SOLID-STATE LOCAL OSCILLATOR SYSTEMS FOR MILLIMETRE-WAVE RADIO ASTRONOMY RECEIVERS

A Thesis

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By

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A man should not abandon his work, O Son of Kunti (Arjuna),
even if he cannot achieve it in full perfection;
because in all work there may be imperfection,
even as in all fire there is smoke.

Bhagavadgita-18:48.

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ABSTRACT

Presented in this thesis is the work on the development of solid-state sources for local oscillator application in millimetre-wave radio astronomy receivers for the two widely used atmospheric transmission windows, 33-50 GHz and 75-110 GHz. Such sources are required to provide a reliable alternative to the highly expensive and short-lived klystrons which have been traditionally employed as local oscillators.

Post-coupled Gunn oscillators have been developed for the 33-50 GHz frequency band in various circuit configurations using a standard rectangular waveguide, a reduced-height waveguide and a circular waveguide. Effects of the post diameter and the backshort position on the oscillation frequency and power output of these oscillators have been investigated.

Resonant-cap Gunn oscillators have been developed for the 75-110 GHz frequency band. These oscillators have been realized in a new circuit configuration using circular waveguide as well as in the standard rectangular waveguide circuit. The effect of the resonant-cap dimensions on the oscillatian frequency has been studied. An empirical relation between the oscillation frequency and the resenat-cap dimensions has been obtained for the circular waveguide configuration. The performance of the circular waveguide oscillator which is simpler in construction is found to be comparable to that of the rectangular waveguide design.

AM sideband noise, which is a critical parameter for local oscillator application, has been measured for a number of millimetre-wave Gunn oscillators and klystrons in the 75-110 GHz frequency band. The noise performance of the Gunn oscillators is found to be better than that of the klystrons,

A phase-lock loop circuit has been developed for the frequency stabilization of millimetre-wave oscillators. The circuit has been used to phase-lock several millimetre-wave Gunn oscillators to a highly stable signal derived from a VHF frequency synthesizer.

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