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Th4.3

Efficient optoelectronic de-embedding for VCSEL intrinsic response extraction, *A. Bacou[1], A. Hayat[1], A. Rissons[1], V. Iakovlev[2], A. Syrbu[3], J. C. Mollier[1], E. Kapon[3]*

[1]: Laboratory of microwaves and optoelectronics ISAE, Institut Superieur de l´Aeronautique et de lEspace , [2]: Bea mExpress S.A., [3]: EPFL, Laboratory of Physics of Nanostructures

In this present work, we propose a new method to remove the parasitics contribution to the VCSEL chip response, in order to obtain the intrinsic transmission behaviour. It has been observed that the S11 reflection coefficient of the chip is only due to the electrical access to the chip composed by the transmission line and cavity contacts. This allows us to decompose the chip into two cascaded subsystems representing the electrical access and the optical cavity respec tively. An equivalent electrical circuit is developed for the electrical access behaviour and, combined with the transfer matrix formalism, it becomes possible to remove the parasitics contribution from the measured S21 response. In this way, the intrinsic 3-dB bandwidth of the VCSEL can be determined.

Th4.4

Photonic Arbitrary Waveform Generator, *M. Gehl, C. Dapkus, A. Siahmakoun*

Department of Physics and Optical Engineering, Rose-Hulman Institute of Technology

An arbitrary waveform generator is demonstrated using WDM fiber-optic components. Cross-gain modulation method in a semiconductor optical amplifier is implemented to convert 3-bit digital words to an arbitrary analog waveform at a rate of 3 Gb/s.

Th4.5

Instantaneous Microwave Frequency Measurement Using an Asymmetric Non-linear Group Delay Profile, *J. Zhou[1], S. Fu[1], L. Xia[1], S. Aditya[1], P. P. Shum[1], C. Lin[1], V. Wong[2], D. Lim[2]*

[1]: Network Technology Research Centre, Nanyang Technological University, [2]: Temesek Lab, NTU

Instantaneous microwave frequency measurement with adjustable measurement range and resolution is demonstrated using a single non-linearly chirped fibre Bragg grating. Frequency measurement with good accuracy is experimentally realized with a compact setup.

Th4.6

Downstream Wavelength Reuse for Converged Wired/Wireless Access Networks Based on Sa turated Semiconductor Optical Amplifiers and Filtering, *G. Puerto-Leguizamón, J. Mora, B. Ortega, J.Capmany*

ITEAM Research Institute, Universidad Politécnica de Valencia

A Fabry-Perot based filter enables a low bandwidth saturated SOA to implement a wavelength reuse scheme for ups tream links featuring combined transport of wired and wireless signals. The architecture is experimentally demonstrated in this paper.

Th4.7

Full Colorless Gigabit WDM-Passive Optical Network With Simultaneous Two Different Signal Transmission, *Y.-Y. Won, H.-S. Kim, Y.-H. Son, S.-K. Han*

Departament of Electrical and Electronic Engineering, Yonsei University

A new wavelength division multiplexed-passive optical network (WDM-PON) scheme supporting the transmission of heterogeneous data as well as broadcast signal is proposed. Both an optical carrier suppression and multi plexing of arrayed waveguide grating (AWG) with 50-GHz channel spacing are employed to generate each optical carrier for the transmission of these data. A reflective semiconductor optical amplifier (RSOA) is also used so that this architecture operates irrespective of wavelength. In case of downlink transmission, error-free transmissions (BER of 10-11) of 1.25-Gb/s and 2.5-Gb/s baseband data are achieved at the same time. Also, 64-quadrature amplitude modulation (QAM) signal of 60 Mb/s is transmitted showing the error vector magnitude (EVM) of 4.7 % in the presen ce of the transmission of 2.5-Gb/s baseband data.

Th4.8

Simple Remote Heterodyne RoF System for Gbps Wireless Access, *I. González-Insua[1], D. Plette meier[1], C. G. Schäffer[2]*

[1]: Dresden University of Technology, [2]: Helmut Schmidt University Hamburg

A simple method for distribution of radio over fiber mm-wave signals for gigabit wireless access is presented. By hete rodyning two uncorrelated lasers, the mm-wave carrier can be freely adjusted. A broadband diode detector in the mobile unit allows envelope detection without a local oscillator and capability for multi-channel configurations.

