社団法人 電子情報通信学会
THE INSTITUTE OF ELECTRONICS,
INFORMATION AND COMMUNICATION ENGINEERS

信学技報
IEICE Technical Report
SAT2005-21 (2005-10)

広帯域衛星通信用簡易再生中継器の特性

桑村 秀嗣† 小川 明† 山里 敬也‡

†名城大学理工学研究科 〒468-8503 名古屋市天白区塩釜口一丁目 501
‡名古屋大学エコトピア科学 〒464-8603 名古屋市千種区不老町

E-mail: †aogawa@ccmfs.meijo-u.ac.jp, ‡yamazato@ieee.org

あらまし 本論文は、広帯域衛星アクセス通信を目指した衛星中継器の実験モデルの特性評価に関するものである。高速で柔軟なインタネットアクセス衛星通信システムを実現するために、簡易な構成の衛星再生中継器の実験モデルを試作した。この中継器では、受信入力が AD 変換され、蓄積されるが、データ部分の同期復調や誤り制御などの複雑な処理は行われず、地球局に任される。信号はパケット状で送られ、その情報データ部分は QAM で変調される。衛星内ルーティングのための情報は、パケットの先頭にあるプリアンブル部分に置かれて差動 BPSK で送られ、遅延検波で復調される。本論文では、このような簡易再生中継器についてビット誤り率特性を測定した結果を示す。

キーワード 衛星アクセス通信、再生中継器、パケット通信、衛星内ルーティング、

Characterization of a simplified regenerative repeater for broadband satellite communications

Hidetsugu Kuwamura† Akira Ogawa† and Takaya Yamazato‡

†Graduate School of Science and Technology, Meijo University

1-501 Siogamaguchi Tenpaku-ku Nagoya 468-8503, Japan

‡Eco Topia Science Institute, Nagoya University

Furo-cho Chikusa-ku Nagoya 464-8603, Japan

E-mail: †aogawa@ccmfs.meijo-u.ac.jp, ‡yamazato@ieee.org

Abstract— This paper is concerned with performance evaluation for an experimental model of a repeater for broadband satellite communications. For the purpose of realizing a high speed and flexible internet satellite communication system, we propose a simplified configuration of satellite regenerative repeater. In this repeater, the amount of signal processing is limited so that the input signal is only AD converted and stored, but a complex function of error control is left to the earth stations. While the information data are modulated with QAM, the necessary information for the onboard routing is carried on the preamble potion placed at the top of the packet and modulated with the differential binary PSK .In this paper, measured results of the bit error rate for this simplified regenerative repeater are described

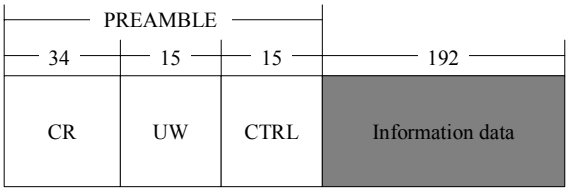
Keywords— satellite access communications, regenerative repeater, packet communications, onboard routing,

1. Introduction

The basic functions of the satellite repeater consist of amplification for signals from earth stations and routing signals to destinations, the aspect of which depends on the associated satellite network configuration. In this paper, we consider a satellite packet network consisting of a number of mini sized earth stations. It may be desired that the repeater configuration of the satellite for this type of network be accommodate with onboard processing such as regenerative repeating, packet switching and error control. There would be problems with this configuration, however, such that we suffer from increase in complexity and

decrease in flexibility. From this point of view, we have developed a simplified version of satellite repeater in which only a routing function and data storage are performed onboard the satellite [1]. We call this repeater "simplified regenerative repeater".

In this paper, an experimental model of the simplified regenerative repeater is described and measured results of bit error rate performance of modulation schemes with emphasis on the effect of input signal level.



CR: clock recovery UW: unique word CTRL: control

Fig.2. Packet format

2. Experimental model of the repeater

The block diagram of the experimental model of the simplified regenerative repeater is shown in Fig.1. The input signal is in the burst mode for the packet communications with IF (50MHz) interface.

The packet format is shown in Fig.2. The information data portion of the packet is modulated with QAM, while preamble portion is differential BPSK modulated in order to ensure highly reliable routing performance.

The input signal in IF form is analog-to-digital converted (ADC) with asynchronous sampling and stored, then transmitted via a digital-to-analog convertor (DAC) under routing control. The routing process is fulfiled through the control (CTR) signal detector and a differential phase detector (delay detector) without any carrier recovery. The parameters for the experimental model are listed as Table1.

As shown in Fig.1, the information data are demodulated for the purpose of measuring the bit error rate in the uplink, but actually the measurement is made in PC connected to the output of the experimental model.

