RF-GENERATORS CONTROL TOOLS FOR KURCHATOV SYNCHROTRON RADIATION SOURCE

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Abstract

Now the technology equipment of the Kurchatov Synchrotron Radiation Source (KSRS) is upgraded. At the same time, new equipment and software solutions for the control system are implemented. The KSRS main ring is the electron synchrotron with two 181 MHz RF-generators, their control system provides measurement of parameters of generation, regulation of tuning elements in wave guides and resonators, output of alarm messages. At the execution level the VME standard equipment is used. Server level is supported by Citect SCADA and the SQL historian server. The operator level of control system is implemented as a PC local network. It allowed to expand number of measuring channels, to increase speed of processing and data transfers, to have on demand historical data with the big frequency of inquiry, and also to improve the accuracy of measurements. In article the control system structure by KSRS RF-generators, including the description of all levels of control is provided. Examples of implementation of the operator interface are given.

RUNNING CYCLE OF KSRS

KSRS is the complex of electron synchrotrons specialized as a source of synchrotron radiation. The running cycle of KSRS includes the injection of electrons from the linear accelerator with energy 80 MeV to the booster storage ring SIBERIA-1, the accumulation of a electron current up to 400 mA and, then, electron energy ramping up to 450 MeV with the subsequent extraction of electrons in the main storage ring SIBERIA-2, and accumulation there up to 300 mA, and at last the energy ramping up to 2.5 GeV. [1]

The composition of RF-system of the KSRS main ring includes two generators of 181 MHz connected by wave guides with three resonators. Total acceleration voltage of resonators changes from 200 kV to 1.8 MV within 100 seconds of the ramping of energy of an electron beam from 450 MeV to 2.5 GeV. RF-generators support a stability of acceleration voltage for compensating of energy losses of the electron beam during long session (sometimes more than one day) on users of synchrotron radiation. [2]

The main objectives of control system are:

- Display of a status of RF-generators in real time.
- Control of tune mechanisms of RF–generators and resonators.
- Viewing of archive trends for the selected period.
- Informing to the operator about a violation of technological process.
- Guiding of log of alarm messages.
- Data security from illegal access.

RF-GENERATORS CONTROL SYSTEM

KSRS control system (CS) [3] is the multilayer and multiprocessor design consisting of three levels: executive, server and operator. All equipment is connected by two local area networks: public and technological (see Fig. 1).

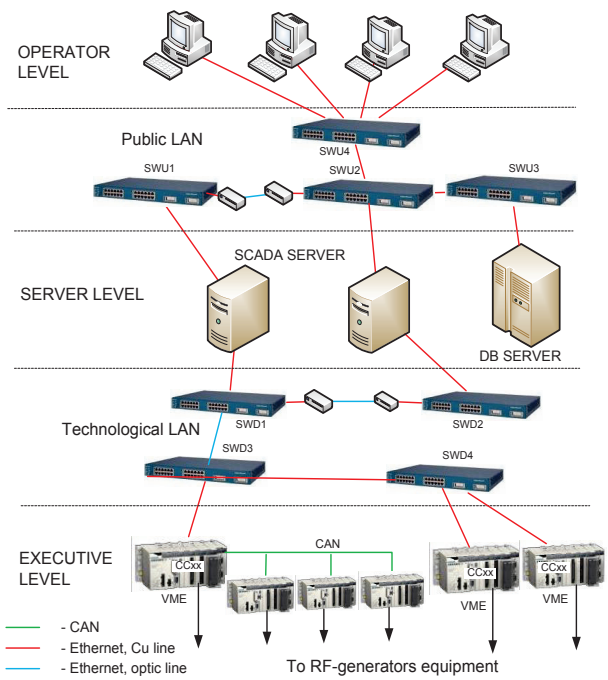

Figure 1: Structure of RF-generators CS.

Executive Level

The executive level of CS is based on bus-modular equipment in the VME standard and controlling equipment with the embedded processors, running under operating systems like LynxOS. The main module executing required algorithms is the processor Emerson MVME55006-0163. At this level should be gathered a diagnostic information and executed a control algorithms by technological systems. This equipment is connected to servers by standard communication lines of Ethernet in a local area technological network.

