which further increases overall transmission capacity. However, in order to implement high speed wireless connectivity, the limited modulation bandwidth of the commercial LEDs (10-20 MHz) requires spectrally efficient modulation techniques, e.g. Orthogonal Frequency Division Multiplexing (OFDM) or Discrete Multi-Tone (DMT) [5]. Most recently, we demonstrated highest capacity of 2.1 Gbit/s by using WDM transmission and DMT modulation of commercial RGB LED [3]. Another gigabit experiment was reported by employing similar approach achieving data rate of 1.25 Gbit/s [6].

In this paper we present a significant increase in data rate for both single channel and WDM VLC links. The improvements in capacity have been achieved mainly by optimizing the DMT implementation and using a receiver with appropriate bandwidth. In a first experiment, we used the RGB LED as a single channel source and we achieved 1.5 Gbit/s capacity. In a second experiment we used the RGB LED as a WDM source, i.e. each color carried a different signal, achieving 3.4 Gbit/s aggregate capacity. The resulting bit error ratios (BERs) in both cases were below $2 \cdot 10^{-3}$, i.e., within the Forward Error Correction (FEC) limit. The luminance level at the receiver was always lower than the value indicated by the European Standard for illumination of working environments, which recommends 500 lux [7].

2. Experimental setup

The experimental setups for the two experiments are reported in Fig. 1.

(a)

(b)

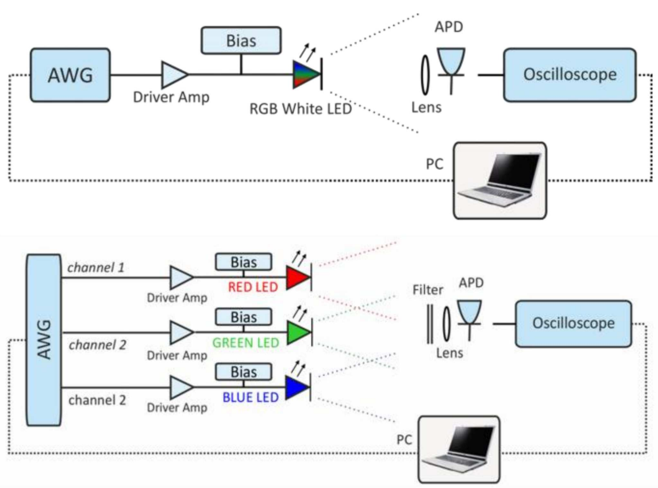

Fig. 1. Experimental setup for single channel (a) and WDM (b) transmission. AWG: Arbitrary Waveform Generator; APD: Avalanche PhotoDiode

The RGB LED (Tx) was a low cost commercially available component (Cree PLCC6 Multichip LED) generating a luminous flux of 6 lm at driving currents of 50 mA (with 120° full emission at half maximum intensity). Its three LED chips had the peak wavelengths of 620 nm (red), 520 nm (green) and 470 nm (blue). In the single channel experiment, the three LED chips were connected in series and modulated together by a single DMT signal consisting of N = 512 subcarriers within a bandwidth B of 280 MHz (B/N = 0.546 MHz carrier spacing). The bandwidth was chosen to fully exploit the available bandwidth and slow frequency roll off of the LED in order to increase the throughput.

In DMT modulation the single carrier signal is decomposed into a multiple subcarriers. Therefore, the finer the decomposition of the single carrier into N subcarriers, the better the DMT system can adapt to the frequency-dependent response of the channel. After an experimental analysis, presented in this work, we found that a number of 512 subcarriers was a good compromise between capacity and complexity.