

Constant-Fraction Discriminator

- Preselected pulse shaping for excellent time resolution with commonly used detectors
- Low walk for timing with a wide range of pulse amplitudes
- No external delay required
- Three modes: Constant-fraction, leading-edge, or slow-rise-time reject

The unique design of the ORTEC Model 473A Constant-Fraction Discriminator provides excellent time resolution with all commonly used detectors, such as HPGe, silicon charged-particle, fast plastic, and NaI(Tl). Three timing modes are provided in the Model 473A. Constant-fraction timing results in the best timing without loss of intrinsic efficiency with HPGe detectors. Slow-rise-time rejection results in superior timing with germanium detectors at the expense of some efficiency. Leading-edge timing is the mode commonly used for single-photon counting. It allows the Model 473A to be converted into a leading-edge discriminator whose count rate is 1 MHz when the shaping mode switch is in the Scint 2 (NaI) position, or is 15 MHz otherwise. Additional versatility is designed into the Model 473A through the provision of three simultaneous outputs: two negative and one positive.

The Model 473A is simple and convenient to operate: only two switches and one control need to be adjusted for normal operation. The shaping mode switch selects the proper delay and fraction for several detector types. Also provided is a switch position that allows both the delay and the triggering fraction to be modified for unusual conditions. The mode selector switch allows the Model 473A to be operated as a normal constant-fraction discriminator incorporating slow-rise-time rejection circuitry. A precision 10-turn potentiometer with a calibrated dial sets the threshold for generation of timing signals, and can be reset instantly to previous settings.

Operation of the Model 473A is stable and reliable as the result of extensive use of integrated circuits and the absence of tunnel diodes. No other modules are required for operation with fast plastic or NaI(Tl) scintillators. When HPGe detectors are used, a Timing Filter Amplifier is recommended as an accessory module. When input signals are low level and have very fast rise times, such as those from silicon charged-particle detectors, a Timing Amplifier is recommended as an accessory module.

PERFORMANCE

INPUT PULSE CHARACTERISTICS Negative pulses accepted to 5 V without saturation; protected to 100 V for duty cycle of 10%.

DISCRIMINATOR RANGE From -50 mV to -5 V.

WALK AND DYNAMIC RANGE

Ge Mode $\leq \pm 2$ ns for range from 100 mV to 5 V with 40-ns rise time.

Scint 1 Mode $\leq \pm 200$ ps for range from 50 mV to 5 V (including test attenuator walk) with 1-ns rise time.

Scint 2 (NaI) Mode $\leq \pm 500$ ps for range from 50 mV to 5 V with 5-ns rise time.

NOMINAL PULSE-PAIR RESOLUTION For input signals > 0.5 V and rise time of < 2 ns.

Ge 65 ns.

Scint 1 65 ns.

Scint 2 (NaI) 1.1 μ s.

Ext 65 ns.

CONTROLS

SHAPING MODE 4-position front-panel switch:

Ge, Scint 1, Scint 2 (NaI) Select the delay and fraction for optimum time resolution for signals from HPGe detectors, from fast plastic scintillators or silicon charged-particle detectors, and from sodium iodide thallium-activated scintillators. Scint 2 (NaI) mode also selects an internal dead time of ~ 1 μ s to prevent multiple triggering on slow-decay signals.

Ext Allows selection of whatever delay is desired by controlling the length of coaxial cable being placed between the front-panel connectors, and also allows the selection of 10%, 20%, or 30% triggering fractions by use of an internal jumper.



TEMPERATURE CHARACTERISTICS

Disc Level Drift typically $\leq \pm 0.5$ mV/°C, 0 to 50°C.

Propagation Delay Instability typically within $\leq \pm 15$ ps/°C, from 10 to 40°C.

EXTERNAL DELAY

DELAY Front-panel input and output connectors for selecting the required shaping delay; 50- Ω cable required.

ELECTRICAL AND MECHANICAL

POWER REQUIRED +12 V, 21 mA; -12 V, 150 mA; +24 V, 10 mA; -24 V, 75 mA; 117 Vac, 42 mA.

WEIGHT

Net 1.1 kg (2.5 lb).

