Low Starting Electron Beam Current in Degenerate Band Edge Oscillators

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***Abstract*— We propose a new principle of operation in vacuum electron-beam-based oscillators that leads to a low beam current for starting oscillations. The principle is based on supersynchronous operation of an electron beam interacting with four degenerate electromagnetic modes in a slow-wave structure (SWS). The four-mode supersynchronous regime is associated with a very special degeneracy condition in the dispersion diagram of a cold periodic SWS called degenerate band edge (DBE). This regime features a giant group delay in the finite-length SWS and low starting-oscillation beam current. The starting beam current is at least an order of magnitude smaller compared with a conventional backward-wave oscillator of the same length. As a representative example, we consider an SWS conceived by a periodically loaded metallic waveguide supporting a DBE and investigate starting-oscillation conditions using the Pierce theory generalized to coupled transmission lines. The proposed supersynchronism regime can be straightforwardly adapted to waveguide geometries others than the periodically loaded waveguide considered here since DBE is a general property that can be realized in a variety of structures.**

***Index Terms*— Cavity resonators, degenerate band edge (DBE), electromagnetic band-gap, electron beam devices, high power microwave generation, periodic structures, slow-wave structures (SWSs).**