OPERATION OF MULTI-GIGAWATT MAGNETIC COMPRESSION LINES

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Non-linear transmission lines (NLTL) filled with saturated ferrite are used as solid-state sources of high-power microwave oscillations [1]. Application of a pulse magnetic field orthogonal to bias constant magnetic field in time less than the relaxation time, leads to the precession of the magnetic moment vector and generation of voltage oscillations across the NLTL output. Recently NLTLs also have been used to increase the peak power of picosecond unipolar pulses in the multi-gigawatt power range [2-3]. Such kind of NLTLs is called Magnetic Compression Line (MCL). Shortening the duration of the input voltage pulse made it possible to obtain only one oscillation at the line output instead of several oscillations. The highest peak power achieved with the MCL is 77 GW with the voltage amplitude of 1.93 MV and pulse duration of 105 ps [3].

In this paper, we numerically study the mechanism of MCL operation. The simulation was carried out using the Maxwell equations and the Landau-Lifshitz equation, which describe the dynamics of the electromagnetic field and magnetization, respectively. It has been found that the MCL regime is realized under the condition when the precession period of the magnetic moment is less than 2 T_0, where T_0 is the electromagnetic wave travel time between the inner and outer conductors of the line (2 T_0 is equal to the period of the H_{01} wave in coaxial line).

The formation of waves of the H_{01} type limits the width of the output pulse to a value close to $2\ T_0$. Several periods of precession are located within the output voltage pulse. Such a mode can be called a multiwave mode with a cutoff, in contrast to the classical mode [1], in which one period of precession corresponds to one period of voltage oscillations.

The studies have shown that the input pulse amplification in power has its maximum value when an input pulse width is around of 4 T_0. While moving along the MCL, the input pulse splits in two peaks and then the energy is redistributed in favor of the first peak [2]. This effect is due to the fact that several periods of precession are located within the first and second peaks, and their number and frequency change during the movement.

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