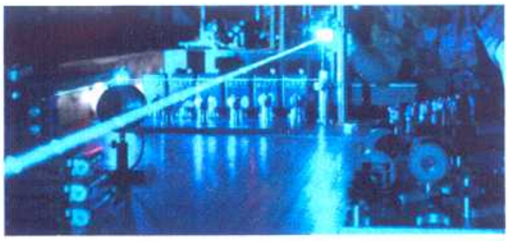
Australian Workshop on Microwave Photonics 2006

8 December 2006
Rydges Carlton, Melbourne Australia



Technical Digest

CUBIN
ARC Special Research
Centre for Ultra-Broadband
Information Networks

Australian Government
Department of Defence
Defence Science and
Technology Organisation

AUSTRALIAN WORKSHOP ON MICROWAVE PHOTONICS

December 8, 2006,
Rydges Carlton Hotel, Melbourne, Australia

PROGRAM

8:30am-9:00am	**Registration and Coffee**
9:00am-10:30am	**WELCOME and PLENARY SESSION** CHAIR: Dr Thas Nirmalathas, NICTA University of Melbourne, Australia **9:00 Welcome address** **9:10** ***“Advanced lightwave modulation techniques for micro- and millimeter-wave photonics”*** Dr Tetsuya Kawanishi, NICT Japan **9:50** ***“Speed lasers: The sky is the limit?"*** Professor Rod Tucker. CUBIN University of Melbourne, Australia
10:30am-11:00am	**Morning Coffee**
11:00am-12:30pm	**Session : DEFENCE APPLICATIONS and IMAGING** CHAIR: Dr Linh Nguyen, DSTO Australia **11:00** ***“T-ray imaging: Bridging the spectral gap between photonics and electronics”*** Professor Derek Abbott, The University of Adelaide, Australia **11:30** ***“Defence applications of RF photonics”*** Dr David Hunter, DSTO Australia **11:50** ***“All fiber high tap count finite impulse response microwave filter”*** Dr Desmond Lim, DSO Singapore **12:10** ***“Polarization Mode Dispersion Mitigation in Coherent Optical OFDM Systems”*** Dr William Shieh, CUBIN The University of Melbourne, Australia
12:30pm-2:00pm	**LUNCH and POSTER SESSION**
2:00pm-3:30pm	**Session : DEVICES and MONITORING** CHAIR: Dr David Hunter, DSTO Australia **2:00** ***“Photonic signal processing with LiNbO3 devices”*** Dr Arnan Mitchell, RMIT University, Australia **2:20** ***“Issues in the implementation of millimeter-wave systems on bulk CMOS”*** Dr Stan Skafidas, NICTA University of Melbourne, Australia **2:40** ***“Passively and actively mode-locked DBR laser for 34.5 GHz and 69 GHz signal generation”*** Dr Frederic Van Dijk, Alcatel-Thales III-V Lab, France **3:00** ***“Dispersion monitoring in WDM systems using microwave modulated ASE”*** Dr Graeme Pendock, CUBIN The University of Melbourne, Australia **3:15** ***“Linewidth-induced signal fidelity degradation in simple passive photonic RF memory”*** Dr Linh Nguyen, DSTO, Australia
3:30pm-4:00pm	**Afternoon Coffee**

4:00pm-5:35pm **Session : SYSTEMS and SIGNAL PROCESSING**

CHAIR: Professor Mike Austin, RMIT University, Australia

4:00 ***"Millimeter-wave photonics for future RoF systems"***
Dr Toshiaki Kuri, NICT Japan

4:20 ***"60 GHz RoF systems using remote frequency conversion technique based on HBT optoelectronic mixers"***
Dr Jae-Young Kim, Yonsei University, Korea

4:40 ***"Electro-optic image scope of electromagnetic near-fields on the basis of ultra-parallel photonic mixing scheme"***
Dr Kiyotaka Sasagawa, NICT Japan

