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MATHEMATICAL MODELING OF MICROELECTRONIC TRANSMITTERS USING PETRI NET

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ABSTRACT

Currently, microprocessor, microelectronic systems and devices used in railway automation and remote control systems are widely used. The use of systems and devices for railway automation and remote control, developed on the basis of microelectronics and microprocessor elements, provides an increase in the level of reliability compared to systems based on electromagnetic relays.

In this article, the modeling of transmitter relays designed to transmit the codes generated by the KPTSH transmitter to road traffic lights and locomotive traffic lights in rail chains equipped with auto-blocking systems and automatic locomotive signaling systems at the joint-stock company «Uzbekistan Temir Yollari» is considered.

The process of modeling «Y» codes (for Yellow codes) based on Petri net graphs of the newly developed integrated microprocessor code transmitter for the transmission of codes formed in railway automation and telemechanics systems is considered. Time descriptions of transmitter relay pulses and «Y» code pulse and interval timing diagrams for transmitter relays. In addition, «Y» codes have been studied.

Keywords: automatic blocking, locomotive automatic signaling, track circuits, code, processes, anchor, relay, Petri nets, graphs.

Introduction

One of the most acute scientific problems in the field of railway automation and telemechanics is to ensure the safety level and reliability factor of control systems and equipment, as well as to improve the areas of analysis and synthesis of their work [1-12].

In order to increase the level of safety in the devices and systems of railway automation and telemechanics, multi-channel control methods have been introduced. The basis of these channels is equipment, software and time reserve, and the goal is to create reserves for the safety and stability of elements, to eliminate equipment failures in the system [12-19].

To date, when implementing the same methods of improving safety on railways, the operating conditions of equipment and systems of railways, the development of railways and the speed of trains operating on them are not always taken into account [8].

As a result, the use of only one technical solution to increase the level of security in most cases leads to the fact that software and hardware systems work more than necessary, which reduces the efficiency of work and complicates their structure.

Therefore, it becomes relevant to increase the level of safety in the operation of equipment and systeMS of railway transport, the development and implementation of methods for assessing their impact on the movement of trains and taking into account economic factors.
Petri nets are a tool for implementing the system. The theory of Petri nets makes it possible to model railway automatic and telemechanics systems in a mathematical hypothesis. The theory of Petri nets was developed to model parallel processes in systems.
Petri nets are built on the basis of P processes, T conditional transitions, I input and O output elements of the problem. Input and output functions are interconnected through processes and conditional jumps. This ensures the correspondence of processes and conditional transitions in the structure of Petri nets [19-24].
The difference between pulses and intervals in the transmission of the relay code of TSH transmitters requires the implementation of separate processes for each code in Petri graphs. Based on the generated Petri charts below, the TSH-65 and TSH-2000 relays. Let's get acquainted with the modeling for the code «Y- (for Yellow)».

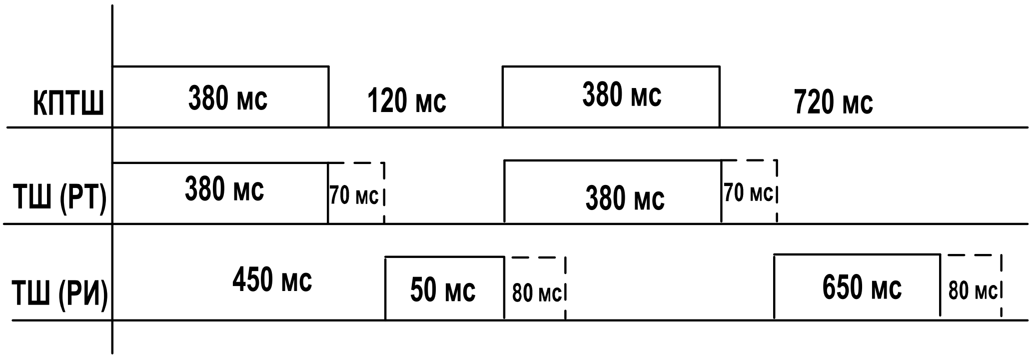

Figure 1. Diagram of the time characteristics of the pulse intervals in the code “Y” for the relay-transmitters TSH-65 and TSH-2000.

