Model 414A
Fast Coincidence Operating and Service Manual

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Advanced Measurement Technology, Inc.

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

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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.

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.

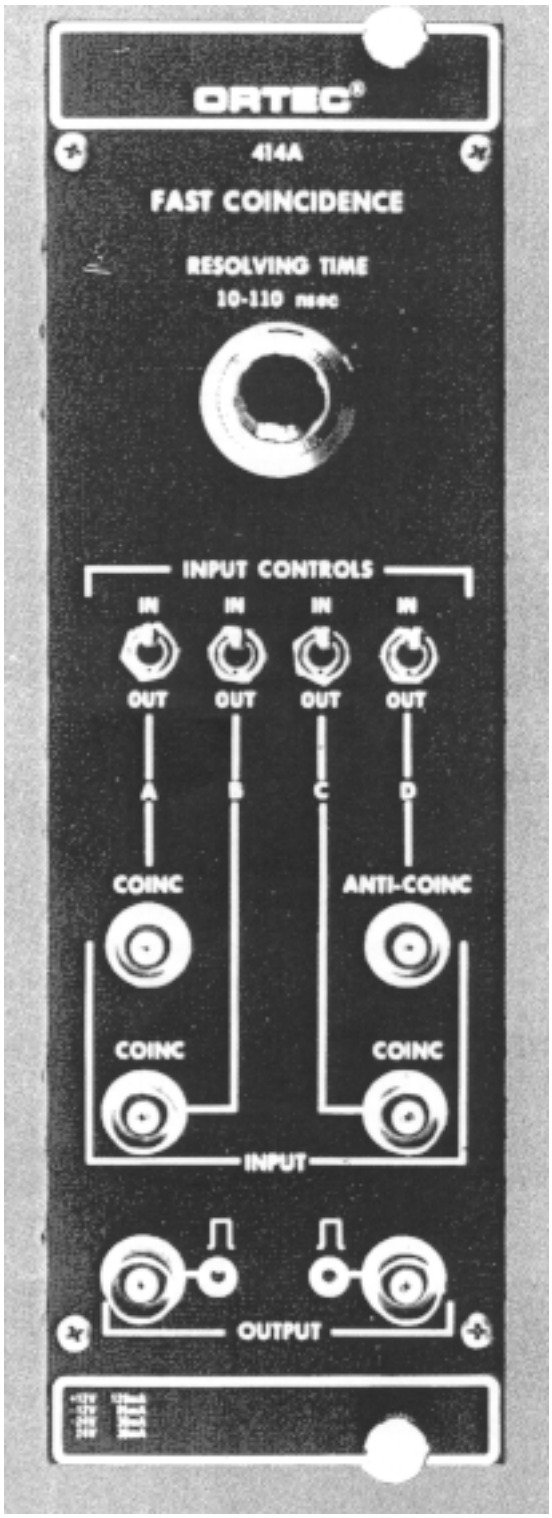
Cleaning Instructions

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®
414A
FAST COINCIDENCE
RESOLVING TIME
10-110 nsec
INPUT CONTROLS
IN
IN
IN
IN
OUT
OUT
OUT
OUT
A
B
C
D
COINC
ANTI-COINC
COINC
COINC
INPUT
OUTPUT

ORTEC 414A FAST COINCIDENCE

1. DESCRIPTION

The 414A Fast Coincidence allows fast coincidence determination between any two or three input signals. A dc-coupled anticoincidence input is provided to inhibit the coincidence output. The coincidence output can be inhibited by a dc voltage or a pulse that overlaps the period of coincidence of the coincident pulses. The resolving time (2τ) of the Fast Coincidence unit may be varied over a 10 to 110 ns range by a 10-turn control for accurate resettability of the resolving time. All four inputs are controlled by In/Out toggle switches. Input signal requirements are compatible with NIM slow positive logic output signals of a variety of ORTEC timing equipment. The output pulse is suitable as an input to the 418A Universal Coincidence module and other modules of the ORTEC 400 Series requiring a logic input pulse. The module obtains the necessary operating power from an ORTEC 4001/4002 Series Bin and Power Supply. The output signal and all signal inputs use front panel BNC connectors.

