

THE SOLID-STATE GENERATOR FOR DIRECT PUMPING OF A CUBR LASER WITH THE ADJUSTABLE PULSE SHAPE*

P.P. GUGIN¹, E.O. DEGTYAREV^{1,2}, V.A. KIM¹

¹Institute of Semiconductor Physics, Siberian Branch, Russian Academy of Sciences, pr. Akademika Lavrent'eva 13, Novosibirsk, 630090, Russia, gugin@isp.nsc.ru

²Novosibirsk State Technical University NETI, 20 Prospekt K. Marksa, Novosibirsk, 630073, Russia

To replace pulsed thyratrons and powerful generator vacuum tubes, the adjustable pulse shape generator based on MOSFET is proposed for CuBr-laser direct pumping by a longitudinal discharge.

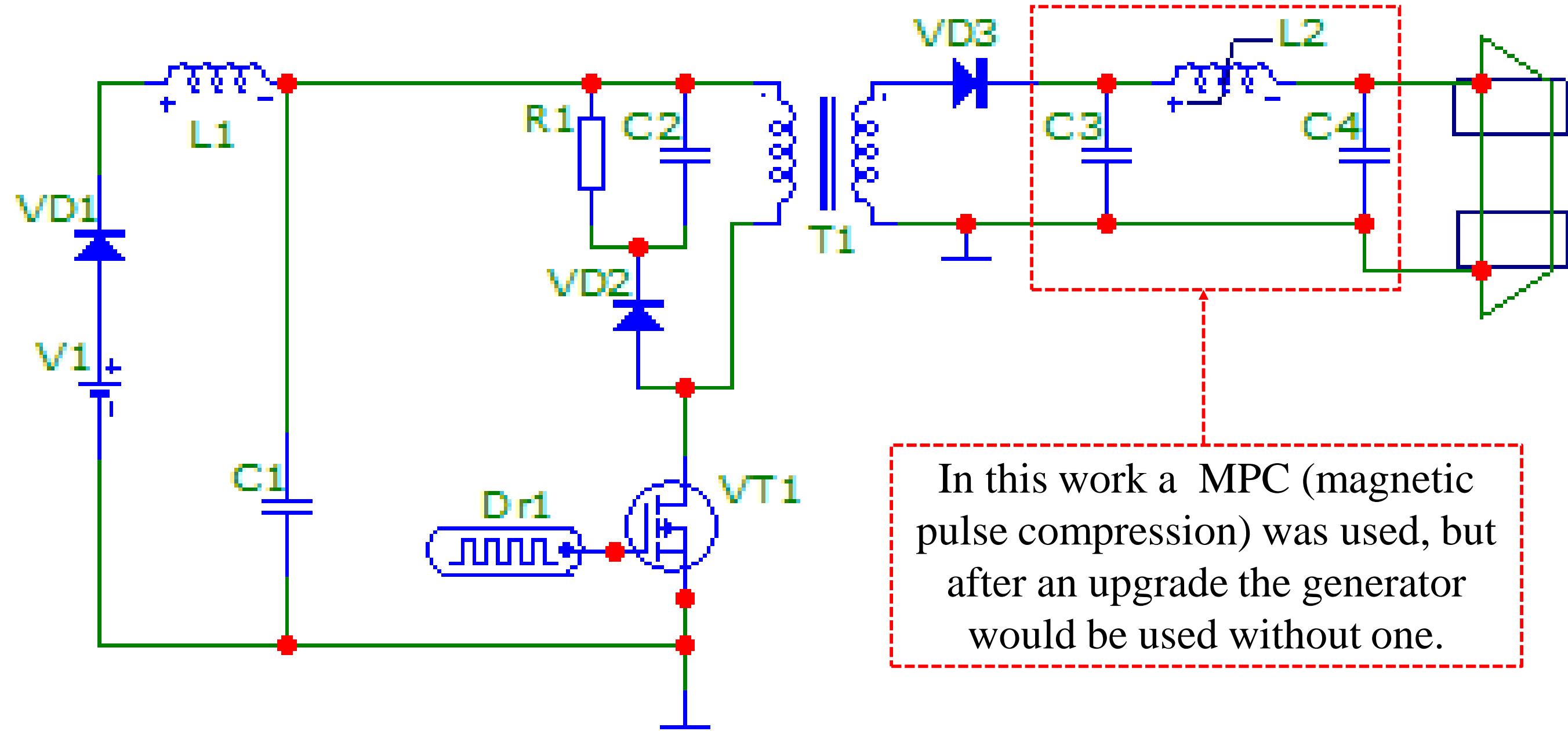


Fig. 1 — Simplified generator circuit

Generator characteristics:

- voltage up to 10 kV;
- current up to 200 A;
- pulse duration 100-200 ns;
- front and back edge of impulse less than 40 ns ;
- current slew rate at the level of 1,5 – 1,7 A/ns per each transistor.
- frequency at least 10 kHz

