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Demonstration of Tunable Delay Detection for Millimeter-Wave Wireless Signal Using Optical Phase Modulator and Optical Fiber Dispersion Effect

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In beyond-5G/6G mobile wireless communication network, wireless carrier frequency will be moved to the higher frequency ranges (millimeter-wave (MMW) or THz) to realize high-speed data transfer with low latency and massive connectivity. For the control and detection of these high-frequency wireless signals, the digital signal processing technique with A/D conversion becomes rather challenging from the point of power consumption. Then, we proposed a new high-speed signal processing technique using an optical phase modular driven by multiple laser signals with different wavelengths combined with a RoF (Radio-over-Fiber) scheme [1]. By tuning the wavelength separation between the two lights to generate an appropriate temporal delay, which can be set to be one symbol in the wireless data signal stream, a delay detection operation of differentially coded signals is obtainable. This detection technique is applicable in the MMW/THz frequency bands with low power consumption. This paper report on tunable delay detection operation using the proposed technique.

Fig. 1 shows the experimental set-up. An electro-optic (EO) phase modulator using an array of antenna-coupled electrodes designed around 30 GHz [2] was used. For the conversion of phase modulated light to intensity modulated light, a single-mode standard silica fiber cable (D =16ps/nm • km) of 4 km long was used, which can also be a delay line for the delay detection operation. Fig. 2 shows the obtained results of the DBPSK signals when the data repetition frequency was changed from 0.4 to 2 GHz. By only controlling the wavelength difference between the two lights supplied to the EO phase modulator, the delay time for the signal detection was changed and the tunable delay detection operation was demonstrated successfully. This technique is also applicable for wireless vector modulation signals like QPSK or QAM.

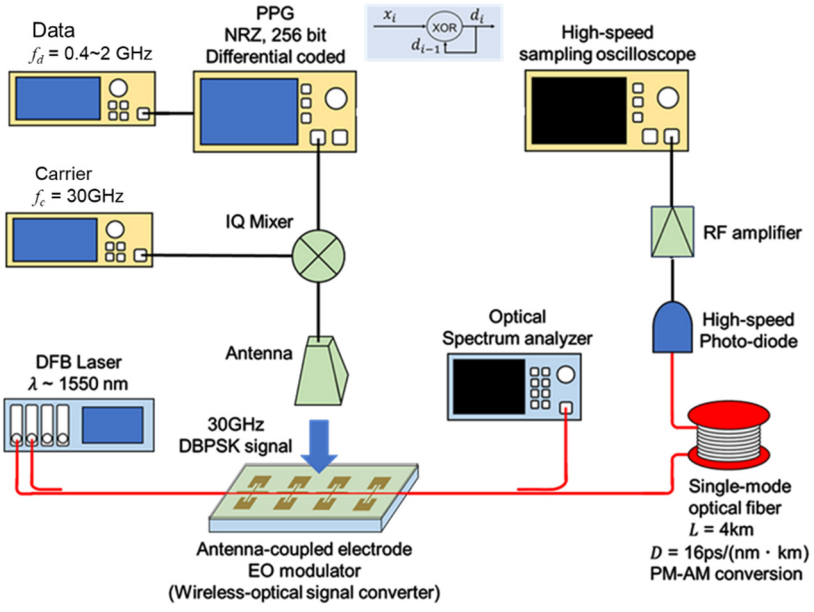

Figure 1. Experimental set-up for tunable signal detection.

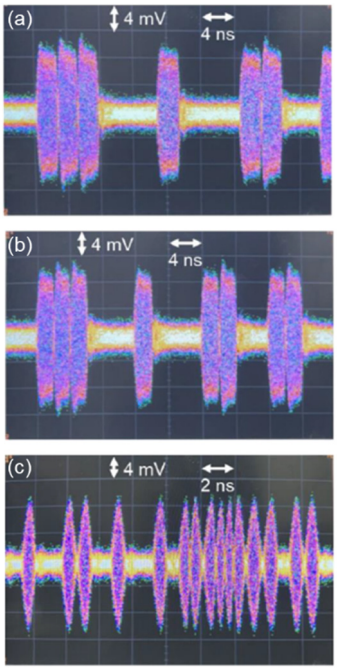

Figure 2. Detected signal.
(a) f_d = 0.4 GHz (b) 0.5 GHz (c) 2 GHz.

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1. N. Ueda, Y. Fujikata, Y. Otagaki, and H. Murata, "Wireless Signal Processing Using Antenna-Coupled Electrode Electro-Optic Modulator and Optical Fiber Dispersion Effect," *4th URSI AT-RASC 2024*, May 2024, Gran Canaria, Spain.
2. H. Murata, H. Yokohashi, S. Matsukawa, M. Sato, M. Onizawa and S. Kurokawa, "Antenna-Coupled Electrode Electro-Optic Modulator for 5G Mobile Applications," *IEEE Journal of Microwaves*, **vol. 1**, no. 4, pp. 902-907, 2021.