Radio-Transponder Systems for Remote Monitoring and Identification of Containers with Fissile Materials

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Summary: The report presents the main scientific and technical solutions being the basis for the radio-transponder system under development, providing remote state monitoring and identification of fissile materials and radioactive materials containers.

Introduction

Hazardous substance containers monitoring includes two interrelated tasks. The first is to take the stock of and monitor integrity (availability) of the containers in a storage area or vehicle during transportation. The second task is related to monitoring the containers content state (monitoring the set threshold values overriding by the monitored parameters). The monitoring becomes especially important in case of off-optimum situations during the storage and transportation (unauthorized access, fire, blows, etc.).

A prospective trend of creating the monitoring systems is contactless monitoring systems development where all required information about the containers is read at the distance from a special mark mounted at each object.

Contactless way of receiving information from the monitored objects is especially important, when not only operability and high process efficiency is important, but it is also important to provide the safety of the personnel carrying out the monitoring (e.g., containers containing radioactive materials).

The report presents the results of radio-transponder systems development consisting of physical parameter sensors set, SAW delay lines and radio-frequency bandwidth compact antennas. Information is received and displayed by a receiving-transmitting unit radiating requesting SHF signal. Contactless pickup of the information is provided at the distance up to several tens of meters.

The main advantages of the system are the radio-transponders nonvolatility and their radiation, heat and mechanical effects stability.

Results and Discussion

The radio-transponder operates in the following way: the radio-transponder generates a code message in answer to the received requesting SHF pulse from the receiving-transmitting unit (RTU) due to a unique arrangement of some reflecting electrodes of SAW delay lines and some electrodes connected electrically with the physical parameter sensors. A response message contains information about the object rating and the state of the physical parameter sensors. The message structure is changed as availability of pulses reflected from interdigital transducers connected electrically with the physical parameter sensors depends on the sensors status.

Various types of the transponder response signals selection are realizable in the receiving-transmitting unit – time, frequency and spatial. In case of time selection information is coded by the pulse position in the response message, providing large number of the objects requested simultaneously. When RTU pulse-repetition interval is To = 0.6 microseconds and the largest size lithium niobate blank is 70 mm, the maximum number of the response signals (equal to the ratio of acoustic wave propagation time in a blank to the repetition interval) is about 70.

The frequency selection of response signals provides increase of the requested objects number according to the frequency channels number.

The spatial selection of reflected radio signals is carried out due to generating narrow antenna pattern of the transmitting-receiving unit.

The report presents evaluation of boundary capabilities for the time, frequency and spatial selection of the radio-transponder code messages.

The radio-transponders survive at the ambient temperature minus 400C to plus 2500C. The transponder antenna survives after single mechanical shocks having acceleration amplitude up to 3000 g and 2-10 milliseconds

duration. The presented experimental works results were drawn using RTU with 7 to 10 W transmitter and a receiver having 120dB/W sensitivity.