Integrated Submillimeter and Terahertz Receivers with Superconducting Local Oscillator

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ABSTRACT

The concept of a fully Superconducting Integrated Receiver (SIR) has been developed and experimentally proven in a tight collaboration between the Institute of Radio Engineering and Electronics (IREE-Moscow) and the Space Research Organization of the Netherlands (SRON-Groningen). A single-chip submm wave receiver includes a planar antenna integrated with a SIS mixer, pumped by an internal superconducting FFO as local oscillator (LO). A DSB noise temperature below 100 K has been demonstrated around 500 GHz. The frequency resolution of a heterodyne spectrometer is one of the major parameters for a practical application. In order to obtain the required resolution (of at least one part per million) the local oscillator must be phase-locked to an external reference. Recently a possibility of FFO phase locking has been experimentally proven for the first time for ANY type of Josephson oscillator.

Comprehensive measurements of the FFO radiation linewidth are performed using an integrated harmonic SIS mixer; the FFO linewidth and spectral line profile is compared to a theory. Essential dependence of the FFO linewidth on frequency and current density is found; possible explanations are discussed. To optimize the FFO design, an influence of the FFO parameters on the radiation linewidth is studied. Novel FFO design at a moderate current density has resulted in a free-running FFO linewidth below 10 MHz in the flux flow regime up to 710 GHz being limited only by the gap frequency of Nb. This relatively narrow free-running linewidth (along with implementation of a wide-band phase locking loop system) allows continuous phase locking of the FFO in the wide frequency range of 500 – 710 GHz. These results are the basis for the development of 550-650 GHz integrated receiver for the Terahertz Limb Sounder (TELIS) intended for atmosphere study and scheduled to fly on a balloon in 2005. We report here also on the design of the second generation of the phase-locked SIR chip for TELIS. SIR on board of TELIS will be the first implementation of the Superconducting FFO in a practical instrument and an important step in realization of a future full superconducting heterodyne spectrometer.

To extend an operational frequency of SIR above 0.7 THz, the gap frequency of Nb, a NbN-based flux-flow-type Josephson oscillator has been developed and preliminary tested. First results for linewidth measurements of NbN based junctions will be presented.

The work was supported in parts by RFBR projects 03-02-16748, INTAS project 01-0367, ISTC project 2445 and President Grant SS-1344.2003.2.

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