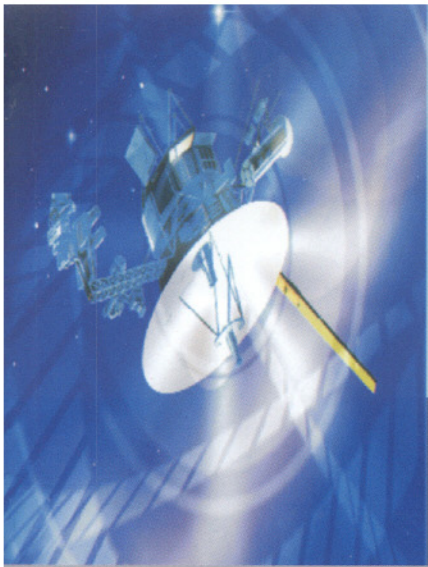

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대한전자공학회 마이크로파 및 전파전파연구회
한국전자파학회 마이크로파 및 전파연구회
대한전기학회 광전자 및 전자파연구회
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♣ 주관 : 한국통신학회 마이크로파 및 전파연구회
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♣ 후원 : 제주특별자치도, 제주대학교 첨단기술연구소

Session Ⅷ 전파통신 · 방송 기술 및 시스템 분야

▶장소 : 공대 3호관 C204

14:00～15:40 좌장 : 김동회(강원대)

[8-1-1] 14:00～14:20	다양한 간섭이 존재하는 위성통신망에서 위성통신링크 최적설계를 위한 분석기법	장재웅 (한국항공우주연구원)
[8-1-2] 14:20～14:40	고속 주파수 도약을 사용하는 위성 네트워크에서 Multi-tone을 이용한 Frequency & Phase Shift Key Modulation 방법에 대한 연구	김성호, 진병일, 오경석 (삼성텔레스)
[8-1-3] 14:40～15:00	위성 DMB 수신신호의 전파환경 분석	노순국 , 정종근 (호남대/한국학술진흥재단)
[8-1-4] 15:00～15:20	차세대 이동통신에서 QoS를 만족시키는 적절한 전송 전력에 대한 고찰	정재욱, 김덕성, 박형근, 김영수 (포항공대)
[8-1-5] 15:20～15:40	계층 변조된 DQPSK-QPSK 시스템을 위한 지향성 다이버시티 수신연구	배재휘, 김영수, 김주연, 임종수, 이수인, 한동석 (한국전자통신연구원)
15:40～16:10	Coffee Break	

16:10～17:50 좌장 : 노순국 (호남대)

[8-1-6] 16:10～16:30	정지궤도위성 드리프트 영향에 대한 내부-외부 에너지 비율을 이용한 타이밍 보정 방안	진병일, 김성호 (삼성텔레스)
[8-1-7] 16:30～16:50	새로운 구조의 CMOS BPSK 복조기를 이용한 60GHz 대역 622Mb/s 전송	고민수, 김두호, 김재영, 최우영 (연세대)
[8-1-8] 16:50～17:10	전파간섭하에 놓인 무선랜의 전송속도 측정	박정근, 장병찬, 최원준, 김경수, 김당오, 배창호, 김채영 (경북대/한국전자통신연구원)
[8-1-9] 17:10～17:30	OFDM 시스템의 신호의 SNR의 성능에 따른 변조방식을 통한 전송률의 성능연구	이두원, 김동회 (강원대)

새로운 구조의 CMOS BPSK 복조기를 이용한 60 GHz 대역 622 Mb/s 전송

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622-Mb/s Transmission in 60 GHz Using a Novel CMOS BPSK Demodulator

Minsu Ko, Duho Kim, Jae-Young Kim, Woo-Young Choi

Yonsei University

Abstract

60-GHz band wireless transmission of 622-Mb/s BPSK data is successfully demonstrated using a novel CMOS BPSK demodulator. The demodulator can demodulate up to 622-Mb/s data without bit errors at the 1.44-GHz carrier frequency. In a 1-meter long wireless link, measured BER is below 10^{-10} and the overall BER performance has power penalty of 2 dB against the IF back-to-back link.

