

**Model 9327  
1-GHz Amplifier and  
Timing Discriminator  
Operating and Service Manual**

# **Advanced Measurement Technology, Inc.**

a/k/a/ ORTEC<sup>®</sup>, a subsidiary of AMETEK<sup>®</sup>, Inc.

## **WARRANTY**

ORTEC\* warrants that the items will be delivered free from defects in material or workmanship. ORTEC makes no other warranties, express or implied, and specifically NO WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

ORTEC's exclusive liability is limited to repairing or replacing at ORTEC's option, items found by ORTEC to be defective in workmanship or materials within one year from the date of delivery. ORTEC's liability on any claim of any kind, including negligence, loss, or damages arising out of, connected with, or from the performance or breach thereof, or from the manufacture, sale, delivery, resale, repair, or use of any item or services covered by this agreement or purchase order, shall in no case exceed the price allocable to the item or service furnished or any part thereof that gives rise to the claim. In the event ORTEC fails to manufacture or deliver items called for in this agreement or purchase order, ORTEC's exclusive liability and buyer's exclusive remedy shall be release of the buyer from the obligation to pay the purchase price. In no event shall ORTEC be liable for special or consequential damages.

### **Quality Control**

Before being approved for shipment, each ORTEC instrument must pass a stringent set of quality control tests designed to expose any flaws in materials or workmanship. Permanent records of these tests are maintained for use in warranty repair and as a source of statistical information for design improvements.

### **Repair Service**

If it becomes necessary to return this instrument for repair, it is essential that Customer Services be contacted in advance of its return so that a Return Authorization Number can be assigned to the unit. Also, ORTEC must be informed, either in writing, by telephone [(865) 482-4411] or by facsimile transmission [(865) 483-2133], of the nature of the fault of the instrument being returned and of the model, serial, and revision ("Rev" on rear panel) numbers. Failure to do so may cause unnecessary delays in getting the unit repaired. The ORTEC standard procedure requires that instruments returned for repair pass the same quality control tests that are used for new-production instruments. Instruments that are returned should be packed so that they will withstand normal transit handling and must be shipped PREPAID via Air Parcel Post or United Parcel Service to the designated ORTEC repair center. The address label and the package should include the Return Authorization Number assigned. Instruments being returned that are damaged in transit due to inadequate packing will be repaired at the sender's expense, and it will be the sender's responsibility to make claim with the shipper. Instruments not in warranty should follow the same procedure and ORTEC will provide a quotation.

### **Damage in Transit**

Shipments should be examined immediately upon receipt for evidence of external or concealed damage. The carrier making delivery should be notified immediately of any such damage, since the carrier is normally liable for damage in shipment. Packing materials, waybills, and other such documentation should be preserved in order to establish claims. After such notification to the carrier, please notify ORTEC of the circumstances so that assistance can be provided in making damage claims and in providing replacement equipment, if necessary.

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**CONTENTS**

WARRANTY .....	ii
SAFETY INSTRUCTIONS AND SYMBOLS .....	iv
SAFETY WARNINGS AND CLEANING INSTRUCTIONS .....	v
1. DESCRIPTION .....	1
2. SPECIFICATIONS .....	3
2.1. PERFORMANCE .....	3
2.2. INPUTS AND OUTPUTS .....	3
2.3. CONTROLS AND INDICATORS .....	4
2.4. ELECTRICAL AND MECHANICAL .....	4
2.5. ORDERING INFORMATION .....	4
3. INSTALLATION AND OPERATION .....	5
3.1. GENERAL .....	5
3.2. CONNECTION TO POWER .....	5
3.3. INPUT CONNECTIONS .....	5
3.4. OUTPUT CONNECTIONS .....	5
3.5. ADJUSTING THE INPUT SIGNAL .....	6
3.6. THRESHOLD ADJUSTMENT .....	6
3.7. WALK AND WALK ADJUSTMENT .....	6
3.8. INPUT RANGE SELECTION .....	7
4. MAINTENANCE AND FACTORY REPAIR SERVICE .....	8
5. POWER CONNECTOR PINOUT .....	8

## SAFETY INSTRUCTIONS AND SYMBOLS

This manual contains up to three levels of safety instructions that must be observed in order to avoid personal injury and/or damage to equipment or other property. These are:

**DANGER** Indicates a hazard that could result in death or serious bodily harm if the safety instruction is not observed.