5:00 ***"Time-Wavelength Signal Processing for Ultra-Fast Data Conversion"***
Dr Jason Chou, UCLA USA

5:20 ***"Integration of microwave and millimeter-wave radio-over-fiber systems in WDM-PON infrastructure"***
Dr Masud Bakaul, NICTA The University of Melbourne, Australia

5:35pm-7:00pm **NETWORKING SESSION**

60GHz RoF Systems Using Remote Up-conversion Technique based on HBT Optoelectronic Mixers

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Abstract — **We have investigated 60GHz radio-on-fiber systems using remote up-conversion technique and optoelectronic mixers. The optoelectronic mixers are implemented with heterojunction bipolar transistors (HBTs) and optically injection-locked HBT oscillators.**

I. INTRODUCTION

Recently, the demand for high quality multimedia services stimulates interests for new types of wireless communication systems that can provide higher capacity. For that, the 60GHz band is very attractive because it can provide wide bandwidth as well as high directivity. The recent spectrum allocation of 60GHz band for license-free operation and standardization activities of IEEE task group for 60GHz WPAN represent the rising interests for 60GHz band. The wireless communication systems in 60GHz band need a large number of antenna base stations (ABSs) due to high transmission loss of 60GHz waves in the air. Consequently, development of the cost-effective antenna base station is very important for reducing of system cost. Radio-on-fiber systems is an attractive candidate for 60GHz wireless networks, because they can connect a large number of base stations to one central station having centralized functions through fiber, which can support low loss and wide bandwidth transmission.

The simplest radio-on-fiber system can be realized based on the optical millimeter-wave transmission technique [1,2]. In this scheme, 60GHz radio signals are optically modulated and transmitted between CS and ABS. Although this method can simplify the ABS architecture, the system cost can be a problem since optical components operating at 60GHz are too expensive as of yet. In another approach called remote conversion technique [3,4], data signals are transmitted in the optical intermediate frequency (IF) domain and frequency up-converted to 60GHz band in ABSs as shown in Figure 1. In addition, optical distribution of 60GHz local oscillator (LO) signals from CS to many ABSs can reduce the system complexity by eliminating the electrical LO source in ABSs [5,6]. The key issue for this approach is the realization of efficient and cost-effective optoelectronic (O/E) mixer. We have achieved this with high-speed electronic devices such as heterojunction bipolar transistor (HBT) [7] and HBT-based optically injection-locked oscillator [8].

II. HBT-BASED OPTOELECTRONIC MIXERS

We investigated O/E frequency up/down conversion using InP HBT-based O/E mixer. When the optical LO signals at λ_{LO} having two optical modes separated by desired LO frequency from CS are injected into HBT in ABS, the photo-detected LO signals are generated with

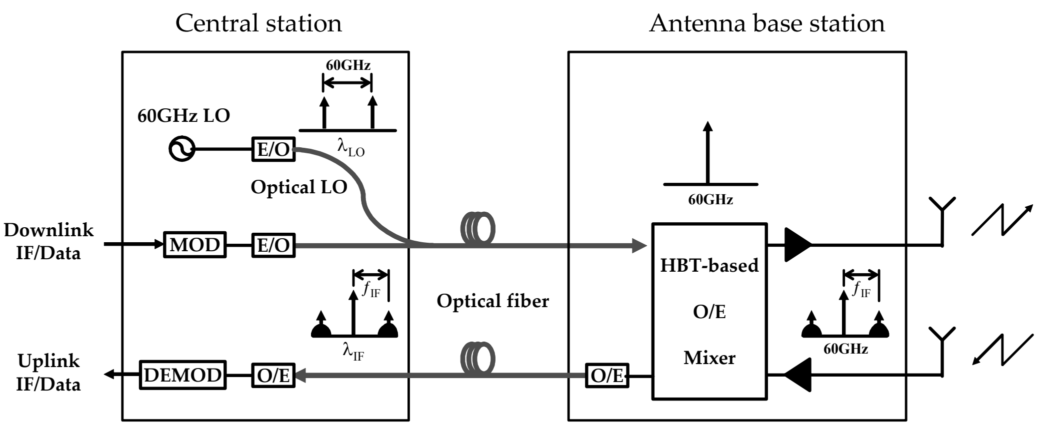

Figure1. Configuration of radio-on-fiber system using remote conversion scheme with optical LO distribution

