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Continuous Supply to Load by Automatic Switchover in System During Fault Condition using PLC and SCADA

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Abstract

Power fluctuation and frequent occurrence of fault in electrical system cause various unreliability problems in the load centers. The main purpose of the project is to provide continuous power supply to the load by switching the switchover automatically placed in the tie-line in case of a fault in the transmission system. If any one of the transmission lines meets fault, the load connected to that source will not get a power supply. In such a case, the disturbed load will get power supply from the next transmission line connected to the first load through the first source via tie-line, and thus load will get supply continuously. The tie-line is isolated by using a switchover which is controlled and operated by PLC and SCADA automation system. This contributes in, network isolation, maintenance works conveniently with proper safety and time and effort saving methods.

Keywords: Automation; Switchover; tie-line; VTScada experiments

1. Introduction

Nepal has good potentiality of generating electricity as per demand though the efficiency and reliability of transmission line are not sufficient to provide uninterrupted power to the load centers. This project introduces the use of PLC (Programmable Logic Controller) with SCADA (Supervisory Control and Data Acquisition) interfacing in transmission lines or tie-lines between two or more transmission lines to isolate faulty transmission and energize tie-line to supply power to loads from every transmission line. There is high power fluctuation and fault occurrence in the power network [1]. It takes a long time and effort to detect the fault position, isolate the network and maintain the fault. So, to enhance reliability, stability and save time in the power system, PLC and SCADA automation is implemented.[2] The automation can perform to detect fault, isolate faulty circuit, and reclose remotely when fault is cleared.

2. Methodology

2.1 Overview

The system architecture designed to improvise the situation of unreliability in the field of interconnected power system. As shown in the figure (2.1), analog signal is received by contactor, whose output is fed to the PLC. The power supply is provided to PLC through SMPS (Switched Mode Power Supply). Meanwhile, PLC is interfaced with SCADA software in computer. The output signal from PLC is supplied through relay and finally to the indicators or load.

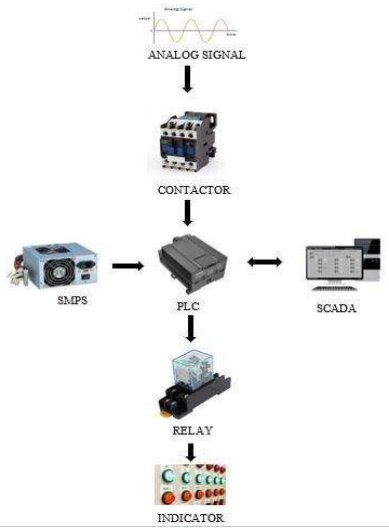

Figure 2.1: System Architecture

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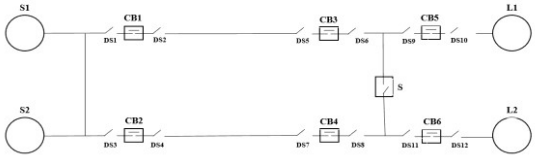

Figure 2.2: Overall System Diagram

The indicators are used to indicate working of the load. This is the general working of the PLC and SCADA implemented system.

Moreover, the single line diagram of the overall system is depicted in the figure (2.2). We have parallel interconnected grid, where first source (S1) and second source (S2) are grid connected in our case. The disconnected switches and circuit breakers are also shown in figure. Initially the respective loads are powered through respective transmission lines.

If any type of fault occurs in any one of the transmission lines, the circuit breaker trips and immediately, the switchover (S) comes into operation and connection to the load (one which is connected to faulty transmission line) is re-established through another transmission line. Hence blackout problem overcomes.

2.2 Methodology

The step-by-step operating method of the system is illustrated by the flow diagram in figure (2.3).