Sources of CS's input signals are the sensors measuring currents and voltage in modules of preamplifiers, RF-generators and resonators, and the mechanisms defining the tuning elements position. Receivers of CS's output signals - an equipment of automation (electric drives,

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regulators). Also CS supports a data interchange on the CAN-bus interface with intelligent units, such as the HF RF preamplifier drivers and the unit of an injection phase choice.

The special program provides the inquiry with maximum frequency (to 10 kHz) for several selected channels. These data collect in the ring buffer within 1 minute and in case of an electronic beam loss are given to the operator for estimation.

Servers

The server level of CS includes two application servers and the data base (DB) server which work under control of the MS Windows Server operating system. At this level are implemented:

- Control algorithm and monitoring of RF system.
- Data interchange with VME processors and with CAN controllers.
- Data interchange with operators workstations.
- Recording of operator's sessions and RF system status in DB.
- Selection and representation of information to user's requests.

The system of monitoring, control and data acquisition of Citect SCADA works at application servers. The second application server works as reserve. The DB SQL server is used for information storage about a current status of RF system by means of reports generation of Citect Historian. This DB is common for processor VME and SCADA modules, it stores data on input and output signals with necessary characteristics and parameters, for example, the factor of translation of a code in units of dimension, frequency of inquiry of the channel, bounds of measurements, levels of preventive and alarm.

Besides, the historian server contains a database for information storage about operation modes of RF systems in case of an alert condition with required sampling rate. This array of data is created by the special program in the VME processor, a condition of an alert is set by the operator, and for example, it can be electron beam loss in the main ring SIBERIA-2.

Operator Level

The upper level of control system consists of RF-system operator workstations, connected with the public local area network of the powerful personal computers working under control of Windows or Linux operating systems. Special applications of Citect SCADA which create graphic representations of occurring processes in real time, history trends, statistical reports, also work at operator level, thanks to support of multithread execution of sub programmes on CitectVBA and CiCode.

Software

The CS's software of RF system is functionally partitioned into three levels of hierarchy [4] (see Fig. 2):

- Processor assemblies of VME under control of LynxOS.
- SCADA Sitect application servers and Citect Historian DB SQL server under control of MS Windows Server.
- The software for workstations of operator's of RF-system includes the Windows 7 Professional 64 bit operating system, and applications, which were developed in the environment of version 7.2SP4 Citect SCADA, and version 4.3 Citect Historian.

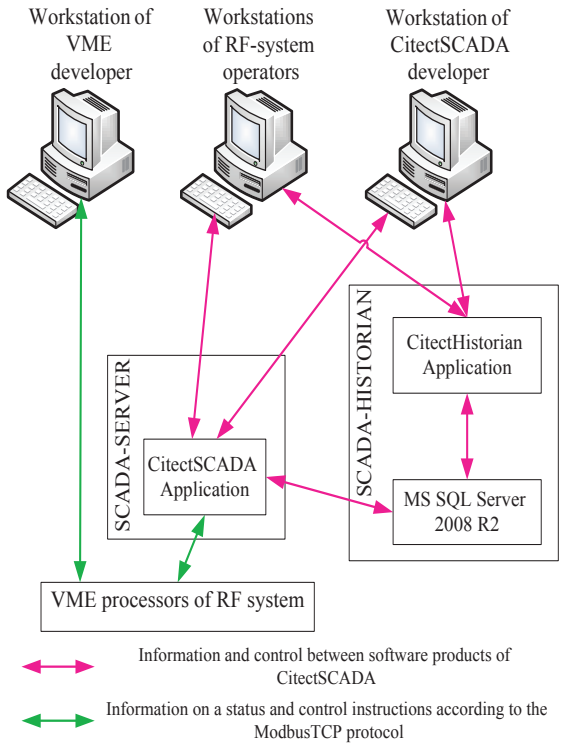

Figure 2: Functional structure of RF-generators CS.

Operator's Interface

The video frame of the main program of the RF-system operator is shown in a Figure 3. This program solves following tasks:

- Display on the monitor of a circuit of RF-system of main ring SIBERIA – 2.
- Viewing of archive and current parameter values in the form of diagrams.
- Display of preventive and alarm messages.
- Control of tuning mechanisms of RF-resonators.
- Authentication of operators.

