HETERODYNE PERFORMANCE OF A QUASIOPTICAL SCHOTTKY DIODE DETECTOR: THEORETICAL AND EXPERIMENTAL RESULTS

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A detailed theoretical and experimental study of the heterodyne performance of a quasioptical Schottky diode detector is presented. The experimental results have been obtained by mixing the radiation from a FIR laser with the output of a 67 - 73 GHz Klystron. The heterodyne signal variation versus various parameters and its relation to the special case of two lasers mixing are described. The mixer characteristics are a NEP value of $2 \times 10^{-19}$ W/Hz and a detector bandwidth of at least 9 GHz. Experimental evidence of harmonics generation of submillimetric frequencies at the diode junction is also presented.

Key Words: Point-contact Schottky Diode, Heterodyne FIR detection, FIR detector, Submillimetric wave detection

Introduction

In previous papers\(^{(1)(2)}\), a theoretical model of a quasioptical Schottky diode detector and its capability of predicting the low frequency response (video) of the diode over the microwave and FIR range have been described in detail. Following on from that, this paper presents an extension of the theory to the case of heterodyne detection and its fit to experimental results obtained by mixing FIR
laser radiation with the output of a 67 - 73 GHz Klystron. A detailed study of the heterodyne signal variations versus various parameters allows for the optimization of the bias current applied to the diode junction. The equations related to the special case of a two lasers mixing experiment are also developed and used to predict the optimum biasing conditions for that particular case. Our experimental results also include NEP and detector bandwidth measurements and give experimental evidence for the harmonics generation of the incident FIR frequency at the Schottky diode junction.

Experimental Set Up

The heterodyne performance of our quasioptical FIR detector used as a mixer in the submillimetric wavelength range has been tested by mixing the FIR laser radiation with a 67 - 73 GHz microwave source. Both sources have been described previously(3). A description of the detector, which consists of a Schottky diode mounted inside a corner cube reflector, can be found in an earlier publication(2). In our system, the FIR laser is the local oscillator (L.O.). The FIR signal to be detected is generated by the detector itself. This corresponds to one particular harmonic of the microwave signal generated by the diode through the non-linear I-V characteristic of the Schottky junction. This mechanism has already been described and observed(1)(2). The heterodyne signal has been measured at the detector output with a spectrum analyser (50Ω input impedance, Hewlett Packard 141T) after a 40 dB amplification (amplifier AMPLICA, noise figure = 2). The detection system, which is connected in parallel with the detector biasing circuit is AC coupled by adding a capacitor (100μF) in series with the amplifier input. The high frequency circuit (heterodyne) is isolated from that of the bias by putting an inductance (220μH) between the detector output and the bias circuit. This set up allows measurements of frequencies between 1 and 500 MHz which is the limit of the amplifier. Both radiations are coupled to the detector antenna and calibrated in power as described previously(2).