Table1. Parameters for the experimental model

IF carrier freq.	50MHz
DAC	Quantize accuracy of 12bit MAX. Sampling Frequency 200MHz
ADC	Quantize accuracy of 12bit MAX. Sampling Frequency 210MHz
Data Modulation	QPSK, 16QAM
Symbol rate	3.125Msymbol/sec

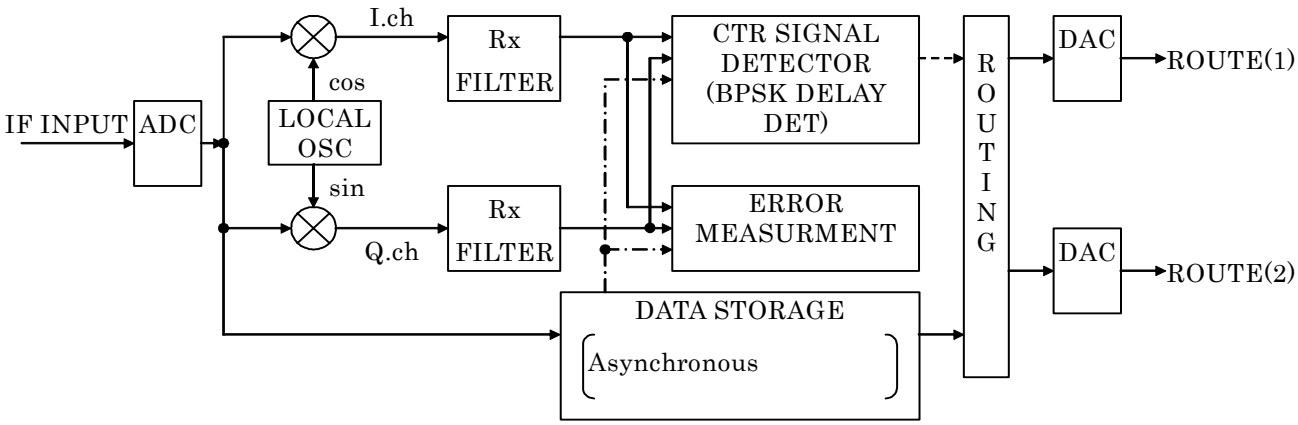
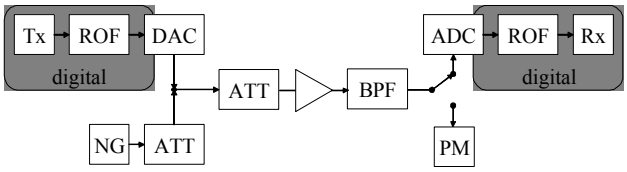


Fig.1. Experimental model of the simplified regenerative repeater

3. Bit error rate measurement

To evaluate the effect of the simplified regenerative repeater, the probability of bit errors caused by the up-link noise and nonlinear effect of the ADC is measured using circuits shown in Fig.3.



Tx: Transmitter, Rx: Receiver,
NG: Noise generator, ROF: Root roll off filter
ATT: Attenuator, PM: Power meter

Fig.3 Circuit for measuring BER

4. Measured results

The measured results of bit error rate (BER) as a function of carrier power to noise ratio (CNR) are shown in Fig.4. These are measured with input levels offering nearly optimum performance.

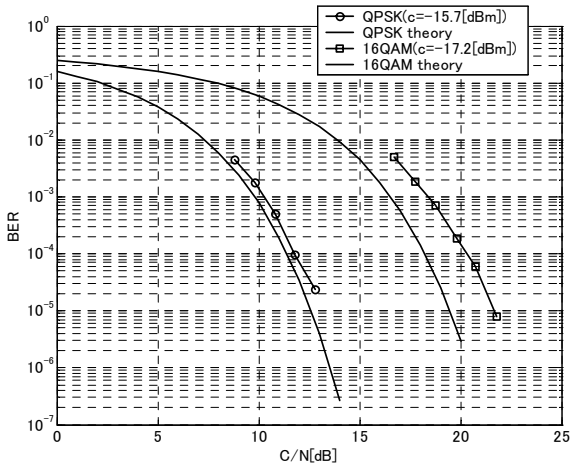


Fig.4. Bit error rate versus CNR

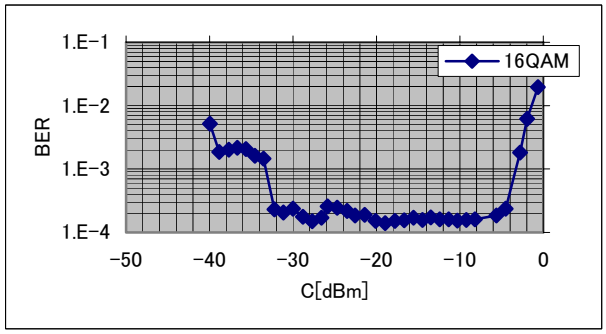


Fig.5. Bit error rates affected by the input level

It is considered that the performance may affected by the nonlinear effect of ADC. We measured, therefore, this effect in terms of BER as a function of the input power level in dBm which is shown in Fig.5. These degradations may be due to the overload characteristics of the ADC.

4. Conclusion

In this paper, the experimental model of the simplified regenerative repeater has been described, and shown the measured results of BER performance with emphasis on the effect of input power level. In order to achieve optimum performance, we may need automatic gain control (AGC), operating point of which should be adjusted according to modulation scheme.

References

[1] T. Yamazato and A. Ogawa: “A note on the simple regenerative repeating process for communication satellites”, to be presented at this conference.

