All-Photonic Heterodyne sub-THz Wireless Transmission at 80 GHz, 120 GHz and 160 GHz Carrier Frequencies

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All Photonic Heterodyne sub-THz Wireless Transmission at 80 GHz, 120 GHz and 160 GHz Carrier Frequencies

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***Abstract*— We experimentally demonstrate a link using a p-i-n photodiode and a photoconductor without any bandwidth-limiting electronic component. As a proof-of-concept, a 100 Mbit/s BPSK stream is successfully transmitted at three different channels with 40 GHz difference using a 3.7 GHz intermediate frequency for signal reception. Optical frequency combs are used for THz generation and detection to reduce the phase noise of the system.**

I. INTRODUCTION

THz communications based on photonics offer sufficient bandwidth and flexibility to reach the capacity demands of future wireless links [1]. However, current realizations of THz links still rely on amplifiers and/or electronic receivers [1], which prevent these systems from exploiting the full potential of THz range. The future of bidirectional ultra-high capacity THz communications is therefore linked to optoelectronic techniques at both ends of the communication link, potentially achieving modulation bandwidths of several gigahertz, tunable ranges for the wireless carrier above one hundred gigahertz as well as the flexibility to multiplex several channels in frequency. Although some works have already attempted to establish a communication link fully based on photomixing technology [2,3], an experimental demonstration of broadband data transmission covering a wide range of the THz spectrum is still missing, mainly due to power limitations.

II. EXPERIMENTAL SETUP AND RESULTS

The proposed system (Fig. 1) is based on a p-i-n photodiode as transmitter and a photoconductor as receiver, both driven by signals extracted from independent optical frequency combs (OFC) to reduce phase noise, allowing phase modulation formats. The comb at the transmitter is achieved by a laser and a phase modulator driven by a local oscillator with frequency $f_{comb,tx}$, which sets the repetition rate (30 – 40 GHz). One of the comb lines is modulated by a Mach-Zehnder modulator biased at the null point and driven by a polar non-return-to-zero signal, resulting in a 100 Mbit/s binary phase shift keying (BPSK) signal. The OFC at the receiver is obtained from a picosecond laser with repetition rate of $f_{comb,rx}$ = 40 GHz.

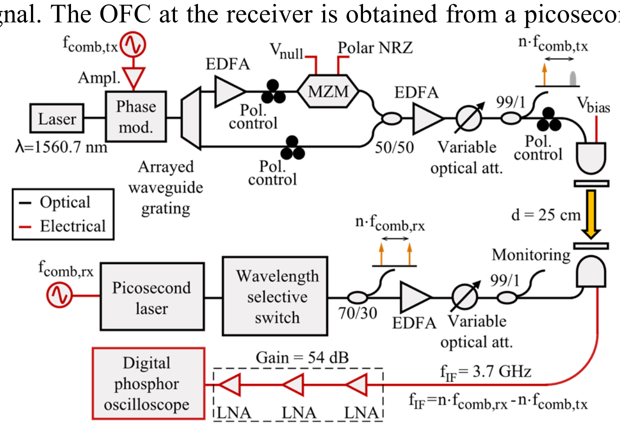

Fig. 1. Schematic of experimental setup for an all-photonic THz wireless link.

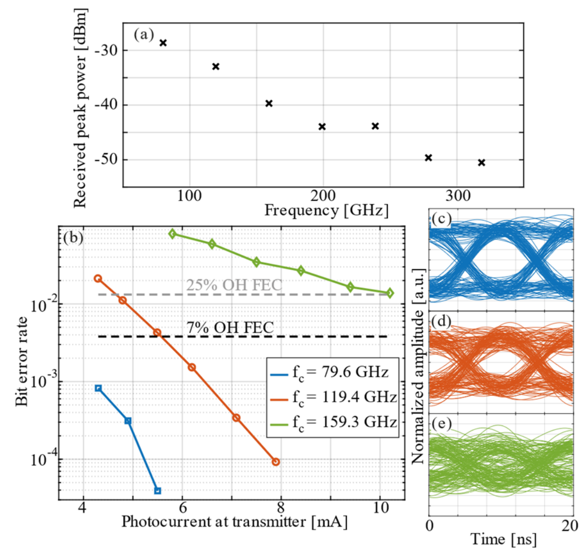

Fig. 2. Experiment results: (a) THz spectrum, (b) bit error rate curves and eye diagrams when the photocurrent at the transmitter is 10 mA and the wireless carrier is (c) 79.6 GHz, (d) 119.4 GHz and (e) 159.3 GHz.

The wireless carrier and intermediate frequency can easily be set by filtering the proper comb lines (in 40 GHz steps) and varying the difference in the repetition rate between the two OFCs (see Fig. 1). The received signal at 3.7 GHz is amplified and captured by a sampling oscilloscope for off-line processing.

Fig. 2(a) shows the detected THz power at the intermediate frequency without modulation. The shape agrees with the THz power profile of the transmitter and the free-space transmission losses. Figs. 2(b)-(e) present the results after demodulating the data with a Costas Loop (without further equalization). The bit error rate (BER) is below 10^{-5} at 80 GHz and 120 GHz for the maximum transmitted power, while it deteriorates to the limit of error correction techniques with 25% overhead when the carrier frequency is increased to 160 GHz.

III. CONCLUSION

The presented work demonstrates a heterodyne sub-THz wireless link for transmission at frequencies between 80 GHz and 160 GHz with scalability prospect to higher THz frequencies. These results are a significant step towards highly tunable THz communications and a full exploitation of the THz range for ultra-broadband communications.

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