Configuration of Regional Control Centre by Using SCADA System

Ei Mon Mon Aung[1], Su Su Win[2], Phoo Ngone Si[3],

Ph.D Student, Electrical Power Engineering Deapartment, Yangon Technological University, Yangon, Myanmar

Email – [1]eimonmonaung.nanei@gmail.com, [2]susuwin1@gmail.com, [3]phoongoneytu@gmail.com

Abstract: Electricity is the most essential requirement for the development of country in any society. As new power system demands regarding energy quality and efficiency, power system load or stability has risen for system operators all around the world. Likewise demand for Electricity in Myanmar is also growing rapidly year by year, thus the power system monitoring and controlling become essential in today complex power system. Without an efficient control methodology, the distribution system will not be reliable although the power generation covers the maximum demand. As our country, Myanmar, is a developing country, there are still some troubles in power system controlling and monitoring. Thus, it is needed to be enhanced Power Distribution Substation able to be controlled reliable firstly. The SCADA (Supervisory Control and Data Acquisition) provides the remote operation, control and monitoring for power system automation and it is also widely used for overall operation of modern power system. In this research the enhancement of Power Distribution Substation supplying Yangon Region by using SCADA System is implemented by Unity Pro XL 8.0 and Vijeo Citect 7.3.

Key Words: - Electricity, Power distribution substation, Unity Pro XL 8.0, Vijeo Citect 7.3, SCADA.

INTRODUCTION:

In Myanmar, the power system is being controlled under the supervision of National Control Centre (NCC) at Naypyitaw and Load Dispatch Centre (LDC) at Yangon. The load dispatch centre is responsible for the dispatch and control of the generation, transmission and distribution system as well as for the operation of the voltage, current and power levels. By adjusting supply capabilities and abilities of stable frequency, the response is stable and not to change in load flow capability for power across the entire supply area. As LDC plays the vital role for the power system controlling and monitoring to be stable and reliable, there must be a modernized control system such as SCADA system with the complexity of the power system network. Likewise, Yangon is the largest load center in Myanmar and there are eight numbers of 230kV substations, twenty numbers of 66 kV substations and 385 numbers of 33 kV substations. It is required to be completely automation for power system control, that is, when a fault occurs in any part of power system, the associated circuit breaker at the faulty part will open and this circuit breaker will be reclosed automatically when the fault is cleared. For this purpose, the enhancement of Power Distribution Substation is the first step to approach the modernized control scheme of the whole power system. In this journal, two 230 kV Distribution Substation Supplying Yangon Region will be enhanced by using Unity Pro XL 8.0 (PLC software), Modicom M340 (PLC Hardware) and Vijeo Citect 7.3 (SCADA Software).

SUPERVISORY CONTROL AND DATA ACQUISITION (SCADA):

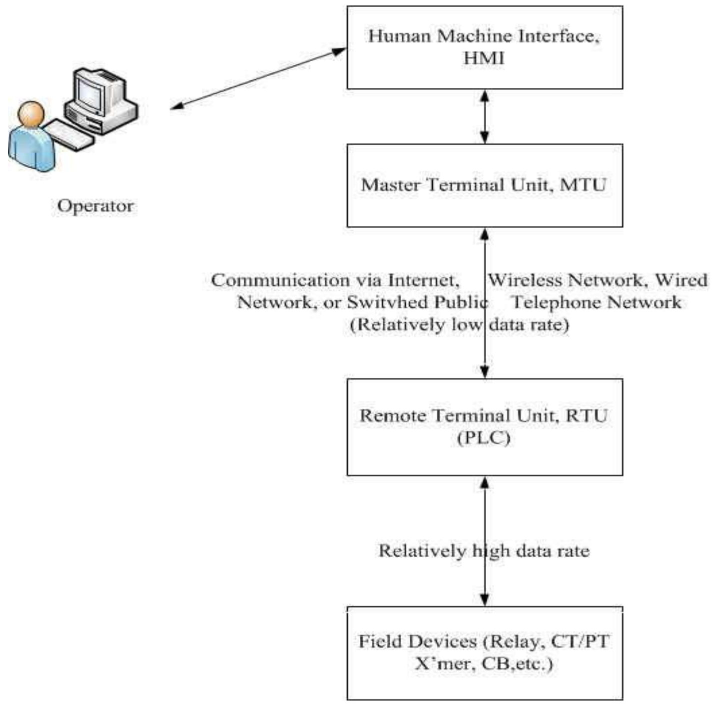

Figure 1 Typical SCADA Control Structure

The term SCADA is the abbreviation for supervisory control and data acquisition. It encompasses the collection of information (data acquisition), transferring the data over physical mediums (the field of telemetry/data communication) and the processing and display of the data at the master station. The master station is also used for centralized control over the communication network and/or to initiate external commands (supervisory control). SCADA masters were originally only intended to communicate to remote terminal units (RTUs), as the master station and the RTU formed the core of a comprehensive SCADA philosophy. Thereafter, SCADA software was developed to communicate to programmable logic controllers (PLCs) and nowadays SCADA software is available that can communicate to virtually any device capable of advanced communications. Figure 1 shows the typical SCADA control structure.

RESPONSIBILITY OF LOAD DISPATCH CENTER (LDC):

Today, the power system of Myanmar is monitored and controlled by National Control Centre (NCC) which is located in NayPyiTaw and Load Dispatch Centre (LDC) in Yangon. NCC is the Head Department of Power System and LDC is the mainly responsible for operation of the power system to be stable. When the fault occurs in any part of the system, substation or generation station associated with the fault have to give information to LDC only via telephone line or VHF carrier. According to the nature of fault, fault clearance time may be different. Almost the whole operating producer of Power System Monitoring and Controlling are carried out by traditional control system in which power line carriers and are used for communication of the power system network. As a result, there are many difficulties such as time delaying to communicate with LDC and substation and generation system. This controlling method is not comfort for the power system stability because this method depends on the human operator completely. Thus, in this journal, Regional Control Centre is configured by using modernized control system SCADA system.

CONFIGURATION OF REGIONAL CONTROL CENTER:

Yangon is the largest load centre in Myanmar and there are eight numbers of 230kV substations, twenty numbers of 66 kV substations and 385 numbers of 33 kV substations. The eight numbers of 230 kV substations are Tharkayta, Ahlone, Hlawga, Bayintnaung, Myaungdaga, Hlaingtharyar, Thanlyin and

East Dagon. Among them, Tharkayta Substation and Hlawga Substation are two of 230 kV Substations which are being upgraded to SCADA system. In this research, LDC is upgraded to Regional Control Center (RCC) by using SCADA system. Firstly, Tharkayta Distribution Substation and Hlawga Distribution Substation are enhanced to automation system.

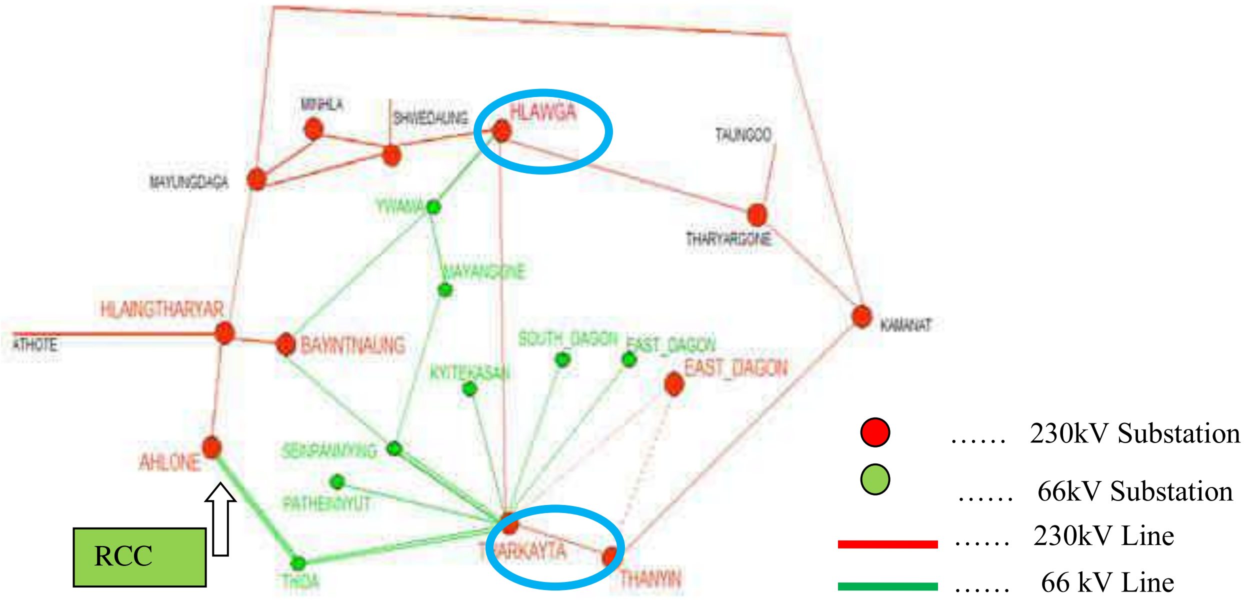

Figure 2 230kV Distribution Substation and 66 kV Line of Tharkayta and Hlawga Distribution Substation Network

A. Tharkayta Distribution Substation

There are two 230 kV Incoming Supply Lines ; Hlawga and Thanlyin on the 230 kV bus. These 230 kV Lines are stepped down to 66kV voltage level by using three numbers of 100 MVA stepped down Transformers and to 33 kV voltage level by using one 100 MVA and one 50 MVA stepped down Transformers. Thus, it can be said that there are five numbers of Transformer Banks. There are eight numbers of 66 kV feeders and five numbers of 33 kV feeders in this substation.

