Several systems for 1Giga bit Modem

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Abstract: We proposed several systems for 1Giga bit Modem. The first, Binary ASK(Amplitude Shift Keying) system has a high speed shutter transmitter and no IF(Intermediate Frequency) receiver only by symbol synchronization. The advantage of proposed system is that circuitry is very simple without IF process. The disadvantage of proposed system are that line spectrum occurs interference to other channels, and enhancement to 4-level system is impossible due to its large SNR degradation. The second, Binary phase modulation system has a high speed shutter transmitter and IF-VCO(IF-Voltage Controlled Oscillator) control by base-band phase rotation. Polarity of shutter window is changed by the binary data. The window should be narrow same as above ASK. The advantage of proposed system is which error rate performance is superior. The disadvantage of proposed system are that Circuitry is more complex, narrow pull-in range of receiver caused by VCO and spectrum divergence by the non-linear amplifier. The third, 4-QAM(Quadrature Amplitude Modulation)system has a nyquist pulse transmitter and IF-VCO control by symbol clock. The advantage of proposed system are that signal frequency band is a half of 1GHz, reliable pull-in of VCO and possibility of double speed transmission(2Gbps) by keeping 1GHz frequency-band. The disadvantage of proposed system are that circuit complexity of pulse shaping and spectrum divergence by the non-linear amplifier.

Keywords: 1Giga bit Modem, Binary ASK, Binary phase modulation, 4-QAM

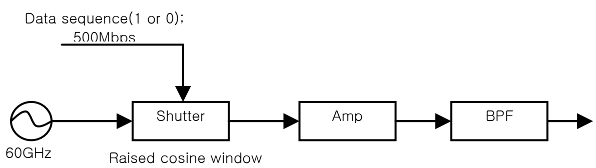
1. INTRODUCTION

A study about confined frequency band is doing made by the sphere of wireless communication, caused by fast innovation of the literature. Specially, study of millimeter wave (30 ~ 300GHz: Electromagnetic wave of 1~10mm) that can get communication line more than 100 times than microwave communication in case of is used in multiplex communication is proceeded most vigorously. It is since that service that exchanges animation at real-time mainly to need communication of such broadband becomes available and necessary bandwidth can increase gradually better as user's request diversifies gradually. In this case, necessity of wireless communication is risen strongly. These day, thing which wireless LAN(local area network) service is supplied slowly in the family may grasp in these veins. But, IEEE 802.11b of present wireless local area network service is main current and it is trend that 802.11a supply is increasing gradually.[1]

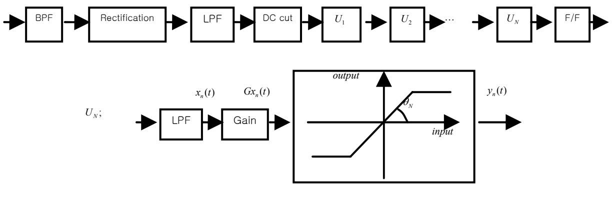
In this paper, we proposed communication systems of high-capacity (1Giga bit).

2. PROPOSED COMMUNICATION SYSTEMS

2.1 Binary ASK system



(a) Transmitter

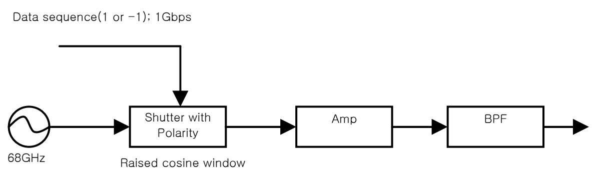


(b) Receiver

Fig. 1 Structure of proposed binary ASK system.

