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Research on the Model of Malfunction and Diagnostics of Digital Devices of Data Transmission Equipment

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Abstract: Currently, in the world, science is rapidly developing techniques, at the same time, there are shortcomings and advantages to these technologies. most of these shortcomings arise in the process of data transmission and reception. taking this into account, this article provides for the study of the diagnostic model of nozzles occurring in digital devices of data transmission equipment. this will help us to prevent or quickly eliminate device malfunctions during the data transmission process. this article focuses on the analysis of the diagnostic model of the malfunction of digital devices of reference transmission equipment.

Keywords: model, digital devices, model of malfunction, Half-split inspection algorithm, wrong orientation.

1. Introduction

High-speed data transmission networks based on Frame Relay, ATM and IP technologies are among the most complex components of modern telecommunications infrastructure. International practice shows that the definition of scientific and technical principles for ensuring information security of data transmission networks depends on the security threats to their facilities. It is known that one of the causes of accidental security threats are failures and failures of the constituent components of data transmission equipment (ADF). The impact of failures and failures of components of the ADF on the safety of the functioning of systems are manifested in the form of a violation of the integrity of information. The modern ADF has a wide range of digital cards using various element base. The widespread use of LSI, VLSI and IPC in modern APD has created, along with indisputable advantages and a number of serious problems in their operational maintenance, associated primarily with the processes of monitoring and diagnostics of malfunctions [1-3].

2. Methodology

The functional testing systems that exist at the moment have insufficient technical and economic indicators, which is due to the following reasons: the high laboriousness of the process of clarifying the place of the defect, at least 80% of the time spent on restoring a complex system at the operational stage, even if the troubleshooting is carried out with the participation of the system developer, especially in case of multiple and illogical faults.

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The variety of methods for detecting the malfunctioning of systems, indicating the location of faults and their elimination is rather difficult to classify due to the constant change in both the principles of constructing the systems themselves and the element base used.

It is known that any method of testing digital devices is based on one or another model of a malfunction, and in accordance with this model, each method is focused on finding specific malfunctions. It should be noted that both the distribution of the malfunction and the physical nature of the defects causing them are largely individual in nature, inherent in a particular type of digital device.

3. Multi-coordinate meatronic module structure

There are various mathematical models of defects and malfunctions, which describe this process with varying degrees of accuracy [2-5].

In view of the rarity of the occurrence of events in the form of failures, an ordinary flow of failures in time without aftereffect is described by Poisson's law:

$$P_m = ((\lambda \Delta t)^m / m!) * e^{-\lambda \Delta t}; \qquad (1)$$

where m is the number of emerging failures over a time interval Δt with an intensity -λ.

Probability of no failure over time Δt equals:

$$P_m = e^{-\lambda \Delta t}; \qquad (2)$$

The uptime in the event of sudden failures of elements is distributed exponentially with a probability density

f(t)=λexp(-λt),

where λ- the intensity of sudden failures.

Allocation of uptime over failures:

$$f(t) = C_1 * (1/\sigma\sqrt{2\pi}) * e^{-(t-T_0^2)/(2\sigma^2)} \qquad (3)$$

where To is the mean time of failure-free operation.

Distribution of uptime for two types of objects:

$$f(t) = C_1 * (1/\sigma\sqrt{2\pi}) \exp[-(t-T_0^2)/(2\sigma^2)] + C_2 \lambda \exp(-\lambda t) \qquad (4)$$

where C1 and C2 are normalizing coefficients.

The uptime for some elements obeys the Weibull distribution law:

$$f(t) = (K/t_0) * t^{k-1} \exp(-t^k / t_0) \qquad (5)$$

where К and t_0 - distribution parameters.

For the exponential law of uptime, the mean uptime is:

$$P(t) = e^{-T/T_0};$$

$$T_{cp} = T_0[1 - P(T)] \qquad (6)$$

Average recovery time for exponential law:

$$\tau_в = 1/\mu, \qquad (7)$$

where μ is the rate of system recovery.

