

Substation Automation system

Arun T V, Lathesh L, Suhas A R

Abstract- Green and sustainable power is the need of the day. With widening supply and demand gap, power management has become one of the most critical areas of concern all over the world. India's energy consumption is increasing at one of the fastest rates in the world. Hence, we require Substation Automation Systems in the present day substations to efficiently control and deliver power. The main objective is to create a SCADA system for the desired substation. Power automation serving electric supply locations often require special protection against the effects of fault-produced. Protection relays need to function immediately when a faulty condition occurs. This is why Intelligent Electronic Devices (IED's) are brought in for safe operation of switchyard devices, which can prevent disasters to energy supply and help in human safety. With the introduction of IEC 61850, utility communication will be used for substation automation and also for protection purposes within a substation and between substations. A Substation Automation System (SAS) provides facility to control and monitor all the equipment in the substation locally as well as remotely. A Supervisory Control & Data Acquisition (SCADA) system provides users with a Human Machine Interface (HMI) which can be used for controlling, monitoring and protection of devices. This saves us cost and time. Substations are key components of the power grid, facilitating the efficient transmission and distribution of electricity. Substation automation systems make their control and monitoring possible in real time and help maximize availability, efficiency, reliability, safety and data integration.

Index terms-microSCADA,PCM600,RTU,SAS,OPC,PO,IED's

I.INTRODUCTION

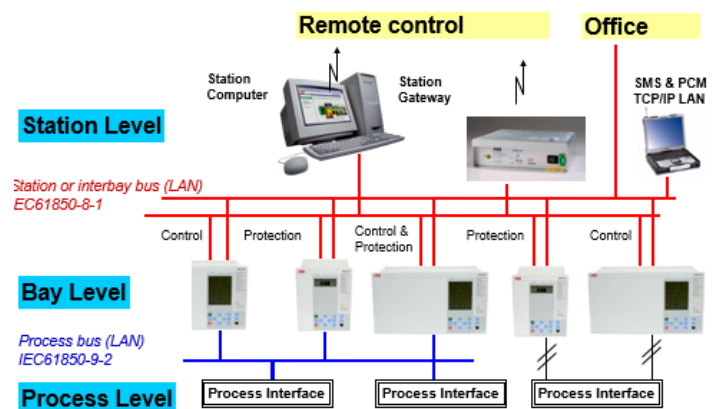
Substation automation is the act of automatically controlling the substation via instrumentation and control devices. Substation automation refers to using data from Intelligent Electronic Devices (IED's), control and automation capabilities within the substation, and control commands from remote users using SCADA to control power-system (switchyard) devices. Substation automation system is commonly used to control, protect and monitor a substation. However, over the years advances in electronics, information and communications technology have brought about sweeping changes in the way substations are operated. The advent of software-based substation automation systems connected by serial links rather than rigid parallel copper wiring gradually became the norm rather than the exception. Though successful and widely accepted, these systems were based on either the manufacturers' own proprietary communication solutions or the defined use of communication standards from other application domains, such as DNP3 or IEC 60870-5-104.

Substation Automation (SA) is a system to enable an electric utility to remotely monitor, control and coordinate the distribution components installed in the substation

High speed microprocessor based Remote Terminals Units (RTUs) or Intelligent Electronic Devices (IEDs) are used for substation automation and protection. IEC 61850 has been introduced in 2003 which defines standard protocols for communication and interoperability of the devices. SAS is based on a decentralized architecture and on a concept of bay oriented and distributed intelligence, for safety and availability reasons.

According to IEC 61850, the SAS layout is structured in three levels:

1. Station level
2. Bay level
3. Process level



Station Level

A redundant PC based HMI enables local station control through the software package MicroSCADA Pro, which contains an extensive range of SCADA functions. The station level contains the station-oriented functions, which cannot be realized at bay level, e.g. alarm list or event list related to the entire substation, gateway for the communication with remote control centres. A dedicated master clock for the synchronization of the entire system shall be provided.

