The mode analysis in a klystron-like relativistic backward wave oscillator (RBWO) with a transverse dimension to free-space wavelength about four is presented. The particle in cell simulations with a 2.5-D full electromagnetic code reveal that microwaves with power of 1.75 GW, frequency of 13.7 GHz are generated with efficiency of 42% when diode voltage is 380 kV, beam current 11 kA, and magnetic field 0.48 T. In the beam-wave interaction region, the electron beam interacts with TM\textsubscript{01} surface wave and TM\textsubscript{04} volume wave simultaneously, and in the output waveguide region, the main mode is TM\textsubscript{03} mode. Then the overmoded klystron-like RBWO is simulated by the 3-D code. When the uniform electron emission model is used, the operation modes are axially-symmetric, the generated microwave power is 1.65 GW and frequency is 13.7 GHz, consistent with those obtained in 2.5-D simulation. However, when random electron emission model is used, the output modes is axially-asymmetric, mainly TM\textsubscript{51} mode, and the power and frequency are 1.07 GW and 14.7 GHz, respectively. Since both the corrugation waveguide and the transverse cross-section of the electron beam are symmetrical, the origin for excitation of these asymmetric modes is axially-asymmetrical initial rf noises in the electron beam, which can be partly suppressed by an externally injected axisymmetrical microwave signal with frequency of 13.7 GHz prior to the TEM voltage wave. For an externally injected microwave power of 10 MW, the axisymmetrical modes are excited first, then the asymmetrical modes, mainly TM\textsubscript{22} mode in output waveguide, gradually develop and dominate, and the generated power decreases from 1.5 GW to 0.64 GW slowly. Increasing the injected microwave power is beneficial for increasing the duration of axially-symmetric mode.