Th4.9

Bidirectional optical access netwok based on POLMUX tecnique using centralized light sources, *J. Mora, B. Ortega, J. Capmany, F. Grassi*

ITEAM Research Institute, Universidad Politécnica de Valencia

We propose and demonstrate an optical network architecture with centralized light sources by using polarization multiplexing technique. The optical source which transports the downstream signal and the CW optical source which will be used in the remote Base Station are polarization multiplexed in the Central Office. After fiber transmission, both optical signals are polarization demultiplexed in the Base Station where the CW optical source is modulated by the upstream data at the Base Station.

Th4.10

2.1 Gbit/s Ultra-wide-band Transmission over 50-m GI-POF using Low-cost VCSEL, *H. Yang[1], E. Tangdiongga[1], J. Lee[1], S. Randel[2], Ton Koonen[1]*

[1]: COBRA Research Institute, Eindhoven University of Technology, [2]: Siemens AG

We report record transmission systems of ultra-wideband MB-OFDM signal over 50-m 900-_ m core graded-index PMMA POF using low-cost VCSEL at 667 nm. A gross bit rate of 2.1 Gbit/s is achieved with BER < 10-3.

Th4.11

622-Mb/s Downlink Transmission in a Fiber-Fed 60-GHz Wireless System Using a CMOS Integra ted Optical Receiver, *M.-J. Lee[1], J.-S. Youn[1], H.-S. Kang[2], D. Kim[1], M. Ko[1], K.-Y. Park[1], W.-Y. Choi[1]*

[1]: Department of Electrical and Electronic Engineering, Yonsei University, [2]: Samsung Electronics Company Ltd.

A fiber-fed 60-GHz wireless system using a CMOS integrated optical receiver for broadband data transmission is demonstrated. The CMOS integrated optical receiver fabricated with 0.13-_m standard CMOS technology consists of CMOS compatible avalanche photodetector, transimpedance amplifier, offset cancellation circuit, and output buffer. Downlink data transmission of 622-Mb/s BPSK data signals in the 60-GHz band is successfully demonstrated with BER less than 10-9 at the incident optical power of -4 dBm.

Th4.12

Low Cost Bidirectionnal QPSK Transmission With Optical Frequency Conversion, *F. Paresys, Y. Le Guennec, G. Maury, B. Cabon, Z. Bouhamri, V. Dobremez*

IMEP-LAHC, INP-Minatec

We propose and demonstrate a low cost bidirectional radio-over-fiber system based on the use of a simple p-i-n pho todiode (PD) and a VCSEL. PD provides both photodetection and frequency conversion capabilities and its mixing effi ciency is evaluated through the measurement of the PD non-linear parameter. The functionality of the RoF up-link and down-link systems is verified experimentally for microwave (MW) subcarrier frequency conversion of a 10 Mbaud QPSK digital signal in the 10 GHz band, measuring conversion gain and Error Vector Magnitude (EVM). The experi mental results demonstrate that the proposed bidirectional RoF system performs efficiently without significant distortion on the digitally modulated subcarrier, and could be advantageously used for mm-wave applications.

622-Mb/s Downlink Transmission in a Fiber-Fed 60-GHz Wireless System Using a CMOS Integrated Optical Receiver

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***Abstract*—A fiber-fed 60-GHz wireless system using a CMOS integrated optical receiver for broadband data transmission is demonstrated. The CMOS integrated optical receiver fabricated with 0.13-µm standard CMOS technology consists of CMOS-compatible avalanche photodetector, transimpedance amplifier, offset cancellation circuit, and output buffer. Downlink data transmission of 622-Mb/s BPSK data signals in the 60-GHz band is successfully demonstrated with BER less than 10^{-9} at the incident optical power of -4 dBm.**

I. Introduction

Recently, there has been a growing demand for broadband wireless data transmission for such applications as high-quality multimedia service and high-speed internet access. 60-GHz wireless systems have been extensively investigated because about 7 GHz bandwidth is available without the need for a spectrum license and 60-GHz components can be very compact. IEEE 802.15 WPAN Task Group 3c [1] has carried out standardization of the 60-GHz band wireless personal area network (WPAN) systems for such applications as HDTV wireless transmission [2] and high-speed ad-hoc wireless access [3].

Fiber-fed 60-GHz wireless systems can be are a promising solution for next-generation broadband communication systems, because optical data transmission using low loss, large bandwidth, and highly flexible fiber can extend the coverage limit due to high free-space loss at 60-GHz [4]–[7]. In these systems, broadband data signals can be optically distributed from a central office to antenna base stations via fiber. At the antenna base stations, transmitted data signals are photodetected and frequency up-converted to the 60-GHz band, and then radiated to mobile terminals through the wireless link. In order to realize these systems, numerous antenna base stations are needed due to the high free-space loss at 60-GHz. Therefore, low-cost antenna base stations are a critical factor for realization of fiber-fed 60-GHz wireless systems.