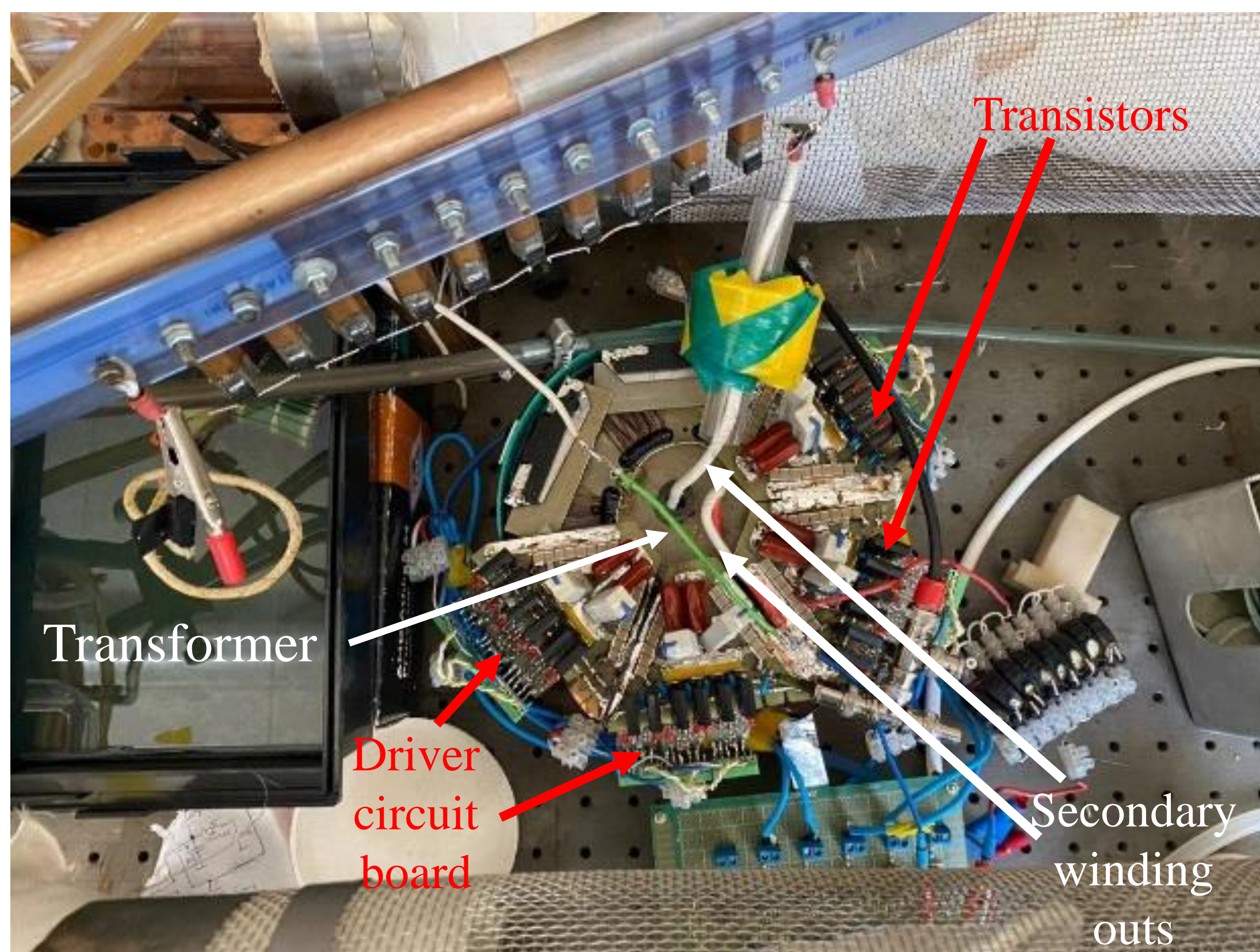


Fig. 2

Main generator features:

- One-turn primary winding transformer with low leakage inductance, which is ensured by the design of transformer. The primary winding of the transformer consists of one turn and is distributed around the entire perimeter of the transformer core. The secondary winding consists of several parallel sections to increase the coupling coefficient of the windings with sufficient electrical insulation.(Fig. 4)
- Parallel connected 48 transistors (STW57n60M2-4: max drain current (pulsed) $I_{DM}=208A$) work synchronously; the advantage of this connection is the operation of transistor at their rated voltage in contrast to serial connection
- The optimization of topology of transistor driver's current loop and the symmetrical distribution of the control signal with its electromagnetic filtering made it possible to ensure safe current slew rate through each transistor at the level of 1,5 – 1,7 A/ns.
- Ability to change the number of transistors depending on the task performed
- Ability to increase the maximum output voltage by serial connection of the secondary windings of transformer (Fig.3)

