A Low Loss Diplexer for Submillimeter-wave Sideband Separating Receivers

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***Abstract*—This work presents a design of a low loss waveguide-based diplexer which enables sharing of a common antenna between two distinct frequency bands. The diplexer works as a passive high/low pass filter for the incoming RF signal. The filtered RF bands are mixed with the LO signal on two sub-harmonically pumped mixers realizing the sideband separating receiver architecture at submillimeter-wave frequencies. Usually, sideband separation is implemented mixing the incoming radio frequency (RF) signal with a quadrature feed local oscillator (LO). However, any changes in gain or phase of either the I or Q path will critically affect the sideband balance and will degrade the receiver performance significantly. In contrast, the diplexer designed in the work is a fully passive (waveguide) structure and is insensitive to such variations leading to an improved overall rejection and receiver stability.**

Keywords*—Diplexer, sideband separation, sub-harmonic mixes, submillimeter wave.

I. Introduction

At submillimeter-wave, radiometry/spectrometry are generally the main drivers for the development of highly sensitive detectors and receivers. This band constitutes a wealth of absorption and emission lines [1] for several gaseous molecules such as oxygen, ozone, water vapor and many more whose physical parameters, such as temperature and pressure, can be extracted by observing the shape of the spectral lines. The vertical distribution of key trace gases on earth's atmospheric layers is a critical observation to help our understanding on the processes that control the overall climate. This can be achieved by limb sounding technique and is commonly implemented with space born instruments. Room temperature GaAs Schottky diode technology-based receivers have been an attractive choice at submillimeter-wave frequencies for limb sounding due to their high reliability, in addition to lower mass, cost, and complexity compared to the cryogenic receivers. Sideband separation technique is known to provide better sensitivity and calibrated measured data compared to double side band counterpart when it comes to the observation of spectral signature of the molecules [3]. This is mainly due to the reduced noise on the single side band system obtained by suppressing/rejecting the image band. Usually, sideband separation is implemented with quasi-optical diplexers and image rejection filters [4]. However, these are lossy, bulky and expensive. A waveguide based low loss, compact and easy to integrate sideband filtering technique is presented in this work. The designed diplexer consists of a waveguide structure comprising of a T-junction, and a series of waveguide steps and stubs which are optimized such that only certain frequencies are allowed in each branch rejecting all other unwanted frequencies. The merit of this design is that the waveguide structures are optimized considering the intrinsic impedances of the mixers such that all the unwanted high frequency signals on lower side band (LSB) branch are reflected back to the upper side band (USB) branch and vice versa. This means, we do not pay the 3 dB penalty from the T-junction split and therefore a low loss RF path can be realized.

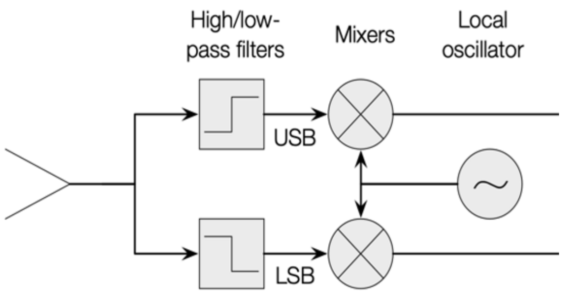

Fig. 1. Block diagram of the 340 GHz sideband separation receiver architecture using RF filtering approach.

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