Model 9307
pico-TIMING™ Discriminator
Operating and Service Manual

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Manual Revision C

Advanced Measurement Technology, Inc.

a/k/a/ ORTEC®, a subsidiary of AMETEK®, Inc.

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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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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:

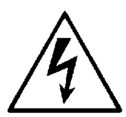
DANGER Indicates a hazard that could result in death or serious bodily harm if the safety instruction is not observed.

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.

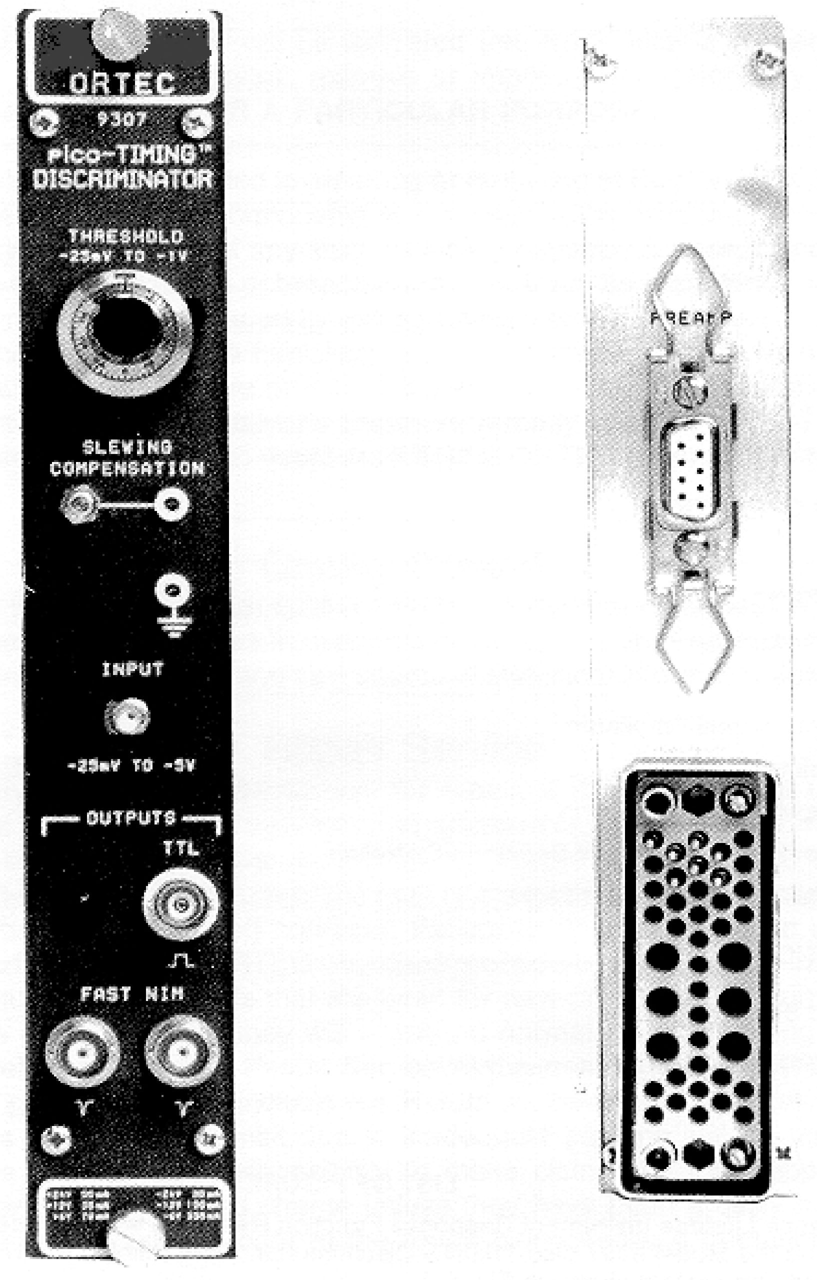
Cleaning Instructions

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
9307
pico-TIMING™
DISCRIMINATOR
THRESHOLD
-25mV TO -1V
SLEWING
COMPENSATION
INPUT
-25mV TO -5V
OUTPUTS
TTL
FAST NIM
PREAMP

