

SIRIUS



HYDRO ELECTRIC PLANT CONTROL

Operating Micro and Mini Hydro-electric Power Plants was never so efficient and secure without the use of SCADA Systems. SIRIUS is a state-of-the art control system product developed by Synergy Systems & Solutions. SIRIUS provides a host of features required to manage Hydroelectric Power Generation Plant operations.

Traditionally, the hydroelectric plants were controlled by means of a series of panels installed at different locations in the plant. Inherently, the above approach was devoid of the following features:

- ❖ Centralized monitoring & control
- ❖ Integration of all intelligent electronic devices (IEDs) e.g. numerical relays, energy analyzers etc.
- ❖ Historical logging of data & alarm/events
- ❖ Remote monitoring & control
- ❖ MIS reports

Key Features

- SIRIUS SCADA software runs on standard IBM compatible PCs with Windows 2000 operating system.
- Comprehensive and user friendly control of the plant from control room.
- Full-featured graphics based man machine interface (MMI) for operator interaction.
- Direct interfacing of SCADA computer with governor, AVR, programmable logic controller (PLC), numerical relays, temperature scanners, energy analyzers etc.
- Unit auto start sequencing
- Monitoring of protection parameters
- Sequence of event List
- Disturbance recording in COMTRADE format
- Trending of selected plant parameters for operator analysis
- Automatic generation of production reports, log sheets and shift end reports etc.
- Redundancy at all levels in the control system.
- Mosaic MIMIC panel



FUNCTIONS

All important functions related to operating a hydroelectric plant are implemented through close coordination between SIRIUS and various IEDs installed in the plant.

Turbine Control

For Turbine Control, SIRIUS interfaces with the following:

- ❖ Proprietary turbine governor controllers supplied with the turbine, else.
- ❖ A PLC programmed with the turbine governor controller functionality.

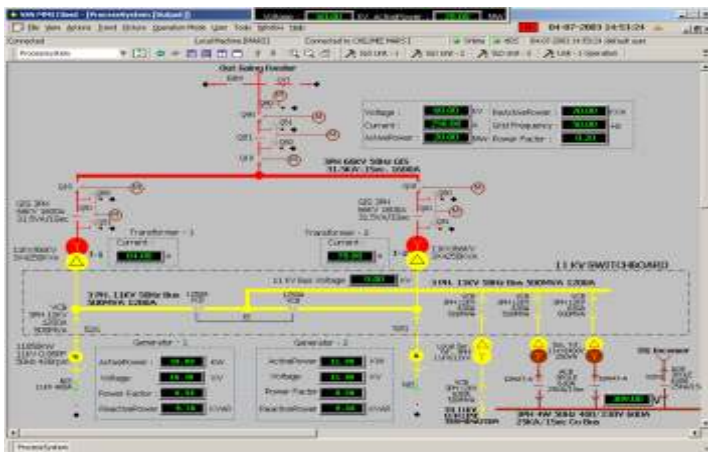
Through this interface, SIRIUS provides the following functions to the operator:

- ❖ **Start/Stop of Generating Unit:** This is possible in the following modes of operation:
 - **Fully Automatic:** In this mode, a single start command from SIRIUS causes a sequence of activities in which the necessary auxiliaries are started, valves are operated, and necessary safety checks are made at each stage of the sequence. The generating unit is also automatically synchronized with the grid.
 - **Step-by-Step:** In this mode, the start sequence pauses after completing each step and waits for the operator command from SIRIUS to begin the next step in sequence.
 - **Manual:** In this mode, the operator himself issues a separate command for operation of each equipment involved in sequential start.
- ❖ **Speed Raise/Lower:** When the generating unit is started but not synchronized with the grid, operator may like to increase/decrease the speed of the generating unit from SIRIUS for bringing the speed close to generating unit's rated speed
- ❖ **Power Increase/Decrease:** When the generating unit is synchronized with the grid, the operator can increase/decrease the power generated by the unit from SIRIUS
- ❖ **Control Modes:** A generating unit can be controlled according to various types of set points, e.g., constant power set point, or a constant reservoir level set point. The operator can issue such commands from SIRIUS
- ❖ SIRIUS provides a special joint control functionality whereby the generating units could be controlled as a group, working together on the basis of a single power generation set point entered from SIRIUS. The algorithm used for joint control takes the following inputs for calculating optimal power set point for each unit:
 - Generator running hours.
 - Generator characteristic curves, or optionally, a table containing generator's efficiency at various power outputs.

