Electroabsorption Transceiver (EAT) for Radio-over-Fiber Applications

A. Stöhr, K. Kitayama[+], T. Kuri[*], and Dieter Jäger

Gerhard-Mercator-Universität Duisburg, ZHO - Optoelektronik, Lotharstrasse 55, 47057 Duisburg, Germany
Phone: +49 203 379 - 2825, Fax: +49 203 379 - 2409, E.mail: stoehr@uni-duisburg.de

[+]Osaka University, Dept. of Electron., Information Systems and Energy Eng., 2-1 Yamadaoka, Suita, 565-0871 Osaka, Japan
Phone: +81 6 6879 – 7962, Fax: +81 6 6879 7688, E.mail: kitayama@comm.eng.osaka-u.ac.jp

*Communication Research Laboratory, Lightwave Network Section, 4-2-1 Nukui-kitamachi, Tokyo 184-8795, Japan
Phone: +81 423 27 – 6331, Fax: +81 423 27 7035, E.mail: kuri@crl.go.jp

Future wireless communication is expected to offer broadband radio access and mobile multimedia services to a large number of subscribers. Consequently, the carrier frequency of such wireless systems will be within the millimeter (mm) wave band where a sufficient number of channels with sufficient bandwidth is available. Since the electrical transmission of such mm-wave signals over long distances is not feasible, radio-over-fiber systems have attracted great interest as they are considered to form the backbone of future broadband mm-wave wireless communication systems. Obviously, the successful implementation of fiber-optic links in mass-market applications will strongly depend on the costs of the infrastructure. In that respect, the cost of each single base station (BS) is a very critical factor since future mm wave fiber-optic networks are expected to support a large number of remote BSs connected to the central station (CS). Consequently, it is of great interest to develop radio-over-fiber system architectures and components that enable a highly centralized CS in conjunction with less-equipped BSs in which the employment of expensive optical and mm wave electronic components is extensively avoided. Recently, various system architectures have already been presented utilizing microwave photonic techniques for optical mm wave generation, transmission and mixing in order to shift functionality towards the CS and simplify the BS complexity. Further system improvements is accomplished by employing integrated multifunctional optical transceivers that are especially tailored for analog mm wave applications and can provide optical mm wave modulation as well as detection and mixing functionality [1-3]. This enables the realization of extremely small and cost-effective full-duplex *single-optical-component* base stations.

In this paper a novel photonic transceiver component and its application in radio-over-fiber networks will be discussed. In detail, the paper is concerned with 1.55µm waveguide electroabsorption transceivers (EATs) that are tailored to mm wave radio-over-fiber applications. The fundamental EAT concept and its characteristic are discussed in detail. Furthermore, various system architectures using different types of EAT are presented and discussed in terms of system performance and cost effectiveness. Experimentally, the employment of a high-speed EAT in 60GHz mm wave radio-over-fiber link is investigated and full-duplex broadband (155.52Mbit/s) fiber optic transmission in a 60GHz point-to-point link is demonstrated. Moreover EAT have been employed in a radio-over-fiber network with a fiber-ring configuration using wavelength routing to allocate the various BSs in the fiber-ring. The presented system architectures will show good perspectives to realize the concept of a single-optical component at the BS demonstrating that the EAT is a promising candidate for a near-term solution.

The electroabsorption transceiver investigated in this paper is dual-function modulator/photodetector device based upon a high-speed 1.55µm EA waveguide structure. The devices simultaneously utilize the quantum confined Stark effect (QCSE) induced electroabsorption changes for modulation as well as the high fundamental absorption at lower wavelength for detection. A coplanar electrical waveguide is used to contact the active high-frequency section of the transceiver and V-grooves are used for the alignment of tapered single mode fibers to the active section.

References

[1] L. Noël, D. Wake, D.G. Moodie, D.D. Marcenac, L.D. Westbrook, and D. Nesset, "Novel Techniques for High-Capacity 60GHz Fibre-Radio Transmission Systems," IEEE Trans. on Microwave Theo. and Technol., vol. 45, no. 8, 1997, pp. 1416-1423.

[2] A. Stöhr, T. Kuri, K. Kitayama, R. Heinzelmann, and D. Jäger, "Full-duplex 60GHz Fibre-Optic Transmission," Electron. Lett., vol. 39, no. 19, pp. 1653-1655, Sept. 1999.

[3] K. Kitayama, A. Stöhr, T. Kuri, R. Heinzelmann, D. Jäger, and Y. Takahashi, "An Approach to Single Optical Component Antenna Base Station for Broad-Band Millimeter-Wave Fiber-Radio Access Systems," IEEE Trans. Microwave Theory and Techniques, vol. 48, no. 12, pp. 2588-2595, Dec. 2000.