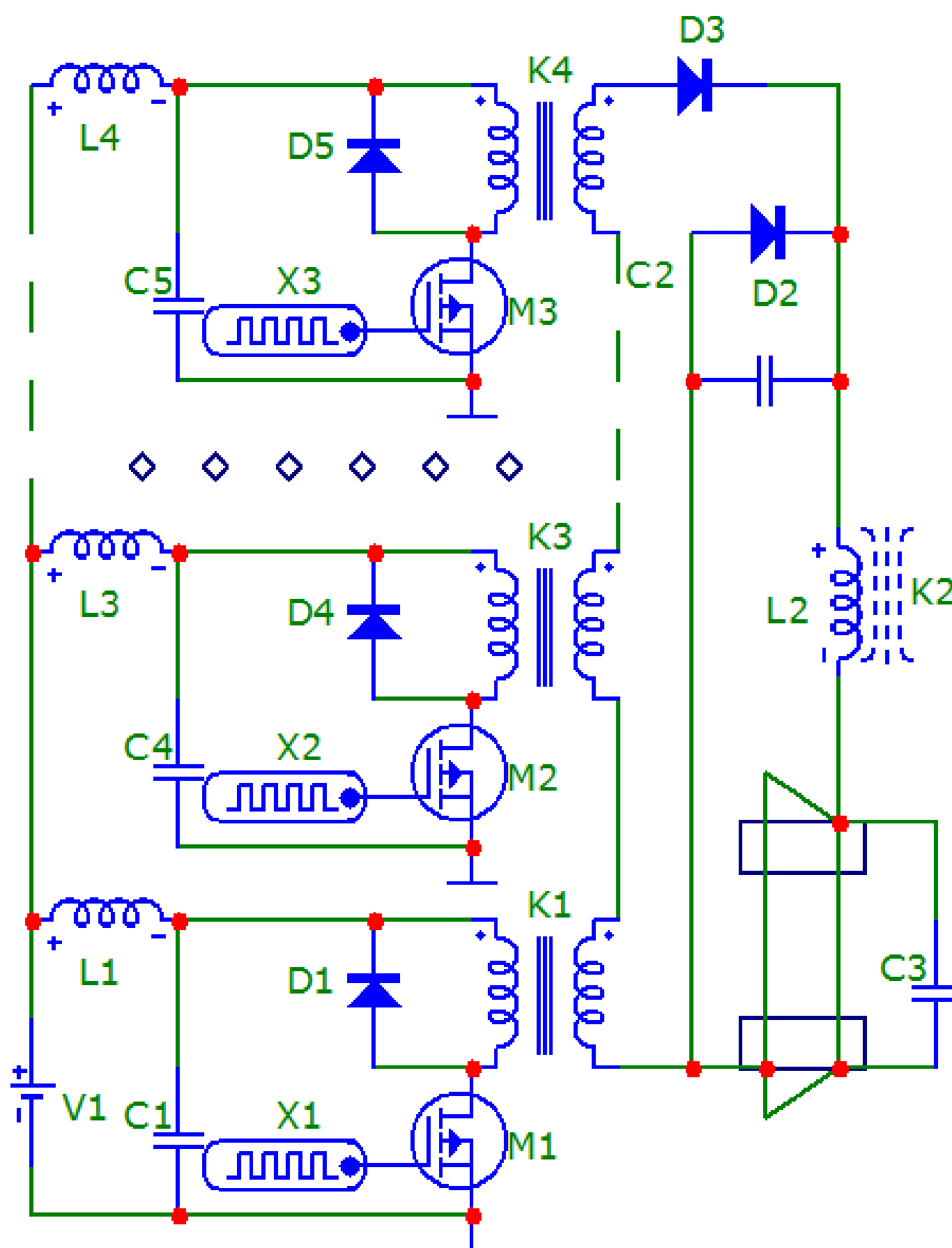


Fig. 3

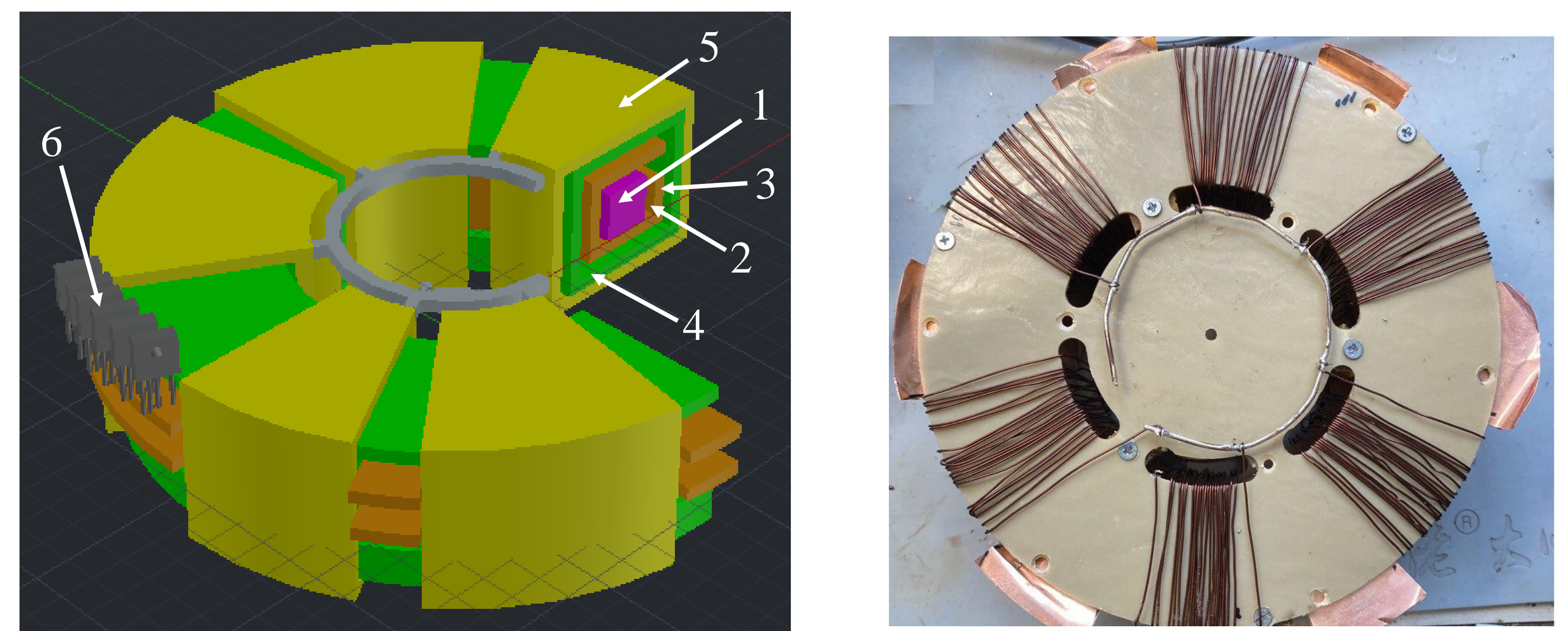


Fig. 4 — Transformer design:

- a) 1 – transformer core (3C11 ferroxcube); 2 – insulation made of teflon tape; 3 – primary winding; 4 – the transformer secondary winding frame; 5 – secondary winding; 5 – transistors
 б) photo of the transformer: top view

