**Slide 1**

Dear Head!

Dear Members of the Examination Commission (EC)!

Your attention is given to the certification of the bachelor's degree on the topic: (----).

(Read the slide)

**Slide 2**

At present, there are significant changes in the power industry related to the introduction of new automation and energy saving technologies.

At the level of enterprises and territories, automated control systems are used for technological processes, which mainly manage information flows.

In the power and gas supply systems, special local control and regulation systems are widely used, located in remote areas, for example, at transformer substations, gas distribution nodes, energy consumption points.

The lack of permanent transport links makes it impossible to monitor the functioning of these systems at all times.

The most common way of implementing such systems is to describe the CA, that is, the development of an automatic machine model.

**Slide 3**

As an object of management (OU) we consider an automatic gas distribution station (AGDS), which is usually located in a remote area without the presence of qualified personnel. Modern AGDS is a complex of equipment and measuring instruments for regulating gas distribution.

Regardless of the method of technical implementation, these systems implement the original control algorithm, described by the corresponding graph-scheme. In this case, there is a problem diagnosing the correct functioning of the control device without the use of indications of real sensors, because their inclusion in the diagnostic mode can disrupt the functioning of critical gas supply systems.

It is worth noting that this system is an open system of control (regulation system).

**Slide 4**

An important task in the construction of automatic control systems is to ensure the reliability of their operation, which is impossible without the use of automatic systems of technical diagnostics.

 In the design of modern systems of technical diagnosis, computer technology of automated design with the use of languages ​​of equipment description and modern technological base is widely used.

This approach will allow to realize the system of diagnosing a remote control point of any power system without the participation of a person and without disabling the main control system for a long time.

**Slide 5**

To convert an AGS (algorithm graph scheme) into an automatic machine, it is necessary to note the state of the machine. As an automatic machine, we will consider Mill's machine. Its states on the AGS are denoted by the vertices entering the operator vertices. On the basis of Mill's automatic machine, the graph of transitions of the spacecraft is constructed.

The graph of transitions of the automaton is represented in the language of the description of VHDL equipment in the form of a two-process automaton template.

**Slide 6**

The slide demonstrates the simulation of a spacecraft on an example of the sequence of transitions A1-A2-A3-A4-A5-A6-A1 and the synthesis results (hardware costs).

The transition from state to state is responsible for the initiation of blocks and sensors. The device initiates and sensors are surveyed.

After a poll of each sensor it is a comparison of their indicators with the necessary for further work.

Positive test (X (1) = X (2) = X (3) = 1) shows that the values ​​do not exceed the permissible ones and the automaton continues to work correctly.

If the check does not pass (A6-A7; X (4) = 0), an emergency situation occurs (Y (10) = 1), which returns the machine to its original state (A1).

**Slide 7**

Diagnostic experiment (DE) over the HDL-model of a finite automaton is to supply it with input influences, in accordance with the chosen strategy of bypassing the content graph of transitions, obtaining initial responses to Waveform and comparing the obtained reactions with the standard. On the basis of this, it is concluded that the HDL model is compliant.

Options forpassing the graph of transitions of the control automat (CA) are stored in the nonvolatile memory and used in conducting the DE with the use of a hardware diagnostic device.

**Slide 8**

When diagnosing the control device (CD) AGDS, working with sensors, measurement of physical quantities, there is a problem of implementation of the output values ​​(pressure, voltage, etc.) that arise in the real work of AGRS.

Proceeding from this, it is proposed to simulate the initial values ​​of the corresponding sensors in the binary alphabet {0, 1} (1 - the parameter is in the given allowable range of physical values, 0 - the parameter has exceeded the limits of the permissible values).

Read from the slide

Thus, the hardware implementation of the diagnostic device (DD) is proposed, which ensures the implementation of all transitions in the control automaton graph (CA), that is, actually implements its direct structural table.

**Slide 9**

Read from the slide

It is worth noting that the main hardware costs go to the implementation of the data register and work with it (actually mimics the work of nonvolatile memory)

Read from the slide

"Let's consider several variants of coding bypassing the column of transitions"

**Slide 10**

Read slide name

**Slide 11**

Read slide name

**Slide 12**

Read slide name

It should be noted that this option is standard in relation to the implementation of digital devices.

