A LOW NOISE HETERODYNE RECEIVER FOR ASTRONOMICAL OBSERVATIONS OPERATING AROUND 0.63 mm WAVELENGTH

A.H.F. van Vliet,** Th. de Graauw,+ S. Lidholm,~ and H. van de Stadt*

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A heterodyne receiver is described in which an InSb hot electron bolometer is used as a mixer. The local oscillator power is obtained by doubling the frequency of a backward wave oscillator. The receiver operates between 460 and 500 GHz (0.65 - 0.6 mm). Noise temperatures amount typically to 1000 K.

Key words: submillimeter, heterodyne receiver, InSb mixer, carcinotron.

Introduction

The need for a high resolution, low noise radiometer in the submillimeter wavelength range has long been recognized, not only in the field of astronomical spectroscopy, but also in that of laboratory spectroscopy. However, it is only recently that significant progress in the development of this type of receiver has been made. For a long time, the supposed lack of a tunable, and sufficiently stable, local oscillator (L.O.) with sufficient output power hindered the application and development of Schottky

*Astronomical Institute, University of Utrecht, Netherlands
+Astronomy Division, Space Science Department of ESA, ESTEC, Noordwijk, Netherlands
~address: Microelectronics Research Centre, University College, Cork, Ireland
diodes as mixers in the submm range, although they were used extensively at mm wavelengths.

The possibility of using an InSb crystal as a microwave mixer was first demonstrated by Arams et al. (1) at wavelengths around 8 mm, and the properties of such a mixer have been reported extensively in the literature (2,3). The low L.O. power requirements for the InSb mixer and its low noise made it a good candidate for use in the short mm and submm range when no other types of mixers with a reasonable efficiency were available and it was consequently applied. This in spite of the disadvantage of its small I.F. bandwidth (∼1 MHz). The L.O. power needed for an InSb mixer in the submm range can relatively easily be obtained by frequency multiplication of the output of a klystron oscillating at a longer wavelength. Receivers based on this principle (4) have been used extensively in recent years by different groups, especially for the observation of molecules in interstellar clouds. Although the required efficiency of the frequency multiplier tends to form a limitation in the application of this detection scheme at the higher submm frequencies, its use has been extended recently up to a frequency of 500 GHz (5).

A backward wave oscillator (B.W.O., carcinotron) delivers a relatively high output power at mm and submm wavelengths. The introduction of the use of this device as a L.O. in the submm range in combination with a Schottky diode mixer (6) has opened up the possibility of producing low noise, wide I.F. bandwidth receivers in this range. Since the output power of the backward wave oscillator decreases strongly with increasing frequency, receivers based on this principle have not given good performance so far for wavelengths below 0.7 mm.

Fortunately the noise level in the side bands of this type of oscillator appears to be sufficiently low to allow its use as a L.O. in combination with an InSb mixer, even though the I.F. sidebands in this case are very close to the carrier frequency (7). This opened up the possibility of using the frequency multiplied output of a B.W.O. in combination with an InSb mixer to construct a low noise receiver for submm wavelengths below 0.7 mm.

In this paper a receiver based on this principle is described which operates around 0.63 mm. The various aspects of receiver design and construction will be discussed with reference to the diagram given in Fig. 1.