DEVELOPMENT AND TESTING OF ELECTRONIC DEVICES PROVIDING FUNCTIONING OF HIGH-CURRENT SWITCHING EUQIPMENT FOR THE iter POWER SUPPLY SYSTEM

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With the ITER tokamak in operation, it is necessary to commutate high DC currents both for generation of the plasma at the beginning of each cycle and for protective energy discharge in case of quench in the superconducting coils. To solve these problems a wide range of devices using different switching principles, schemes and methods has been developed at the NIIEFA.

One of the key components of the system is the Pirobreaker with its unique combination of switching characteristics. This switch is triggered by explosion of an electric detonator, for which purpose it is necessary to generate a current pulse more than 600 А in amplitude with duration of 300 ns and rise rate no less than 3×109 А/s. Besides, it is necessary to provide a galvanic isolation of the generator output from the ground potential for 28kV RMS, 50Hz testing voltage.

The generator is made by the scheme of high-frequency high-voltage resonant converter. Power section of the generator consists of a full-bridge feedback oscillator operating on the primary winding of an air transformer, and a high-voltage high-frequency diode bridge which rectifies the voltage appeared on a resonance circuit, consisting of the secondary winding and capacitor.   
The bridge output charges a storage capacitor which is connected in parallel with a spark gap and the electric detonator.

The generator operation principle is as follows: upon receipt of an external signal the control circuit generates a start-up signal for the oscillator with the result that the storage capacitor starts charging till a breakdown voltage of the spark gap (~ 2.5 kV), whereupon the capacitor is discharged through the spark gap on electric detonator bridge.

This scheme ensures the required current value and rise rate. As the storage capacitor is located close to the electric detonator, the inductance of the connection circuits is essentially reduced (as well as the value of stored energy) and, hence, the dimensions of the generator are less than in schemes with pre-stored energy. The other important advantage is that the active elements of the generator operate at nominal currents and voltages in opposite to the regime of surge currents.

Besides, the system of secondary power supply has been developed for devices placed at a high potential with a galvanic isolation for 28kV RMS, 50Hz testing voltage. The system consists of a power supply unit generating 5А, 50kHz stabilized sinusoidal current, which flows through a closed current loop with energy receivers installed around it. The number of receivers varies from 1 to 5. The sinusoid was chosen in order to reduce the spectrum of interferences radiated by the loop. Each receiver produces a voltage of 24 V with a power of 5 W. The receivers are based on pulse-width modulation (PWM) stabilization.

The developed devices have successfully passed a lot of tests, the results of which have completely confirmed the conformance of the obtained parameters to the requirements of the technical specification.