Model 567
Time-to-Amplitude Converter
Single-Channel Analyzer
Operating and Service Manual

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Manual Revision B

Advanced Measurement Technology, Inc.
a/k/a/ ORTEC®, a subsidiary of AMETEK®, Inc.

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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.

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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.

CONTENTS

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.

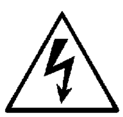
WARNING Indicates a hazard that could result in bodily harm if the safety instruction is not observed.

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.

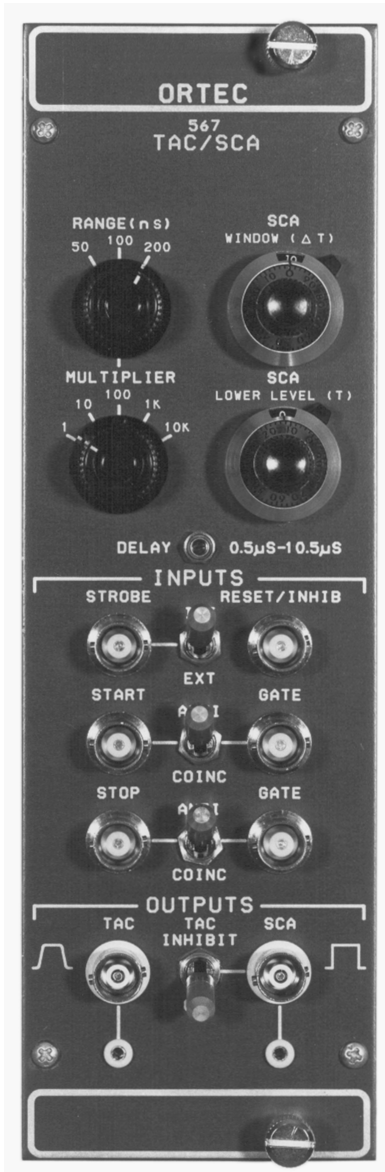
Cleaning Instructions

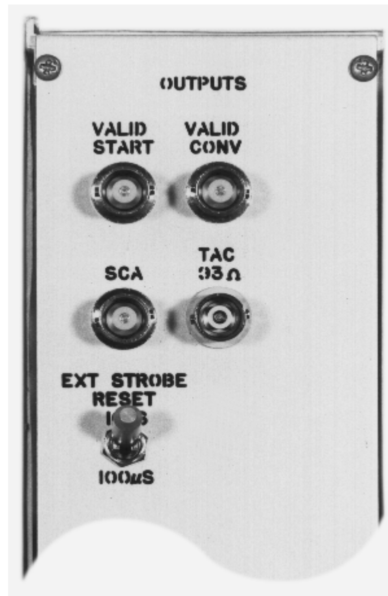
To clean the instrument exterior:

- 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
567
TAC/SCA
RANGE(ns)
50
100
200
SCA
WINDOW (ΔT)
MULTIPLIER
1
10
100
1K
10K
SCA
LOWER LEVEL (T)
DELAY
0.5μS-10.5μS
INPUTS
STROBE
RESET/INHIB
EXT
START
GATE
COINC
STOP
GATE
COINC
OUTPUTS
TAC
TAC
INHIBIT
SCA


OUTPUTS
VALID
START
VALID
CONV
SCA
TAC
93 Ω
EXT STROBE
RESET
100μS

ORTEC MODEL 567 TIME-TO-AMPLITUDE CONVERTER/SCA

1. DESCRIPTION

1.1. PURPOSE AND FEATURES

The ORTEC 567 Time-to-Amplitude Converter/Single-Channel Analyzer (TAC/SCA) measures the time interval between pulses to its start and stop inputs, generates an analog output pulse proportional to the measured time, and provides built-in-single-channel analysis of the analog signal. Additional gating modules are not necessary with this unit, and timing experiments requiring time ranges of 10 ns to 2 ms may be performed with single-channel analysis, giving the experimenter unparalleled flexibility in analyzing random nuclear events that occur within a selected time range. Time ranges from 50 ns to 2 ms are provided via the front panel controls.

Separate gating (anticoincidence or coincidence) of the start and stop inputs eliminates unwanted events from time spectra via externally imposed energy or timing restrictions. The 567 also incorporates a built-in SCA inhibit feature in which a TAC output is available only if the output pulse falls within the window restrictions imposed by the SCA. This feature may be switched in or out by a convenient front panel switch.

In addition to its start and stop gating capabilities, the 567 provides for a pulsed or dc-level Reset/Inhibit signal via a front panel input connector. A Reset/Inhibit input signal terminates the conversion cycle and maintains a reset condition, inhibiting further TAC conversions for the duration of the Reset/Inhibit pulse. A TAC output pulse which is in process at the time a Reset/Inhibit input is received will be completed before converter reset is initiated.

Valid Start and Valid Conversion outputs are provided on the rear panel for each accepted start and stop input respectively. The duration of the Valid Start output indicates the interval from the accepted start until the end of reset. Valid Conversion occurs from the end of the internal delay after stop to the end of reset.

The selectable TAC output width and variable delay, which are easily adjustable, further serve to make the 567 a flexible instrument. The output of the TAC may be synchronized with the stop signal or an external strobe signal to further enhance its versatility.

The SCA section of the 567 allows the experimenter to place very specific time restrictions on the timing spectrum. The SCA is operated in the Window position where the upper-level discriminator setting is added to that of the lower-level discriminator. The SCA output pulse width is equal to the time from the occurrence of the TAC output until the end of the reset pulse or the end of the TAC output. The synchronization of the SCA output with the stop input virtually eliminates any time walk in the SCA output.