Acknowledgement

This work is partially supported by the SCOPE project of the Ministry of Public Management, Home Affairs, Post and Telecommunications, Japan.

Characterization of a simplified regenerative repeater for broadband satellite communications

Hidetsugu KUWAMURA† Akira OGAWA†
and Takaya YAMAZATO‡

†Meijo University ‡Nagoya University

Correction

- A correction should be made for Fig.5. in the manuscript.

  Please change it to the figure delivered at this place.

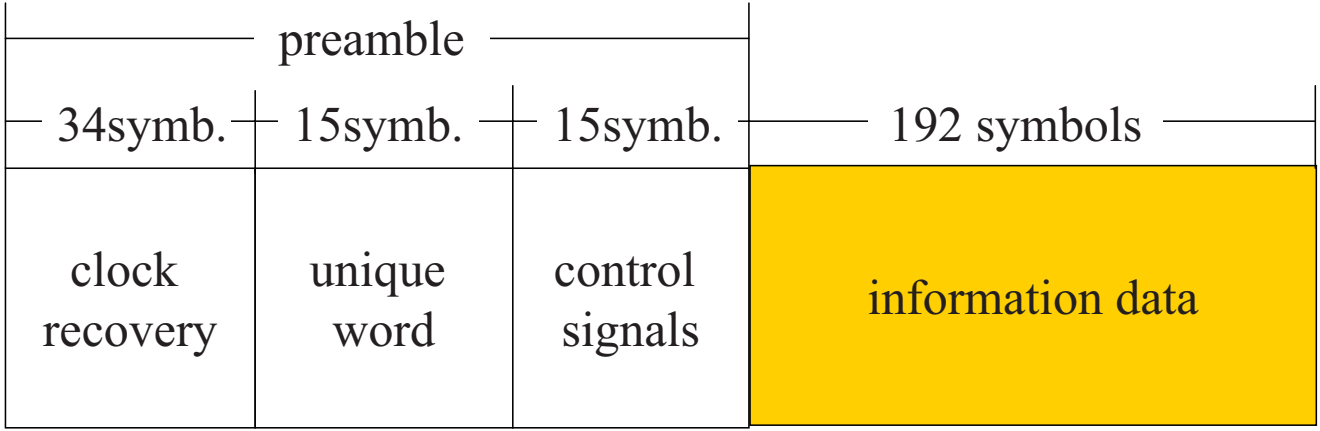
Introduction

- The simplified regenerative repeater for the packet satellite communications has been proposed at the preceding presentation of this session.
- The object of this presentation is to show the results of experimental evaluation for the performance of the proposed repeater, as well as to describe the experimental model.

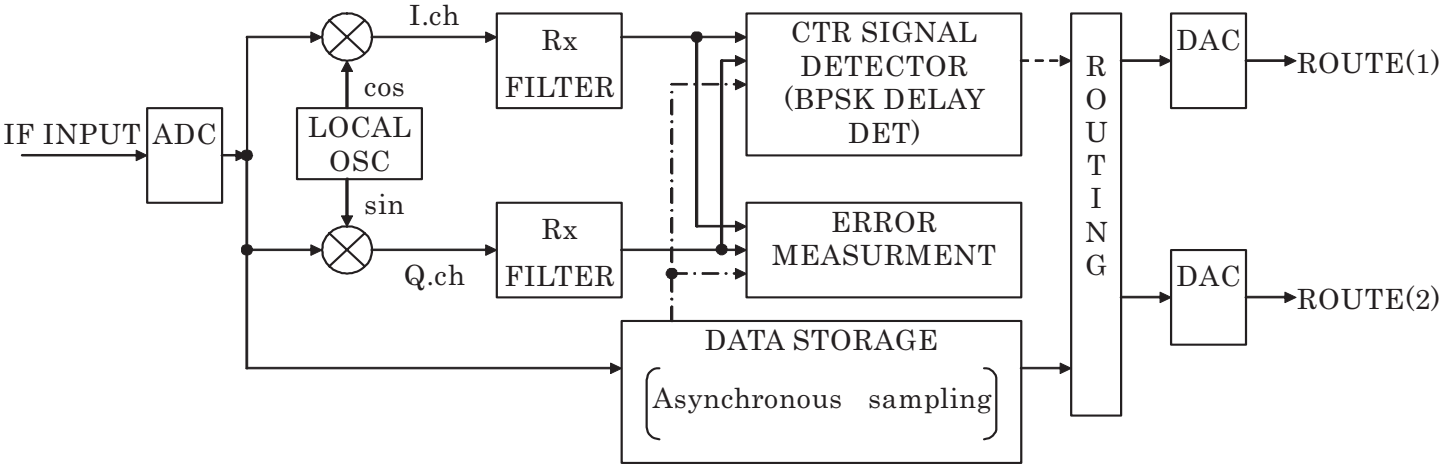
Major parameters of the system

- Symbol rate: 3.125Msymbol/sec
- IF carrier frequency: 50MHz
- A/D and D/A converters
  - Sampling frequency: 200MHz,
  - Quantization bits: 12bits
- Modulation for data: QPSK, 16QAM
- Modulation for preamble: DBPSK
- Tx filter: Root cosine roll-off filter (α =0.2) with aperture compensation
- Rx filter: Root cosine roll-off filter (α =0.2)

