Enabling Next Generation Datacenter Interconnects

How the UXR Oscilloscope Helps to Realize Highest Speed Data Communications

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Client

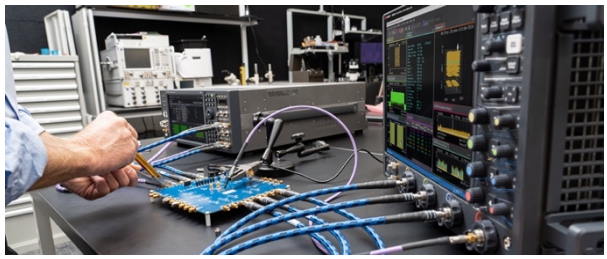
ETH Zürich is the leading technical university in continental Europe, its institute of electro-magnetic fields (IEF) has a long and given reputation in the optical data communications community. The institute is led by Prof. Dr. Juerg Leuthold who has worked in that field for his whole life. As a recent PhD. student at IEF Laurenz Kulmer has lately contributed to the results as follows.

Background

The IEF institute is one of the leading contributors to high bandwidth electro optic modulators, with a special focus on plasmonic modulators. This has enabled many applications from highest speed small form factor and low energy consumption optical data communication to transparent – subTHz – fiber data links enabled by plasmonic modulators. All this was made possible through
the advanced manufacturing capabilities of highest speed modulators as well as the broad knowledge in high-data-rate optical communication links.

Challenge

The ever-growing demand for faster communication links, whether wired or wireless, has led to the development of higher capacity data links. 6G or subTHz wireless channels are becoming increasingly popular in research for their abundance of bandwidth and telecom standards foresee that data rates for communication systems will grow beyond 100 to 200 Gbit/s. However so far high bandwidth signals, taking advantage of the abundant bandwidth of plasmonic devices have been limited by the bandwidth of available DAC and ADC. Hence most implementations in the past have been using multiplexing in wavelength or polarization as well as higher modulation formats to increase data rates. These are possibilities, but the single channel line rate still needs to be improved to further increase the efficiency of future communication networks. This is necessary to keep system complexity low with a special emphasis on short reach high throughput datacenter links.
In order to increase the single channel line rate, high speed equipment is needed to take advantage of the modulators bandwidth.



Solution

While commercially available solutions are starting to reach electro optic bandwidths around 110 GHz, plasmonic modulators have been presented to work for higher frequencies. Many publications have indicated the vast electro optic

bandwidth of plasmonic modulators. A 3 dB bandwidth in excess of 500 GHz is anticipated with operation shown at up to 2.4 THz. Furthermore, plasmonic modulators have been shown to offer low driving voltages enabling operation at lower power consumption. This should enable high bandwidth operation and single channel line rates in excess of 1 Terabit/s. So far demonstrations have been limited by the available electrical sources as well as receivers. The Keysight Arbitrary Waveform Generator (AWG) featuring 256 GSa/s mitigates the problem at the transmitter. Together with the UXR oscilloscope from Keysight featuring 110 GHz of bandwidth and a sampling rate of 256 GSa/s a solution at the receiver is also available. Finally, the available bandwidth of electro optic devices can be utilized more effectively. This equipment in combination with these devices has already enabled and will allow highest single line rate performances.

Results

Recently racetrack modulators, a subset of plasmonic modulators, have been shown to be highly efficient for data communication [1]. They provide lower device losses compared to their normal counterpart and therefore offer a good solution to high losses often seen in plasmonic modulators. The structure of the modulator together with the experimental setup of the now presented results can be seen in Figure 1.

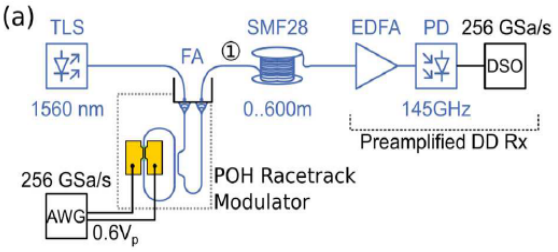


Fig. 1 System setup of the presented results. Adapted from [1].

Fiber-to-fiber losses of only 7 dB with pure device losses in the region of 1 dB were demonstrated. In addition, a 3 dB bandwidth of over 110 GHz was confirmed. With help of the new equipment these device characteristics could be exploited to show highest speed data transmission over a medium length fiber link. The modulator was driven by the new AWG enabling symbol rates of up to 220 GS/s featuring line rates of up to 408 Gb/s. The signals were then sent through a fiber span of up to 600m which could enable future short distance data center links. Afterwards the signal was detected using IM/DD and being sampled by the new UXR oscilloscope.
The results obtained with the help of the new equipment can be seen in Figure 2.

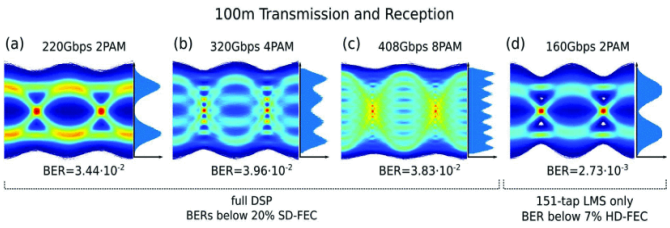


Fig. 2 Obtained eye-diagrams of the presented results enabled by plasmonic racetrack modulators as well as the new high-speed equipment.

By offering higher speeds as well as better bandwidth characteristics with the new transmitter and receiver equipment, highest symbol rates could be achieved. Together with our newly optimized devices this succeeded in highest realized symbol rates with racetrack modulators using direct detection.

Key Advantages

The Keysight M8199A AWG (Arbitrary Waveform Generator) offers sample rates of up to 256 GSa/s on up to 4 channels simultaneously. This industry leading sample rate is an enabling technology to demonstrate the capability of plasmonic modulators to work with symbol rates of up to 220 GS/s featuring line rates of up to 408 Gbits/s.
To demonstrate these data rates the superior performance of the Keysight UXR Oscilloscope with bandwidths of 110 GHz and sample rates of 256 GSa/s on four channels simultaneously is required to act as a decoder on the receiver side.

References

[1] M. Eppenberger et.al., “Plasmonic Racetrack Modulator Transmitting 220 Gbit/s OOK and 408 Gbit/s 8PAM”, presented at the 2021 European Conference on Optical Communication (ECOC), 2021

Photo Credits

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