Prevention of Transformer Overloading using Programmable Logic Controller

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Abstract— This paper is based on open loop distribution system for industries means the loads are connected to two feeders and any section of the feeder can be isolated without interruption. Thus, the average outage time is reduced to the time required to locate the fault and do necessary switching the service. In this paper, the automation is suggested with the help of programmable logic controller and the switching is performed automatically with help of ladder logic.
Keywords: PLC, relays, power grid system, fault isolation

I. INTRODUCTION

Supply disruptions are cause by factors like overloading that causes fuses to blow, lightning, poor workmanship of materials and equipment incorrect operations, relay failures and inadequate maintenance without distribution automatic system, these problems always cause failures anywhere within the service substations and would leads to power failure for an complete area. Power failures can last for extended periods, causing much inconvenience and financial losses to customers similarly as utilities. Although the faults are considered as minor within the substations, they are handled by equipment which is very close to customers. Some minor fault might jeopardize continuous electricity supply to customers.

Power control operation with PLC system is mandatory to runsmooth control in industries and other area. Control algorithm measures critical parameters and adjust variable output to optimize power by turning ON/OFF loads with improved performance.

PLC is employed for automation and realize the whole system and perform the experiment for result analysis.

II. AUTOMATION TOOL

The automation is done with help of programmable logic controller. The PLC which is used is Allen Bradley MicroLogix 1100 series B programmable logic controller. It includes built-in 10/100MBps Ethernet/IP port for peer to peer messaging. It provides 8KB memory (4KB user program with 4KB user data). It access, monitor and program from any Ethernet connection and that they also supports online editing. It supports up to 144 digital I/O points. It's 2 analog inputs, 10 digital inputs and 6 digital outputs, the Micrologix 1100 controller can handle a wide variety of tasks. The input sources transform the real time analog electric signals to appropriate digital electric signals and these signals are applied to the PLC through the connector rails. These input signals are stored within the PLC external image memory in location reffered to as bits. Programmable controller is a digital computer used for automation of normally industrial processes such as control of machinery on factory assembly lines, amusement rides or light fixtures.

PLC's designed for multiple analogue and digitalI/Oand O/P arrangements, extended temperature ranges causes to electrical noise and resistance to vibration and impact.

The functionality of PLC elaborate over the years to include sequential relay control, motion control, process control, distributed control system and networking.

The main dissimilarity from other computer is that PLC's are used for severe condition's [such as dust, moisture, heat, cold] and have a facility for extensive I/O arrangements.

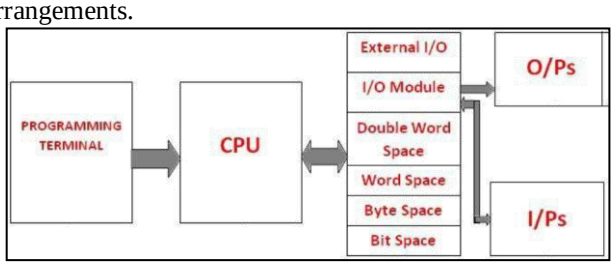

Fig. 1: Basic Block Diagram of PLC

III. FAULT DETECTION

There may be always chance of system over voltage due to the sudden disconnection of large load the magnitude of this voltage is higher than its normal level but frequency is same as it way in normal operating condition. Over voltage in the power system causes on increases in stresses on the insulation of transformer.

Increased voltage causes proportionate increases in the working flux. The increase flux is distracted from the transformer core to other steel structural parts of the transformer.

Experiencing through over-voltage in transformer is absolutely depends upon connection between the two transformers.

The overvoltage of parallel transformer divided into two categories:

1) Caused by overvoltage at the network side
2) Caused by a fault, depending on the region of the cause.

A. Over-voltage from the network side:

When there is lightning, or operating overvoltage of parallel transformers at the network side, the overvoltage are transmitted to the valve side through the transformer coupling. As there are arrestors installed at the network side. Conferring to the voltage level, to limit lightning and operating overvoltage, the amplitude of the overvoltage of the network side will be significantly reduced transferring to the valve side.

