

APMP 2010

Asia-Pacific Microwave Photonics Conference 2010

The Hong Kong Polytechnic University

26 - 28 April 2010

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Welcome Message

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Asia-Pacific Microwave Photonics Conference 2010 (APMP2010) will be held at [The Hong Kong Polytechnic University](#), Hong Kong SAR from 26 to 28 April 2010. The Conference is organized by The Hong Kong Polytechnic University and Jinan University, China. It is co-sponsored by the IEEE LEOS Hong Kong Chapter. The Conference will cover all major areas in microwave photonics along with tutorial sessions and invited sessions in areas of current interest. We look forward to your participation in the APMP2010 to make the Conference a success. Please note that the conference paper submission deadline has been extended to 17 January, Sunday, 2010.

Devices, components and subsystems :

Wideband and linear photonic devices
Signal processing and techniques for optical spectra synthesis
Optically controlled and/or injected microwave devices
Optical probing and measurements
High-speed optical analogue to digital conversion
Hybrid and chip-level integration of photonics devices and circuits
Photonic and electromagnetic wave band-gap structures
Sensors using photonic and microwave technologies
Lightwave technologies for millimeter-wave and THz signal processing
MEMS for microwave photonics

Systems and applications:

Photonic generation, distribution, detection, processing, filtering and control of microwave signals
Fiber-fed wireless and cellular radio systems and networks
Analog, digital and subcarrier multiplexed microwave photonic links
Optical frequency metrology and control
Optical wireless systems based on free-space optics
Optical controlled phase array antenna systems and antenna remoting
Lightwave transmission systems using advanced modulation formats
Tera-Hertz waves and system applications
Microwave photonic design and modeling
Field trials
Novel applications of microwave photonic systems (biomedical, ultrawideband, terahertz)

Submission of Papers: Authors are invited to submit 2-page papers in the form of an electronic file in PDF. The title of the paper, author's name, affiliation, complete return address, telephone number and email address must appear at the top of the first page, followed by a 35-word abstract. Sample template can be found from the homepage of the Conference.

Important Dates:

Paper Submission Deadline	:	Sunday, 17 January 2010
Acceptance Notification	:	1 February 2010
Early Bird Registration Deadline	:	Monday, 22 March 2010
Hotel Accommodation Deadline	:	Friday, 26 March 2010
Conference	:	26 - 28 April 2010

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Optoelectronic Mixers for Fiber-fed 60-GHz Wireless Systems

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Abstract

We have investigated millimeter-wave fiber-fed wireless systems using optoelectronic mixers based on hetero-junction bipolar transistors and CMOS avalanche photodiode. In addition, the CMOS integrated optical receiver for the base station front-end has been implemented and, with it, 60-GHz broadband data transmission demonstrated.

Introduction

Recently, the demand for high quality multimedia services has stimulated great interests for wireless communication systems that can provide Gbps-level transmission capacity. In particular, 60-GHz wireless communication is very attractive because it can provide large data throughput using the license-free wide-bandwidth 60-GHz carrier. However, as the data rate increases, wireless receivers usually demand increased power and the coverage of each base station becomes smaller, resulting in the increased number of base stations. In addition, higher directivity of 60-GHz signals can introduce larger shadowing areas. The fiber-fed wireless system can solve these problems. With such advantages of optical fiber as low loss, large bandwidth and transparent characteristics, one central station with centralized functionality can support large number of base stations through fiber. Then, the antenna base station can be greatly simplified for overall cost reduction

The simplest scheme for fiber-fed wireless system can be realized with the optical millimeter-wave transmission technique [1]. In this scheme, the base station only converts optically modulated millimeter-wave signals to electrical signals for wireless transmission. Although this method can simplify the base station architecture, in high frequency applications such as 60-GHz wireless communication, the cost can be a problem since optical components operating at 60 GHz are too expensive as of yet. In another approach called remote up-conversion technique [2], data signals are transmitted through optical fiber in intermediate frequency (IF) domain and frequency up-converted to 60-GHz band in base stations as shown in Fig 1. This scheme can reduce the burden of high-speed optical components.

One of the key components of the remote up-conversion technique is the efficient and cost-effective optoelectronic (O/E) mixer, which performs photo-detection and frequency conversion functions

simultaneously. We have demonstrated O/E mixers with high-speed electronic devices such as hetero-junction bipolar transistors (HBTs) for 60-GHz applications [3]. HBT-based optically injection-locked oscillator has been also demonstrated, which can utilize the optically distributed local oscillator (LO) signals from central station replacing the electrical LO source in base stations [4]. As a more cost-effective solution, CMOS technology has been employed. CMOS based 60-GHz harmonic optoelectronic mixers and harmonic self-oscillating mixers have been achieved, that are based on nonlinearity of CMOS avalanche photo-diodes (APD) [5, 6]. The most significant advantage of CMOS technology is its capacity for integration of optoelectronic devices with electric circuits. A CMOS integrated optical receiver having APD and trans-impedance amplifier (TIA) was implemented and employed as the base station front-end followed by an electrical up-conversion mixer [7]. In this paper, fiber-fed wireless systems based on these O/E mixers are briefly reviewed.