**WARNING** Indicates a hazard that could result in bodily harm if the safety instruction is not observed.

**CAUTION** Indicates a hazard that could result in property damage if the safety instruction is not observed.

Please read all safety instructions carefully and make sure you understand them fully before attempting to use this product.

In addition, the following symbol may appear on the product:



**ATTENTION – Refer to Manual**



**DANGER – High Voltage**

Please read all safety instructions carefully and make sure you understand them fully before attempting to use this product.

## SAFETY WARNINGS AND CLEANING INSTRUCTIONS

**DANGER** Opening the cover of this instrument is likely to expose dangerous voltages. Disconnect the instrument from all voltage sources while it is being opened.

**WARNING** Using this instrument in a manner not specified by the manufacturer may impair the protection provided by the instrument.

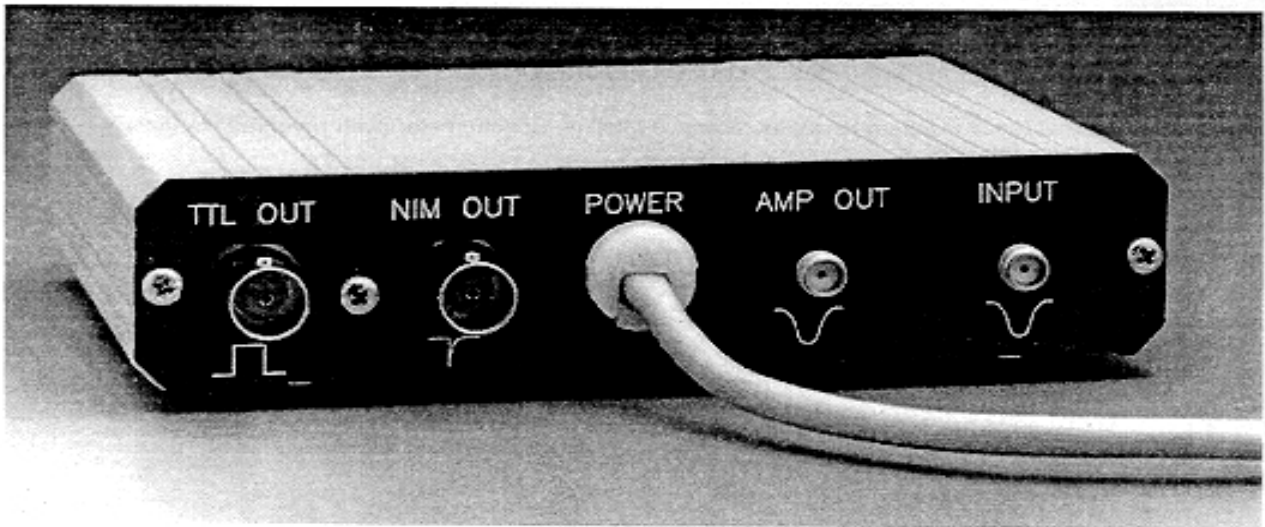
### Cleaning Instructions

To clean the instrument exterior:

- Unplug the instrument from the ac power supply.
- Remove loose dust on the outside of the instrument with a lint-free cloth.
- Remove remaining dirt with a lint-free cloth dampened in a general-purpose detergent and water solution. Do not use abrasive cleaners.

**CAUTION** To prevent moisture inside of the instrument during external cleaning, use only enough liquid to dampen the cloth or applicator.

- Allow the instrument to dry completely before reconnecting it to the power source.



