SIMULATION OF A RECEIVING SYSTEM WITH AMPLITUDE DEMODULATION AND TIME DIVISION OF CHANNELS IN A LABVIEW ENVIRONMENT

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The paper is received on May 30, 2018

Abstract. The development of systems for receiving and transmitting information led to the need for more efficient use of the allocated frequency range. One of the methods of compaction of information in the communication channel is the Time Division Multiple Access (TDMA) method. This method is now widely used in satellite communication systems and in cable networks, as well as for cellular networks (GSM, PDC). This article describes one of the ways to implement the time division of channels in the LabView programming environment. Reception of information was carried out with the help of a software-defined radio system of NIIPS. The transmitter encoded the original sequence of binary symbols, and then made a temporary join of the channels. The receiver demodulated the input sequence and used a temporary demultiplexing, which allowed to restore the original sequence. The demodulation and demultiplexing unit was considered in more detail in the article. The block decoder converts the sequence of input complex numbers into a bit sequence, and the unit responsible for the temporary demultiplexing writes the resulting sequence into a single array and offers its demultiplexing according to the principles of time division into three initial sequences.

Key words: LabView, time division multiple access, amplitude keying.

The time-based method of dividing channels is based on the alternate transmission of different signals along a single line. The system provides transmission of N signals on one line, connecting N transmitters with N receivers. Receivers and transmitters are connected to the line by two special switches operating in synchronized mode.

Unlike other ways of dividing channels, TDMA technology manipulates two signal parameters – a frequency and time. Each channel in TDMA technology is assigned a broader frequency band (up to 200 KHz). This frequency band is divided into time-spaced logical channels. The advantages of this system are higher noise immunity and the ability to reuse the same frequency band.

In this method, often used signals with amplitude-shift keying (ASK, n-QAM) – change in the amplitude of the carrier wave according to the law of the modulating signal. The modulating signal is a bit sequence. ASK modulation is more noise-proof, compared to n-QAM modulation, since it has only two possible amplitude states.

The purpose of this work is to simulate a receiving device for decoding a known transmitter signal. The signal at the output of the transmitter is formed from three independent bit sequences. These sequences are combined into one using a time division multiplexer and then transformed into complex numbers of the signal constellation of the ASK carrier signal.

To realize the receiver with time division of channels and amplitude demodulation in the LabView environment, was developed block diagram (figure 1).

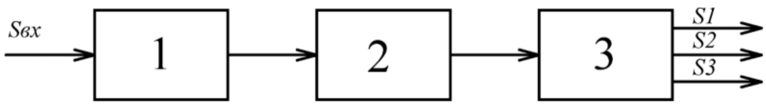


Figure 1. Block diagram of a receiver with TDMA and an ASK carrier signal

On figure 1: 1 – block to convert complex numbers to a bit sequence, 2 – block of recording the resulting sequence into a single array, 3 – block of recording the resulting sequence into a single array.

The algorithm of the receiver in the LabView environment is presented on figure 2.

After the program is started, the received sequence is going at the input of the simulated device in the form of complex numbers. Then, using block 1 (figure 1), it is converted into a bit sequence. The obtained sequence is written in the form of a matrix consisting of one row and 3N columns (N is the length of each original sequence). After this, the received sequence is divided into three initial ones and check the end of the data receipt.

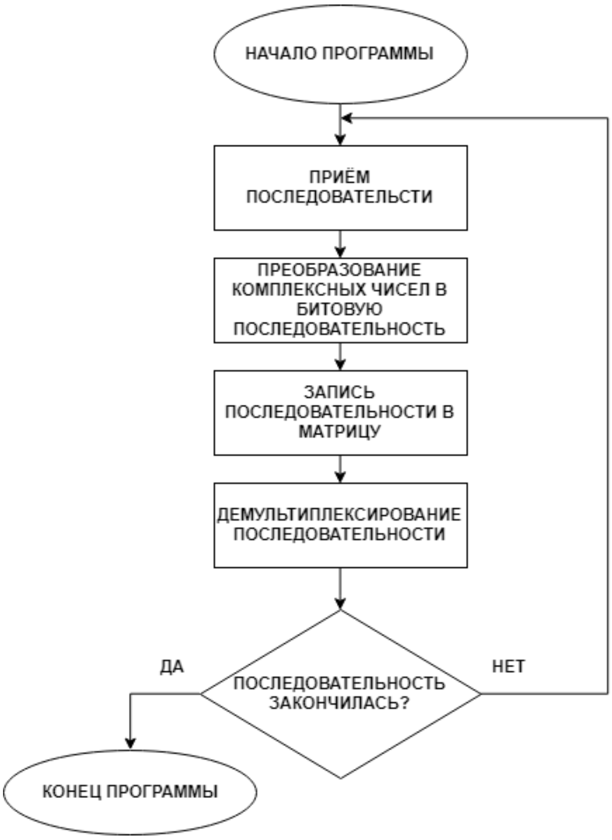


Figure 2. The algorithm of the program

The implementation of the presented block diagram in the LabView environment is shown on figure 3.