All 567 inputs are printed wiring board (PWB) jumper selectable to accept either negative or positive NIM-standard signals. All inputs and outputs are dc-coupled so that changing input count rates will not hinder normal operation of the 567. The TAC output should be connected to the dc-coupled input of a multichannel analyzer (MCA) for optimum high-count-rate performance.

1.2. OPERATION

Start-to-stop time conversion is accomplished only after a valid start has been identified and after a stop pulse has arrived within the selected time range. The start input is disabled during the busy interval to prohibit pileup; the stop input is disabled after the first accepted stop signal. An inhibit/reset circuit permits the operator to abort and cancel a measurement after a true start has been recognized. The input gate for the start circuit can be operated in either an anticoincidence or a coincidence mode.

Time ranges may be switch-selected for full-scale intervals from 50 ns to 2 ms. Each time measurement is analog-stored in a low-loss stretcher amplifier until a linear gate is opened by either an internal or an external strobe. The internal strobe can be obtained from either the start or the stop input pulse and in either case occurs automatically at a selected delay following the reference. An external strobe can be used for a prompt output at the strobe time provided that a time measurement has been completed and reset has not occurred. A rear panel switch can select either 10 or 100 µs after stop for an automatic reset if no strobe has been furnished. If reset occurs before a strobe, no TAC output signal is available. There are two other sources for reset: one occurs if the start-to-stop time interval exceeds the range that is selected and the other occurs as a result of an input pulse through the Reset/Inhibit Logic Input connector on the front panel. The normal setting for the rear panel switch is 100 µs; the 10 µs setting should be used only if the stop-strobe mode is used and the delay is adjusted to minimum, or if the external-strobe mode is used and the strobe will be furnished within the selected interval.

The peak amplitude of the TAC signal is sampled by the SCA at the time of a true-stop input. If the amplitude is within the adjusted acceptance range of the SCA, an SCA logic output is generated. The width of the SCA output is from the start of a TAC linear output to either end of reset or end of linear output; PWB selectable; factory-set at end of reset.

The SCA has a lower-level discriminator that can be adjusted through the full linear range of the TAC signals from 0.05 through 10.05 V. The range for the SCA window discriminator is also 0.05 through 10.05V.

2. SPECIFICATIONS

2.1. PERFORMANCE

Time-to-Amplitude Converter

TIME RESOLUTION FWHM ≤0.01% of full scale plus 5 ps for all ranges.

TEMPERATURE INSTABILITY ≤+0.01%/°C (±100 ppm/°C) of full scale plus 10 ps/°C, 0 to 50°C.

DIFFERENTIAL NONLINEARITY Typically ±1% from 10 ns or 2% of full scale (whichever is greater) to 100% of full scale.

INTEGRAL NONLINEARITY ≤±0.1% from 10 ns or 2% of full scale (whichever is greater) to 100% of full scale.

RESET CYCLE Fixed 1.0 µs for X1 and X10 Multipliers, fixed 5 µs for X100 Multiplier, and fixed 50 µs for X1k and X10k Multipliers. Occurs after Overrange, Strobe cycle, or Ext Strobe Reset cycle.

START-TO-STOP CONVERSION TIME Minimum ≤5 ns.

INPUT COUNT RATE >30 MHz.

Single-Channel Analyzer

THRESHOLD INSTABILITY ≤±0.01%/°C (±100 ppm/°C) of full scale, 0 to 50°C (referenced to +12V NIM bin).

THRESHOLD NONLINEARITY ≤±0.5% of full scale.

2.2. FRONT PANEL CONTROLS

Range (ns) Three-position rotary switch selects full scale time interval of 50, 100, or 200 ns between accepted Start and Stop input signals.

MULTIPLIER Five-position rotary switch extends time range by a multiplying factor of 1, 10, 100, 1k, or 10k.

DELAY 20-turn screwdriver-adjustable potentiometer varies the delay of the TAC and SCA outputs from 0.5 µs to 10.5 µs, relative to an accepted Stop input signal; operable in the Int Strobe mode only.

STROBE MODE Two-position locking toggle switch selects either Internal or External source for initialing the strobe cycle to strobe valid information from the TAC and SCA outputs.

START GATE MODE Two-position locking toggle switch selects Coincidence or Anticoincidence mode of operation for the Start circuitry. Start circuitry is enabled in the Coinc postion or inhibited in the Anti position during the interval of a Start Gate input signal.

STOP GATE MODE Two-position locking toggle switch selects Coincidence or Anticoincidence mode of operation for the Stop circuitry. Stop circuitry is enabled in the Coinc position or inhibited in the Anti position during the interval of a Stop Gate input signal.

SCA WINDOW (≻T) Ten-turn precision locking potentiometer sets the SCA upper-level discriminator threshold from 0.05V to 10.05V above the Lower-Level (T) setting .

SCA LOWER LEVEL (T) Ten-turn precision locking potentiometer sets the SCA lower-level discriminator threshold from 0.05V to 10.05V.

TAC INHIBIT Two-position locking toggle switch. In the Inhibit position the TAC output is available only if the output amplitude is within the SCA window. In the Out position, the SCA has no effect on the TAC output.

2.3. REAR PANEL CONTROLS

EXT STROBE RESET Two-position locking toggle switch allows the converter to be reset nominally 10 µs or 100 µs after an accepted Stop input signal if an Ext Strobe signal has not been received.