## ORTEC MODEL 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  $\leq \pm 40$  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

### 1. DESCRIPTION

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. 1.1), Time-of-Flight Mass Spectrometry (Fig. 1.2), 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- $\Omega$  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

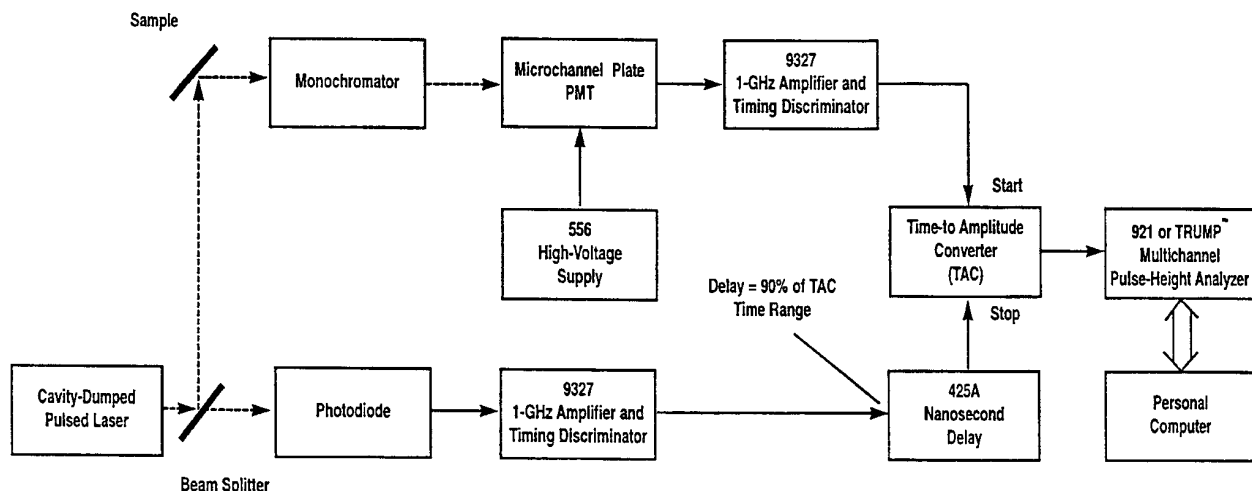
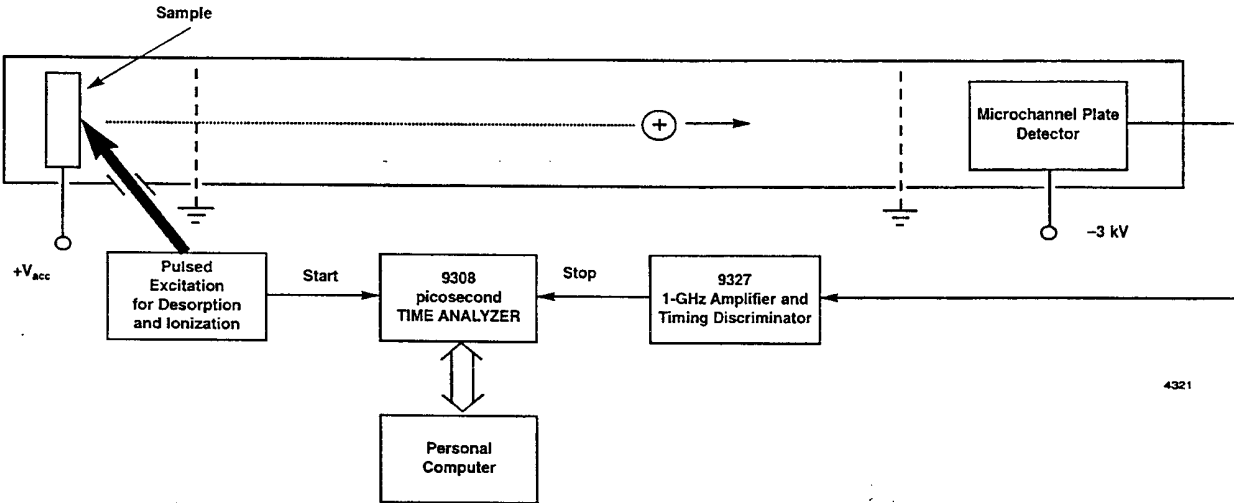


Fig. 1.1. Typical Block Diagram for a Fluorescence Lifetime Spectrometer (with reversed start/stop assignments).

