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Traceability System as a Component of Lifecycle Management of Radio-Electronic Products

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***Abstract*: This report is devoted to the review, analysis of the implementation and application of the traceability system in the lifecycle management of radio-electronic products. The main problems of traceability application at the enterprises of the radio-electronic industry, the ways of its integration into life cycle management are identified. The importance and the advantages of modern traceability systems are highlighted. The main issues of their implementation and related problems are addressed. The main ways to provide identification of electronic components, printed circuit boards, equipment and personnel are described. The technical requirements for project realization and its stages are numbered.**

Complex supply chains and high risks related to it make traceability systems with its advanced functions, tools for control, management and analysis necessary for the lifecycle management of electronic products. Their implementation not only reduces the risks, but also provides the enterprises with a number of advantages witch boost effectiveness and profitability.

Keywords: electronic devices, identification, life cycle, traceability, quality

I. INTRODUCTION

The development and production of electronic products is a high-tech direction in the field of modern industry and is characterized by a high level of science intensity. High demands are placed on this product to provide its quality. At industrial enterprises, the quality of radio-electronic products is ensured by the introduction of modern life-cycle and product quality management systems, which include the automation of core processes for the creation and production output [1]. An entire category of general-purpose systems, Product Lifecycle Management (PLM) systems is being used for that.

PLM systems provide information support for the processes of creation, production and use of radio-electronic devices, integrating solutions for design automation, production preparation, engineering analysis, organizing collaboration between designers and other development participants, providing workflow automation, visualization of product structure, change and configuration management, document flow in the process of working on products [2-4]. Today, these key components of PLM are complemented by vendors of relevant solutions with the functions of product portfolio managing, regulatory compliance managing, marketing processes integration, sales and after-sales services, production management capabilities, quality assurance tools and product analytics [5-7].

METHODOLOGY

II. TRACEABILITY SYSTEM REQUIREMENTS

According to the authors, a traceability system must be an integral part of the lifecycle management of radio-electronic products, which has a significant impact on their quality. Let us consider what this statement is based on and what needs to be undertaken to do this.

In accordance with ISO 8402 “Quality Management and Quality Assurance - Vocabulary", traceability is “the ability to track the prehistory, application or location of an entity by means of recorded identifications”. Note that another procedure is closely related to traceability - identification, which represents the ability to distinguish one product from another.

Identification should be subject to everything that is controlled during the life cycle of products, namely:

- commodity, materials and components;
- employment and equipment involved in production;
- production staff involved in the process.

Directly for radio-electronic products, identification of electronic components, printed circuit boards, equipment and personnel is required.

III. IDENTIFICATION OPTIONS

There are various ways to provide identification. At enterprises with poor automation of production and life cycle management processes identification is carried out in paper form with the design and attachment of tags on products in accordance with the design and technological documentation, indicating the designation of the product number and type, date of manufacture, batch number, mark of the controller about his acceptance and other necessary data. Moreover, various labels, accompanying sheets, route descriptions can be used for this [8-10]. These types of identification are difficult to automate; as such information is badly adapted for automatic reading during production process. At the same time, production data are not available in real time, do not exist in electronic form,

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and are not convenient for analysis, storage and statistics. Such a state of affairs cannot contribute to the integration of a traceability system into product life cycle management processes[11-14].

In modern electronic industries, identification can be applied using RFID tags, i.e. in the form of integrated microcircuits installed in the product and storing a unique identifier that can be read at a certain distance by a radio signal [15-18]. This method allows you to set up the serial number of the product without direct access to the product board when the board is already installed in the case or covered with a layer of sealant. In addition, the same method can be used to identify company employees involved in the production process (using personal employee access cards). These tags can be recorded in the system and subsequently tracked at all stages of the product life cycle.

Quite often, companies in the electronic industry use barcode marking. Both linear (1D) and two-dimensional (2D) codes are used. The last one is used for cases when you need to encode a large amount of information or when on the case, on a printed circuit board or on other radio elements of the device there is no enough space to place a barcode. It is also worth noting that there is a particular type of symbolism (encoding standards) for each of the groups of barcodes. Barcodes can be applied while commodity receiving, materials and components, during the manufacturing process (by a marker, stickers or others), or markings already coming into production can be used (for example, standard marking of the component manufacturer).

IV. TRACEABILITY SYSTEM IMPORTANCE

A. Advantages for an enterprise

Let us note the importance of having a traceability system at the enterprises of the electronic industry. Through tracking, enterprises reach the level of satisfaction of their customers, increase the availability of manufacturing processes. Unfortunately, currently defective goods, as well as regulatory conditions, are the main problem for all modern manufacturers. Each customer wants the products he ordered to be high quality and reliable. If the product does not meet his requirements, due to unforeseen damage, the customer may require a replacement or return of the product. However, the risks associated with the increasing complexity of the nature of the supply chain have made understanding of this topic even more critical for the manufacturers. The influence of product defects and regulatory conditions is a problem for all the manufacturers, regardless of their size. While the need for traceability systems mostly grows because of customer requests and contractual agreements, production teams face increasing internal pressure directed to implement reduction activities. In order to harmonize all efforts, manufacturers must first identify areas in which improvements are needed, such as introductory supplies, processes without impact or workers' mistakes. When this task is completed, we can identify the root causes in the processes, which may then be subject to adjustment plans. The traceability system provides the data, which are necessary for tracking and quickly correcting previously undetected defects in production processes. These data have proven that they provide significant quantitative advantages - reduced production cycles, changeover times, and improvement of sales, supply, data entry and internal management processes. The usage of this data helps to identify inefficient processes or repetitive work, resulting in reduced mistakes, waste and activities without added value. Working traceability systems can result in a significant reduction in the total cost of creating radio-electronic products.

