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WIRELESS BASEBAND TRANSMISSION EXPERIMENTS

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1 Introduction

The purpose of this study is to pursue the limit of a high speed wireless transmission. The scheme we call wireless baseband transmission radiates a baseband signal stream directly from an antenna. Namely, a carrier in terms of sinusoidal radio wave or light wave is not used in the transmission. We have studied experimentally in order to explore the possibility of this wireless baseband transmission. In the experiment, baseband pulses generated with a data generator (DG) were radiated directly from an antenna, and received waveforms were observed with a digital storage oscilloscope (DSO). We have used a pair of discone antennas for transmission and reception.

2 Wireless Baseband Transmission

2.1 Concept

Due to increasing data transmission speed, a pulse width of a baseband signal becomes shorter and shorter. Consequently, required carrier frequency increases with increasing baseband signal bandwidth. For example, frequency at around THz signals is needed if we want to transmit signals with 10 Giga-symbol/s. This goes into a region of a optical space communication.

However, when we change the view and pay attention to the information signal bandwidth, we can expect that such a baseband signal can propagate by its own ability without a carrier. Therefore, the idea is born that original information itself is directly transmitted from an antenna without a modulation operation[1]. That is the concept of the wireless baseband transmission. This system could also be expressed as an application of baseband transmission employed in cable transmission to wireless transmission. Because baseband pulses are radiated directly, extremely wide band is occupied as appeared in ultra-wideband (UWB)[2]. Therefore, it is presumed that the coexistence with other wireless systems becomes an important problem. Accordingly, this system is suitable for short distance communications in millimetre wave region; e.g. point-to-point communications.

We consider wireless systems which do not use a carrier. Similar system is known as UWB based on impulse radio (IR)[3]. IR radiates directly baseband pulses called monocycle, while the wireless baseband transmission system radiates baseband signal waveforms. As mentioned above, this system aims at extremely high speed wireless communications.

2.2 Required Relative Bandwidth for Total Transmission Channel

In order to estimate the necessary bandwidth realizing the wireless baseband transmission, ideal band-pass filter (BPF) characteristics are assumed as a channel model including transmitting and receiving antennas. The required relative bandwidth is judged by observing waveform distortion for the assumed channel. In this paper, the relative bandwidth is defined as

$$B_r = \frac{f_h - f_l}{f_h}, \tag{1}$$

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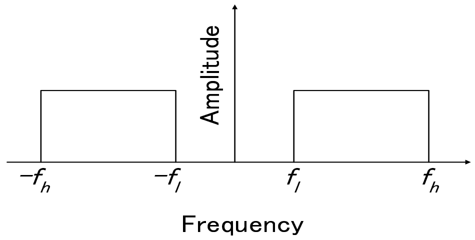
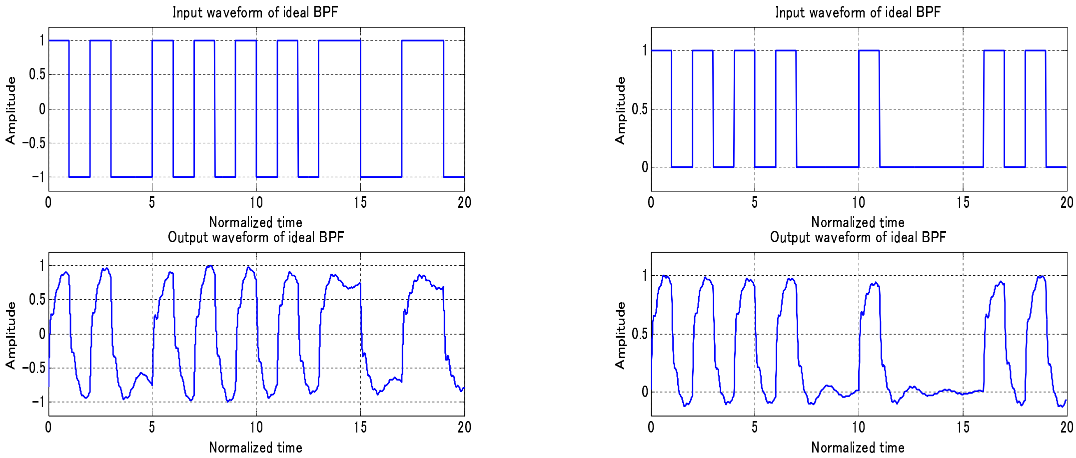


