

SCADA SISTEMI U PROŠIRENJU I AUTOMATIZACII T.S 110/10 kV “DRAČEVO” SCADA SYSTEMS IN UPGRADE AND AUTOMATISATION OF S.S. 110/10 kV “DRACEVO”

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Sadržaj: 35/10 kV trafostanica Dračevo je radila u sklopu distributivne mreže grada Skoplja u toku niz godina. Kao rezultat povećanje potrošnje trafostanica je proširena i podignuta na 110 kV naponski nivo. Ovo proširenje uključuje izgradnju 110 kV naponskog nivoa kao i zamenu postojećih 10 kV čelija sa novim čelijama za unutrašnju montažu. Projekt je obuhvatao i instalaciju novog sistema za automatizovano vodjenje trafostanice Sicam PAS koji je omogućio daljinsko upravljanje sa rasklopnim uredima na 110 kV nivou kao i povezivanje i razmenu podataka sa loklanim kontrolnim sistemom na 10 kV nivou. Kompletno hardversko i softversko rešenje je proizvod kompanije Siemens .

Abstract: 35/10 kV substation Dracevo operated for many years as part of the power distribution network of Skopje, the capital of the Republic of Macedonia. Due to the increase of the consumption, the substation was upgraded on 110 kV voltage level. The upgrade of the substation included 110kV switchyard and replacement of the existing 10kV switchyard with new enlarged indoor 10 kV switchgear. The project included installation of new automation system Sicam PAS for remote control of switchgear devices on 110 kV level as well as connection and data exchanging with local control system of 10 kV level. Complete hardware and software solution is product of company Siemens.

1. INTRODUCTION

Increasesment of consumption of electricity in the region of city Skopje, has lead to upgrade of s.s. 35/10 kV Dracevo to 110 kV level. Reconstruction included installation of new 110 kV switchyard, as well as replacement of complete 10 kV switchyard with new 10 kV switchgears. Besides replacement and upgrade of primary equipment also complete reconstruction and modernization was done in the part of secondary equipment: protection relays and installation of new system for substation remote control Sicam PAS. For that purpose on 110 kV side were installed intelligent electronic devices-IEDs – bay control units (BCUs) capable of handling the complex control and monitoring tasks. On 10 kV side combined protection and control unites were installed which enable connection and data exchanging with 10 kV level and with higher control center while carrying out simultaneously the protection functions in 10 kV switchgears. On that way s.s Pet rovec was integrated in system for local control and monitoring on substation level but in the same time using IEC 101 protocol it was integrated in the control system on the level of whole distribution network in the city of Skopje-Distribution Dispatching Center Skopje.

2. SISTEM OVERVIEW

The SICAM PAS system is an open modular structured telecontrol and substation automation system for digital energy automation. The specific functions of a telecontrol system are combined with those of a programmable controller automation system. On Fig. 1 is presented the starting requirement for substation automation while on Figs. 2 and 3 is presented technical solution of automation system

regarding configuration of control center on substation level and configuration of BCUs on 110 kV level subsequently. Generally SICAM PAS Station Unit is based of SICOMP IMC Industry – Microcomputer with 19 inch rack system. SICAM PAS is suitable for operating the substation not only from one single station computer (station unit), but also in combination with other SICAM PAS systems or station control units.

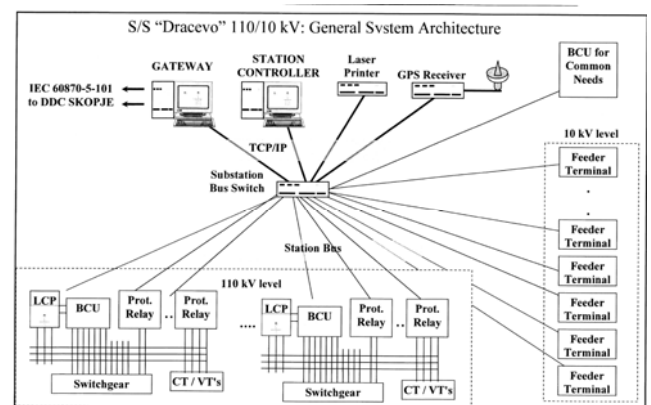


Fig. 1. Overview of system requirements

Communication in this network is based on a powerful Ethernet LAN. With its features and its modular expandability, SICAM PAS covers a broad range of applications and supports distributed system configurations. A distributed SICAM PAS system operates simultaneously on several computers. SICAM PAS can use existing hardware components and communication standards as well as their connections. It controls and registers the process data for all devices of a substation, within the scope of the data transfer protocols supported. SICAM PAS works on PC -