ORTEC Model 9307 pico-TIMING Discriminator

1. DESCRIPTION

The ORTEC Model 9307 pico-TIMING Discriminator defines the arrival time of analog pulses from ultra-fast detectors with picosecond precision. Moreover, this superb performance is delivered over an extremely wide range of pulse heights with negligible influence of pulse amplitude on the timing output. With the Model 9307, the difficult task of adjusting pulse-shaping cables has been eliminated. The internal pulse shaping in the pico-TIMING Discriminator is optimum for single-photon or single-ion time measurements with microchannel plate detectors, microchannel plate photmultiplier tubes, and fast silicon photodiodes.

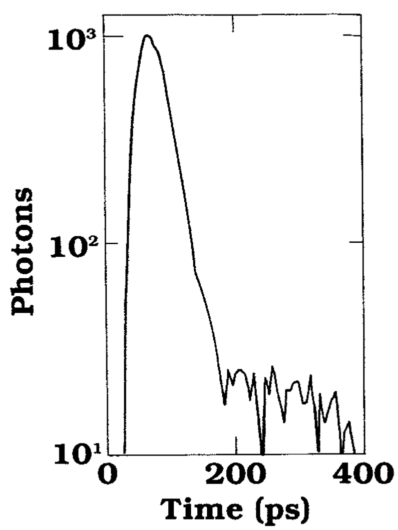


Fig. 1.1. The Fluorescence Lifetime Instrument Response Function Recorded with a Model 9306 1-GHz Preamplifier and the Model 9307 pico-TIMING Discriminator. Time resolutions from 30 to 60 ps FWHM are possible with the system shown in Fig. 1.2.

The pico-TIMING Discriminator accepts analog input pulses with amplitudes ranging from -50 mV to -5 V, and pulse widths from 400 ps to 5 ns FWHM. The amplitude threshold for generating a timing output is adjustable from -25 mV to -1 V with a 10-turn locking dial.

Ultra-fast circuits are incorporated in the pico-TIMING Discriminator to minimize time slewing. As a result, input amplitudes can vary over as much as a 100:1 range with negligible shift in the timing output. This ensures excellent time resolution, even when the signal source produces a wide range of randomly varying signal amplitudes. A front-panel screwdriver adjustment permits fine-tuning the slewing compensation to match the characteristics of a particular detector. An adjacent test point makes it easy to monitor the adjustment with a voltmeter.

Two fast negative NIM outputs provide the flexibility to trigger a time-to-amplitude converter (TAC) while simultaneously driving other instruments. The 500-ns-wide TTL output can be used with instruments that require a positive logic signal, such as counters and ratemeters. A front-panel LED flashes with each output pulse to indicate triggering.

For detectors having rise times less than 1 ns, the ORTEC Model 9306 1-GHz Preamplifier should be used to amplify small signals before presentation to the input of the Model 9307 pico-TIMING Discriminator. For rise times $\geq$1 ns, the Model VT120 Fast-Timing Preamplifier should be substituted for the Model 9306. The Model 9307 incorporates a compatible, 9-pin D connector on its rear panel to supply power to either preamplifier.