2.4. INPUTS

All six front panel inputs listed below are dc-coupled, edge-triggered, and PWB jumper-selectable to accept either negative or positive NIM-standard signals. Input impedance is 50Ω in the negative position and >1 kΩ in the positive position. The threshold is ~-400 mV in the negative and ~+2 V in the positive position.

STROBE Front panel BNC connector provides an external means to strobe a valid output signal from the TAC in the Ext Strobe mode. The input signal, exceeding threshold within the Ext Strobe Reset interval after the Stop input, initiates the read cycle for the linear gate to the TAC output. Factory-set in the positive input position. Ext Strobe Reset interval has minimum value of ~ 0.5 µs and a maximum value of nominally 10 µs or 100 µs Switch-selectable on rear panel.

START Time conversion initiated when Start input signal exceeds threshold. Factory-set in negative input position.

STOP Time conversion terminated when Stop input signal exceeds threshold. Factory-set in negative input position.

RESET/INHIB Terminates conversion cycle and maintains reset condition, inhibiting further TAC conversions for the duration of the reset cycle or the Reset/Inhib pulse, whichever is longer. A TAC output pulse in process at the time of Reset/Inhib signal will be completed before converter reset is initiated. Factory-set in the positive input position.

START GATE Provides an external means of gating the Start circuitry in either Coincidence or Anticoincidence with the Start input signal. Start Gate input signal must cross threshold ≻10 ns prior to the Start input signal and overlap the trigger edge of the signal. Factory-set in the positive input position.

STOP GATE Provides an external means of gating the Stop circuitry in either Coincidence or Anticoincidence with the Stop input signal. Stop Gate input signal must cross threshold ≥10 ns prior to the Stop input signal and overlap the trigger edge of the signal. Factory-set in the positive input position.

2.5. OUTPUTS

TAC Front and rear panel BNC connectors provide unipolar pulse.
Amplitude 0V to +10V proportional to Start/Stop input time difference.
Time End of delay period in Int Strobe mode; prompt with Strobe input in Ext strobe mode.
Width Adjustable by PWB potentiometer from 1 µs to 3 µs.
Impedance Front panel Z, <10Ω; rear panel 93Ω.
Rise Time ~250 ns.
Fall Time ~250 ns

VALID START Rear panel BNC connector provides NIM-standard slow-positive logic level signal.
Amplitude Nominally +5V. Complement signal selectable by PWB jumper.
Time and Width From accepted Start input to end of reset.
Impedance Z ≤10Ω.
Rise Time ≤50 ns
Fall Time ≤50 ns

VALID CONV Rear panel BNC connector provides NIM-standard slow-positive logic level signal to indicate a Valid Conversion.
Amplitude Nominally +5V. Complement signal selectable by PWB jumper.
Time and Width From end of internal delay after Stop to end of reset.
Impedance Z≤10Ω.
Rise Time ≤50 ns.
Fall Time ≤50 ns.

SCA Front and Rear panel connectors provide NIM-standard slow-positive logic level signals.
Amplitude Nominally +5V. Complement signal selectable by PWB jumper.
Time and Width From start of TAC linear output to either end of reset or end of linear output; PWB selectable. Factory-set at end of reset.
Impedance Z, ≤10Ω
Rise Time ≤50 ns.
Fall Time ≤50 ns.

2.6. ELECTRICAL AND MECHANICAL

POWER REQUIRED +24V, 95 mA; -24V, 165 mA; +12V, 210 mA; -12V, 330 mA.

WEIGHT
Net 1.4 kg (3 lb)
Shipping 2.7 kg (6 lb).

DIMENSIONS NIM-standard double-wide module 6.90 x 22.13 cm (2.70 x 8.714 in.) per TID-20893 (Rev).

3. INSTALLATION

3.1. GENERAL

The 567, used in conjunction with a standard NIM bin and power supply such as the ORTEC 4001A/4002A, is intended for rack mounting. Therefore, vacuum tube or other high-temperature equipment operating in the same rack with the 567 must be sufficiently cooled by circulating air to prevent exceeding the 50°C (120°F) maximum operating temperature of the 567. The ORTEC Model M127/N NIMFAN® is available for rack mounting above a NIM bin to provide forced-air cooling.

3.2. CONNECTION TO POWER

The 567 is designed per TID-20893 and accepts its operating power requirements through a mating power connector when it is installed in a standard NIM bin and power supply. As a safety precaution, always turn off the power for the bin before inserting or removing any modules. Monitor the dc voltages at the test points on the control panel of the bin after all modules have been installed and the power is turned on in order to determine that none of the dc voltages have been reduced by an overload.

3.3. CONNECTION INTO A SYSTEM

The 567 can accept both start and stop pulses from NIM modules that furnish NIM-standard positive and fast-negative logic signals or from the timing output of a photomultiplier tube base. The input impedance of 567 inputs depends on the selected polarity. Inputs set for negative signals will have a built-in 50Ω terminating impedance, whereas inputs set for positive signals will have a nominal 1 kΩ terminating impedance. Inputs that are factory-set for negative signals include Start and Stop, and 50Ω coaxial cable is recommended for proper connection to these inputs. Inputs that are factory-set for positive signals include Strobe, Reset/Inhib, Start Gate, and Stop Gate, and these need to be externally terminated with the same characteristic impedance of the cable used only if reflections are present. For instructions on changing inputs to accept a different polarity, refer to Section 3.5.