**Slide 13**

This slide reflects the fragment of the VHDL model of the control device (CD) , or rather the synchroprocess.

**Slide 14**

The slide presents a comparison of the synthesis results of the control automaton AGDS and the diagnostic machine. It should be noted that these hardware costs are comparable.

**Slide 15**

The connection between the control device CD and the DD is a specific control and diagnostic system of the device or even a separate system. The CA can operate separately from the DD, by controlling the operation of the system or device, in the form of supplying output signals that initiate the execution of operations. Using a complete control and diagnostic system is a test mode for verifying the behavior of a device or system.

**Slide 16**

This slide reflects the result of simulating the device for diagnosing and synthesizing this device. The simulation of the operation of the PD for the option of bypassing the sequence a1 - a2 - a3 - a4 - a5 - a6 - a1.

**Slide 17**

Thank you for your attention, dear commissions!

Suggest a brief discussion ("If you have any questions, I will gladly answer them").

**LIST OF POTENTIAL QUESTIONS:**

**Why is the machine is Mili, not Moore?**

This system is not a real-time system.

**Which system is AGDS?**

Closed system of regulation

**The answer to the question about each of the methods of encoding the bypass graph of the transitions of the diagnostic device's CA:**

**Slide 10**

According to this variant, the sequence of states of the automaton is encoded in a bit array, each link of which corresponds to the state. If the bit is equal to 1, then the transition goes to the next state marked 1. The transition between the states is described as an ordinary two-process template. Zero in the link array corresponds to the return to the original state. The absence of bits "-" means that this link does not play any role, because there was a return to the initial state (A7 = 0).

Read from the slide

**Slide 11**

According to this version there is a description of the CD, which takes an array of 4-bit numbers into the input, each of which is a description of the state. As soon as the vector of a further state equal to the initial ("0001") is found, then the sequence is considered complete and there is a return to the original state. If the detected sequence is not the end of the array, then the following are ignored.

Read from the slide.

**Slide 12**

This variant is a control device (CD) that accepts an array of 4-bit numbers, each of which is a state description. The first process is responsible for copying the input array into an intermediate and assigning the initial values ​​to the signals of the current (output - A1) and the subsequent states of the input array (in order to exclude the double assignment of the same values). After assigning signals to the initial values, with the front of the clock signal, there is a left shift to one element of the array and the assignment of the unit to avoid transitions that do not correspond to the sequence. If the next state is equal to the output (the initial one is A1), then the sequence is considered complete.

Read from the slide

**Give a comparative description of options for traversing the graph**

**Slide 14**

Analysis of the synthesis results of various variants of circuit implementations of the DD showed the following:

1. Hardware costs for the implementation of DDs in the first option are minimal, but with this method of encoding the sequence of states of the automaton there are problems if the graph of transitions is a multigraph, that is, between a pair of vertices there is more than one arc, which transitions are determined by different signaling signals (for the considered automaton it pair of states a8-a1).

2. In the scheme implementation of the DD option 3 there are approximately 2 times more sliders (Slice Flip Flops) than in other embodiments. This is due to the fact that in this option, the input c\_Test\_sequence array is copied to the DD register, which actually simulates the work with external nonvolatile memory.

3. From the point of view of the scalability of the DD for the number of machine states, the third variant of the circuit implementation is preferable, since with the increase in the length of the sequence to bypass the machine graph, the hardware costs in this variant grow in a small amount, which can not be said about option 2.

4. The hardware costs of the PD with the first-best chance of the implementation of the scheme can be compared with the hardware costs of the CD, which confirms the correctness of the chosen method of constructing a hardware diagnostic device.

**Why did I implement the sync process exactly?**

**Slide 13**

Brief story of this fragment:

- Why so?

- What problems led to the formation of a fragment.

- How did it affect hardware costs?

**Additional information**

**Slide 16**

The constructed VHDL models of the control and diagnostic automata must be verified by the tools of the Active-HDL simulation system. Verification results are analyzed by a waveform, in which the law of functioning of the indicated automata is visually displayed. The result of the simulation of the work of the PD on the implementation of the option of bypassing the graph a1 - a2 - a3 - a4 - a5 - a6 - a1 is presented. Also, the total hardware costs for the synthesis of the CD and DD model by means of the XILINX ISE CAD in the Spartan 3E FPGA are shown in the table.