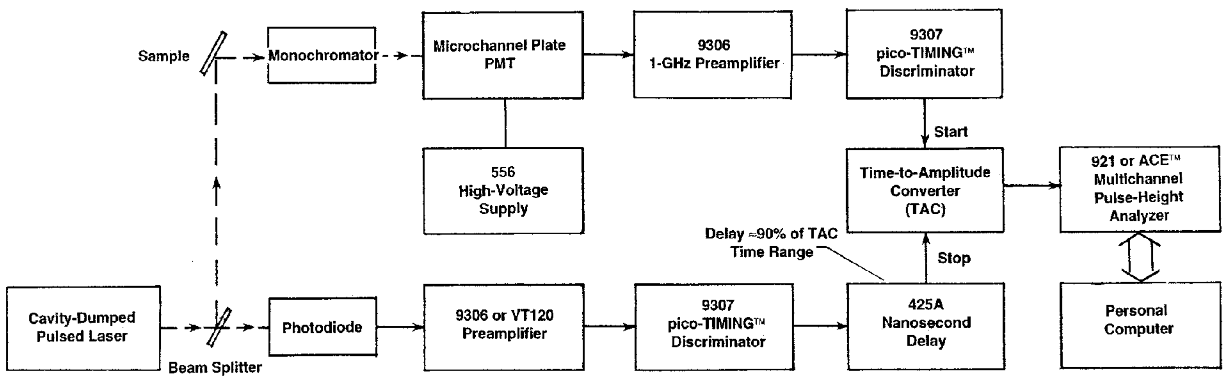


Fig. 1.2. Typical Block Diagram for Fluorescence Lifetime Spectrometer.

2. SPECIFICATIONS*

2.1. PERFORMANCE

TIME SLEWING (Walk) <±20 ps shift in the timing output for input signal amplitudes from -150 mV to -1.5 V. (Typically <±50 ps for signal amplitudes from -50 mV to -5 V.) Measured using a 1-ns-wide input pulse with 350-ps rise and fall times.

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

MAXIMUM INPUT/OUTPUT RATE Accepts burst rates up to 100 MHZ.

OPERATING TEMPERATURE RANGE 0 TO 50°C.

THRESHOLD TEMPERATURE SENSITIVITY <±0.1 mV/°C (0 to 50°C).

TRANSMISSION DELAY TEMPERATURE SENSITIVITY <±10 ps/°C (0 to 50°C.)

2.2. CONTROLS AND INDICATORS

THRESHOLD Front-panel, 10-turn potentiometer with locking dial allows adjustment of the input discriminator threshold from -25 mV to -1 V.

SLEWING COMPENSATION Front-panel, 20-turn, screwdriver fine-tuning to minimize time slewing as a function of input pulse amplitude. Adjustable over a range of approximately ±30 mV. A front-panel test point located next to the potentiometer facilitates monitoring the actual setting. Test point output impedance: 100 Ω.

OUTPUT LED Front-panel LED flashes on each output pulse to indicate active triggering.

2.3. INPUTS

INPUT Front-panel SMA connector accepts unipolar input signals with amplitudes in the range of -50 mV to -5 V. Minimum input pulse width: 400 ps (FWHM). Maximum input pulse width: 5 ns (FWHM). Input impedance: 50 Ω. The input is protected to ±5 V.

2.4. OUTPUTS

FAST NEGATIVE NIM OUTPUTS Front-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 2.5 ns.

TTL OUTPUT Front-panel BNC connector provides a positive TTL pulse, triggered by the fast negative NIM output. The 500-ns width of the TTL pulse is non-updating. Output impedance: <1 Ω, short-circuit protected.

PRAMP POWER Rear-panel, 9-pin D connector provides ±12-V and ±24-V power for the ORTEC Model 9306 1-GHz Preamplifier, the Model VT 120 fast-Timing Preamplifier, or other preamplifiers utilizing the industry-standard preamplifier power plug.

2.5. ELECTRICAL AND MECHANICAL

POWER REQUIRED The Model 9307 derives its power from a NIM bin/power supply, such as the ORTEC Model 4001A/4002D. Required dc voltages and currents are: +12 V and 35 mA, +6 V at 70 mA, -6 V at 360 mA, and -12 V at 100 mA.

WEIGHT
Net 0.9 kg (2.0 lb).
Shipping 1.8 kg (4.0 lb).