No input or output connectors need be terminated when they are not in use.

In any experiment in which it is reasonable to assume that the count rates for start and stop will be equal or nearly equal, use the signal furnished from the origin of events into the start input and the signal furnished from the response into the stop input. The 567 will then measure the time difference (T) from origin to response and furnish an output amplitude that is some fraction of the selected full-scale amplitude, proportional to the ratio of T, to the selected full-scale time range.

In any experiment in which the two count rates differ noticeably, such as one in which fewer responses than event origins can be expected, use the lower count rate as the start input to the 567. This assures that the 567 dead time will be minimized because it analyzes the time difference only after a start signal is accepted. When the response is used as a start signal, furnish the signals from the origin of events through a delay line into the stop input, and adjust the delay to match the selected full-scale time of the 567. At each start input signal the 567 will analyze the time until its related origin signal is furnished to the stop input. The time measured is then delay time minus T, and produces a so-called inverted time spectrum. The purpose of this type of system connection is to reduce the number of conversions and the corresponding dead time during the experiment. For each signal accepted through the start input there must be a conversion, but for each signal through the stop input there need not be a conversion. For each start signal that is not followed by a stop signal within the selected time full range, the converter measures a time equal to the total range, even though no output pulse is generated.

3.4. LINEAR OUTPUT SIGNAL CONNECTIONS AND TERMINATING IMPEDANCE

The source impedance of the standard TAC output with the 0 to 10V linear range is about 1Ω through the connector on the front panel and 93Ω through the connector on the rear panel.

For the front panel circuit, the interconnection to other modules does not usually require any special considerations, especially if the interconnecting cable is shorter than 4-ft in length. Paralleling several loads on a single output will still not reduce the 0 to 10V signal span significantly unless the combined load is <100Ω.

The rear panel TAC output circuit is designed for use of 93Ω cable to transfer the signals into a measuring circuit that has an input impedance of at least 1000Ω. With this series impedance-matched circuit connection, there will usually not be any interference with the signal. If oscillations should occur, it will be necessary to provide an additional shunt termination of 100Ω in parallel with the input circuit of the receiving instrument, but this will result in ~50% loss of signal amplitude.

As with any analog instrument, oscillations may be observed occasionally when unterminated lengths of cable are used. Short cable lengths (up to 4ft) need not be terminated. When longer cable lengths are required for transfer of a linear signal, the cable should be terminated in a resistive load equal to the cable impedance to prevent reflections and oscillations in the cable. Oscillation suppression can be effected by either a series termination at the sending end of the cable or by a shunt termination at the receiving end. For convenience a BNC tee can usually accommodate both the cable and a mating terminator at the input of the receiving instrument. These units are available commercially, including BNC terminators with nominal values of 50,100, and 1000Ω. Ortec stocks a limited quantity of all but the 1000Ω terminators for your convenience, as listed below:

BNC Tee Connector	C-29
50Ω Terminator	C-28
100Ω Terminator	C-27

When a shunt termination at the receiving end of the cable is impractical, consider series termination at the sending end. For a series termination the full signal amplitude span is available at the receiving end only if the input impedance is many times the characteristic impedance of the cable. For series termination install the correct resistance between the actual amplifier output on the etched circuit board and the output connector. Effectively, the terminating resistance is in series with the input impedance of the receiving instrument, and may result in some loss in signal amplitude. For example, if the series terminator is 93Ω and the driven load is 900Ω, the available signal span will be only about 90% of the maximum signal amplitude for each pulse. The termination of a 93Ω cable in a 93Ω load will cause ~50% loss for the signal.

3.5. CHANGING INPUT POLARITIES

All six input circuits are jumper-selectable to accept NIM-standard positive or negative pulses. Inputs set for negative signals will have a built-in 50Ω terminating impedance, and inputs set for positive signals will have a nominal 1kΩ terminating impedance. Factory settings (listed in Section 2.4) may be changed or checked by the following procedure:

1. Turn off NIM bin power switch and remove 567 from NIM bin.

2. Remove the right-side (from front view of module) cover by removing the four small fastening screws.

3. Refer to the following table to identify the label of the desired input jumper to be changed on the 567.

Input	Polarity Jumper Label
Start	ST
Stop	SP
Start Gate	STG
Stop Gate	SPG
Reset/Inhibit	RS
Ext/Strobe	STA

4. Refer to Fig. 1 to locate the jumper to be changed on the 567.

5. Using a pair of pliers, remove the small blue jumper selected and reconnect it as shown in Fig. 1 for either positive or negative polarity.

