Generator of the form of accelerating voltage and currents for tubes Booster's RF system

Ganyushkin Fedor

VBLHEP, JINR

14.06.2024

Introduction

The NICA (Nuclotron based Ion Collider fAcility) accelerator complex is being developed at the Joint Institute for Nuclear Research to study the characteristics of dense baryonic matter. The injection part of the complex includes the Booster and Nuclotron synchrotrons.

The development of the device is part of a cycle of work to improve the injection complex, in particular the improvement of the accelerating systems of the collider injection chain.

Device requirements:

➤ Automation of the RF system setup process;

➤ Time accuracy of accelerating voltage setting (up to 0.1 ms);

➤ Keep human intervention to a minimum to reduce the chance of failure;
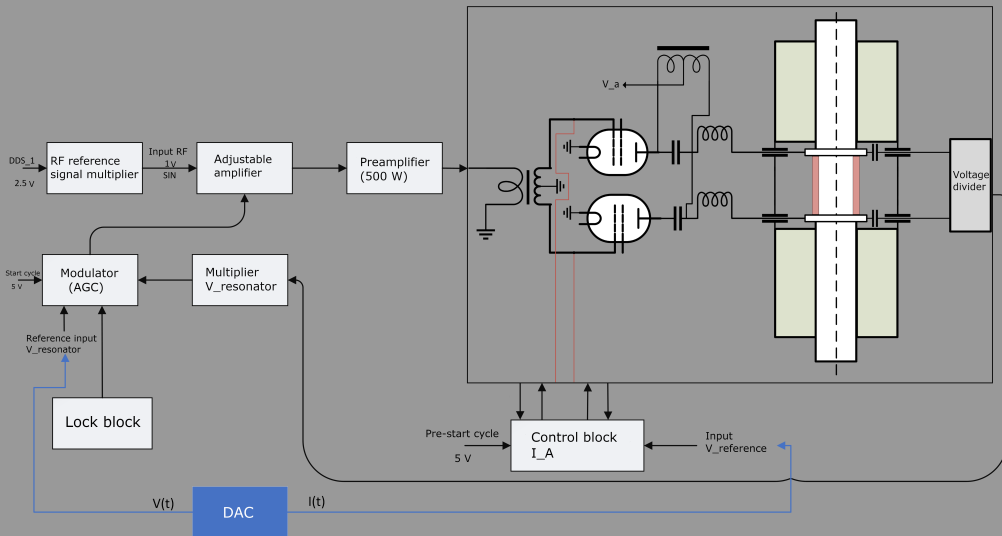
➤ Ease of use.

RF system

Figure 1: Scheme of Booster's RF system.

Device

1. The ADC digitizes the derivative of the magnetic field;
2. The microcontroller sends the received array to the computer using the TCP/IP protocol;
3. The program processes the array and sends voltage and current arrays to the microcontroller;
4. The microcontroller triggers two DACs based on the start pulse.
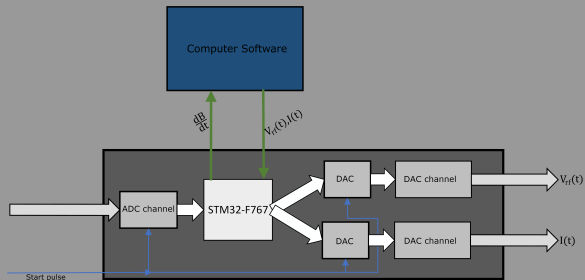

Figure 2: Scheme of Booster's RF system.

Device

The **ADC** channel digitizes the acceleration cycle magnetic field derivative signal and sends it to the microcontroller.

Two **DAC** channels set the form (envelope) of the sine of the accelerating voltage and current in the amplifier tube tetrodes.

ADC:
- ✧ Frequency: 10 kHz
- ✧ Bit depth: 8 bits
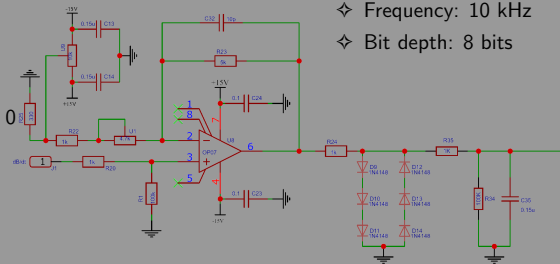
Figure 3: Analog-to-Digital Converter channel.

