# Compact dual channel Spectroscopy Amplifier cum Discriminator

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## Introduction

A single width NIM module having two channels of spectroscopy amplifier cum discriminator has been developed for Nuclear Physics experiments at IUAC. Each channel contains a shaping amplifier along with logic circuits to generate the energy and timing information respectively. The module accepts energy signal from charge sensitive preamplifiers connected to detectors such as Silicon surface Barrier (SSB) detectors, scintillation and gas detectors. The performance of the module is at par with the commercially available NIM modules.

Nuclear Physics experiments generally require detectors which generate charge that are processed by the charge sensitive preamplifiers. These signals are further processed using spectroscopy amplifier, timing filter amplifier (TFA), timing single channel analyzer (TSCA) and associated logic circuits such as gate and delay generator (GDG) to get energy and timing information. Typical commercial electronics setup would require many modules which occupy large area, interconnecting cables and connectors. We have developed a single width NIM module that contains two independent channels of electronics to process detector energy signal coming through pre-amplifier. Unipolar output and Gate output from the module can be given to the analog input and strobe of analog to digital converter (ADC) respectively for data collection while prompt Trig_F/NIM output can be used for co-incidence logic or to generate master gate.

### Module Details

The module block diagram is as shown in Fig 1. The single width NIM module has two identical channels and each channel accommodates a spectroscopy amplifier to generate pulse height information and logic circuits to generate timing information. The module generates base line corrected, semi-gaussian unipolar output, and logic outputs such as trigger and ADC gate signals. The logic outputs are available both in TTL and fast NIM logic. The essential controls such as gain, polarity, pole/zero control, threshold adjustments as well as gate width and delay can be adjusted on panel. All the interconnections to module are made through Lemo-00 series connectors.

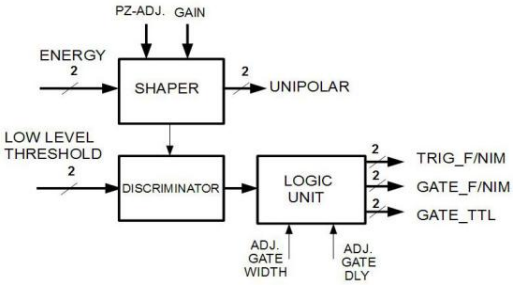


**Fig. 1** Block diagram of "Spectroscopy amplifier cum Discriminator" module

## Spectroscopy amplifier

The various items and their font size andThe spectroscopy amplifier [1] has fixed shaping time constant of 1μs. It accepts energy input signal in the range of 100mV to 8V. The polarity of the input signal may be selected by a switch. Adjustable pole-zero (P/Z) compensation network has been provided for input signal decay time ~50μs. Large input signals may be attenuated by a factor of 10 using an on-board jumper. To handle small input signals high gain is achieved using two gain stages where a novel gain adjustment technique has been adopted [3]. The gain blocks along with overload recovery have been implemented with low noise, high slew rate operational amplifiers. The gain stages are realized using analog switched resistors in the feedback path of the operational amplifier. The first and second gain stage provides eight and three discrete gain values respectively. The

total gain range of the amplifier is ~ (x1.5 to x275). The semi-gaussian shape is achieved with early differentiation stage and two stages of second order active integration. The DC baseline is restored using active gated base line restorer with fixed threshold. Push-pull buffer in composite amplifier configuration has been used for the output stage that is series terminated with a 50 Ω resistor.

## Timing Circuit

The timing signal to mark arrival of the pulse is generated with low level threshold discriminator. To generate timing information, linear signal is tapped before active integration. The base line corrected signal is buffered and fed to a ultra fast comparator that is used as a low level threshold discriminator (LLTH). When the input exceeds the set threshold level, the discriminator generates energy dependent timing signal ($t_{LLTH}$). The LLTH discriminator provides energy selection across a specified range. To accommodate wide range input signal LLTH can be adjusted through a potentiometer in the range of +100mV to +1.6V while monitoring it on the front panel. The $t_{LLTH}$ signal drives a monostable multivibrator to generate fixed width (~200nS) trigger pulse. The other output of the discriminator is further processed using monostable multivibrator circuits to generate Gate pulses for analog to digital converters (ADC).

## Test result

The module was subjected to various tests to evaluate the performance in parallel with commercial modules. Typical energy shift observed in 1408 keV peak of $Eu^{152}$ over a period of 24 hours is <0.04%. We used Canberra pulser (model 8210) to conduct Integral non-linearity test and the measured error is better than +/- 0.0002%.

The module has been used for offline measurements with radioactive sources as well as in beam nuclear physics experiments with the IUAC Tandem-LINAC accelerator. It has been tested with silicon surface barrier detectors using 241Am alpha source and beams such as 16O, 19F, 28Si, 32S, 48Ti with energies ranging from

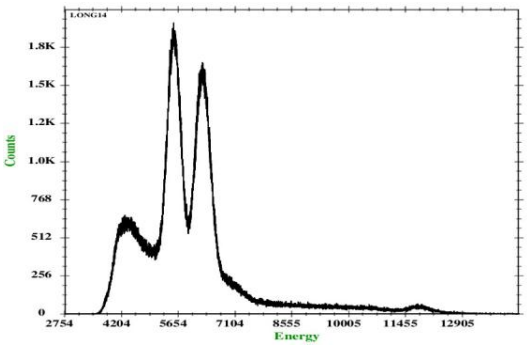


**Fig 2**: Energy spectrum of $Co^{60}$ source with NaI detector.

50 – 250 MeV. It has also been used with NaI detectors. The results obtained are identical to that obtained with the commercial modules such as Ortec 572, Canberra 2012, CAEN N986. Typical spectrum obtained with $Co^{60}$ source is shown here.

## Conclusion

We have successfully demonstrated the possibility of incorporating electronics signal processing circuits to generate energy and timing information by processing only energy signal. This electronics module has given excellent results in a typical experimental environment.

## Acknowledgement

Sincere thanks to Dr.Amit Roy, Ajith Kumar B.P (IUAC) for their support at various stages for successfully completing this work.

## References

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[2] Devlopment of INGA clover electronics module, DAE-BRNS Symp. on Nucl. Phys. Pg 424, Vol: 45B (2002)

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