

# Wireless communication link at 300 GHz with up to 160 GBit/s

S. Nellen<sup>1</sup>, S. Lauck<sup>1</sup>, E. Peytavit<sup>2</sup>, P. Szriftgiser<sup>3</sup>, G. Ducournau<sup>2</sup>, B. Globisch<sup>1,4</sup>

<sup>1</sup>Fraunhofer Institute for Telecommunications, Heinrich Hertz Institute, Einsteinufer 37, 10587 Berlin, Germany

<sup>2</sup>IEMN-UMR CNRS 8520, Institut d'Electronique, de Microélectronique et de Nanotechnologie, Lille University, France

<sup>3</sup>Laboratoire de Physique des Lasers Atomes et Molécules (PhLAM), UMR CNRS 8523, Université Lille, F-59655

Villeneuve d'Ascq Cedex, France.

<sup>4</sup>Technische Universität Berlin, Institut für Festkörperphysik, Hardenbergstr. 36, 10623 Berlin, Germany

**Abstract—** We demonstrate a wireless communication link in the 300 GHz band with a maximum single channel data rate of 160 GHz achieved with QAM32 modulation at 32GBaud. To the best of our knowledge this is the highest data rate reported for a single channel in this frequency band. The system employs a broadband optoelectronic emitter (PIN-PD) and a heterodyne detector.

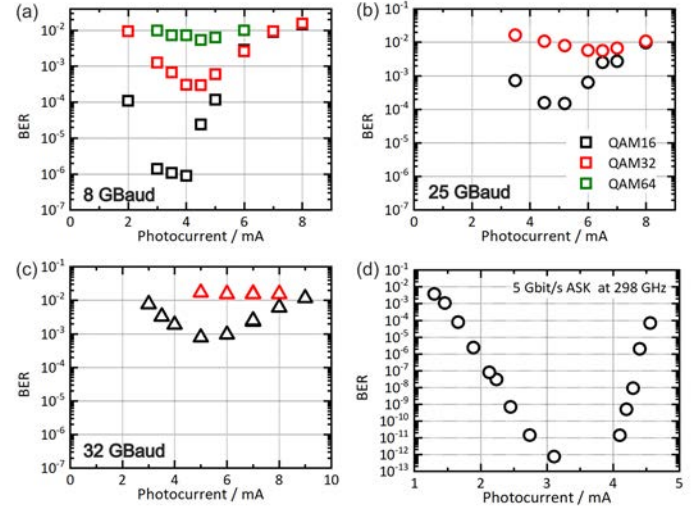
## I. INTRODUCTION

WITHIN the last decade, mobile technologies have experienced an exponential growth and recent network analyses forecast that the majority of IP-traffic will be generated by mobile-related applications in the future. However, existing networks and systems do not have the capacity to enable this growth. Therefore, new wireless solutions with carrier frequencies around 300 GHz are currently being investigated due to low atmospheric attenuation and a large available bandwidth of almost 100 GHz. As the generation of frequencies  $> 200$  GHz with all-electronic components is extremely challenging photonic approaches can be a promising alternative [1]. Photonics based wireless networks offer direct connectivity to the fiber optical infrastructure, carrier waves with high stability and low phase noise, and allow for spectrally efficient, complex modulation formats. In a recent publication, we have demonstrated that a broadband PIN photodiode (PD), which is commonly employed as an emitter in continuous wave terahertz spectroscopy systems, can also be used as an emitter in terahertz wireless links with up to 128GBit/s data rates [2].

In this paper we extend this study and investigate the influence of the data rate, the modulation format and the photocurrent of the PIN-PD emitter on the bit error ratio (BER) of the wireless link. We achieved a record high data rate of 160 GBit/s over a single channel.

## II. SETUP AND RESULTS

In our experiments, we used both a setup for direct and coherent detection. In both experiment, two free-running external cavity diode lasers emitting in the C-band are used in order to generate two optical carrier waves with a frequency spacing of 300 GHz. For coherent transmission, one of these tones is fed into an I/Q modulator, which is driven by a digital-to-analog converter (DAC) for in-phase and quadrature modulation. Afterwards, the modulated and unmodulated optical carrier waves are spatially combined. The resulting optical beat note is used to illuminate a fiber-coupled emitter, which contains a waveguide integrated InP-based PIN photodiode. For broadband THz emission a 90° bow-tie antenna is attached to the diode. A hyper-hemispherical silicon lens with a diameter of 10 mm is used as a substrate lens to couple the



**Fig. 1.** Bit error ratio (BER) in a wireless communication link as a function of the photocurrent of the PIN-PD emitter for a symbol rate of 8GBaud (a), 25 GBaud (b) and 32 GBaud (c). BER as a function of the photocurrent in an ASK link with 5Gbit/s is shown in (d) for comparison.

terahertz radiation into free space. Since the radiation pattern of the THz transmitter is divergent with an angle of  $\pm 15^\circ$  a pair of high-density polyethylene (HDPE) lenses is placed between transmitter and receiver in order to transmit the data signal over a distance of 0.5 m. For coherent detection we used a heterodyne receiver and DSP

In Fig. 1 the bit error ratio (BER) as a function of the photocurrent of the emitter is shown for different modulation formats and symbol rates of 8 GBaud (a), 25 GBaud (b), and 32 GBaud (c). Note that QAM64 modulation with a BER below the threshold for forward error correction (FEC) could be transmitted with a symbol rate of 8 GBaud, which highlights the linearity of the whole transmission THz system. For QAM32, a symbol rate of 32 GBaud could be transmitted, which corresponds to a record high gross data rate of 160 GBit/s. In addition, one observes a strong dependence of the BER on the photocurrent of the PD. A photocurrent of 4 mA – 5 mA seems to be ideal for low BER, whereas the optimal value increases for higher baud rates and more complex modulation. We attribute this behavior to THz reflections on the edges of the PIN-PD chip and on the silicon lens. This will be discussed in more detail in the full paper.

## REFERENCES

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