Figure 1: Assumed channel characteristic



(a) Manchester code

(b) RZ code

Figure 2: Transmission characteristics of pulse stream (f_l = 0.6, f_h = 3, B_r = 0.8)

where f_l is the lower limit of pass band, and f_h is the upper limit of one as shown in Fig.1. Input and output waveform of Manchester code and return-to-zero (RZ) code in the case of $f_l = 0.6$, $f_h = 3$, $B_r = 0.8$ are shown in Fig.2. From the figure, waveform transmission can be realized under that condition.

3 Experiments

3.1 Setup

The experiment setup is shown in Fig.3. In the transmitter side, Manchester code and RZ code signals are generated respectively from DG and supplied to the transmitting antenna directly. In the receiver side, the amplitude of received waveform is measured with DSO. The discone antennas are used at the transmitter and the receiver side because it is verified that a discone antenna have a sufficiently wide bandwidth and a flat phase characteristic in the stage of antenna design. The amplitude of generated codes is 1V. Considering that the upper frequency range of DSO is 500MHz, the clock of generated waveform is chosen to 500MHz. Acquisition of data is performed by connecting DSO and a personal computer (PC) with General Purpose Interface Bus (GPIB). The height from the ground to the feed point of an antenna is 2m, and the distance between transmitting and receiving antennas is 5m. All experiments were carried out in the radio anechoic chamber.

The antenna shown in Fig.4 is used in the experiment. It is the discone antennas consisted of 12 aluminum pipes. In order to observe waveforms with DSO directly, with analog bandwidth 500MHz, fairly large sized antennas were designed and made. The measured standing wave ratio (SWR) characteristic is shown in Fig.5. As found from Fig.5, SWR is suppressed below 2 at the frequency range from 100MHz to 3GHz.

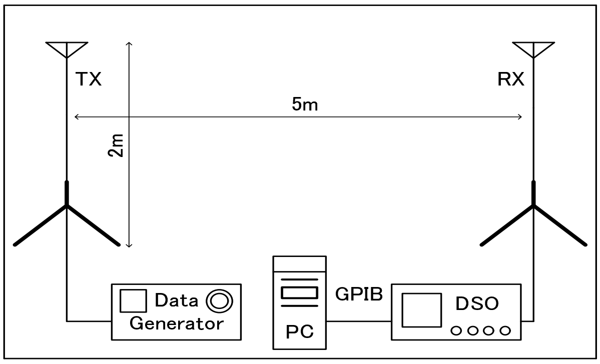
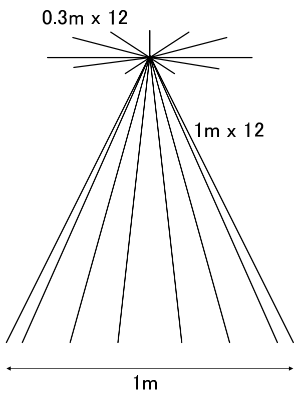
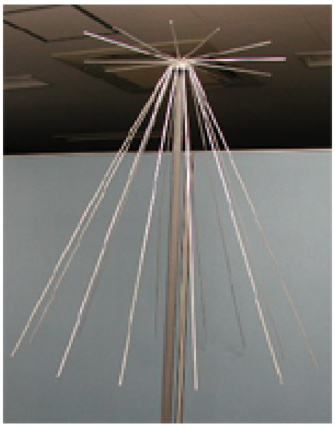


Figure 3: Configuration of experiment system (in the radio anechoic chamber)