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

2.6. ORDERING INFORMATION

To order, specify:

Model	Description
9307	pico-TIMING™Discriminator
SMA 58-0.15	RG-58U (50-Ω) Coaxial Cable with SMA Connectors, 0.15-m length
SMA 58-0.5	RG-58U (50-Ω) Coaxial Cable with SMA Connectors, 0.5-m length
SMA 58-1.5	RG-58U (50-Ω) Coaxial Cable with SMA Connectors, 1.5-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

3. INSTALLATION AND OPERATION

3.1. GENERAL

The Model 9307 power requirements must be furnished from a NIM-standard bin/power supply that includes ±6-V power distribution, such as the ORTEC 4001A/4002D, 4001C/4002D, or 4001C/4002E NIM Bins/Power Supplies.

The NIM bin/power supply in which the 9307 normally will be operated is designed for relay rack mounting. If the equipment is rack mounted, be sure that there is adequate ventilation to prevent excessive localized heating in the Model 9307. The temperature equipment mounted in racks can easily exceed the maximum limit of 50°C unless precautions are taken.

3.2. CONNECTION TO POWER

The power demanded by a NIM bin full of NIM modules that incorporate high-density electronic circuits can exceed the maximum power available from the NIM bin power supply. Before installing the modules in the NIM bin, add the current requirements specified for each module, and check that the total current required at each voltage does not exceed the maximum output of the power supply. Also check the total power required against the maximum power specification for the power supply. If the suite of modules demands excessive power, some of the modules must be moved to a second NIM bin/power supply.

CAUTION

Do not insert the Model 9307 in a NIM bin without first turning off the NIM bin power. Inserting the module in the NIM bin with power on may damage the ultra-fast comparators in the Model 9307. The NIM bin power should be turned on only after the Model 9307 has been securely installed in the NIM bin.

Before installing the Model 9307 in the NIM bin, turn off the NIM bin power, then slide the 9307 into a convenient slot and tighten the retaining screws at the top and bottom of the module. The Model 9307 should be installed in the NIM bin at a location that is close to the module that utilizes the output of the Model 9307. After all the modules have been mounted in the NIM bin, turn on the NIM bin power. Using a voltmeter and the test points at the right side of the NIM bin, check that the power supply voltages are operating at their correct values. A sagging power voltage indicates that the current demand from the modules exceeds the limit of the power supply, or it indicates a possible fault in the power supply.

3.3. INPUT CONNECTIONS

For Detector Rise Times <1 ns The Model 9307 pico-TIMING Discriminator has been designed for use with ultra-fast detectors, which have pulse rise times as short as 350 ps. In order to obtain the best time resolution, special care must be exercised to preserve the fast rise time. Normally, this requires the use of short, 50-Ω, coaxial cables with SMA connectors. Typically, a fast preamplifier, such as the Model 9306 1-GHz Preamplifier, is required between the detector and the input of the Model 9307 to increase the amplitude of the detector output pulses (see Fig. 1.2). The total length of the coaxial cables from the detector to the preamplifier and from the preamplifier to the pico-TIMING Discriminator should be kept less than 1.7 meters to avoid degradation of the signal rise time. The coaxial cable between the detector and the Model 9306 preamplifier also should be as short as possible to minimize electrical interference from neighboring instruments. The inputs of both the Model 9306 and the Model 9307 include internal 51-Ω resistors for proper termination of the 50-Ω cable.

For Detector rise Times >1 ns If a detector having an output rise time ≥1 ns is employed, a longer length of 50-Ω coaxial cable with BNC connectors can be used between the preamplifier and the Model 9307. See the Ordering Information at the end of Section 2, or consult the ORTEC catalog for the proper coaxial cables and the BNC to SMA connector adapters. If the detector produces negative pulses with amplitudes that cover a substantial portion of the range from -50 mV to -5 V, the detector can be connected directly to the input of the Model 9307. Note that the input of the Model 9307 is protected only to ±5 V. If the detector produces signal amplitudes beyond ±5 V, diodes will have to be installed at the signal source to limit the amplitude to within ±5 V. If signal amplification is required for a detector having a rise time ≥1 ns, the Model VT120 Fast-Timing Preamplifier should be used in place of the Model 9306.

