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DEVICE OF REMOTE MEASUREMENT OF THE MODE OF OPERATION OF THE HEATER OF THE ELECTRON ACCELERATOR “LU-10”

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A device designed for continuous remote control of the parameters of the incandescent circuit of the electronic gun of the accelerator LU-10 has been developed. The created device allows to measure with galvanic isolation of electric quantities of operating voltage and current which are under potential of 5 kV relative the ground bus.

INTRODUCTION

The main feature of radiation-technological processes with the use of electron accelerators is the transfer to each unit of processed products the value of the absorbed radiation dose within the established limits [1]. Typically, the monitoring of radiation processing is carried out using technological measuring channels, through which information from the primary sensors is transmitted to the automatic workstation of the operator, and is displayed as graphical and numerical data on the display screen and entered into the electronic archive. The need for continuous remote control of the parameters of the incandescent circuit of the electronic gun is due to the fact that during operation of the accelerator there is a change in the parameters of the spiral, associated with the thinning of its diameter, especially when the vacuum is lost. The existing method of controlling the electrical parameters of the incandescence is to measure the supply parameters of the primary winding of the incandescent transformer and gives inaccurate results due to the low magnetic connection between the windings. This is due to the presence of an air gap to ensure the electrical strength of the transformer, the secondary winding of which is below the potential of 5kV.

PRINCIPLE OF WORK

The device was created using NRF24L01 wireless modules and STM32 microprocessors [2,3]. Figure 1 shows the functional diagram of the module NRF24L01, Figure 2 - its schematic diagram, Figure 3 - its appearance. The transmitting device is located in the hopper (see Fig.4), it is installed on the incandescent transformer and connected to the secondary winding. The measured voltage is used as a power source. A current transformer is used to measure the incandescent current. The range of voltage measurements is: 5-15 V; current strength: 1-20 A, which corresponds to the actual modes of operation of the filament. It is possible to expand the range of measured values, to reduce the limit of the measured voltage requires a converter, which increases whether the built-in battery.

The software for the operation of the receiving and transmitting modules is developed in the C programming language using the free development environment for STM microcontrollers - STM32CubeIDE, provided by STM. The current and voltage measured by the ADC, after additional processing by the microprocessor by the method of variable average to improve filtration, are transmitted to the receiving device.

The diagram of connection of the filament with the transmitting module is shown in Fig.4.

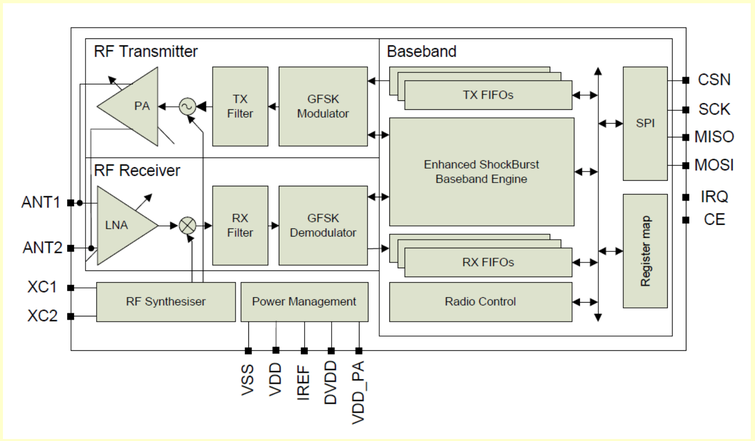

Fig. 1. Functional diagram of the nRF24L01 module.

