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#11-128 Analog Pulse Shape Discrimination based on Combination of Time Duration with Pulse Hight

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Pulse Shape Discrimination (PSD) is a useful technique used to detect and distinguish between different types of radiation interactions. PSD methods are frequently adopted for n/γ or α/β discrimination. Over the years, many techniques for performing PSD were presented, both analog and digital implementations. A digital PSD enables implementation of complex algorithms, which analyze various parameters, hence provides advanced discrimination capabilities. However, digital PSD requires high speed acquisition hardware, especially for pulses with fast decay time, e.g. originating from plastic and organic scintillators. Furthermore, sophisticated algorithms require long processing time that limits the count rate and increases the dead time. Moreover, fast samplers require significant power consumption making them less suitable for portable devices. On the other hand, analog PSD methods can be more suitable for high speed scintillators both from rate and power consumption perspectives. Common analog discrimination methods are based on pulse-height and pulse-energy discrimination techniques. Other techniques rely on the time difference in the pulse width such as the Zero-Crossing (ZC) methods. Neither of the above combine both amplitude and time methods.
In degraded light collection conditions, such as long and opaque scintillators, a lower pulse-height is obtained, while the noise level is unaffected. Consequently, lower signal to noise ratio is obtained, causing amplitude-based methods to yield a considerable number of miss-classification. Contrarily to pulse height and energy that decrease proportionally to the light collection efficiency, the pulse shape is less affected. Time and pulse width-based methods are not error proof either. Pulse width at over threshold of fast and high amplitude pulses can have a similar width as slower pulses with lower amplitude.
We present a novel analog PSD topology that overcomes this issue. The topology is based on discrimination according to the pulse duration in time combined with compensation function of the pulse height. Amplitude of the pulse is used as a restraining factor. Subsequently, our topology correctly identifies fast pulses that are prolonged in time due to their high amplitude. The topology was realized on a high speed printed circuit board techniques providing superior discrimination capabilities with an uncertainty gap smaller than 1 ns in the pulse width. The ability to control both the time and the amplitude parameters individually, provides tailored adjustment for various detectors and PSD applications.

Primary authors: HARN, Ron (Nuclear Research Center –Negev, Ben-Gurion University); OSOVIZKY, Alon (NRCN&Rotem industries); MANOR, Avi (NRCN); Mr KADMON, Yagil (Electronic and Control Laboratories NRCN); GHELMAN, Max (Electronic and Control Laboratories NRCN)

Presenter: HARN, Ron (Nuclear Research Center –Negev, Ben-Gurion University)

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