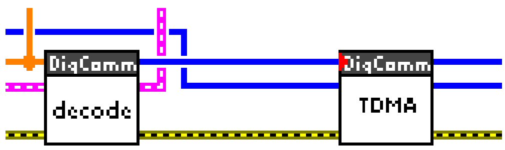


Figure 3. Demodulation and Time Division Blocks

The "decode" block converts the sequence of complex numbers into a bit sequence. The "TDMA" block writes the received sequence to a single array and demultiplexes it according to the principles of time division into three initial sequences.

The structure of the decode block is shown on figure 4.

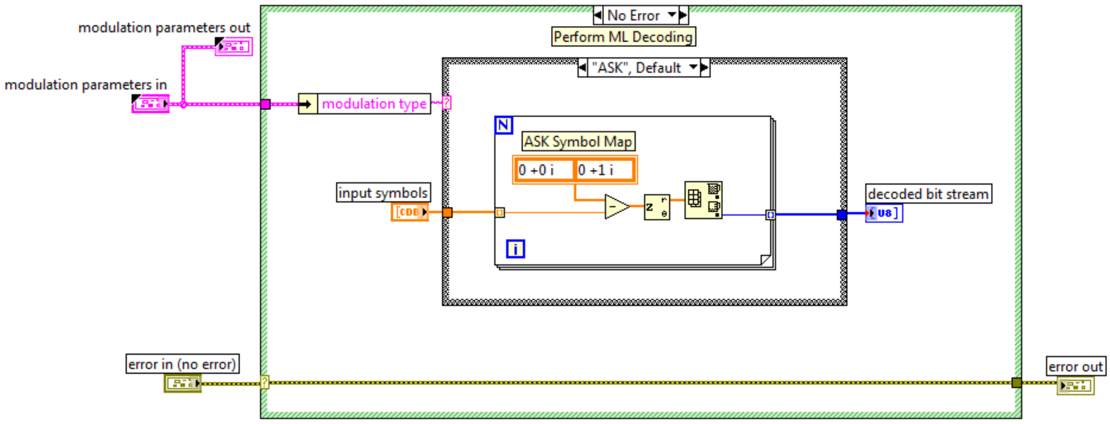


Figure 4. Demodulation block of the input sequence

The input of the block receives a complex sequence characterizing the signal constellation of the received ASK signal. These complex numbers are sequentially fed to the block, where they are alternately subtracted from the symbols of the matrix (0 + 0i, 0 + 1i). After this, two subtraction results go to the complex to polar function block, from which the values of the modules of the complex subtraction results (r) are taken. The values of the modules are written to the matrix "array max & min function". From the matrix output, the cell index with the minimum value of the module is removed. Thus, the function of the block is to convert the complex values of the signal constellation into bit values of the original sequence.

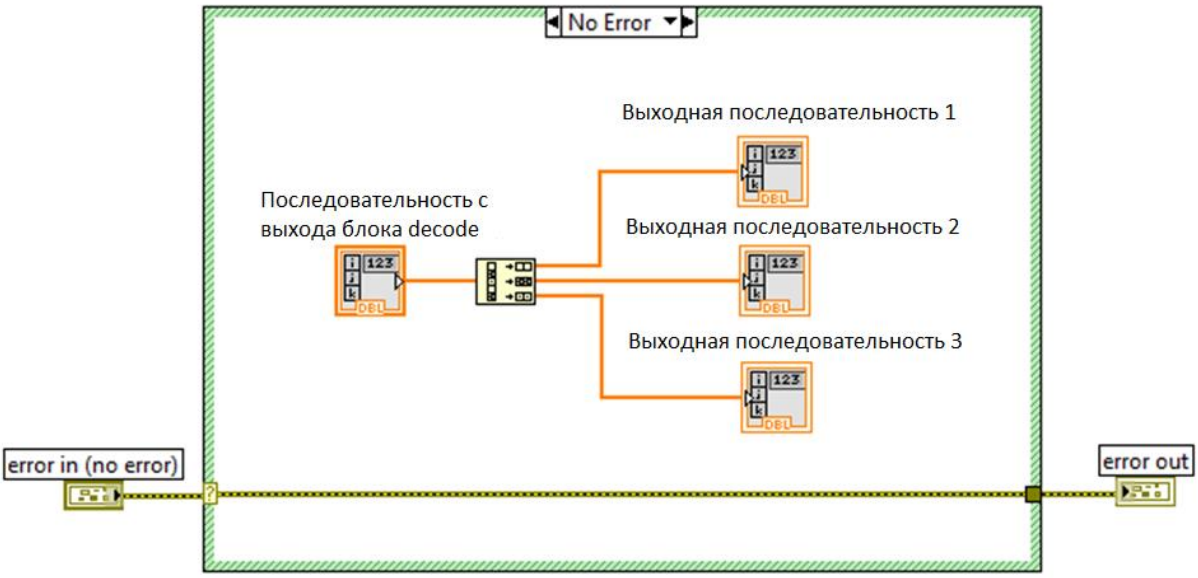
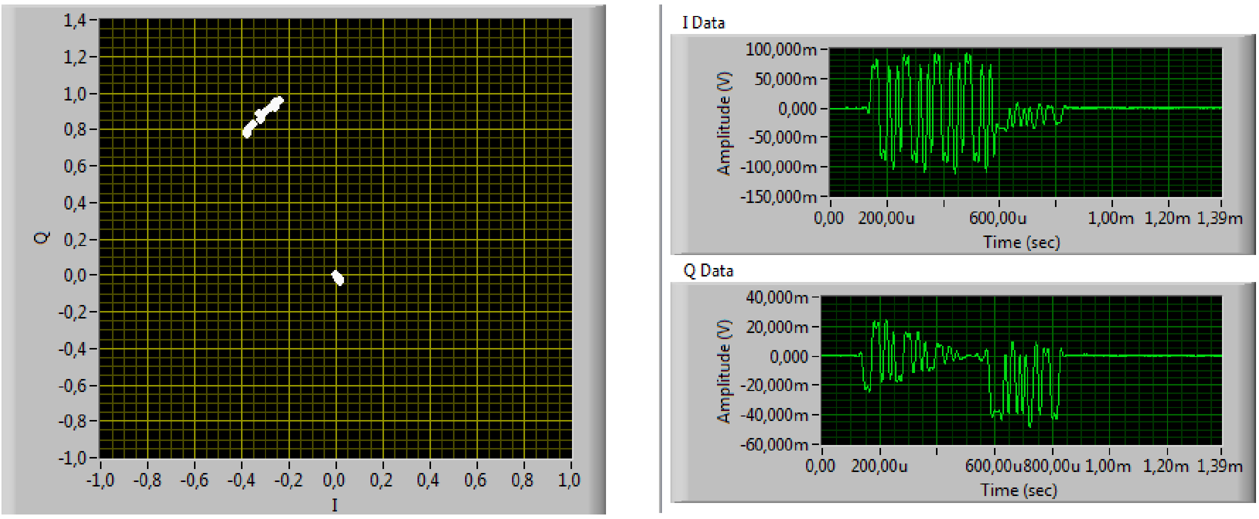