6. Reinstall side Cover.

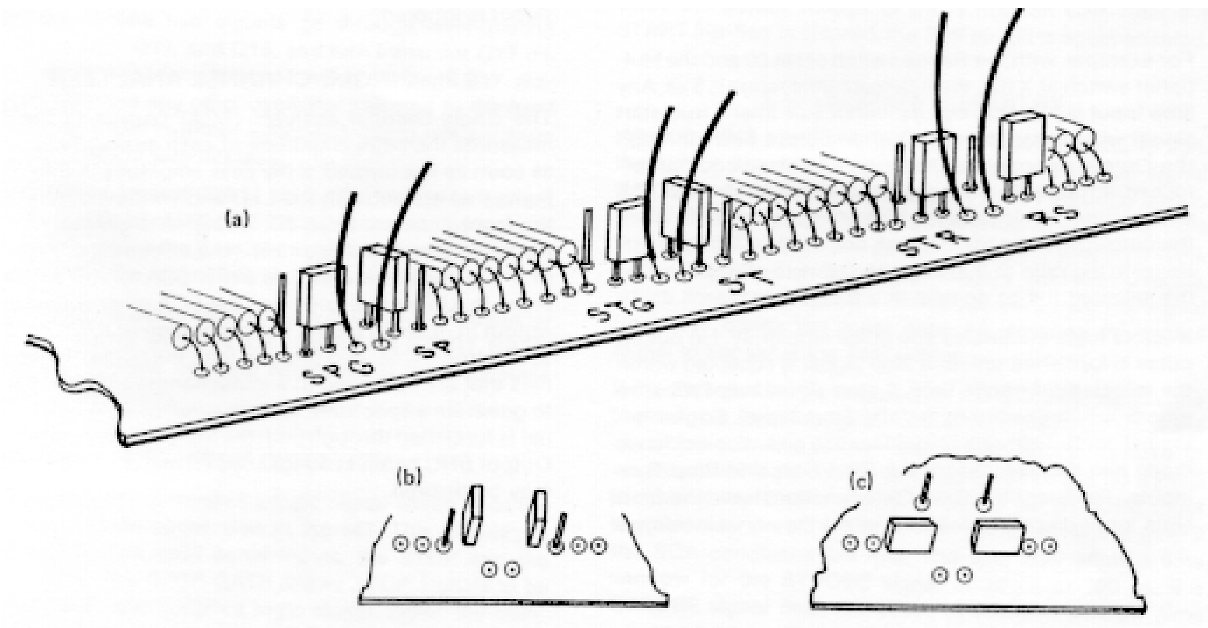


Fig. 1. Input Polarity Jumper Selection for (a) Factory-Set Input Positions, (b) Inputs Set in Negative Position, and (c) Input Set in Positive Position.

4. OPERATING INSTRUCTIONS

4.1. TIME-TO-AMPLITUDE CONVERSION

There are nine front panel controls on the 567. Of these, four are directly associated with the conversion of a start-to-stop interval into an analog equivalent TAC output pulse. These controls are Range ns, Multiplier, TAC output Delay, and Anti/Coinc. If the SCA inhibit switch is set at In, this also affects the generation of a TAC output.

The Range (ns) and Multiplier switches determine the full scale limit for time conversion. Any of 15 combinations may be selected as follows:

Switch Settings		
Range (ns)	Multiplier	Full-Scale Time Limit
50	x1	50 ns
100	x1	100 ns
200	x1	200 ns
50	x10	500 ns
100	x10	1 µs
200	x10	2 µs
50	x100	5 µs
100	x100	10 µs
200	x100	20 µs
50	x1k	50 µs
100	x1k	0.1 ms
200	x1k	0.2 ms
50	x10k	0.5 ms
100	x10k	1 ms
200	x10k	2 ms

For example, with the Range switch set at 50 and the Multiplier switch at X100, the full-scale time range is 5 µs. Any stop input signal that occurs within 5 µs after a true-start signal will initiate the gating of an output pulse through the Output connector. The output pulse will not be furnished through this connector unless it is strobed. The strobe condition is selected by a front panel switch. When the output does occur, its peak amplitude will be proportional to the ratio of the measured start-to-stop interval to the selected full-scale time in a 0 to 10V range.

Internal logic eliminates any pulse ambiguity. No output pulse is furnished unless a stop signal is accepted within the selected full-range time. A stop signal is not effective unless it is preceded by a Valid Start signal. For further logical control either a coincidence or an anticoincidence mode can be selected for the Start Gate and Stop Gate inputs. To defeat the Start Gate function, leave the Start Gate input disconnected and select the anticoincidence position of the Start Gate Mode switch. If the start gate signal is applied in the anticoincidence mode, start pulses will be blocked during the start gate signal. Anticoincidence gating will function in the same manner when controlling the Start or Stop Gate input.

For coincidence gating of the Start or Stop input circuit set the Start Gate or Stop Gate Mode switch to Coincidence and furnish an appropriate polarity gate signal through the Start or Stop Gate input connector when Start signals are to be accepted.

If a signal is furnished through the Inhibit/Reset connector on the front panel, any time measurement that may be in process will be aborted and no new measurement can begin until the inhibit/reset signal is removed. To be effective, the inhibit/reset signal must precede an output strobe time.

The rear panel Strobe External switch selects the source for the strobe signal for the TAC output. When the switch is set at Ext, an input pulse must be furnished through the adjacent BNC connector and the TAC output signal is strobed promptly at the external signal time.

The timing of an external strobe input signal must be within the switch-selected interval, 10 or 100 µs, after the true-stop pulse for the measurement. If the strobe is furnished prior to stop, the signal is not accepted. In the case of a strobe pulse failing to arrive within the selected interval after stop, the 567 will have been automatically reset internally, so there is no available output and the strobe signal is ignored.

4.2. SINGLE-CHANNEL ANALYZER

The single-channel analyzer (SCA) portion of the 567 measures the peak amplitude of each analog TAC pulse as soon as it is formed. If the peak amplitude is within the limits that are set with the LLD and Window controls on the front panel, an SCA output signal is generated. The signal can be used to control the subsequent generation of a TAC output if the front panel SCA Inhibit switch is set at In. Under this condition the SCA must generate an output in order to permit the generation of a TAC output at its strobe time, and this can limit the range of time signals that are furnished to a multichannel analyzer (MCA) to generate a spectrum. An independent SCA output signal is furnished through both the front and rear panel SCA Output BNC connectors for any external applications that may be desired.