The instrument is designed to meet the recommended interchangeability standards outlined in DOE Report TID-20893 (Rev). An ORTEC 4001/4002 Bin and Power Supply provides all necessary power through the rear module connector. All signal levels and impedances are compatible with other modules in the ORTEC 400 Series.

The 414A is basically a threefold AND circuit, with each input to the AND circuit regenerated, or reshaped, to a standardized waveform in passing from the input connector to the actual AND circuit. The general connotation of the word “fast” tends to be in terms of elapsed time or speed, but in this instrument the term “fast” is actually intended to indicate the general nature of the coincidence circuit; that is, the input pulses are reshaped and the actual coincidence determination is made on the leading edge, or leading portion, of the input pulses.

The three coincidence inputs to the 414A feed into identical but separate shaper circuits. The shaper circuit contains a voltage limiter to allow a wide dynamic range of input pulse amplitudes. The output of the limiter feeds into a regeneration circuit, where a standard pulse is generated for each input pulse regardless of the actual waveform of the input signal. This standard pulse is then fed into the resolving time network, where it is reshaped to satisfy the 2τ resolving time selected via the front panel Resolving Time control. The outputs of the three resolving time networks are fed in parallel to an “overlap” coincidence network, that is, an AND network. When portions of the reshaped input pulses overlap each other, the AND circuit recognizes a coincidence event within the resolving time set on the front panel Resolving Time control and produces an output. The coincidence recognition output from the AND circuit may be inhibited by a signal from the anticoincidence input. This inhibit signal may be a pulse or a dc voltage since the anticoincidence circuit is dc-coupled. The inhibit period is determined by the width of the input pulse. If the output from the AND circuit is not blocked by the anticoincidence circuit, it is regenerated into a standard output signal from the 414A, indicating that coincidence event has been detected.

The coincidence inputs are controlled by front panel toggle switches, which permit selection of one-, two-, or threefold coincidence. A switch is also provided for the anticoincidence input. These switches allow each input to be disabled without the associated coaxial cable having to be removed.

2. SPECIFICATIONS

2.1. PERFORMANCE

PULSE PAIR RESOLUTION <100 ns on any signal input; for coincidence events <1µs on the coincidence output.

RESOLVING TIME (2τ) Continuously variable from 10 to 110 ns for coincidence signals; set by the width of the input pulse for the anticoincidence signal.

TEMPERATURE INSTABILITY 2τ changes <0.2%/°C, 0 to 50°C.

2.2. CONTROLS

RESOLVING TIME, 10-110 ns Front-panel 10-turn potentiometer for controlling resolving time for inputs A, B, and C over a range of 10 to 110 ns.

IN/OUT Toggle switches for using any input combination desired and for disabling input signals to the coincidence and anticoincidence circuits without input coaxial cables having to be removed.

2.3. INPUTS

COINC Front panel BNC connectors provide 3 ac-coupled coincidence inputs (A,B,C) of positive polarity; 2V threshold, 20 ns minimum width required; absolute maximum input 50V; impedance >3000 Ω.

ANTICOINC Front panel BNC connectors provides one dc-coupled anticoincidence input, (D), for inhibiting coincidence output; +2V threshold, 20 ns minimum width required; absolute maximum input 50V; impedance >3000 Ω.

2.4. OUTPUTS

OUTPUTS Two separate buffered coincidence output signals through BNC connectors on front panel provide positive pulses ≥500 ns wide with 5V minimum amplitude; ac-coupled with <10Ω impedance; monitored through oscilloscope test points on front panel.

2.5. ELECTRICAL AND MECHANICAL

POWER REQUIRED +24V, 30mA; –24V, 30mA; +12V, 120mA; –12V, 85mA.

WEIGHT
Net 1.09 kg (2.4 lb)
Shipping 2.0 kg (4.4 lb).