The functional diagram of RF-system of the KSRS main ring shows two sets of radio racks, preamplifiers, RF-generators, wave guides and three RF-resonators. By clicking on the system element one can open popup window of control of this element. The technical status application presents system parameters on the screen and in addition creates a colour warning and a sound alarm in case of a deviation from a normal mode of operation. The graphic interface allows the user to choose control channels and the form of graphic representation.

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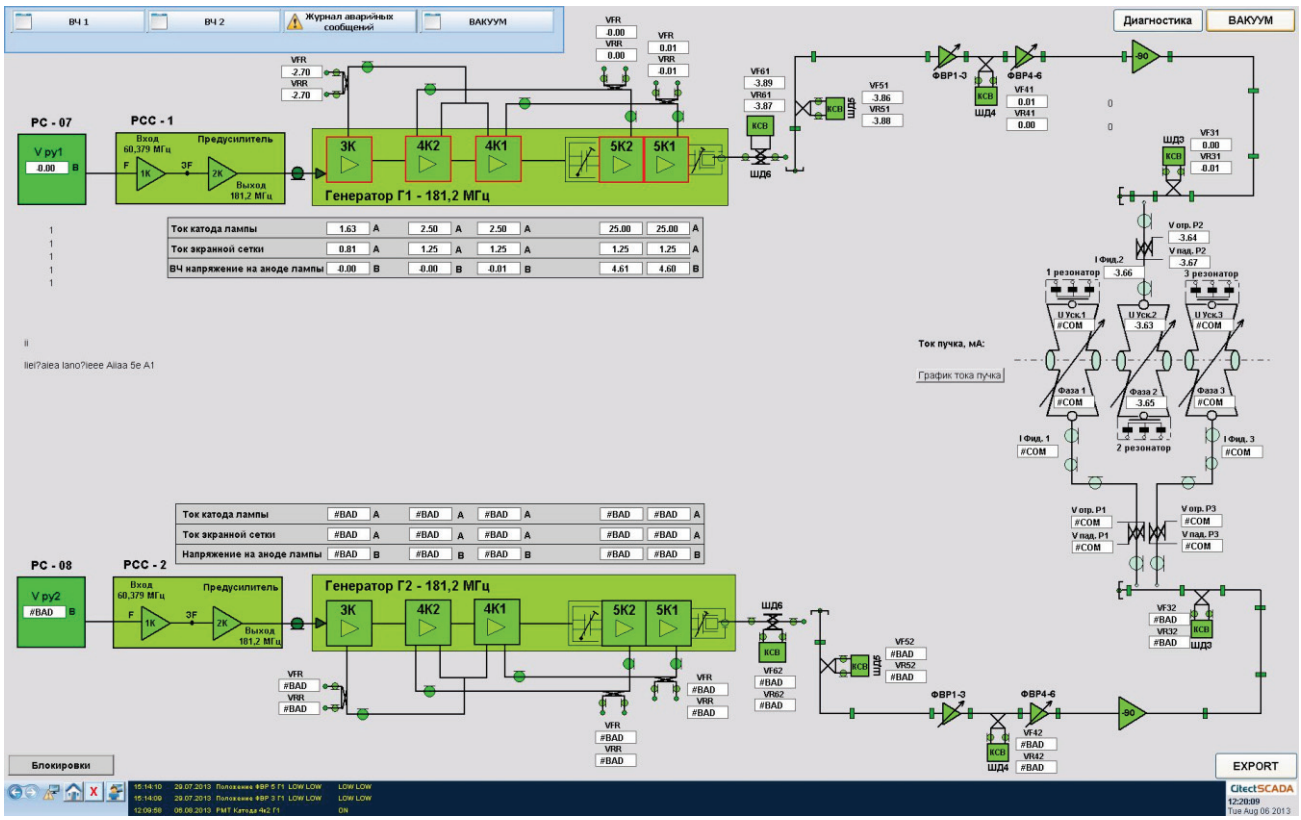

Figure 3: The video frame of functional diagram of RF-system of the main ring KSRS.

WORK IN PROGRESS

This upgrade of RF-system is a part of the project of modernization of KSRS control system. In the first phase is created test stand, which is designed to develop and debug software for local subsystems VME and CAN-bus equipment. [5] By the present moment the monitoring system of one RF-generator and one resonator is tested, collected and launched, the moment of tests is recorded on the circuit given above.

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