

180 MW/180 kW PULSE MODULATOR FOR S-BAND KLYSTRON OF LUE-200 LINAC OF IREN INSTALLATION OF JINR

Kim Dong Su^a, A. P. Sumbaev^{b,1}, V. N. Shvetsov^b

^a Dawonsys Co., LTD, Siheung City, Korea

^b Joint Institute for Nuclear Research, Dubna

The offer on working out of the pulse modulator with 180 MW pulse power and 180 kW average power for pulse S-band klystrons of LUE-200 linac of IREN installation at the Frank Laboratory of Neutron Physics (FLNP) at JINR is formulated. Main requirements, key parameters and element base of the modulator are presented. The variant of the basic scheme on the basis of 14 (or 11) Stage 2 Parallel PFN with the thyatron switchboard (TGI2-10K/50) and six parallel high-voltage power supplies (CCPS Power Supply) is considered.

Сформулировано предложение по разработке импульсного модулятора с импульсной мощностью 180 МВт и средней мощностью 180 кВт для клистронов 10-см диапазона ускорителя ЛУЭ-200 установки ИРЕН Лаборатории нейтронной физики ОИЯИ. Приведены основные параметры и требования к модулятору, его элементной базе. Рассмотрен вариант принципиальной схемы на основе формирующей линии (14 Stage 2 Parallel PFN) с тиратронным коммутатором (TGI2-10K/50) и источником питания высокого напряжения инверторного типа (CCPS Power Supply).

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The S-band klystrons are used as RF power supply forming 4- μ s length's impulses in the linear electron accelerator LUE-200 [1, 2] of the Frank Laboratory of Neutron Physics of JINR. The parameters of klystrons that are used or can be used as adequate to the requirements for pulse RF and average RF power are presented in the Table. As seen from the Table, impedances of the presented klystrons are within the range of ≈ 800 –880 Ω .

Klystron	Pulse power, MW	Beam voltage, kV	Beam current, A	Impedance, Ω
E3730A Toshiba	50	320	360	888
E3712A Toshiba	80	400	488	820
E37317 Toshiba *	50	350	414	845
Hubei Hanguang Technology Co., LTD, China	65	350	415	843
5045 SLAC	60	350	400	875

* Klystron is being developed.