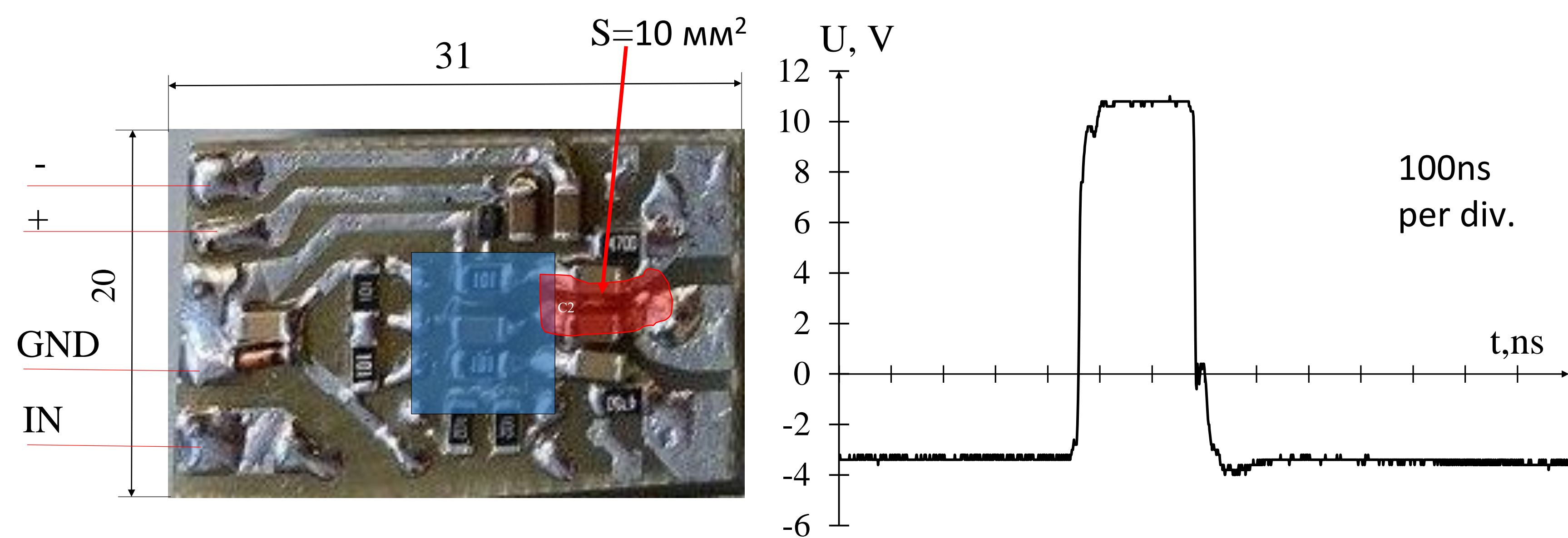


Fig. 5 — Driver PCB

(blue polygon - area of the driver chip; red polygon - gate current loop area)

Fig. 6 — Voltage across the gate of the transistor at the input voltage range from 0 to 12 V