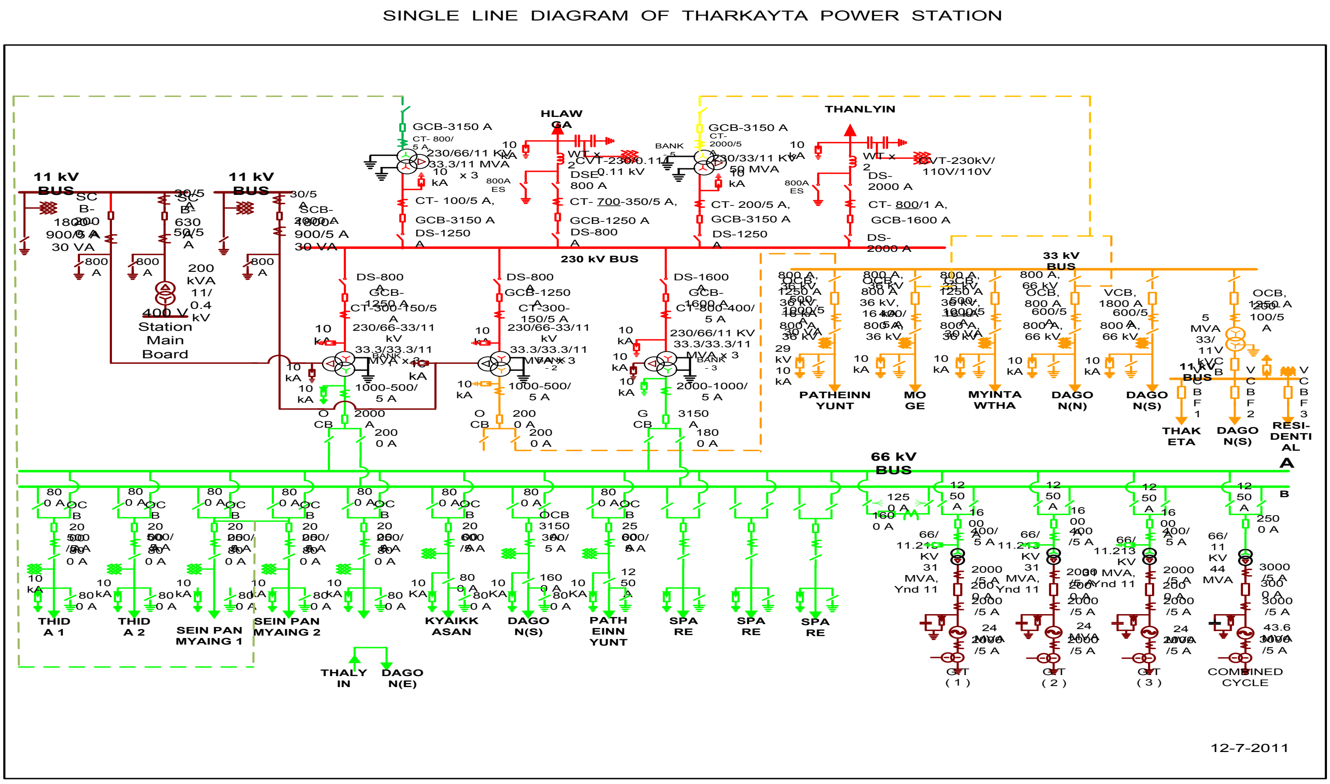

Figure 3 Single Line Diagram of Tharkayta Distribution Substation

B. Hlawga Distribution Substation

There are two 230 kV Incoming Supply Lines ; TharYarGone and ShweDaung while one 230 kV Outgoing Lines ; Tharkayta on the 230 kV bus. These 230 kV lines are stepped down to 66kV voltage level by using one number of 60 MVA stepped down transformer and to 33 kV voltage level by using three numbers of 100 MVA stepped down Transformers. Thus, it can be said that there are four numbers of Transformer Banks. There are nineteen numbers of 33 kV feeders and one number of 66 kV feeders.

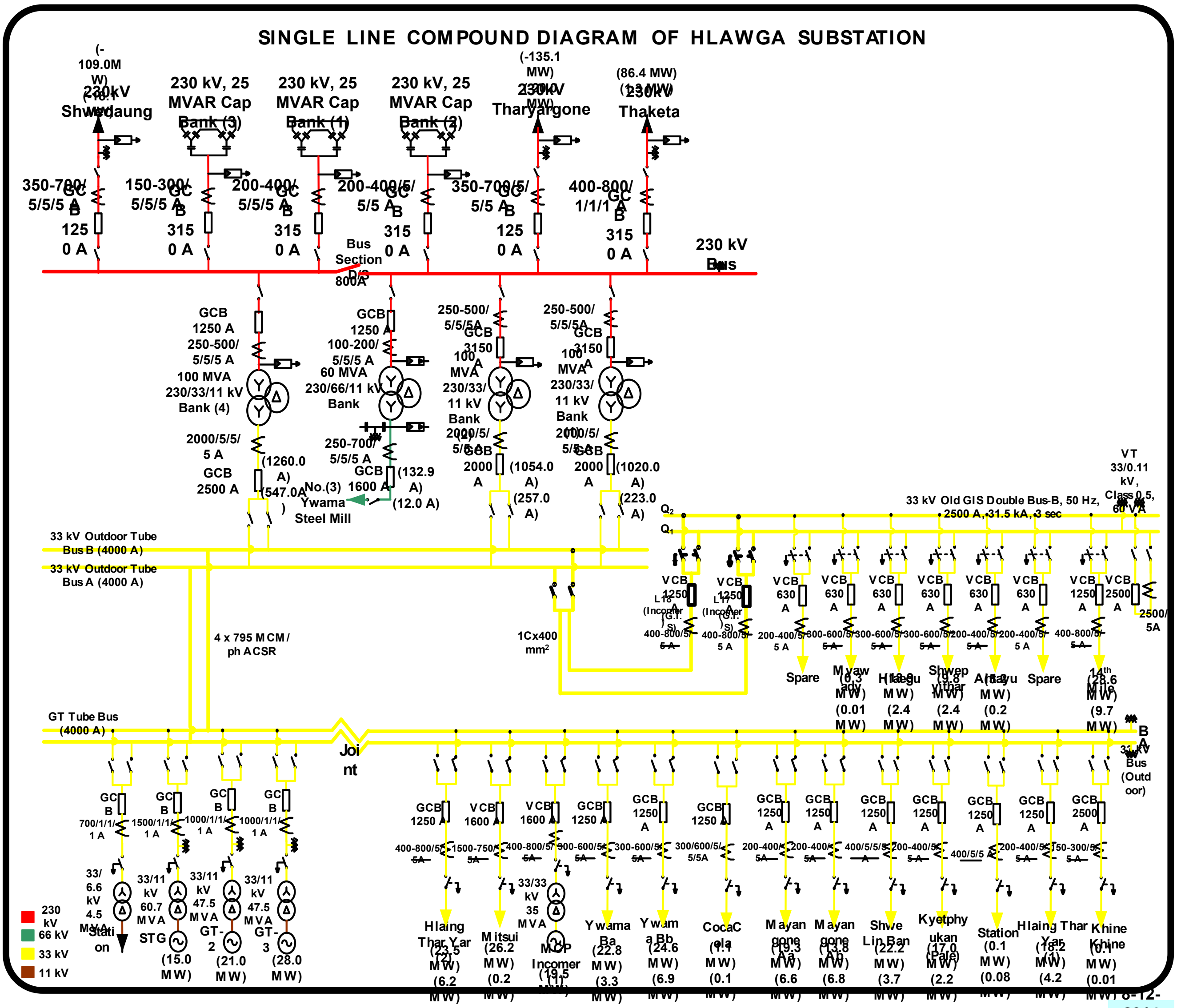

Figure 4 Single Line Diagram of Hlawga Distribution Substation

Since the controlling system of these substations was traditional system in the past, it was not comfortable because the events and measurements could not be seen easily as they could only be seen on the associated relays and meters. In recent, this substation is upgrading using SCADA which is partially completed. The status of events, fault records and measurements can be seen on the HMI in the control room. The faults occurred the most are over current phase fault and over current earth faults. The condition when these faults occur are implemented by using Unity Pro XL 8.0, Modicon M340 and Vijeo Citect 7.3which all are Schneider Electric's products.

