Abstract—Transmission lines are a vital component of power system. It is used in systems with LV, HV, EHV and even more amount of voltage levels. However, sometimes lines require outage because of various reasons like maintenance or fault. Mal-operation or a small mistake during outage process can be very dangerous. Currently a process carries out outage where communication between operational engineers at two different substations plays a vital role in line outage. Miscommunication and human errors can be a threat to life of personnel involved and damage to equipments, So to ensure a proper outage process using PLC, a ladder logic is used which will check status of various equipments like circuit breakers, isolators and ground and perform sequential process of opening, isolating and grounding involved in line outage automatically. Operator now can see and check the status of whole process on SCADA screen.

Key words: Programmable logic controller (PLC), Supervisory control and data acquisition (SCADA), Personnel computer (PC), Substation (s/s), Breaker (Bkr)

I. INTRODUCTION
Programmable Logic Controllers or programmable controller is a digital computer used for automation of typically industrial electromechanical processes, such as control of machinery on factory assembly lines, amusement rides, or light fixtures. PLCs are used in many industries and machines. PLCs are designed for multiple analogue and digital inputs and output arrangements, extended temperature ranges, immunity to electrical noise, and resistance to vibration and impact. Programs to control machine operation are typically stored in battery-backed-up or non-volatile memory. The functionality of the PLC has evolved over the years to include sequential relay control, motion control, process control, distributed control systems and networking. The data handling, storage, processing power and communication capabilities of some modern PLCs are approximately equivalent to desktop computers. The main difference from other computers is that PLCs are armored for severe conditions (such as dust, moisture, heat, cold) and have the facility for extensive input/output (I/O) arrangements.

II. RELATED WORK
In the literature survey, we have studied existing outage process, interlocks involved, wrong operations involved followed by definition of problem statement. Then using group discussion, research and why -why analysis methodology, resulted into solution of using PLC for automation. We have made a working models of equipments involved in line outage process. Development of control circuits for control & status of equipment operation and development of ladder logic in PLC. Interfacing of hardware model with PLC & testing of outage process. Preparation of SCADA screen of single line diagram of transmission line model for purpose of demonstration and monitoring of process.

III. BLOCK DIAGRAM
The block diagram consists of four blocks:
- Master PLC: It has bidirectional interfacing with the scada screen showing visual update of the logic.
- HMI & SCADA: It gives us a visual description of process and status of inputs and outputs in form of animation.
- I/O Module (Substation-A): It consists of equipments connected to it, which are breaker, isolator & ground at Substation-A location.
- I/O Module (Substation-B): It consists of equipments connected to it, which are breaker, isolator & ground at Substation-B location.

IV. PLC SPECIFICATIONS
Rockwell Automation – MicroLogix 1400 PLC

<table>
<thead>
<tr>
<th>Catalog No.</th>
<th>1762-L32BWAA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Module</td>
<td></td>
</tr>
<tr>
<td>Dimensions</td>
<td></td>
</tr>
<tr>
<td>Height:</td>
<td>90 mm</td>
</tr>
<tr>
<td>Depth:</td>
<td>87 mm</td>
</tr>
<tr>
<td>Width:</td>
<td>40 mm</td>
</tr>
<tr>
<td>Number of I/O</td>
<td>22 inputs (20 digital &amp; 2 analog) and 14 output (12 digital &amp; 2 analog)</td>
</tr>
<tr>
<td>Power supply</td>
<td>240V AC, 50hz</td>
</tr>
<tr>
<td>Power</td>
<td>120VA</td>
</tr>
</tbody>
</table>
B. Outputs:
- Breaker-A: CLOSE Command.
- Isolator-A: OPEN Command.
- Isolator-A: CLOSE Command.
- Ground-A: OPEN Command.
- Ground-A: CLOSE Command.
- Breaker-B: OPEN Command.
- Breaker-B: CLOSE Command.
- Isolator-B: OPEN Command.
- Isolator-B: CLOSE Command.
- Ground-B: OPEN Command.
- Ground-B: CLOSE Command.

V. PANEL SPECIFICATIONS

A. Inputs:
- Breaker-A: OPEN Status.
- Breaker-A: CLOSE Status.
- Isolator-A: OPEN Status.
- Isolator-A: CLOSE Status.
- Ground-A: OPEN Status.
- Ground-A: CLOSE Status.
- Breaker-B: OPEN Status.
- Breaker-B: CLOSE Status.
- Isolator-B: OPEN Status.
- Isolator-B: CLOSE Status.
- Ground-B: OPEN Status.
- Ground-B: CLOSE Status.

VI. SCADA

Scada software used is ‘FactoryTalk View Studio’. It is visual based software. FactoryTalk View Studio has all the SCADA functionalities for large generation and transmission utilities, such as alarm handling system, fully redundant client-server architecture, distributed processing, historical recording of all monitored variables, report generation, support for main communication protocols, etc. It also has a set of electrical applications that helps operators to maintain a safe and efficient operation. FactoryTalk View Studio SCADA provides solutions for connecting with other applications through any physical medium, be it via intranet (via TCP/IP or IPX/SPX protocols), ethernet, dial-up or private lines, satellites, radio links, or serial. The method being used is based on the concept of Remote Applications, where data from any given application (Server) is accessed by a client that can write and/or read any parameter. Various symbols like pipes, tanks, valves etc. are used which are created as bitmaps. Different process parameters can be recorded in Scada. Graph of process parameters versus time can be plotted in Scada for analysis. Scada communicated with the devices on network and collects values from devices into tags. Tags can be used in different formats like color animation.

VII. PROCESS
- Open Breaker-A at Substation -A
- Open Breaker-B at Substation -B
- Open Isolator-B at Substation-A
- Close Ground-A at Substation -A
- Close Ground-B at Substation -B

This is a sequential process. Each step is performed after checking the status of equipments in previous stage and satisfying various interlock conditions for safe operation of equipment.

After this process, transmission line is de-energized, isolated and grounded. Now Line can be handed over to maintenance engineer.

VIII. RESULT

Below are some SCADA screens which shows all the functions of the equipment, the status of inputs and outputs and the controls which are operated.

IX. CONCLUSION

In this paper, a system has been successfully designed that should prove very useful in the field of technology. Based on actual tests and evaluations, we believe the use PLC and SCADA as interfaced with process of transmission line outage and restoration. We learnt systematic approach to design SCADA and PLC based system.
REFERENCES