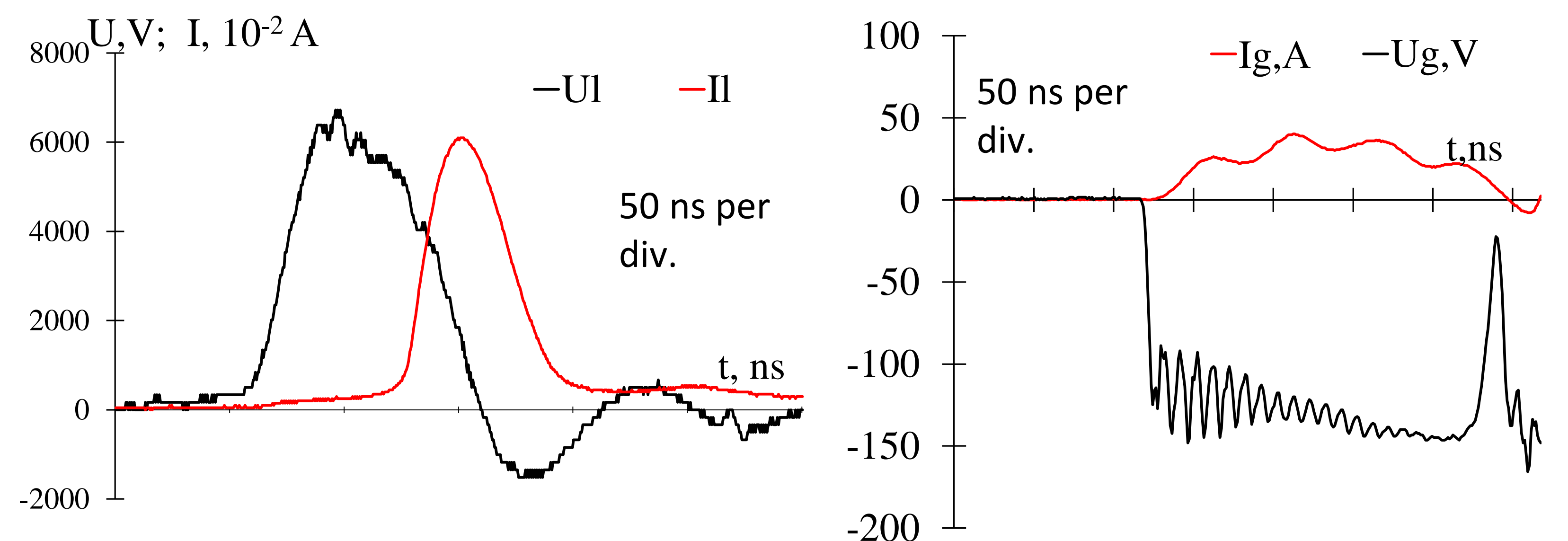


Fig. 7 — a) oscillograms of voltage across the load and current at an inductance-active load
 б) oscillograms of voltage across the transistor and current at transformer outputs