The overvoltage waveform of transformer after transmitting of the fault from the network side is shown in Fig.2.

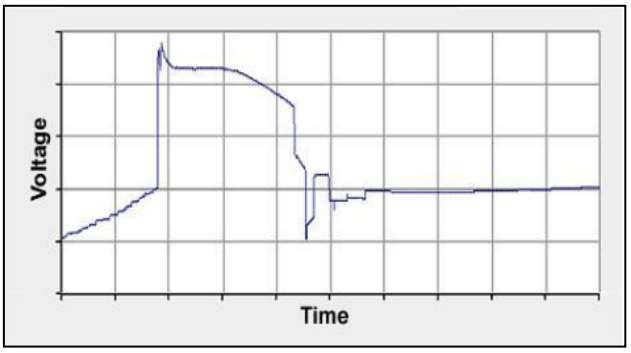

Fig. 2: Operating overvoltage waveform after transmission from the network side.

The X-axis and Y-axis shows the time and voltage respectively. Fig.2. shows the overvoltage waveform of transformer under fault condition. The voltage level rise to 2-3 times the normal condition and falls down when the fault is neutralize.

The internal overvoltage of an HVDC transmission system is affected by various switching operations or faults within AC and DC systems, respectively, on each sides of the converter station, including temporary overvoltage and switching overvoltage. The temporary overvoltage may last from a few to large of power frequency cycles. The switching overvoltage generally maintains its peak for less than half a cycle and then attenuates rapidly. The internal overvoltage of an HVDC system differs from that of an AC system within the forming mechanism, frequency of occurrence, amplitude and wave. Additionally to the kinds of switching operation and fault, the DC system configuration, arrangement, time sequence of control and protection actions, and transmitted power will affect the amplitude, wave shape, and also duration of the internal overvoltage.

B. Switching overvoltage on DC transmission lines:

Given the static and electromagnetic interactions between the bipolar transmission line, the short circuit between one transmission line pole and also the ground under bipolar operation will produce switching over-voltages on the healthy pole, which can propagate along the transmission lines to the DC switchyard at the converter station. This switching overvoltage will effect the scheme of the tower for DC transmission lines as well as the overvoltage protection and insulation coordination of the DC switchyard at both converter stations. The overvoltage amplitude depends on the transmission line parameters and also the impedance at both ends.

IV. METHODOLOGY

The design and implementation is done with help of PLC module given in the fig.3. It shows the various component which are used and in what way they are connected in the circuit.

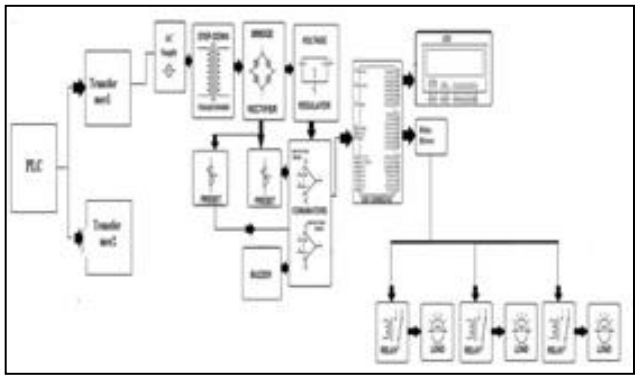

Fig. 3: Block diagram of module

Module is design for switching of transformer when there is fault in working transformer. In the hardware the components are installed accordingly. The PLC is connection is done between both the transformer. Former transformer is in working condition while lateral one is in standby mode. The PLC ladder logic is done such that when the over voltages stuck in working transformer and the complete load automatically shifted to the standby transformer and it continuously supply power to the feeder till the fault is neutralize in former transformer. At the time of overvoltage fault the detection circuitry immediately detect and inform the information about the same, until the fault gets neutralize and the load shifts to the first transformer again.