Table 2.5 lists the processes and descriptions of the processes in Petri nets for the code «Y»:

Table 1

Order of proceedings	**Purpose of the procedure**
P1	The supply was given and the impulse started to come.
P 2	During the pulse, the process of raising the armature of the RT relay.
P3	The process of checking the arrival of a pulse for 380 MS.
P4	70 MS to reset the RT relay within the interval after the end of the delay time pulse.
P11	
P5	Dropping of RT relay armature .
P6	Processing interval 50 MS.
P7	Relay armature lifting RI.
P8	The delay in the arrival of the pulse and the armature of the relay RI is 80 MS and the process of the arrival of the pulse is 380 MS.
P13	
P9	Delay time 80 MS for the arrival of the pulse and deactivation of the armature of the relay RI after the process of checking the timeout interval.
P10	Relay armature drop RI
P12	Process arrival interval 650 MS
Order of conditions	**Assigning transition conditions**

t1	Start of pulse reception 0÷380 MS
t2	Checking the transition condition to the interval after the end of the impulse.
t3	After a delay of 70 MS, the armature of the PT relay switches from on to de-energized.
t12	
t4	Checking if the 70 MS delay time expires and the 50 MS interval continues.
t5	Checking the start of the 80 MS delay after the 50 MS interval.
t6	Check pulse arrival for 300 ms.
t7	After a delay of 70 MS, relay RT is de-energized and RI is turned on.
t8	80 MS latency check after 650 MS interval.
t9	Relay RI de-energized.

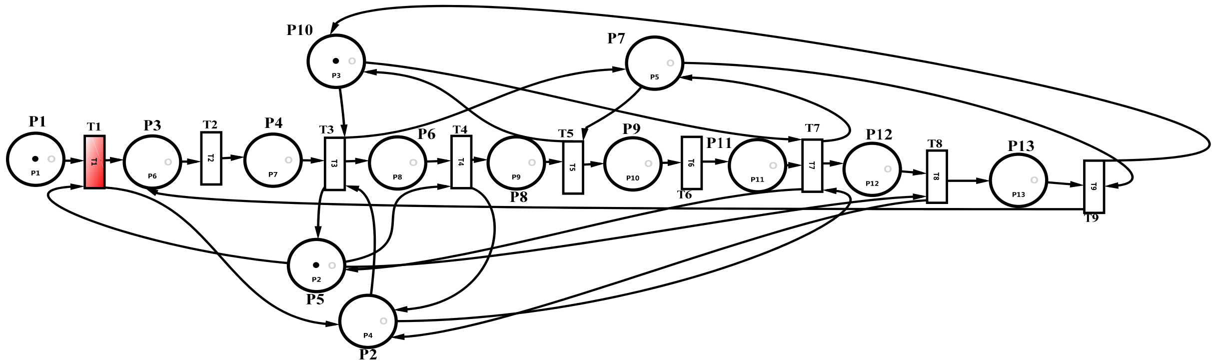

Figure 2. Code "Y" Initial state of the transmitter relay TSH when power is connected
Graphical representation of a Petri net

The graph uses state transitions t1, t2, ... and t14 and positions P1, P2 .... and P16.
In figure 2, when the power is connected and a pulse is input, the P1 chip activates the position. And the transition condition t1 checks the fulfillment of the condition for receiving an impulse within 380 MS, and if the condition is met, outputs O(t1) = {P2, P3} are formed. These outputs activate the positions shown in Figure 3. As a result of the activation of the process P2 by the transition t1, the relay PT picks up the armature, i.e. it changes to the current state. And process P3 controls the process of receiving a pulse to P2 for 0÷380 MS. After the specified time has elapsed, I(t2)={P3} checks the condition for the beginning of the interval at the end of the input pulse.