Transmitter is chopped a Millimeter-wave by high speed shutter circuit. In the receiver circuit U_n, the bandwidth and θ_n play very significant roles. It is better to change θ_n as $\theta_1 < \theta_2 < \theta_3 < \cdots$. By the bandwidth of LPF, we have different solutions. For SNR=14dB, the signals after U_4 are as follows. The first and second are respectively for narrow and wide bandwidths. These are no-error cases.[2]

2.2 Binary phase modulation system



(a) Transmitter

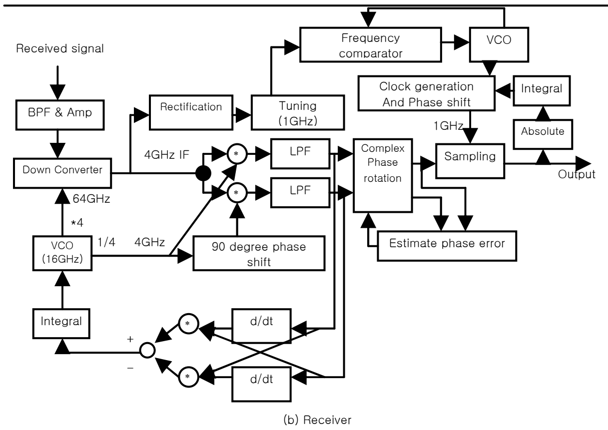


Fig. 2 Structure of proposed binary phase modulation system.

At same SNR, the error rate is very close to that of ASK. However, it appears superior error rate under constraint of same CNR(carrier amplitude to noise power ratio). The receiver structure becomes rather complicated because IF-processing is necessary in order to control carrier phase. The receiver structure becomes rather complicated because IF-processing is necessary in order to control carrier phase. Since the signal at receiver contains large line spectrum at fNHz, it is theoretically possible to extract the clock frequency.[2]

2.3 4-QAM system

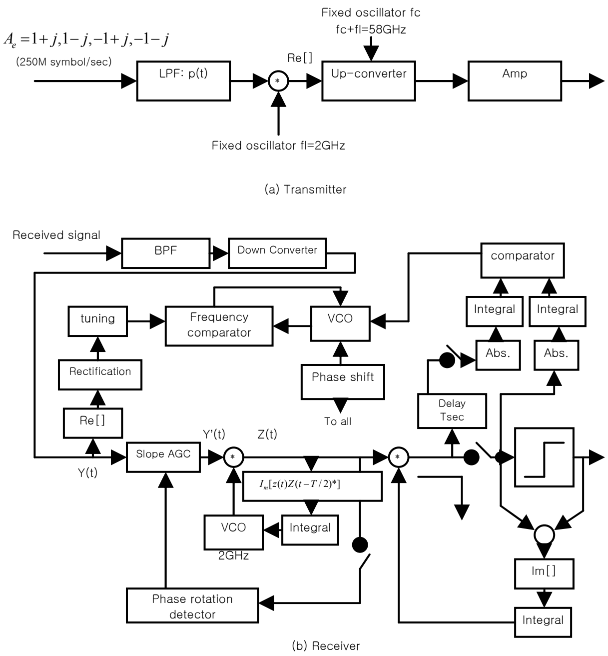


Fig. 3 Structure of proposed 4-QAM system.

Binary phase modulation can be enhanced to 4-QAM. 16-QAM should be noted that it is difficult to eliminate the non-linear distortion in the receiver. In conventional low-frequency applications where everything is linear, we can treat equalization model in simple context as follows. The equivalent base-band signal can be given by;[3][5]

$$Y(t) = \sum_{i=-\infty}^{\infty} A_i H(t - iT) \quad (1)$$

$H(t)$ is a distorted pulse which is convolved by transmitting pulse, channel filter and band-pass receiving filter. Usually, we sample above signal at every T second interval and equalize by FIR (Finite Impulse Response) digital filter. This process is written as follows.

The sampled signal is given by;

$$Y(kT + \tau) = \sum A_i H(kT - iT + \tau) \quad (2)$$

In simple notation like $H_{k-i} = H(kT - iT + \tau)$, above is expressed in discrete form as follow.

