Preface

The topic of this dissertation is *rel*ativistic elec*tron* based High Power Microwave (HPM) oscillator *reltron*, that has a collection of exceptional qualities. Its operating principle has roots in the Spit Cavity Oscillator (SCO), Side-coupled Linear Accelerator, and biased gap klystron, and it combines their advantages. The device was first reported in the year 1992. Since the invention, considerable research efforts have been put towards its improvement. As a result, the reltrons have emerged as a highly efficient, compact and versatile HPM oscillator covering a wide microwave spectrum.

The present dissertation aims to bridge a few research gaps of reltron's development –

(i) The device has been studied through simulation to identify the distinct relations among its three normal modes and seven dimensional-parameters. The cavity parameters that govern the mode separation has been identified. This study helps in designing the RF interaction structure that results in equal and maximum mode separation, which is essential for its optimum performance. A test cavity is constructed, and the cold-test measurements have been carried out to validate the simulation.

(ii) The dispersion relation has been derived by forming an eigenvalue problem, and solving them by matrix method. Consequently, the coupling coefficients between the on-axis cavities and the side cavity are calculated.

(iii) The effect of two prime parameters – causing the mode separation – has been studied on device performance by Particle in Cell (PIC) simulation. The simulation also provides a better understanding and meaningful insight into the reduction in energy spread due to the application of postacceleration potential.

(iv) A modified modulation section that resulted in performance improvement in terms of a faster build-up of the oscillation – than the conventional design – has been proposed.

The present works have been reported part-wise at national and international conferences, and reputed journals namely, National Symposium on Vacuum Electron Devices and Applications (VEDA), IEEE MTT-S International Microwave and RF Conference (IMaRC), URSI Asia Pacific Radio Science Conference (URSI-APRASC), URSI Regional Conference on Radio Science (URSI-RCRS), International Journal of RF and Microwave Computer Aided Engineering (RFCAD), IEEE Transactions on Plasma Science (TPS), and Journal of Electromagnetic Waves and Applications (JEMWA).

The author hopes that the studies carried out in the present thesis will be helpful to the research community in better understanding and future improvement of the reltron.