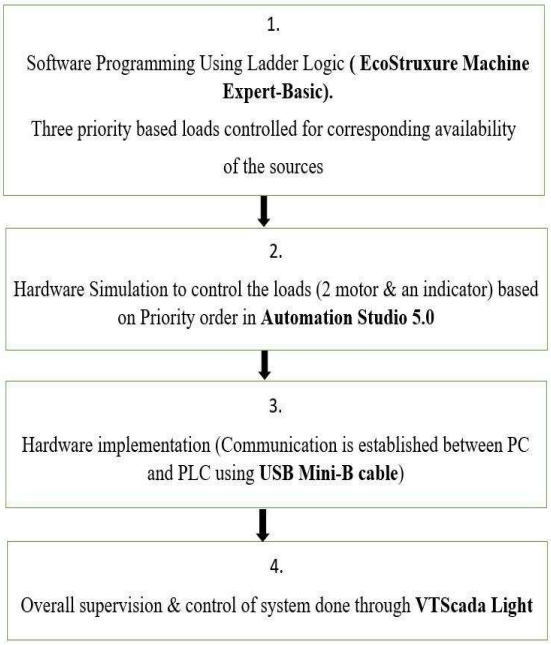

Figure 2. 1: Flow diagram

Along with that the working flowchart of the system is illustrated below in figure (2.4). In the figure, we check the conditions of Transmission lines. If everything is normal i.e., no faults are detected, both transmission lines supply to the respective loads. Now when fault is detected in first transmission line while there is no fault in second, then supply through the first line to its load opens and that load is supplied through the switchover from the second one. And similar process is applied for next case when there is fault in second transmission line while first one is healthy. Here our project does not address the case when both transmission lines are faulty.

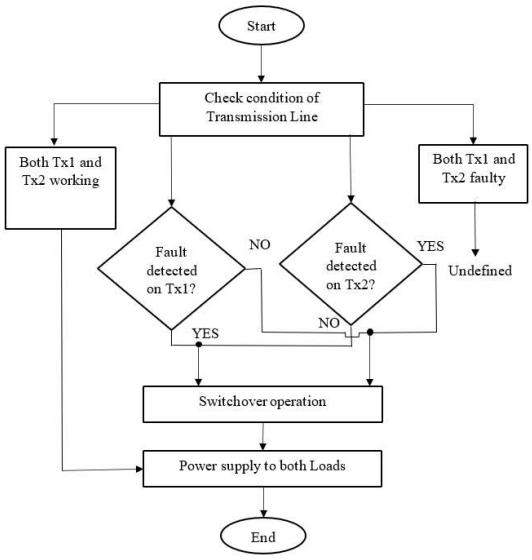

Figure 2. 2: Flowchart of project

Furthermore, the project simulation is done using ladder logic programs before implementation in hardware. The simulated logics in EcoStruxure and circuits are given below respectively.

Normal condition:

At normal condition, all the power sources provide supply for their respective loads. Sources S1, S2 provide supply to their respective loads. It is depicted in figure (2.5).

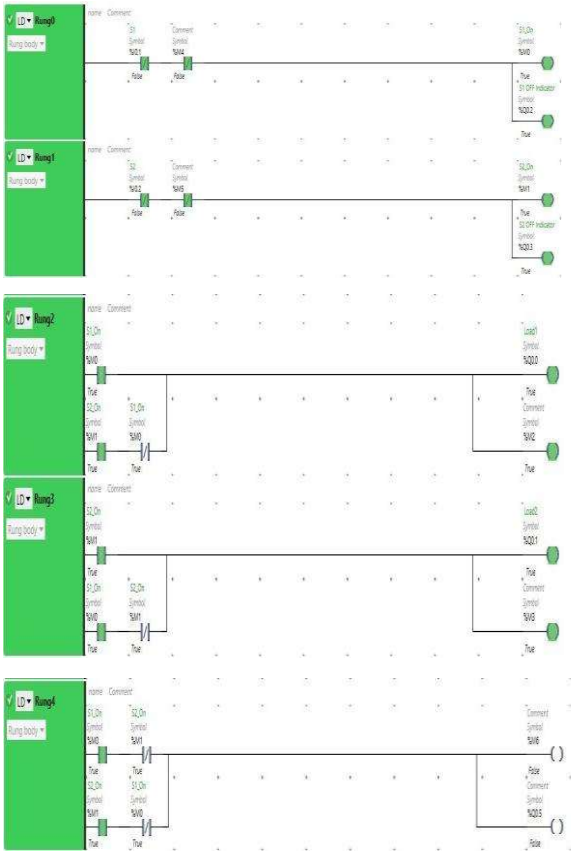

Figure 2. 3: Ladder logic at normal condition

Fault on Tx 1:

When there is fault on Tx1 (Transmission line 1) then the ladder logic provides logic to provide power supply to load L1 (Load 1) through Tx2. (Transmission line 2). It is depicted in Figure (2.6).

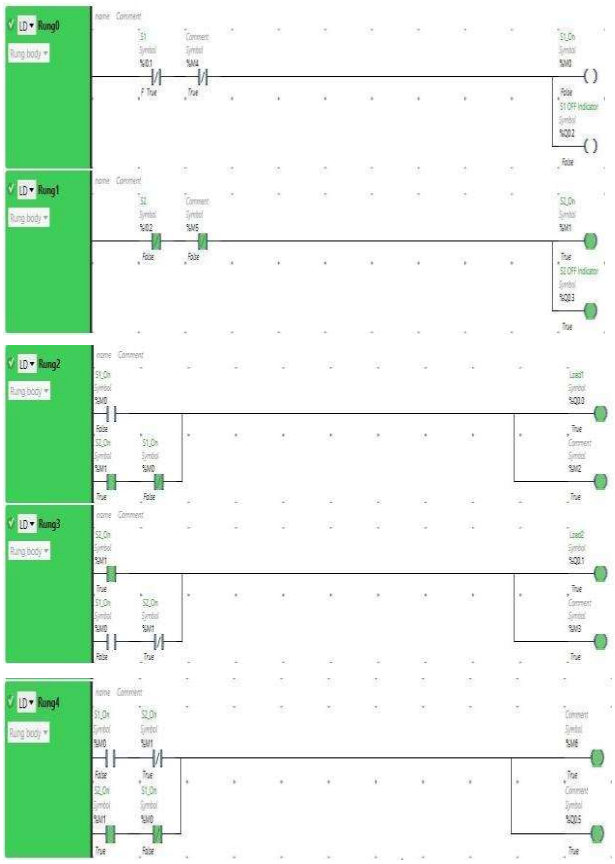

Figure 2. 4: Ladder logic at fault on Tx 1

Fault on Tx 2:

When there is fault on Tx2 then the ladder logic provides logic to provide power supply to load L2 (Load 2) through Tx1. It is depicted in Figure (2.6).

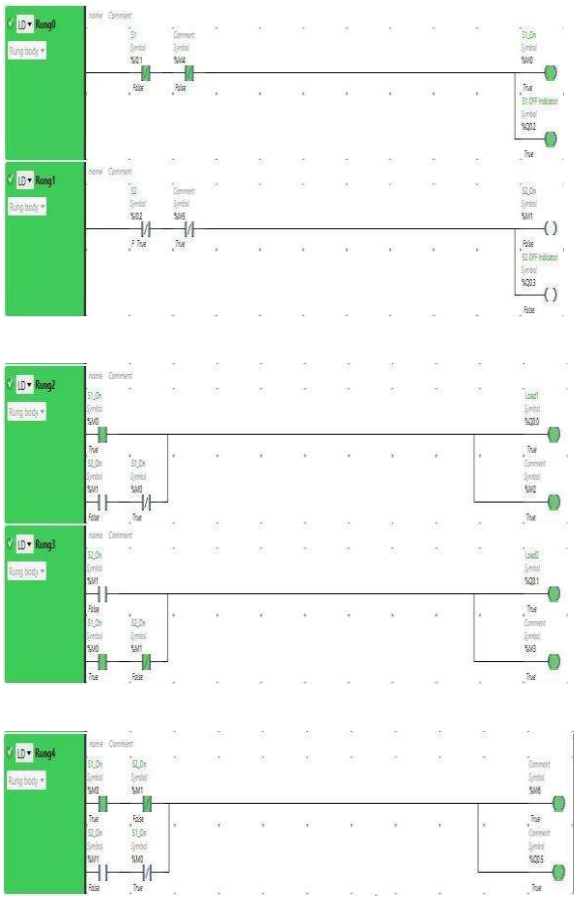

Figure 2. 5: Ladder logic at fault on Tx 2

Undefined condition:

In case of fault on both transmission line the system is undefined.

