

## SCA

The single channel analyzer (SCA) or discriminator is the instrument which measures the energy (i.e., amplitude) of an amplifier's output pulse, and properly prepares a standardized pulse for input into counting devices. Introducing an amplifier's output pulse directly into a counting device (that is, a counter or ratemeter) with no discrimination of the amplitude, would give uncertain results due to the low level noise content. If it is desired to measure the gross number of the particles detected, a discriminator, set to pass only those pulses with amplitude above a fixed threshold, will insure that only detected nuclear events are counted. The measurement signifies that the event exceeded a desired threshold, and a standardized output pulse is generated in a form that can be easily acted on by other instruments appropriate to the application. Referred to as logic signals, the NIM Standard includes two signals: a "SLOW" positive 8 V signal, and a "FAST" negative 16 mA current pulse. Canberra also provides TTL outputs on all instruments.

The single channel analyzer not only permits the discrimination of pulses below a certain amplitude, but those above an upper threshold as well, allowing the measurement of only those events occurring in a selectable energy window. For convenience, the upper threshold may be defined and set as a  $\Delta E$  window value which rides above the discriminator threshold  $E$  setting. Further,  $E$  may be controlled from an external voltage level by an SCA Sweep to drive the window across a selected energy range while the resulting energy spectrum is recorded.

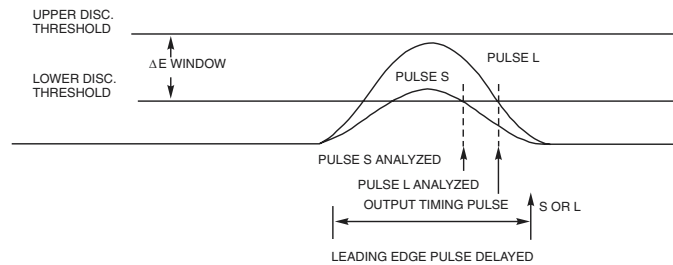


Figure 1 Pulses in the SCA Window

## Applications

The Canberra Model 2030 Single Channel Analyzer provides separate logic signal outputs for pulses which exceed the lower level discriminator (LLD) and for those which exceed the upper level discriminator (ULD). In addition to the SCA output, these may be used together or individually in a wide variety of applications such as in distinguishing between alpha and beta particles when used with a proportional counter biased for the beta plateau, an alpha-beta plastic detector or any dual particle/dual energy detector.

Of paramount importance in the design of the single channel analyzer or discriminator is the accuracy and stability of the threshold detection. Canberra's use of linear and digital integrated circuits and careful attention to stabilization of the incoming signal insures that offsets, count rate related inaccuracies, and drift are minimized. The Model 2030 Single Channel Analyzer, for example, guarantees discriminator stability of better than  $\pm 0.005\%$  of full scale over a 0 to 50 °C range.

Timing Single Channel Analyzers extend the measurement one additional step. Besides permitting the selection of only those pulses representative of a specific energy window in the spectrum, the Timing SCA generates its output logic pulse timed to mark the occurrence of the event. Such timing is required when further analysis involving the coincidence/anticoincidence of the event or discrimination of the pulse shape are required.

As is evident from the figure, amplitude discrimination results in an output with timing dependent upon the amplitude and shape of the pulse, and is therefore not acceptable for timing measurements.

For those applications where both energy constraints and the precise timing of successive pulses is important, the Timing Single Channel Analyzer provides the necessary measurement tool. The TSCA combines the energy discriminator functions of the conventional SCA described above, with a timing analyzer keyed to gate its logic outputs at a point that is stabilized in time for wide variations in the amplitude of the analog input pulse. The variance in timing due to amplitude fluctuations is called "walk".

There are a number of methods of timing discrimination used, each optimized for a specific input pulse condition, and each providing commensurate walk behavior. The Model 2037A offers both low level leading edge timing for fast, shaped input pulses from scintillation detectors, and crossover timing for either bipolar amplifier signals or double delay line (DDL) signals. The choice of technique depends as much on user familiarity and preference as on the overlapping areas of performance.

The paramount requirement for the instruments in this category is stability: temperature and time stability of the energy discrimination threshold. In this key parameter, the instruments in the Canberra 2030 series excel, with an average temperature stability of better than  $\pm 50$  ppm/°C.

### **Design Tradeoffs**

To accommodate high count rate signals, the instruments in the Canberra 2030 series employ direct coupled discriminator inputs. While this approach improves performance to the point that the restorer of the main shaping amplifier becomes the limiting factor in precise high rate counting, it does require that the dc offset of the amplifier be taken into account in exploiting the full dynamic range of these instruments.

### **Performance Features**

As mentioned earlier, stability of the discriminator threshold is the hallmark of the Canberra 2030 series. For user convenience, all threshold controls use 10-turn dial potentiometers calibrated to read the reference voltage directly. An expanded 10% window ( $\Delta E$ ) range is also provided on the Model 2030 and 2037A. The Model 2030 has a front panel LED indicator which may be used instead of an oscilloscope, if desired, in setting the LOWER LEVEL (E) control just above the main shaping amplifier's noise level for wide range counting, and an external LLD reference input is provided.

Positive logic pulse output signals in this series have been made user adjustable to permit maximum flexibility in interfacing all types of new and old instruments. The instruments are shipped with socketed resistors which limit the output voltage pulse to +5 V, nominal, for interfacing common TTL level inputs on current instruments. If desired, the resistor is simply removed for a +8 V output pulse for older instruments with higher input thresholds. All logic outputs are source matched to 50  $\Omega$  to ensure that ringing and consequent multiple counting does not occur, and all output connectors are of the isolated BNC type so that fast pulse currents do not run through the instrument or NIM Bin chassis.

The 2037A TSCA also features a useful pileup rejection logic which prevents ambiguous event timing or energy discrimination for the crossover timing modes.

More advanced timing instruments designated to operate from preamp output pulses directly using constant fraction derivation techniques are discussed in the TIMING section of this catalog. The Preview Chart which follows will help you select the SCA best suited to your requirements.

### Canberra SCA Preview Chart

The chart below will help you select the SCA that will best suit your requirements.

Canberra SCA Preview Chart					
Model 2030 Maximum Flexibility, Precision SCA	<u>Stability</u> ≤0.005%/°C of full scale	<u>Pulse Pair Resolution</u> ≤0.65 μs	<u>Window</u> 1 V/10 V	<u>Outputs</u> LLD ULD SCA	<u>Comments</u> LED Monitor
Model 2037A General Purpose Timing SCA	<u>Stability</u> ≤0.005%/°C of full scale	<u>Cross-over Walk</u> ±4 ns at 10:1 ±8 ns at 50:1	<u>Leading Edge Walk</u> 40 ns at 10:1 ±100 ns at 50:1	<u>Delay</u> 0.1 - 1.1 μs 1 - 11 μs	<u>Comments</u> Leading Edge Timing Crossover Timing Low Cost