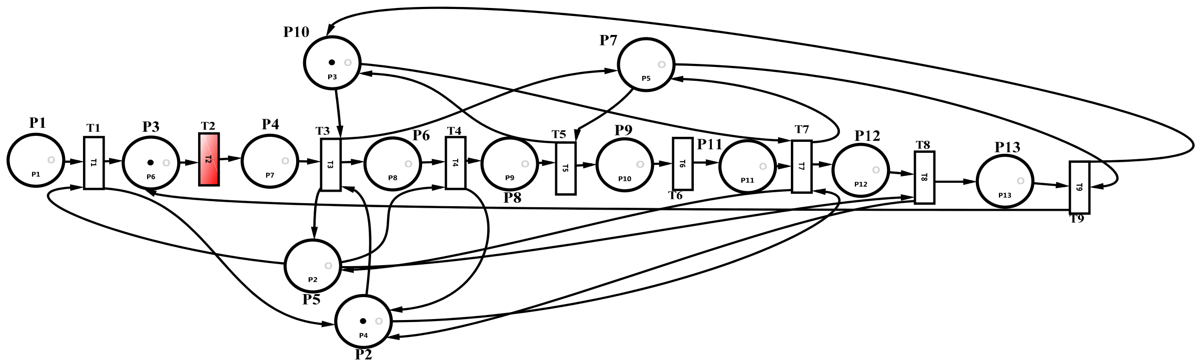

Figure 3. When the power is connected to the relay of the TS transmitter for the code "Y", a pulse with a duration of 0÷380 MS arrives. Representation of the Petri net graph

Checking for another 70 MS delay before the end of the pulse to drop the armature RT is created by activating position P4 (fig. 4).

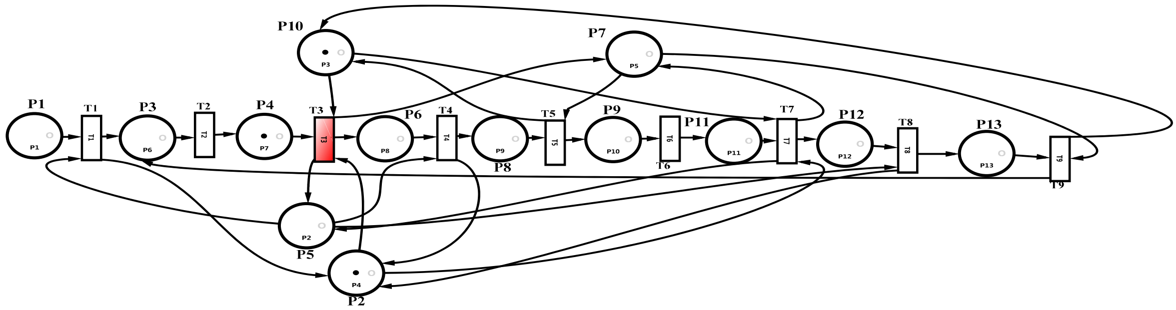

Figure 4. Plot of the Petri net of the 70 MS delay process for checking the drop of the PT armature for the "Y" code when power is applied

After the 70 MS delay time for R4 to de-energize the RT armature, the I(t3)={P4,P10} inputs check that the armature is fully de-energized, that is, the process condition for RT transitioning from the energized state to the de-energized state.