$$Y_k = \sum A_i H_{k-i} = \sum A_{k-j} H_j \quad (3)$$

Apply the equalizer to Y_k, we have

$$Z_k = \sum A_{k-j} \sum_{n=-N}^{N} H_{j-n} W_n \quad (4)$$

The destination in ideal is written as

$$\sum_{n=-N}^{N} H_{j-n} W_n = \delta_j \quad (5)$$

Such story is very simple and clear. However, non-linear device cuts off this context. The simplest model may be written by

$$Y(t) = \int f(\sum A_i p(t - \xi - iT)) Q(\xi) d\xi \quad (6)$$

where $f(\,)$ is memory-less nonlinear function. This function does not disturb the eye-opening because of its memory-less property. The question is whether we can equalize channel distortion $Q(\xi)$ or not in sense of discrete processing as mentioned above. The answer is “No” except cases that the signal is insensitive to the non-linearity, for example,

$$X(t) \approx f(X(t)) \quad (7)$$

3. Simulations

3.1 Binary ASK system

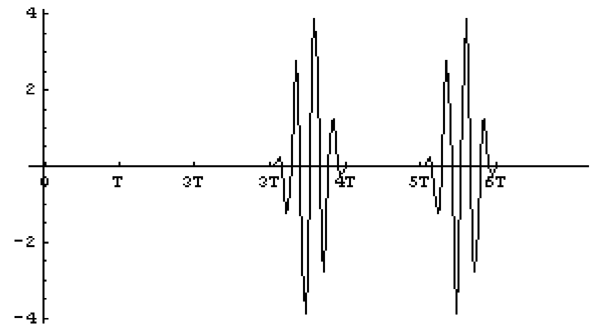


Fig. 4 Transmitter's input modulation frequency.

Assume chopping by the raised cosine window, the modulated pulse train(Fig. 4)and its spectrum(Fig. 5) at sutter, where the following notations are common in this paper.

T : symbol interval

fN=1/T : Nyquist bandwidth

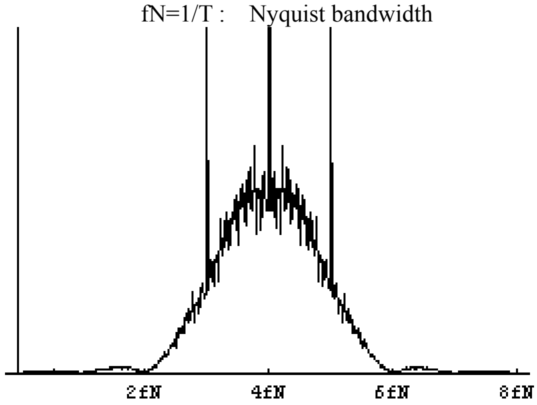


Fig. 5 Spectrum of modulation frequency.

Square of power spectrum in Fig. 5 has three line spectra at carrier and Nyquist frequencies which come from carrier's coherency and explicit symbol clock factor.

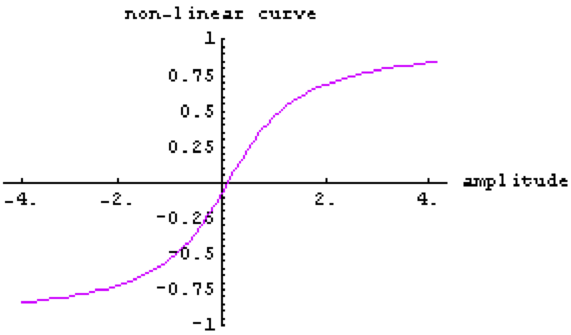


Fig. 6 Non-linearity of Amplifier.

Non-linearity of the high power amplifier is assumed as ArcTan(Fig. 6).

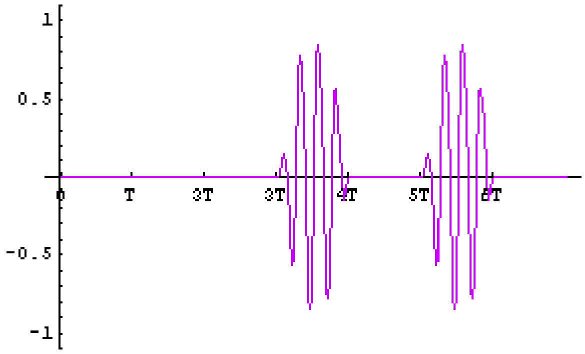


Fig. 7 Signal that is amplified in Amplifier.