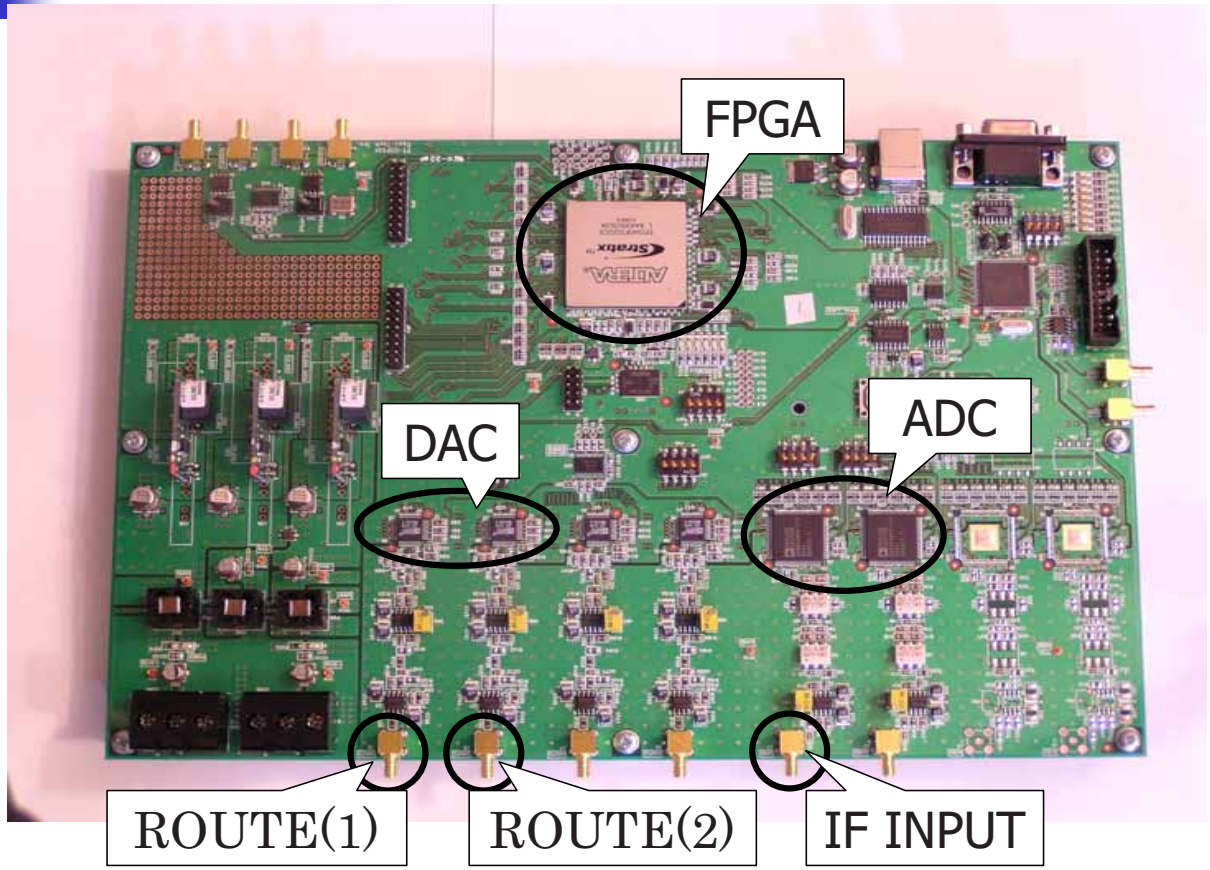
Packet format



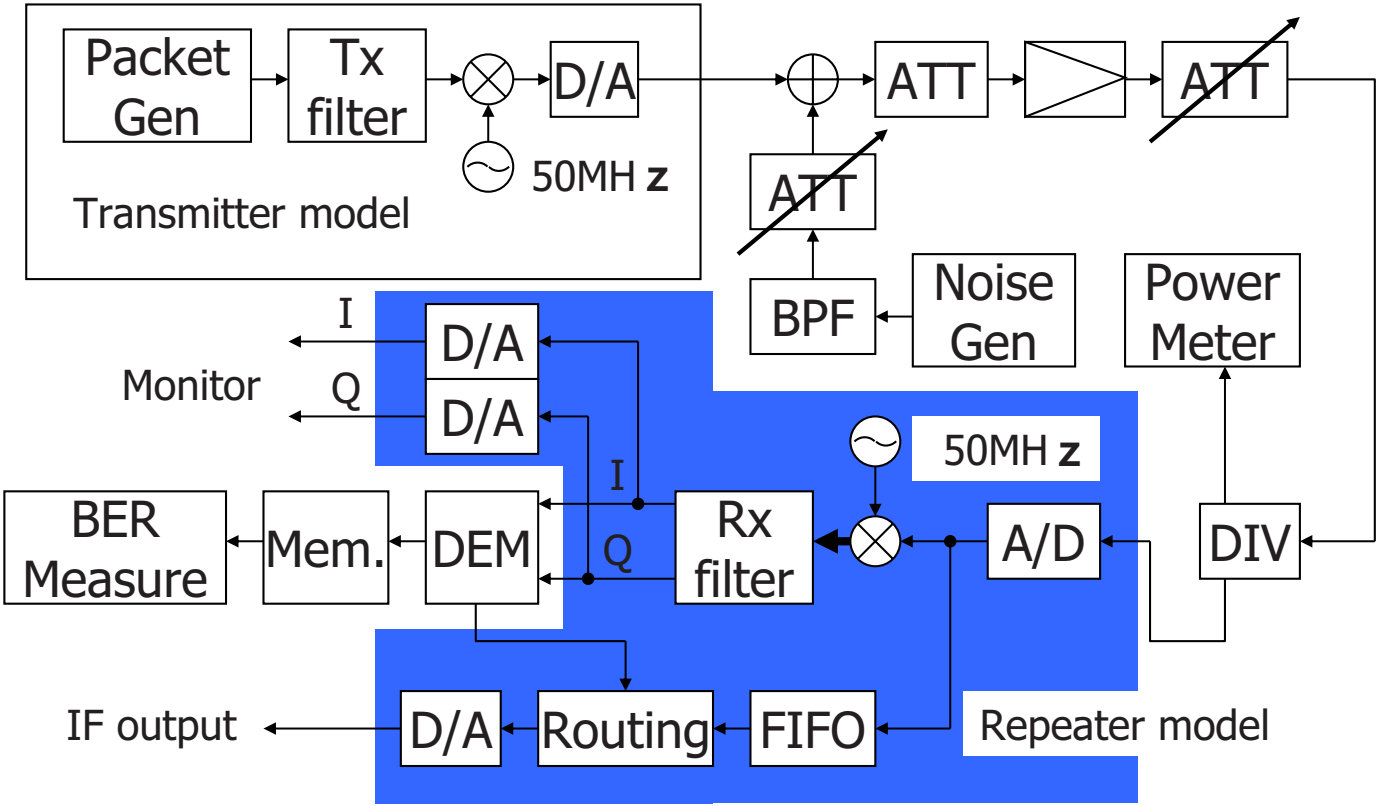
Experimental model of the simplified regenerative repeater



