# MODERNIZATION THE MODULATORS KLYSTRONS ACCELERATING STAND OF THE ELECTRON LINEAR ACCELERATOR LINAK-800

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*Abstract*

The report presents the work on the modernization of the modulator klystron second accelerating station of the acceleration stand on the basis of electron linear accelerator LINAC-800. The analysis of the modulator first accelerating station and made suggestions for improving the management system modulator. The functional circuit blocks control the modulator.

## INTRODUCTION

Equipment for control of the modulator klystron 1-st accelerator accelerating station of the acceleration stand on the basis of a linear electron accelerator LINAC-800 was based on the so-called "hard" logic and provides a fixed control algorithm modulator.[1] Operational management of the klystron power level produced a local manual closing desired number of sections modulator (PFN modules). Also carried out manually switching frequency modulator battery life and modulator switching trigger from an external clock source. In the operation of the modulator identified the need provide both local manual control modulator and local indication of the state of the modulator, and the potential control modulator using computational tools and providing top-level to the top level of operational information section operation modulators.

To implement the requirements set forth above new algorithms have been developed management of the modulators klystrons of the accelerating stations the linear electron accelerator of the acceleration stand and new hardware requirements. They are as follows.

Instead, the pulse generator to the "hard" logic was applied management controller specifically designed for this task. Due to the need to develop specific requirements regarding management of the modulator, the implementation of the user interface and the input and output channels of information.

Instead, the control unit on the PFN "hard logic" used block-based 8-bit microcontroller.

To increase the reliability of electronic components and diminishing the amount of electronic components instead of discrete active components and chips low degree of integration applied chips with medium and high level of integration, applied to surface mounting technology instead of mounting holes. This reduced the size of the nodes, which reduced the level of interference from the pulse amplifier and improve noise immunity of the whole device.

To organize the cable connections between control units PFN and PFN modules was introduced patch panel, allowing to increase the reliability of connections and reduce errors when connecting modules.

For communication with the top management level was selected RS-485 interface. Selection of the interface due to the fact that the requirements on the speed of information exchange with the upper level is initially low (not more than several packets per second) on the one hand and on the other - to the requirements of simplicity and reliability of the interface RS-485 fully satisfies.

## FUNCTIONAL BLOCK DIAGRAM OF THE CONTROL MODULATOR

As a result, the control circuit is a modulator of a multiprocessor system with one master controller and several slave controllers (Fig. 1).

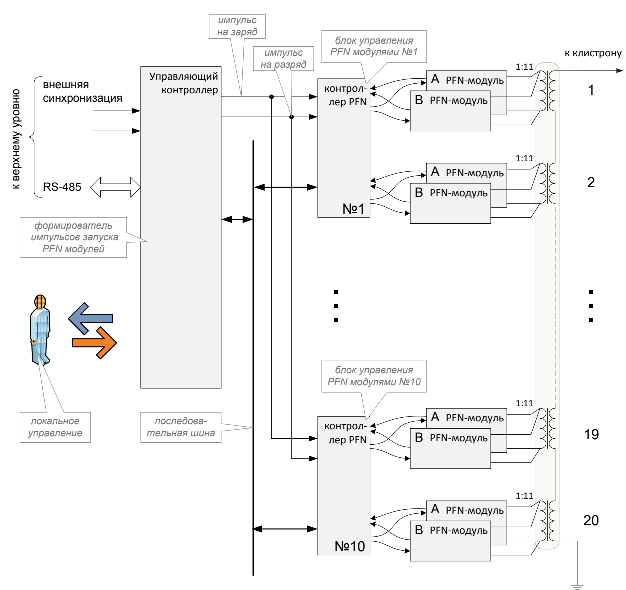


Figure 1: Functional diagram of the control unit modulator.

The control unit by a modulator consists of the control controller which generates pulses start modules PFN, and ten controllers PFN, which form the charge and discharge pulses modules PFN, PFN modules include team-master controller and the controller sends control information on the charging and discharging storage modules PFN. Operator on the master controller is set startup frequency modulator with local work or run mode from the external clock. Is defined as the number of units involved PFN to obtain the required RF power. Next, the master controller generates control pulses to the general charge and discharge of storage modules PFN and sends serial

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commands to turn on or off the required modules PFN. PFN controllers confirm their activation or deactivation, the impulse to run their modules PFN and on request of the control of the controller provide information on the real events charge and discharge of a particular module. PFN is controlled by the controller as a fact of physical cable connections to the modules PFN. In the master controller laid excess computing power for a possible modulator control system modernization. For the same purposes are reserved 8 input logic signals with levels 0..24V, 8 input logic signals with levels 0..5V 7 output logic signals with levels 0..5V and 8 analog signals that may be involved either directly or through additional normalizing signal conditioners.