compatible hardware with the Windows XP embedded operating system. The advantages of this platform are low hardware and software costs, ease of operation, scalability, flexibility and constantly available support. A system stores and organizes the database (e.g. configuration data, administrative status data, et c.). The station control unit function for communication with IEDs supports a large number of well-established protocols: IEC 61850 based on Ethernet thus supporting direct exchange of data between IEDs, IEC 60870-5-103, PROFIBUS FMS, PROFIBUS DP, IEC 60870-5-103. The SICAM PAS data normalization function allows such conversions as measurement filtering, threshold calculation and linear characteristics.

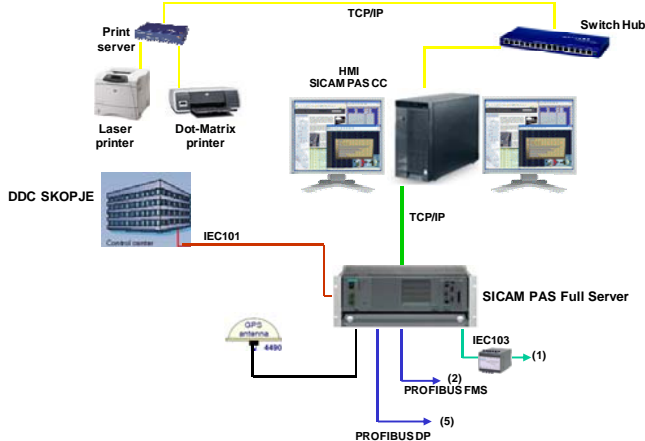


Fig. 2. Architecture of control system on substation level

According to the substation configuration on 110 kV level there are two 110/10 kV transformers, one coupler switchgear, and two over-head transmission lines. Applied solution of automation system on 110 kV level is based on principle that protection and control functions are completely separated therefor in each 110 kV cubicle IEDs for protection functions are installed in protection relays (e.g. 7UT relay for transformer differential protection) while for control purposes are used BCUs-6MD63 which are fully capable of performing all control and monitoring functions. Their connection to the SICAM PAS station unit is established using PROFIBUS FMS protocol while connection to DDC Skopje is established via IEC 101. All substation common signals are led in one programmable logic control module ET 200 S containing 64 digital inputs and 10 analog inputs. As for automatic control of transformer tap-changer which enables automatic regulation of transformer secondary voltage Eberle REGSys™ is used. It is also integrated in substation control system with the aid of IEC 101 protocol. Each REG-D controller can be used as a controller and at the same time as a measuring transformer, recorder and statistics unit. In measuring transformer mode all important network measured values are displayed, in recorder mode the time progression of the voltage being controlled and a second selectable measured value are registered. It has PC-supported archiving and evaluation of recorder data [1].

On 10 kV level are used numerical combined protection and control units 7UT63 which have large display and full set of protection, control and monitoring functions for specified 10 kV switchgear. Part of 10 kV switchgear is presented on Fig. 4.

