

ORTEC  
404A Pile-Up Inspector  
Operating and Service Manual

This manual applies to instruments marked  
"Rev 05" on rear panel

Rev Level 06  
No Manual Change

## STANDARD WARRANTY FOR ORTEC INSTRUMENTS

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

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

### QUALITY CONTROL

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

### REPAIR SERVICE

If it becomes necessary to return this instrument for repair, it is essential that Customer Services be contacted in advance of its return so that a Return Authorization Number can be assigned to the unit. Also, ORTEC must be informed, either in writing or by telephone [(615) 482-4411], 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 nearest 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 will be repaired at the standard charge unless they have been grossly misused or mishandled, in which case the user will be notified prior to the repair being done. A quotation will be sent with the notification.

### 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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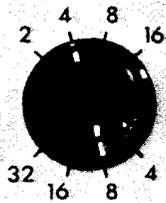
**ORTEC**

**MODEL 404A**

**PILE-UP  
INSPECTOR**

INSPECT INTERVAL

$\mu$  sec.

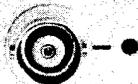


$\mu$  sec.  
INHIBIT INTERVAL

INPUT



SINGLES  
OUTPUT



INHIBIT OUTPUT  
POS



NEG



+12V 45mA  
-12V 50mA  
+24V 15mA  
-24V 35mA

## ORTEC 404A PILE-UP INSPECTOR

### 1. DESCRIPTION

#### 1.1 General

The ORTEC 404A Pile-Up Inspector makes use of the pulse pair resolution of a fast discriminator (such as the ORTEC 260) to reject pulses whose proximity to each other is within the linear amplifier resolving time, and whose presence would therefore represent distortion of the linear analysis signal caused by pulse pile-up. Since the ratio of discriminator resolving time to amplifier resolving time is normally nanoseconds to microseconds, the pile-up distortion is reduced by two to three orders of magnitude.

The 404A furnishes a positive 5-V output for single event counting, and both positive and negative 10-V outputs to be used in the pile-up reject function.

The 404A is a standard single width NIM module, and is designed to meet the recommended interchangeability standards outlined in AEC Report TID-20893 (Rev.).

#### 1.2 Description of Basic Functions

Whenever a pulse occurs at the input, a Singles output is generated with width selected as an inspect interval with the front panel switch. For a period of time equal to the Singles width, the circuit is "inspecting" for the occurrence of a second pulse. Should a second pulse be detected during this Inspect Interval, an Inhibit signal is immediately generated whose width is twice the Inspect Interval. The operation is the same for any number of pulses which occur within the Inspect Interval of the first pulse; that is, the Singles output is merely extended one full Inspect Interval from the last pulse, and pile-up rejection is still provided for the last pulse. The Singles output is used to count or scale the single events, whereas the Inhibit output is to be used in anticoincidence with the linear signal.

The minimum pulse-pair resolution of the instrument is approximately 20 nanoseconds. The 404A is normally used in conjunction with a fast discriminator which supplies the NIM standard Type 1 fast negative logic pulse to operate the instrument.

### 2. SPECIFICATIONS

**Input** Negative; nominal 0.6 V, width  $\geq 4$  ns (minimum 0.3 V, 10 ns wide), maximum limited by desired resolving time, input protected to 100 V

**Input Impedance** 50 ohms

#### Outputs

**Singles** Positive 5 V, width equal to switch-selected Inspect Interval

**Inhibit** Positive and negative 10 V, width equal to twice the Inspect Interval

**Output Impedance**  $\leq 10$  ohms on all outputs

**Inspect Interval** Front panel switch selectable, 2  $\mu$ s, 4  $\mu$ s, 8  $\mu$ s, or 16  $\mu$ s

**Inhibit Interval** Twice the Inspect Interval

**Resolving Time** 20 ns minimum

**Connectors** All BNC

**Operating Temperature Range** 0°C to 50°C

**Power Required** +24 V 25 mA +12 V 50 mA  
-24 V 45 mA -12 V 55 mA

**Dimensions** One module wide, designed to meet interchangeability standards outlined in AEC Report TID-20893 (Rev.)

### 3. INSTALLATION

#### 3.1 General Installation Considerations

The 404A, used in conjunction with the 401A/402A Bin and Power Supply, is intended for rack mounting. It is necessary to ensure that other equipment operated in the same rack (particularly vacuum tube equipment) has sufficient cooling air circulating to prevent any localized heating of the all-transistorized circuitry used throughout the 404A. The temperature of equipment mounted in racks can easily exceed the recommended maximum unless these precautions are taken. The 404A should not be subjected

to temperatures in excess of 120°F (50°C). To obtain the best in temperature stability, the 404A should not be exposed to high velocity drafts of cooling air, especially if the temperature of the cooling air is not stable.