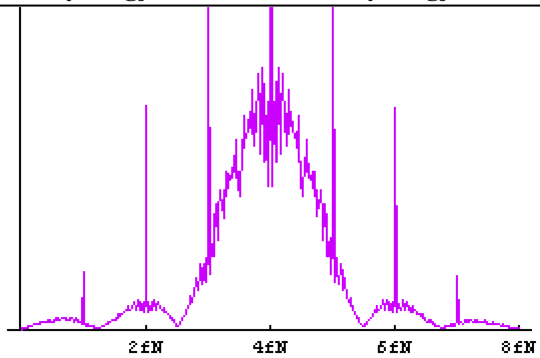


Fig. 8 Signal spectrum that is amplified in Amplifier.

Fig. 7 and Fig. 8 draws signal waveform and spectrum after Amp. The tail of power spectrum at amplifier diverges over bandwidth of 4fN Hz and its line spectra are distributed in wide range.

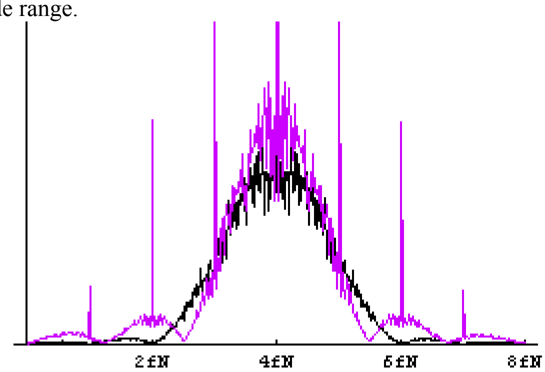


Fig. 9 Composition of figure 5 and 8.

Both spectrum Fig. 5 and Fig. 8 are over-upped in Fig. 9.

3.2 Binary phase modulation system

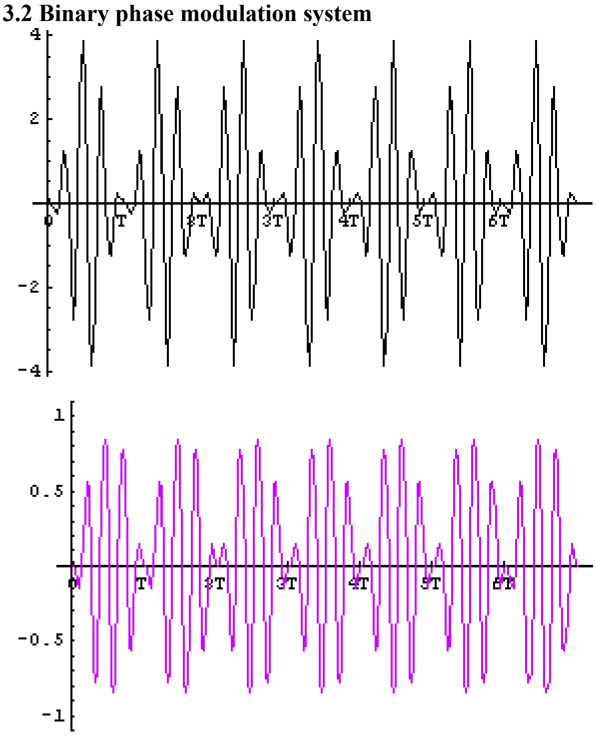


Fig. 10 Modulated signals before and after non-linear AMP.

Fig. 10 shows the modulated signals before and after non-linear Amp.

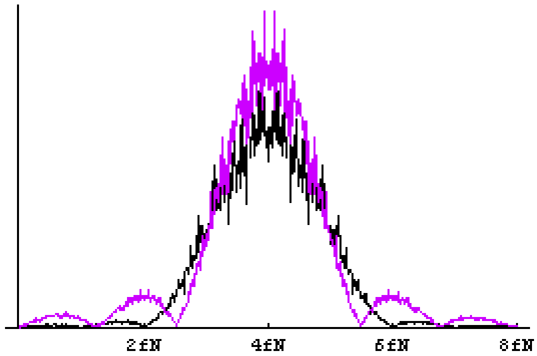


Fig. 11 Spectrum before and after non-linear AMP.

Spectrum before and after non-linear Amp shown in Fig. 11 diverge over bandwidth of 4fN Hz, but does not contain the line spectrum.

