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한국 광 학 회  
[광 자 기 술 분 과]



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[광전자 및 전자파 연구회]

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15:20	(English Presentation)1.25Gbps WDM-RoF Wired/Wireless Optical Transmission Using Multiple SSB Carriers in FP LD by Multiple-mode Injection Locking	
F3B-2	Thang T. Pham, Hyun-Seung Kim, Yong- Yuk Won, Sang-Kook Han(Yonsei Univ.)	302
15:35	<b>자기 발진 고조파 광전 주파수 변환기를 사용한 광섬유 지원 60 GHz 대역 self-heterodyne 무선 시스템</b>	
F3B-3	이명재, 강효순, 최우영(연세대), 이광현(삼성전자)	304
15:50	X-밴드용 위상 배열안테나를 위한 4-비트 광 실시간 지연선로의 지터 특성	
F3B-4	윤영민, 이민영, 신종덕, 김부균(숭실대)	306
16:05	S-bending 기반 가변 컵 광섬유 격자를 이용한 주파수 가변 포토닉 마이크로파 Notch Filter	
F3B-5	정우진, 이주한(서울시립대), 배준기, 이관일, 이상배(KIST)	308

**학술발표 F3C 광섬유소자**

14:50-16:20 좌장 : 김창석(부산대)

14:50	(초청논문)레이저 가공을 이용한 다양한 광섬유 소자 제작과 활용	
F3C-1	신우진(APRI)	310
15:20	편광유지 광섬유 내 유도 브릴루앙 산란을 이용한 가변형 동적 격자의 구현	
F3C-2	송광용(중앙대), Kazuo Hotate(동경대, Japan)	312
15:35	(English Presentation)Bending Sensor based on a Helical Long-period Fiber Gratings (H LPG) Fabricated by Twisting	
F3C-3	정호중, 오경환(연세대), 신우진, 고도경, 이종민(APRI), 김준기(Fraunhofer IOF)	314
15:50	광자 결정 광섬유의 제작과 분산 특성 측정	
F3C-4	김봉균, 김태훈, 남호철, 정영주(GIST), 문대승(삼성광통신), 한영근(한양대)	316
16:05	VAD 공법을 이용한 판다형 편광유지광섬유 제조 및 특성평가	
F3C-5	최성순, 구석수, 조형수, 정창현, 이경구, 오치환, 유기선(옵토매직), 조민식, 권오선, 최우석, 송기원(국방과학연구소)	318

**학술발표 F3D LCD광학**

14:50-16:20 좌장 : 김학린(경북대)

14:50	기능성 광학필름을 이용한 반투과형 액정 표시장치에 관한 연구	
F3D-1	Yong-Woon Lim, Wonsuk Lee, Sin-Doo Lee(Seoul National Univ.)	320
15:05	바나나 모양 이축성 네마틱 액정의 온도에 따른 유전율 이방성 특성	
F3D-2	조진석, 이각석, 윤태훈, 김재창(부산대)	322

## Fiber-Supported 60-GHz Band Self-Heterodyne Wireless System with a Self-Oscillating Harmonic Optoelectronic Mixer

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Department of Electrical and Electronic Engineering, Yonsei University, <sup>1</sup>Samsung Electronics

### Abstract

We present a fiber-supported 60-GHz band self-heterodyne wireless system with a self-oscillating harmonic optoelectronic mixer (SO-HOM), which is based on a CMOS-compatible avalanche photodetector. The SO-HOM executes photodetection and frequency up-conversion at once. In order to demonstrate the feasibility of the system, downlink data transmission of 5 MS/s 32 QAM signals in 60-GHz band is achieved well.

There is growing interest in using 60-GHz band for broadband wireless network applications due to the availability of about 7 GHz of license-free band around 60 GHz. Furthermore, due to low-loss, large bandwidth, and a flexible medium of fiber-optic technology, fiber-supported millimeter-wave systems have been extensively studied for next generation broadband communication systems [1]. In this paper, we demonstrate a fiber-supported 60-GHz band self-heterodyne wireless system with a self-oscillating harmonic optoelectronic mixer (SO-HOM) based on a CMOS-compatible avalanche photodetector (CMOS-APD). 5 MS/s 32 QAM data transmission is performed well in the 60-GHz band.

Fig. 1 shows the schematic of the proposed system. Using a self-heterodyne method, a simple mobile terminal is possible by eliminating a phase-locked oscillator because RF data signals are transmitted with a local oscillation (LO) signal at the same time [2]. At an antenna base station, the SO-HOM consists of a CMOS-APD and feedback circuits including a band-pass filter (BPF), an amplifier, and a coupler. CMOS-APD provides photodetection and optoelectronic mixing which is owing to the nonlinear characteristic of avalanche process. The detailed device structure and characteristics of the fabricated CMOS-APD can be found in [3]. By feeding back the output of CMOS-APD to its input using the coupler, the SO-HOM is realized. Oscillation frequency is determined by the bandwidth

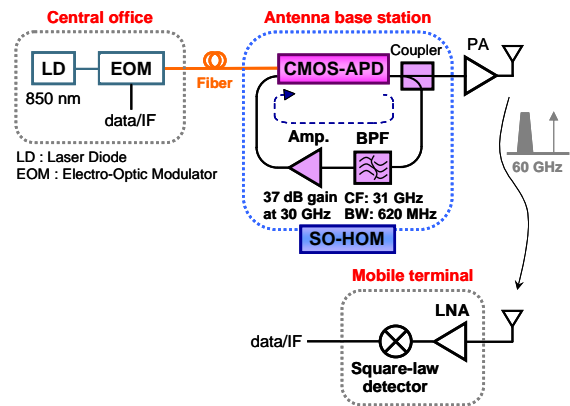


Fig. 1. Fiber-supported 60-GHz band self-heterodyne wireless system with the SO-HOM.

of the BPF, and the loop-gain must be larger than unity. The SO-HOM can simultaneously perform oscillation, photodetection, and optoelectronic mixing, so the simple antenna base station can be realized.