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

3. INSTALLATION

3.1. GENERAL INSTALLATION CONSIDERATIONS

The 414A contains no internal power supply but is used in conjunction with a 4001/4002 Series bin and power supply, which is intended for rack mounting. Therefore, if vacuum tube equipment is operated in the same rack, there must be sufficient cooling air circulating to prevent any localized heating of the all-transistor circuitry used throughout the 414A. The temperature of equipment mounted in racks can easily exceed the recommended maximum unless precautions are taken; the 414A should not be subjected to temperatures in excess of 120°F (50°C).

3.2. CONNECTION TO POWER

Turn off the bin power supply when inserting or removing modules. The ORTEC 400 Series is designed so that it is not possible to overload the bin power supply with a full complement of modules in the bin. Since, however, this may not be true when the bin contains modules other than those of ORTEC design, the power supply voltages should be checked after the modules are inserted. The 4001/4002 has test points on the power supply control panel to monitor the dc voltages.

3.3. LOGIC INPUTS TO THE FAST COINCIDENCE

The input pulses to the Fast Coincidence unit may come from any source of logic pulses. The input impedance of the Fast Coincidence is >3000Ω, and some care must be given to ensure that reflections in the driving transmission cable do not occur.

There are three general methods of termination that are used. The simplest of these is shunt termination at the receiving end of the cable. A second method is series termination at the sending end. The third is a combination of series and shunt termination, where the cable impedance is matched both in series at the sending end and in shunt at the receiving end. The most effective method is the combination, but termination by this method reduces the amount of signal strength at the receiving end to 50% of that which is available in the sending instrument.

To use shunt termination at the receiving end of the cable, connect the 1Ω output of the sending device through 93Ω cable to the input of the receiving instrument. Then use a BNC tee connector to accept both the interconnecting cable and a 100 Ω resistive terminator at the input connector of the receiving instrument. Since the input impedance of the receiving instrument is normally 1000Ω or more, terminator will be of the order of 93Ω, and this correctly matches the cable impedance.

For series termination, use the 93Ω output of the sending instrument for the cable connection. Use 93Ω cable to interconnect this into the input of the receiving instrument. The 1000Ω (or more) normal input impedance at the input connector represents an essentially open circuit, and the series impedance in the sending instrument now provides the proper termination for the cable.

For the combination of series and shunt termination, use the 93Ω output in the sending instrument for the cable connection and use 93 Ω cable. At the input for the receiving instrument, use a BNC tee to accept both the interconnecting cable and a 100 Ω resistive terminator. Note that the signal span at the receiving end of this type of receiving circuit will always be reduced to 50% of the signal span furnished by the sending instrument.

For customer convenience, ORTEC stocks the proper terminators and BNC tees, or you can obtain them from a variety of commercial sources.

4. OPERATING INSTRUCTIONS

4.1. FRONT PANEL CONTROLS

IN/OUT Toggle switches which allow the input signals to the coincidence and anticoincidence circuits to be disabled without the input coaxial cables having to be removed. The circuit may be effectively changed to either a onefold, twofold, or threefold coincidence circuit, as desired, by operating these switches.

RESOLVING TIME 10-turn potentiometer which determines the 2τ resolving time of the coincidence circuit; resolving time is variable from 10 to 110 ns.

4.2. TESTING AND OBSERVATION OF WAVEFORMS

Refer to Sections 6.1 and 6.2 for information on testing performance and observing waveforms.

4.3. CONNECTOR DATA

INPUTS A, B, AND C The coincidence Inputs A,B, and C are BNC connectors providing ac-coupled coincidence inputs. Input impedance is >3000Ω. A positive 2V pulse with 20 ns minimum width is required. To minimize reflections when driving from a low impedance source into these connectors, a terminator equal to the characteristic impedance of the driving cable should be shunted from this connector to ground.

INPUT D The anticoincidence Input D is a BNC connector providing a dc-coupled anticoincidence input. Input impedance is >3000Ω. A positive 2V pulse with 20 ns minimum width is required; longer pulse durations, to dc, are acceptable and determine the anticoincidence control period. To minimize reflections when driving from a low impedance source into this connector, a terminator

equal to the characteristic impedance of the driving cable should be shunted from this connector to ground.

