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ELECTROMAGNETIC ANALYSIS OF DISPERSION AND FORM FACTOR CHARACTERISTICS OF A DISC-LOADED CYLINDRICAL WAVEGUIDE FOR A GYRO-TWT AMPLIFIER

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Abstract—A disc-loaded cylindrical waveguide structure for its potential use in a gyro-TWT amplifier operating in the *TE* mode is analysed for its electromagnetic behaviour. A modal matching technique is used to develop a dispersion relation in order to study the shape of the dispersion curve for wide device bandwidth. The band-pass characteristic of the structure has also been explored. The structure dispersion characteristic has been numerically plotted over a wide range of structure parameters to appreciate the role of individual parameter on the dispersion behaviour of the structure. It has been found that the disc-hole radius may be decreased and the structure periodicity increased for widening the device bandwidth. To validate the theoretical considerations, the structure is also simulated using commercially available simulation software "CST Microwave Studio" in order to observe the penetration of the travelling electric fields in different regions of the disc-loaded structure. A good agreement ($< 1\%$) has been achieved between the analytical and simulation results of dispersion characteristics. The analysis is extended further to derive the form factor which plays a very important role in the optimization of the electron-beam position for maximum interaction between RF wave and electron beam. Maximum coupling of the cyclotron wave to the resonant waveguide mode is found to be at the ratio of hollow beam radius to waveguide wall radius ($r_b/r_W = 0.44$) for TE_{01}, ($r_b/r_W = 0.39$) for TE_{02} and ($r_b/r_W = 0.35$) for TE_{03} mode.

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