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Research Paper

Creating Checking Elements of Hamming Codes on a New Elemental Base Based on Programmable Logical Integral Schemes

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ABSTRACT

The article presents a technique on a specific example of the rule building of the Hamming code, correcting one error in the transmitted information combination. The purpose of the study is to increase the reliability of information transfer. The research methodology is based on the determination of a check digit using a programmable logic integrated circuit. As a result, the check bits are restored by information bits at characteristic points of the programmable logic integrated circuit. Recommendations are given on the practical use of check bits of the Hamming codes on the new element base based on programmable logic integrated circuits.

Keywords: codes; integrated circuit chip; code combination; discharges; check characters

INTRODUCTION

In modern telecommunication systems, when transmitting messages over digital channels, it is encoded with a noise-resistant code. The idea of robust coding is to add extra characters to the message to help notice the error. Then the set of code combinations increases and consists of two subsets: allowed combinations and forbidden combinations. If, as a result of an error, the original combination has moved to a set of forbidden, then the error can be detected. However, it is possible that the set of errors will transfer the transmitted code combination to another allowed one. In this case, instead of one letter, we get another letter and the error will not be detected. In order to detect and correct errors, the allowed combination must be as different from the forbidden as possible.

MATERIALS & METHODS

In recent years, in all developed countries of the world, the transmission of information is widely used error-correcting codes. Based on this, this research option is relevant and timely. The main aim of the work is ensure the construction of test bits using a programmable logic integrated circuit.

Consider the rules for constructing [6, 3] Hamming code, correcting one error in the transmitted information combination (a_1, a_2, a_3, a_4).

We write out the truth table for the three test bits. Denote the information digits by the symbol bi. Then, the test bits are restored for information on the following rule:

X_2	X_1	X_0		
0	0	0		
0	0	1	b_0	$b_0 = a_1 \oplus a_2 \oplus a_4$
0	1	0	b_1	$b_1 = a_1 \oplus a_3 \oplus a_4$
0	1	1	a_1	
1	0	0	b_2	$b_2 = a_2 \oplus a_3 \oplus a_4$
1	0	1	a_2	
1	1	0	a_3	
1	1	1	a_4	

Those. the value of b_0 is formed from all ak for which $x_0 = 1$. The value of b_1 is formed from all a_k for which $x_1 = 1$, etc. A self-correcting Hamming code [6, 3] is fed to the transmitter of the communication channel, which has the form

(b_0, b_1, a_1, b_2, a_2, a_3, a_4).

At the receiving end of the communication channel for verification symbols, a similar combination is constructed:

$B_0 = a_1 \oplus a_2 \oplus a_4$

$B_1 = a_1 \oplus a_3 \oplus a_4$

$B_2 = a_2 \oplus a_3 \oplus a_4$

The difference between the transmitted bits and the received check bits for bi can detect and localize the error. The location of the error is determined by the formula

$M = 2^0 (b_0 \oplus B_0) + 2^1 (b_1 \oplus B_1) + 2^2 (b_2 \oplus B_2)$

For example, consider the Hamming construction of a code word for a message (111001111). To encode k = 9 information bits by Hamming, it is required to determine the number of check symbols from the equality $2r \geq k + r + 1$.

Simple selection find r = 4; $24 \geq 9 + 4 + 1$. Those. we need the code [13, 9]. Consider the rules of construction [13, 9]. Hamming code correcting one error in the transmitted information combination (a_1, a_2, a_3, a_4, a_5, a_6, a_7, a_8, a_9). We write the truth table for the four test bits. Denote the information bits as a_i, and check as b_i. Then, the check digits are restored according to the following rules for information:

X_3	X_2	X_1	X_0		
0	0	0	0		
0	0	0	1	b_0	$b_0 = a_1 \oplus a_2 \oplus a_4 \oplus a_5 \oplus a_7 \oplus a_9$
0	0	1	0	b_1	$b_1 = a_1 \oplus a_3 \oplus a_4 \oplus a_6 \oplus a_7$
0	0	1	1	a_1	
0	1	0	0	b_2	$b_2 = a_2 \oplus a_3 \oplus a_4 \oplus a_8 \oplus a_9$
0	1	0	1	a_2	
0	1	1	0	a_3	
0	1	1	1	a_4	
1	0	0	0	b_3	$b_3 = a_5 \oplus a_6 \oplus a_7 \oplus a_8 \oplus a_9$
1	0	0	1	a_5	
1	0	1	0	a_6	
1	0	1	1	a_7	
1	1	0	0	a_8	
1	1	0	1	a_9	