OUTPUTS Two separate, buffered coincidence output signals are provided on BNC connectors. These signals are >5 V in amplitude and are 500 ns wide. The outputs are ac-coupled with <10Ω output impedance.

COINCIDENCE OUTPUT TEST POINTS (TP1 AND TP2) These oscilloscope test points are for monitoring signals on each coincidence Output BNC connector, to which they are connected by a 470 Ω series resistor.

POWER CONNECTOR The Nuclear-standard module power connector is an AMP 202515-5.

4.4. TYPICAL OPERATING CONSIDERATIONS

The Fast Coincidence circuit measures coincidence from the leading edge, or leading portion, of the input wave-form. The input signals are reshaped to a standard pulse width from the leading edge. Figures 4.1 and 4.2 illustrate that the input pulses can actually overlap in time but not satisfy the coincidence requirements as dictated by the front panel Resolving Time control.

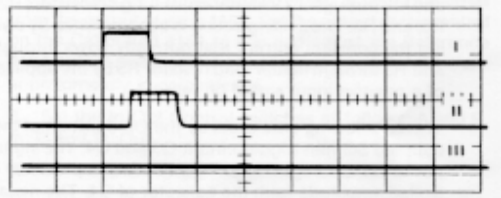


Fig. 4.1. Illustration of Actual Overlapping of Input Pulses I and II, but Not During the Leading-Edge Resolving Time; Trace III Illustrates No Output Pulse.

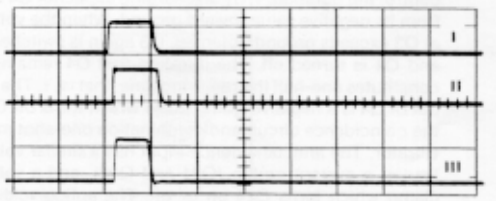


Fig. 4.2. Illustration of Input Pulses I and II Overlapping During the Leading-Edge Resolving Time and Producing Output Pulse III.

5. MAINTENANCE

5.1. TESTING PERFORMANCE

The following paragraphs are intended as aids in the installation and checkout of the 414A. These instructions present information on front panel controls, waveforms, at test points, and output connectors. The following, or equivalent, test equipment is needed:

ORTEC 419 Precision Pulse Generator
Tektronix Model 475 or 485 Oscilloscope or equivalent
100 Ω BNC terminators
Vacuum tube voltmeter
ORTEC 450 Research Amplifier
Two ORTEC 416A Gate and Delay Generators
Schematic and block diagram for 414A

Preliminary procedures consist of the following:

1. Visually check module for possible damage due to shipment.

2. Connect ac power to ORTEC 4001/4002.

3. Plug module into bin and check for proper mechanical alignment.

4. Switch on ac power and check the dc power supply voltages at the test points on the 4002 control panel.

Testing the performance of the 414A involves the following:

1. Feed the output of the 416A into coincidence Input A. Terminate with 100Ω the RG-62/U connecting cable feeding Input A.

2. Set the In/Out control toggle switches as follows: A, In; B, C, and D, Out.

3. Set the Resolving Time control to 100.

4. Observe the Fast Coincidence output pulse; it should be a positive pulse, 6.5 ± 0.6 V and 0.5 ± 0.1 µs wide. Loading the 414A output with 100Ω should reduce the output to not <5 V and the width to not <0.5 µS.

5. Putting In/Out switch B or C to the In position should inhibit the pulse on the 414A Output. Check that both B and C inhibit. Connect the input into Input B and check that both A and C inhibit. Connect the input into Input C and check that both A and B inhibit.

6. Connect the equipment as shown in Fig. 6.1. Keep all coaxial cables terminated in their characteristics impedance.

7. Ensure that a positive logic pulse is being received from the output of each 416A. Set the output delay control on the Calibrated 416A to 200 and adjust the Reference 416A output pulse until the leading edges of the pulse are approximately in coincidence.