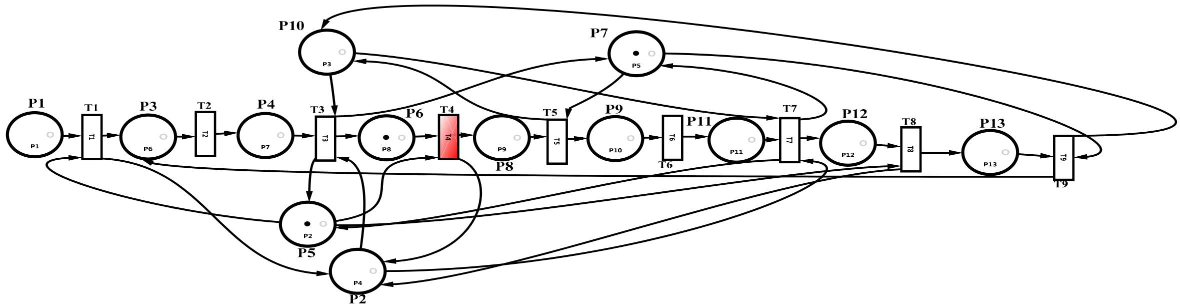

Figure 5. Petri net plot of PT anchor drop and 50 MS interval for code "Y".

In Figure 5, as a result of the output O(t3)={P5}, a chip is generated in process R5, which represents that the RT anchor has dropped. The occurrence of the output O(t3)={P7} is the basis for the transition of the armature RI from the de-energized state to the on state. And the output O(t3)={P6} activates the P6 position, P6 in turn organizes the interval duration process for 50 MS. The sequential occurrence of P4 and P6 processes ensures a total interval of 120 MS. After the process of P6 is completed, we have the output O(t4)={P2} and thus start sending a pulse to start cycle 2.

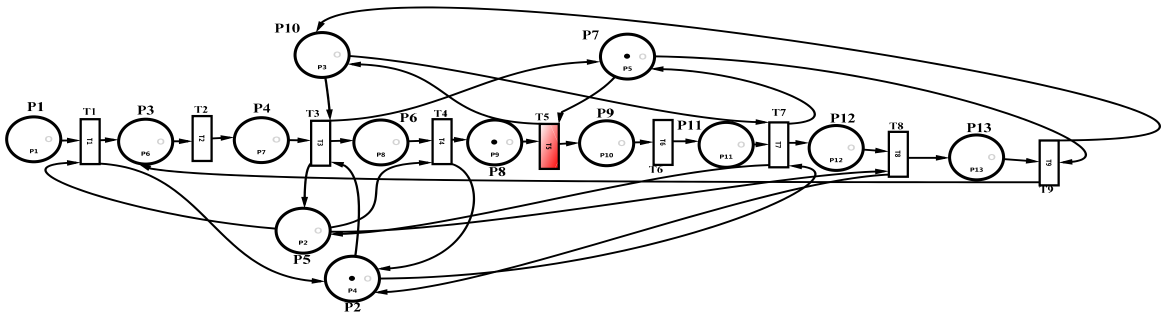

Figure 6. Plot of the Petri net of the 80 MS delay process for checking the drop of the RI armature for the "Y" code when power is applied

I(t5)={P8} checks the start condition after a delay of 80MS after parameter t5 is enabled. When this condition is met, process P8 is activated. Figure 6.

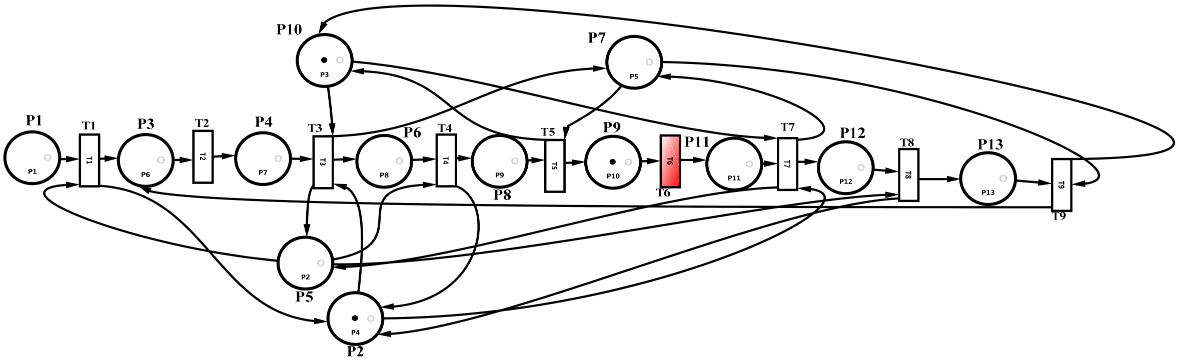

Figure 7. (Image of Petri nets of impulse arrival for 300 MS)