#### 3.2 Connection to Power – Nuclear Standard Bin, ORTEC 401A/402A

The 404A contains no internal power supply, and therefore obtains necessary operating power from the nuclear standard bin and power supply, ORTEC 401A/402A. Turn the power

supply off when inserting or removing modules. The 400 Series is designed so that it is not possible to overload the power supply with a full complement of modules in the bin. However, this may not be true when the bin contains modules other than those of ORTEC design. In such instances the power supply voltages should be checked after the insertion of modules. The ORTEC 401A/402A has test points on the power supply control panel to monitor the dc voltages. The power supply voltages should read within

$\pm 0.5\%$  of the nominal values for proper operation of NIM standard instruments.

### 3.3 Connection into a System

The input of the 404A is dc-coupled into an impedance of approximately 50 ohms. The outputs are also dc-coupled, each having an output impedance of 10 ohms or less.

## 4. OPERATING INSTRUCTIONS

### 4.1 Front Panel Controls

The 404A provides an adjustable inspect time interval front-panel four-position switch. The inhibit time interval is twice the inspect time interval for each setting, as indicated by the front-panel switch.

### 4.2 Initial Testing and Observation of Pulse Waveforms

For this information refer to Section 6 of this manual.

### 4.3 Connector Data

**Input** The input is dc-coupled into an impedance of 50 ohms through the Input BNC connector.

**Singles Output (BNC)** The positive 5-V Singles output has approximately 10 ohms driving source impedance, dc-coupled.

**Inhibit Outputs (BNC)** Both positive and negative 10-V Inhibit outputs have approximately 10 ohms driving source impedance, dc-coupled.

### 4.4 Typical Application

A typical experimental setup for which the 404A might be used is that shown in Figure 1. The 403A discriminator level setting is adjusted so that the 260 triggers on all events which are causing pile-up. The 403A which supplies the power and discriminator level setting to the 260 provides the negative logic pulse to operate the 404A. The Singles output of the 404A is used in scaling the single events, and the Inhibit output is used in anticoincidence with the linear signal at the input to the ADC circuitry of the multichannel analyzer, or at an external linear gate as shown in Figure 1.