8. Set the In/Out Control switches as follows: A and B, In; C and D, Out.

9. Set the Resolving Time control to 1100.

10. With the equipment connected as shown in Fig. 6.1, two pulses (the Calibrated 416A output and the 414A output) should be visible on the oscilloscope. Set the horizontal time base to 20 ns/div. It may be necessary to use the Delayed Sweep function on the oscilloscope in order to observe both pulses at this horizontal sweep speed.

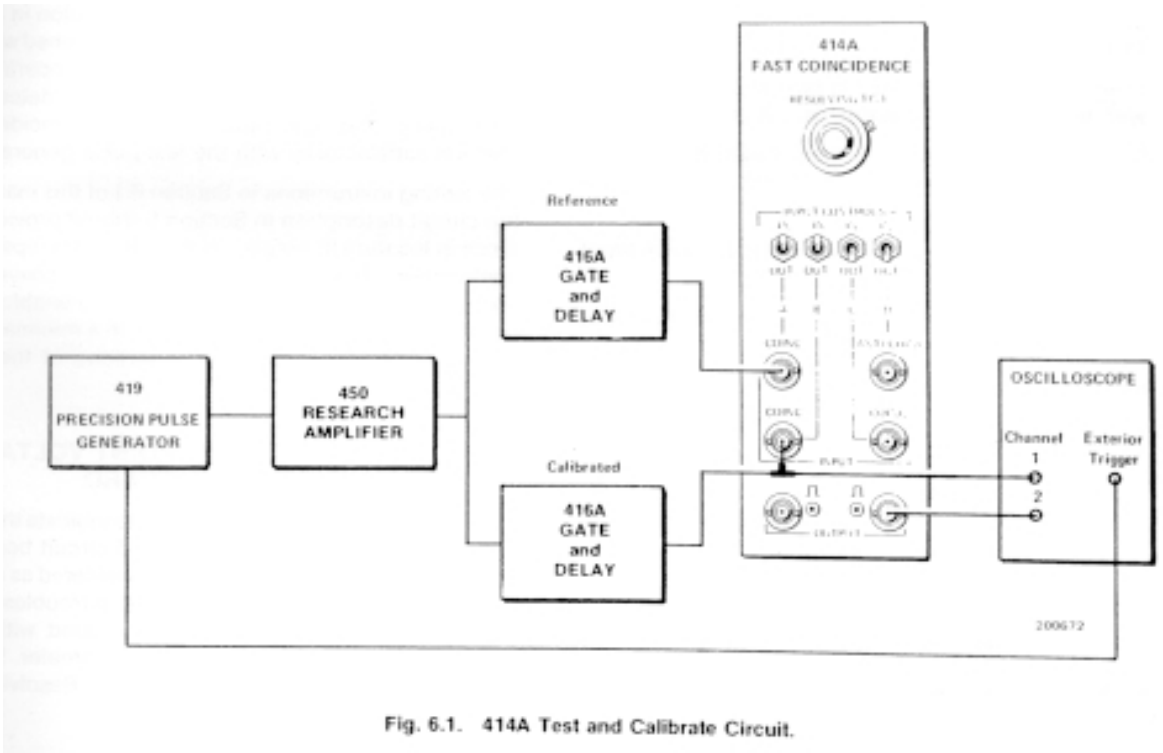


Fig. 6.1. 414A Test and Calibrate Circuit.

11. Decrease the output delay control on the Calibrated 416A until the 414A output pulse disappears.

12. Increase the output delay control on the Calibrated 416A, and the 414A output pulse should reappear and disappear again as the delay is increased. Measure the change in delay of the Calibrated 416A pulse from the time that the 414A output pulse reappears until it disappears again. This time can be accurately measured looking at the oscilloscope. The time measured represents the 2τ resolving time of the 414A with the Resolving Time control set at 1100 and should be 110-150 ns.