(a) Size



(b) View

Figure 4: Designed discone antenna

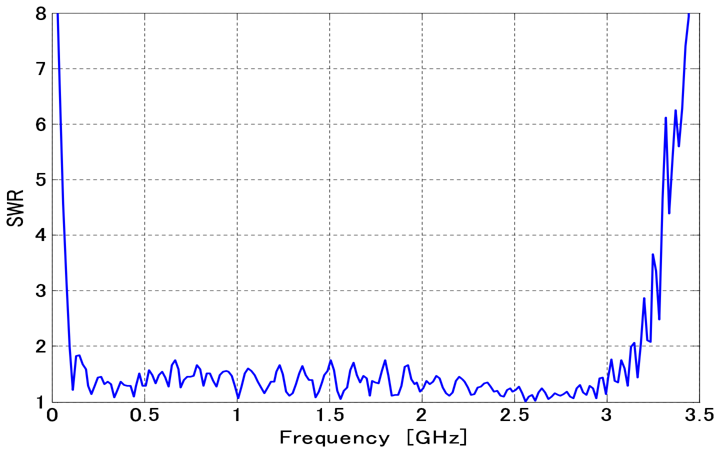
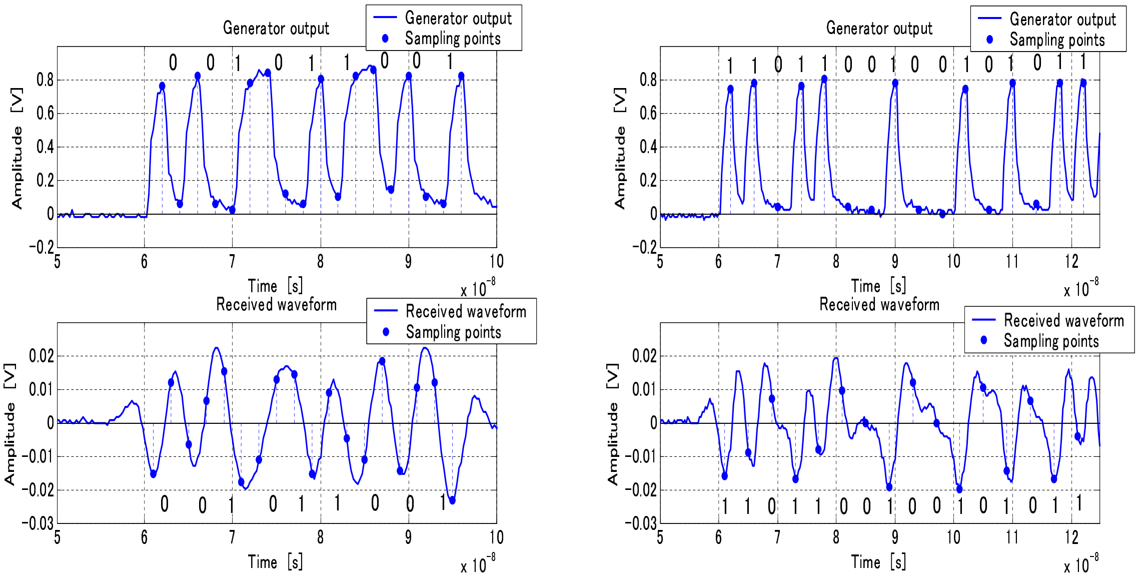


Figure 5: SWR characteristic of the discone antenna (measured)

3.2 Experimental Results

The DG output and received waveform of RZ code and Manchester code are shown in Fig.6. The distorted waveform seen in the figure for generator output is not due to the DG but due to the performance limit of the DSO.



(a) Manchester code (b) RZ code

Figure 6: Transmission characteristics of pulse stream (measured)

Although the reversed waveform of generator output is received on both cases, the data itself can be identified correctly as seen in the figure. Here, we detected the data from a voltage difference per two sampling points in the case of Manchester code; i.e. from High (Low) to Low (High) then 0 (1). In the case of RZ code, if we set threshold voltage to slightly offset from 0V to minus, correct detection can be done. When comparing two codes, we could recognise that Manchester code is detected more clearly as shown in Fig.6.

4 Conclusion

The feasibility of the wireless baseband transmission is examined experimentally. Namely, when using the antennas with a sufficiently wide bandwidth and a flat phase characteristic, the wireless baseband transmission is no more dream. We consider that Manchester code is promising for this wireless baseband transmission.

As future subjects, we consider to design still better antennas for this wireless baseband transmission and investigate the propagation characteristic.

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