ANALYTICAL TREATMENT AND OPTIMUM PARAMETERS FOR DSB SIS RECEIVERS

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ABSTRACT

The quantum theory of mixing developped by Tucker [1] has been widely used to predict SIS mixer performance using either the three or five-frequency approximations. Most of the current SIS receiver developments above 500 GHz use matching circuits to resonate the SIS intrinsic parasitic capacitance at the operating frequency. The three-frequency approximation is then a good assumption since the harmonics of signal, image and Local Oscillator (LO) frequencies are shunted by the SIS specific capacitance which is not resonated any more by the matching circuit. Moreover the SIS mixer is operated as a Double Side-Band (DSB) mixer as long as the Intermediate Frequency (IF) is much lower than the instantaneous RF bandwidth at the resonance frequency of the matching circuit (low IF limit). With these two assumptions the IF output impedance of the mixer and the conversion gain can be calculated analytically [1].

It has been already shown [2] that the contours of constant IF conductance are circles in the RF source admittance plane (G_S, B_S) With some additionnal assumptions the contours of constant DSB conversion gain are also circles [2]. We present here the full analytical formalism including contours of constant mixer and receiver noise temperature. We then derive analytically the minimum receiver (and mixer) noise temperature and the source admittance associated to it. Also all the parameters (bias voltage, LO power, RF admittance, IF conductance) for minimum receiver and mixer noise are given versus LO frequency. We discuss the location of the minimum mixer noise admittance in the (G_S, B_S) plane and the way SIS receivers can be optimized above the gap frequency.

[1] J.R. Tucker and M.J. Feldman, Rev. Mod. Phys. **57**, 1055 (1985)
[2] P. Febvre, Proc. 5th THz Conf., Univ. of Michigan, May 1994.