The R9 position is activated by the input I(t6)={P9}. The P9 state represents the arrival of a 300 ms pulse. At the same time, the process of activation also occurs in the P2 state, which means that the RT armature is in a live state.

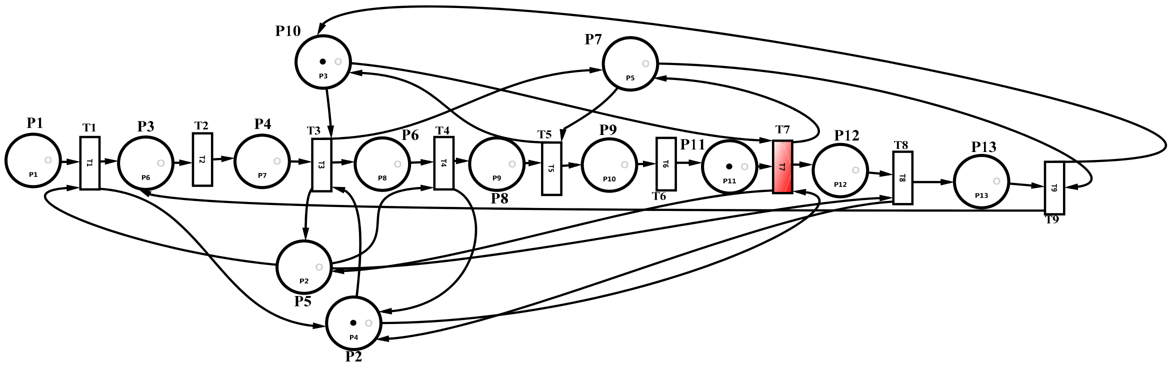

Figure 8. Plot of the Petri net of the 70 MS delay process for checking the drop of the PT armature for the "Y" code when power is applied

(I(t7)={P11} input shows the execution process of the delay time condition for R11 position RT anchor to fall. I(t7)={P10,R11} inputs represent the end of 70 MS delay.)

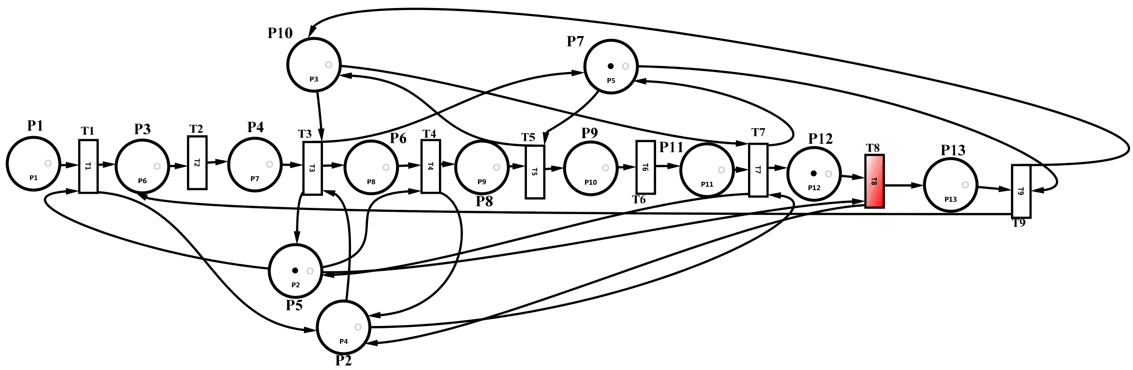

Figure 9. Interval of 650 the code «Y» Petri net chart

(O(t7)={P12} is generated when process R12 is activated, which means that there is an interval of 650 MS.
It is shown that the RT armature switches from the uncurrent state to the current state as a result of the generation of the output O(t8)={P2}.)