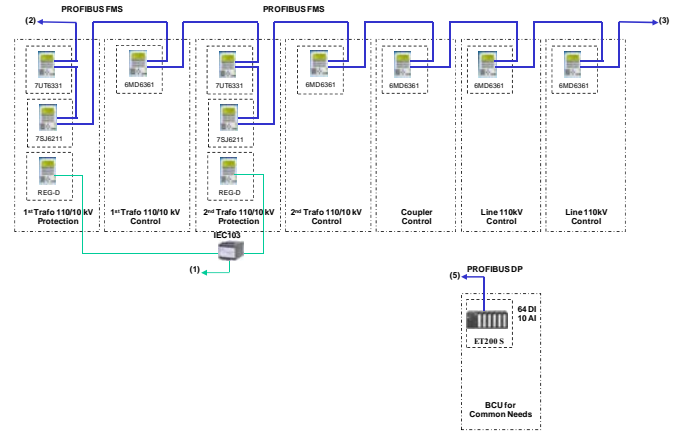


Fig. 3. Architecture of control system on 110 kV control level

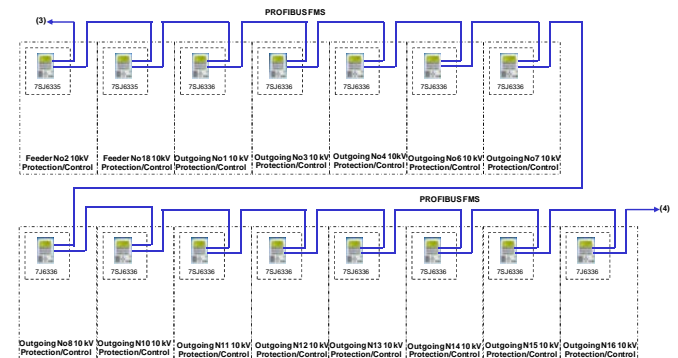


Fig. 4. Architecture of control system on 10 kV control level

3. SISTEM'S CHARACTERISTICS

With its features and its modular expandability, SICAM PAS covers a broad range of applications and supports distributed system configurations. A distributed SICAM PAS system operates simultaneously on several computers. SICAM PAS can use existing hardware components and communication standards as well as their connections. It controls and registers the process data for all devices of a substation, within the scope of the data transfer protocols supported. SICAM PAS is a communication gateway. This is why only one single data connection to a higher-level system control center is required. SICAM PAS enables integration of a fully graphical process visualization system directly in the substation. Time synchronization of all process data is achieved with a module in a station unit for the time synchronization of the connected IED (if supported by the protocol) and the connected HMI-PCs (SICAM PAScc). The clocktime receiver (GPS) is connected to a PC slot of the SICAM PAS station unit. The SICAM PAS is the clocktime master in the system and synchronizes connected bay units and I/O function modules. The time stamp of acquired information is allocated as follows:

Time stamping of the centrally acquired information items is done directly on the I/O function modules. Bay units which are connected via PROFIBUS FMS are each clock-synchronized through the communication connection. The information items are assigned a time stamp there (time with date) for the above protocols, in the bay units directly. Bay units which are connected via IEC 60870-5-103, are clock-synchronized through the communication connection. The

information items are allocated there a time stamp (time without date) for the above logs directly in the bay units. The SICAM PAS adds the date. Further control aspects of SICAM PAS are: interlocking functions such as bay blocking and telecontrol blocking, redundancy, and software for evaluation of measured and metered values as well as software for automatic retrieval of fault recordings from protection relays [2].

SICAM PAS features bay blocking and telecontrol blocking functions. The telecontrol blocking function can also be configured for specific channels so as to prevent the transfer of information to one particular control center during operation, while transfer continues with other control centers. The bay blocking and telecontrol blocking functions act in both the signaling and the command directions. Channel-specific switching authority also makes it possible to distinguish between local control (SICAM PAS C C) and remote control for the switching direction, but also between control center connections. Circuit-breakers can be controlled in synchronized/unsynchronized mode.

The SICAM PAS station unit can be used in a duplicate configuration and can be upgraded to further boost the availability of the station control level. This duplication is possible with IEDs or substation devices that support simultaneous communication with two masters or clients (IEC 61850) SICAM PAS C C serves as the process visualization system.

IndustrialX-Controls are used to control and monitor switchgear. These switching device objects support four different forms of presentation (IEC, DIN, SINAUT LSA, SICAM) for circuit-breakers and disconnectors. It is also possible to create bitmaps (defined for a specific project) to represent switching devices, and to link them to the objects. For informative visualization, not only nominal and spontaneous flashing are supported, but also the display of various device and communication states.

Software package SICAM Valpro can be used to evaluate measured and metered values. It not only allows a graphical and a tabular display of archived values, but also enables subsequent evaluation functions such as minima, maxima and averages (on an hourly or daily basis).

