

## FIXED-TUNED SUBMILLIMETER WAVEGUIDE MULTIPLIERS USING MMIC TECHNOLOGY

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### Abstract

In preparation for the instrument announcement of opportunity for the Far Infrared and Submillimeter Space Telescope, an ESA/NASA space astrophysics observatory mission, local oscillator sources at high frequencies (1200 GHz) are being developed. As part of a multiplier chain beginning at ~100 GHz, we are developing single and multiple diode waveguide circuits up to 640 GHz. These multipliers are expected to have high efficiency and broad bandwidth (20% fixed-tuned). This paper will describe the current status in the development of broad band fixed tuned waveguide multipliers to 640 GHz.

Continuing the concept presented last year [1], we have developed tools and fabrication processes which led to the design and fabrication of a MMIC waveguide doubler to 320 GHz and a MMIC waveguide quadrupler to 640 GHz. This includes extensive diode modeling and analysis/optimization [2], design and fabrication of input and output ridge-waveguide to microstrip transitions [3,4] to provide the fixed tuned input and output ports, and the design and fabrication of the MMIC multiplier chips containing the active devices and all matching elements.

To date, measurements have yielded 10  $\mu$ W at 640GHz and 420  $\mu$ W (2.7% efficiency) at 320 GHz, with 15 mW pump at 160 GHz. We believe these are the first working waveguide MMIC multipliers above 200 GHz. The waveguide block concept used for these multipliers is very efficient for mounting/unmounting devices, allowing rapid measurements of different chips.

The circuit configuration used for 640 GHz appears to have some inherent problems, such as microstrip higher order mode coupling and ground disconnect, that we are planning to fix by using a CPW configuration.

Designs, measurement results and future work will be presented.

[1] J. Bruston, M. Kim, S. C. Martin, I. Mehdi, R. P. Smith, and P. H. Siegel, "Design and Analysis of Broad-Band Fixed-Tuned Submillimeter-Waveguide Multipliers using MMIC Style Circuit Topology," Seventh International Symposium on Space Terahertz Technology, March 12-14, 1996.

[2] Jean Bruston, R. Peter Smith, Imran Mehdi and Peter H. Siegel, "Analysis and Optimization of Planar Rectangular T-anode Schottky Barrier Diodes for Submillimeter-wave Multipliers", 26<sup>th</sup> European Microwave Conference, September 1996.

[3] M. V. Schneider, B. Glance, W. F. Bodtmann: "Microwave and Millimeter Wave Hybrid Integrated Circuits for Radio Systems," Bell System Technical Journal, July-August 1969, pp. 1703-1726

[4] D. Winkler, A. H. Worsham, N. G. Ugras, D. E. Prober, N. R. Erickson and P. F. Goldsmith: "A 75-110 GHz SIS mixer with integrated tuning and coupled gain," Nonlinear Superconductive Electronics and Josephson Devices, Plenum Press, NY, 1991, pp. 73-79

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