5. MAINTENANCE

5.1. TESTING PERFORMANCE

The following test procedures are furnished as a guide during installation and checkout of the 567 TAC/SCA.

TEST EQUIPMENT The following test equipment is recommended. Each test procedure refers to this list by the unit identification number for the required item(s) of test equipment. An equivalent unit may be substituted for any item in the list, providing that it furnishes the function required for each specific application.

1. Hewlett-Packard 215A Pulse Generator
2. ORTEC 436 100 MHz Dicriminator
3. ORTEC 416A Gate and Delay Generator
4. ORTEC 425A Nanosecond Delay
5. Photomultiplier tube with scintillator and radiation source
6. ORTEC 449 Log/Lin Ratemeter
7. Tektronix Type 475 Oscilloscope
8. ORTEC 7100, 7150, 7450 Multichannel Analyzer or 918 Multichannel Buffer
9. ORTEC 414A Fast Coincidence
10. ORTEC 444 Gated Biased Amplifier

PRELIMINARY PROCEDURES Take the following preliminary steps when the 567 is installed.

1. Check the module visually for possible damage
2. With the power turned off, install the 567 into a NIM-standard bin and power supply such as the ORTEC 4001A/4002A.
3. Check the installation for proper mechanical alignment.
4. Switch on ac power and check the dc power voltage levels at test points on the 4001A.

BASIC SWITCH SETTINGS Set the 567 controls as follows:

Range	50 ns
Multiplier	1
Window	10 (fully clockwise)
LLD	0 (fully counterclockwise)
TAC Inhibit	Out
Logic Input	Anti Coinc
Ext. Strobe	100 µs

CONVERSION TESTS Use the typical test setup shown in Fig. 2 and supply a start and stop pair of input signals with known time difference into the 567. Observe the TAC output. Then use the following procedures:

1. Adjust the delay for the stop input to 50 ns.
2. Check to see that the full-scale time range is 50 ns.
3. Measure the signal through the TAC Output connector. It should be about 10V for a 50 ns delay or 5V for a 25 ns delay.
4. Turn the Range ns switch through its 50, 100, and 200 settings and observe the pulse amplitude at each setting; each successive switch position should decrease the pulse amplitude to about ½ of the amplitude for the previous setting.
5. Return the Range ns switch to 50 and set the Multiplier switch at 10. The output amplitude should be reduced to about 1/10 of the reading for step 3.

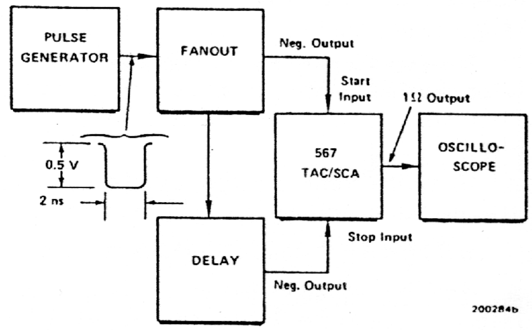


Fig. 2. Test System for Checking Conversion.

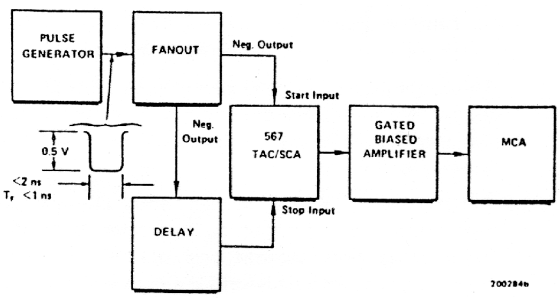


Fig. 3. Test Systems for checking Converter Resolution.

RESOLUTION TESTS See Fig. 3 for the typical test setup used for resolution checks. The start and stop pulses used for this test must have fast rise time and be jitter-free. The minimum delay recommended for the stop pulses is 15 ns. The resolution of any scale can be measured with this setup, and the main consideration is that each stop signal delay be within the linear region of the selected time range. The testing procedure consists of the following:

1. Adjust the delay for the stop input to basic setting of 30% to 80% of the selected time range.

2. Operate the system and obtain a timing spectrum. Normalize the output amplitude full range for the normally digitized full range of the ADC in the analyzer.

3. After you have accumulated an adequate spectrum to assure statistical accuracy of photopeak measurements (~1000 counts in the peak channel), identify the peak channel number and measure the FWHM channel number limits. Log for reference.

4. Increase the delay for the stop signal by a fixed and known amount. This may be done by switching in a fixed delay line cable (ORTEC 425A) or by careful adjustment of the delay unit controls. The total delay for the stop signal must still be <100% of the selected time full range.

5. Accumulate a spectrum for this measurement of increased time intervals.

6. Observe the relocated photopeak in the timing spectrum and record its peak channel number and its FWHM channel number limits.

7. Subtract the peak channel number in step 3 from the peak channel number in step 6. This is the number of channels that represents the time variation injected at step 4.

8. Using the formula below, calculate time resolution effective for the established system calibration:
   >t per channel = stop delay increase : channel shift

9. With the equation below, calculate the converter resolution using the FWHM channel width from either step 3 or step 7. These widths should be the same at either peak location.

Time resolution (FWHM) = FWHM channel width
x>t per channel.

This resolution is affected adversely by any jitter that may be present in the discriminator and by the resolution of the amplifier. Allowances should be made for these contributions.