Software package SICAM RecPro supports automatic retrieval and archiving of fault recordings from protection units connected with IEC 60870-5-103, PROFIBUS FMS and IEC 61850. SICAM PAS has following features:

- Multilingual capability
- All operation and monitoring functions on-board. This include not only the graphic system for plant displays and the signalling and archiving system for alarms and measured values, but also a reporting and logging system. Further advantages are integrated user administration, along with the granting and checking of access rights for configuration and runtime operations.
- Consistently scalable, even via the Web in conformity with requirements, the bandwidth ranges from simple single-user through to distributed multi-user systems with redundant servers and multi-site solutions with Web clients.
- Open standards for easy integration

Using any external tools, archived data can be accessed through a series of open interfaces (such as SQL and ODBC) for further editing. Manufacturer-independent

communication with lower level controllers (or with applications such as MS Excel) is supported with OPC (OLE for Process Control). Visual Basic for Applications (VBA), VBScript or ANSI-C create an ideal scope for project-specific solutions.

4. HUMAN-MACHINE INTERFACE

In the SICAM PAS substation automation system the fully graphic process visualisation system SICAM PAScc is the interface between the operator and the computer supported monitoring and control system, the Human Machine Interface- HMI. For efficient operation management a multiplicity of individual information items must be administered and displayed quickly and transparently. The plant status is correctly presented and logged at any instant. Essential indications, and measured and counter values of previous time intervals are archived such that they are available at any time for specific evaluations in curve or tabular form. As for the software requirements WINDOWS XP operating system is needed. After starting of runtime mode by SICAM PAScc, the overview diagram of the plant is displayed (Fig.5). The diagram display is approx. 5 seconds and the update time approx. 2 seconds for the switch objects and the measured value variables. If communication to a device or a module is faulty, the switching device or information items acquired are displayed with the last registered state, in cyan (light blue). If communication between SICAM PAS and SICAM PAScc is faulty, all switching device are displayed dark green indicating fault status, the background of the measured values is coloured in dark grey.

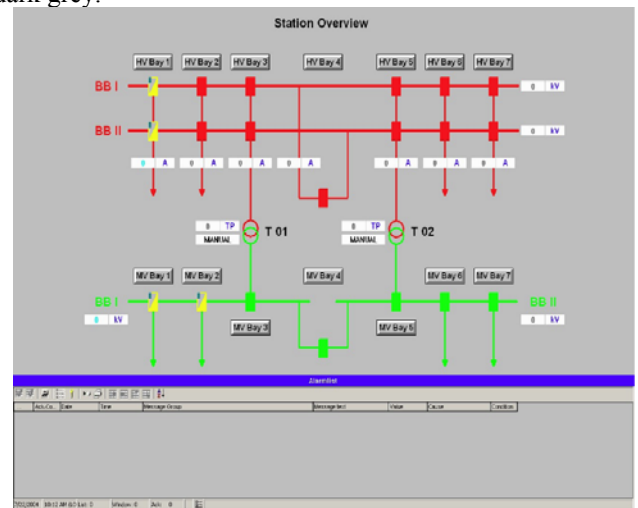


Fig. 5. General substation overview in SCADA system

Status of the switching devices is graphically changed according to the actual state of the switching device- Table 1.

Table 1: Switching device dynamic symbol

Switching device	Status	Symbol on single line diagram
Circuit breaker and disconnector	On	
Circuit breaker and/or disconnector	Off	
Circuit breaker and disconnector	Disrupted	

Buttons with bay names are displayed above the bus bars. By clicking these buttons the detail picture can be activated.