¹E-mail: sumbaev@nf.jinr.ru

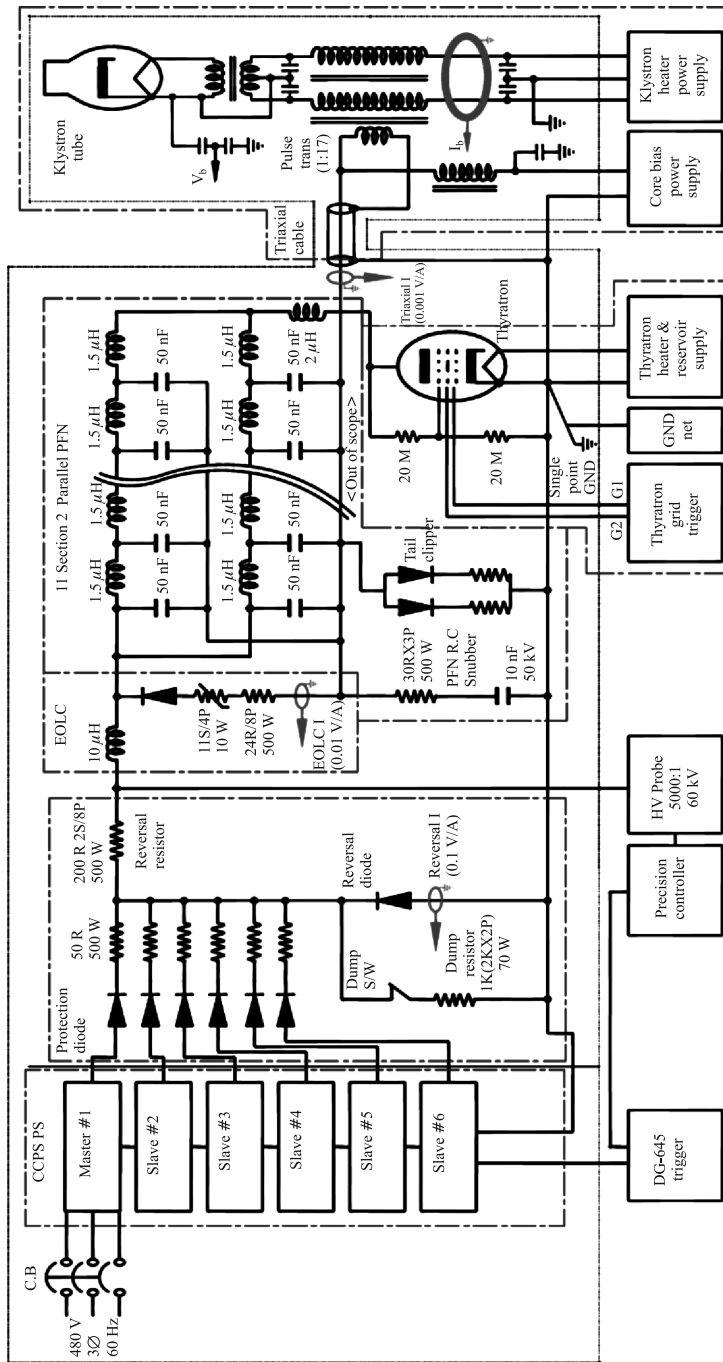


Fig. 1. Principle circuit of the modulator

The distinctive feature of the new modulator powering klystrons with a high-voltage impulse will be its capability of working with the load, whose value can vary depending on the type of klystron having its impedance within the range of 800–880 Ω . The principle scheme of a modulator based on two parallel PFN of 14 (or 11) stages made of capacitors with the capacitance $C_c = 50$ nF and inductors with the inductance of $L_c \approx 1.5$ μ H is presented in Fig. 1. The conventional klystron with the parameters close to the parameters of klystrons given in the Table is used as a load in the circuit.

High-voltage power supplies of inverter type (CCPS Power Supply) produced by Dawon-sys were used for charging PFN. Six power supplies of 50 kV/30 kW are connected in parallel with the single control by one of them.

The simulated diagrams of charging voltage and charging current of PFN for two cycles of charging are given in Fig. 2. The simulated diagrams of voltage and current on the load are presented in Fig. 3. Thus, the possibility of generating pulse voltage at the powerful klystron with the required parameters with repetition rate up to 120 Hz is proven by simulation.

Two PFN consist of the high-voltage pulse condensers of CSI Technologies, Inc. (USA), possessing a substantial resource of charging — discharging cycles up to $6 \cdot 10^{11}$.

For a possibility of fine tuning of wave resistance in PFN the inductors with changeable inductance are used. The sketch of such an inductor is presented in Fig. 4.

The value of inductance of every inductor is defined by the value of the load impedance and can be arranged roughly in the range from 0 to 3.89 μ H by change of number of turns in the inductor, or to be arranged smoothly in the range of ± 0.5 μ H by means of the tuning cylinder entered into inductor.

Thyratron TGI2-10K/50 (design and production of «Pulsetech», Ryazan, Russia [3]) having necessary working parameters — working voltage to 50 kV, pulse current to 10 kA, average current to 10 A — is planned to be used as a switchboard.

Prototyping PFN assembled by capacitors K75-35 with the capacitance $C_c = 2 \times 24$ nF with the thyratron TGI2-10K/50 in the regime close by parameters to the working regime of a modulator at repetition rate 1 Hz has been carried out at the testing stand of the Veksler and Baldin Laboratory of High Energy Physics of JINR for verifying the proposed principle solutions.