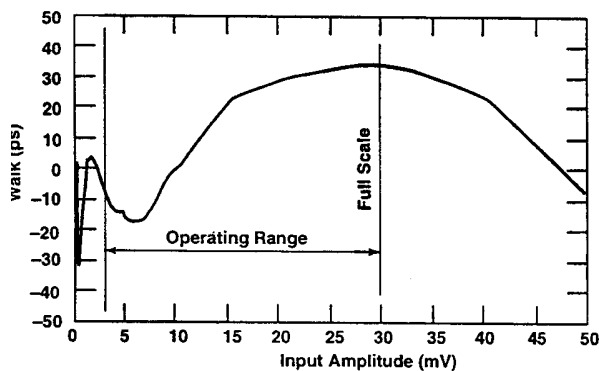


**Fig. 1.2. The Model 9327 in a Simplified Illustration of a Time-of-Flight Mass Spectrometer.**  
The Model 9308 picosecond TIME ANALYZER functions as a multiple-stop time spectrometer.

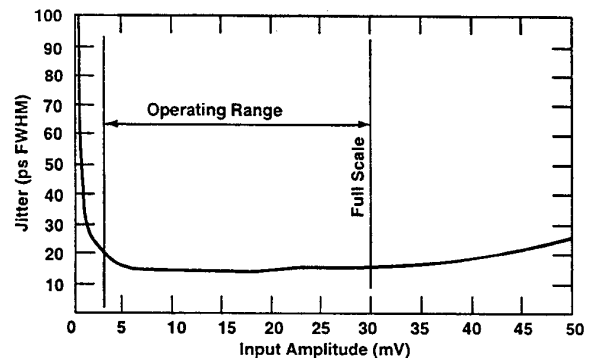
amplitudes: 0 to -30 mV and 0 to -150 mV. A fine gain control permits varying the gain over nominally a 2:1 range. An oscilloscope is not needed to adjust the gain, because an over-range LED indicates when pulse amplitudes have exceeded the full-scale limit of the amplifier. Detector and/or amplifier 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  $\pm 40$  ps over the top 90% of full scale when employing a 300-ps input pulse width (Fig. 1.3). The typical contribution of the 9327 to timing jitter is illustrated in Figure 1.4. 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.



**Fig. 1.3. 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. 1.4. 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.



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 9308 or 9328 picosecond TIME ANALYZER, 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.

## 2. SPECIFICATIONS<sup>1</sup>

### 2.1. 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  $\mu$ V rms on the 0 to -30 mV range.

**TIME SLEWING (Walk)** Typically  $\leq \pm 40$  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**  $\leq \pm 10$  ps/°C from 0 to 50°C. Measured at 50% of full scale with the pulse shape listed under TIME SLEWING.

### 2.2. 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  $\Omega$  ac, <1000  $\Omega$  dc to ground. Diode clamps provide protection against overload to  $\pm 2$  V dc, or  $\pm 10$  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- $\Omega$  coaxial cable terminated in 50  $\Omega$ . Test point output impedance: 1000  $\Omega$ . 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- $\Omega$  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  $\Omega$ , 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  $\Omega$ . 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.

<sup>1</sup> Subject to change without notice.

## 2.3. 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  $\pm 150$  mV. A WALK test jack permits monitoring the setting through an output impedance <100  $\Omega$ .

**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.

## 2.4. ELECTRICAL AND MECHANICAL

**POWER REQUIREMENTS** 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 9328, 9308, 4003, 4002P, or 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 x 12.5 x 13.5 cm (1.3 x 4.9 x 5.3 in.).