3.3 4-QAM system

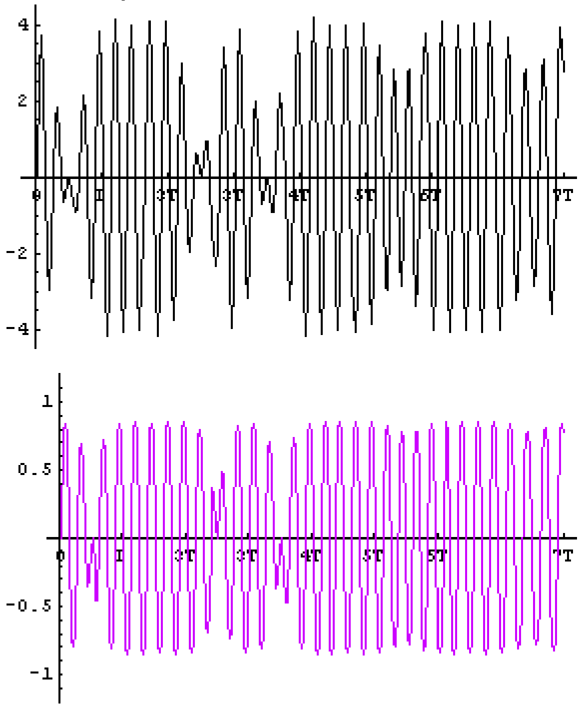


Fig. 12 Modulated signals before and after non-linear AMP.

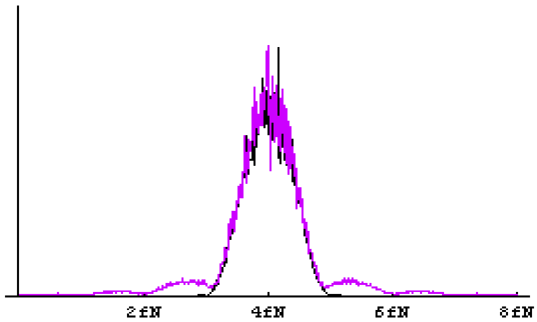


Fig. 13 Spectrum before and after non-linear AMP.

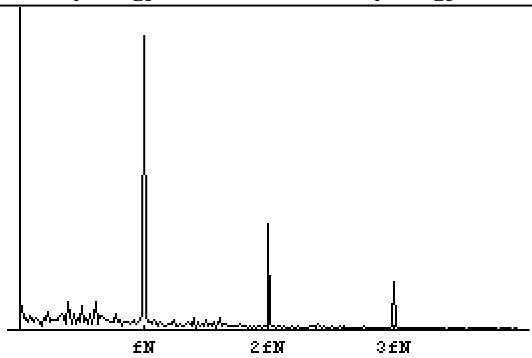


Fig. 14 Symbol clock line spectrum after rectification.

Fig. 14 implies that symbol clock information(1GHz) can be extracted from signal at rectification.

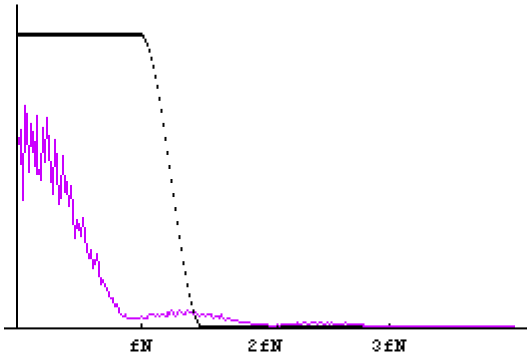


Fig. 15 Band-limitation at non-linear AMP.

The band-limitation of Fig. 15 is very broad and tamely cut-off. In practical cases, there are ripple of amplitude and phase warp in this band-limiting filter, and eye diagram of Fig. 16 will be widely spread.