Automation Studio

The ladder logic designed in EcoStruxure is tested in Automation studio software. It is a simulation software for ladder logic program of hardware PLC device in order to ensure hardware safety. The normal condition applied in automation software is depicted in figure (2.8).

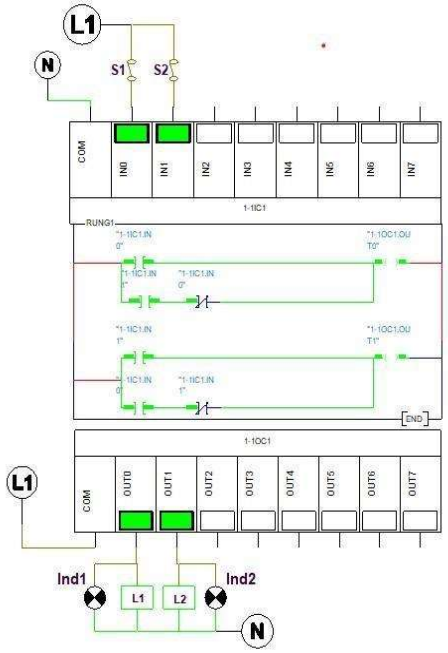

Figure 2. 8: Normal ladder logic in automation studio

3. Results and Discussion

We have achieved some results after completing the project. The ladder logic program is implemented in the PLC hardware. Here we have used the VTScada software for user interface. The results for different cases can be visualized by using VTScada interface.

The results for different cases are explained below with corresponding figures. The two push-button switches are used to represent fault creation and fault cleared conditions. Here, Green line represents working condition (showing connection), and red line represents not working condition (showing disconnection).

Normal Condition:

In normal condition, both loads are working normally, so switchover action is not required. Both sources S1 and S2 are supplying power. There is no fault on the transmission line thereby, both loads are operating fine.

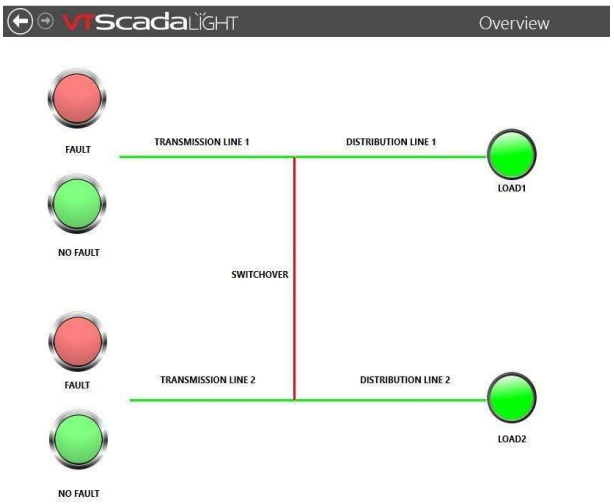

Figure 3.1: Normal condition

Fault on Tx1:

In case of fault on first transmission line, the switch-over line comes into action automatically by the operation of PLC and First load, L1 gets power supply from the switchover line.