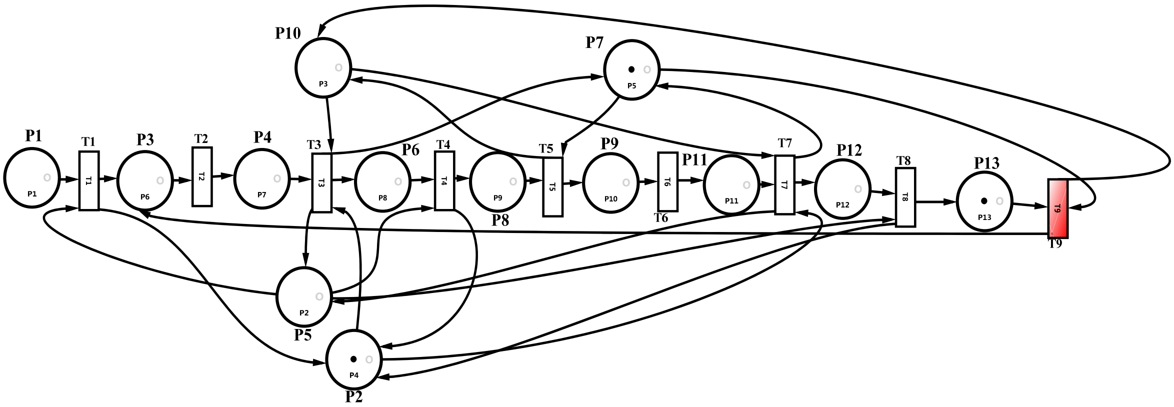

Figure 10. Plot of the Petri net of the 80 MS delay process for checking the drop of the RI armature for the “Y” code when power is applied
Fig. 10 (The fact that we have input I(t7)={P2} means that the pulse start process and the pulse arrival process 380 MS into the cycle are activated.)
As a result of the input I(t9)={P13}, it is expressed that the 80 MS delay process shown in its technical characteristics occurs for the transition of the RI armature from the current state to the non-current state.

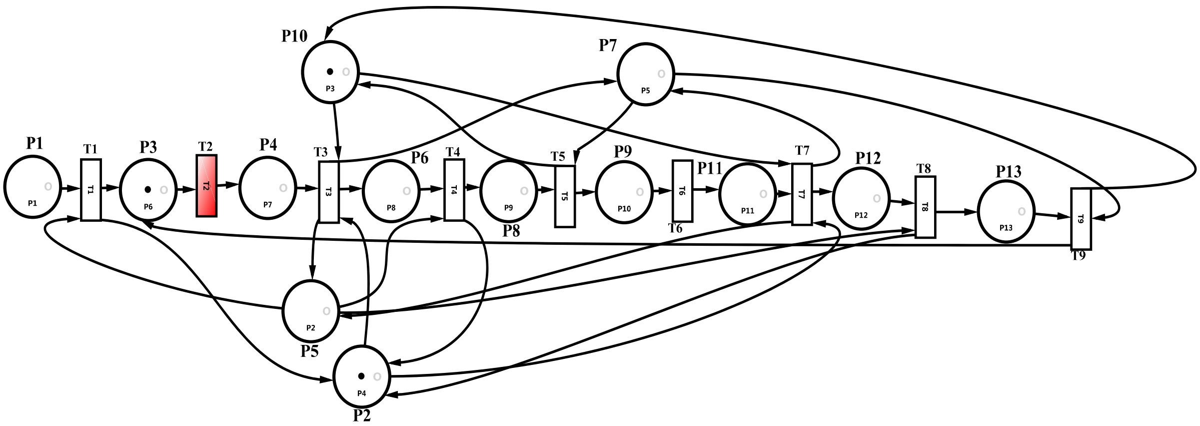

Figure 11. Beginning of the 2nd cycle for the code “Y” Petri net chart

I(t9)={P7,R13} shows that as a result of the fulfillment of the input conditions, RI lowers its anchor through the output O(t9)={P10}, meaning that the interval is over. And through the output O(t9)={P3}, the code "Y" returns to its original state.
These processes will be started again if the code “Y” will not change, and will continue in that order.