PLC/SCADA CONFIGURATION:

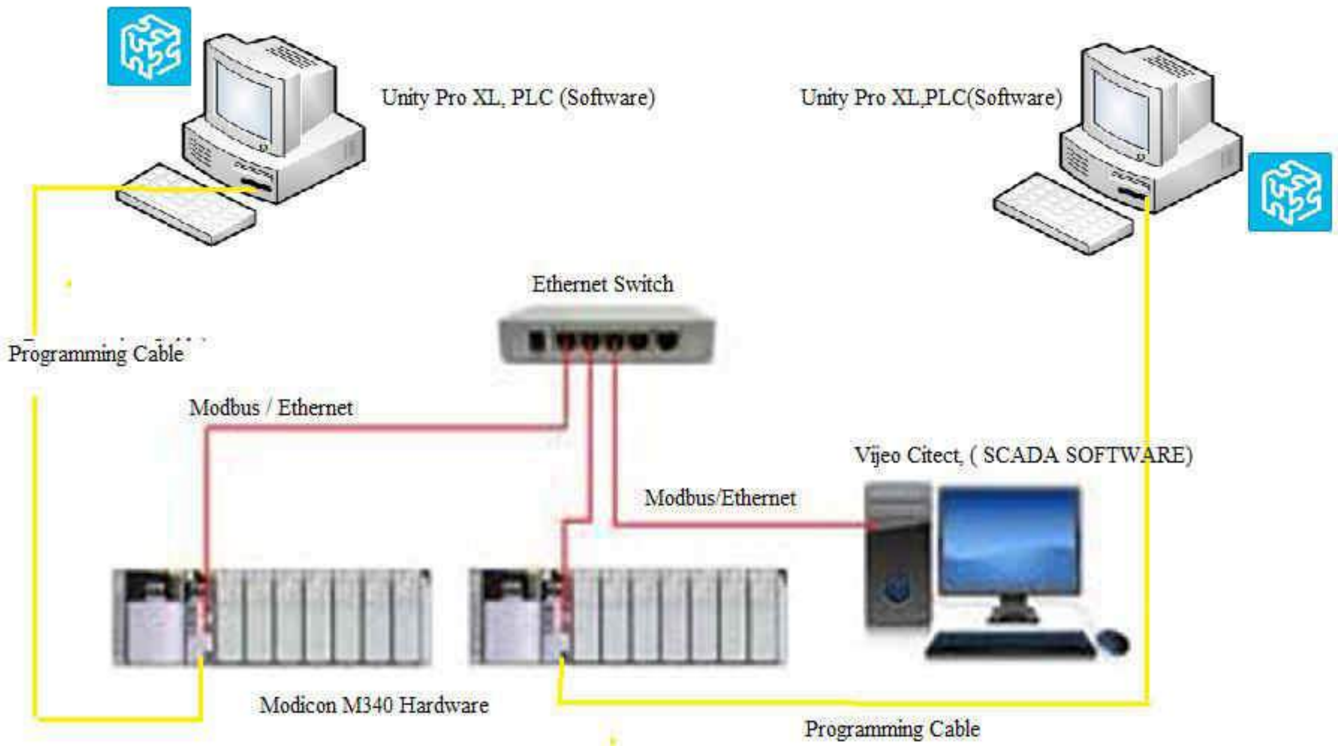

Figure 5 Configuration of PLC/SCADA

The operating and controlling sequences of the substation are programmed in the Unity Pro XL 8.0 and then the programme are transferred to the Modicon M340 (PLC Hardware) via the programming cable. After that, Modicon M340 is connected to Vijeo Citect 7.3 (SCADA Software) via Modbus/Ethernet communication link. In Vijeo Citect, the graphical pages, alarm page, trend page and record page are configured.

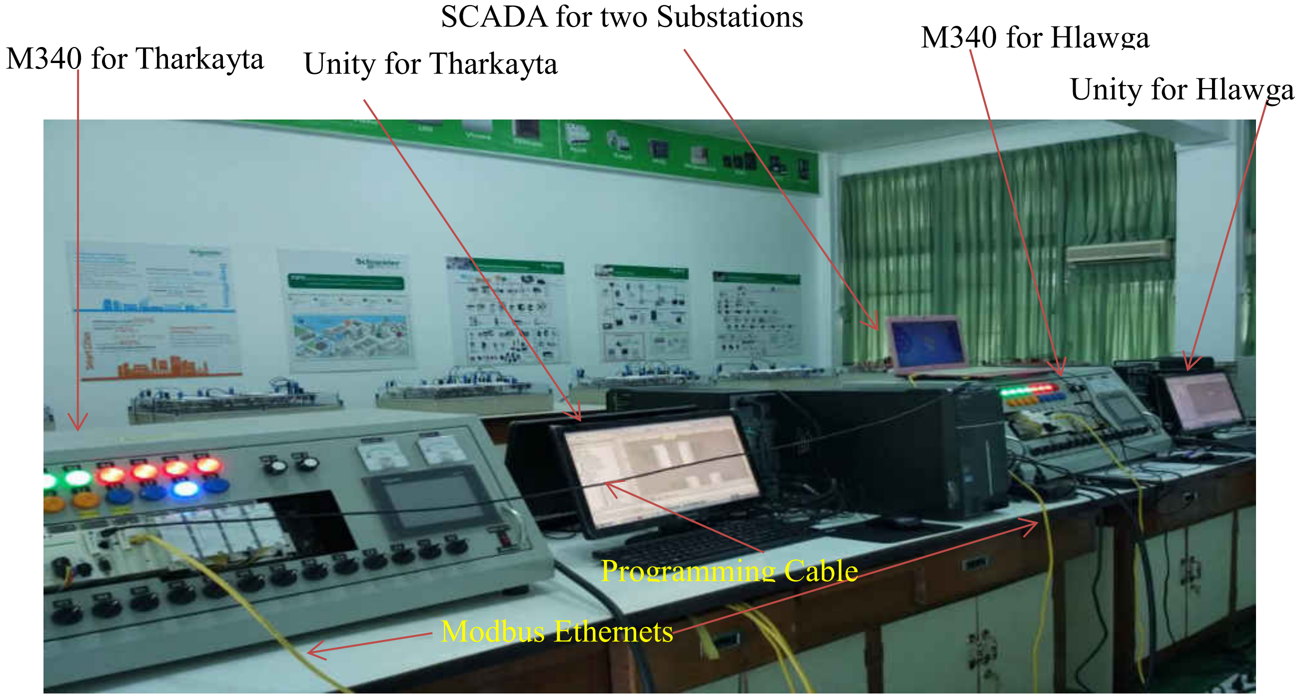

Figure 6 Configuration of PLC/SCADA in Schneider Lab, YTU, Myanmar

ENHANCEMENT OF 230 KV DISTRIBUTION SUB-STATION:

I. Automatic Generation Control

A. Tharkayta Distribution Substation

Under normal condition, all transformer banks and all feeders are drawing current within their relay setting currents. At the 230 kV bus, the sum of the currents of Hlawga and Thanlyin must be equal to the sum of currents of the five transformer banks. For the system stability, Hlawga line current is kept constant within its setting currents and Thanlyin line current is used as a variation of the transformer banks currents. When there is an increase or decrease in transformer bank currents, it will effect to the Thanlyin line currents.

$$\mathrm{I}\,(230\ \mathrm{kV}) = \mathrm{I}\,(\mathrm{Hlawga}) + \mathrm{I}(\ \mathrm{Thanlyin}) = \mathrm{Ip}(\mathrm{B}_1) + \mathrm{Ip}(\mathrm{B}_2) + \mathrm{Ip}(\mathrm{B}_3) + \mathrm{Ip}(\mathrm{B}_4) + \mathrm{Ip}(\mathrm{B}_5) \qquad 1$$

$$\mathrm{I}(\ \mathrm{Thanlyin}) = \mathrm{I}\,(\mathrm{Hlawga}) - [\ \mathrm{Ip}(\mathrm{B}_1) + \mathrm{Ip}(\mathrm{B}_2) + \mathrm{Ip}(\mathrm{B}_3) + \mathrm{Ip}(\mathrm{B}_4) + \mathrm{Ip}(\mathrm{B}_5)] \qquad 2$$

If there is an outage or any trouble of Hlawga line supply, it can cause Thanlyin line to be overloaded. To prevent this condition, Bank 4 and Bank 5 are commanded to be temporary OFF automatically. Only when the Hlawga line is back to normal, the breakers of these two bank can be closed from the SCADA.

