# 9327
## 1-GHz Amplifier and Timing Discriminator

- **For picosecond timing with mV signals from**
  - **Microchannel Plate Detectors**
  - **Microchannel Plate PMTs**
  - **Fast Photodiodes**
  - **Fast Photomultiplier Tubes**
- **1-GHz Amplifier and Timing Discriminator are internally matched for minimum walk and timing jitter**
- **Walk typically <±40 ps over the top 90% of full scale**
- **Jitter <20 ps FWHM at 50% of full scale**
- **Optimized for pulse widths from 250 ps to 1 ns; accepts pulse widths up to 5 ns**
- **Selectable input pulse height range: 0 to –30 mV, or 0 to –150 mV full scale**
- **2:1 Fine Gain control**
- **Over-Range LED for precise gain adjustment without an oscilloscope**


The Model 9327 1-GHz Amplifier and Timing Discriminator combines into one compact preamplifier sized package the two functions normally needed for picosecond timing with ultra-fast detectors. It is ideal for Fluorescence/Phosphorescence Lifetime Spectrometry (Fig. 1), Time-of-Flight Mass Spectrometry (Fig. 2) and LIDAR applications. The Model 9327 is optimized for use with the millivolt signals produced by microchannel plate detectors, microchannel plate photomultiplier tubes, fast photodiodes, and fast, discrete-dynode photomultiplier tubes. The compact package avoids degradation of the sub-nanosecond signals from these detectors by enabling an exceptionally short cable connection between the detector and the amplifier. The timing discriminator output logic pulse can be transmitted over much longer cables to the rest of the time spectrometer without compromising the picosecond time resolution.

The amplifier provides a 1-GHz bandwidth to minimize the noise and rise time contributions to timing jitter on detector pulses having widths as narrow as 250 ps. The 50-Ω amplifier input includes diode clamps to protect against overload pulses. A PC-board-mounted jumper controls the coarse gain to yield two ranges for full-scale input pulse amplitudes: 0 to –30 mV and 0 to –150 mV. A fine gain control permits varying the gain over nominally a 2:1 range. An oscilloscope is not needed to adjust the gain, because an over-range LED indicates when pulse amplitudes have exceeded the full-scale limit of the amplifier. Detector and/or amplifier gain can be increased until the over-range LED turns on, and then decreased until the LED just turns off. This ensures that the pulses utilize all of the amplifier's linear range.

The timing discriminator employs a zero-crossing technique that processes pulse widths from 250 ps to 5 ns without the need to adjust pulse-shaping cables. The zero-crossing technique results in minimal timing jitter and walk as a function of pulse amplitude. It is optimized for sub-nanosecond pulse widths, but will accommodate pulses up to 5 ns wide. The shift in the timing output (walk) as a function of pulse amplitude is typically less than ±40 ps over the top 90% of full scale when employing a 300-ps input pulse width (Fig. 3). The typical contribution of the 9327 to timing jitter is illustrated in Figure 4. With such a small contribution from the 9327, the detector normally becomes the dominant source of timing jitter. The Model 9327 includes a noise discriminator adjustable over a major fraction of full scale. With the source of detector events turned off, the discriminator threshold can be adjusted until the associated LED is turned on by triggering on noise. Subsequently, the threshold is adjusted until the LED just turns off, thus ensuring that the discriminator will not trigger on noise.

The Model 9327 provides two fast-negative NIM logic signals suitable for operating other timing instruments with picosecond time resolution. A 100-ns wide TTL output is also provided for counting applications. In addition to excelling in high-resolution time spectrometry, the Model 9327 can be used for single-photon and single-ion counting applications.

A 3-meter long captive power cord terminated in a 9-pin, D connector supplies power to the unit. Power can be derived from the mating connectors on a 4002P Portable Power Supply, a 4003 Preamp Power Output Module, or any ORTEC spectroscopy amplifier. Alternatively, a DC power source in the range of +12 to +15 V at 350 mA can be connected to the designated pins on the power connector.

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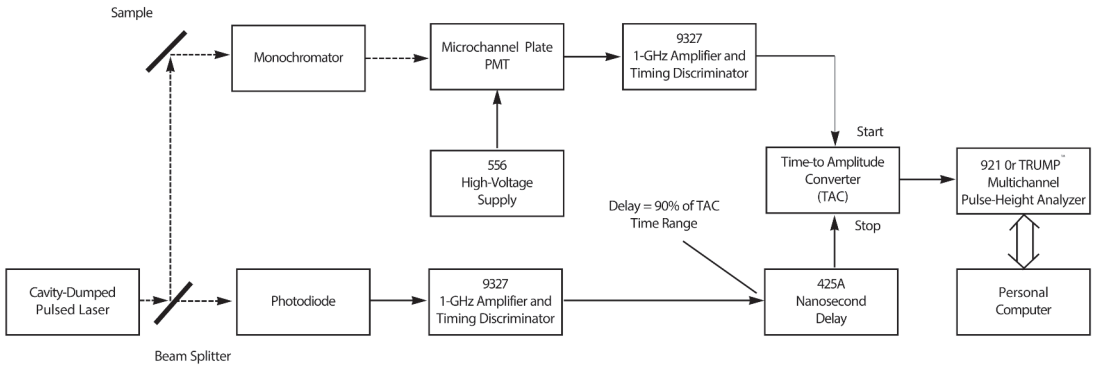