Downlink data transmission of 5 MS/s 32 QAM signals in 60-GHz band was demonstrated. As shown in Fig. 1, 850 nm optical signals were modulated by electrical 950 MHz IF data signals at the central office and transmitted to the antenna base station on 2-m long multimode fiber. The transmitted optical IF data signals were photodetected by CMOS-APD and upconverted to the 60-GHz band by the second order harmonic of the SO-HOM. Fig. 2 shows the spectrum of upconverted double sideband signals and second order harmonic of the SO-HOM. The input optical power was about 1 dBm, and the reverse bias voltage

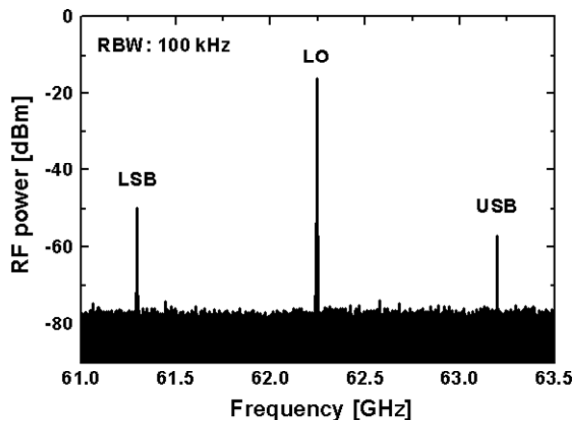


Fig. 2. Spectrum of upconverted signals and LO signal.

of 10.3 V was applied to CMOS-APD. The antenna base station sends out the RF data signals with a LO signals to the mobile terminal through 1-m free space by a 24-dBi gain antenna. The wireless link loss is about 68 dB in 60-GHz band, and a 26-dB gain power amplifier was used to compensate the free-space loss. At the mobile terminal, received data and LO signals were amplified by a 36.5-dB gain low-noise amplifier. Then, the data signals were downconverted to 950 MHz IF band using a square-law detector and analyzed by a vector signal analyzer. Fig. 3 shows the spectrum of downconverted data signals, and Fig. 4 shows the constellation and eye diagram of demodulated 5 MS/s 32 QAM data signals. The eye was clearly open and the measured error-vector magnitude was about 1.83 %, which corresponds to the 30.7 dB signal-to-noise ratio. We believe this should be adequate for most wireless applications.

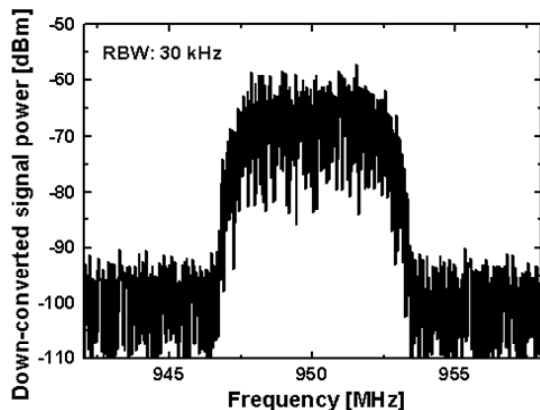


Fig. 3. Spectrum of downconverted signals.

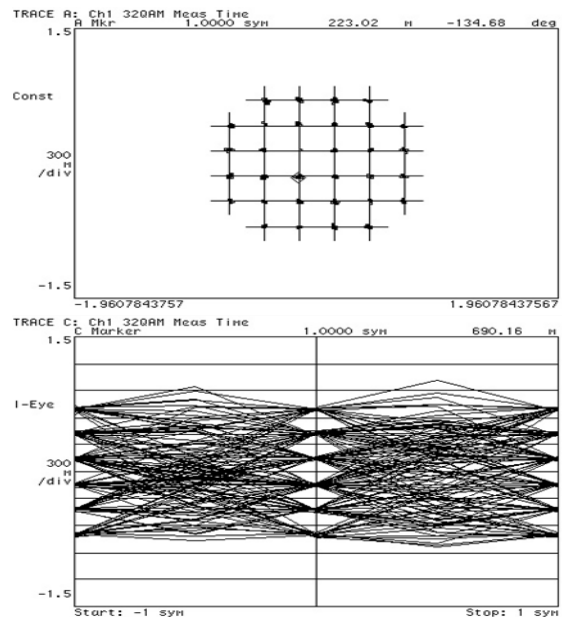


Fig. 4. Constellation and eye diagram of demodulated 5 MS/s 32 QAM data signals.

In summary, we presented the fiber-supported 60-GHz band self-heterodyne wireless system with the SO-HOM, which performs oscillation, photodetection, and optoelectronic mixing at the same time. To manifest the feasibility of our system, downlink data transmission of 5 MS/s 32 QAM data signals successfully performed in 60-GHz band. Although the feedback loop was executed by discrete components in this work, the SO-HOM can be realized by monolithic integration of CMOS-APD and required CMOS circuits.

## References

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- [2] Y. Shoji *et al.*, "Millimeter-wave remote self-heterodyne system for extremely stable and low-cost broad-band signal transmission," *IEEE Trans. Microw. Theory Tech.*, vol. 50, no. 6, pp. 1458–1468, Jun. 2002.
- [3] H.-S. Kang and W.-Y. Choi, "CMOS-compatible 60 GHz harmonic optoelectronic mixer," *IEEE MTT-S Int. Microw. Symp.*, pp. 233–236, Jun. 2007.