Shipping 2.0 kg (4.5 lb).

DIMENSIONS NIM-standard single-width module 3.43 X 22.13 cm (1.35 X 8.714 in.) per DOE/ER-0457T.

RELATED EQUIPMENT

The Model 473A accepts input signals from various ORTEC fast-timing systems using the following detectors:

HPGe DETECTORS A Timing Filter Amplifier is used to differentiate the signal and improve the signal-to-noise ratio of the preamplifier output before it is provided to the Model 473A.

SCINTILLATION DETECTORS (Fast Plastic and NaI) In general, signals taken from the photomultiplier anode do not require additional amplification or shaping prior to the Model 473A.

SILICON CHARGED-PARTICLE DETECTORS The use of a fast charge-sensitive preamplifier is recommended. A Fast Timing Amplifier is also often used for additional amplification prior to the Model 473A.

PHOTON COUNTING DETECTORS A fast current-sensitive preamplifier is recommended for initial amplification of weak anode signals. A Fast-Timing Amplifier is also recommended for additional amplification prior to the Model 473A.

TIMING MODE 3-position front-panel switch selects timing mode desired:

C.F. Constant-fraction timing operation; triggering fraction and shaping delay controlled by the shaping mode switch selection.

S.R.T. Rejects slow-rise-time detector pulses; less efficient than the C.F. mode, but gives the best timing operation. Any signal not crossing the output discriminator threshold in ~ 20 ns after the response in the constant-fraction zero-crossing pickoff will not generate an output. Ideal for improving time resolution when using large HPGe detectors.

L . E . Bypasses constant-fraction circuitry, allowing operation as a leading-edge discriminator whose count rate is limited by the dead time associated with the shaping mode selectors. Unit will normally operate to 15 MHz on all positions except Scint 2 (NaI), where it is limited to ≈ 1 MHz.

DISC LEVEL 10-turn precision locking potentiometer adjusts trigger level of the signal input discriminator; range -50 mV to -5 V. An internal constant-fraction pickoff arming discriminator is set automatically at 50% of the adjusted level.

EXT WLK 20-turn screwdriver adjustment for precise setting of walk compensation when the External mode is selected.

INPUTS

NEG Front-panel BNC connector accepts negative input signals from a fast preamplifier or from a timing amplifier; dc-coupled; normal range from Disc Level to -5 V; input impedance 50 Ω . Reflections typically $< 10\%$ for input signals up to -5 V amplitude and rise time ≥ 1 ns. Input directly compatible with current pulses from PM anodes.

OUTPUTS

NEG Two NIM-standard fast negative logic output signals generated separately and furnished through two BNC connectors on front panel; nominally -16 mA (800 mV on $50\text{-}\Omega$ load); width <10 ns; rise time ≤ 2.5 ns.

POS NIM-standard slow positive logic output signal furnished through BNC connector on front panel; nominally $+5$ V; width 500 ns; rise time ≤ 25 ns; output impedance $10\ \Omega$.

C.F. MON Permits observation of the constant-fraction shaped signal through BNC connector on front panel, output impedance $50\ \Omega$.

Typical Timing Resolution

Detector	Source	Energy Range	FWHM	FW.1M
Plastic-Plastic 2 each 1 x 1 in. KL236 scintillators mounted on Burle 8850 PM tubes	^{60}Co	1.17 MeV $\pm 10\%$ 20 keV - 2 MeV	200 ps 295 ps	390 ps 725 ps
Plastic-HPGe 1 each 1 x 1 in. KL236 scintillator mounted on Burle 8575 PM tube	^{22}Na	511 keV $\pm 10\%$ 80 keV - 1.6 MeV	3.9 ns* 4.7 ns*	9.3 ns* 12.8 ns*
1 ea. ORTEC true coax, 52.6 cc, 8.6%, 2.13 keV FWHM at 1.33-MeV energy liner for ^{60}Co	^{22}Na ^{60}Co	80 keV - 1.6 MeV 1.17 MeV $\pm 10\%$	4.7 ns 2.4 ns*	13.5 ns* 7.6 ns*

*Data taken with slow-rise-time (SRT) reject feature.