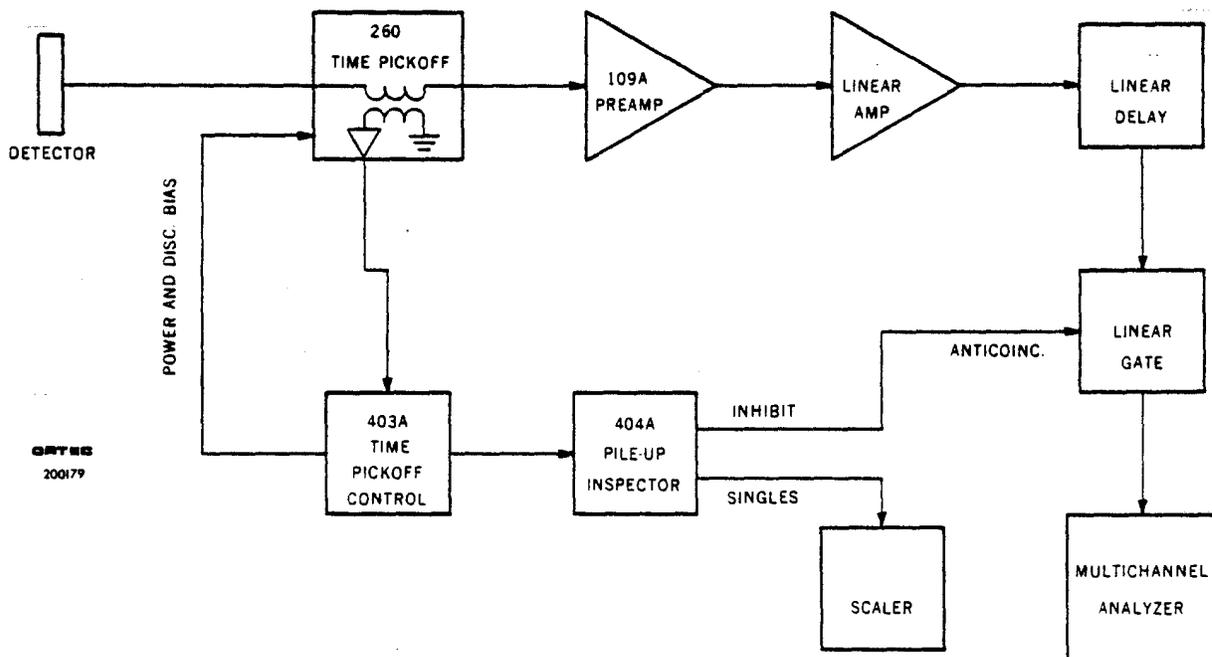


Figure 1. Pile-Up Rejection Diagram

## 5. CIRCUIT DESCRIPTION

The negative logic input pulse triggers the transistor pair Q1 and Q2, and is fed simultaneously into the base of Q3 and through a 4-foot length of RG-174/U coaxial cable delay line to the emitter of Q6. Transistors Q3, Q4, and Q5 and the delay line form a network which clips the input pulse to approximately 6 ns and then feeds it into a normally closed gate comprised of Q15, Q16, and Q17.

The base of Q6 is set at a constant negative 5.8 V by the reverse breakdown voltage of the base-emitter junction of Q7 which thus serves as a Zener diode. Q6 provides the current drive to saturate Q9, which is part of a fast, zero dead time one-shot multivibrator comprised of Q8, Q9, Q10, Q11, Q12, and Q13. The multivibrator output at the collector of Q12 is buffered by the emitter follower Q14, and is brought out as the Singles output signal. This pulse is also fed into the base of Q16 and opens the gate for a second input pulse lying within the Inspect Time Interval.

If a second input pulse appears within this interval, upon reaching the gate, it passes on through and triggers the one-shot comprised of Q19, Q20, Q21, Q22, Q23, and Q24. The multivibrator output pulse is buffered by the emitter follower Q25 and is brought out as the positive Inhibit signal. Q26 and Q27 provide the inversion for the negative Inhibit output signal. D1, D2, and D3 comprise a limiter which protects the input to 100 V.

The two one-shot multivibrators incorporated in the design have the desirable feature of being able to respond to input signals as narrow as 4 nanoseconds, as well as having zero dead time. Zero dead time means that for a double pulse input, there exists no foreshortening of the second output pulse, regardless of how close it lies to the trailing edge of the first output pulse. This assures a constant Inspect Time Interval following each input pulse.

## 6. MAINTENANCE

### 6.1 Test Equipment

The following equipment is recommended for testing the 404A. Equivalent equipment can be used if appropriate adjustments are made in the test procedure.

1. ORTEC 401A/402A Bin and Power Supply
2. EH 139B Double Pulse Generator
3. Tektronix Model 585A Oscilloscope with 1A2 Plug-in unit.

### 6.2 Preliminary Procedures

1. Visually check the 404A for possible damage due to shipment.
2. Connect ac power to the Bin and Power Supply
3. Plug the 404A into the Bin and check for proper mechanical alignment.
4. Switch on ac power and check the dc voltages at the test points on the 401A Power Supply control panel.

### 6.3 Test Procedure

A double pulse generator is used so the position of the second pulse with respect to that of the first pulse may be varied in time. Adjust the amplitude of the pulse generator to be -0.6 V, and the width to be approximately 10 nanoseconds. Connect the output of the pulse generator to the input of the 404A. With the oscilloscope, monitor the Singles output and one of the Inhibit outputs. With

the Inspect Interval set at 2  $\mu$ s, adjust the double pulse spacing inward from 3  $\mu$ s until an Inhibit pulse is obtained. At this point the double pulse spacing should be approximately 2  $\mu$ s. The lack of dead time in the circuitry of the 404A can be noticed by the absence of foreshortening of the second Singles output pulse. The Inhibit output pulse should be present for all values of time difference from 2  $\mu$ s down to approximately 20 ns. The Singles output pulse should be present throughout the entire test. A similar test can be made for the Inspect Intervals of 4, 8, and 16  $\mu$ s.