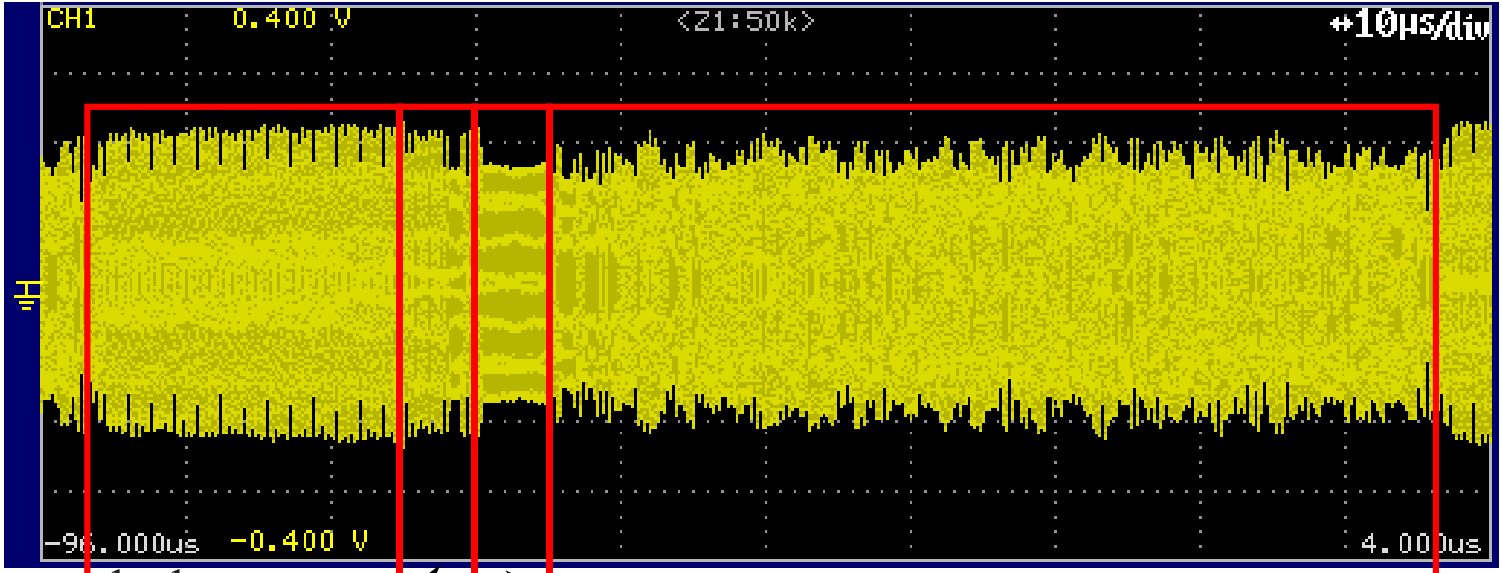
Experimental board



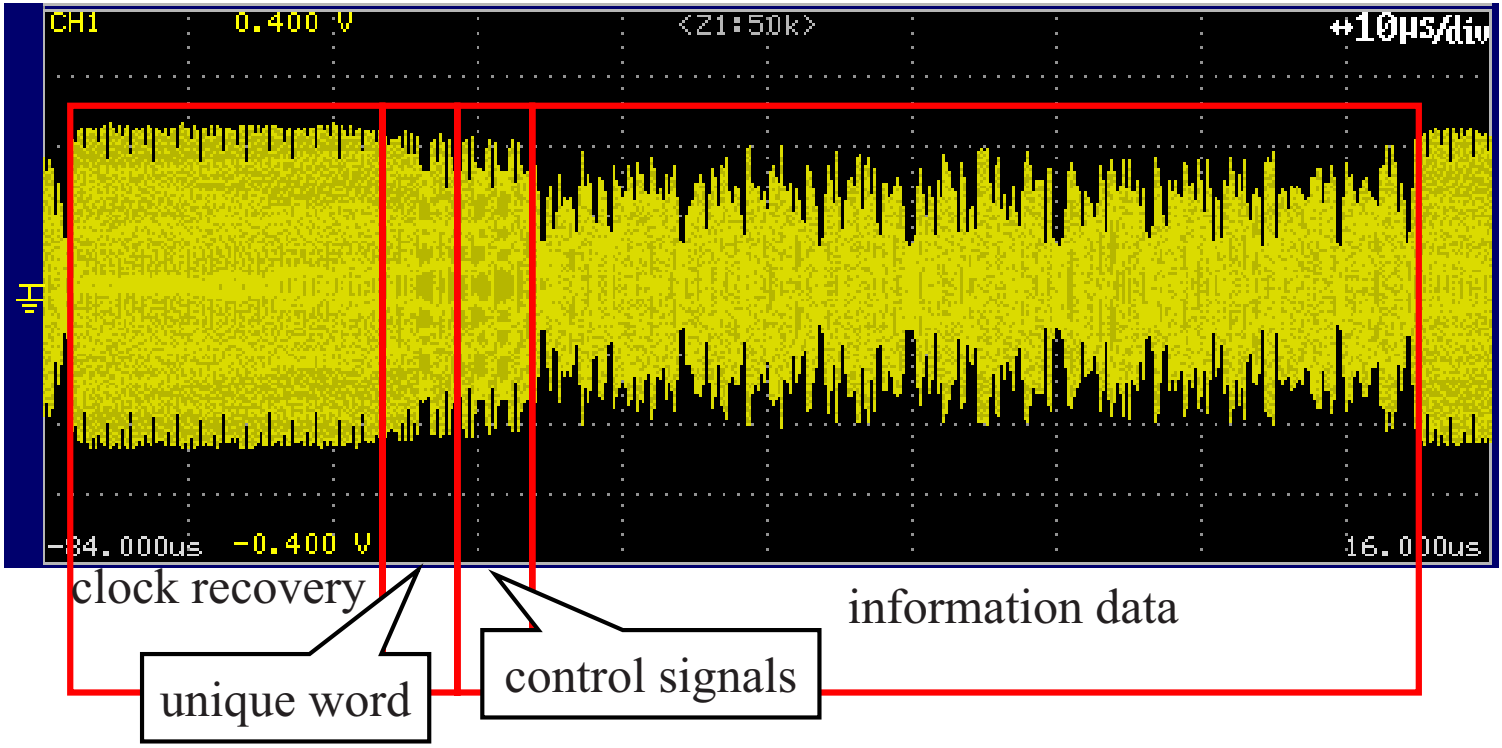