## FUNCTIONAL OF THE PULSE START OF THE PFN-MODULES

Functional diagram of the pulse start PFN is shown below in Fig. 2. The microcontroller generates a local charge and discharge pulses drive the modulator controls the switch clock to supply pulses of charge (\ LTR) and discharge (\ OTR) for PFN either from its own clock, or galvanically separated from the external clock. Diagrams indicating pulses control the corresponding LEDs on the front panel. Character OLED display and encoder are also located on the front panel and provide operator feedback. Through the driver «serial TTL» microcontroller communicates with the slave controller PFN modules, and through the RS-485 driver microcontroller can communicate with the upper level. In the EEPROM stores the current settings and the settings of the control unit modulator, correction factors and other service information.

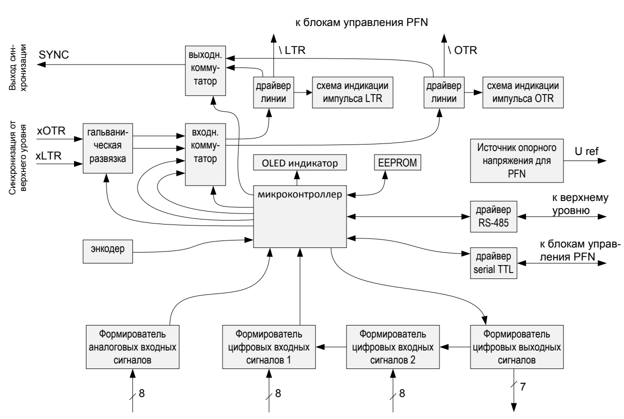


Figure 2: Functional diagram of the control of the controller.

## FUNCTIONAL DIAGRAM OF THE CONTROL UNIT PFN-MODULES

Functional diagram of the control unit PFN modules is shown below in Fig. 3. MCU control unit PFN modules enables or disables the pulse amplifier, run the module PFN. The microcontroller provides control of two pairs of PFN modules. The signals on the prohibition or authorization of the microcontroller module control unit PFN module receives from the master controller. Pulses supporting charging and discharging PFN module supplied to an amplitude discriminator is processed by microcontroller and serial controller transmits control on request. Also transmits information about the physical connection PFN modules. When the real presence of the pulse charge and discharge is displayed flashes of the LED display circuit pulses. It also displays the fact physical connection PFN module and enable signal operation.

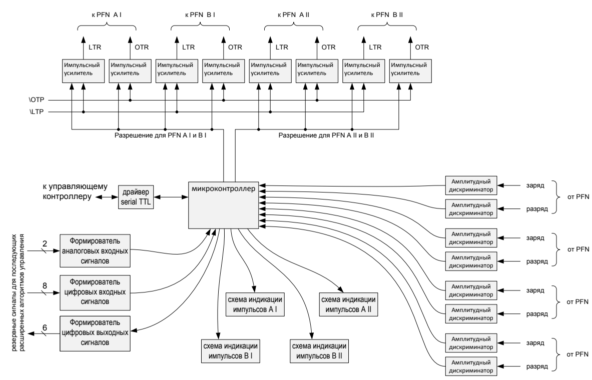

Figure 3: Functional diagram of the control unit PFN modules.

The output current of the accelerating section of the induction sensor and the measured Faraday (Fig. 3) cup energy through 45-degree bending magnet. Electron beam with a current of 5 mA was accelerated to an energy of 20 MeV. Further work continued to increase in the current and began assembling the undulator infrared. After installation of the undulator (Fig. 4) the accelerated electron beam was conducted through an undulator and outlet undulator registered the infrared radiation with a wavelength of 14 microns. Studies over the undulator radiation were stopped in order to continue the work on the second accelerator station. Was upgraded modulator the klystron second accelerating station mounted klystron and the waveguide system. Obtained working vacuum in the accelerating sections and waveguide tract (Fig. 5). Are currently under commissioning in the second accelerator station.

## CONCLUSION

As a result of this work has been offered a new concept of management of the modulator klystron, designed and created functional circuit control unit modulator. Are currently under commissioning at the modulator.

## REFERENCES

[1] N.I. Balalykin et al., Start modulator klystron VA938D 1-st accelerating station electron linear accelerator LINAC-800; JINR, Dubna, RuPAC 2012 Conf., S.-Peterburg.



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