X-ray counting system
DM0011

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1 description

The DM0011 is a wide dynamic range, X-ray counting system. X-rays up to 100 keV are detected using a scintillator coupled to a photomultiplier and signal processing electronics to provide a TTL output.

The detector uses a window discriminator to detect X-rays within a selected energy band. The width and threshold (lower limit) of the window and the HV of the photomultiplier can be set by the user with the DM0011CONTROL. A schematic of the window discriminator and read out is shown in section 5.

Fast count rates are achieved by using a YAP(Ce) scintillator, selected for its very fast (30 ns) decay time, and high speed electronics, designed to minimise dead-time. A plot of indicated counts against true counts is shown in section 6.

As well as counting X-rays in a set energy band, the unit can be used to generate an energy spectrum by using a narrow (energy) window and progressively increasing the lower threshold. This feature is also used to calibrate the detector, using gamma and X-ray sources of known energy. A sample energy spectrum is shown in section 7.

2 applications

The unit is designed to count X-rays in laboratory or production equipment and in synchrotron radiation experiments.

3 features

- 10 MHz count capability
- 0.15 Hz background count
- adjustable window discriminator
- adjustable sensitivity
- compact assembly
- operates from a single low voltage supply
- TTL output

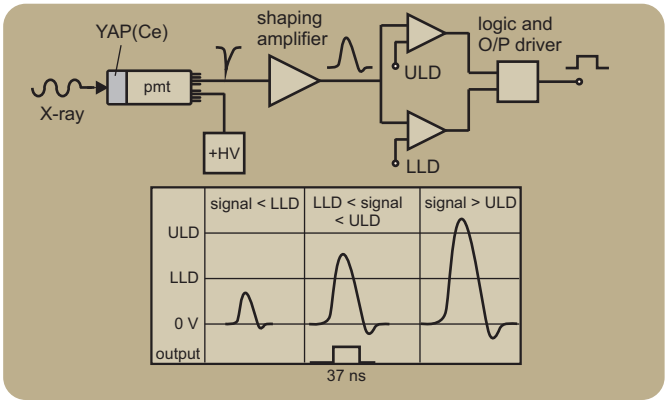
4 specification

detection range	5 keV to 100 keV
window discriminator	
lower (min)	0.100 V
upper (max)	3.00 V
window width	variable, 3 V max
count rate	
actual counts	10 MHz max (note 1)
indicated counts	5 MHz max
scintillator	YAP (Ce) 21.8 mm dia
background counts	0.15 Hz (note 2)
supply voltage	+4.75 V min +5.25 V max ripple < 100 mV pk-pk
supply current	60 mA max at 1 MHz count rate

note 1: after dead-time correction
note 2: 0.15 Hz maximum (8 keV to 50 keV), unit shielded with 6 mm of lead

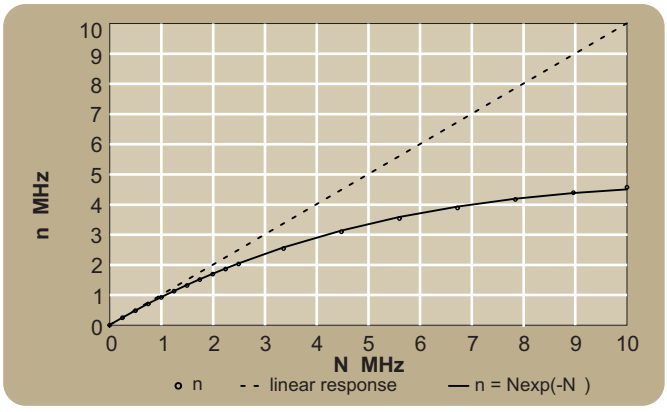
5 window discriminator schematic

Only pulses falling in the window, between the lower level (LLD) and upper level (ULD) are detected.



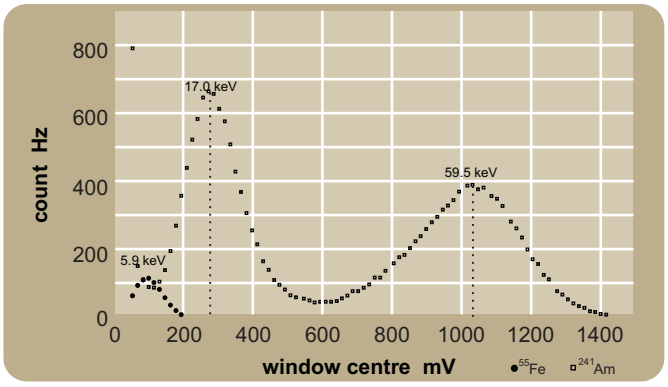
6 indicated counts vs true counts

The true count rate N can be calculated from the measured value n by iteration, using the expression $n = Ne^{-N}$, where is the dead-time. This may be approximated for n <<1 to N = n/(1-n).

