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# ANTENNA BASED UWB RECEPTION AND TRANSMISSION

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## ПЕРЕДАЧА И ПРИЕМ UWB СИГНАЛОВ ОСНОВАННЫЕ НА ДЕКОДИРОВАНИИ И КОДИРОВАНИИ АНТЕННАМИ

В работе рассматривается концептуальная возможность декодирования импульсного сверхширокополосного сигнала, кодированного по положению импульсов (Pulse Position Coding) непосредственно приемной антенной приемника и передача закодированного сигнала путем импульсного возбуждения передающей антенны.

The transmission of data using pulsed ultra-wide-pulse signals (IR-UWB) remains an attractive and promising method in connection with many advantages over the transmission of continuous signals based on sinusoidal carriers.

However, ultrashort pulses of practical power (units, tens of watts) carry the small energy equal to the pulse power $P_i$ multiplied by its duration $\tau_i$: $E_i = P_i \tau_i$. As a result, the signal-to-noise ratio $E_i / N_0$, which determines the probability of reception errors, is low. Therefore, data transmission is performed by a series of pulses, the group of which determines the transmitted symbol. This group of pulses $T_s$ is encoded in accordance with a time code (Pulse Position Coding - PPC) orthogonal to codes of other symbols or signals of other transmission systems operating in the same frequency band. An example of such a signal is shown in Fig.1.

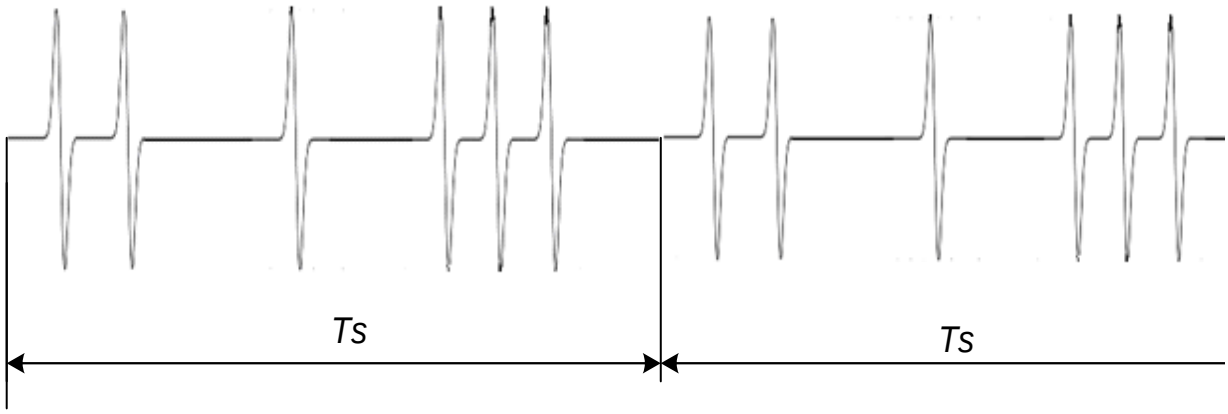


Fig.1. Pulse Position Coding.

To separate the signals at reception it is necessary to apply the correlation method of symbol allocation. The correlator can be an active, selecting symbol by comparing the received signal impulse series with the signal structure (code).

An active correlator requires the synchronization of a sample of the code sequence with the received signal. Ultrashort pulse duration makes it practically impossible to get acceptable accuracy synchronization in receivers.

A passive correlator based on a delay line with taps, also requires high construction accuracy. Such receiver unit can be simplified by applying the "non-energy" receiver circuit [1], in which the received ultrashort pulses are replaced by "standard" pulses of amplitude and duration suitable for processing by digital devices.

**UWB RECEIVER WITH CODED PULSE POSITION.** The discrete nature of the IR-UWB signal with the encoding of information symbols by the position of the pulses allows them to be received and decoded at the input of the receiver by means of an antenna whose design is consistent with the time structure of the signal.

Figure 2 shows the receiver circuit with such an antenna.