13. Connect the Calibrated 416A output to Input C on the 414A.

14. Set the In/Out control switches as follows: A and C, In; B and D, Out.

15. Repeat steps 9 through 12.

16. Connect the Reference 416A output to Input B on the 414A.

17. Set the In/Out control switches as follows: A and D, Out; B and C, In.

18. Repeat steps 9 through 12.

19. Repeat steps 9 through 16 with the following exceptions:

    a. In step 9 set the Resolving Time control to 100.

    b. In step 10 set the oscilloscope horizontal time base to 10 ns/div.

    c. In step 12 the 2τ resolving time should be <10 ns with the Resolving Time control set at 100.

20. Set the output delay control on the Calibrated 416A so that its output occurs approximately 100 ns prior to the Reference 416A output.

21. Connect the reference 416A output to the 414A Input A.

22. Connect the Calibrated 416A output to the 414A Input D.

23. Set the Resolving Time control to 1100.

24. Set the In/Out control switches as follows: A, In; B, C, and D, Out.

25. A pulse should be present at the output of the 414A. Place In/Out control switch D to the In position, and the 414A output pulse should disappear.

5.2. ALIGNMENT OF RESOLVING TIME TRIMMER CAPACITORS

If the resolving time readings (Section 6.1) were not satisfactory, the trimmer capacitors in each resolving network may be adjusted to optimize the resolving time in each channel:

1. Connect and adjust the equipment as stated in Section 6.1, steps 6 and 7.

2. Set the In/Out control switches as follows: A, In; B, C, and D, Out.

3. Set the Resolving Time control to 100.

4. Observe the 414A output with an oscilloscope.

5. Using an insulated screwdriver, adjust capacitor C4 until the output pulse disappears. Continue to rotate C4 adjustment until the output reappears. Stop the adjustment of C4 as soon as an output pulse appears for each input pulse.

6. Set the In/Out control switches as follows: A, C, and D, Out; B, In.

7. Adjust C23 as explained in step 5.

8. Connect Reference 416A to Input C.

9. Set the In/Out control switches as follows: A, B, and D, Out; C, In.

10. Adjust C18 as explained in step 5.

11. Perform the tests outlined in Section 6.1, steps 1–25, to check the instrument performance.

5.3. SUGGESTIONS FOR TROUBLESHOOTING

In situations where the 414A is suspected of malfunction, it is essential to verify such malfunction in terms of simple pulse generator impulses at the input and output. The 414A must be disconnected from its position in any system, and routine diagnostic analysis performed with a test pulse generator and oscilloscope. It is imperative that testing not be performed with a source and detector until the amplifier and logic inputs to the Fast Coincidence unit perform satisfactorily with the test pulse generator.

The testing instructions in Section 6.1 of this manual and the circuit description in Section 5 should provide assistance in locating the region of trouble and in repairing the malfunction. The guide plate and shield cover can be completely removed from the module to enable osicilloscope and voltmeter observations with a minimal chance of accidentally short-circuiting portions of the etched board.

5.4. TABULATED TEST POINT VOLTAGES ON ETCHED BOARD

The following voltages are intended to indicate the typical dc voltages measured on the etched circuit board. The voltages given here should not be considered as absolute values, but should be used as an aid in troubleshooting. All voltages were measured from ground with VTVM having input impedances of 10 MΩ or greater. Voltages are dc-values with no input pulses. Set Resolving Time control to 100 divisions.

Table 6.1. Typical dc Voltages.

Test Point	Voltage	Test Point	Voltage
Q1c	7.4	Q14c	1.2
Q2c	1.2	Q13c	3.8
Q3c	3.8	Q11c	12.8
Q19c	7.4	Q7c	12.0
Q18c	1.2	Q10b	6.5
Q17c	3.8	Q20e	5.5
Q15c	7.4	Q22e	0.9

5.5. FACTORY REPAIR

This instrument can be returned to ORTEC for service and repair at a nominal cost. The standard procedure for repair ensures the same quality control and checkout that are used for a new instrument. Always contact Customer Services at ORTEC (865) 483-2231, before sending in an instrument for repair to obtain the necessary 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 factory.

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 4001A and 4001C Modular System Bins.