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TITLE: A PORTABLE BETA SPECTROMETER/DOSIMETER

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A PORTABLE BETA SPECTROMETER/DOSIMETER

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SUMMARY

As part of an ongoing program[1,2] to upgrade health and safety radiation survey instruments, the Los Alamos National Laboratory has developed a portable, battery-operated, computerized beta spectrometer/dosimeter. The instrument will support many different detectors, but the one chosen here is a combination plastic scintillator and NaI crystal. The instrument includes pulse conditioning circuits, 128-channel pulse height analyzer with integral liquid crystal display, and a microcomputer system which calculates dose and dose rate from betas incident on the detector. Instrument operating life is about 8 hours between charges. The instrument will, at the user's option, display a beta spectrum or the accumulated dose in millirad, as well as give the user beta dose rates in millirad per hour. (At this point, the dosimetry algorithms are still under development.) Data accumulated in the instrument can be read out through an RS-232 serial port on the instrument. The entire unit weighs 8 pounds, including internal batteries, and is packaged in a small case 25-cm long, 15-cm wide, and 15-cm high.

GENERAL DESCRIPTION

The beta spectrometer/dosimeter was developed to provide the health protection technician with a portable instrument sophisticated enough to account for the beta energy-dependent nature of both the detector response and the dose distribution in tissue. The instrument shown in Fig. 1 is packaged in a single case 25-cm long, 15-cm wide, and 15-cm high, weighing 3.8 kg. Controls consist of a power switch and a 16-key keyboard which calls all of the spectrometer and dosimeter functions of the instrument. The instrument is powered by a set of 6 AA NiCd batteries which have an average lifetime between charges of 8 hours. The instrument may also be powered indefinitely off its accessory battery charger.

The beta spectrometer/dosimeter uses a small beta-ray detector built by Bicron, Inc. which is capable of measuring the energy of beta rays from 100 keV to about 4 MeV. The instrument performs spectrum unfolding and conversion of fluence to absorbed dose versus depth in tissue. Other thin dE/dx detectors will be evaluated with this system too.

ELECTRONIC DESCRIPTION

A block diagram of the beta spectrometer/dosimeter is shown in Fig. 2. The electronic circuit consists of three basic sections: input signal processing unit, microcomputer, and display.

The input section is a standard pulse height analyzer front end. Pulses from the detector are shaped and amplified by a preamp and then are fed, with the proper timing, to an 8-bit analog-to-digital converter. The converter outputs a digital word whose amplitude is proportional to the height of the input pulse.

The microcomputer is designed around an NSC800 low power CMOS microprocessor manufactured by National Semiconductor. The microprocessor is supported by 16K bytes of data memory, all of which are low power CMOS in order to keep battery drain to a minimum. The memory has been made sufficiently large to allow for future expansion of functions in the instrument. The user communicates with the computer through a 16-key keyboard located on the front panel of the instrument. With the keyboard, all of the functions and display modes can be readily called up.

The display is a dot matrix LCD array 80 dots wide and 28 dots high. The microcomputer communicates with it through two logic cards, one of which is provided by the display manufacturer as part of the display package. The display logic contains all the circuits necessary to convert the data from the microcomputer to readable spectral or dose information, as required. Also part of the display logic is an on-board memory array which stores current display information. This array, with its associated logic, refreshes the display periodically so that the control processor does not have to be tied up for long periods, rewriting the same data to the display over and over.

FUNCTIONAL DESCRIPTION

All of the functions of the instrument are accessible via the keyboard located on the front panel. This keyboard includes keys to generate and move pulse height spectra, generate dose information, and initiate data acquisition.

Data acquisition is controlled by two keys, ACQ and HLT. The acquire key, ACQ, causes the input circuits to be enabled and initiates input signal processing by the microprocessor. Signal processing continues until the halt key, HLT, is pressed. The HLT key inhibits the passage of further input pulses through the system.

There are five keys which allow the operator to generate various types of displays. Of these five, all but the DOSE key cause different types of spectra to be generated. Pressing the DOSE key will cause the microprocessor to calculate accumulated dose and dose rate from the raw data. This information is then displayed on the LCD in units of millirad, millirem, millirad/hr, and millirem/hr. A pulse height spectrum of incoming data will be generated on the display when the DATA key is pressed. Pressing the LOG key yields a spectrum of the same data displayed in semilog format. When the RAD key is pressed, the instrument will display a plot of the dose in millirads as a function of energy in keV. The REM key performs a similar function but displays the dose in millirem as a function of energy.

Four modify keys are provided on the instrument to modify displayed spectra, aiding in the analysis of spectral information. The up arrow and down arrow keys are vertical scale control keys. When pressed, they scale the spectrum up or down. The left arrow key rolls the 80-channel display left horizontally, ten channels at a time, so that all 128 channels of any spectrum may be viewed. In the same fashion, the right arrow key rolls the display to the right ten channels at a time.

Finally, there are two control keys on the keyboard. The first is the CLR key. The CLR key simply clears whatever is being displayed, be it dose or spectral information. This key serves as an aid in calibrating the gain of input circuits and finds use

whenever the operator needs to clear the data memories. The second key is the reset or RST key. The RST key reinitializes the instrument. It has the same effect as turning the power off and back on. The RST key is used to start the dosimeter while keeping all the internal power supplies stable.