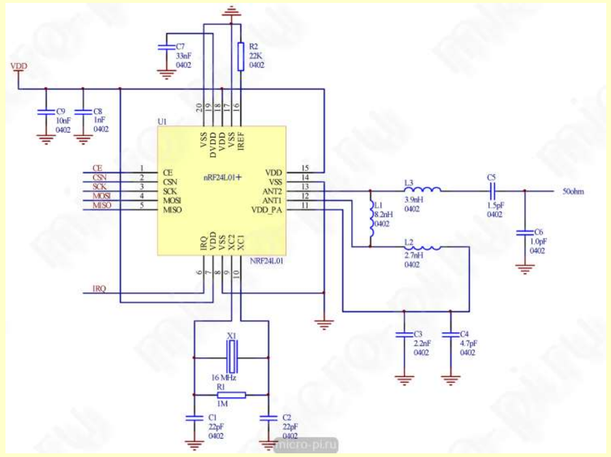

Fig. 2. Schematic diagram of the nRF24L01 module.

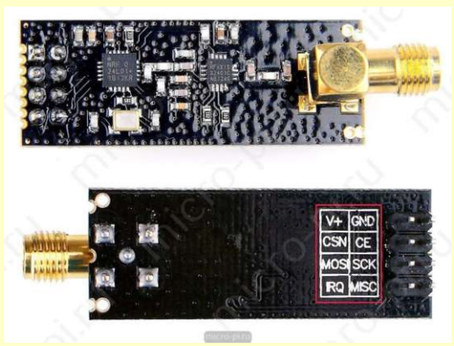

Fig. 3. Appearance of nRF24L01 modules.

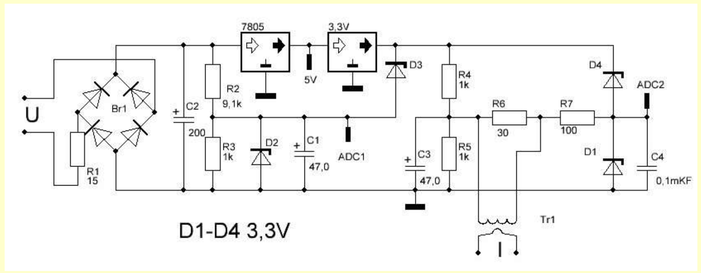

Fig.4 Diagram of connection of the filament with the transmitting module.

The receiving device (see Fig.5 and Fig.6) consists of a second wireless module, a microprocessor and a liquid crystal display, which displays the measured values of voltage and current, as well as the calculated resistance of the filament. Of interest is the reliability of the transmitting device operating at a potential of 5 kV relative to the ground bus. Data transmission is provided by wireless technology. Reception is possible before entering the premises of the operators of the accelerator LU-10 directly during operation under the beam.

Fig. 5. Transmitting module.

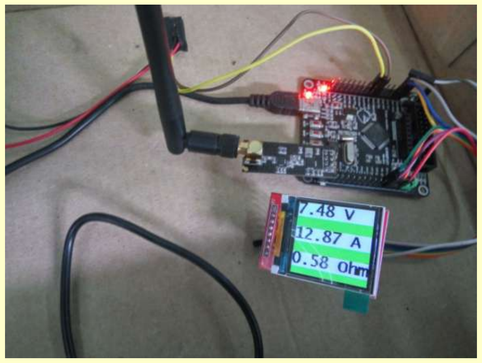

Fig. 6. Disassembled receiving module.

Fig. 7. Receiving module assembly.

CONCLUSIONS

Continuous remote control of the parameters of the incandescent circuit of the LU-10 accelerator injector is necessary to ensure the specified radiation characteristics. Validation of the created device within 10 months as a part of a radiation-technological complex on the basis of the LU-10 accelerator showed its reliable uninterrupted work and possibility of use on a constant basis. In the near future, the device is expected to be used as part of an automated control system of the radiation-technological complex based on the LU-10 accelerator.

REFERENCES

1. Standard ISO 11137-2006. Sterilization of health care products - Radiation sterilization.
2. nRF24L01 + Single Chip 2.4GHz Transceiver Preliminary Product Specification. https://www.sparkfun.com/datasheets/Components/SMD/nRF24L01Pluss_Preliminary_Product_Specification_v1_0.pdf
3. STM32 programming. NRF24L01. Data transfer. https://narodstream.ru/stm-urok-105-nrf24l01-peredayom-dannye-chast-1/