Preamplifier Power Connection Either the Model 9306 or the Model VT120 can derive its power from the preamplifier power plug on the Model 9307 rear panel.

Avoiding Ground-Loop Noise To avoid noise induced by ground loops, the detector and preamplifier should be isolated from any grounds in the vicinity of the detector. The only ground supplied to the detector and preamplifier should come directly from the NIM bin housing the Model 9307. This can be accomplished by mounting the detector high-voltage supply in the NIM bin next to the Model 9307, and by relying on the high-voltage cable, the preamplifier power cable, and the coaxial signal cables to provide the ground to the preamplifier and detector.

Getting the Right Input Signal Polarity The Model 9307 input requires a negative signal polarity. This is the normal pulse polarity provided by the anode of a photomultiplier tube (PMT), a microchannel plate, or a microchannel plate PMT. For detectors which have a positive signal polarity, a fast inverting transformer (such as the Model IT 100) or the Model VT 120B Fast-Timing Preamplifier can be used to invert the signal.

The Proper Input Pulse Width For best timing performance, the pulse supplied to the input of the Model 9307 should have a width at half its amplitude that falls in the range of 400 ps to 5 ns. This is the typical pulse width for single-photon or single-ion timing with micorchannel plates, microchannel plate PMTs, and photmultiplier tubes. The pico-TIMING Discriminator can be used with fast scintillators on PMTs, but the resulting time resolution will be 10% to 30% worse than can be obtained with a conventional Constant-Fraction Discriminator. Conversely, the Model 9307 is the optimum solution for single-photon or single-ion timing.

3.4. OUTPUT CONNECTIONS

There are three outputs on the Model 9307: two fast negative NIM logic outputs, and one TTL output.

FAST NIM Outputs The two FAST NIM outputs are intended for precise timing applications with a Time-to-Amplitude Converter (TAC), such as the ORTEC Models 457, 566, or 567 (see Fig. 1.2). Each of these two outputs generates a current pulse, which has a rise time of ~400 ps, a width of 2.5 ns, and an amplitude of approximately -16 mA. The leading edge of the output pulse at the input to the pico-TIMING Discriminator. The FAST NIM outputs are intended to drive a 50-Ω cable terminated in 50 Ω at the remote end of the cable.

Thus, these two outputs produce pulses of nominally -800-mV amplitude on a terminated 50-Ω cable. The quiescent level between pulses is nominally 0 V. Most TACs provide the 50-Ω termination internally at their inputs. A 50-Ω cable with BNC connectors can be used to connect the FAST NIM outputs to either the START or STOP input on the TAC. Normally, the length of this cable is not critical. When driven by a noise-free pulser with a rise time <1 ns at the input of the Model 9307, the pico-TIMING discriminator is capable of a time resolution <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 Model 9307 input.

TTL Output The third output provides a positive TTL logic pulse with a width of approximately 500 ns. This output is useful for driving slower instruments such as counters and ratemeters. Either 50-Ω or 93-Ω cables with BNC connectors can be used with the TTL output. For cable lengths <1 meter, it is not necessary to terminate this cable in its characteristic impedance. The TTL output can drive either TTL inputs or Slow Positive NIM Logic inputs. The TTL output is triggered from the FAST NIM outputs, and it flashes the adjacent LED on every output pulse.

3.5. ADJUSTING THE INPUT SIGNAL AMPLITUDE

Large Pulse Amplitudes from a PMT Anode If the amplitude of the output signal from the anode of a photmultiplier tube is large enough to use directly with the input to the pico-TIMING Discriminator, the range of signal amplitudes can be selected by adjusting the high voltage applied to the photomultiplier tube. An oscilloscope with a 500-MHZ bandwidth and a 50-Ω input impedance is adequate to measure the PMT pulses. The high voltage should be increased until the signals cover most of the 0 to -5-V operating range. The PMT manufacturer's instructions regarding operating voltage and maximum anode signal should be consulted to select the optimum voltage range, and to avoid distortion of the signals by anode saturation. Do not exceed the ±5-V limits on the input to the Model 9307.