Circuit diagram for the measurement



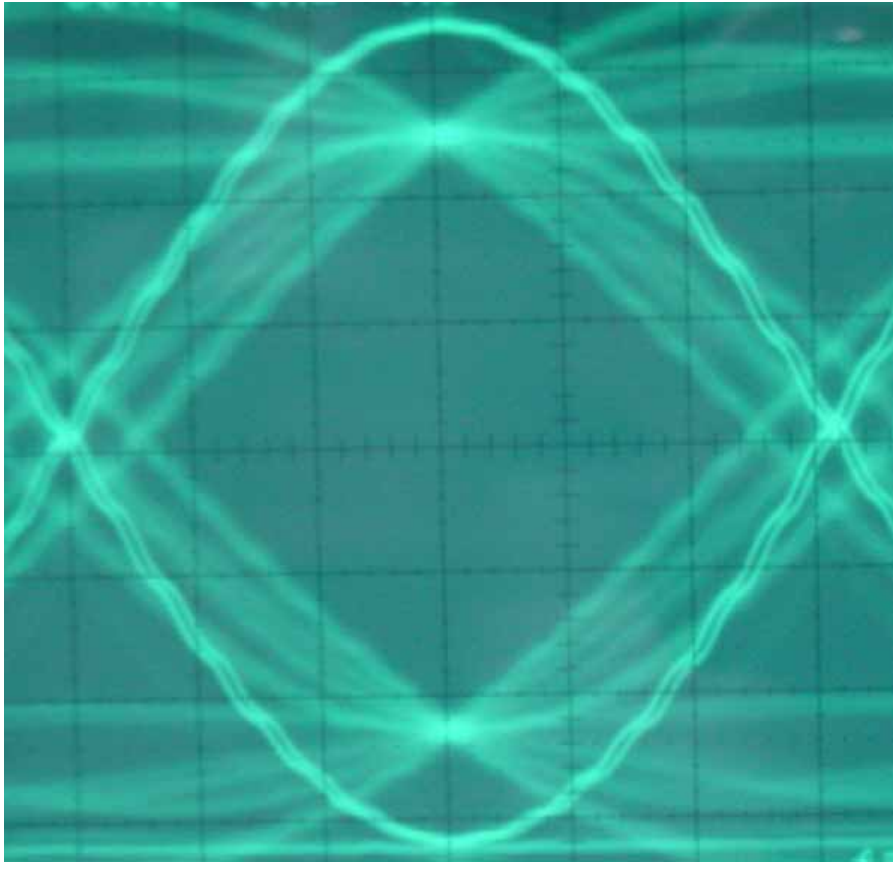
Packet signal waveform (QPSK)