help of high responsivity and wide photo-detection bandwidth of HBT. Consequently, the optical IF signals at λ_{IF} injected into HBT are firstly photo-detected, amplified and frequency up-converted to 60GHz band by photo-detected 60GHz LO signals as shown in Figure 2. Also, the frequency down-conversion of uplink RF signals can be done by injecting the RF signals into base terminal of HBT. Because the HBT O/E mixer offers multi-functions of photo-detection, amplification and frequency up/down-conversion from and to 60GHz band, ABS can be greatly simplified. Utilizing the HBT O/E mixer, we successfully demonstrated bi-directional transmission of 20Mbps 16QAM signals in 60GHz band including 30Km fiber-optic link and 3m wireless link [7]. In addition, the HBT-based optoelectronic mixer provides the possibility of single-chip realization of the ABS, in which all the necessary electronic components such as amplifiers and filters are monolithically realized along with the O/E mixer.

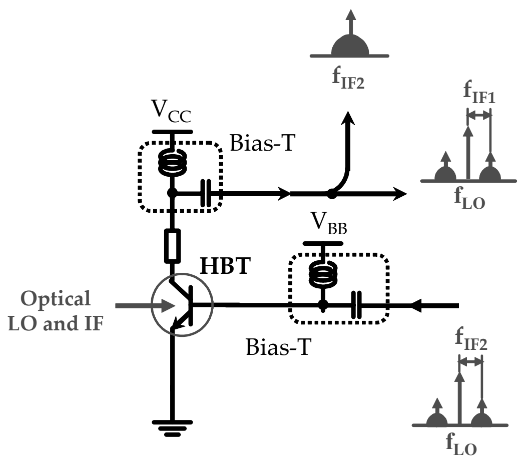

Figure2. Frequency up/down conversion using HBT O/E mixer

The optically injection-locked self-oscillating O/E mixer (OIL-SOM) based on HBT oscillator is an upgraded version of HBT O/E mixer, which shows higher frequency conversion efficiency. In OIL-SOM, the optically distributed LO signals from CS can injection-lock the free-running HBT oscillator, and the injection-locked LO signals are used for frequency up-conversion of photo-detected optical IF signals as shown in Figure 3. Because the LO power of OIL-SOM depends only on the power of free-running oscillator not on injected optical LO power, the supplied electrical LO power for frequency conversion can be greatly enhanced, while the low phase noise conditions are maintained. By the same reason, the conversion efficiency of OIL-SOM is not sensitive on optically injected optical LO power while the variation of optical LO power directly influences for performance of the HPT O/E mixer. Using the OIL-SOM as a harmonic frequency up-converter, we demonstrated 60GHz downlink transmission of 20Mbps 16QAM data for wide range of optical LO power from -11 to 0dBm [8].

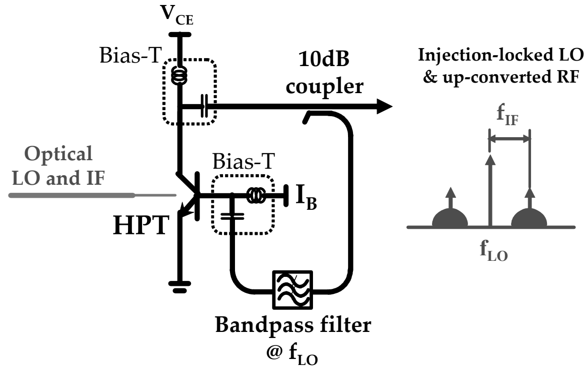

Figure3. Operation principle of HBT-based OIL-SOM

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