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

## 2.5. ORDERING INFORMATION

To order, specify:

Model	Description
<b>9327</b>	1-GHz Amplifier and Timing Discriminator

Suggested Cable Accessories:

<b>SMA58-0.15</b>	RG58U (50- $\Omega$ ) Coaxial Cable with SMA connectors, 0.15-m length
<b>SMA/BNC</b>	SMA to BNC Adapter with male SMA and female BNC
<b>BNC/SMA</b>	BNC to SMA Adapter with male BNC and female SMA
<b>C-25-12</b>	RG58A/U (50- $\Omega$ ) Coaxial Cable with BNC connectors, 3.7-m (12-ft) length

### 3. INSTALLATION AND OPERATION

#### 3.1. GENERAL

The 9327 is packaged in a compact case, allowing it to be placed close to the signal source (such as a detector). Short input cables will minimize the signal losses and pickup.

Local voltage regulation within the 9327 allows flexibility in the supply voltage, which must be supplied via the 9-pin cable. The unit may be powered from standard ORTEC preamp power jacks, or may be supplied from a separate supply in the +12-V to +15-V range.

#### 3.2. CONNECTION TO POWER

The 9327 uses dc to dc converters, which draw a current surge on powerup, and more current as the supply voltage drops. To minimize current limit problems in the power source, there is a small delay after application of power to the 9327 before full power operation of the 9327.

#### 3.3. INPUT CONNECTIONS

The 9327 is designed for use with sub-nanosecond input pulses. To maintain good input matching and preserve pulse bandwidth, it is recommended that the inputs be connected using SMA connectors and short 50- $\Omega$  coax cable.

An input protection network is provided on the 9327. Small (<100 mV) dc biases are acceptable, but large dc offsets will destroy the protection network. Large transients may damage the amplifier inputs.

The unit is designed and optimized to work with sub-nanosecond, negative-going-input pulses. The 9327 will process wider input pulses with degraded performance.

#### CAUTION

Ensure that the cable is discharged to ground before connecting to the 9327 input. The unit can be damaged if coax cables with high-voltage charges are hooked to the input. Leakage currents from detectors operating at high voltages could charge up coax cables. After the input is connected, the 9327 input protection network will prevent high-voltage buildup.

#### 3.4. OUTPUT CONNECTIONS

There are four outputs on the Model 9327: two fast-negative NIM logic outputs, one TTL output, and one amplifier output.

**FAST NIM Outputs** The two FAST NIM outputs are intended for precise timing applications with a Time Analyzer (such as the ORTEC 9308) or a Time-to-Amplitude Converter (TAC) such as the ORTEC Models 457, 566, or 567. Each of these two outputs generates a current pulse, with a width of 4 ns to 5 ns, and an amplitude of approximately -16 mA. The leading edge of the output pulse precisely marks the time of arrival of the detector pulse at the input to the 9327. The FAST NIM outputs are intended to drive a 50- $\Omega$  cable terminated in 50  $\Omega$  at the remote end of the cable. Thus, these two outputs produce pulses of nominally -800 mV amplitude on a terminated 50  $\Omega$  cable. The quiescent level between pulses is nominally 0 V. Most Time Analyzers and TACs provide the 50- $\Omega$  termination internally at their inputs. A 50- $\Omega$  cable with BNC connectors can be used to connect the FAST NIM outputs to either the START or STOP input of the Time Analyzer. Normally, the length of this cable is not critical. When driven by a noise-free sub-nanosecond pulser, the 9327 is capable of a time resolution of <15-ps FWHM (Full Width at Half Maximum peak height). Consequently, most of the contribution to the time resolution comes from timing jitter or noise in the detector connected to the 9327 input.

**TTL Output** The third output provides a positive TTL logic pulse with a width of approximately 100 ns. This output is useful for driving slower instruments such as counters and ratemeters. Either 50- $\Omega$  or 93- $\Omega$  cables with BNC connectors can be used with the TTL output. The TTL output is triggered from the FAST NIM outputs, and it flashes the output LED when active.

**AMPLIFIER Output** When connected to a 50- $\Omega$  load via 50- $\Omega$  cables, this output allows the amplifier output to be observed with approximately 21:1 voltage attenuation. It can be used for diagnostics, amplitude monitoring, observing distortion, etc.