Amplified Pulses with >1-ns Rise Times For single-photon counting with a photomultiplier tube, a fast amplifier is typically needed to increase the amplitude of the pulses from the PMT anode. An oscilloscope with a 500-MHZ bandwidth and a 50-Ω input impedance can be used to observe the amplified pulses. The easiest way to select the pulse amplitude range is to adjust the high voltage on the PMT. Consult the PMT manufacturer's specifications for the allowable voltage on the photmultiplier tube. The high voltage should be adjusted until the largest pulse amplitudes lie just within the linear range of the amplifier output. If the linear range of the amplifier output is exceeded, the pulses will be distorted, and the time resolution will be compromised. Do not exceed the ±5-V limit of the Model 9307 input.

Amplified Pulses with <1-ns Rise Times For microchannel plate PMTs, a fast preamplifier with an output rise time of about 350 ps is typically used to prepare the pulses for the Model 9307 input. To observe these pulses an oscilloscope with a bandwidth ≥4 GHz and a 50-Ω input impedance is required. The simplest method for selecting the range of signal amplitudes is to adjust the high voltage applied to the microchannel plate PMT. Consult the manufacturer's specifications regarding the allowable range of anode voltage. If it is not possible to adjust the anode voltage, high bandwidth attenuators, such as the Hewlett Packard Models HP 8494B and HP 8495B, can be inserted between the microchannelplate PMT output and the input to the fast preamplifier. These attenuators can be adjusted to select the desired range of pulse amplitudes at the preamplifier output. One of the above two methods should be used to adjust the gain so that the largest pulse amplitudes are just less than the linear limit of the preamplifier output. Do not exceed the ±5-V limit of the Model 9307 input.

If a 4-GHz oscilloscope is not available, the pulse amplitude can be increased until a noticeable distortion of the peak in the time spectrum is observed (see section 3.7). This distortion is caused by saturation of the pulses at the preamplifier output. Gradually reduce the pulse amplitudes until the distortion is eliminated.

3.6. THRESHOLD ADJUSTMENT

Function and Range The 10-turn locking dial on the front panel controls the amplitude threshold for accepting input pulses that are allowed to produce a timing output. This threshold is adjustable over the nominal range of -25 mV to -1.0 V. The dial reading is moderately accurate on pulse widths near the 5 ns FWHM limit. On pulse widths approaching the 400 ps limit the actual threshold will be higher than the dial indication due to bandpass limitations in comparator circuits.

Initial Adjustment to Reject Noise The THRESHOLD control is typically used to prevent the Model 9307 from triggering on low-level noise from the signal source. 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 dial is turned counter-clockwise until the output LED glows brightly. Under this condition the Model 9307 is triggering on noise from the detector and preamplifier. Next, the THRESHOLD dial is slowly rotated clockwise, until the LED turns off. Locking the dial at this point will set the threshold just above the detector 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 monitor the counting rate at the Model 9307 TTL output on a counting ratemeter or counter/timer. Connect the TTL output of the Model 9307 to the input of the ratemeter or counter/timer. Note the counting rate produced by the setting in the previous paragraph. Now raise the THRESHOLD to a higher value. Record the THRESHOLD dial reading, the counting rate, and the time resolution in the time spectrum on the multichannel analyzer (Fig. 1.2). Repeat this process for a number of threshold setting and plot the results on graph paper. From the graph, choose a THRESHOLD setting that provides the best compromise between better time resolution and higher counting rate. Lock the THRESHOLD dial at the desired setting.

3.7. ADJUSTING THE SLEWING COMPENSATION

Function and Effect When the SLEWING COMPENSATION is properly adjusted to match the characteristics of the signal from the detector and preamplifier, there will be minimal systematic bias in marking the arrival time of smaller pulses versus larger pulses. If the SLEWING COMPENSATION is adjusted too far in the negative voltage direction, the lower-amplitiude pulses will produce a timing output that arrives too early compared to the arrival of the timing output from the higher-amplitude pulses. If the SLEWING COMPENSATION is adjusted too far in the positive voltage direction, the smaller pulses will generate a timing output that arrives too late compared to the arrival time of the timing output from the larger pulses.