I. Introduction

Over the past decade, there has been significant progress in the development of wireless communication technology. Recently, the demand of users is moving into higher capacity transmission such as high quality multimedia services, high speed internet access, and wireless data bus for cable replacement. For that, wireless systems using millimeter-wave bands can be a solution because they can provide wide bandwidth as well as high directivity. Among them, systems using the 60-GHz band have been enthusiastically discussed and studied. Now, standardization of 60-GHz band millimeter-wave wireless personal area network (mmW WPAN) systems is being discussed in the IEEE 802.15 TG3c [1].

IEEE 802.15.3c uses 57~66-GHz band which does not require license in many countries. Its primary target is full HDTV applications which need 3~4-Gb/s data rate. Some groups fabricated integrated 60-GHz RF transceiver circuits in a SiGe BiCMOS process or a GaAs mHEMT MMIC process, and demonstrated the 60GHz band broadband transmission of 630-Mb/s QPSK-OFDM data [2], 2-Gb/s DQPSK uncompressed HDTV data [3], and 1.5-Gb/s ASK data [4].

In this paper, we demonstrated 622-Mb/s transmission in 60 GHz using a novel BPSK demodulator [5]. Even though bandwidth-efficient modulation techniques such as QPSK and QAM are preferred, we tried BPSK first because it is simpler modulation scheme for the initial trial. The bit error rate (BER) performance was measured in a 1-meter long wireless link.

II. BPSK Demodulator

We fabricated the BPSK demodulator chip with a novel PSK demodulation scheme in Fig. 1 by using a TSMC 0.18-μm CMOS process. The main idea of Fig. 1 is that BPSK demodulation can be done by using a half-rate bang-bang phase detector (PD) commonly used in clock and data recovery (CDR) circuits. Fig. 1 shows the demodulation process. The shape of the BPSK signal is similar to "1010…" when data is high and "0101…" when data is low. By using the half-rate bang-bang PD and the phase controller, the clock of the receiver can synchronize the modulated signal. After the synchronization, it samples the data sequence like "1010…0101". Finally, by inverting the data sampled at the falling edge, primary data is recovered.

In order to implement the desired PD, the PD given in [6] is modified as shown in Fig. 2. MUXs inside the dotted line are added to invert samples at falling edge of the clock. Fig. 3 shows the block diagram. Basically it uses the phase control algorithm in [7], but the additional interpolator is added to make a clock with 90-degrees phase difference.

