GAMMA COUNTER LG-1

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Radioimmunoassay (RIA) analysis is widely used in medical laboratories in the process of diagnosis of illness of patients [1]. Large size laboratories employ for this purpose multi-well gamma counters [2] or gamma counters with automatic sample changing [3]. For medium size laboratories, a few well-type gamma counters seems sufficient [4]. For small size laboratories, a single well-type gamma counter is required and such a gamma counter with proper software has been developed. Block diagram of the counter illustrating the principle of operation is shown in Fig.

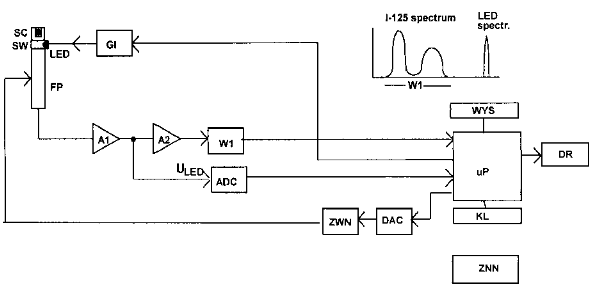

Fig. Block diagram of measuring channel of gamma counter: SC – well scintillator NaI(Tl); SW – lightguide; LED – light emitting diode; FP – photomultiplier tube; GI – pulse generator approximately 1000 p/s; A1, A2 – pulse amplifier; W1 – single channel analyzer; ADC – analog-to-digit converter for LED pulse measurement; ZNN – low voltage supply; ZWN – high voltage supply; DAC – digit-to-analog converter; WYS – LCD display; KL – keyboard; uP – microprocessor; DR – external printer; U_{LED} – LED pulse discrimination level.

^{125}I radiation of the analyzed sample is measured with an NaI(Tl) well scintillator. The pulses from a photomultiplier tube (PMT) after amplification and shaping in two pulse amplifiers are counted by a single channel analyzer under the control of a microprocessor system. The measured count rate is proportional to the activity of measured sample in the energy range 15-80 keV.

To ensure high stability of the measurement, an automatic gain control circuit is employed. Light emitting diode (LED) fixed in the lightguide and a pulse generator are used to produce reference light pulses for automatic gain control circuit of the PMT. During the gain control process, the pulse generator is activated and reference light pulses are generated. Immediately after the gauge is switched on, the microprocessor system starts to increase the PMT high voltage through a digit-to-analog converter, beginning from some minimum voltage. Simultaneously, pulse voltage originating from the reference light pulse is compared if it is not higher than the fixed LED pulse discrimination level. As soon as the pulse voltage becomes higher than the discrimination level, the increase of PMT voltage is stopped. Automatic gain control is carried out after the gauge is switched on. Additionally, when measurements of samples are carried out, the gain of the PMT is automatically checked at the beginning of each measuring cycle and, if needed, is automatically corrected.

To decrease the background due to natural radiation, the scintillator is shielded by a layer of lead. Pulse count rate originating from the measured radiation is proportional to the concentration of the determined substance in the investigated sample. Random error due to statistical fluctuations of ionizing radiation is kept to an acceptable level by selecting time of measurement (from 1/4 to 8 min). Random error connected with preparation of samples to be measured is decreased to an acceptable level by measuring two or three samples (vials) with the same concentration. Standard RIA or immunoradiometric assay (IRMA) includes the following steps: setting measuring parameters, measurements of reference samples, calibration curve computation, measurement of control samples, and at the end measurement of unknown samples. The software of the counter enables programming of all the steps of an analysis that is to be carried out. Digital processing of the measured pulse count rate matches two types of calibration curves:

- type RIA – Pulse count rate decreases against the substance concentration. Calibration curve: lin(A/Ao) *vs*. log(CONC);
- type IRMA – Pulse count rate increases against the substance concentration. Calibration curve: log(A/T) *vs*. log(CONC);

where: A – sample pulse count rate, Ao – pulse count rate at the concentration CONC=0 for curve RIA, T (TOTAL) – pulse count rate corresponding to the total activity of the sample. If repeated samples of the same concentrations are measured (two or three samples), the average count rate is taken in constructing the calibration curve. The results of calibrating measurements and the calibration curve, as well as the results of measurements of the control samples and unknown samples are printed on a computer (tractor) paper that makes a written document of the analysis performed.

References

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[4]. LG-4 gamma counter. www.zami.ajaksoft.com.pl/eng.htm.