The sensor and comparator circuit is used to sense and compare the input supply voltage. If the input voltage is found greater than the reference voltage then output of the comparator is high and if the input voltage is lower than the reference voltage then output is low. The comparator circuit compares the voltage difference in between the sending end to receiving end. If the voltage difference is not in limit or unacceptable and not in the range; then detector will display the overload in the substation and automatically OFF the extra load connected in the industry. Until the load comes to normal condition the signal will shown in the LCD screen.

V. LADDER LOGIC AND IMPLEMENTATION

The ladder logic is shown below in the fig.4. The ladder diagram is designed in the RSlogix Micro software. In this ladder diagram, there is one input and two outputs i.e. Transformers. The output will change by increasing the voltage. By increasing the voltage the fault will be created in the transformer i.e. overvoltage fault. After the fault is created the output will be switch to the second output i.e. standby transformer. When the fault is neutralize, the transformer 1 will come to an action and the load shift to the first transformer.

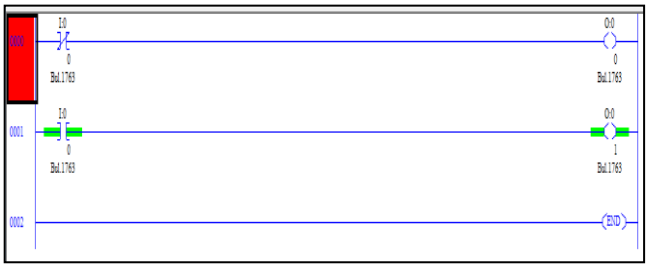

Fig. 4: PLC Ladder logic

The various waveform of transformer behaviour has been obtain with the help of digital storage oscilloscope, shown in fig.5 and fig.6.

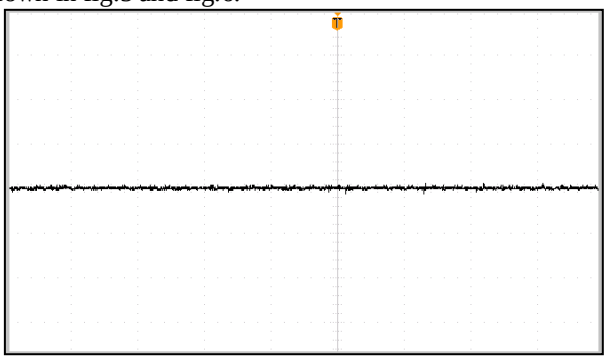

Fig. 5: Transformer working in normal condition

It is observed that in normal condition the output voltage is very much stable and in the range as per input voltage of transformer. Transformer performs efficiently.

In the above fig.5, the X-axis and Y-axis are denoted by time and voltage respectively. This waveform shows transformer is working in normal condition. So the waveform is sinusoidal and normally the voltage is 1.5 to 1.8 volts.

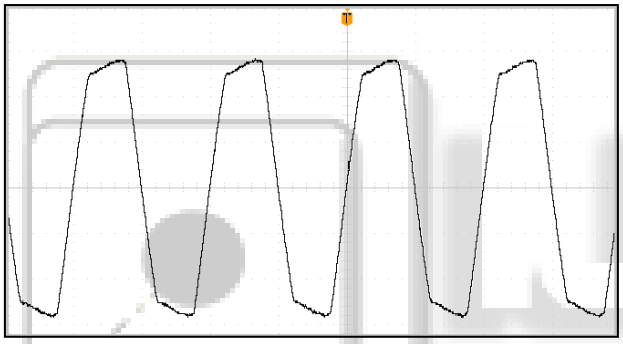

Fig. 6: Output waveform during switching

In fig.6, the waveform shown is during switching. This denotes the voltage rise to 2-3 times more i.e. 3V and drops to normal voltage after transformer 1 is switched to standby transformer.

VI. Conclusion

This system is based on the over-voltage protection of transformer.. PLC ladder logic is used for the switching of transformer, when there is overvoltage's in working transformer and analyzed the fault. When the PLC identifies over-voltage the supply gets automatically switch to the another stand by transformer. The overall system not only designed for switching but also for making unnecessary loads shut down. Because of this system industries or other large consumers working on high voltages will get more reliable, highly efficient and continuous supply.

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