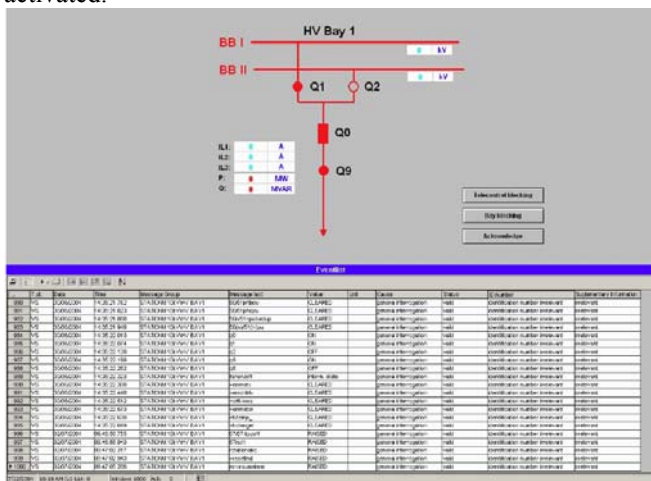


Fig. 6. Detailed overview of 110 kV feeder

The event list is selected by pressing the event list button and the alarm list is selected by pressing the alarm list button. All indications are listed in the event list. Coming entries in the alarm list, which need to be acknowledged are displayed in red. Going entries in the alarm list, which need to be acknowledged are displayed in green. All other entries are shown in black.



Fig. 7. SCADA event list

The SICAM PAScc Valpro package application (measured/counter value processing unit) is used for processing, display and printout of archived measured and counter values. Archiving of measured and counter values is done every 15 minutes. SICAM PAScc Valpro is started using a button in the upper area of the WinCC screen. After start the main window is displayed. The measured and counter values (variables) to be displayed in a variable group are selected there. The presentation can be in curve or tabular form. The individual display formats (zoom, scaling) can be adapted online. Support for following process functions is provided: minimum and maximum derivation, average value formation, power factor computation.

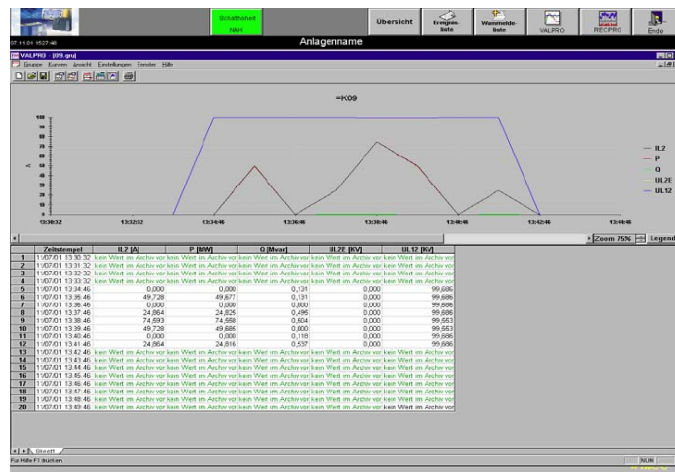


Fig. 8. SICAM PAScc Valpro window of metered values

5. CONCLUSION

Modern contemporary solution of SCADA systems - Sicam PAS, product of company Siemens is implemented in reconstruction and upgrade of high voltage substation 110/10 kV T.S. "Dracevo" in the city of Skopje. The complete high voltage switchyard 110 kV is remotely controlled and monitored from Sicam PAS system by the aid of Sicam PAScc visualisation program interconnected via Sicam station unit with distributed bay control units each one placed in each 110 kV bay. On 110 kV level control and protection functions are completely separated by using separate hardware units for protection and control i.e. bay control units for control and monitoring functions and numerical protection relays for protection functions. On 10 kV level control and protection functions are combined in one complex numerical protection relay enabling control of 10 kV switchyard to be performed locally from protection relays placed in 10 kV panels as well as remotely from SCADA system. Substation control system via protocol IEC 101 is connected to Dispatching Distribution Center of city Skopje. Bay control units and protection relays on 110 kV level as well as protection relays in 10 kV bays are connected to station control unit via PROFIBUS FMS. All important process parameters are remotely controlled including transformer tap-changer position. This contemporary software solution has considerably improved the operation of complete substation enabling to be remotely controlled and monitored thus cutting down the operational cost and reducing the time for faults location and cost for everyday maintenance.

REFERENCES

- [1] Vasilija Sarac, Dragan Minovski "Application of Sicam Pas system in automation and control of T.S. 400/ 110 kV Stip", "10th International Conference Control of Power System", Tatranske Matliare, Slovak Republic, May 2012, p.p 161-162.
- [2] Siemens, *Power Engineering Guide*, Erlangen: Publics Pro, 2008.