1 Gb/s Integrated Visible Light Communication System Comprising CMOS drivers, receivers and GaN micro-LEDs


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The use of Gallium-nitride-based light-emitting diodes for simultaneous illumination and data transmission (which has been referred to as “Li-Fi”) is an area of research that has attracted a great deal of interest in recent years. This technology opens up the visible spectrum for use in wireless communications, supplementing existing radio-frequency (RF) wireless communications and can help meet the ever-growing demand for wireless data communication.

Although typical off-the-shelf LEDs have relatively low modulation bandwidths, of the order of 10-20 MHz, data transmission rates over 1 Gb/s have been achieved by the use of spectrally-efficient, though relatively complex, modulation schemes [1]. Micro-LEDs, devices with individually-addressable LED pixels with dimensions < 100 μm, have been reported with modulation bandwidths an order of magnitude higher than their off-the-shelf counterparts [2], which has been attributed to their low device capacitance and operating current densities.

Using such micro-LEDs, data rates of 3 Gb/s over free space [3] and 10 Gb/s bi-directional transmission over polymer fibre [4] have previously been reported. However, these demonstrations used single pixels from their respective micro-LED arrays, and did not utilise the multi-pixel array-nature of these devices. Here we report on a complete integrated system, comprising of micro-LED arrays, a complementary metal-oxide-semiconductor (CMOS) LED driver chip, and a CMOS-based avalanche photodiode (APD) array. This allows each pixel in the micro-LED to be individually-controlled in a flexible fashion. Each micro-LED can either be used to transmit the same data, in order to increase the transmitted power (“ganging” configuration), or different pixels can simultaneously transmit independent data streams (“MIMO”), whilst retaining compatibility with any optical modulation scheme. Similarly, at the receiver, a 3×3 array of high-speed APDs can either be read out independently, or have their inputs summed together. We will present recent results using this system showing data transmission rates exceeding 1 Gb/s over 1 m of free space. This represents an important milestone towards a scalable, flexible and high-speed integrated VLC system.