Using a CMOS-compatible opto-electronic mixer can provide an attractive solution for low-cost integrated antenna base stations. We have previously reported a cost-effective fiber-fed 60-GHz wireless system using a CMOS-compatible harmonic optoelectronic mixer [8] and a self-oscillating harmonic opto-electronic mixer [9] in the antenna base station. In this paper, we demonstrate broadband data transmission in a fiber-fed 60-GHz wireless system using a CMOS integrated optical receiver, which consists of CMOS-compatible avalanche photodetector (CMOS-APD), transimpedance amplifier (TIA), offset cancellation circuit, and output buffer [10]. At the mobile terminals, transmitted data signals are demodulated with a mixed-mode binary phase shift keying (BPSK) demodulator [11]. Data transmission of 622-Mb/s BPSK data signals in the 60-GHz band is successfully demonstrated.

II. Fiber-Fed 60-GHz Wireless System Using a CMOS Integrated Optical Receiver

Fig. 1 shows a schematic diagram of a fiber-fed 60-GHz wireless system based on a CMOS integrated optical receiver for broadband data transmission. At the central office, broadband data signals at the IF band are converted into optical signals and transmitted to the antenna base station through optical fiber. The transmitted optical signals are photodetected using the CMOS integrated optical receiver and frequency up-converted to the 60-GHz band with a mixer and phase-locked oscillator (PLO). The frequency up-converted signals are transmitted to the mobile terminal through the wireless link. At the mobile terminal, received signals are frequency down-converted to the IF band and data are demodulated.

A configuration of the CMOS integrated optical receiver fabricated with the 0.13-µm standard CMOS technology is shown in Fig. 2 [10]. The receiver is composed of CMOS-APD, TIA, offset cancellation circuit, and output buffer. For a high-speed and high-responsivity photodetector, CMOS-APD is used [12], and the output photocurrents of CMOS-APD are

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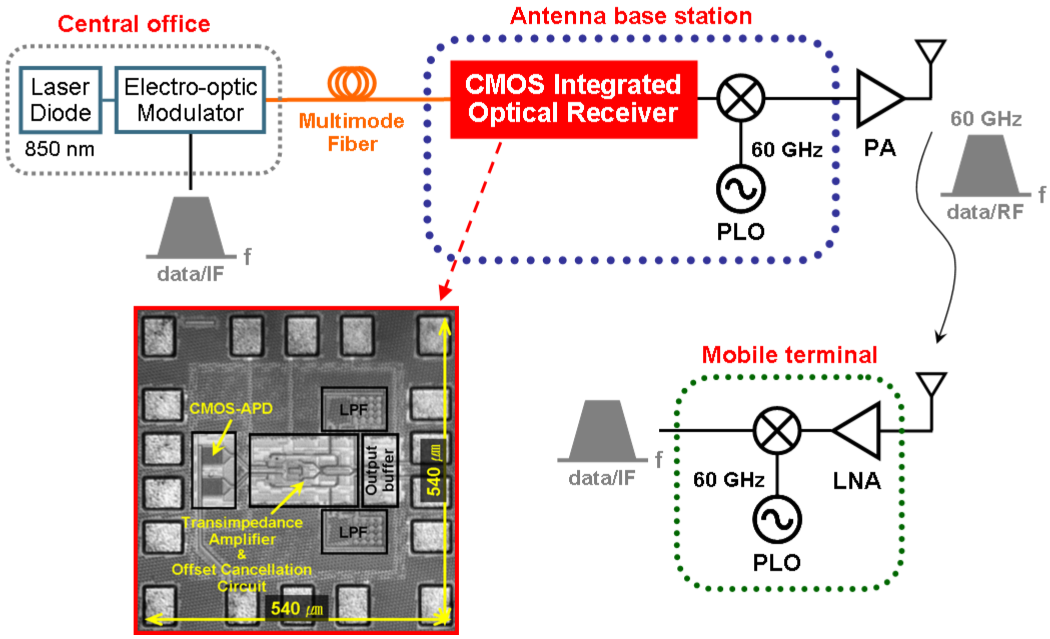

Figure 1. Schematic diagram of a fiber-fed 60-GHz wireless system using a CMOS integrated optical receiver for broadband data transmission. Inset is a microphotograph of the fabricated CMOS integrated optical receiver.