### 6.4 Random Time Interval Test Performance

In Figure 3 is shown the results of pile-up inspection on the system of Figure 2. A random time interval generator with variable pulse height and count rate<sup>1</sup> is used to simulate the pulse obtained from a nuclear radiation detector bombarded by a monoenergetic source. Pulse height analysis is performed on the low count rate signal from the 419 Precision Pulse Generator. Baseline restoration is used to remove most of the positive-on-negative pile-up as demonstrated in the noninspected spectrum of Figure 3A, which represents pile-up of a  $4 \times 10^4$  cts/sec random rate on a 50 cts/sec pulser signal (the signal of interest) with an 11:1 pulse height ratio.

<sup>1</sup>Williams, C. W., "Reducing Pulse Height Spectral Distortion by means of DC Restoration and Pile-up Rejection," IEEE Trans. Nucl. Sci. NS-15 (1) (Feb. 1968)

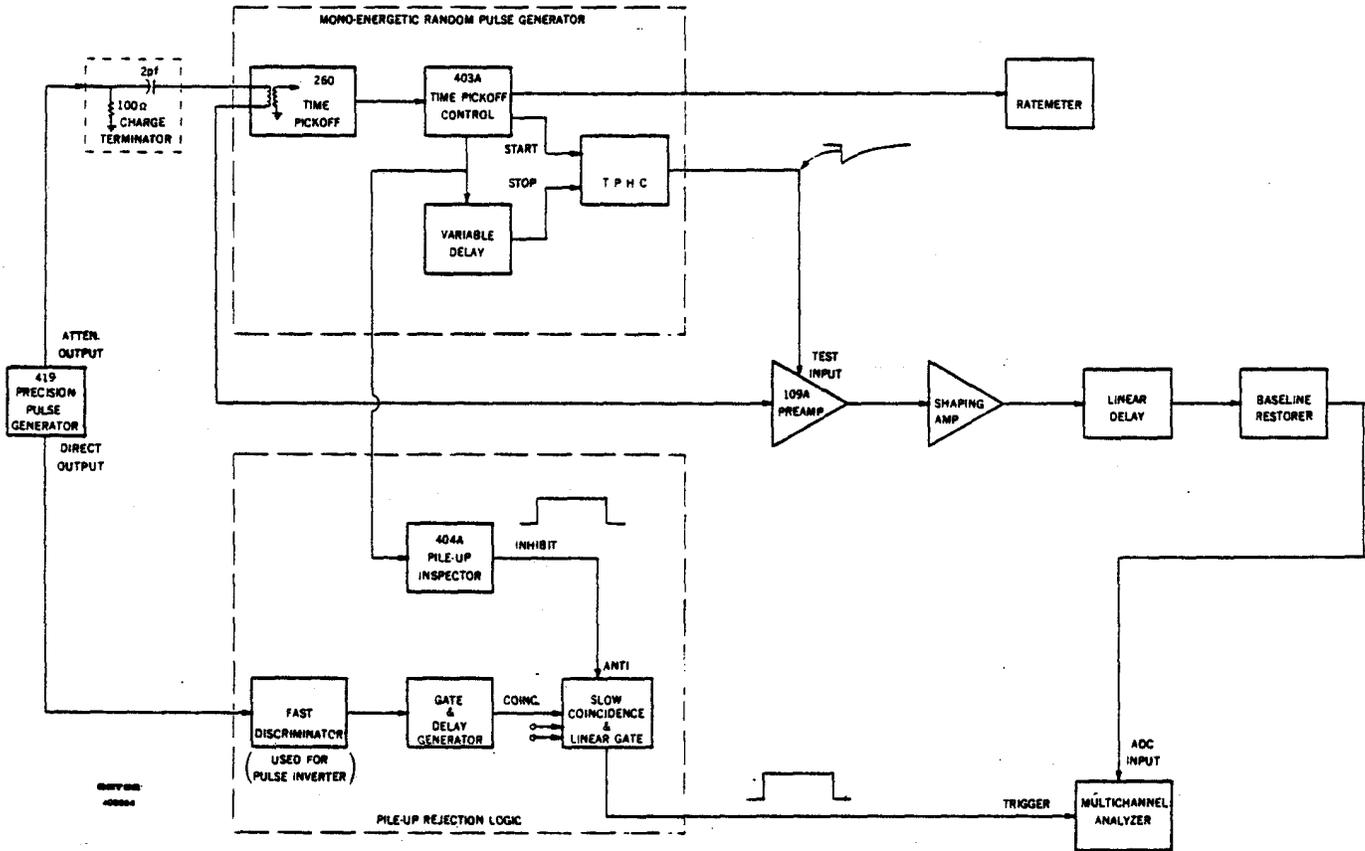
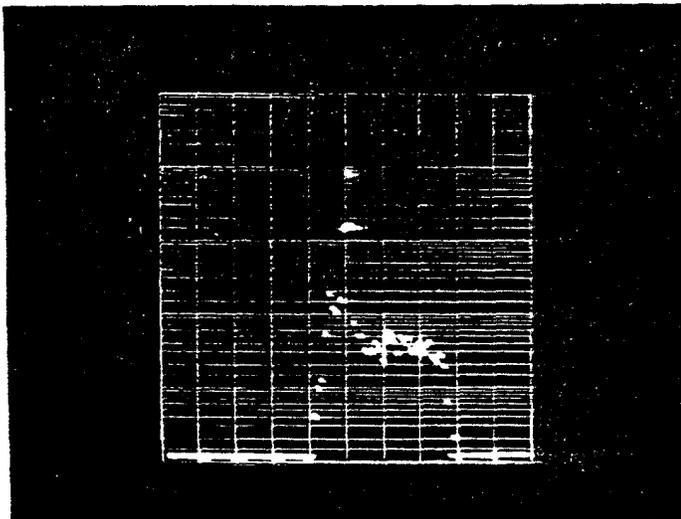
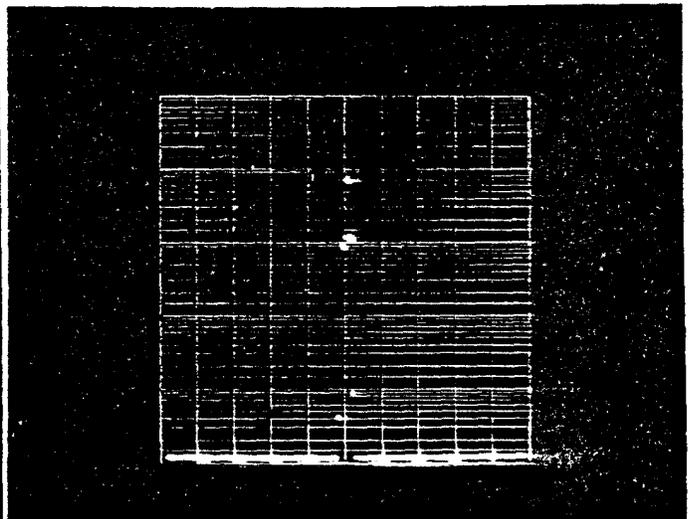