Setting up for the Adjustment The easiest way to optimize the SLEWING COMPENSATION is to set up the complete timing system (e.g., Fig. 1.2). Choose a pulsed source of photons or ions that should generate a timing peak having a FWHM of <100 ps. In other words, the pulsed source of ions or photons must have negligible intrinsic time spread.

Determining the Initial Conditions Record the THRESHOLD setting that will be used for normal operation. Next, set the THRESHOLD control on the Model 9307 as low as possible without triggering on noise (see section 3.6). Measure the SLEWING COMPENSATION setting at the front-panel test points with a voltmeter. The reading should be measured and recorded to the nearest mV. Disconnect the voltmeter and record a time spectrum on the MCA with at least 10,000 counts in the peak height. Observe the shape of the peak on a logarithmic vertical scale. Note the width of the peak and the symmetry of the peak shape, particularly near the base of the peak. If the base of the time peak is skewed towards earlier time, the SLEWING COMPENSATION should be adjusted towards a more positive voltage. If the base of the peak is skewed towards later time, the SLEWING COMPENSATION should be adjusted towards a more negative voltage.

Making the Necessary Adjustments Make the adjustment of the SLEWING COMPENSATION indicated by the results in the previous paragraph. Use the voltmeter to monitor the change. Remove the voltmeter and record another time spectrum.

Observe the effect of the adjustment on the symmetry of the time peak at its base. Make further adjustments in the same manner until satisfactory symmetry and minimum peak width and achieved. Typically, a setting of -12 ±10 mV will be measured when optimum SLEWING COMPENSATION has been achieved.

Asymmetry Intrinsic to the Signal Source Note that the detector or the photon source may have an inherent asymmetry that shows up in the time spectrum. In such cases it will not be possible to achieve perfect peak symmetry with the SLEWING COMPENSATION (see Fig. 1.1, for example). When adjusting the SLEWING COMPENSATION on the Model 9307 it will become obvious which asymmetries in the time peak are affected by the SLEWING COMPENSATION adjustment, and which asymmetries are intrinsic to the detector and pulsed photon source.

Returning to the Operating Conditions Once the desired SLEWING COMPENSATION adjustment has been achieved, record the final voltmeter reading for future reference, and return the THRESHOLD adjustment to the desired operating setting determined in Section 3.6. The Model 9307 is now ready for use.

3.8. LIMITING THE COUNTING RATE TO AVOID SPECTRUM DISTORTION

Typically, the Model 9307 pico-TIMING Discriminator will be used in conjunction with a TIME-to-Amplitude Converter (TAC), as illustrated in Fig. 1.2. Time-to-Amplitude Converters enable the measurement of nanosecond time intervals with picosecond time resolution. To achieve such high resolution one must accept a compromise, because a Time-to-Amplitude Converter can only measure the time interval between pairs of start and stop pulses. In other words, the TAC measures the time interval from the first accepted start pulse to the next stop pulse. It ignores all subsequent start pulses and any additional stop pulses until it has finished converting the first pair of start and stop pulses.

Consider the obviously logical arrangement, where the laser pulse in Fig. 1.2 is the start pulse for the TAC and the detected fluoresced photon generates the stop pulse. (The benefit of reversed start/stop logic will be discussed in the next section.) If the probability of observing a fluoresced photon after each laser pulse is very high, then fluoresced photons emitted late in the decay time scale will often find that the TAC has already responded to a stop pulse from a photon emitted earlier in the decay process. Consequently, the efficiency for recording the shortest decay time intervals will be approximately 100%, while the efficiency for the longer time intervals will be much less than 100%. This causes a distortion of the recorded time spectrum and leads to an error in the measurement of the fluorescence decay time constant.