COUNT RATE TESTS In many applications it is important for a time-to-amplitude converter to handle high count rates, both external and internal. Since the start input is gated internally and the conversion circuits are all direct-coupled, the limit for its external count rate capability is determined solely by the input pulse width, and there are no pileup effects. The limit on the internal count rate is imposed by the conversion and reset process, where the start input is disabled through a converter busy interval following each accepted start signal. A converter busy interval is the measured time plus 1 µs for start- stop intervals within the selected time range for X1 and X10 multiplier, 5 µs for X100, and 50 µs for X1k and 10k multipliers.

The following test, based on the system connection shown in Fig. 4, permits accumulation of a basic timing spectrum for the start-stop input pulses at 60 Hz. As the external count rate for start only is increased by regulating the random pulse generator, the internal pulse rate in the 567 is increased, and a ratemeter will monitor the resulting rate at which the internal capability is impaired.

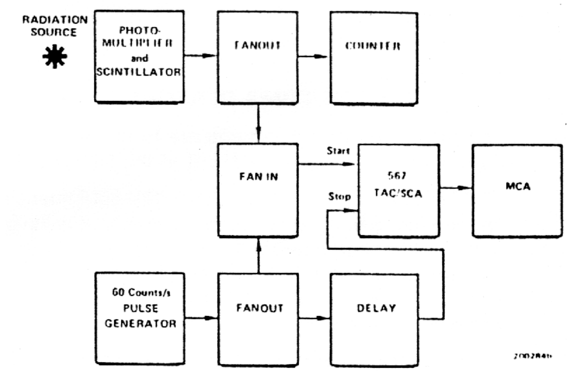


Fig. 4. Test system for Checking Count Rate.

1. The photomultiplier may be used as a random pulse generator, triggered by a radiation source. Use an initial sensitivity setting above the energy level for a zero output pulse rate.

2. Adjust the delay for the stop input to ~0.4 µs.

3. Select the 0.5 µs time range with the 567.

4. Adjust the system for a timing spectrum accumulated for the 60-Hz input pulses.

5. Decrease the threshold of the discriminator to generate random start signals with no corresponding stop signals. Monitor the random rate with the ratemeter.

6. Observe the timing spectrum as the random input rate is gradually increased. Watch for interference in the accumulated spectrum.

DIFFERENTIAL LINEARITY MEASUREMENTS A system for testing differential linearity of the 567 is shown in the block diagram in Fig. 5. In this system the random pulse generator is used as the source for start signals, and a pulse generator with a fixed rate is used for stop signals. The measurable time interval between a start and stop is a random value, with equal probability that it will be any time difference up to the periods between the regular stop signals. For an infinite number of 567 outputs the count levels for each channel of the MCA should be equal. After the test has been run long enough to assure statistical accuracy (e.g., >25,000 counts/channel), the spectrum should be similar to those illustrated in Fig. 6. Any deviation from a straight line represents a differential nonlinearity, and the percent of deviation is the difference between this count level and the average divided by the average count level.

1. Select the 567 time range to be tested.

2. Calculate the maximum stop pulse repetition rate for the selected time range. This should be slightly lower than the reciprocal of the time range. For example, for the 1 µs time range the reciprocal is 1×10^6, and a pulse generator rate of 4 to 5 times 10^6 should be satisfactory. A lower rate increases the time required to run the test, while a faster rate will reduce the window level response because of MCA dead time.

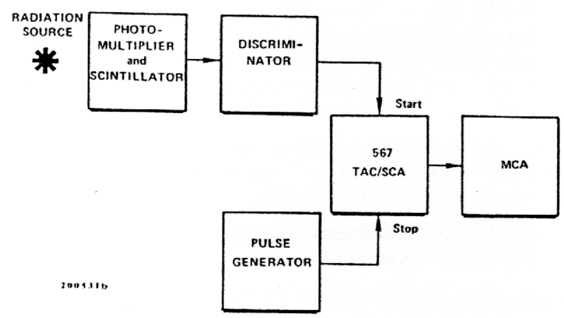


Fig. 5. Test System for Checking Differential Linearity.

3. Operate the system and monitor the dead-time meter on the MCA. Regulate the random start rate to cause the MCA dead time to be ~10%.

4. Clear the analyzer to zero and operate the system until the average count level stored in each channel is sufficient to ensure statistical accuracy.
5. Compare any nonlinearity indications to the specifications listed in Section 2. Some nonlinearity can be expected in channels in the lower 5% of the MCA range as shown in Fig. 6 because of the stop pulse width and the TAC gating time.

CHECKING EXTERNAL STROBING MODE The system for checking the external strobing mode is shown in Fig. 7. This system can be used to verify the principles of operation of the 567.

1. Set the delay for the stop signal at about 400 ns.

2. Set the 567 time range for 500 ns.

3. Use the internal strobe mode for the 567. Adjust the oscilloscope sweep as required to identify the TAC output pulses.

4. Adjust the delay for the strobe signal >500 ns to ensure that it will occur later than the full time range.

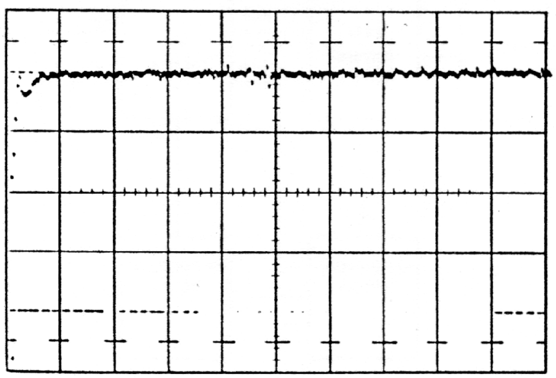
5. Switch the 567 to its external strobe mode and observe the TAC output pulse. It should be identical to the pulse observed in step 3 except for the time at which it occurs.