Bay Level

A bay comprises of circuit breaker and associated isolators, earth switches and instrument transformers. At bay level, the IEDs provide all bay level functions such as control (command outputs), monitoring (status indications, measured values) and protection. The IEDs

are directly connected to the switchgear without any need for additional interposing or transducers. Each bay control IED is independent of the others and its functioning is not affected by any fault occurring in any of the other bay control units of the station.

Process Level

It consists of all the switchyard devices which are hardwired using copper cables and use fibre optic cables to connect the bay level IED's used for control and protection.

The SAS shall contain the following main functional parts:

- Human Machine Interface (HMI) with process database.
- Separate gateway for remote supervisory control via SCADA.
- Master clock (e.g. GPS receiver)
- Collection of the relevant data concerning the substation and distribution of the data where needed.
- Data exchange between the different system components via serial bus.
- Bay and station level devices for control, monitoring and protection.
- Bay-oriented local control panels with mimic diagram.

Control mode selection

As soon as the operator receives the operation access at bay level the operation is normally performed via the local HMI. During normal operation the local HMI is guided and allows the safe operation of all switching devices via the bay control IED.

Local mode

On the HMI the object has first to be selected. In case of a blocking or interlocking conditions the selection will not be possible and an appropriate alarm annunciation shall occur. If a selection is valid the position indication will show the possible direction, and the appropriate ON or OFF button shall be pressed in order to close or open the corresponding object. Control operation from other places (e.g. REMOTE) shall not be possible in this operating mode.

REMOTE mode

Control authority in this mode is given to a higher level (the station level) and the installation can be controlled only remotely. Control operation from lower levels shall not be possible in this operating mode.

EMERGENCY mode

The position indication shall be directly from the primary equipment circuit breaker. On the mimic board, the selection push button and either the ON or OFF push button has to be pushed simultaneously in order to close or open the circuit breaker. Control operation from other places (e.g. from REMOTE) shall not be possible in this operating mode.

Introduction to SCADA

SCADA (Supervisory Control And Data Acquisition) is a system for remote monitoring and control that operates with coded signals over communication channels (using typically one communication channel per remote station). The control system may be combined with a data acquisition system by adding the use of coded signals over communication channels to acquire information about the status of the remote equipment for display or for recording functions. It is a type of industrial control system (ICS). Industrial control systems are computer-based systems that monitor and control industrial processes that exist in the physical world. SCADA systems historically distinguish themselves from other ICS systems by being large-scale processes that can include multiple substations, and large distances.

Common System Components

A SCADA system usually consists of the following subsystems:

- Remote Terminal Unit (RTU)
- Telemetry system
- Data Acquisition Server
- Human Machine Interface
- A supervisory (computer) system, gathering (acquiring) data on the process and sending commands (control) to the SCADA system.
- Communication infrastructure connecting the supervisory system to the remote terminal units. Various processes and analytical instrumentation.

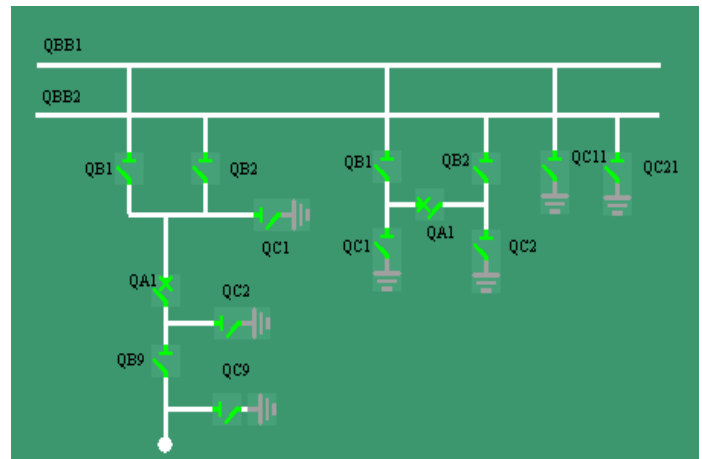
IED(Intelligent Electronics devices)

An Intelligent Electronic Device (IED) is a term used in the electric power industry to describe microprocessor-based controllers of power system equipment, such as circuit breakers, transformers and capacitor banks. IEDs receive data from sensors and power equipment, and can issue control commands, such as tripping circuit breakers if they sense voltage, current, or frequency anomalies, or raise/lower voltage levels in order to maintain the desired level. Common types of IEDs include protective relaying devices, On Load Tap Changer controllers, circuit breaker controllers, capacitor bank switches, recloser controllers, voltage regulators etc.