Figure 2. Random Time Interval Test



a) Without Pile-Up Inspection



b) With Pile-Up Inspection

A  $4 \times 10^4$  cts/s random rate, 0.4-MeV equivalent energy superimposed on a 60-Hz pulser rate, 4.4-MeV equivalent energy

Figure 3. Test Results of Pile-Up Reduction by Inspection

### 6.5 Suggestions for Troubleshooting

If the 404A is suspected of malfunction in a system, the unit should be removed from the system and tested, using the double pulse generator method outlined in Section 6.3. If a malfunction exists, Table 1, which provides typical dc values for various test points, should be helpful in isolating the problem.

### 6.6 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 Customer Services at ORTEC, (615) 482-4411, 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. Typical DC Voltages**

Location	Reading
+24 bus	+ 23.9
+12 bus	+ 11.6
-12 bus	- 11.5
-24 bus	- 23.6
Q1b	0.
Q1c	- 5.0
Q2b	- 0.18
Q3b	- 0.87
Q5b	- 5.1
Q6b	- 5.7
Q8b	+ 0.59
Q8c	- 11.7
Q9b	- 11.7
Q10b	- 4.9
Q10e	+ 0.64
Q12b	- 4.4
Q13b	- 4.8
Q14b	- 0.13
Q15b	- 0.16
Q16b	0
Q17b	+ 0.62
Q18e	- 5.8
Q18c	- 11.4
Q19b	+ 0.60
Q19c	- 11.4
Q20b	- 11.4
Q21b	- 5.0
Q21e	+ 0.60
Q23b	- 4.4
Q24b	- 4.9
Q25b	- 0.20
Q26b	- 0.78
Q27b	- 0.10