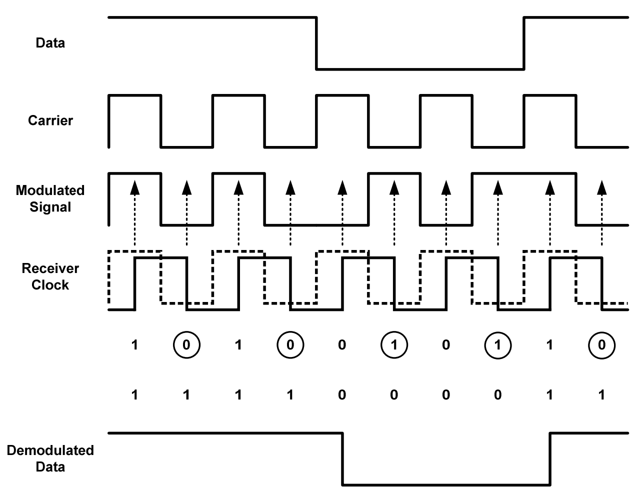

Fig. 1. PSK demodulation scheme

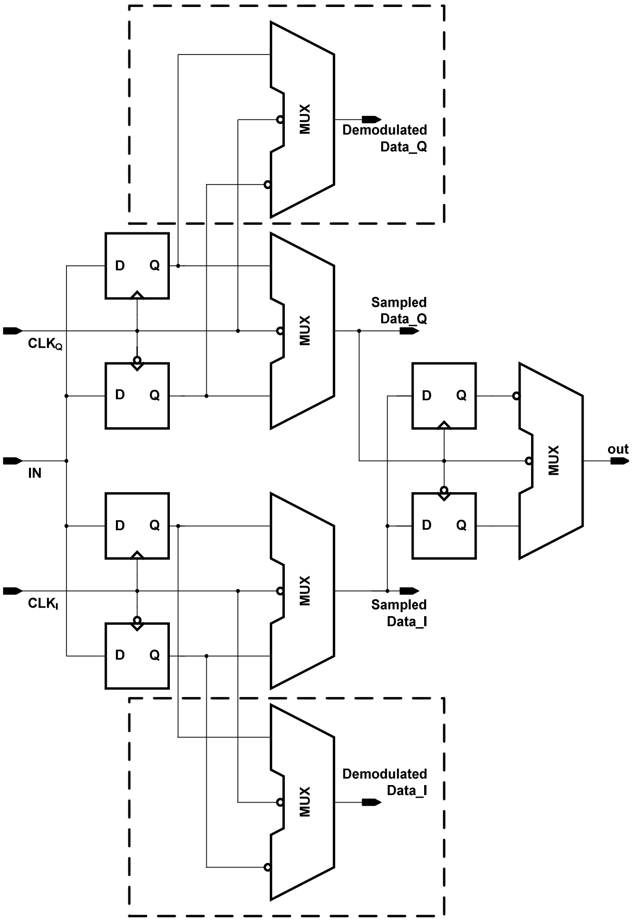

Fig. 2. Modified half-rate bang-bang PD

III. Experimental Setup

Fig. 4 shows the experimental setup for 60-GHz broadband wireless transmission. The BPSK modulator is realized with a signal generator, a mixer, and filters. The input data is 622-Mb/s non-return-to-zero (NRZ) 2^7-1 word length pseudorandom binary sequence (PRBS) provided by a pattern generator. An LPF limits the bandwidth of input data to 70 % of its data rate. After that, it

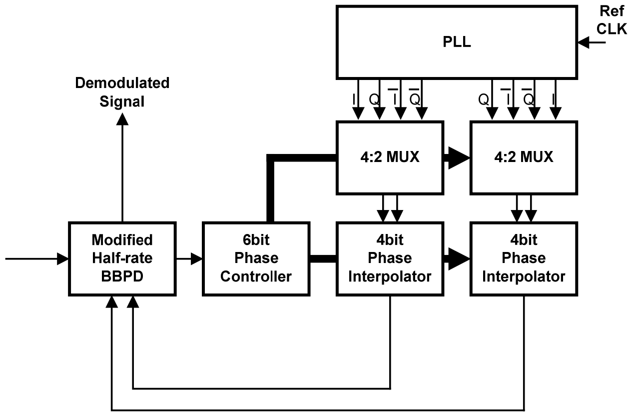

Fig. 3. Block diagram of BPSK demodulator

is modulated to the BPSK signal using a simple frequency up-conversion technique with the IF frequency of 1.44 GHz. A step attenuator is set up between the BPSK modulator and the RF transmitter in order to control the IF input power.

The 60-GHz RF transceiver is composed of the discrete components which are balanced mixers, a 60-GHz PLO, BPFs, a PA, a LNA, and horn antennas. The IF BPSK signal is up-converted to the 60-GHz band with the center frequency of 61.44 GHz. BPFs filter out the lower sideband of the up-converted signal and the 60-GHz LO leakage from the mixer. The transmission distance is fixed as 1 meter and the transmission power was controlled only at the IF input by the step attenuator. Antennas are high-gain horn antennas which have 3-dB beam width of 9 degrees. Measured transmission loss of the 1-meter free-space including antennas was about 20 dB. We used one 60-GHz phase-locked oscillator (PLO) at the transmitter and the receiver because of the limitation of experimental equipments. The total 60-GHz RF receiver gain was below 0 dB because of the conversion loss of the mixer and the indispensable cable loss of 6.5 dB between the LNA and the mixer. Detailed specifications for the 60-GHz RF transceiver are listed in Table I.

