES

[1] Alta's, A. Sharaf, "Novel on power logic controller for three phase systems", Renewable Energy, vol. 33, pp 388-399, 2008.

[2] Sharaf, R. Chhetri, "A novel dynamic capacitor compensator/green plug scheme for 3-phase 4-wire utilization loads", Proceeding IEEE-CCECE Conference, Ottawa, Ontario, Canada 2006.

[3] H. Fargali, F. Fahmy, M. A. El-Sayed, "Control and optimal sizing of current to operate three phase loads", Al-Azhar Engineering 10th International Conference, Cairo, Dec. 24-26, 2008.

[4] A. M. sharaf, G. Wang, "Voltage stabilization of standalone three phase system using active power compensator", International Journal of Global Energy Issues, vol.26 No. 3-4, pp. 417-429, 2006.

[5] Jason Hsu,"Power Management in energy from three phase networks", ACM Transactions on Embedded Computing Systems (TECS)-Special Section LCTES'05 TECS, pg.no 7, Sep 2007.

[6] Channaveer P. Malad, K. Uma Rao, "Simulation of a Single Phase Voltage Source Inverter for Distribution Generation Systems", Vol.2, Issue.5, Sep.-Oct. 2012

[7] X. Yaosuo, C. Liuchen, B. K. Kjaer, J. Bordonau and T. Shimizu, "Topologies of three-phase inverters for small distributed power generators: An overview", IEEE Trans. PowerElectronics, vol. 19, no. 5, pp. 1305–1314,Sep. 2004.

[8] I.T. Roman, "A three-phase current-source inverter with active power filter for grid-tied Power systems", 3rd IEEE International Symposium on Power Electronics for Distributed Generation Systems (PEDG), Aalborg, pp. 349-356, June 2012.