

### **IAP 2325P52 Plastic Scintillator Detector**

The 2325P52 plastic scintillator detector is sensitive to fast neutrons and gamma rays. The detection of ionizing radiation by the scintillation light produced in certain materials is one of the oldest techniques on record. Images could be collected or intensity measurements could be made. Nowadays the light output is converted into voltage pulses that are processed in the same way as pulses from proportional detectors, semiconductor detectors etc.

The plastic scintillators may be considered as solid solutions of organic scintilla that they are available commercially with a good selection of standard sizes of rods, cylinders, and flat sheets. Because the material is relatively inexpensive, plastics are often the only practical choice if large-volume solid scintillators are needed. In these cases the self-absorption of the scintillator light may no longer be negligible, and some attention should be given to the attenuation properties of the material. These scintillators are inert to water, air, and many chemicals, and for this reason they can be used in direct contact with the radioactive sample. The disadvantages of these scintillations are that the amount of light produced is very small. Therefore, a photomultiplier tube should be used to amplification or multiplication of the scintillator's light.

The operation of a scintillations may be divided into two broad steps:

1. Absorption of incident radiation energy by the scintillator and production of photons in the visible part of the electromagnetic spectrum
2. Amplification of the light by the photomultiplier tube and production of the output pulse

This model consists of the following parts:

- Detector cell
- Photomultiplier tubes (PMT)
- Aluminum housing shell

#### **Applications**

- The counting of pulsed and continuous neutron sources
- Portal Monitoring gates
- Timing systems

- Radiotherapy
- Particle physics measurements

### 1. Detector Specifications

#### A. IAP 2325P52 Detector Technical Specifications

- Scintillator Material: EJ-212 (EJ-212) plastic scintillator manufactured by Eljen (equivalent to NE-102A)
- Dimensions of the scintillating cell: 2 in 5 inches
- Neutron energy response range: 200 KeV -30 MeV
- Photomultiplier tubes (PMT): Model XP4512B from PHOTONIS Co.
- Detector housing shell: Aluminum
- Weight: 5.4 Kg
- Dimension of the detector:  $\phi 16 \times 44.5$  cm
- Voltage divider: IAP- 2051aP
- Typical working voltage: -1600 V/2 mA
- Maximum working voltage: -2000 V/2 mA
- Anode pulse rise time: approximately 4 ns
- The Full width at half maximum (FWHM) of the common anode pulse: approximately 10 ns
- Power connector: SHV
- Anode and dynode signal output connector: BNC

#### B. IAP 2325P52 Plastic Scintillator Specifications

- Light output: 65%
- Scintillation efficiency, (photons /1 MeV  $e^-$ ): 10000
- Maximum emission wavelength: 423 nm
- Rise time: 0.9 ns
- Decay time: 2.4 ns
- Full width at half maximum (FWHM) of Pulse: 2.7 ns
- No. of H atoms per  $cm^3 \times 10^{22}$ : 5.23

- No. of C atoms per  $\text{cm}^3 \times 10^{22}$ : 4.74
- No. of electron per  $\text{cm}^3 \times 10^{22}$ : 3.37
- Density (g/cc): 1.03
- Polymer base: Polyvinyl toluene
- Refractive index: 1.58
- Steam pressure: Vacuum compatible
- Linear expansion coefficient:  $7.8 \times 10^{-5}$
- Output light versus the temperature: at  $+60^\circ \text{C}$ , L.O = 95% in  $+20^\circ \text{C}$  unchanged from  $+20^\circ \text{C}$  to  $-60^\circ \text{C}$

## 2. Photomultiplier Tube Characteristics

Photomultiplier tube is a non-thermionic vacuum tube, usually made of glass, that converts very small light signals into a measurable electric current and has been used to detect low-energy photons in the UV to visible range, high-energy photons (X-rays and gamma rays) and ionizing particles using scintillators. Photomultipliers are used in all detectors based on scintillating material. A photomultiplier consists of 3 main parts: a photocathode for converting photons into electrons by the photoelectric effect, a multiplier chain consisting of a series of dynodes for multiplying the number of electron, an anode for collecting the resulting current. In linear photomultiplier, the structure of the dynode is such that it can minimize the pulse transit time and rise time. The lamp used in this model XP4512B made by PHOTONIS Co. The tube model XP4512B is a fast PMT of the type End Window with a blue-green sensitive photo catalyst and 12 dynodes. This PMT is used in the counting of bursts of chemical samples and high energy physics. Its characteristic includes high gain and excellent linearity.

In a photomultiplier tube, the average energy of the electrons is low traveling from stage to stage. So, it is very sensitive to stray magnetic fields even the magnetic field of the earth. In situations which the tube is placed in the near equipment with stray magnetic fields, it is essential that a magnetic shield be provided to prevent gain shifts of the PM tube. Therefore, the influence of the magnetic field may be minimized by surrounding the photomultiplier tube with a cylindrical sheet of p-metal. The p-metal is commercially available in various shapes and sizes.

### Operating Manual

This detector has a SHV connector for power and two BNC connectors for output. First, connect the power supply voltage to the voltage divider and then proceed for receiving output by using RG-58 cable. The signal that comes out of the detector is very weak. Therefore, before it can be recorded, it will have to be amplified by a factor of a thousand or more. To achieve this, the signal will have to be transmitted through a 2 m cable to the next instrument of the counting system, which is the preamplifier. If reflection signals is observed, 50  $\Omega$  terminate should be used. Following diagram can be used to acquire gamma or neutron source spectrum and, by placing a suitable offset, you can obtain an estimate of the activity of the source by counting the area under the curve. The anode signal of this detector is used in timing circuits.