Figure 5. *TDMA block*

The resulting sequence is input to the "TDMA" block (Figure 5), where in the "Decimate 1D block function" block it is divided into three parallel output channels. In these channels we obtain the original sequences.

We will simulate the reception of the signal at a frequency of 100 MHz. The following is shown: the diagram of the received constellations (Figure 6a), the oscillogram of the received signal (Figure 6b) and the resulting bit sequences (Figure 7):



a b

Figure 6. Display of received signal parameters: a-diagram of constellation ASK; b - time diagram of the incoming signal

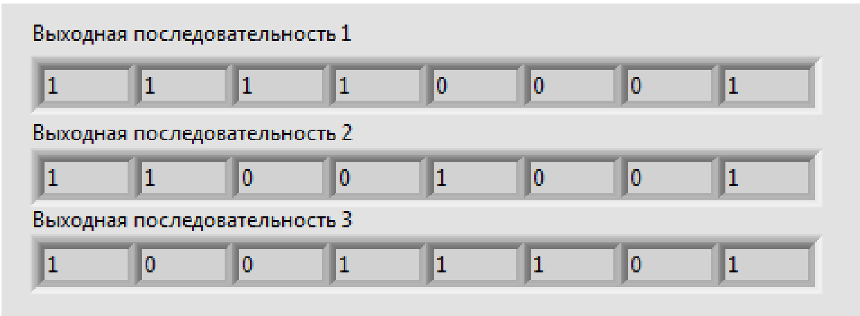


Figure 7. Recovered sequences

Thus, the LabView environment makes it possible to simulate real systems for receiving and transmitting information.

Simulation of the receiving system with TDMA and ASK carrier signal showed that at the carrier frequency of 100 MHz, the bit sequence is accepted without errors. It should be noted that when the carrier frequency is increased, the number of erroneous bits increases

References

1. Shulgin V.I. *Osnovy teorii peredachi informatsii. Chast' 2. Pomekhoustoichivoe kodirovanie. Uchebnoe posobie* [Fundamentals of the theory of information transfer, Part 2. Noise immunity coding. Student book]. Kharkiv. Kharkiv National aerospace universityю, 2003, 87 p. (In Russian)

2. Shvarcman V.O., Emelyanov G.A. *Peredacha diskretnoi informatsii. Uchebnik dlya sdudentov elektrotekhnicheskikh institutov* [Discrete information transfer. Textbook for students of electrical engineering universities]. Moscow, Radiosvyaz Publ., 1982, 240 p. (In Russian)

3. Fedosov V.I. *Osnovy programmirovaniya LabView. Uchebnoe posobie* [Basics of LabView programming. Student book]. Saratov, Chernyshevsky Saratov State University Publ., 2010, 53 p. (In Russian)

For citation:
Ya. A. Zazulin, P. Yu. Karpunin, K. V. Kireev. Simulation of a receiving system with amplitude demodulation and time division of channels in a LabView environment. *Zhurnal Radioelektroniki - Journal of Radio Electronics*. 2018. No. 6. Available at http://jre.cplire.ru/jre/jun18/10/text.pdf
DOI 10.30898/1684-1719.2018.6.10