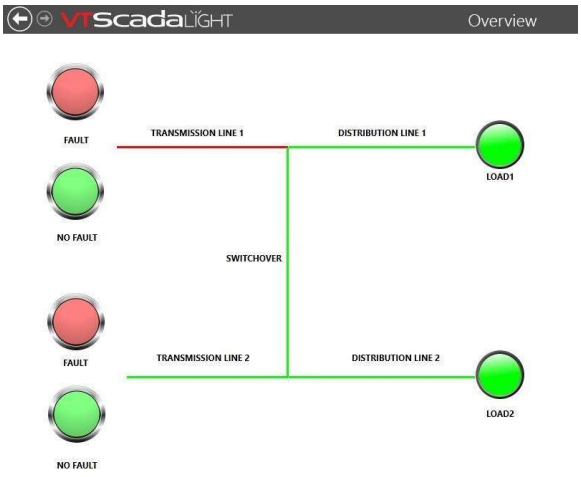

Figure 3.2: Fault on Tx1

Fault at Tx 2:

In case when second transmission line meets fault the switchover line again comes into action and second load gets supply through switchover. And both loads come to operation.

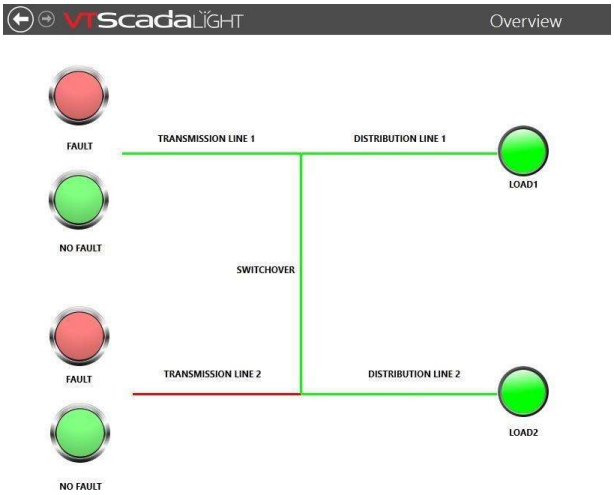

Figure 3.3: Fault at Tx 2

Undefined Condition:

In case when both transmission lines meet fault, it is undefined condition for our project (None of the load is working).

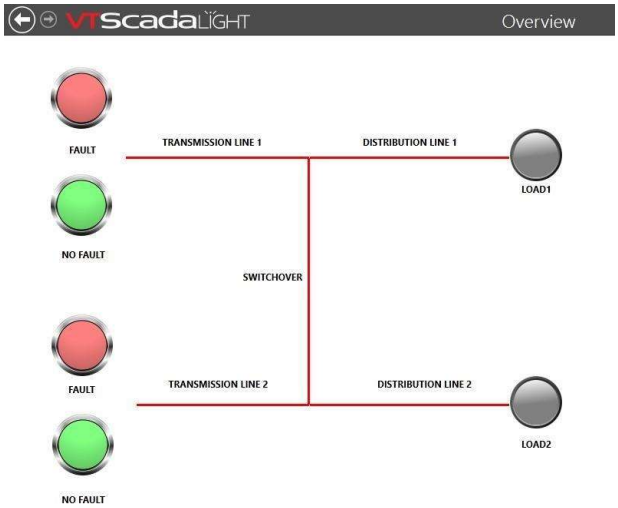

Figure 3.4: Undefined case output

Hardware Implementation

Figure 3.5: Hardware output in normal case

This picture shows the hardware implementation of the project, by using two 1 HP (Horsepower) as output devices and 120-volt, 2 power sources Button switches are attached to create fault on each of two lines. And in this system when we supply and maintain power as per described in the methodology all process were working without further issues Here, all loads are brightened. Hardware shows the respective output as shown in scada software outputs.

4. Conclusions

This project demonstrates the steps for PLC designing and implementing an automatic transfer switch using a PLC with SCADA. It delivers real-time data on manufacturing activities to management, increases plant and personnel safety, and implements more efficient control paradigms [5]. Here, a PLC-based control system combines with SCADA for automating the whole system. We have used ladder logic programming to automatize the system. The PLC and SCADA along with other hardware are used to supply the continuous power to the loads even in case of occurrence of faults on any of the transmission lines.

To sum up, continuous supply to loads is provided with the help of our project based on PLC and SCADA.

Acknowledgment

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