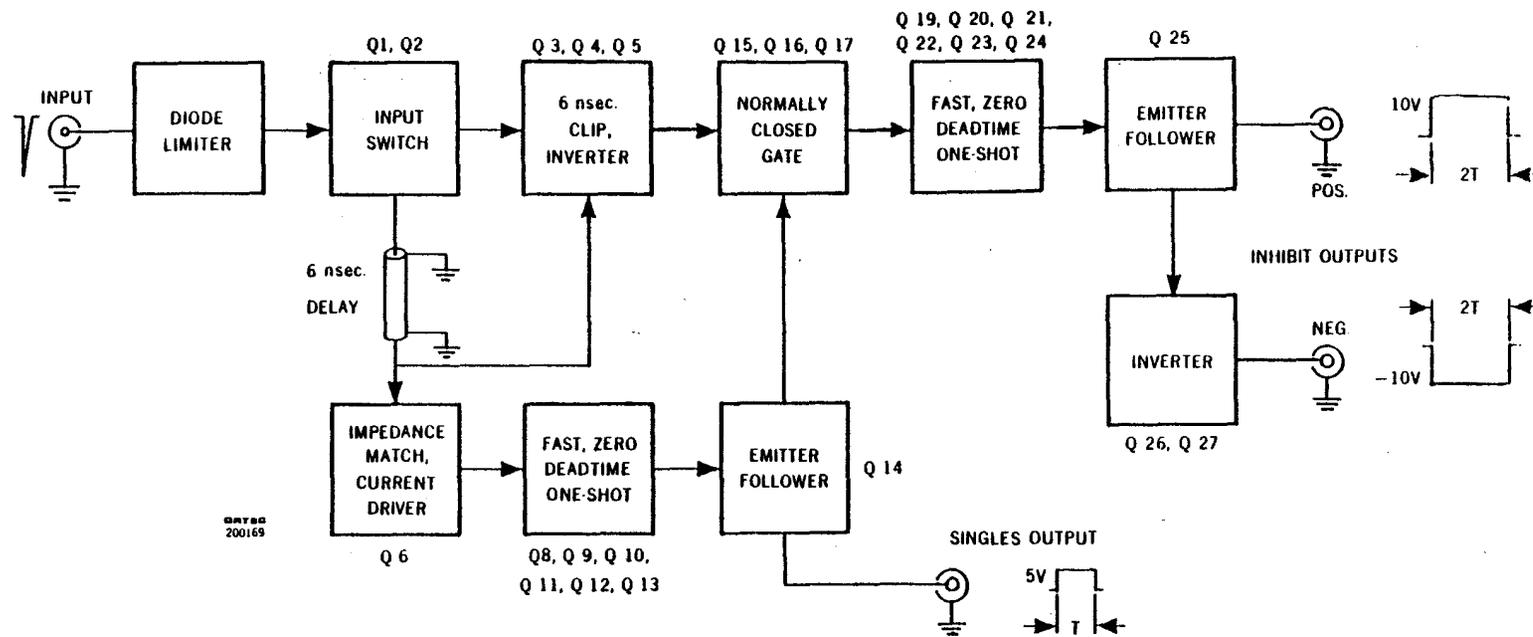


Figure 4. 404A Pile-Up Inspector Block Diagram

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Q5b	- 5.1
Q6b	- 5.7
Q8b	+ 0.59
Q8c	- 11.7
Q9b	- 11.7
Q10b	- 4.9
Q10e	+ 0.64
Q12b	- 4.4
Q13b	- 4.8
Q14b	- 0.13
Q15b	- 0.16
Q16b	0
Q17b	+ 0.62
Q18e	- 5.8
Q18c	- 11.4
Q19b	+ 0.60
Q19c	- 11.4
Q20b	- 11.4
Q21b	- 5.0
Q21e	+ 0.60
Q23b	- 4.4
Q24b	- 4.9
Q25b	- 0.20
Q26b	- 0.78
Q27b	- 0.10