### 3.5. ADJUSTING THE INPUT SIGNAL

The OVER RANGE indicator has been provided to assist the user in adjusting the operating conditions. Maximum dynamic range is available when signal amplitudes and gains are such that the OVER RANGE indicator occasionally flickers.

Controls within the 9327 include the Coarse Gain jumper, and the Fine Gain adjustment. The coarse gain jumper changes the discriminator input levels by about 6:1. The Fine Gain adjustment changes the amplifier gain over typically a 2:1 range.

Detector operating conditions or external attenuations prior to the 9327 input will also allow the input signal level to be adjusted. Any external attenuators must have sufficient bandwidth to preserve the risetime of the signal.

### 3.6. THRESHOLD ADJUSTMENT

A 15-turn threshold adjustment controls the amplitude threshold for accepting input pulses that are allowed to produce a timing output.

The adjustment range is -10 mV to -1 mV, representing the signal level at the amplifier output/discriminator input. The corresponding level at the amplifier input/detector output is scaled down by the amplifier gain, which depends on the Coarse Gain jumper setting, Fine Gain adjustment, and pulse width.

**Initial Adjustment to Reject Noise** The THRESHOLD control is typically used to prevent the Model 9327 from triggering on low-level noise. The simplest way to adjust this control is to turn off the supply of photons or ions to the detector, while leaving the detector in its normal operating condition. Subsequently, the THRESHOLD adjustment is turned clockwise until the OUTPUT indicator glows brightly. Under this condition the 9327 is triggering on noise. Next, the THRESHOLD adjustment is turned counter-clockwise until the OUTPUT indicator turns off. The threshold setting will now be just above the noise.

**Raising the Threshold for Improved Time Resolution** When the source of photons or ions is turned on, it may be desirable to raise the THRESHOLD above the value set in the previous paragraph. The smallest pulse amplitudes from the detector have inherently greater timing jitter. Consequently, the time resolution with any detector can be improved by rejecting the lower amplitude

pulses. The best way to make this additional adjustment of the THRESHOLD is to record resolution (FWHM) of the entire system, along with throughput (counts/second) as a function of the threshold setting. Pick the threshold setting that provides the best trade-off for the application.

### 3.7. WALK AND WALK ADJUSTMENT

Walk is the amplitude dependence of the system propagation delay. Walk can be a critical parameter in experiments which require accurate timing despite substantial fluctuations in the input signal amplitude.

The walk adjustment has the greatest effect on the lowest 10-20% of the input range.

**Function and Effect** When the WALK is properly adjusted to match the characteristics of the signal from the detector, there will be minimal systematic bias in marking the arrival time of smaller pulses vs. larger pulses. If the WALK is adjusted too far in the positive voltage direction, discriminator delay will increase as the signal gets smaller. If the walk is set too far negative, then the discriminator speeds up as the signals get smaller (for very small signals).

**Underlying Causes of Walk** In addition to dispersion already present at the 9327 input, there are three major sources of walk within the 9327:

- (1) Comparator gain-bandwidth limitations;
- (2) Amplifier distortion causing pulse shape changes;
- (3) Comparator propagation delay dispersion as a function of overdrive level.

The walk adjustment compensates for the first source. The comparator requires some Volt\*Second product over threshold in order that its output switch. When signals are very small and just barely cross the comparison threshold, the comparator propagation delay increases slightly, giving rise to walk. The walk adjustment introduces an offset voltage at the comparator input, causing the comparison to be made a few millivolts sooner (when the test-point value is negative). This offset has minimal effect on large signals, but speeds up the trigger on small signals, thereby counteracting the gain-bandwidth delays. The optimum setting for walk performance for the 9327 is typically around -20 mV (measured at the test point), but will vary from unit to unit as a function of the variations in comparator offsets.

The amplifier's distortion contribution to walk is minimized by operating with signals and gain that only occasionally cause amplifier overload.