B. IS0 9000 Requirements

The importance of traceability systems in ensuring the quality of electronic products should be mentioned as well. In accordance with the requirements of the ISO 9000 series of standards, a product traceability system is an essential element of an enterprise's quality management system and provides solutions to issues such as excluding the possibility of transferring products to a customer during production without conducting established control procedures and necessary technological operations, as well as products that have inconsistencies.

C. Useful functions

In addition, the product traceability system is an integral part of the enterprise accounting and planning system and provides:

- identification of commodities, materials and components arriving to the enterprise;
- tracking the use of marked materials and components in the manufacturing process;
- providing information for the timely withdrawal from manufacturing of products and materials that do not meet the established requirements;
- possible counterfeit elimination;
- tracking the use of off-the-shelf radio-electronic ones.

V. TRACEABILITY SYSTEM IMPLEMENTATION

A. Traceability system as a part of PLM

The analysis shows that in majority of enterprises the manufacture radio-electronic items product traceability is carried out by compiling technological passports, route maps and other documentation, which have a note about the necessary technological and control operations and where the detected defects and measures taken to eliminate them are indicated [19-22].

In the age of informatization, the traceability system should be a computer database, in which all the necessary information about the product would be focused, including for subsequent presentations (reports, graphs, search results). The traceability system should be implemented in software and hardware as an add-on module within the PLM product lifecycle management systems. Through the suggested organization of a traceability system, interaction with the information systems of suppliers and customers can be organized [22-25].

B. Technical requirements

The implementation of a modern traceability system at enterprises of the radio-electronic industry based on information technologies will require the support of the following:

- software that includes a database for storing accumulated information and specialized workstations for data input and processing;
- unification with software of lifecycle management systems for PLM products implemented at enterprises, as well as at customers and suppliers;
- the use of modern identification tools using RFID tags, barcodes;
- the use of modern technical means and equipment for the implementation of tracking marked products and materials at various stages of the life cycle: printers, scanners, data collection terminals.

C. The main objectives

The main objectives of the suggested system are:

- integration into the lifecycle management system of PLM products at the enterprises of the radio-electronic industry;
- unequivocal identification of raw materials, materials and components arriving to the enterprise, tracking the use of marked materials and components in the manufacturing process;
- unique identification and company marking of finished electronic products in one of the ways that exclude counterfeit possibility;
- the possibility to trace the prehistory of radio-electronic products manufacture.

D. Coherence of requirements

The introduction of an automated product traceability system at the enterprises of the radio-electronic industry is possible only with the coherent decision-making: engineering ones - at the places of identification of electronic products and suitable marking materials, technological decisions - at the places of integration new jobs for marking into the technological chain, reading and transmitting information, information-technological - for the used reading devices and organization of the computing base. Different requirements for materials for marking products (due to their different sizes, conditions for further operation, features of the production technology - surface quality, painting order, etc.) make it necessary to select the marking material individually, including both laboratory and long-term practical tests. Label printers should be selected only on the basis of the selected labeling material and the required performance, determined for each customer individually by the total. Information and economic security requirements make it necessary to organize the printing of labels directly with the special software of the system. This requires the implementation of a software interface to a customer-selected label printer. The requirements for the coding of products, containers and consignments are special for each customer, since they are determined by its relationship with counterparties - suppliers and consumers. The task of traceability of the use of materials and components in the technological process, obviously, should be solved individually for each customer, as even the same products can be produced using different technologies.

B. Project stages

Ultimately, an automation project consists of the following steps:

- preliminary design;
- supply of hardware and software by the stage;
- development of technical specifications for each type of special software (data exchange gateways, software for data collection terminals, software for marking places);
- set-up and installation of equipment, software installation by the stages;
- user training and commissioning of the system by the stages;
- system maintenance and correction of possible errors.

VI. RESULTS

It should be noted that the implementation of a traceability system in life cycle management, besides the direct product data collection, can implement an additional function - monitoring the collected data in real time and checking them for compliance with the specified parameters. Monitoring should be carried out for each radio-electronic product. In addition to direct monitoring of the radio-electronic products, it is necessary to monitor component parts and materials. Of course, the usage of the appropriate software and hardware systems and the compliance with the accepted labeling rules are necessary for that. Reading the appropriate labels allows to track the movement of components within the enterprise: you always know where exactly and in what quantity the required material is located. In most enterprises searching for the right component or unit is time-consuming. The use of this system will make it possible to identify electronic devices in which components the defects are identified, which will directly affect the increase in the percentage of suitable devices.

VII. DISCUSSION OF RESULTS

A. Features of the implemented system

The most important feature of the introduced modern traceability system should be the possibility of applying labeling technologies and accumulated information to exclude the use of counterfeit products, i.e. complex labeling of products, packaging and consignments, and the availability in the database of the system the information about the placing of identified products in a specific container and about the entry of packaging places into a consignment. Furthermore, at the request of the customer, additional measures of cryptographic protection of identification information should be implemented. This include maintaining a system of protocols for the procedures for printing labels, generating users requests by lists of printed labels, requests for defective products, destruction and other requests and actions critical for the customer. The use of special materials guarantees, on the one hand, a high degree of protection against aggressive environmental influences,

and on the other, it prevents removing the label without mechanical destruction during the warranty period of the product.

VIII. CONCLUSION

Thus, the implementation of a traceability system in the lifecycle management of electronic products is important, additionally due to complex supply chains and the occurrence of high risks. In order to get rid of them, it is necessary to carry out identification and traceability thoroughly.

The traceability system should provide a clear understanding of the various stages of the production process, which ultimately will affect the quality of the final product and will allow to:

- reduce the number of defects;
- resolve the identified problems in the technological processes of production;
- reduce costs;
- improve the process of creating radio-electronic devices;
- provide protection against counterfeit products.

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