

LOW BACKGROUND BETA COUNTING SYSTEM
(For measuring gross beta activity / contamination)

TYPE: LB 615

Technical Data

FEATURES :



- Measures gross Beta activity / contamination in water and other environmental samples. Including Air, Water, Soil, Vegetation & Biological samples.
- Highly recommended for low beta counting of environmental samples at environmental survey labs Nuclear power stations.
- Efficiency with Sr-90, Yt-90, better than 50%, with only Sr-90, it is better than 25%.
- Background with 80mm lead shielding in anti-coincidence mode: $\leq 2\text{CPM}$ (0.033 cps).
- Minimum Detectable Activity: Better than 0.03Bq. in 5000 sec (Typical $>0.015\text{ Bq}$).
- Uses two PMT's coupled with plastic scintillators in coincidence mode. Gives out both COIN & ANTI-COIN output.
- Outputs on Dual Counter/Timer with two channels.

Low Background Beta counting system LB615 is primarily designed for the measurement of gross Beta activity / contamination in **water** and other **environmental samples**. It is highly recommended for testing of water samples by **Radio analytical Labs** and **environmental survey labs** at Nuclear power stations for this application. Counting of samples having very low specific beta activity becomes difficult with conventional G.M. Counters having high background and low efficiency. A thin plastic scintillation detector based beta counting system has twin advantage of low background and high efficiency when compared. This system uses thin plastic scintillation detector based main counter and another wide area plastic scintillator based guard counter. System works on the principle of anticoincidence. The detector assembly is provided with a 80mm lead shield to reduce background.

Applications: This system is highly recommended for the estimation of gross Beta activity in Environmental samples, including air, water (river, lake, pond, ground & sea waters), soil, vegetation & biological samples. System can be used by testing labs, Environmental survey labs at Nuclear Plants, in normal or in a Nuclear disaster scenario.

SPECIFICATIONS

The **Low Background Beta counting systems** manufactured by NUCLEONIX essentially consist of the following constituent units.

- Mini Bin MB403 & Power supply PS403
- High Voltage Units (Two Nos) HV 502
- Coincidence Analyzer - CA570
- Dual Counter Timer- CT542A
- Plastic scintillator based main & guard counter.
- Lead Shielding Enclosure

Two **High Voltage Units** of this counting system are used for biasing the **Guard counter** and **Main counter** respectively. Outputs from these counters are routed through **coincidence analyser unit**. The output signals from these two detectors are then fed to the coincidence unit for obtaining both coincidence and Anti-Coincidence outputs which are in turn fed to the **Dual counter timer unit**.

This system is very useful in estimating gross beta activity in environmental samples and samples of low specific beta activity. The twin advantages of low background and high efficiency offers excellent sensitivity for this counting system. Brief specifications of individual constituent units are given as follows.

1. Mini Bin (MB 403)

MINIM INSTRUMENTATION BIN is a standard Minibin designed to power Standard Nuclear Instrumentation Modules with 24-pin type of power connectors.

It provides mounting space for 8 standard module widths of the 8 3/4 inch high type. The eight corresponding module connectors are provided with necessary wiring for distribution of all standard power supply voltages, +/-12V & +/-24V DC.

2. Power supply (PS 403):

Operating Voltage: 230V AC, 50Hz
 Out put Voltage: +12V @1.5A, -12V@1.5A, +24V@0.75A
 Regulation (Line & Load): ± 0.5% from no load to full load.

Ripple: Less than 10mV (rms) peak to peak at full load.

3. High Voltage Unit (HV 502):

Output Voltage: 0V to 2000V continuously variable by a ten turn helipot provided on front panel. (All specifications are valid from 10V to 2000V).
 Output Current: It can deliver upto a maximum of 1mA.
 Line & Load Regulation: Better than 0.05% of full scale.

4. Coincidence Analyzer (CA570):

This unit is a two bit module which receives the output pulses from both guard and **main counters** converts these signals to TTL levels and checks for coincidence and anti-co-incidence condition to give both outputs i.e., anti-co-incidence output is released if there is output due to main counter only and there is no guard counter output with in its occurrence. Also if guard counter output comes first, then further upto its pulse duration any output coming from the main counter will be treated as co-incidence event. Output(s) from this unit are counted in a **Dual counter timer**.

