A Novel Slow-Wave Structure for High-Power K_a-Band Backward Wave Oscillators With Mode Control

Ushemadzoro Chipengo, *Student Member, IEEE*, Muhammed Zuboraj, *Student Member, IEEE*, Niru K. Nahar, *Senior Member, IEEE*, and John L. Volakis, *Fellow, IEEE*

***Abstract*— We present a novel slow-wave structure (SWS) to significantly enhance the performance of high-power backward wave oscillators (BWOs). The design features a periodic metallic ring insertion and a deeply corrugated cylindrical waveguide. Both serving to improve interaction impedance and flexibility in dispersion curve engineering. A new technique for mode control in waveguides is also introduced. In addition to demonstrating mode control in SWSs, the key aspects of the presented design are mode dominance reversal and a 100% improvement in interaction impedance that can be exploited to achieve greater power conversion efficiency and output mode purity. Performance comparisons on group velocity, phase velocity and interaction impedance of the new SWS versus the conventional corrugated waveguide are provided. We extend the concept of inhomogeneous SWSs by designing a three-section inhomogeneous SWS. Further simulations using a Particle in Cell code of a highly efficient three-section inhomogeneous K_a-band BWO generates a peak output power of a 5.92 MW at 27 GHz with a 58% peak efficiency.**

***Index Terms*— Backward wave oscillator (BWO), interaction impedance, mode control, slow-wave structure (SWS).**