DAC×2:
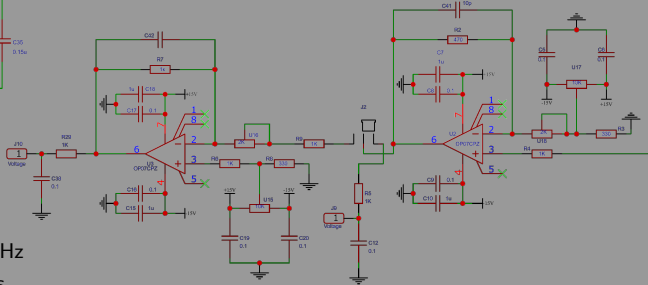- ✧ Frequency: 10 kHz
- ✧ Bit depth: 8 bits

Figure 4: Digital-to-Analog Converter channel.

Software

The main feature of the program is the search for **the beginning of an increase in the derivative of the magnetic field** in order to synchronize the accelerating voltage with the magnetic field in the dipole magnets.
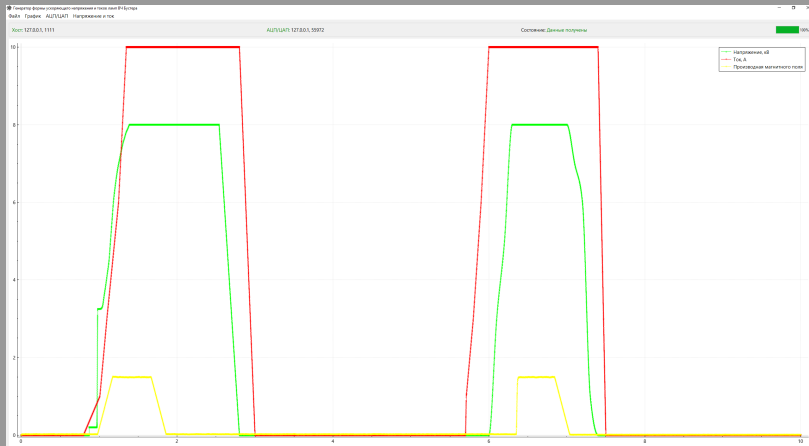

Figure 5: Main interface of the software.

Software

Digital filters used:

- ✧ Running average filter with adaptive coefficient $\times 2$;
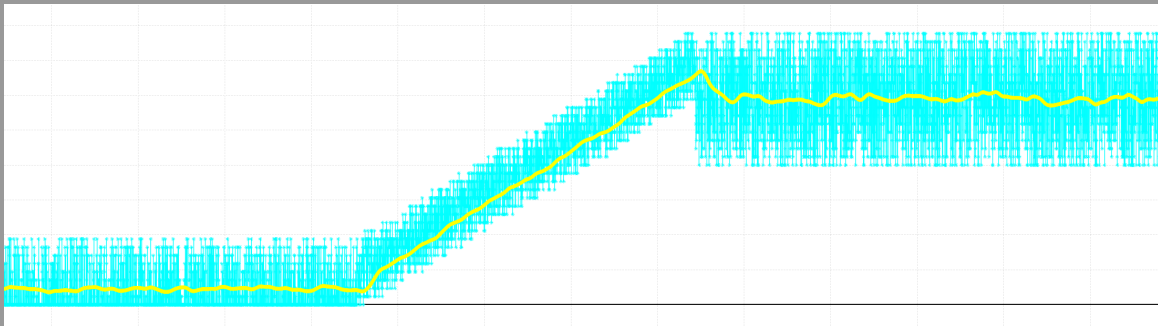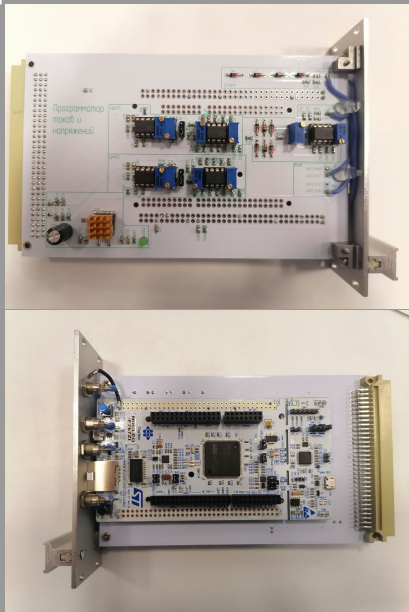- ✧ Filter by stretched arithmetic mean.

Figure 6: Example of using digital filters to remove noise.

Complete device

Thanks for your attention!