Different types of relay used for protection:

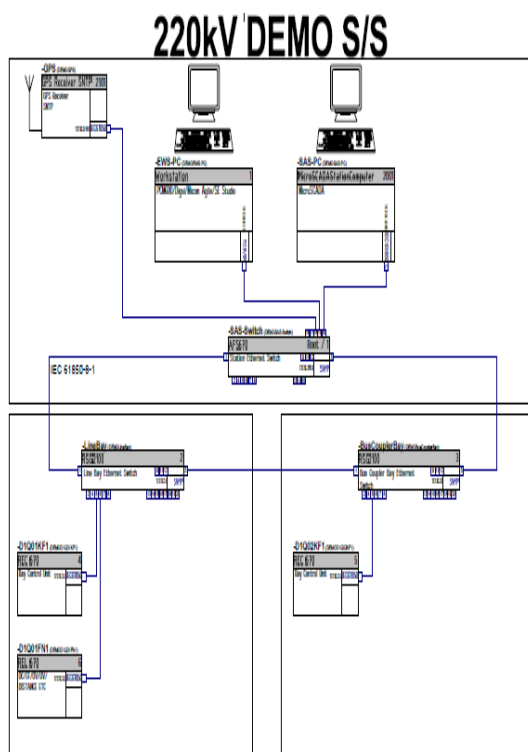
- RED:Relay for differential protection.
- RET:Relay for transformer protection
- REB:Relay for bus protection
- REL:Relay for line protection
- REC:Relay for controlling



Single line diagram

Output verification

- Established communication between the IED's and HMI. Using PCM600.
- Developed the configuration for overcurrent protection which is a part of SCD file.
- Created the SCD file.
- Wrote the SCD file onto both the IED's.



Typical 220 kv station design for protection

- Disturbance Reports
- Wavewin Results
- Measurement Reports
- Events Display
- Alarm Display

Conclusion

IEC 61850 was originally defined exclusively for substation automation systems (including protection applications). It will be soon extended to other application areas. These are automation of wind power systems, hydro power systems, and distributed energy resources such as combined heat and power systems or photovoltaic plants. The fact that the standard is being applied in the domain of distributed energy resources indicates the significance of IEC 61850 for Smart Grids. In the future, more components will facilitate the adoption of the architecture of the SAS system and permit the better physical distribution of the primary equipment, providing the full advantage of the process bus.

Future Scope :

IEC 61850 was originally defined exclusively for substation automation systems (including protection applications). It will be soon extended to other application areas. These are automation of wind power systems, hydro

power systems, and distributed energy resources such as combined heat and power systems or photovoltaic plants. The fact that the standard is being applied in the domain of distributed energy resources indicates the significance of IEC 61850 for Smart Grids. In the future, more components will facilitate the adoption of the architecture of the SAS system and permit the better physical distribution of the primary equipment, providing the full advantage of the process bus.

References

- [1] SCADA, "MicroSCADAStartup"
- [2] Control System Structure, "Protection Application Handbook"
- [3] Communication Networks and Systems in Substations- Introduction and Overview, "IEC61850-1", IEC, First Edition 2003-04, Ref. No. IEC/TR 61850-1:2003(E)
- [4] Network General, "Protection Application Handbook"
- [5] Substation Control, "Protection Application Handbook"
- [6] Communication Networks and Systems in Substations- General Requirements, "IEC61850-3", IEC, First Edition 2002-01, Ref. No. IEC/TR 61850-3:2002(E)
- [7] Product Integration Training Course, "REC Engg"
- [10] Product Integration Training Course, "MicroSCADAEngg"
- [11] PCM 2.5 Overcurrent, "PCM600 Application Configuration"
- [12] Substation Automation Products Training, "Control IED REC670"
- [13] Substation Automation, "MicroSCADA System Supervision"