Defect detection and search are processes for determining the technical condition of an object. Thus, the tasks of diagnosing are the tasks of checking the serviceability, operability and correct functioning of the object, as well as the tasks of finding defects that violate the serviceability, operability or correct functioning. The strict formulation of these problems presupposes, first, the direct or indirect assignment of the class of possible defects and, second, the presence of formalized methods for constructing diagnostic algorithms, the implementation of which ensures the detection of defects from a given class with the required completeness or the search for the latter with the required depth.

Research shows that the most common problems with digital ADF devices are [2,3]:

- short circuits of printed conductors - 34%;
- breaks of printed conductors - 27%;
- wrong orientation - 15%;
- missed and mistakenly installed elements - 17%;
- defective items - 5%, and other defects - 2%

In this regard, one of the effective ways to improve the operational and technical characteristics of the ADF is to increase the intensity of repair and restoration work on the basis of promising methods and technical means for monitoring and diagnosing digital devices.

Of the many areas of diagnostics, modern combined test and functional diagnostics stand out, in which the functional diagnostics tools are assigned the task of only promptly detecting the fact of a malfunction, and the search for a faulty component is carried out using test diagnostics tools. In the operating conditions of the ADF, the sequence of monitoring the diagnostics of malfunctions is as follows: ADF, block (subunit), technical replacement element (TEC), individual integrated circuits and electrical radio elements.

One of the most powerful external diagnostic tools for microprocessor systems is a signature analyzer (SA) [1,6]. The principle of operation of the CA is based on the method of signature analysis, i.e. compression of long sequences into 4-digit hexadecimal signatures. Physically, this method is implemented on a linear shift register with feedback, the signals of which are summed modulo 2 with the input sequence.

For troubleshooting, it is necessary to compile a table of reference signatures and a troubleshooting algorithm. Conventional troubleshooting trees or algorithms are useful tools for recovering faulty digital cards.

A method that can be used in constructing a troubleshooting tree is halving. It can provide the shortest path to malfunctions. When divided by half, the test point is chosen approximately halfway between the beginning and the end of the circuit, for which it is equally likely that the fault can be both before and after this point.

In order to practically determine the possibilities of using the CA for drawing up an algorithm for monitoring the health of digital boards as a whole and their nodes, we measured reference signatures for one of the most typical digital boards, assembled by 9 microcircuits (U1, ..., U9), which are counting triggers.

4. Mathematical analysis of multicore coordinate mechatron module

In this regard, the algorithms for diagnosing digital boards using the CA by the method of troubleshooting from output to input, and an algorithm using the half-split method are considered.

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Based on the analysis of the considered diagnostic algorithms, the time costs for monitoring and diagnostics are given (Table 1).

From the data obtained, it can be seen that the half-split method allows one to reduce the diagnostic time by a factor of 1.4 compared to the method from output to input.

Table 1. Characteristics of control algorithms and diagnostics of the digital board CA

Designation IMS in the scheme	Algorithm of control by the method from output to input		Half-split inspection algorithm	
	Number edit.	Time edit,s	Number edit.	Time edit,s
У9	2	0,67	5	1,70
У8	3	1,02	5	1,70
У7	4	1,36	4	1,35
У6	5	1,70	4	1,35
У5	6	2,04	4	1,35
У4	7	2,34	4	1,35
У3	8	2,72	4	1,35
У2	9	3,06	4	1,35
У1	9	3,06	4	1,35
ΣN_i , Σt_i	53	17,97	38	12,85
$\overline{N_{cp}}$, $\overline{t_{cp}}$	5,8	1,99	4,2	1,42

Thus, the extensive capabilities of the CA tools in the search and localization of faults provide a significant reduction in the time for repair and restoration work of digital devices and a decrease in the requirements for the qualification level of repair personnel.

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