At the IF output, a limiting amplifier is added to compensate the sensitivity limit of the fabricated BPSK demodulator. After amplified by the limiting amplifier, the down-converted BPSK

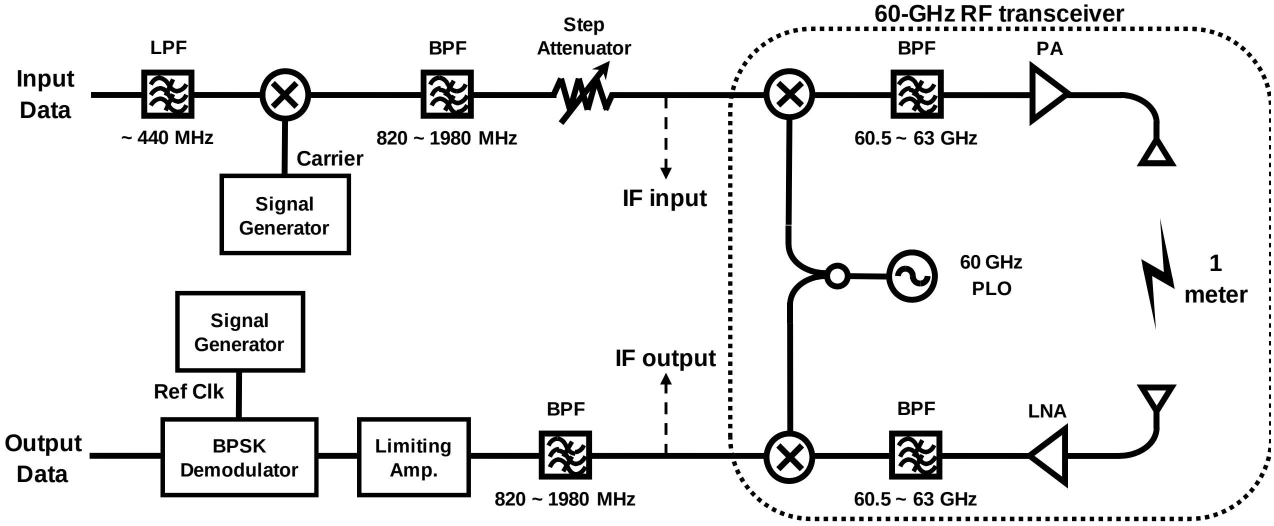

Fig. 4. Experimental setup for 60-GHz wireless transmission

TABLE I

SPECIFICATIONS OF 60-GHZ RF TRANSCEIVER

Local frequency	60 GHz
RF center frequency	61.44 GHz
IF input/output frequency	0.5 ~ 3 GHz
Total transmitter gain	21 dB
transmitter output 1-dB compression point	11 dBm
Total receiver gain	-1 dB
Total receiver noise figure	~ 5 dB
Antenna gain	24 dBi
Antenna 3-dB beam width	9 degrees

