Broadband Tunable Supra-THz Test Sources

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***Abstract*—Two broadband tunable sources are presented covering 1100-1500 GHz and 1750-2200 GHz. Both sources utilize a common driver chain covering the full WR-4.3 (170-260 GHz) band with >10mW output power. The WM-164 source provides greater than 1uW average power from 1100-1500 GHz. The WM-130 source provides greater than 0.5uW output power from 1750-2200 GHz.**

I. INTRODUCTION

SOURCES above 1 THz have typically been narrowband and highly targeted for specific applications. The availability of broadband general test sources and receivers, similar to those available at lower millimeter-wave frequencies, would enable more rapid advances in many scientific and technical fields, including gas spectroscopy/analysis, compact range radars, far-IR camera and antenna characterization, biological testing, picocell cellular communications with ultra-high bandwidths, and likely many other examples.

To develop broadly tunable supra-THz source power, we utilize recent advances in InP HBT MMIC sub-millimeter power amplifiers [1]. With access to wideband power amplifiers operating up to 300 GHz, it is now possible to generate broadband tunable power up to 2.2 THz using Schottky diode multipliers driven by these sub-millimeter power amplifiers. A 1.25-1.5 THz source and receiver developed for testing THz astronomy receivers was presented in [2]. The receiver included the same WR-4.3 power amplifier used in this work. Here we use the WR-4.3 amplifier to enable the source to achieve larger bandwidths and higher frequencies, specifically a 1100-1500 GHz and a 1750-2200 GHz source.

II. DESIGN AND RESULTS

The WR-4.3 (170-260 GHz) driver for both test sources presented here consists of a x18 active multiplier chain starting from a 10-15 GHz input. An initial active doubler module is followed by a 20-30 GHz power amplifier (from Spacek Labs) with 29 dBm saturated output power. This is followed by VDI (Virginia Diodes, Inc.) WR-13 and WR-4.3 frequency triplers The WR-4.3 amplifier module following the second tripler contains the InP HBT MMIC amplifier described in [1] packaged in a compact WR-4.3 waveguide housing powered by a single +5V supply. This packaged WR-4.3 amplifier gives >10mW over the full WR-4.3 band. We expect that further optimization of the package will increase the output power to a minimum 20mW over a full waveguide band. However, 10mW is sufficient to pump the adequately drive the subsequent multiplier chains.

For the 1100-1500 GHz source, the WR-4.3 driver chain is followed by a VDI WR-2.2 doubler and a VDI WM-164 (WR-0.65) tripler. The power at the WR-2.2 doubler output is 0.5-1.0mW. The output of the complete WM-164 source is shown as the red trace in Fig. 1. While the average power is greater than 1uW over the band, there is significant variation indicating that the WM-164 tripler is underpumped. New diodes are being fabricated to address this issue and improvement is expected. The WM-164 tripler block has an integrated diagonal horn output. The output power is measured using a VDI PM4 power meter with the diagonal horn output connected through a transition to overmoded WR-10 waveguide. The output power is then corrected for the 2" of overmoded WR-10 waveguide to the power sensor.

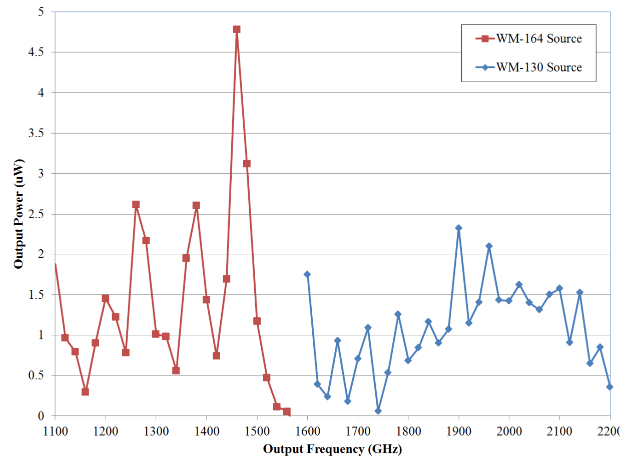

Fig. 1. Measured output power of the WM-164 and WM-130 sources.

For the 1750-2200 GHz source, the WR-4.3 driver chain is followed by a VDI WR-1.5 tripler and a VDI WM-130 (WR-0.51) tripler. The power at the WR-1.5 tripler output is 0.2-0.6mW. The output of the complete WM-130 source is >0.5uW from 1750-2200 GHz, shown as the blue trace in Fig. 1. The WM-130 tripler also includes an integrated diagonal horn and the output power is measured in a similar manner as for the WM-164 output. There is less frequency ripple seen at the WM-130 output, indicating that this tripler is more optimally pumped than the WM-164 tripler.

As an example application, this power is sufficient to drive a HEB mixer through a beamsplitter, allowing for a broadband astronomical spectral survey around 2 THz. Near-term improvements in sub-millimeter power amplifier packaging and supra-THz tripler efficiency are expected to provide significant improvement to these initial results.

REFERENCES

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