The distortion of the time spectrum can be made negligible by limiting the counting rate of the detected fluoresced photons. For example, the optical intensity can be restricted so that the probability of detecting a single fluoresced photon after each laser pulse is <0.01 (or <1%). Under these circumstances the probability of observing 2 photons at the detector output for each laser pulse will be $<(0.01)^2$, which is <1% of the single photon rate. This will render the distortion of the time spectrum insignificant. To turn this guideline into a limit on the detected counting rate of photons, it is sufficient to know the repetition rate of the pulsed laser at the sample. For example, a pulsed laser repetition rate of 1 MHZ requires an upper limit on the fluoresced photon counting rate of 10 KHz (i.e., 0.01 x 1 MHZ) to achieve less than 1% distortion of the time spectrum from the lost second-stop pulses.

In general, the limit on the detected photon rate to avoid significant spectrum distortion from lost second-stop pulses with a pulsed excitation source is: Max. Counting Rate ≤0.01 x Source Repetition Rate.

Operating at counting rates below this limit will further reduce the distortion. Note that this limit applies to the start pulse rate when the reversed start/stop logic is used, as described in the next section.

3.9. THE BENEFIT OF REVERSED START/STOP LOGIC

When operating with a pulsed excitation source that has a high repetition rate, the efficiency of data collection can be improved drastically by using reversed start and stop logic. Instead of starting the TAC with the signal from the pulsed source, and stopping the TAC with the detected fluoresced photon, the TAC is started with the fluoresced photon and stopped by a delayed source pulse. This is the scheme actually depicted in Fig. 1.2. The signal from the pulsed excitation source is delayed by approximately 90% of the TAC time range and used as the stop pulse. The fluoresced photon detector provides the start pulse. This results in a time spectrum that is reversed, with shorter times to the right and longer times to the left.

If reversed start/stop logic is NOT used, the TAC spends most of its time converting start pulses without stop pulses. This results in excessive dead time in the TAC and MCA. The TAC and MCA spend most of the time processing signals with no recordable data. The reversed start/stop logic solves this problem. The TAC only starts a conversion on the low rate pulses from the fluoresced photon detector. For each of these start pulses a delayed stop pulse from the pulsed excitation source is guaranteed to occur. With reversed start/stop logic the busy time or dead time of the TAC and ADC is determined by the collection of useful data at a counting rate set by the fluoresced photon detector.

In general, it is best to use the signal with the higher counting rate as the stop input to the TAC.

4. MAINTENANCE AND SERVICE

No regular maintenance is required for the Model 9307, except to remove any collection of dust that might interfere with good electrical insulation and adequate heat dissipation.

In the unlikely event of instrument failure, this unit can be returned to the ORTEC factory for service and repair at a nominal cost. The ORTEC standard procedure for repair ensures the same quality control and checkout that are used for a new instrument. Always contact Customer Service at ORTEC before sending an instrument for repair to obtain shipping 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.

Table 1. Bin/Module Connector Pin Assignments for Standard Nuclear Instrument Modules per DOE/ER-0457T

Pin	Function	Pin	Function
1	+3 V	23	Reserved
2	−3 V	24	Reserved
3	Spare Bus	25	Reserved
4	Reserved Bus	26	Spare
5	Coaxial	27	Spare
6	Coaxial	*28	+24 V
7	Coaxial	*29	−24 V
8	200 V dc	30	Spare Bus
9	Spare	31	Spare
*10	+6 V	32	Spare
*11	−6 V	*33	117 V ac (Hot)
12	Reserved Bus	*34	Power Return Ground
13	Spare	35	Reset (Scaler)
14	Spare	36	Gate
15	Reserved	37	Reset (Auxiliary)
*16	+12 V	38	Coaxial
*17	−12 V	39	Coaxial
18	Spare Bus	40	Coaxial
19	Reserved Bus	*41	117 V ac (Neutral)
20	Spare	*42	High-Quality Ground
21	Spare	G	Ground Guide Pin
22	Reserved		

Pins marked (*) are installed and wired in ORTEC's Model 4001A and 4001C Modular System Bins.