Development for a wideband 100 GHz SIS mixer

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Abstract—We are developing 100GHz SIS mixers to meet the requirement of “FOREST”, which is a new multi-beam array receiver in 100GHz band developed for 45-m millimeter wave telescope located at Nobeyama Radio Observatory (NRO), Japan [1]. FOREST has four (=2x2) beams which has an ortho-mode transducer and two sideband-separating (2SB) mixers, and obtains 16 IF signals with high-sensitivity. The final goals of our new SIS mixer are the noise temperatures of lower than 40 K within a range of 70–120GHz of RF band and of 4–12 GHz of IF band.

I. INTRODUCTION

The present SIS mixer operating in FOREST has bow-tie probe antennas, stepped-impedance choke filters, a coplanar inductor loaded microstrip transformer and a series array junction (e.g. Fig. 1), however has no specific structure for IF signals. The result of the measurement shows however that noise characteristics become worse rapidly toward the higher IF frequency, independently of frequency of RF signals. This characteristics is common among all mixers, and thus this fact indicates that the impedance matching for both RF and IF signals should be seriously investigated for the improvement of the high frequency and wideband receiver system.

Fig. 1 Present SIS mixer in 100-GHz band operating in FOREST

II. DESIGN

We are designing and analyzing some wide-band elements such as probe antennas, choke-filers and tuning circuits. The combination of reduced height of waveguide and fan-shaped probe antenna is one of the best solution which can cover a range of 70-120 GHz of RF band. We have designed the feed-point impedance of this probe antenna to be 30 ohm without complex circuit (e.g. Fig. 2).

For wider IF bandwidth, We have changed the present choke-filter to another low-pass filter called ‘Hammer filter’ which has good frequency selectivity. We have designed this hammer filter to stop RF signals and transmit IF signals without significant reflection loss (e.g. Fig. 3). The size of this Hammer filter is small enough to integrate in tuning circuit, so that we can make an IF readout line connecting to SIS junctions directly.

Fig. 2 The fan-shaped probe antenna and its impedance characteristics

Fig. 3 The structure of Hammer filter and its characteristics (5cells)

We are optimizing each element by measuring test pieces, then combine them with series array SIS junction to make a new mixer. At the conference, we describe our approach and progress of the development of the new mixers.

REFERENCE