**Fig. 1. Typical Block Diagram for a Fluorescence Lifetime Spectrometer (with reversed start/stop assignments).**

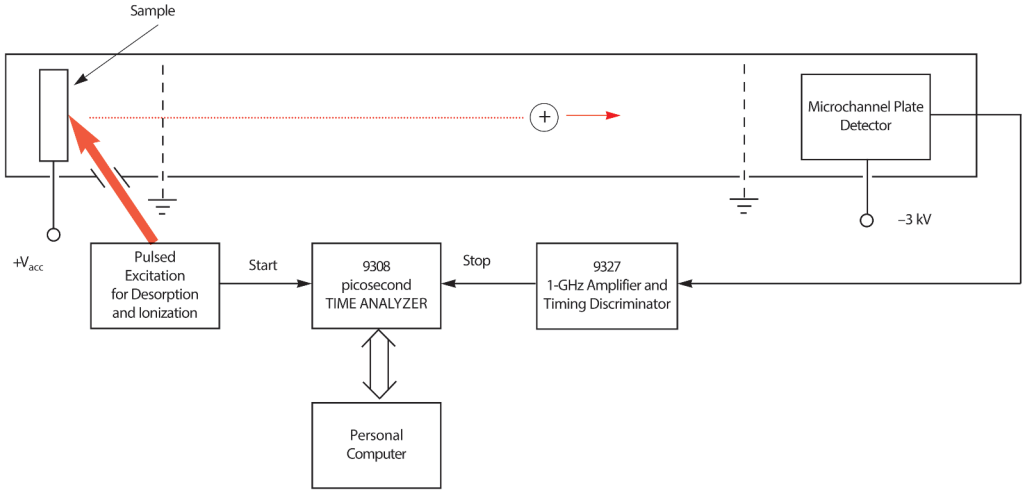


**Fig. 2. The Model 9327 in a Simplified Illustration of a Time-of-Flight Mass Spectrometer.**

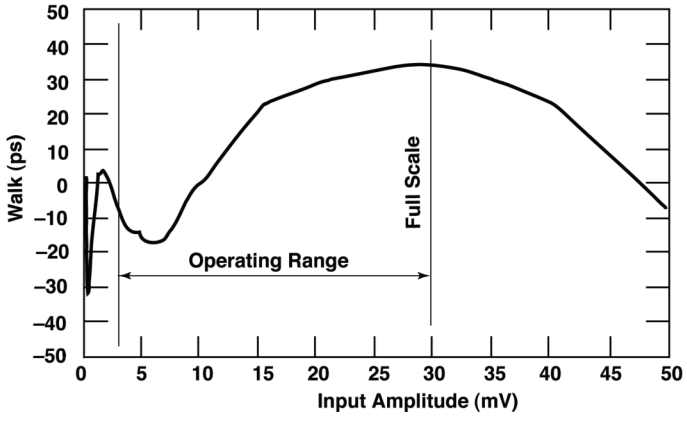


**Fig. 3. Typical Walk vs. Pulse Amplitude.** Full scale is denoted by the Over Range LED turning on. Measured with a pulse width of 300 ps FWHM.

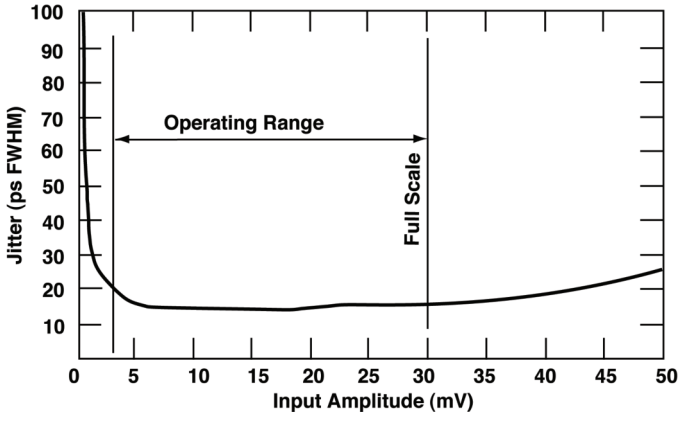


**Fig. 4. Timing Jitter vs. Pulse Amplitude.** Measured with the system in Fig. 1 by replacing the detectors with a pulser having a pulse width of 300 ps FWHM. Full scale is denoted by the Over Range LED turning on.

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## Specifications

### PERFORMANCE

Performance is measured on the 0 to –30 mV input range unless specified otherwise.

**INPUT RANGE** 0 to –30 mV (full scale) or 0 to –150 mV (full scale), selectable via a circuit board jumper.

**EQUIVALENT INPUT NOISE** <100 µV rms on the 0 to –30 mV range.

**TIME SLEWING (Walk)** Typically <±40 ps shift in the timing output as a function of pulse amplitude over the top 90% of full scale. Includes the contribution of both the amplifier and the timing discriminator. Measured with an input pulse width of 300 ps FWHM.

