THE PULSED HIGH VOLTAGE POWER SUPPLY FOR THE NICA BOOSTER INJECTION SYSTEM

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Abstract

Three pairs of electrostatic deflecting plates will be used in the injection system of booster ring. The electric circuit and design of the power supply system for one plate are presented in the report. The experimental results of testing are also presented.

INTRODUCTION

The NICA ion collider [1] is currently under construction at Joint Institute for Nuclear Research. The booster of the main accelerator NUCLOTRON is used for initial acceleration and cooling of ion beams.

Electrostatic septum and three deflecting devices will be used in the booster injection system [2]. Electric plates are used as actuating elements. Hydrogen thyratrons are used as switches.

PARAMETERS OF ELECTRIC PULSES

The number of supplied plates and amplitude of applied voltages depend on type of injection [2]. All electrical plates are supplied with identical pulses that differ in amplitude of the applied voltage. Main parameters of electric pulse with maximum amplitude are shown in Table 1.

Table 1: Main Characteristics of Electric Pulse

Maximum electrical potential on the plate	60 kV
Duration of pulse plateau at least	30 us
Nonuniformity of voltage on the plateau	≤ 1%
The discharge time	≤ 0,1 us
Residual voltage	≤ 0,5 kV

The parameter values given in Table 1 are generally achieved without major difficulties except for residual voltage value.

To reduce residual voltage and improve reliability of high voltage components, it was decided to use a pulse charging.

The conceptual version of such scheme was tested and results were published [3]. Then the parameters of main elements were optimized and device was designed and manufactured.

THE POWER SUPPLY SCHEME AND DESIGN

PSPICE model of the power supply circuit is presented in Fig.1.

The initial pulse of the thyristor generator is applied to the primary winding of the step-up transformer. We use industrial measuring transformer GE-36. Thyratron is triggered near the top of the pulse when the current in the primary winding of the transformer crosses zero value.

The discharge chain C_1, R_2-R_3 maintains the discharge current through the thyratron in a few tens of microseconds, thereby preventing fast afterpulses. Slow processes are suppressed by leakage of charges through the secondary winding of transformer. Besides that the reversal magnetization of the transformer produces negative potential of several tens of volts at the diode set.

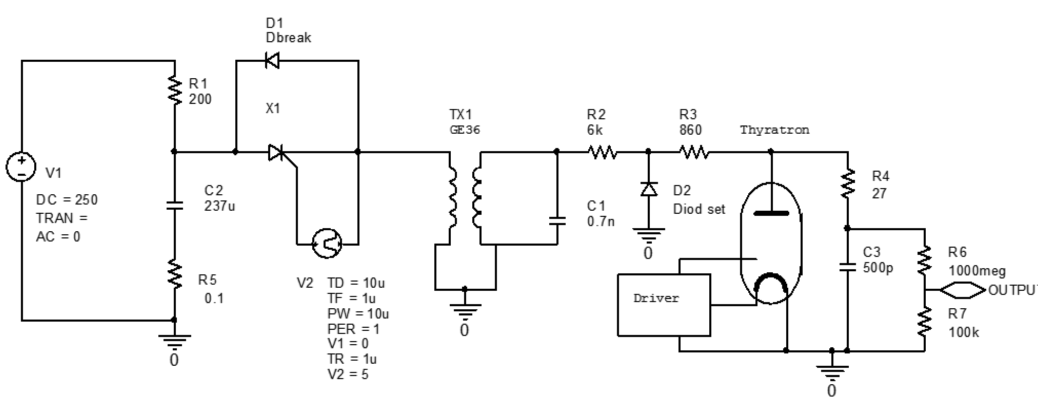

Figure1: PSPICE model of the power supply circuit. C_3-equivalent load, R_6-R_7 – divider VD-60

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This variant of scheme was designed and manufactured. The view of device is presented in Fig.2.

Figure 2: The photo of device at testing bench.

This pulse power supply was tested at different output voltages up to maximum working parameters. The oscillograms are presented in fig.3.

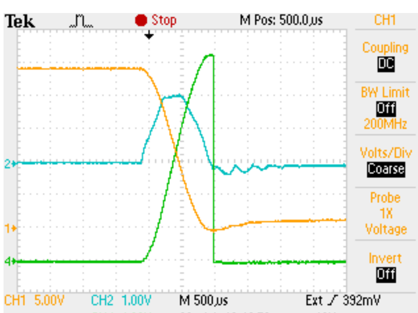

Figure 3: Measurement results. Voltage (10 kV/div) at the equivalent capacitance (green), input current (40 A/div) of the transformer (blue) and voltage at C_2 (50 V/div).

CONTROL SYSTEM INTEGRATION

The power supply is controlled by system based on National Instruments hardware – CompactRIO [4] controller with few acquisition modules for analog and digital input and output, CAN interface module and FPGA for timing control.

The control unit communicates with NICA control system by means of TANGO Controls [5] device servers and provides synchronization with the booster injection and setting of power supply parameters.

CONCLUSIONS

The pulse power supply for deflecting plate was developed, manufactured and tested at working parameters. The test results put in a strong performance. The device is ready to use at booster injection system.

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