Excitation System

An Automatic Voltage Regulator (AVR) is used for controlling the excitation system. SIRIUS interfaces with the AVR for providing the following functions:

- ❖ **Voltage raise / lower:** When the generating unit is running but not synchronized, the operator can issue voltage/raise lower command to bring the voltage build-up level close to the rated value.
- ❖ **Control Modes:** When the generating unit is synchronized, AVR could be set to the following control modes from SIRIUS:
 - Power factor control mode
 - VAR control mode



Equipment Protection

Equipment like generators, transformers and line etc. are protected using numerical protection relays which are intelligent electronic devices. Apart from protecting the equipment these equipment also make available a lot of data related to the current state of various measurements, history of alarms/events and history of disturbances. SIRIUS system communicates with all the protection relays to show the protection related data on the MMI.

Temperature scanners are used for protecting the generator bearings, windings of generators & transformers etc. from excessive heating which may cause permanent damage to these equipment. SIRIUS interfaces with the temperature scanners over a multi-dropped serial communication channel.

Plant Control

A PLC is used for integrating all the common equipment which are not monitored through other electronic devices in the plant. Oil pumping units (OPU), De-watering pumps, circuit breakers / isolators / earth switches, reservoir & tailrace water levels, power feeders to auxiliaries, penstock valve etc. are monitored and controlled via the PLC.

Generator Synchronization

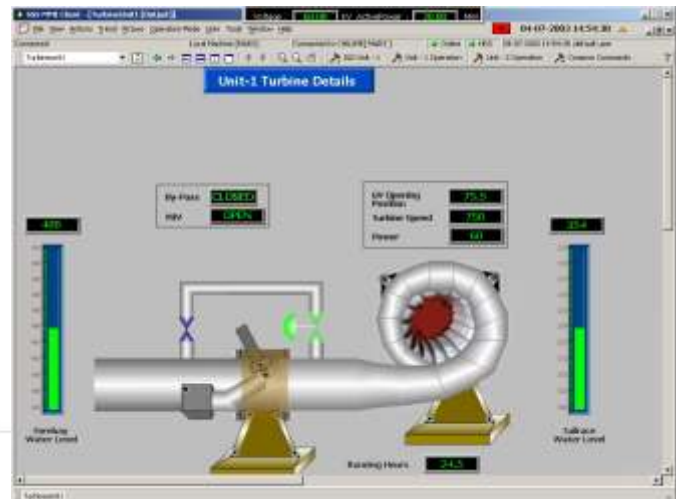
After a generating unit is started, it is synchronized before connecting it to the grid. Synchronization involves matching the frequency and voltage of the unit with that of the grid and when that happens, closing the unit's circuit breaker. An auto synchronizer is used for this purpose. Auto-synchronizer is interfaced through the PLC for initiating automatic synchronization.

SOE Recording

SOE are the events containing millisecond resolution local time-stamp from the intelligent device. Typically the numerical protection relays are capable of generating SOE. For common I/O, special SOE recorders are used. SOE from all such devices is acquired and presented by SIRIUS for analysis of trips. SIRIUS provides disturbance recording at device and SCADA levels with support for industry standard COMTRADE format.

Time Synchronization

All the equipment, especially the ones involved in generating sequence of events and disturbance records, must be time-synchronized with a single time-source (called Master Clock). Typically, a Master Clock is a GPS receiver. SIRIUS synchronizes its SCADA servers from the GPS receivers. Servers synchronize all other equipments through the communication channels, thus providing a very effective and economical method of time synchronization.



Mosaic MIMIC

A Mosaic tile-based MIMIC panel depicts plant single-line diagram and provides monitoring and control of various equipments through annunciators, indicating instruments, semaphore indicators, lamps, push-buttons and selector

Reports

A flexible reporting system, based on crystal reports or excel, allows preparing a variety of user-specific reports from the current or logged data. Typical reports for hydro electric power plant are:

- ❖ Daily log sheets
- ❖ Daily production reports
- ❖ Shift end/day end reports
- ❖ Equipment availability reports

Process Visualization & Control

An advanced graphics based MMI is used for process visualization. Data acquired from various IEDs is presented on the Process Graphics. Graphics can be prepared as per the end-user requirements and linked with each other to make an easy navigational scheme. A flexible coloring scheme ensures that the user can select his own preference of colors for viewing the process data. Alarms/events & trends could be configured according to the end user requirements. On-demand trends can be brought up on any point from a process graphic. Controls are specified on the graphics at desired locations from where the operator controls the plant.