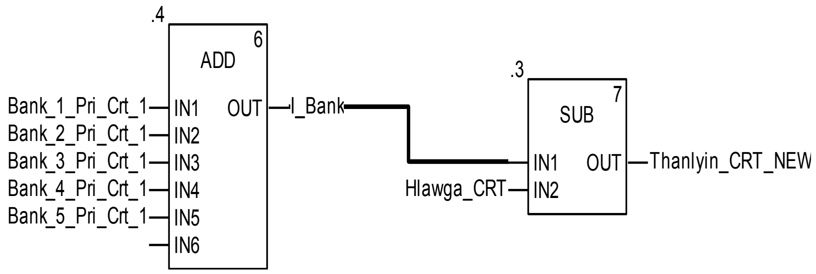

Figure 7 Function Block Diagram for the Power Flow of 230kV Bus in Tharkayta Distribution Substation (in Unity Pro XL)

At the 66 kV Bus_B , the incoming lines are Bank-1 secondary and generation of GT and STG and there are four feeders. Generation of GT – 1 and GT -3 are considered and GT-1 and Bank -1 supply are kept constant and then the generation of GT – 3 depends on the load of 66 kV Bus _B.

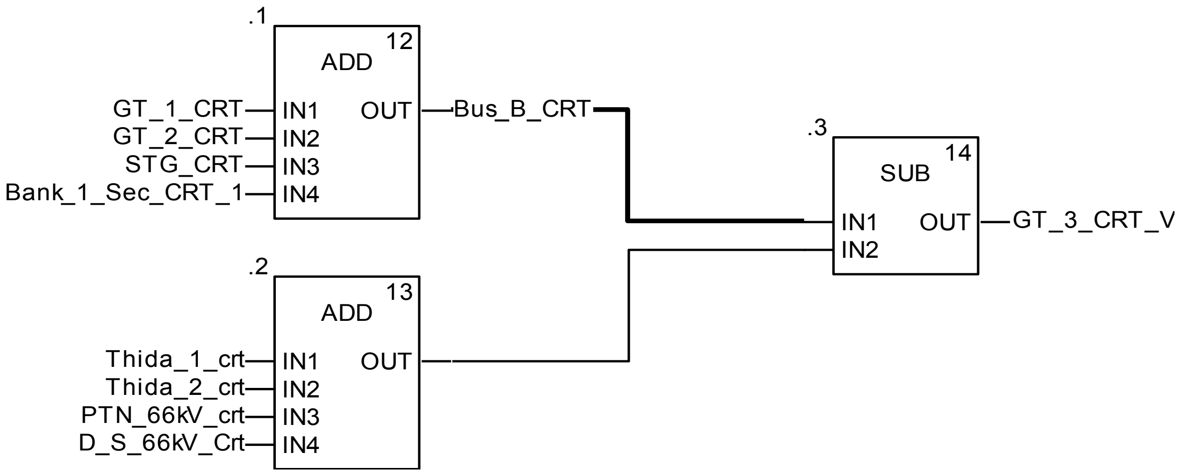

Figure 8 Function Block Diagram for the Power Flow of 66 kV Bus_B in Tharkayta Distribution Substation (in Unity Pro XL)

If there is any trouble in the incoming line of the 66kV Bus_B , it can cause to GT3 to be overloaded. To overcome this condition, as soon as I (GT3) has reached to maximum current, the breaker of Thida_1_66kV, Thida_2_66kV and D_S_66kV will be OFF and PTN_66 kV_Crt is limited up to 230 A automatically. After the condition is back to normal, these two breakers can be swith ON.

At the 33 kV_Bus, there are also the generation of the Max Power Engines with the Bank_2_secondary as the incoming supply and then three 33kV feeders are supplying. For the power system stability purpose, the incoming from Bank_2 is maintained as a constant and the generation of Max Power Engines is considered as a variable one.

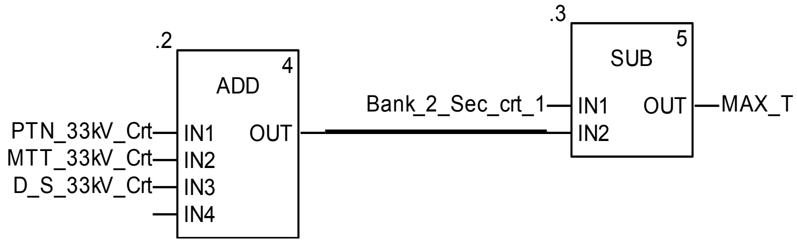

Figure 9 Function Block Diagram for the Power Flow of 33 kV Bus in Tharkayta Distribution Substation (in Unity Pro XL)

If there is also any shortage from the incoming supply of Bank_2, D_S_33kV breaker will be OFF and PTN_33kV and MTT_33kV feeder will be permitted to draw the current according with the Max_Power_Crt automatically.

B. Hlawga Distribution Substation

At the 230 kV bus, the sum of two incoming currents; TharYarGone and ShweDaung must be equal to the sum of outgoing currents; Tharkayta and the current of the four numbers of transformer banks. For the system stability, TharYarGone current is kept constant within its setting currents and ShweDaung current is used as a variation of the sum of Tharkayta current and the currents of the transformer bank. When there is an increase or decrease in the sum of the outgoing current from the 230 kV Bus, it will effect to the ShweDaung currents.

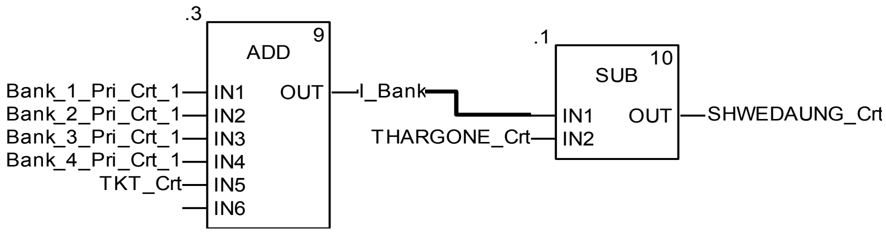

Figure 10 Function Block Diagram for the Power Flow of 230kV Bus in Hlawga Distribution Substation (in Unity Pro XL)

At the 33 kV Bus_B , the incoming lines are Bank-1 secondary, Bank-2 secondary and generation of GT_3, STG and MCP_2 and there are twelve feeders. Generation of GT – 3, STG , Bank - 1 and Bank_2 supply are kept constant and then the generation of MCP_2 depends on the load of 33 kV Bus _B.

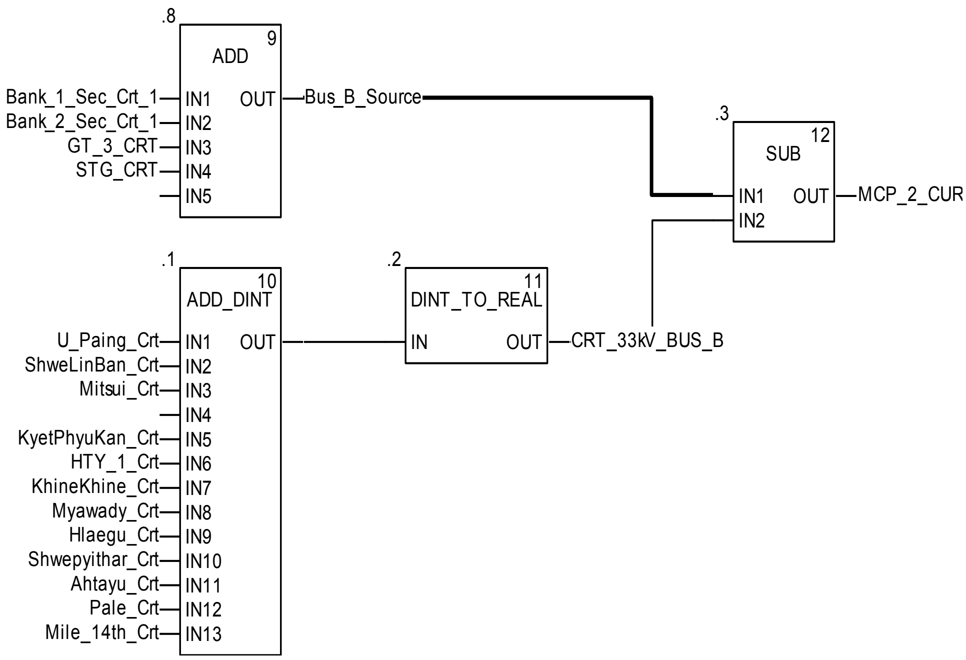

Figure 11 Function Block Diagram for the Power Flow of 33kV Bus_B in Hlawga Distribution Substation (in Unity Pro XL)

If there is any trouble in the incoming line of the 33kV Bus_B , it can cause to MCP_2 to be overloaded. To overcome this condition, as soon as I (MCP_2) has reached to the maximum current, the breaker of ShwePyiThar_33kV and 14th_Mile_33kV feeders will be OFF automatically. After the condition is back to normal, these two breakers can be Switch ON.

