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Abstract

The second harmonic gyrotron traveling wave amplifier (gyro-TWT) is a high-power, broadband, millimeter-wave amplifier with a low applied magnetic field. The mode exhibits the lowest ohmic dissipation in previous gyro-TWT experiment. Moreover, it’s field peaks at a radial position of half the waveguide radius, so the quality of electron beam isn’t degraded. However, operating of the high current, the output power, gain, and efficiency of gyro-TWT will be degraded where the absolute instability, gyrotron backward oscillation (gyro-BWO) and reflective oscillation occur to cause mode competition. Stability issues comprise the key factors limiting the performance of the gyro-TWT. The multi-stage structure with losses section was shown to be effective in suppressing absolute instability. Moreover, the severed section to decrease interaction length of gyrotron backward oscillations in effect. Therefore, the multi-stage interaction structures with losses and severed structure were more stability for absolute instability and gyrotron backward oscillations. This study presents a nonlinear analysis of typical oscillations, including absolute instability, gyrotron backward oscillation (gyro-BWO) and reflective oscillation. The multi-stage gyro-TWT seem to increase effectively the start-oscillation currents of the absolute instability, gyro-BWO, and reflection oscillation. The multi-stage gyro-TWT is predicted to yield a peak output power of 215 kW at 89.9 GHz with an efficiency of 14.3 %, a saturated gain of 60 dB and a bandwidth of 1.7 GHz for a 100 kV, 15 A electron beam with an axial velocity spread .
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