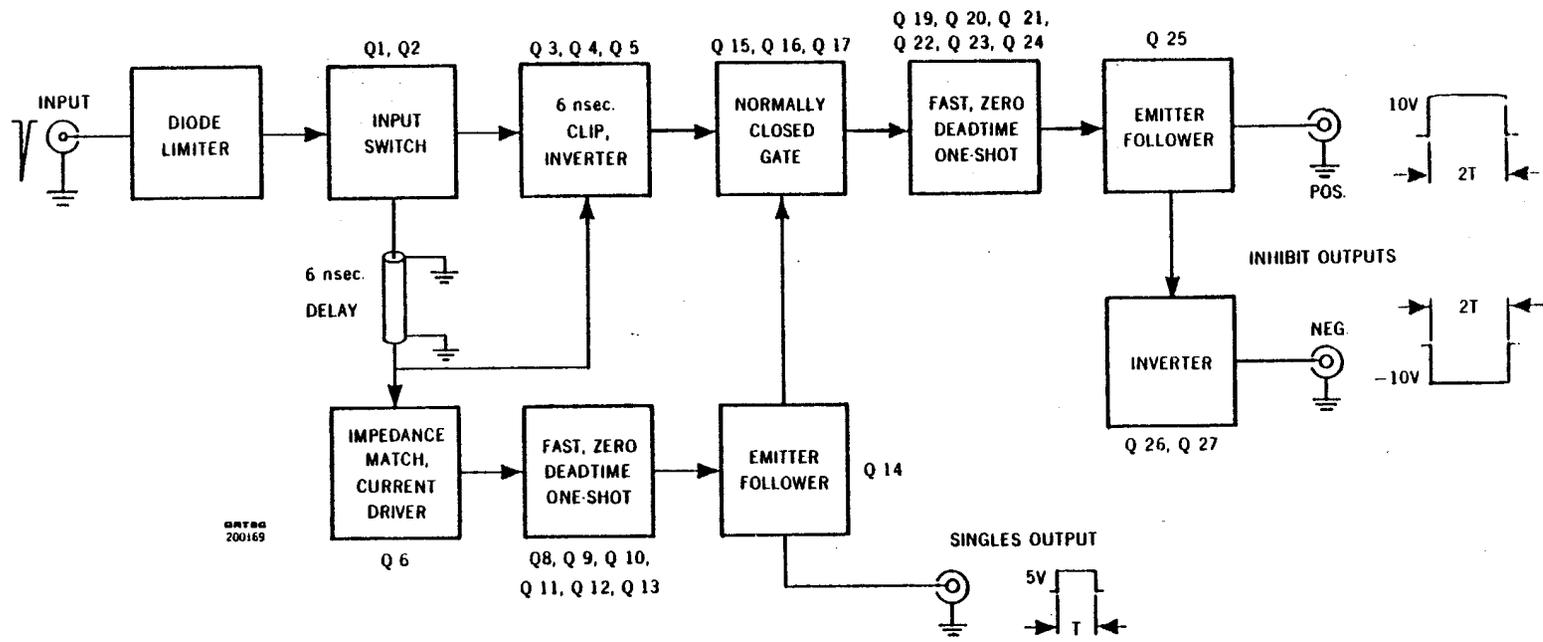
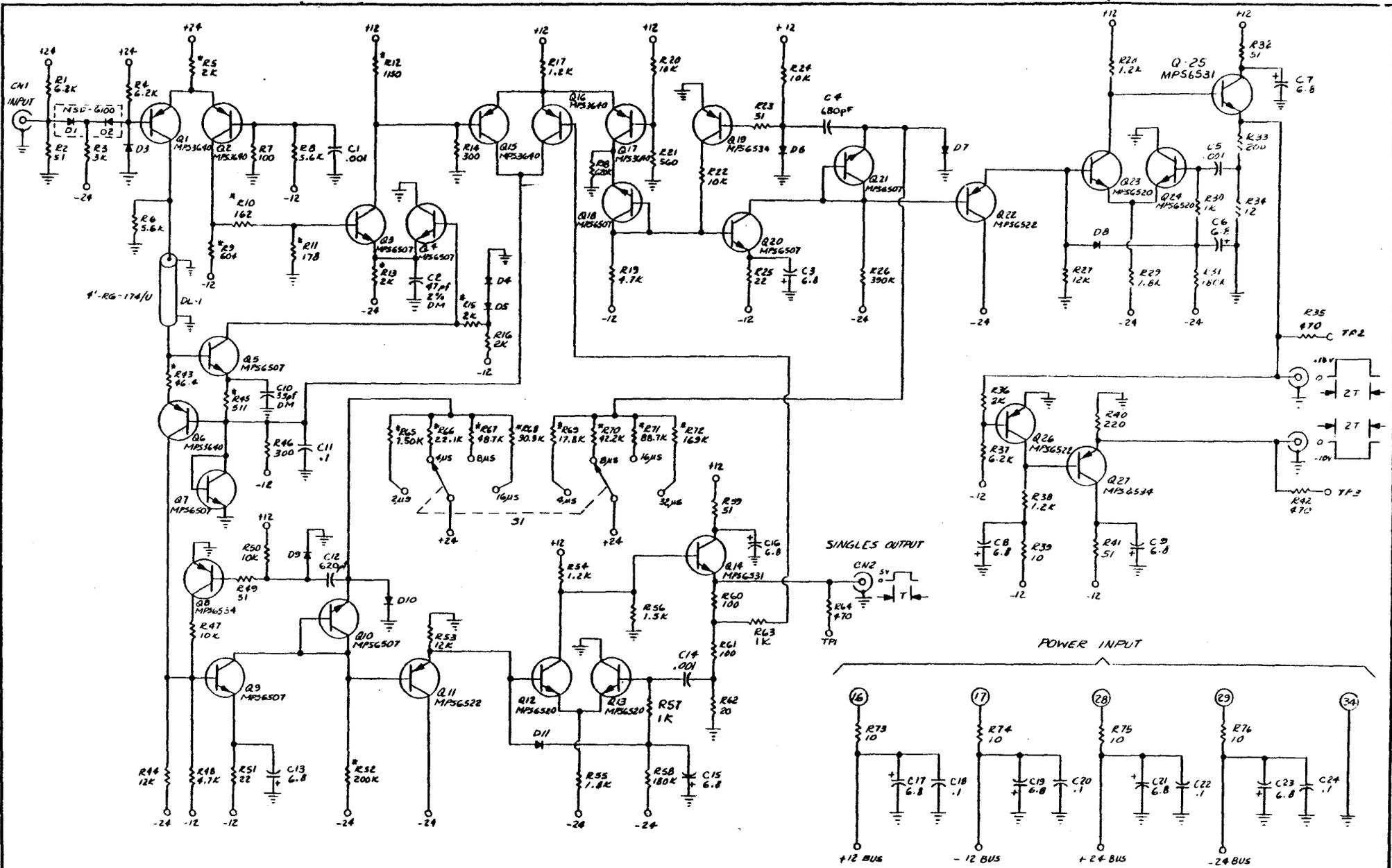