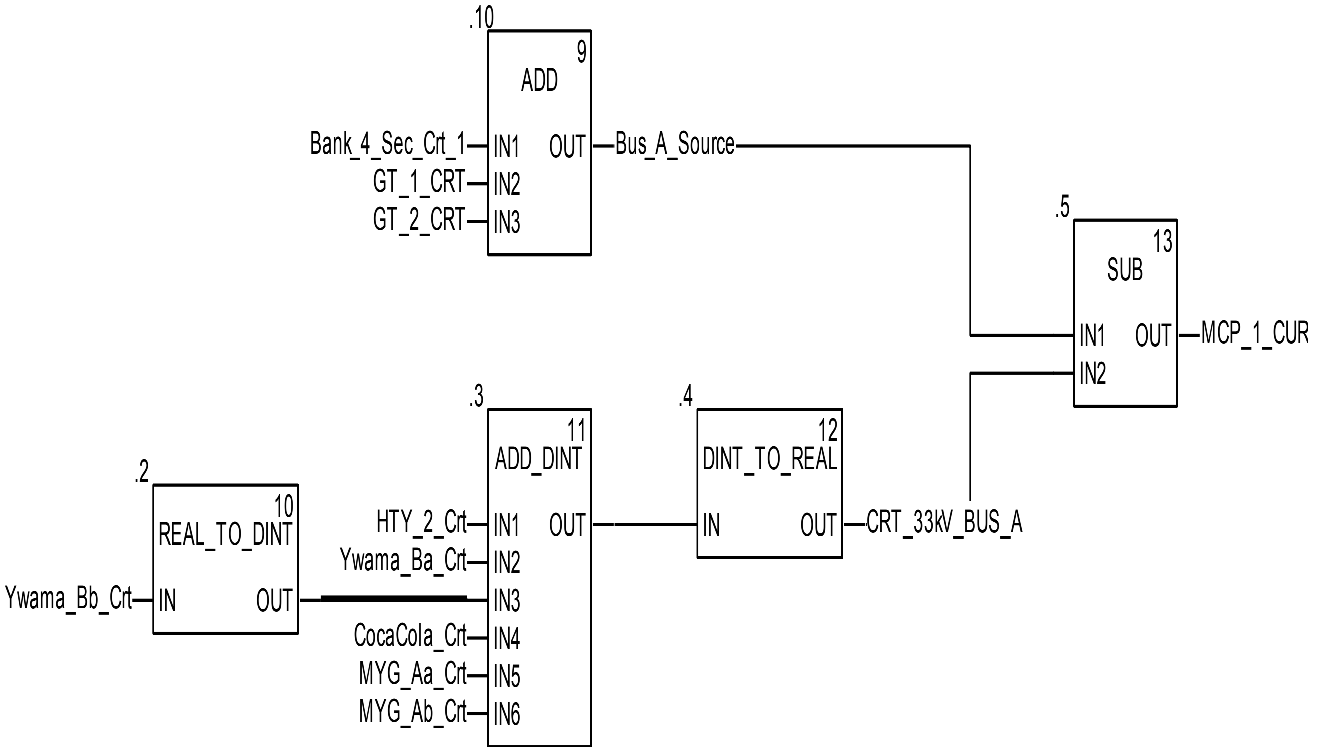

Figure 12 Function Block Diagram for the Power Flow of 33 kV Bus_A in Hlawga Distribution Substation (in Unity Pro XL)

At the 33 kV_Bus_A, there are also the generation of the GT_1, GT_2, MCP_1 with the Bank_4_secondary as the incoming supply and then six numbers of 33kV feeders are supplying. For the power system stability purpose, the incoming from Bank_4 and generation of GT_1and GT_2 are maintained as constant and the generation of MCP_1 is considered as a variable one. If there is also any shortage from the incoming supply of Bank_4, the breakers of YWM_Ba and YWM_Bb feeders will be OFF and automatically.

II. Faults mostly occurred in Substation

The faults mostly occurred in Substation are

1. Transformer Differential Fault
2. Single Line to Ground Fault
3. Single Line to Ground Fault
4. Line to Line Fault
5. Double line to Ground Fault

The condition when the fault occurred can be easily seen by using SCADA operator screen and the fault record can be store in the record page.

SIMULATION OF 230 KV DISTRIBUTION SUB-STATION BY USING PLC/SCADA:

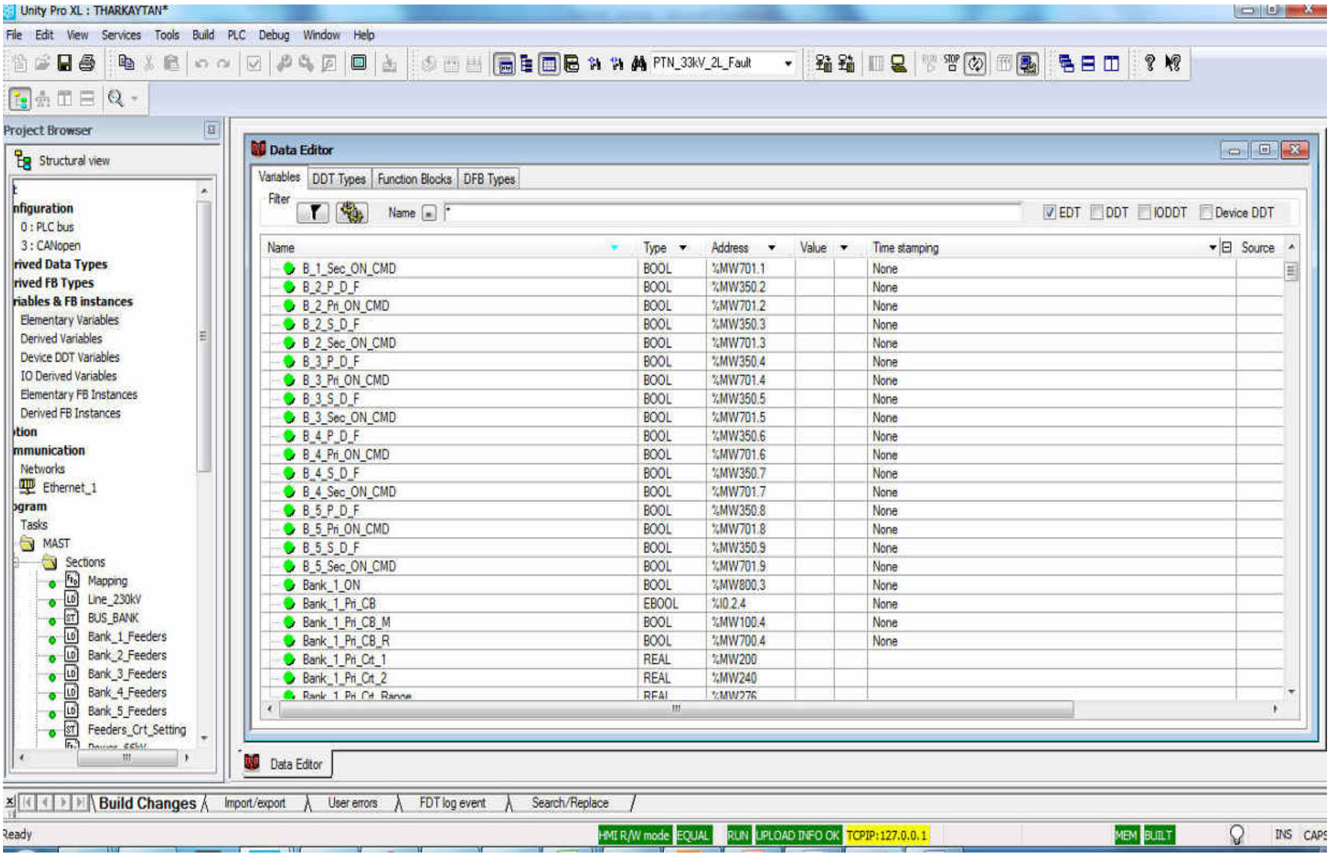

Figure 13Variable Tag Page in Unity Pro XL 8.0

This figure shows the Variable tag page which is needed to be configured the variable tag name of the Analog and Digital input/output an in the Unity Pro XL.