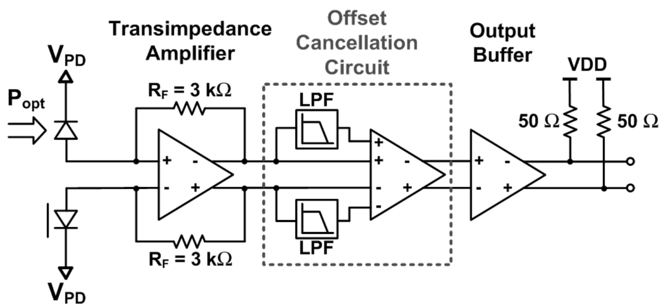

Figure 2. Configuration of the CMOS integrated optical receiver.

converted to voltage signals with amplification using a TIA [10]. The offset cancellation circuit is utilized for differential signaling because of the pseudo-differential output signals of the TIA, and output buffer for driving 50-Ω load. The chip size of the CMOS integrated optical receiver is 540 by 540 μm^2 as shown in the inset of Fig. 1.

Fig. 3 shows measured photodetection frequency responses of CMOS-APD and CMOS integrated optical receiver when the reverse bias voltage of the CMOS-APD is about 10 V and the incident optical power is about 0 dBm. As shown in this figure, the photodetected signal power is enhanced about 27.5 dB at the IF band.

III. EXPERIMENTAL RESULTS

Fig. 4 shows the experimental setup for downlink data transmission of 622-Mb/s BPSK data in the fiber-fed 60-GHz wireless system. At the central office, the BPSK data signals are generated by mixing 622 Mb/s 2^7-1 pseudo-random binary sequence (PRBS) data from a pattern generator with 1.44-GHz signals from a signal generator. The data signals are converted

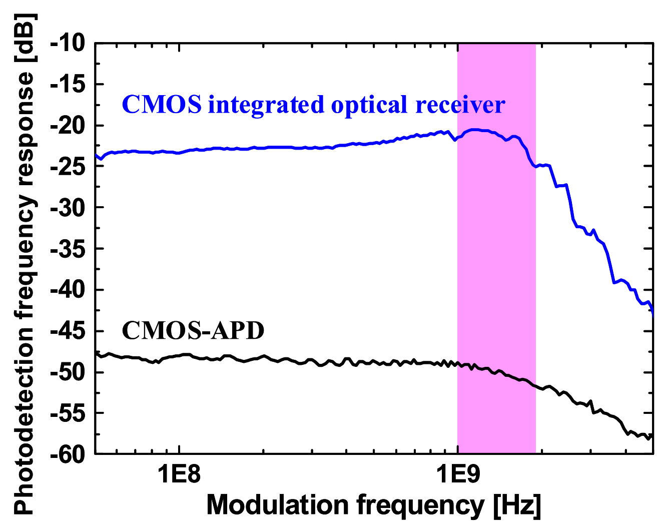

Figure 3. Measured photodetection frequency responses of the CMOS-APD and CMOS integrated optical receiver.

to optical signals utilizing an 850-nm laser diode (LD) and electro-optic modulator (EOM), and transmitted via 4-m long multimode fiber (MMF). The transmitted optical data are photodetected and converted to voltage signals with amplification using the CMOS integrated optical receiver at the antenna base station. The output signals are frequency up-converted to the 60-GHz band by a mixer and PLO, and then radiated to the mobile terminal through 1-m free space utilizing a horn antenna having 24-dBi gain. The wireless link loss in the 60-GHz band including antennas is about 20 dB. A 28.7-dB power amplifier (PA) is added to compensate this loss. At the mobile terminal, received data signals are amplified using an 18.3-dB low-noise amplifier (LNA) and frequency

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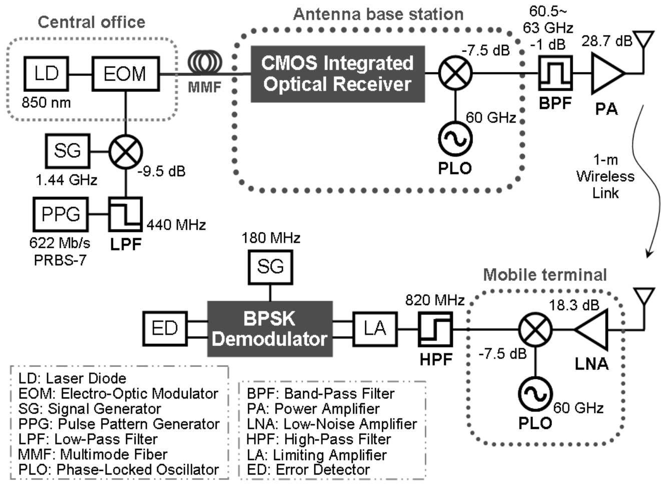

Figure 4. Experimental setup for broadband data transmission in the fiber-fed 60-GHz wireless system using the fabricated CMOS integrated optical receiver and BPSK demodulator.