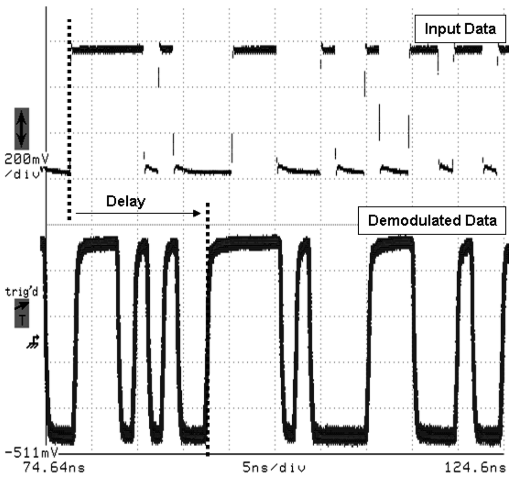

Fig. 5. Demodulation of 622-Mb/s BPSK data in back-to-back link

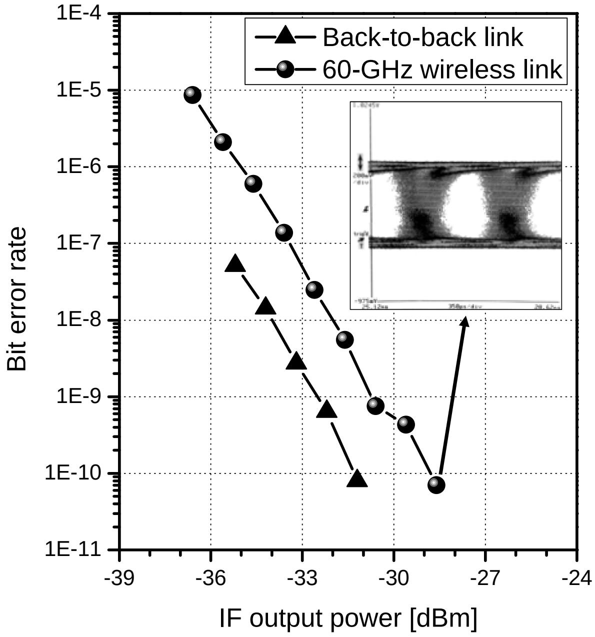

Fig. 6. Relationship between IF output power and BER

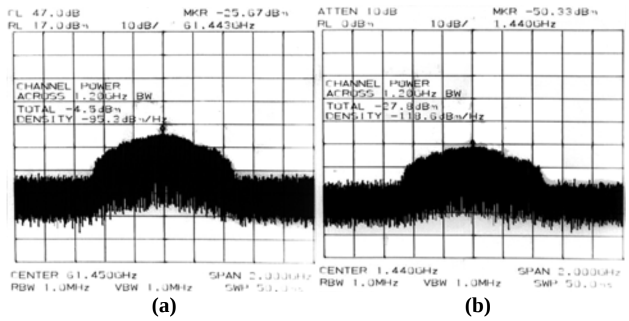

Fig. 7. Spectra of (a) 60-GHz RF transmitter output signal and (b) IF output signal when no error bit is detected. Noise floors in spectra come from spectrum analyzer, and actual noise floors of signals are much lower.

signal is demodulated to baseband data by the demodulator. The reference clock of 180 MHz is needed to demodulate the signal with IF frequency of 1.44 GHz. The resulting signals were observed by using a spectrum analyzer, a sampling oscilloscope, and an error detector.

IV. Experimental Results

We observed the demodulator achieved the maximum error-free data rate of 622 Mb/s in the back-to-back link measurements. For the configuration of the back-to-back link, the IF input was directly connected to the IF output. Fig. 5 shows 622-Mb/s input data and demodulated data. We confirmed that input data is demodulated successfully only with a time delay.

Fig. 6 shows the BER as a function of the IF output signal power for the 622-Mb/s BPSK data at the 1.44-GHz carrier. We controlled the IF input power, not the transmission distance for experimental convenience. Controlling the IF input power has similar results as controlling the transmission distance. In both the back-to-back link and the 60-GHz wireless link, BER curves had a natural shape. However, sync loss was detected when the IF output power was less than about -36 dBm. The input sensitivity of the limiting amplifier may cause this phenomenon.

As shown in Fig. 6, when the IF output power was greater than -28 dBm, error-free transmission (below 10^{-10} BER) was achieved in 60-GHz wireless link measurements. And the overall BER performance had a power penalty of 2 dB against the back-to-back link. This mainly comes from the noise figure and nonlinearity of the RF receiver. The spectra of the RF transmitter output signal and the IF output signal when the error-free condition was achieved (IF output power of -28 dBm) are shown in Fig. 7.

We can predict that if we increase the transmitter output power and the transmission loss by a same amount, this BER results will be the same. When the IF output power was -28 dBm, the transmitter output power was -7 dBm, and subsequently the receiver input power was -27 dBm with 1-meter long transmission loss of 20 dB. Because the RF transmitter can handle the transmitted power up to 11 dBm, we can apply more transmission loss of 18 dB. Therefore we can expect that the fabricated demodulator operates well with no bit errors in the implemented wireless link having a 38 dB transmission loss.

V. Conclusion

We fabricated a new BPSK demodulator having the maximum data rate of 622 Mb/s at the 1.44-GHz carrier, and realized the 1-meter long 60-GHz wireless link for BPSK data transmission. The wireless link had power penalty of 2 dB on BER against the back-to-back link. By using these links, 622 Mb/s data was successfully transmitted without bit errors.

Acknowledgments

The work at Yonsei University was supported by the Korean Ministry of Science of Technology through the National Research Laboratory program.

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- 국문 논문제목: 새로운 구조의 CMOS BPSK 복조기를 이용한 60 GHz 대역 622 Mb/s 전송
- 영문 논문제목: 622-Mb/s Transmission in 60 GHz Using a Novel CMOS BPSK Demodulator

- 분야명: (위성/이동/고정 등)전파통신/방송관련 기술 및 시스템 분야
- 발표양식: 구두