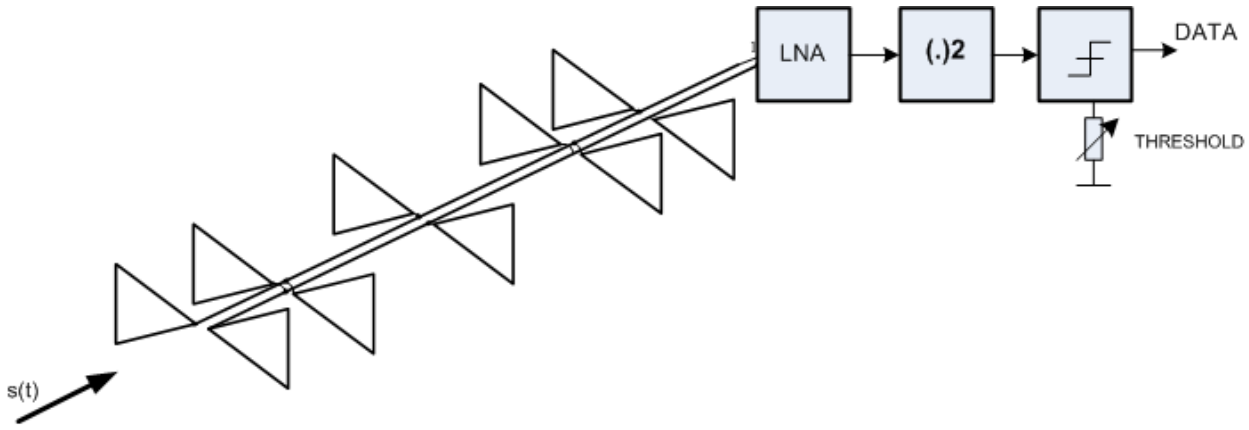


Fig.2. Pulse Position Coded Receiver

The received signal propagates along the antenna, which is a long feeder line connected to flat ultra-wideband vibrators forming dipoles. The feeder line plays the role of an adder of the correlator: the vibrators are taps-offs of a long line. The position of the dipoles (the distance between them) corresponds to the position of the impulses of the signal in the feeder (taking into account the propagation slowdown in it) when one Pulse Position Coding (PPC) is received. Thus, the antenna is a filter matched to the signal.

With a temporary mismatch, the antenna generates noise at the output of the feeder line, which reflects the separate excitation of the vibrators by the pulses of the signal. When the structure of the signal coincides with the antenna structure, a pulse appears at the output of the feeder line, corresponding to the sum of the voltages in

the vibrators (correlation peak) caused by the coincidence in time of excitation of all or most of the vibrators. In a simplified form - without noise, interference and distortion of the shape of the pulses due to the non-ideality of the characteristics of the antenna elements – signals at the output of the antenna are illustrated in Fig.3.

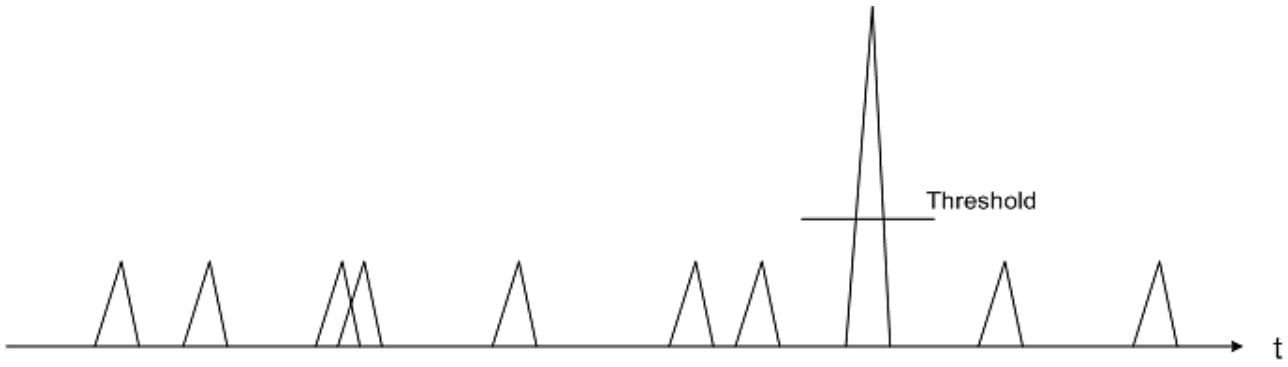


Fig.3 Signals after Squarer

The signals at the output of the antenna feeder are amplified by a low-noise LNA amplifier, squared to obtain a unipolar voltage, and fed to a threshold device with a pre-set threshold. Exceeding the trigger threshold causes a pulse at the output of the receiver informing you of the reception of a bit of the given antenna code.

The antenna in the horizontal plane has a one way "information" directivity within one-sided lobe of the dipole antenna, i.e. reception of the information with asymmetric code can be conducted only from one side. The energy pattern corresponds to the dipole pattern.