Inter-Connectivity

For better monitoring of the various power houses, many power-houses are linked with each other for exchange of data of interest. Alternately, various power houses are integrated with a master control room using remote communication.

Architecture

SIRIUS has **scalable architecture**. SIRIUS is divided into many sub-modules. These could either be installed in a single computer, or for a large installation, could be distributed into different computers. All sub-modules communicate on TCP/IP network.

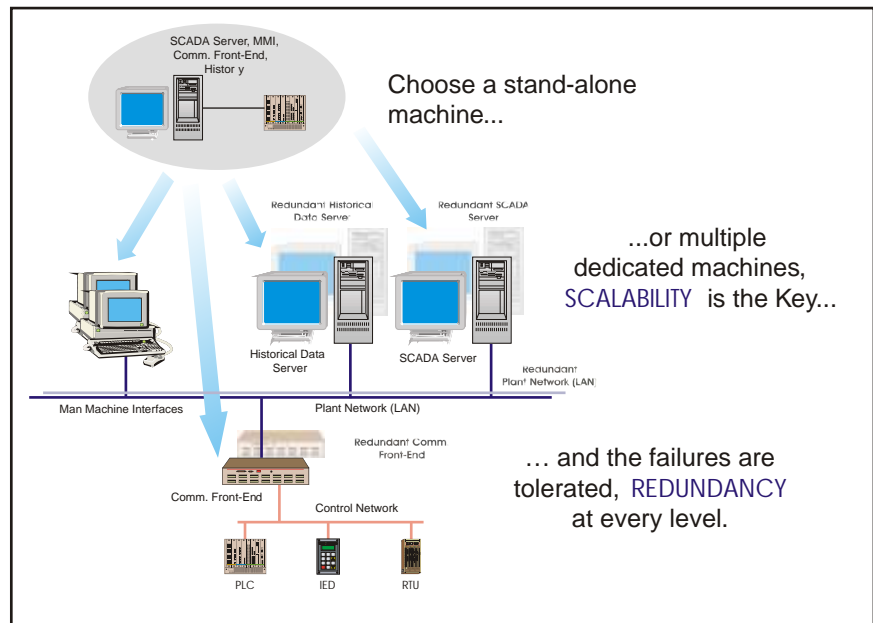
SIRIUS allows **multi-layered** networks which segregate the data exchange for plant monitoring & control from the data transfers for control system management in client server architecture.

SIRIUS system architecture supports the following networks:

- ❖ **Control Network:** All the field controllers and other intelligent electronic devices (IEDs) are connected on a communication network designated as Control Network. These controllers at one end communicate with the process and other end exchange information with SCADA servers/ front end processors. Control Network could be based on industry standard field buses such as Profibus, Modbus, Modbus+ etc. or other open communication protocols such as OPC, DNP3.0, IEC 870-5.

Depending on the selection of the controller and the protocol both ethernet (10/100 MBPS) and RS 485 (up to 10 MBPS) based networks can be configured. Optical fibre and copper cable based communication media are supported on the control network.

- ❖ **Plant Network:** As part of client server architecture, all the SIRIUS sub modules such as front end processors, servers and man-machine interface communicate with each other on a load balancing and fault tolerant ethernet based 100 MBPS TCP/IP network. Optical fibre and copper cable based communication media are supported on the plant network.



SIRIUS supports **redundancy** of the following which enables fault tolerant, high availability system architecture.

- ❖ SCADA servers
- ❖ Communication front end processors
- ❖ PLCs / IEDs
- ❖ Communication networks
- ❖ Printers (Alarm/event, reports)

Project Execution

Synergy Systems & Solutions handles the following scope related to execution of a control system project for a hydro electric power plant:

- ❖ Design and customization of control system for the end-user
- ❖ Supply of turnkey solution including hardware & software
- ❖ Factory acceptance testing of integrated system
- ❖ Installation & commissioning of supplied system
- ❖ Long term system maintenance support and software updates
- ❖ Comprehensive training programs

SIRIUS based control system empowers the operators with the features that help in effective and convenient control of a hydroelectric plant