Those. the value b_0 is formed from all a_k for which $x_0 = 1$. The value b_1 is formed from all a_k for which $x_1 = 1$, etc. Considering that for the combination (a_1, a_2, a_3, a_4, a_5, a_6, a_7, a_8, a_9) = (111001111). For the verification characters, we get

$b_0 = a_1 \oplus a_2 \oplus a_4 \oplus a_5 \oplus a_7 \oplus a_9 = 1 \oplus 1 \oplus 0 \oplus 0 \oplus 1 \oplus 1 = 0$

$b_1 = a_1 \oplus a_3 \oplus a_4 \oplus a_6 \oplus a_7 = 1 \oplus 1 \oplus 0 \oplus 1 \oplus 1 = 0$

$b_2 = a_2 \oplus a_3 \oplus a_4 \oplus a_8 \oplus a_9 = 1 \oplus 1 \oplus 0 \oplus 1 \oplus 1 = 0$

$b_3 = a_5 \oplus a_6 \oplus a_7 \oplus a_8 \oplus a_9 = 0 \oplus 1 \oplus 1 \oplus 1 \oplus 1 = 0$

The code word has the form (b_0, b_1, a_1, b_2, a_2, a_3, a_4, b_3, a_5, a_6, a_7, a_8, a_9) = (0010110001111). Considering the above, it is possible to judge that the implementation of information transmission with the help of error-correcting codes can be implemented on the basis of a new element base of a programmable logic integrated circuit. The construction of a programmable logic matrix (PLM) is based on the fact that any combinational function can be represented as a logical sum (OR operation) of logical products (AND operations). Then the scheme that implements the combinational function can be represented as in fig.1.

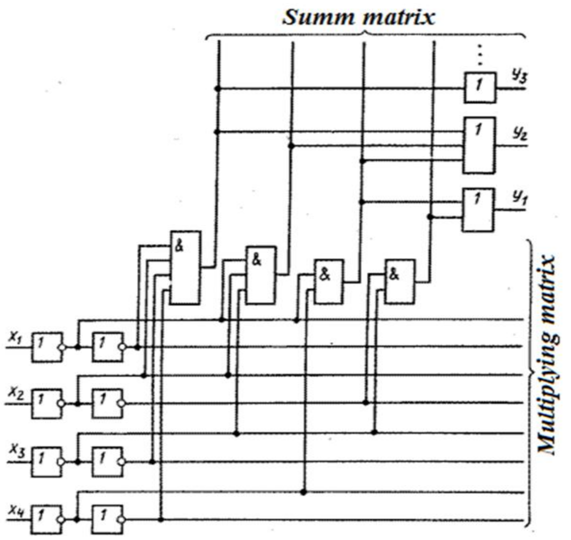

Fig.1. The principle of constructing a programmable logic matrix

At the characteristic points of a programmable logic integrated circuit, we can get the check bits of Hamming codes.

RESULT & DISCUSSION

Based on these considerations, programmable integrated circuits can be used in encoders. The truth table at different points for the said programmable logic integrated circuit is presented in the following table 1.

Table 1: The table of truth PLM.

X_1	X_2	X_3	X_4	A_1	B_1	A_2	B_2	A_3	B_3	A_4	B_4	M_p	M_c
0	0	0	0	1	0	1	0	1	0	1	0	0	1
0	0	0	1	1	0	1	0	1	0	0	1	0	1
0	0	1	0	1	0	1	0	0	1	1	0	0	1
0	0	1	1	1	0	1	0	0	1	0	1	0	1
0	1	0	0	1	0	0	1	1	0	1	0	0	1
0	1	0	1	1	0	0	1	1	0	0	1	0	1
0	1	1	0	1	0	0	1	0	1	1	0	0	1
0	1	1	1	1	0	0	1	0	1	0	1	0	1
1	0	0	0	0	1	1	0	1	0	1	0	0	1
1	0	0	1	0	1	1	0	1	0	0	1	0	1
1	0	1	0	0	1	1	0	0	1	1	0	0	1
1	0	1	1	0	1	1	0	0	1	0	1	0	1
1	1	0	0	0	1	0	1	1	0	1	0	0	1
1	1	0	1	0	1	0	1	1	0	0	1	0	1
1	1	1	0	0	1	0	1	0	1	1	0	0	1

PLA are embedded in programmable logic integrated circuits (PLIC). The use of PLIC in encoding devices that implements Hamming coding codes increases the reliability and reliability of information transmission in telecommunication systems.

CONCLUSION

As a result of the research, it is proved that the test bits are restored by information bits. This can be verified by comparing Table 1 and the table rules for constructing check bits using the Hamming method. This option is carried out on a new element base programmable logic integrated circuit.

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