Extended input (I) and output (O) functions for the Petri graph in the code "Y" of the TSH-65 relay are presented in Table 2.

Table 2

I(t1) = {P1}	O(t1)={P2,P3}
I(t2)={R3}	O(t2)={P4}
I(t3)={R2,P4}	O(t3)={P5}
I(t4)={P4}	O(t4)={P6}
I(t5)={P6}	O(t5)={P8}
I(t6)={P5}	O(t6)={P7}
I(t7)={P8}	O(t7)={P9}
I(t8)={P7,R8}	O(t8)={P10}
I(t9)={P9}	O(t9)={P12}
I(t10)={P6}	O(t10)={P11}
I(t11)={P12}	O(t11)={P13}
I(t12)={P11,R12}	O(t12)={P14}
I(t13)={P14}	O(t13)={P15}
I(t14)={P13}	O(t14)={P1,R16}
I(t15)={P15,R16}	O(t15)={P17}

Corresponding to the expression in table 2, the expression forMS matrices 1 and 2 in shape.

$$i_{j\varepsilon} = \begin{cases} 1, agar \rightarrow p_\varepsilon \in P^I t_j \cup t_j \in T^0 p_\varepsilon, \\ 0, agar \rightarrow p_\varepsilon \notin P^I t_j \cap t_j \notin T^0 p_\varepsilon \end{cases}$$

Matrix 1

$I=|t_{\tau\varepsilon}| =$

P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	
1	0	0	0	1	0	0	0	0	0	0	0	0	t1
0	0	1	0	0	0	0	0	0	0	0	0	0	t2
0	1	0	1	0	0	0	0	0	1	0	0	0	t3
0	0	0	0	1	1	0	0	0	0	0	0	0	t4
0	0	0	0	0	0	1	1	0	0	0	0	0	t5
0	0	0	0	0	0	0	0	1	0	0	0	0	t6
0	1	0	0	0	0	0	0	0	1	1	0	0	t7
0	0	0	0	1	0	0	0	0	0	0	1	0	t8
0	0	0	0	0	0	1	0	0	0	0	0	1	t9

Matrix 2

$O=|t_{\tau\varepsilon}| =$

P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	
0	1	1	0	0	0	0	0	0	0	0	0	0	t1
0	0	0	1	0	0	0	0	0	0	0	0	0	t2
0	0	0	0	1	1	1	0	0	0	0	0	0	t3
0	1	0	0	0	0	0	1	0	0	0	0	0	t4
0	0	0	0	0	0	0	0	1	1	0	0	0	t5
0	0	0	0	0	0	0	0	0	0	1	0	0	t6
0	0	0	0	1	0	1	0	0	0	0	1	0	t7
0	0	0	0	0	0	0	0	0	0	0	0	1	t8
0	0	1	0	0	0	0	0	0	1	0	0	0	t9

Conclusion

In the field of automation and telemechanics of Joint Stock Company «Uzbekistan Temir Yollari « in the field of autoblocking and automatic locomotive signaling, the Petri graphs of the integrated microelectronic code transmitter device, which are proposed to be used instead of TSH-65 and TSH-2000 relays, which serve to transmit the codes generated by the KPTSH relay to the locomotive traffic lights or road traffic lights, are based on «Y " was modeled for the code. As a result, it is recommended to abandon contact devices and use a new type of microelectronic device.

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