The third source of walk is related to the first source, but also seems to be related to recovery from saturation conditions associated with solid output switching. This source is the dominant driver in the walk performance of the 9327 for most usable signal levels. This component of walk is more prevalent when processing very narrow pulses, since there is very little time between the saturated output condition prior to pulse arrival and the time where the comparator must respond to the pick-off comparison. Hence, walk performance for very narrow pulses is more difficult to achieve than one might expect.

#### Walk and Jitter as a Function of Walk Setting

Jitter and walk are not usually optimized at the same walk setting. Walk is usually optimized at a slightly negative setting (e.g., -20 mV), while the best jitter typically occurs at a slightly positive walk setting.

### 3.8. INPUT RANGE SELECTION

Two gain ranges are available in the amplifier, nominally providing either 0 to -30 mV input range or 0 to -150 mV input range.

The high gain range (nominally 0 to -30 mV) bypasses an attenuation resistor (R50) by placing the jumper between stake pins SP1 and SP2, as shown in Figure 3.1.

The low gain range (nominally 0 to -150 mV) attenuates the signal via R50 by placing the jumper between stake pins SP3 and SP4.

To check or change the jumper setting, the board must be slid out of the case. Three screws must be removed to slide the board out: next to the GND test point; to the left of the TTL output; and to the right of the INPUT. Pull the board out by pulling on the end panel that incorporates the captive power cord.

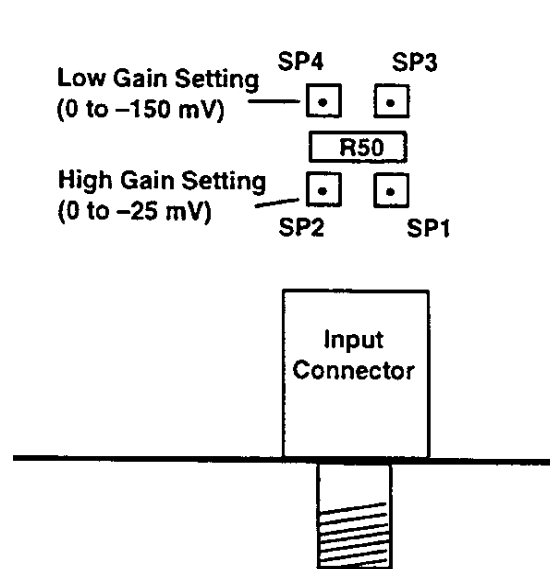


Fig. 3.1. Coarse Gain Jumper.

#### 4. MAINTENANCE AND FACTORY REPAIR SERVICE

No regular maintenance is required for the Model 9327 other than removal of dust and tightening of mechanical connections.

In the unlikely event of instrument failure, this unit can be returned to the ORTEC factory for service and repair at a nominal cost. Our standard procedure for repair ensures the same quality control and checkout that are used for a new instrument. Always contact ORTEC Customer Service (800) 251-9750 or (865) 482-4411, before sending an instrument for repair to obtain shipping instructions and so that the required Return Authorization Number can be assigned to the unit.

The Return Authorization Number should be written on the address label, the outside of the package, and on the explanatory letter enclosed with the unit. A multitude of packages flow into the Receiving Department at ORTEC each day. Consequently, the Return Authorization Number is critical to ensure that your package will be promptly routed to the Customer Service Department.

After inspecting your unit, the Customer Service Department will contact you regarding the necessary repairs and the expected cost.

#### 5. POWER CONNECTOR PINOUT

The power cable of the 9327 is compatible with the ORTEC standard preamp power outputs:

9327 Usage		Standard Preamp Power	
<u>PIN</u>	<u>FUNCTION</u>	<u>PIN</u>	<u>FUNCTION</u>
1	Ground	1	Ground
2	Ground	2	Ground
3	Reserved	3	+6 V
4	+12 to +15 V	4	+12 V
5	Reserved	5	- 6 V
6	Reserved	6	-24 V
7	Reserved	7	+24 V
8	Reserved	8	Reserved
9	Reserved	9	-12 V