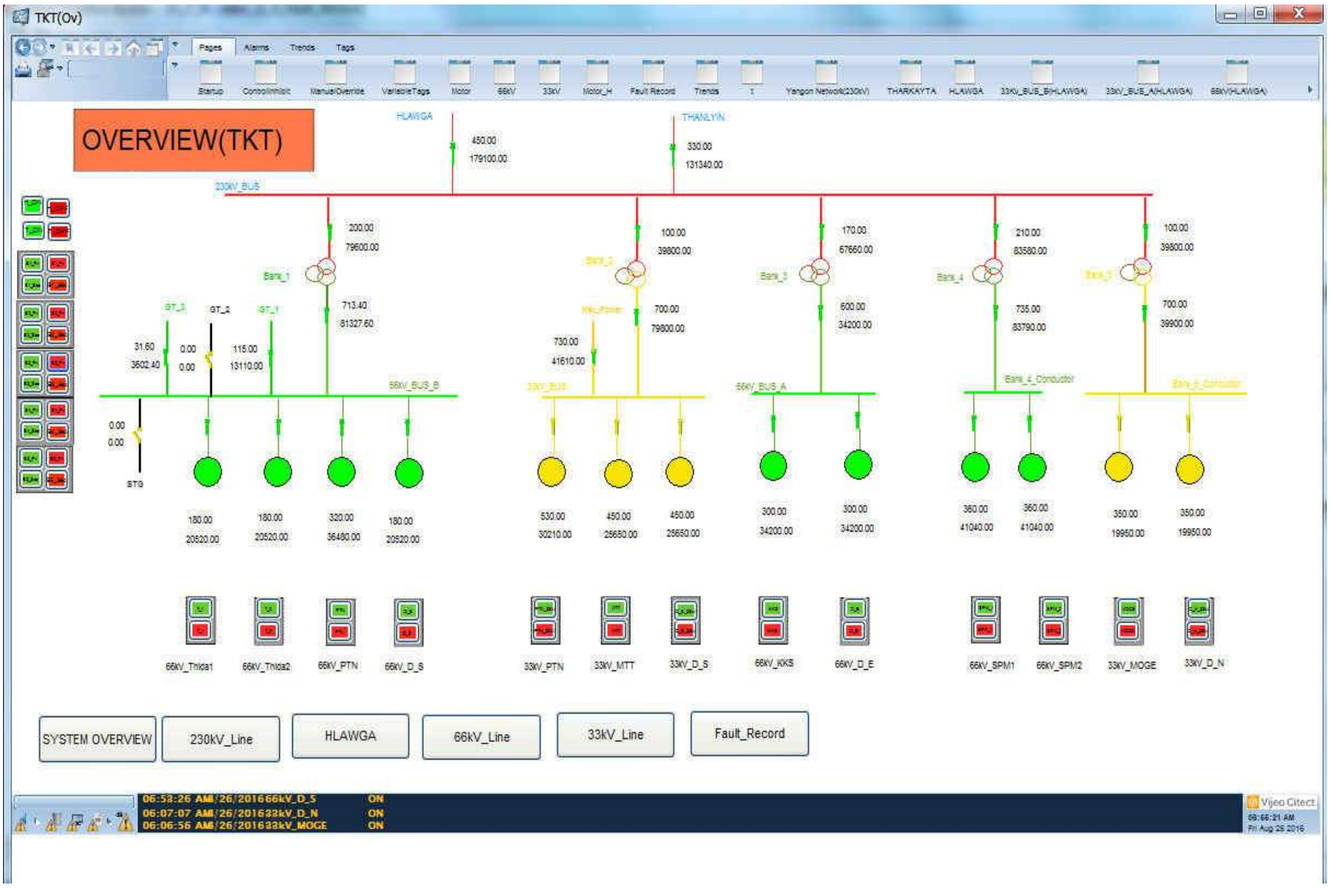

Figure 14 Overview Page of Tharkayta Distribution Substation in Vijeo Citect 7.3

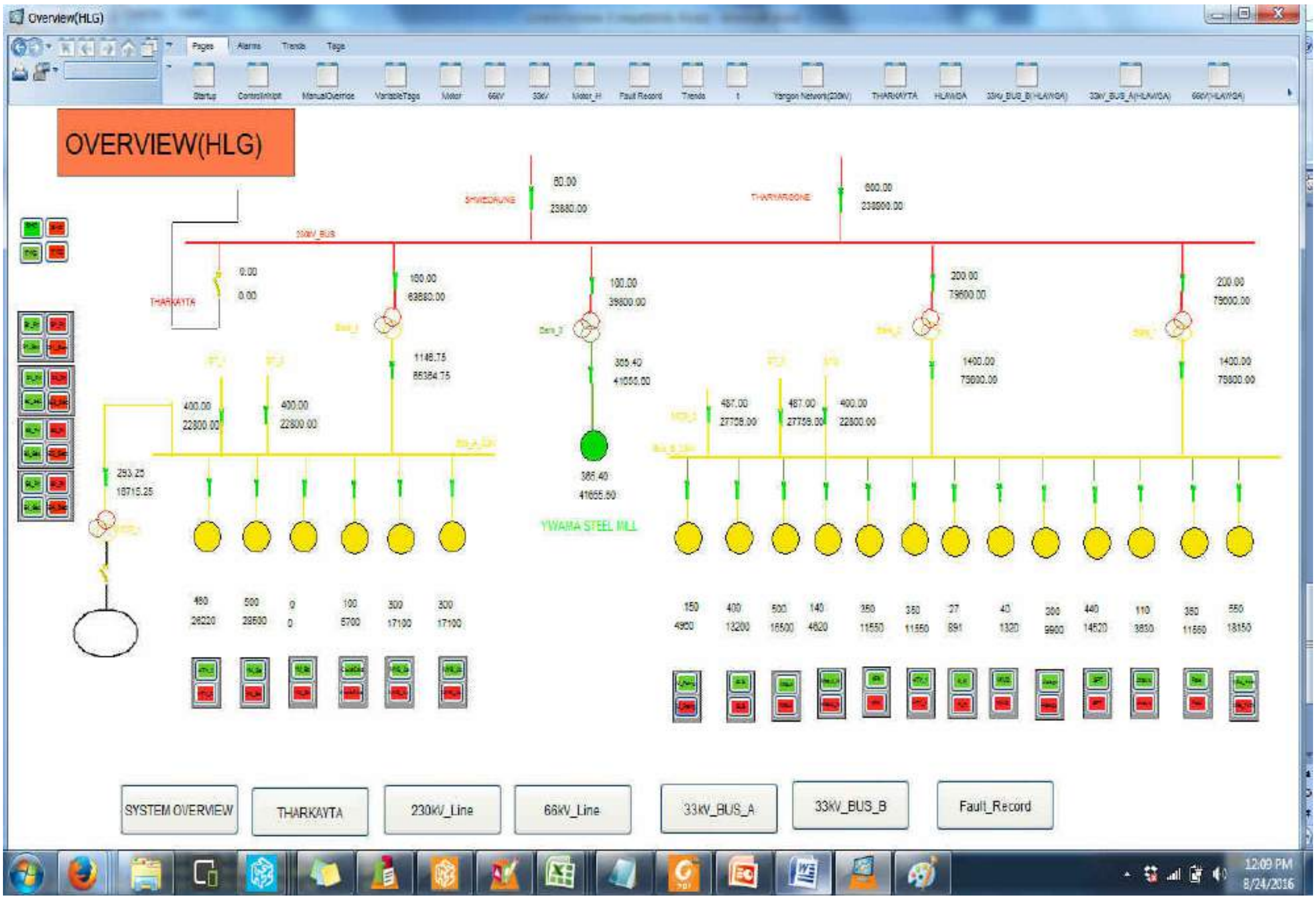

Figure 15 Overview Page of Hlawga Distribution Substation in Vijeo Citect 7.3

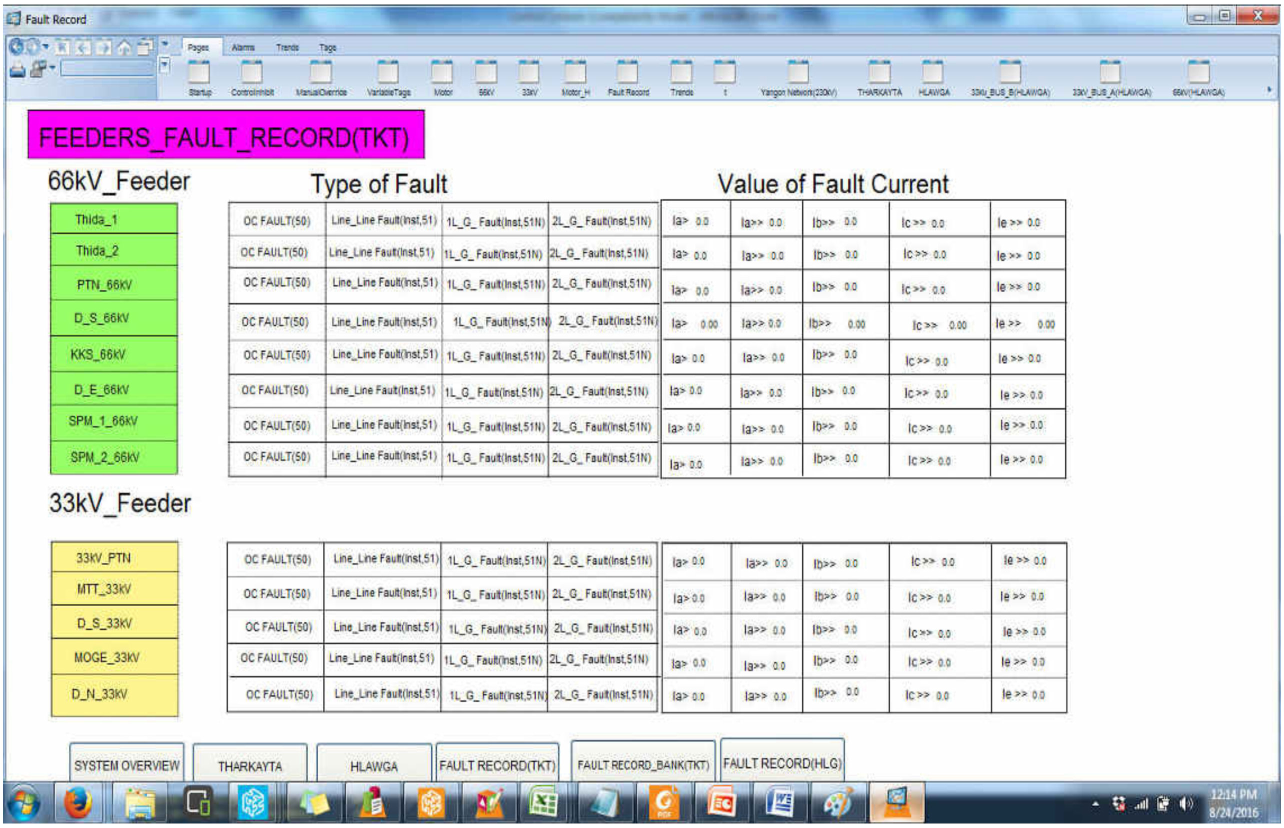

Figure 14 Fault Record Page in Vijeo Citect 7.3

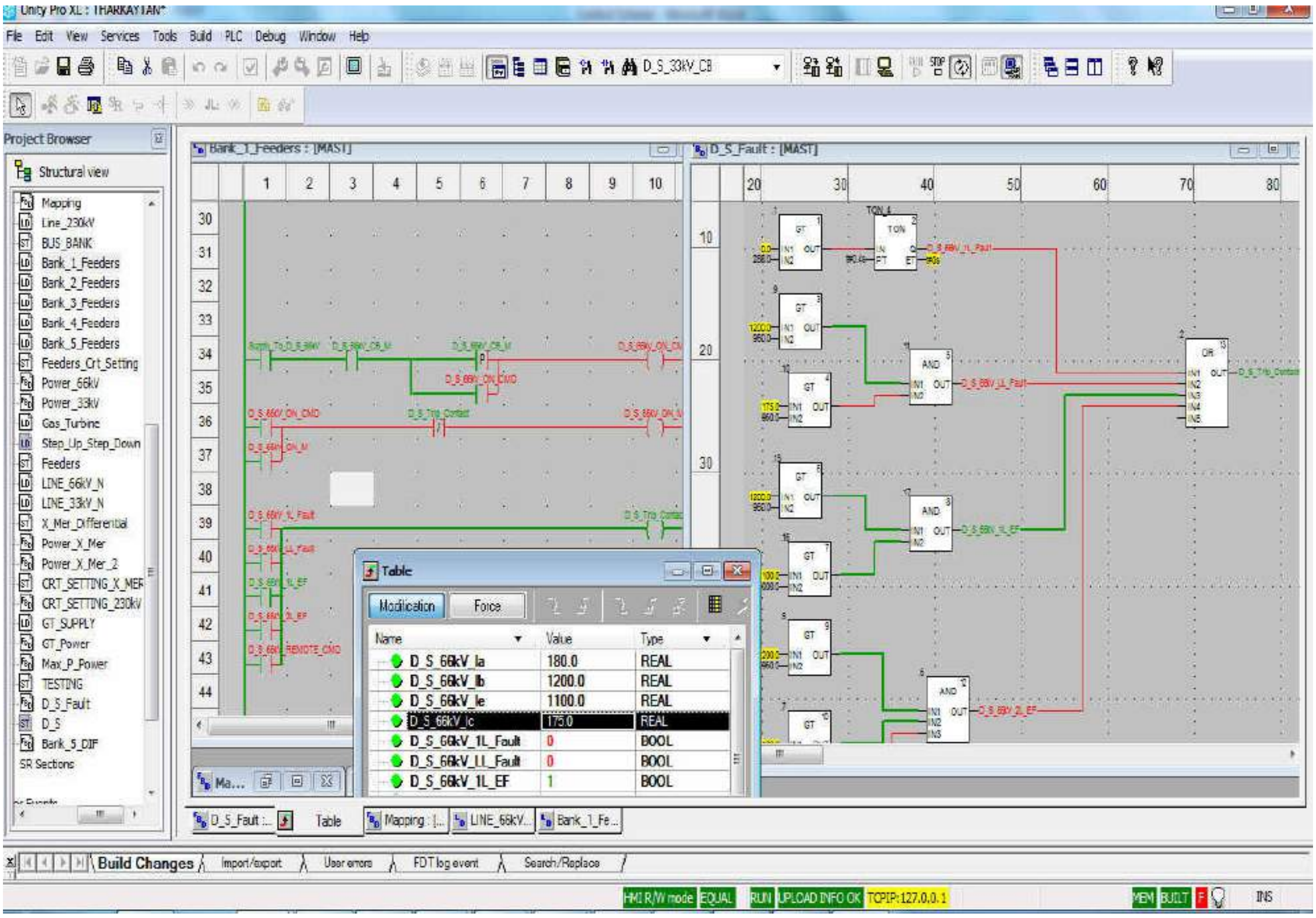

Figure 15 Unity Pro page when the Single Line to Ground Fault occurs

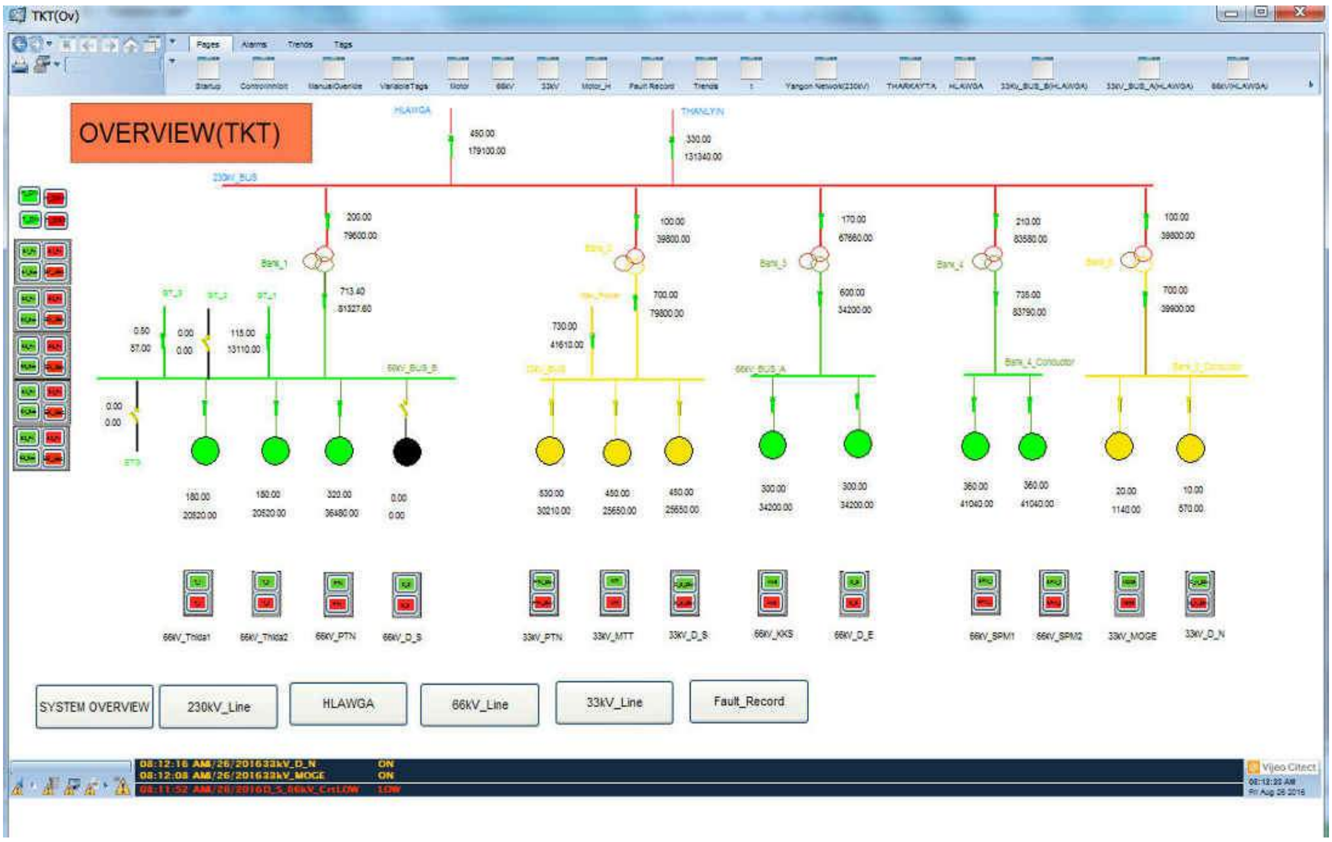

Figure 15 Vijeo Citect Page; The condition of Single Line to Ground Fault occurs

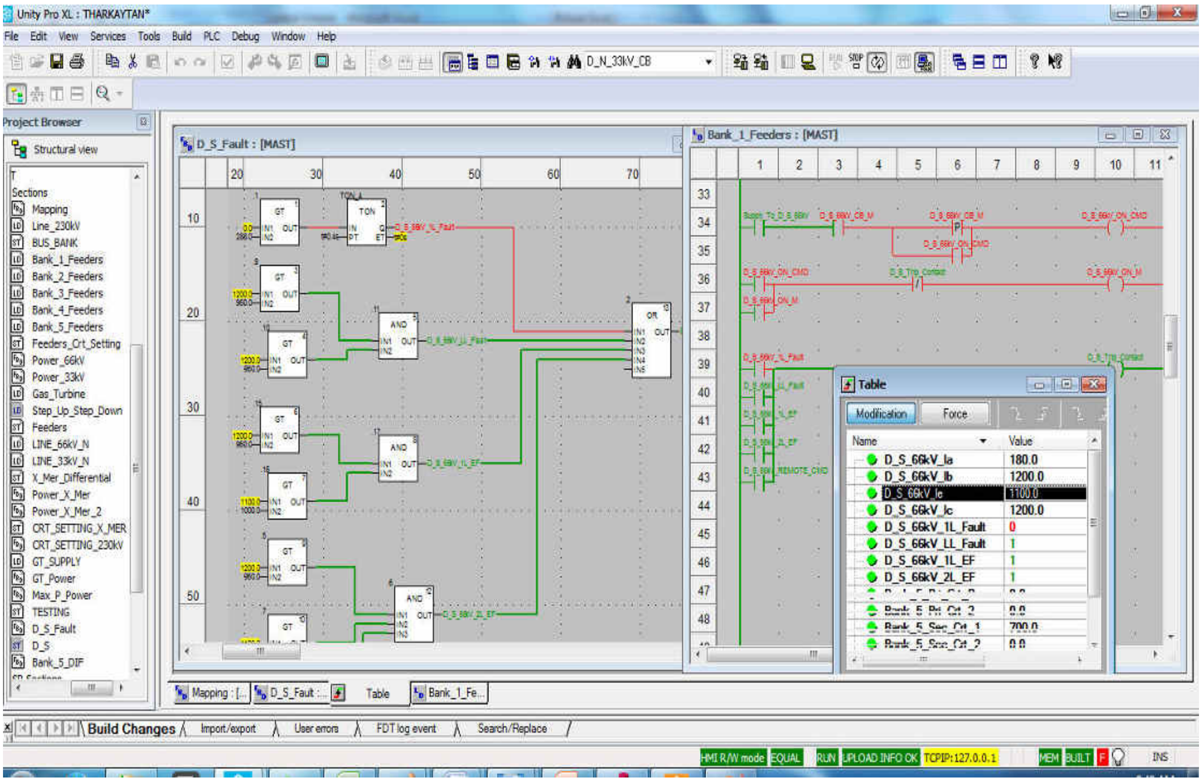

Figure 16 Unity Pro page when the Double Line to Ground Fault occurs

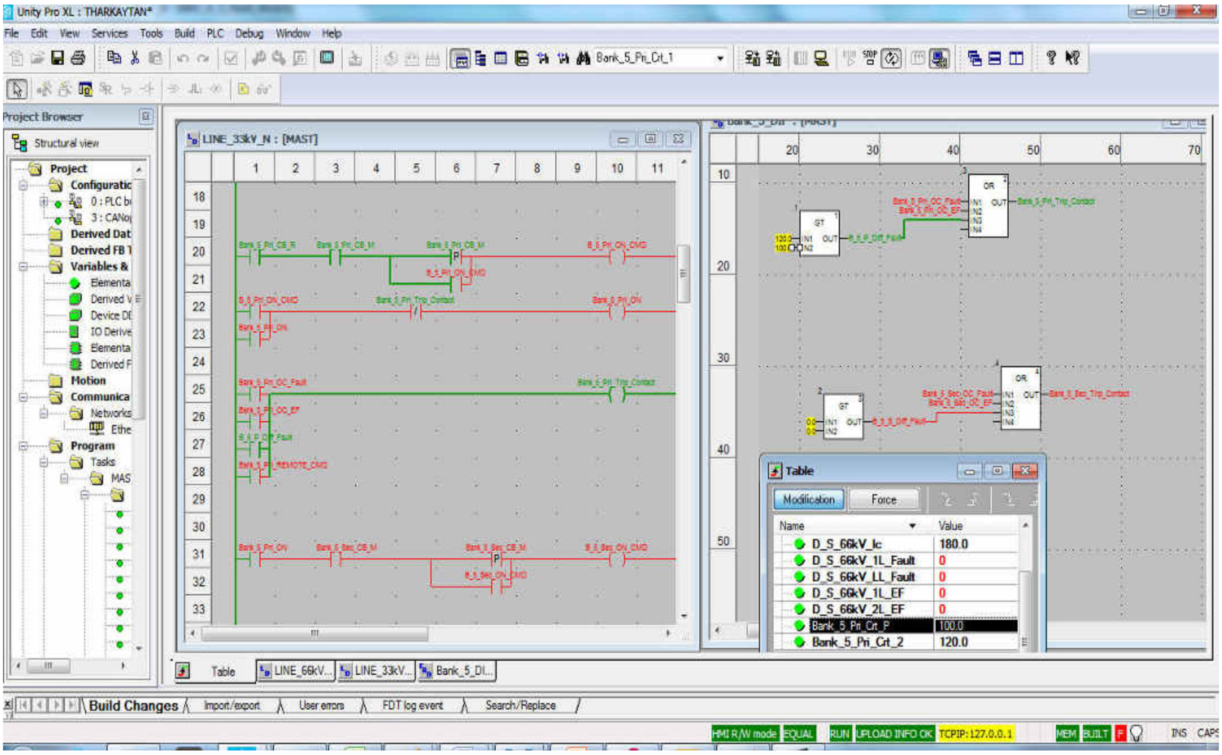

Figure 17 Unity Pro page when the Tripped by Differential Protection

CONCLUSION:

The configuration of regional control entre by Enhancing of Tharkayta and Hlawga Substation by using SCADA , the condition of operating is can be easily seen such as which lines are normal and which are abnormal and can be controlled from the HMI remotely. By monitoring and controlling the Power System in a such way, as the system condition can be directly and exactly known by RCC in time, it can reduce time leakage between Station and LDC and the power system can be controlled and monitored easily. Moreover, there is no need to collect data from individual meters in the site and thus it make less number of human worker and can reduce the time delay. The whole power system also can be extended based on these two substations to SCADA system for the controlling and monitoring of the power system with reliability and safety.

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BIOGRAPHY:

Ms. Ei Mon Mon is a Ph.D Research Student from Department of Electrical Power Engineering, Yangon Technological University, Yangon, Myanmar. She is also Sub Assistance Engineer at Tharkayta Power Plant in Yangon, Myanmar since 2011. She got Master of Engineering (M.E) from Technological University (Thanlyin) in 2011. She has participated in the Sixth International Conference on Science and Engineering (ICSE) 2015, Yangon and 33rd Conference of ASEAN Federation of Engineering Organisations (CAFEO 33) 2015, Malaysia.

Mrs. Su Su Win is Associate Professor from Department of Electrical Power Engineering, Yangon Technological University, Yangon, Myanmar. She got Ph.D from University of Stuttgart, Germany and Mandalay Technological University, Myanmar since 2011. She is interested in Power System and High Voltage Engineering.

Mrs. Phoo Ngone Si is Associate Professor from Department of Electrical Power Engineering, Yangon Technological University, Yangon, Myanmar. She got Ph.D from Mandalay Technological University, Mandalay, Myanmar since 2018. Her specialist field is Power System Analysis and Control.