6. Vary the strobe delay and observe that there is no change in the TAC output amplitude but that the output delay follows the strobe delay.

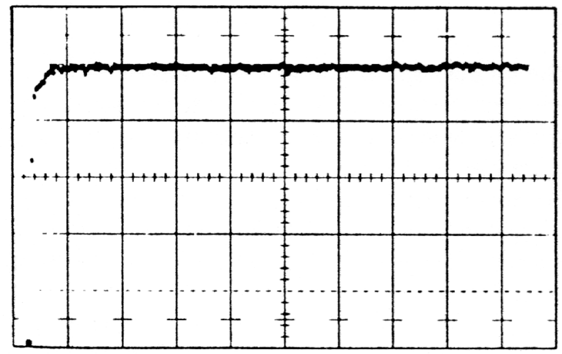
TESTING THE SINGLE-CHANNEL ANALYZER
The SCA can be tested by the following procedure:

1. Use the circuit shown in Fig. 2. Select a convenient time range and adjust the stop delay to obtain an output of ~5V through the TAC Output connector.

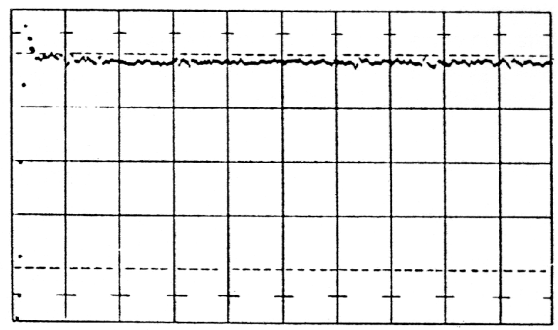
2. Set the lower-level discriminator dial at 4.0 and the window-level discriminator dial at 2.0. Change the stop delay to change the TAC output pulse amplitude from 3V to 7V. Note that the SCA output pulse is present only when the TAC output amplitude is within the range of 4 to 6V.



Range = .1 }
Multiplier = X1 } 100
(Vert) : Full Scale 5 x 10^4 counts
(Horiz) : Full Scale = 105% range



Range = .1 }
Multiplier = X1 } 100ns
(Vert): Full Scale 5 x 10^4 counts
(Horiz): Full Scale = 105% range



Range = .1 }
Multiplier = x100 } 1µs
(Vert): Full Scale = 5 x 10^4 counts
(Horiz): Full Scale = 105% range

Fig. 6. Differential Linearity for the Indicated Ranges.

5.2. CORRECTIVE MAINTENANCE

Clean the surfaces of the printed circuits, the connectors, and all chassis parts periodically to prevent accumulated dust from forming leakage paths between the circuit components.

If the instrument is suspected of malfunctioning, use the performance tests of Section 5.1 to aid verification. When incorrect operation is identified, disconnect the 567 from its position in the system and perform routine diagnostic tests with a pulse generator and an oscilloscope. Use the timing chart in Fig. 7 to isolate the problem, and use schematic diagram 678890 at the back of this manual to localize the malfunctioning.

CALIBRATION Three critical calibrations that may need to be made are described:

Output Offset Calibration Potentiometer R223, located on the printed wiring board (PWB), adjusts the dc offset voltage of the TAC output over a ±85 mV range. To calibrate the output offset, connect power to the 567 with no input signal connections. While monitoring the dc voltage at the TAC output, adjust R223 to obtain 0 V dc.

Conversion Current Calibration This calibration affects the conversion gain of the TAC circuitry. To calibrate the conversion gain of the 567, set up the circuit as shown in Fig. 2, and follow the setup procedures outlined in steps 1 through 3 of Section 5.1, "Conversion Tests."

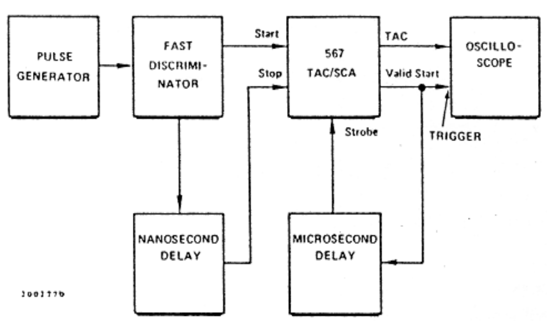


Fig. 7. Test System for Checking External Strobing Mode.

1. Adjust PWB-mounted potentiometer R128 fully counterclockwise. A TAC output pulse of ~8.5 to 9.8V should be present at the TAC output.

2. Adjust R128 clockwise until the output pulse reaches +10V and begins to half-fire.

3. Turn R128 slightly in the counterclockwise direction until the TAC output is solid or full-firing.

Output Width Adjustment Leave the system connected as described above. TAC output pulse width may be adjusted over a range of 1 to 3 µs via PWB-mounted potentiometer R163. Factory-adjusted width is nominally 2 µs.

5.3. FACTORY REPAIR

This instrument 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 the Customer Service Department at ORTEC, (865) 483-2231, before sending in an instrument for repair to obtain shipping instructions and so that the required Return Authorization Number can be assigned to the unit. Write this number on the address label and on the package to ensure prompt attention when it reaches the ORTEC factory.

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.