**TIMING JITTER** <20 ps FWHM for a pulse amplitude at 50% of full scale. Measured with the same pulse shape listed under TIME SLEWING.

**PULSE-PAIR RESOLUTION** <10 ns at the fast negative NIM outputs.

**OPERATING TEMPERATURE RANGE** 0 to 50°C.

**TRANSMISSION DELAY TEMPERATURE SENSITIVITY** <10 ps/°C from 0 to 50°C. Measured at 50% of full scale with the pulse shape listed under TIME SLEWING.

### INPUTS AND OUTPUTS

**INPUT (Amplifier)** Rear-panel SMA connector for negative input pulses. Accepts pulse widths from 250 ps to 5 ns FWHM. Optimized for sub-nanosecond pulse widths. Input range is jumper selectable for 0 to –30 mV or 0 to –150 mV. Input impedance: 50 Ω AC, <1000 Ω DC to ground. Diode clamps provide protection against overload to ±2 V DC, or ±10 V for a 50 ns-wide pulse at a duty cycle <1%.

**AMP OUT** Rear-panel SMA test point suitable for oscilloscope monitoring via a 50-Ω coaxial cable terminated in 50 Ω. Test point output impedance: 1000 Ω. The amplifier drives the timing discriminator input in parallel with the output monitor via an internal connection.

**NIM OUT** Front- and rear-panel BNC connectors provide two independent, fast-negative NIM output logic pulses. Output amplitude is nominally –800 mV into a 50-Ω load. Pulse width is nominally 4 ns.

**TTL OUT** Rear-panel BNC connector provides a positive TTL pulse, triggered by the fast-negative NIM output. The 100-ns width of the TTL pulse is non-updating. Output impedance: <50 Ω, short-circuit protected.

**THRESH** Front-panel test-point jack near the THRESH control permits monitoring of the threshold setting with a voltmeter for resettability. Output impedance is 1000 Ω. Nominal output range is –10 mV to –1 V.

**WALK** Front-panel test-point jack near the WALK adjustment for monitoring the walk (time slewing) adjustment. See WALK under Controls and Indicators.

**GND** Front-panel test-point jack for connecting the ground lead of a voltmeter.

### CONTROLS AND INDICATORS

**INPUT RANGE (Coarse Gain)** Circuit board jumper near the amplifier INPUT permits input range selection for 0 to –30 mV or 0 to –150 mV.

**FINE GAIN** Front-panel, 15-turn screwdriver adjustment to calibrate the full-scale sensitivity. Can be used as a fine gain control with approximately a 2:1 range of gain adjustment.

**THRESH** Front-panel, 15-turn screwdriver adjustment to set the input discriminator threshold. Adjustable from <2% to >50% of full scale. THRESH test-point jack permits monitoring the setting with a voltmeter.

**WALK** Front-panel, 15-turn, screwdriver fine tuning to minimize time slewing as a function of input pulse amplitude. Adjustable over a range of approximately ±150 mV. A WALK test jack permits monitoring the actual voltage setting through an output impedance <100 Ω.

**OUTPUT LED** Front-panel, LED flashes on each output pulse to indicate active triggering. Used to set the threshold beyond the noise level.

**OVER RANGE LED** Front-panel, LED flashes on each preamplifier pulse that has an amplitude exceeding full scale. Used during detector gain adjustment to avoid overloads while maximizing pulse amplitudes.

**PWR LED** Front-panel LED indicates when power is being supplied to the unit.

### ELECTRICAL AND MECHANICAL

**POWER REQUIRED** The Model 9327 derives its power through a 3-meter long (9-ft.) captive power cable terminated with a 9-pin D, preamplifier power connector. This connector is compatible with the preamplifier power connectors on ORTEC Models 4003, 4002P, and most ORTEC spectroscopy amplifiers. Power required is +12 to +15 V at 350 mA (Pin 4) and ground (Pins 1 and 2).

**WEIGHT**
**Net** 0.48 kg (1.1 lb).
**Shipping** 1.1 kg (2.5 lb).

**DIMENSIONS** Approximately 3.3 cm x 12.5 cm x 13.5 cm (1.3 in. x 4.9 in. x 5.3 in.).

**MISCELLANEOUS** Meets EEC standards (CE) for emissions, susceptibility, and power.

## Ordering Information

To order, specify:

| Model | Description |
|---|---|
| **9327** | 1-GHz Amplifier and Timing Discriminator |

Suggested Cable Accessories:

| | |
|---|---|
| **SMA58-0.15** | RG-58A/U (50-Ω) Coaxial Cable with SMA connectors, 0.15-m length |
| **SMA/BNC** | SMA to BNC Adapter with male SMA and female BNC |
| **BNC/SMA** | BNC to SMA Adapter with male BNC and female SMA |
| **C-25-12** | RG-58A/U (50-Ω) Coaxial Cable with BNC connectors, 3.7-m (12-ft) length |

Specifications subject to change
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