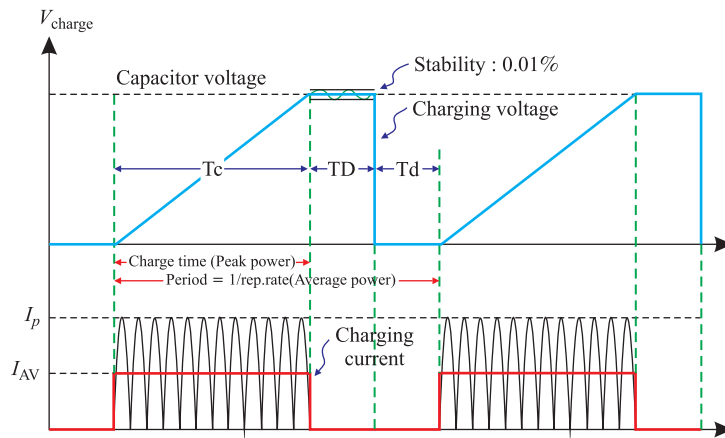


Fig. 2. Diagrams of charging voltage and charging current (simulations)

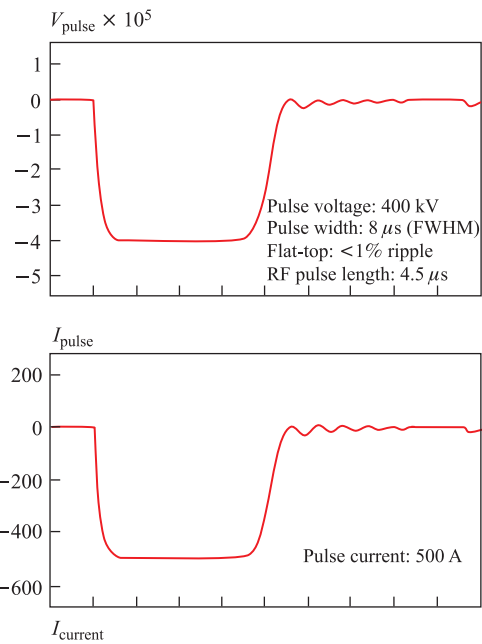


Fig. 3. Diagrams of pulse voltage and pulse current (simulations)

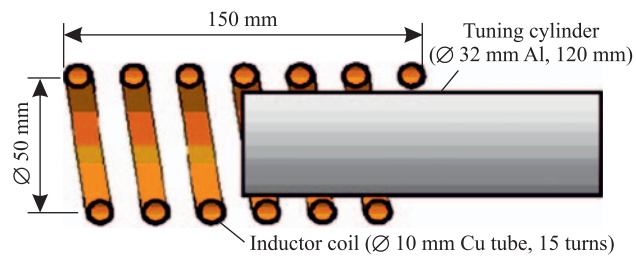


Fig. 4. Scheme of inductor with variable inductance

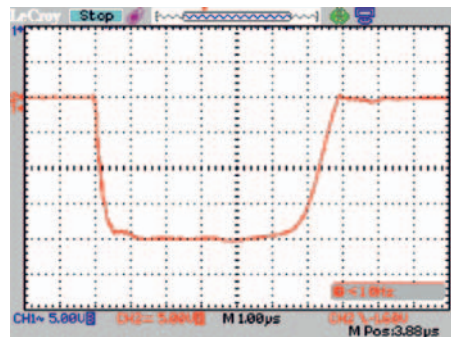


Fig. 5. The current oscillogram on PFN exit coordinated with resistive load at prototyping on the full-scale high-voltage test stand

The current oscillogram on PFN exit coordinated with the resistive load $R = 3 \Omega$ is presented in Fig. 5. The load current is 6 kA. In the next tests the increase in current on the load (and on thyatron) to 8.5–9.0 kA is planned and it will fully correspond to the working regime of a modulator by current.

CONCLUSION

The principle possibility of production of a powerful impulse modulator with the parameters needed for powering klystrons with the output pulse RF power of 50–60 MW has been verified by simulation and prototyping.

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