5. Dual Counter Timer (CT542A):

Count Input(s) IN1 & IN2: 100mV to 10V, unipolar or positive bipolar semi-gaussian pulse
 Pulse Width: 1 µsec (min)
 Polarity : Positive or Negative
 Input Impedance: 5.0 K ohms
 Input Counts Capacity: 999999 counts
 Input Frequency (max): 1 MHz

Pulse Height Discrimination:
 100mV - 10V by a trimpot provided (inside) on PCB
 Counts Indication: 16 x 2 dot-matrix LCD display

Modes of Data Acquisition:

- a. Counts for a preset time
- b. CPS
- c. CPM

TIMER: Preset Time Setting:
 Programmable through tactile switch control buttons

Control Buttons: START, STOP, PROG, STORE, INC, DEC.

Preset Time / Elapsed Time Indication: On 16 x 2 LCD Dot matrix display .

Preset Time Range: 1 to 99999 sec
 Printer Port: Built-in
 Serial Port: RS 232C built-in

Additional Options:(at extra cost):

- a. Data communication Software for down loading of data can be given at extra cost.
- b. Printer.

Module connector :

Amphenol Connector Type: 26-159-24P-H (24 Pin Type) or NIM Standard as per AEC specifications TID 20893 (Rev) Type : AMP 204186-5

6. Plastic scintillator based Beta Counter

Main Counter :

Operating Voltage : 900 - 1000V
 Sensitive Area : 28mm φ.

Energy range : 50keV to 3 MeV.

Calibration Accuracy : +/- 15% with Sr90 .

Guard Counter:

Operating Voltage : 900 - 1000V
 Sensitive Area : 50mm φ

Background (Inside the shield) : < 50 cpm

7. Background (with 80mm shielding) : < 2 CPM (Anti-coincidence mode)

8. Efficiency : Better than 50% with Sr90, Yt-90 with only Sr-90, it is ≥25%.

9. MDL (as measured with Background in Hyderabad at our works): 0.00000151085µCi (0.0559016Bq)

NOTE: MDL vary in your place depending upon the background at your place.

10. SS Planchets : Planchets are required, to place the prepared environmental samples for counting. These planchets are of 25mm dia & have a depth of 2mm. These are designed to fit into the sample / source holder / drawer of the detector assembly.



SS/ Aluminium planchets

11. Lead Shielding for Low Background Beta Counting System(LS 280) :

This Lead Shielding encloses the detector assembly consists of two PMT's with plastic Scintillators arranged in coincident geometry. Total Lead Shielding assembly is in 15 parts including bottom & top discs and central rings. There is an opening cover with handle in the middle to facilitate sample loading.

Outer dimension (dia) : 310mm. (approx)

Inner diameter : 150mm. (approx)

Lead Thickness : 80mm. (approx)

Total lead weight : 450 kg. (approx)

12. MINIMUM DETECTABLE ACTIVITY (MDA) CALCULATIONS :

LS 280

The minimum detectable activity is that amount of activity under the same counting time gives a count which is different from the background by 3 times the standard deviation of the background counting rate.

$$MDA = BG \text{ (cpm)} + \{ \{ 3 * (BG)^{1/2} \} / t \}$$

Where t is the time in minutes

Minimum Detectable Activity (MDA) calculations for Low Background Beta Counting System (LB615):

For Counting samples:

Example (1) : What is the MDA for a counter with background of 120 counts in 1 hour?

$$\begin{aligned} MDA &= \{ 2 + \{ (3 * (120)^{1/2}) / 60 \} \} \\ &= 2 + \{ (3 * 10.95) / 60 \} \\ &= 2.5475 \text{ CPM} \\ &= 0.0424 \text{ CPS.} \end{aligned}$$

Thus any gross beta counts over 2.5475CPM can be considered to be due to radioactivity. That is to say any gross counts above 153 counts per hour can be considered to be due to radioactivity.

To calculate the MDA in terms of Bq, divide by the efficiency of the detector

The lower the MDA, the more accurately the activity of samples with low counting rates can be determined. This can be statistically achieved by increasing the counting time and /or by decreasing the BG

Example (2) : What is the MDA (in Bq) for a counter with background of 120 counts in 60 minutes and an efficiency of 40% for the nuclide of interest?

$$\begin{aligned} MDA &= \{ (3 * (120)^{1/2}) / 60 \} = 0.5477 \text{ CPM} \\ &= 0.5477 / 0.40 \text{ (efficiency)} = 1.369 \text{ DPM} \\ 1.369 \text{ DPM} &= 0.022 \text{ DPS or } 0.022 \text{ Bq} \end{aligned}$$

M. S Powder Coated Stand for Lead Shielding for LB615 :

Dimensions : -

Height : 550mm.

Base (L x W) : 592 x 592mm.

Top (L x W) : 400 x 400mm.

