

# Multiplier-based Sources of Terahertz Power

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**Abstract**—The performance of terahertz sources based on frequency multipliers continues to improve in terms of power, maximum frequency and frequency agility. This talk will describe the range of performance that is possible with this technology; including narrow-band sources that generate greater than 400mW above 100 GHz and broadly tunable sources that generate 10's of microwatts above 1THz. This talk will also consider the unique source characteristics required by the wide range of applications being explored, and their impact on source performance and design. This includes the need for power modulation and pulsing, rapid frequency sweeping, achieving highly stable and phase locked signals, as well as phase locking the source to a heterodyne receiver

## I. INTRODUCTION AND BACKGROUND

GaAs Schottky barrier diodes have been used as the nonlinear element in high frequency mixers and multipliers since at least the 1950's. However, the performance of these components, and the systems that rely on them, continues to improve. With the recent rapid growth in interest in terahertz technology for scientific, military and commercial applications, this "classic" technology is perhaps in greater today than at any time in the past. In fact systems based on nonlinear semiconductor diodes are responsible for much of the growing interest in the terahertz spectrum, and continued improvements in the performance of diode based systems is of critical importance for many applications.

This talk will briefly review that status of multiplier based sources of terahertz power, defined here as being in the frequency range from about 100 GHz through 10THz. Emphasis will be placed on the power levels and frequency tuning that are achieved, as well as secondary performance characteristics such as phase noise, frequency stability, pulsed performance and rapid frequency tuning. Examples of recent results at VDI will be used to highlight both the capabilities of this technology and the continuing improvements in the performance of the sources. Two interesting examples are presented in this brief abstract.

## II. HIGH POWER VARACTOR MULTIPLIERS

Varactor diodes have long been used to generate power in the terahertz frequency band. However, higher levels of device integration, advanced computer simulation tools and clever circuit design continue to lead to improved performance. Figure 1 shows the power versus frequency for a very recently developed multiplier chain to the upper part of the WR10 waveguide band. The peak power, in excess of 400mW, is greater than has previously been reported in this frequency band, and the tuning band of nearly 25GHz with greater than 100mW is particularly impressive. This new

result is a clear indication that this important technology is continuing to advance.

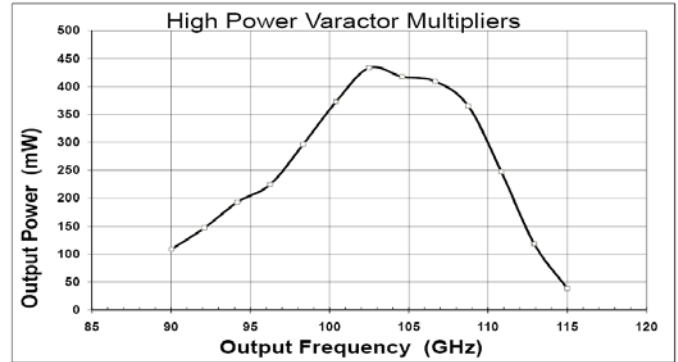


Fig. 1: The output power versus frequency of a new varactor multiplier chain showing record output power.

## III. FREQUENCY AGILE TxRx SYSTEMS WITH HIGH DYNAMIC RANGE

A complete TxRx system operating in the 800 – 840 GHz frequency range is shown in Fig. 2. The Tx signal and the receiver LO are locked to the same 10 MHz crystal reference, thereby maintaining a very narrow and well defined IF frequency as the Tx frequency is swept. The synthesizer is digitally controlled by the user and its frequency can be set in 1 Hz steps. Considering the multiplication factor of 48, the output frequency can thereby be set in steps of 48 Hz. The Phase Noise at the output is measured as -75dBc/Hz at 10kHz offset. The transmitter power is ~5mW and the receiver noise figure is about 10dB. The system has a demonstrated dynamic range of 125dB, without using an IF amplifier.

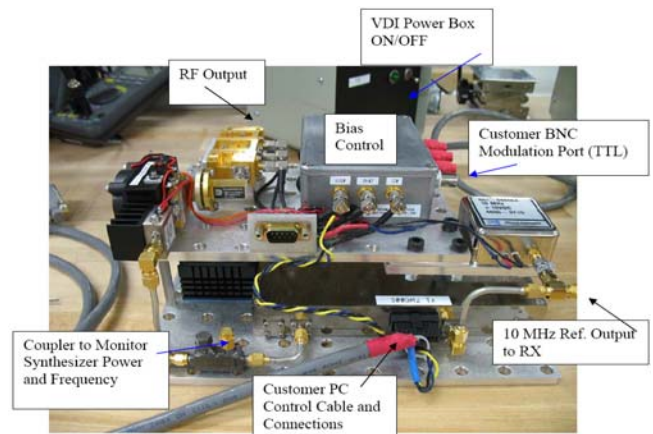


Fig. 2: An 800-840 GHz Phase –Locked TxRx System.