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WLAN Radio-on-Fiber Systems Based on CMOS Compatible Avalanche Photodetectors

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Abstract We demonstrate Radio-on-Fiber (RoF) systems for IEEE 802.11a Wireless Local Area Network (WLAN) based on Si avalanche photodetectors fabricated in standard CMOS process. Downlink data transmission of 20 Mb/s, 16 QAM signals in 5.24 GHz band is successfully performed.

Radio-on-fiber (RoF) systems for wireless local area network (WLAN) are becoming attractive because of their advantages including easy distribution of microwave signals and extended coverage between central station and access points [1]. With employing low-cost AlGaAs/GaAs VCSELs and multimode fibers, cost-effective implementation of RoF systems also can be possible. In addition, utilization of CMOS compatible avalanche photodetectors (CMOS-APDs) enables further cost reduction as a result of single chip integration of remote antenna units. The CMOS-APD can detect 850 nm optical signal and provide internal gain due to avalanche process. In this work, we demonstrate the RoF systems for IEEE 802.11a WLAN using the CMOS-APD. The bias voltage of the CMOS-APD is optimized and 20 Mb/s, 16 QAM data transmission at 5.24 GHz band is performed for feasibility demonstration.

Fig. 1 shows the proposed RoF system downlink configuration for WLAN based on CMOS-APDs. In the central station, data signal is frequency up-converted using WLAN transmitter and direct modulated to optical signal using a VCSEL. At remote antenna units, transmitted optical signal through multimode fiber is photodetected by the CMOS-APDs, amplified and then radiated via antennas. The mobile terminals have no modification to conventional WLAN receivers.

The CMOS-APD is implemented using 0.18 ㎛ standard CMOS process and detailed structure is shown elsewhere [2]. In the experiments for the demonstration of RoF system, WLAN transceivers board provided by

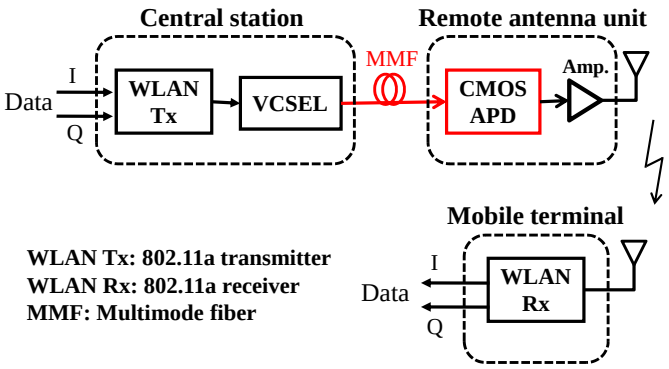

Fig. 1. RoF system downlink configuration for WLAN based on CMOS-APDs.

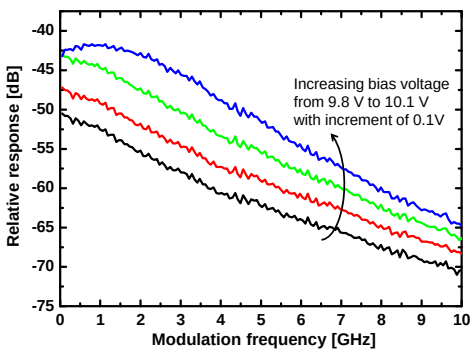

Fig. 2. Photodetection frequency response of CMOS-APDs at different bias voltages.

MAXIM-IC were used and wireless link was omitted by connecting the output of the CMOS-APD and input of the WLAN receiver without an amplifier. For the generation and demodulation of baseband data signal, vector signal generator (VSG), and analyzer (VSA) were used. In order to optimize bias voltage of the CMOS-APD, we measured photodetection frequency response at different bias voltage as shown in Fig. 2. It is seen that the photoresponse increases with increasing bias voltages and rf-peaking enhances photodetection 3-dB bandwidth, thus photodetection efficiency at high frequency region [2]. For narrow band application such as WLAN, the frequency roll-off of photodetection frequency response has no problem [1]. Utilizing the CMOS-APD, we transmitted 20 Mb/s, 16 QAM data through RoF systems. Fig. 3 shows output spectrum of the CMOS-APD. It is clearly observed that 5 MHz data signal at 5.24 GHz band is transmitted and photodetected by the CMOS-APD. For the evaluation of transmitted data, this photodetected signal is frequency down-converted and demodulated using WLAN receiver and VSA, respectively. Fig. 4 shows constellation and eye diagram of demodulated 20 Mb/s, 16 QAM data signal at VSA. These results confirm the successful data transmission of RoF systems using the CMOS-APD. The measured error vector magnitude (EVM) is approximately 4.6 %, which corresponds to about 24 dB signal-to-noise ratio (SNR).

We implement RoF systems for IEEE 802.11a WLAN based on CMOS-APDs and demonstrate data transmission. These results verify that CMOS-APDs can be used in remote antenna units for RoF systems of WLAN in cost-effective manner. Utilizing the proposed systems, coverage between central station and remote antenna units can be extended with the help of fiber-optic technique.

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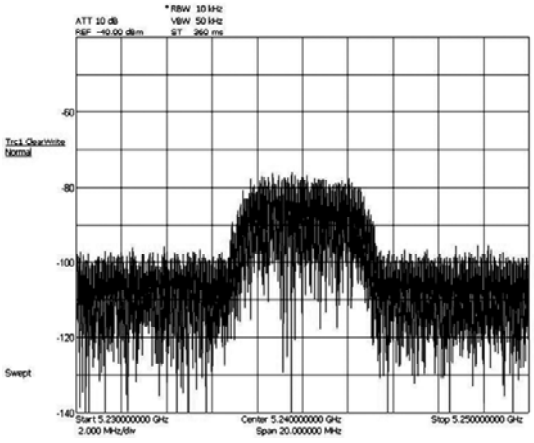

Fig. 3. Spectrum of the CMOS-APD output.

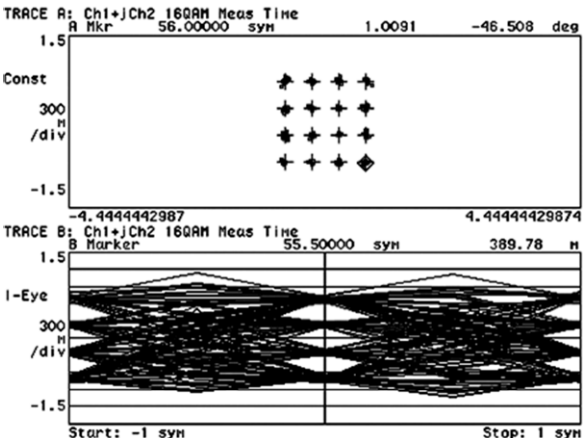

Fig. 4. Constellation and eye diagram of demodulated 20 Mb/s, 16QAM data signal.