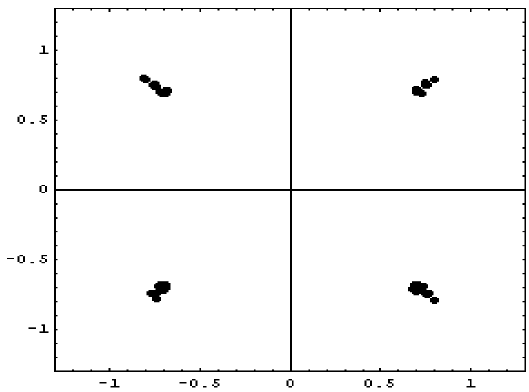


Fig. 16 Two dimensional eye-diagram of demodulated signal after phase rotation.

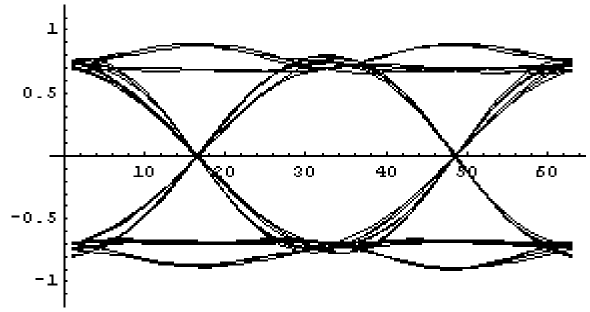


Fig. 17 Eye-pattern of demodulated in-phase signal after phase rotation.

The eye in Fig. 16 and Fig. 17 at phase rotation shows acceptable opening for binary cases, but will be poor if enhanced toward 16-QAM.

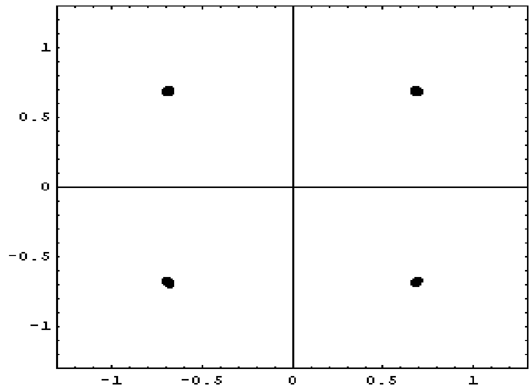


Fig. 18 Eye diagram without band-limiting filter.

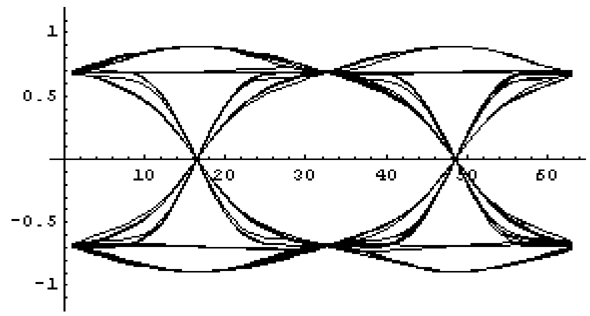


Fig. 19 Eye pattern without band-limiting filter.

Eye diagram and eye pattern are ideally opened as shown respectively in Fig. 18 and Fig. 19.

4. Conclusion

In this paper, we proposed several communication systems for 1Giga bit modem.

The first, Binary ASK system's advantage and disadvantage is following:

<Advantage>

(1) Circuitry is very simple without IF process.

<Disadvantage>

(1) Line spectrum occur unordinary interference to other channels.

(2) Enhancement to 4-level system (2bit/symbol) is impossible due to its large SNR(signal to noise ratio) degradation.

The second, Binary phase modulation system's advantage and disadvantage is following:

<Advantage>

1. Superior error rate performance compared to ASK.

<Disadvantage>

1. Circuitry is more complex compared to ASK.
2. Narrow pull-in range of receiver caused by VCO.
3. Spectrum divergence by the non-linear amplifier.

The third, 4-QAM system's advantage and disadvantage is following:

<Advantage>

1. Signal frequency band is a half of 1GHz.
2. Reliable pull-in of VCO.
3. Possibility of double speed transmission (2Gbps) by keeping 1GHz frequency-band.

<Disadvantage>

1. Inferiority of error rate performance compared to Bi-polarity AM
2. Circuit complexity of pulse shaping.
3. Spectrum divergence by the non-linear amplifier.

The proposed systems are considered to be helpful if you supplement disadvantages of the proposed systems.

ACKNOWLEDGMENTS

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