USE AND APPLICATIONS

The beta spectrometer/dosimeter was designed to aid those concerned with beta dosimetry in unknown and potentially hazardous beta fields. Problems of beta dosimetry stem from the typically broad energy spectra encountered and the energy-dependent nature of both detector response and dose distribution in tissue. In the past, very large, bulky instrumentation was required to measure the energy spectra and calculate dose from those measurements. Today, with powerful microprocessors, the instrument can be reduced to a handheld portable unit.

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REFERENCES

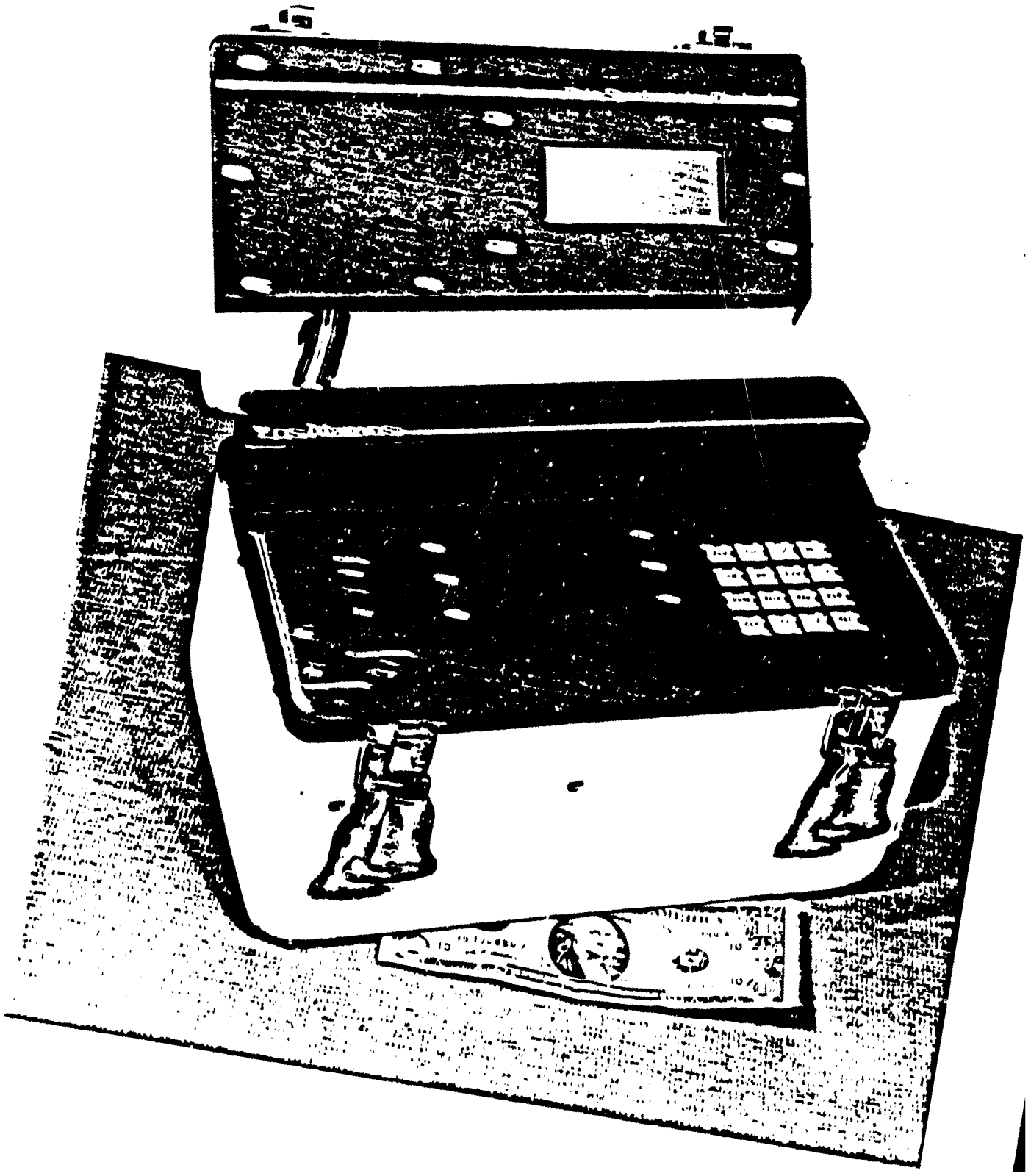
1. C. J. Umbarger, G. O. Bjarke, B. H. Erkkila, F. Trujillo, D. A. Waechter, and M. A. Wolf, "New Generation of Radiacs: Small Computerized Multipurpose Radiation Monitors," IEEE Trans. Nucl. Sci., NS-30, No. 1 (1983) p. 528.

2. D. A. Waechter, B. H. Erkkila, and D. B. Vasilik, "A Portable Neutron Spectrometer/Dosimeter," IEEE Trans. Nucl. Sci., NS-30, No. 1 (1983) p. 525.

Figure Captions

Fig. 1. Portable Beta Spectrometer/Dosimeter

Fig. 2. Electronics block diagram



A PORTABLE BETA SPECTROMETER/DOSIMETER
BLOCK DIAGRAM