EXPERIMENTAL INVESTIGATION OF MILLIMETER WAVE GUNN OSCILLATOR CIRCUITS IN CIRCULAR WAVEGUIDES

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Millimeter wave Gunn oscillator circuits using circular waveguides for 33-50 GHz and 75-110 GHz frequency bands are described. These oscillators are simpler to construct at millimeter wavelengths compared to the conventional rectangular waveguide circuits. The effect of various circuit parameters on the oscillator frequency and output power has been experimentally studied. The CW power and mechanical tuning range obtained from the circular waveguide Gunn oscillators are found to be comparable and sometimes even better than those obtained with conventional rectangular waveguide circuits using the same Gunn device.

Key words: Millimeter waves, Gunn oscillator, circular waveguide.

Introduction

Gunn oscillators are ideally suited for local oscillator application in low-noise millimeterwave receivers due to their excellent AM and FM noise characteristics. In the past few years, a number of millimeter wave Gunn oscillator circuits have been realized in a variety of transmission media, e.g., rectangular metal waveguides, fin-line, microstrip and image guide (1-4). The rectangular waveguide oscillator circuits give the highest CW powers and best FM Noise characteristics due to the higher Q of metal waveguide oscillator
cavities. However, the fabrication of rectangular waveguide oscillator cavities at millimeter wavelengths is rather difficult due to the tight dimensional constraints, necessitating the use of high precision milling machines. We describe here the use of circular waveguides for the realization of millimeter wave Gunn oscillator circuits which are much simpler in construction. Circular waveguide oscillator mounts can be fabricated using an ordinary lathe and require no precision milling operations. Moreover, the realization of non-contacting adjustable backshorts, an important part of any waveguide oscillator circuit, becomes very easy in the circular waveguide geometry since no special circular to linear motion mechanism is needed in this case.

The use of circular waveguides is generally avoided due to the overmoding problems associated with this transmission medium. However, in our application, the presence of the Gunn diode-bias post metal structure across the circular waveguide inhibits the excitation of the first higher order mode \( \text{TM}_{01} \), thus providing a reasonable bandwidth for single mode operation in the dominant mode \( \text{TE}_{11} \). Commercially available circular to rectangular waveguide transitions can be used for testing of these oscillators with standard rectangular waveguide measuring equipment.

These oscillators have been developed for local oscillator application in low-noise millimeter wave radioastronomy receivers (5). The choice of frequency bands (33-50 GHz and 75-110 GHz) is dictated by the windows in the absorption spectrum of the earth's atmosphere, which are exploited for ground based radio astronomical observations.

33-50 GHz Band Gunn Oscillators

A cross-sectional view of the circular waveguide Gunn oscillator circuit for the 33-50 GHz band is shown in fig. 1 and a photograph of the assembled oscillator in fig. 2. The Gunn diode package (Varian N34 case style) is screwed on to a copper plug for good heat-sinking and inserted into a section of a circular waveguide. The circular waveguide is realized by simply drilling and reaming a hole of appropriate diameter in another copper block. The d.c. bias for the Gunn diode is provided by a solid cylindrical metal post which sits directly on the Gunn diode. The post also contains