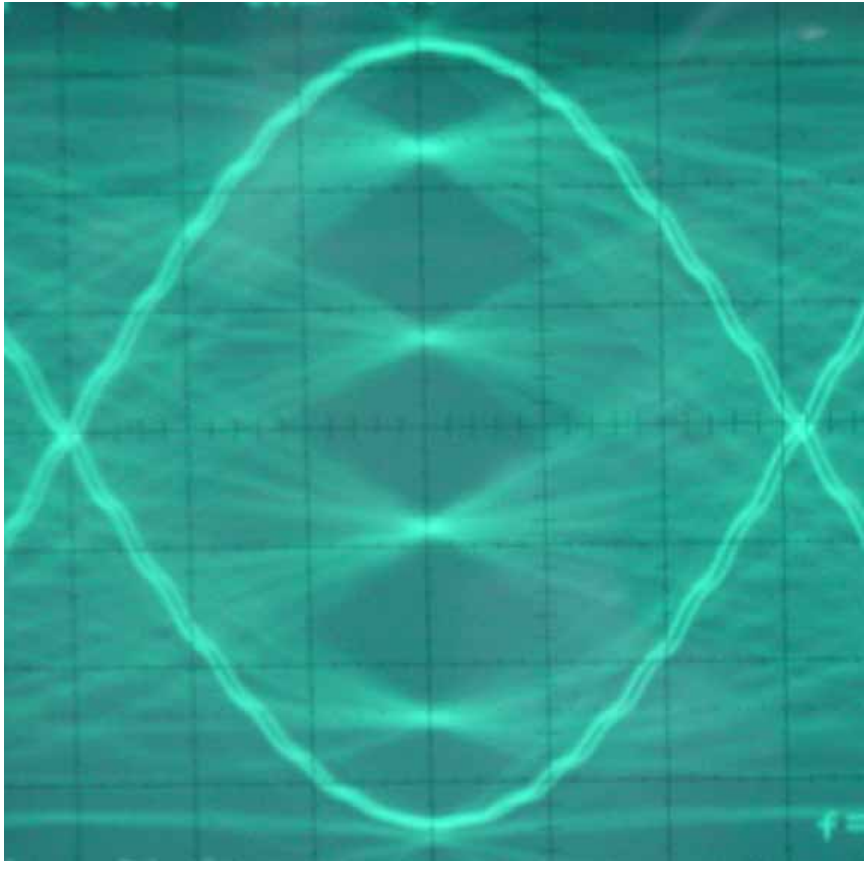
Packet signal waveform (6QAM)