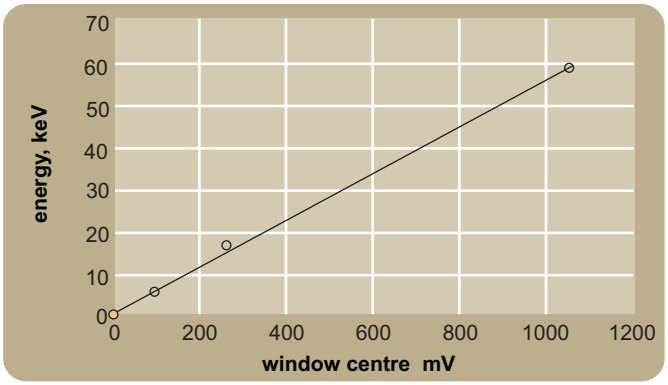


7 calibration and generation of energy spectra

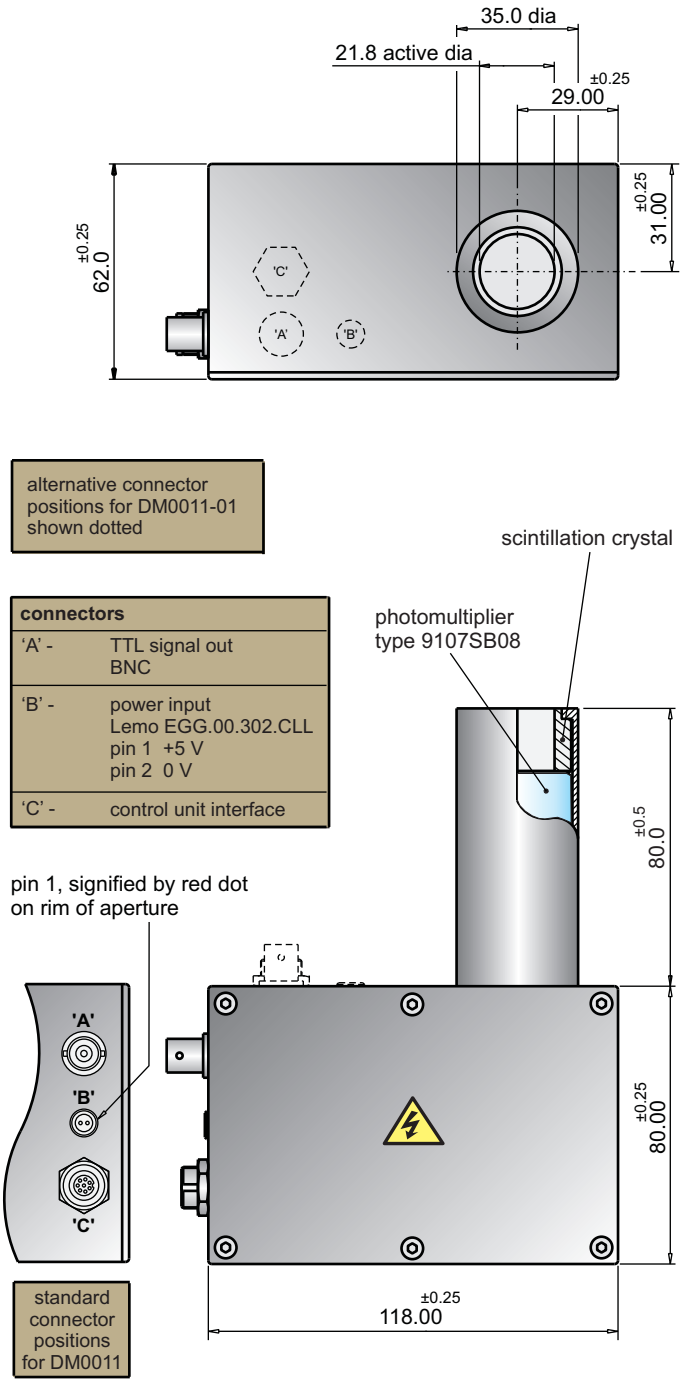
The detector is calibrated using very low activitity sources; for example, ^{55}Fe (5.9 keV), ^{241}Am (17.0 keV and 59.5 keV). The discriminator window is set, using the DM0011 CONTROL, to the lowest width of 50 mV. The lower threshold of the window is raised in steps, from a minimum of 50 mV up to a maximum of 3 V. The counts are recorded at each step and plotted against the voltage of the window centre (= threshold voltage plus half the window width). The voltage of the window centre has a linear relationship to the mean energy of the detected X-rays, enabling an energy spectrum to be produced, as illustrated in the figure below.



The coordinates of the three peak positions are transferred to a linear calibration curve relating X-ray energy to mV setting, as shown. Alternatively, the scale on the x axis in the above graph may be expressed in keV by using the calibration curve. The detector can then be used to generate the absolute energy spectrum of an unknown X-ray source by using the some procedure as for calibration.



9 outline drawing (mm)



10 precautions

Avoid touching the scintillation crystal window. It is a very thin membrane and, consequently, is very delicate.

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