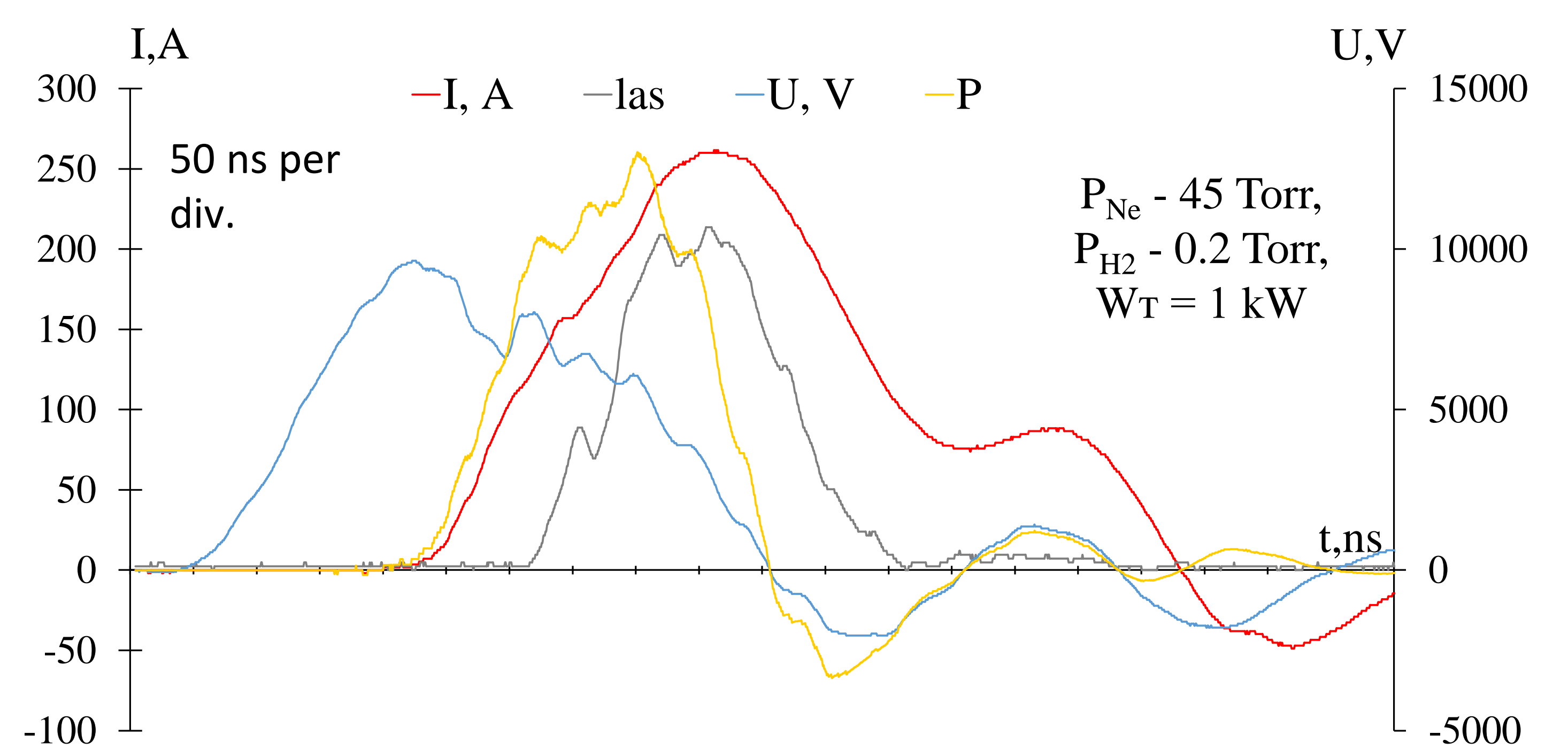


Fig. 8 — Oscillograms of the laser pulse, current and voltage across the tube

Conclusion :

- The solid-state generator for direct pumping of a CuBr laser with the adjustable pulse shape has been developed, which completely replaces generators based on rare used today base (pulsed thyratrons and powerful generator vacuum tubes)