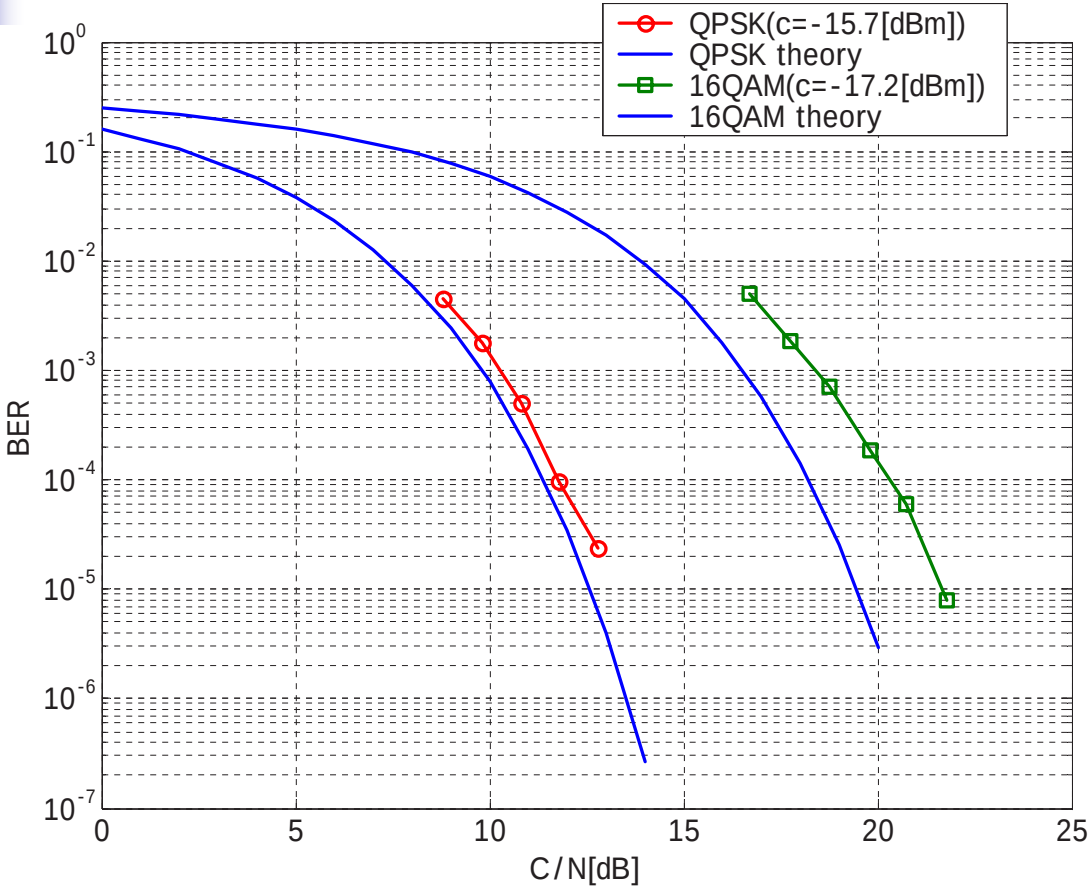
Eye diagram (QPSK)



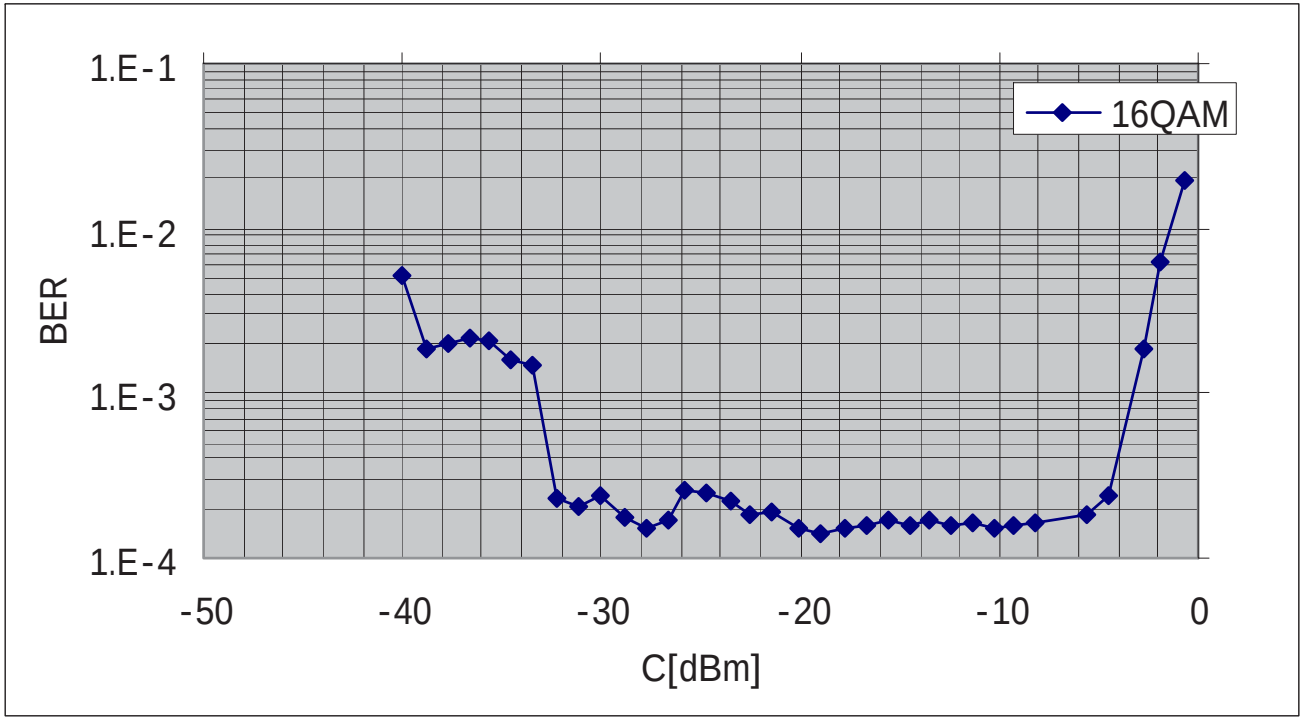
Eye diagram (16QAM)



Bit error rate vs. CNR



Effect of input level on BER



Conclusion

- The BER performance of an experimental model for the simplified satellite regenerative repeater has been evaluated.
- This bit errors are to be caused by the up-link noise, the effect of which may be almost the same as the case of a bent pipe type of satellite repeater.
- The number of quantization bits of the A/D converter can be reduced.