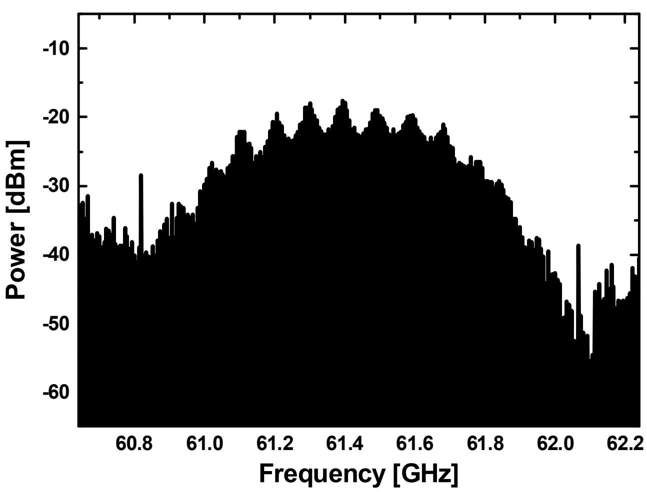

Figure 5. Measured spectrum of frequency up-converted signals.

down-converted by a mixer and PLO. After a high-pass filter (HPF) which filters out any signals below 820 MHz, a limiting amplifier (LA) is added before the BPSK demodulator designed in-house and fabricated by with 0.18-µm standard CMOS technology [11].

Fig. 5 shows the output spectrum of the PA at the antenna base station in the 60-GHz band. In order to evaluate the system performance, bit error rate (BER) characteristics were measured. Fig. 6 shows the BER as a function of the incident optical power. The BER achieves below 10^{-9} at the incident optical power higher than -4 dBm. For BER of 10^{-6}, which is an acceptable value in the wireless transmission, about -8 dBm is required. These results show that CMOS integrated optical receivers are good enough for fiber-fed 60-GHz wireless systems.

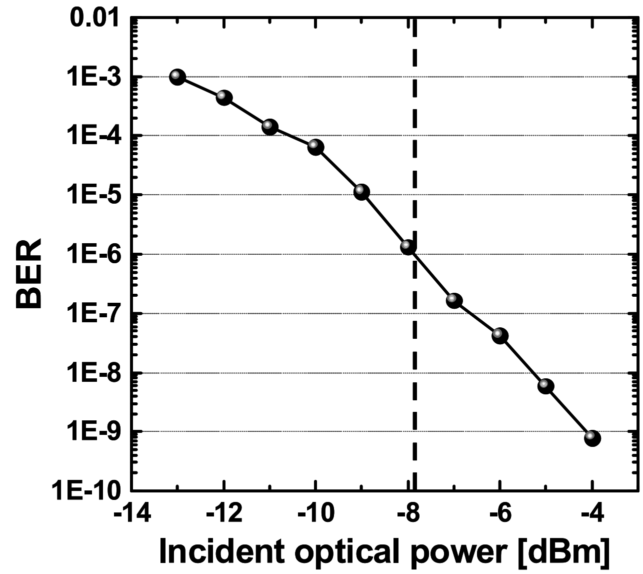

Figure 6. BER as a function of incident optical power.

IV. CONCLUSION

We demonstrate a fiber-fed 60-GHz wireless system using a CMOS integrated optical receiver for broadband data transmission. The CMOS integrated optical receiver is fabricated with 0.13-µm standard CMOS technology and composed of CMOS-APD, TIA, offset cancellation circuit, and output buffer. Using the CMOS integrated optical receiver provides cost reduction and simplification of antenna base stations. To demonstrate the feasibility of the system, downlink data transmission of 622-Mb/s BPSK data signals is executed and successfully performed with BER less than 10^{-9} at the incident optical power of -4 dBm. Experimental results show that the proposed fiber-fed 60-GHz wireless system can be useful for realizing 60-GHz band millimeter-wave wireless applications.

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