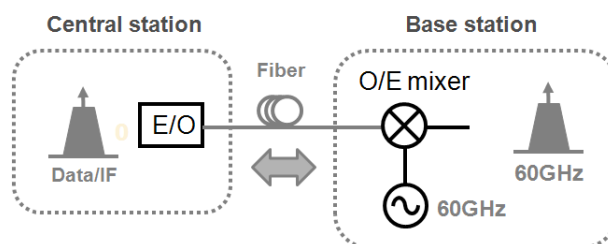


Fig. 1. Configuration of fiber-fed wireless system using remote up-conversion scheme.

O/E mixers based on InP HBT and CMOS APD

Fig. 2 shows a bi-directional fiber-fed wireless realized with an InP HBT O/E mixer. The optical LO signals having two optical modes separated by 60 GHz are supplied from central station to the HBT O/E mixer in base station resulting in photo-detected LO signals. The optical IF signals are also optically injected into the HBT O/E mixer, and photo-detected, amplified and frequency up-converted to 60-GHz band by photo-detected LO signals [3]. The uplink RF signals injected into the HBT mixer are frequency down-converted to IF band. Using this system, we have successfully demonstrated bi-directional transmission of 20-Mb/s 16-QAM signals in 60-GHz band including 30-Km fiber-optic link and 3-m wireless link [3].

Fig. 3 shows a system using a 60-GHz CMOS harmonic O/E mixer. The mixer was implemented with a

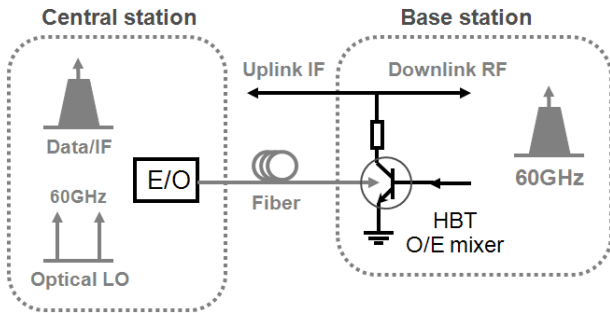


Fig. 2. Schematic of bi-directional fiber-fed wireless system based on frequency up/down conversion of HBT O/E mixer.

Si APD which provides photo-detection of 850-nm optical signal with avalanche gain. With the reverse bias voltage increases, avalanche gain increases due to the enhanced electric field. Consequently, photo-detected IF signals can be modulated by external LO signals. Our harmonic O/E mixer can generate 60-GHz RF signals with 30-GHz electrical LO and IF signal can be optically injected into the device as shown in Fig. 3. Using the harmonic O/E mixer in base station, we successfully demonstrated downlink data transmission of 25-Mb/s 32-QAM signals in 60-GHz band including 3-m multimode fiber link [5].

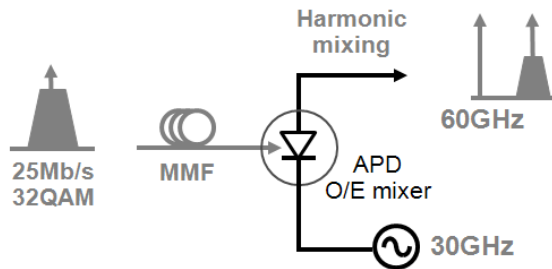


Fig. 3. Schematic diagram of 60-GHz harmonic O/E mixer based on CMOS avalanche photo-diode.

Self-oscillating O/E mixers

A self-oscillating O/E mixer (SOM) is an upgraded version of an O/E mixer. A self-oscillating mixer is based on an oscillator and generates higher power LO signals for higher conversion efficiency than a simple O/E mixer. However, the LO signal generated in SOM is a free-running oscillator with phase noises and frequency drift, which can seriously affect phase modulated signals. One solution is optical distribution of phase-locked LO signals from central station as shown in Fig. 4. Because the SOM can be locked by the injected LO signal and can provide constant output, the SOM conversion efficiency is not sensitive on optically injected optical LO power. Using an InP HBT-based SOM as a harmonic frequency up-converter and optical LO injection, we demonstrated 60-GHz downlink transmission of 20-Mbps 16-QAM data for wide range of optical LO power

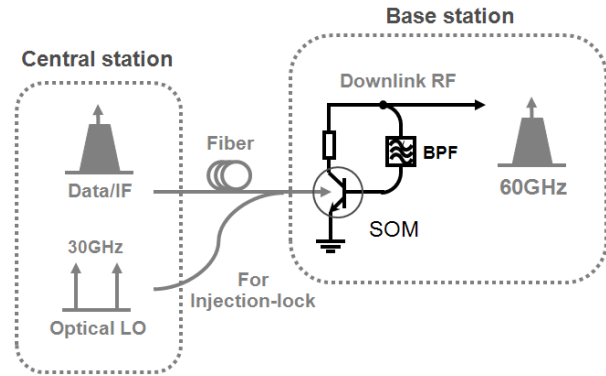


Fig. 4. Schematic diagram of 60 GHz fiber-fed wireless system based on self-oscillating mixer and optical LO distribution.

from -11 to 0 dBm [4]. CMOS APD can be also used for realizing the SOM. Using this, we demonstrated downlink transmission of 25-Mb/s 32-QAM data including 3-m multimode fiber and 1-m 60-GHz wireless link [6].

Acknowledgement

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