200 GHz coherent wireless link using photonics-based emission

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***Abstract*— We investigated a coherent THz link at 200 GHz, with variable data rate up to 11 Gbit/s, featuring the combination of a quasi-optic UTC-PD emitter and a high sensitivity electronic receiver. This coherent link relies on an optical frequency comb generator at emission to produce an optical beat note with 200-GHz separation. BER testing has been carried out using an indoor link configuration and the error-free operation is obtained up to 10 Gbit/s with a received power less than 2 µW.**

I. Introduction

THZ communications are very promising [1] as it opens a huge space for new high data-rate services. Among different technological solutions, coherent THz links pave the way to high performances in terms of data-rate and sensitivity at receiver circuits. For example, using photonics at emission, [2] have achieved real-time coherent 100 GHz up to 11 Gbit/s and [3] reported 200 Gbit/s in W-band using off-line demodulation and signal processing. Above W-band, [4] reported very recently up to 100 Gbit/s for a 20 m link at 237.5 GHz, also using off-line detection.

II. Wireless Link and Results

The wireless link is described in fig. 1. First, an optical frequency comb generator [5] is used to produce a dual mode optical signal, with 200-GHz separation. This signal is modulated up to 11 Gbit/s using a Mach-Zehnder modulator (MZM), and a quasi-optic uni-travelling carrier (UTC-PD) module is used to radiate the modulated 200 GHz signal.

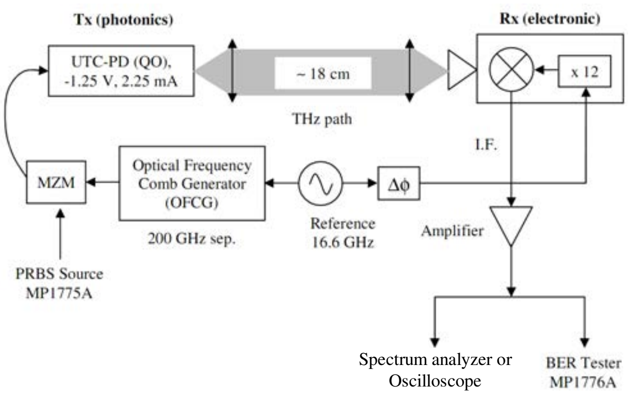

Fig. 1. Experimental setup of the 200-GHz coherent data link. CW = Continuous Wave, $\Delta\phi$ = Fixed electrical phase shifter.

The receiver is an electrical mixer working at 200 GHz, pumped by an electrical multiplication chain, working at 100 GHz. The mixer output feeds a 33-dB gain amplifier and a limiting amplifier is used at the end for eye diagram monitoring and BER testing.

The fig. 2 shows the photonics-based emission (UTC-PD) and electronic receiver (Schottky-based).

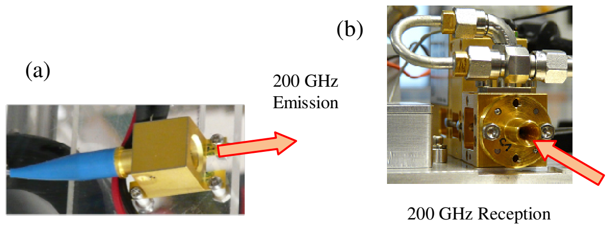

Fig. 2. Views of Quasi-optic UTC-PD module (a) and electronic receiver (b), both operated at 200 GHz.

No off-line processing to tackle the phase locking problem between Tx and Rx is required in the proposed architecture, i.e. the BER is measured in real-time. For that, BER was tested using the combination of MP1775A (Anritsu) for PRBS generation and MP1776A (Anritsu) for BER measurement with 2^{15}-1 bit sequences.

The error-free operation is obtained at 5 Gbit/s for 0.7 mA in the UTC-PD, corresponding to a 1.5-µW power at UTC-PD output (Fig. 3). This should correspond to ~ 0.75-µW (< -30 dBm) received power. For 10 Gbit/s, the error-free operation was obtained with 1-mA photocurrent in the UTC-PD, corresponding to ~ -28-dBm received power.

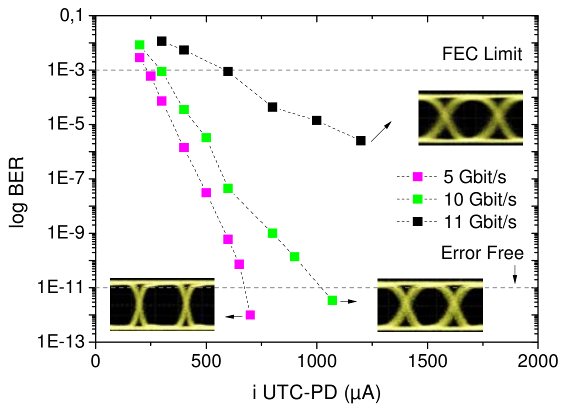

Fig. 3. BER curves, using a 11-Gbit/s limiting amplifier, and eye diagrams for highest photocurrents tested in each data-rate.

The BER curve obtained for the 11-Gbit/s data rate was presenting a reduced slope, and the achieved BER performance was limited to few 10^{-6}. This comes from a limited available bandwidth at the heterodyne receiver. To illustrate that point, the Rx was tested in waveguide condition using a continuous wave source coming from a vector-network analyzer, and the frequency was tuned from 180 GHz and 220 GHz. The figure 4 presents the results.

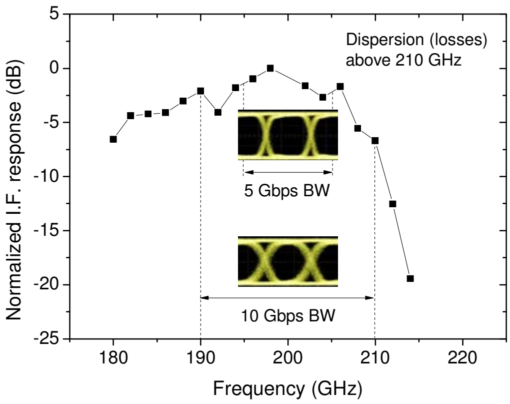

Fig. 4. Frequency response of the heterodyne receiver including I.F. wideband amplifier.

From this curve, the 20 GHz bandwidth found (+/- 10 GHz around carrier frequency) enables an up-to 10 Gbit/s error free operation. For higher data rates, a too large amount of amplitude distortion is affecting the receiver, caused by an increase of the conversion losses (decreasing IF response). For that reason, the eye diagrams beyond 10 Gbit/s were degraded and the BER performance was limited.

III. Conclusions

A coherent transmission system was demonstrated at 200 GHz, using a photonics-based emission, and featuring a very low power requirement at reception. Error-free operation was obtained up to 10-Gbit/s data rates, with a limitation due to the receiver bandwidth, not by the comb or UTC-PD transmitter. Next steps will concern high distance transmission using powerful photomixers at emission.

Aknowledgment

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