**REPEATER.** Considering the reciprocity of the antennas for receiving and transmitting, it is possible to transmit the PPC signal by the antenna described above by its pulse excitation. To do this, an ultra-short video pulse is applied to the input of the feeder line. Ultra-wide-band vibrators connected to the feeder in the code sequence will emit radio pulses in the order of propagation of the video pulse along the feeder, i.e. in the form of the PPC code specified by the antenna.

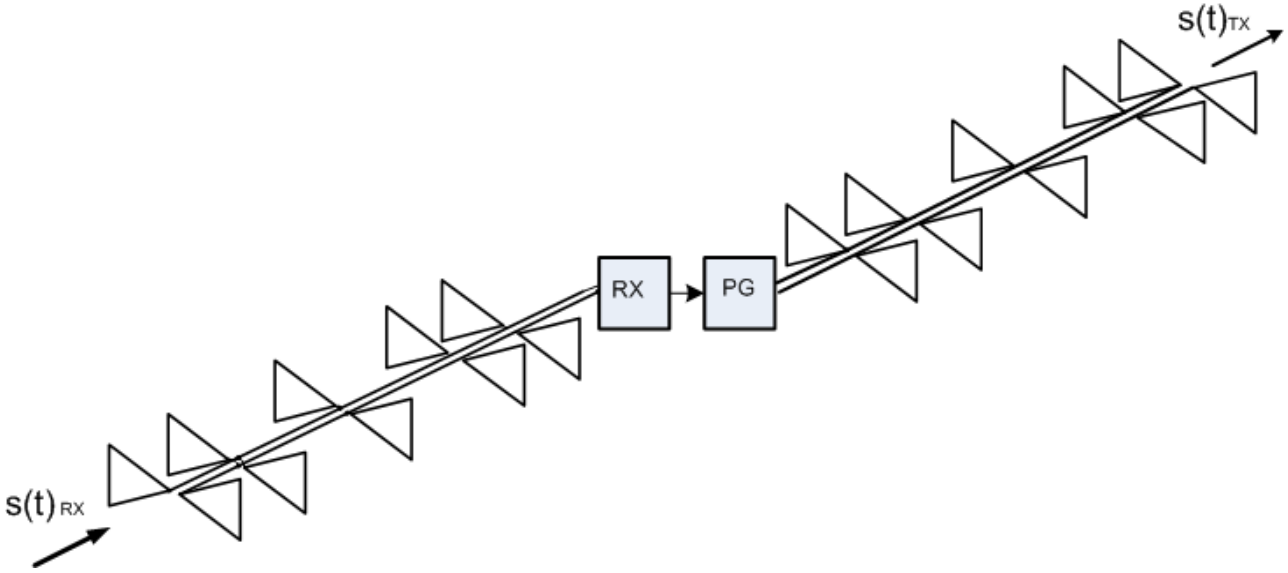


Fig.4 UWB pulse transcoded repeater.

The connection in series of the receiver with decoding antenna and the transmitter with the coding antenna allows the construction of a repeater of encoded or transcoded PPC signals (fig.4). The receiver output (RX) is connected to the input of an ultrashort pulse generator (PG). The reception pulse of the information bit at the output of the receiver triggers the generation of the excitation pulse for the transmitting antenna, which causes radiation corresponding to the code given by this antenna.

The transmitting antenna also has a one-way "information" orientation.

**CONCLUSION.** The method for receiving, transmitting and retransmitting UWB pulse signals with Pulse Position Coding has been proposed. The discrete nature of UWB signals allows them to be decoded when they are received directly by the receiver antenna, whose design is consistent with the signal.

The transmission of UWB signals with their simultaneous PPC coding can be accomplished by pulsed excitation of a multi-element collinear antenna with a predetermined arrangement of its vibrators. The combination of the receiver and the transmitter allows the repeater to be implemented with or without changing the signal code.

The proposed ideas are conceptual. The paper does not address issues related to signal distortions due to the non-ideality of the characteristics of circuit elements in ultra-wideband signal conversion.

**References**

1. S. Bunin, Non-Energy IR-UWB Receiver. Telecommunication Sciences, vol.1, No.1, July – December 2010, pp. 7 – 13.
2. S. Bunin. The Self-Organizing Radio Networks and Ultra Wide Band Signals. Telecommunication science, vol.4, No.2, 2014. pp. 3-7.