Figure 4. 404A Pile-Up Inspector Block Diagram

**BIN/MODULE CONNECTOR PIN ASSIGNMENTS  
FOR AEC STANDARD NUCLEAR INSTRUMENT MODULES  
PER TID-20893**

Pin	Function	Pin	Function
1	+3 volts	23	Reserved
2	-3 volts	24	Reserved
3	Spare Bus	25	Reserved
4	Reserved Bus	26	Spare
5	Coaxial	27	Spare
6	Coaxial	*28	+24 volts
7	Coaxial	*29	-24 volts
8	200 volts dc	30	Spare Bus
9	Spare	31	Spare
*10	+6 volts	32	Spare
*11	-6 volts	*33	115 volts ac (Hot)
12	Reserved Bus	*34	Power Return Ground
13	Spare	35	Reset
14	Spare	36	Gate
15	Reserved	37	Spare
*16	+12 volts	38	Coaxial
*17	-12 volts	39	Coaxial
18	Spare Bus	40	Coaxial
19	Reserved Bus	*41	115 volts ac (Neut.)
20	Spare	*42	High Quality Ground
21	Spare	G	Ground Guide Pin
22	Reserved		

*\*These pins are installed and wired in parallel in the ORTEC 401A and 401B Modular System Bins.*



NOTES: UNLESS OTHERWISE SPECIFIED.  
 1. RESISTORS MARKED \* ARE METAL FILM, 1%, 1/8 W(T.O.)  
 ALL OTHER RESISTORS ARE 5%, 1/4 W.  
 2. ALL DIODES ARE IN4009.  
 3. ALL CAPACITORS ARE IN  $\mu$ F.

C-24  
 R-76  
 D-11  
 Q-27  
 DL-1

UNLESS OTHERWISE SPECIFIED DIMENSIONS IN INCHES TOLERANCES				<b>ORTEC</b> INCORPORATED 100 MIDLAND ROAD, OAK RIDGE, TENNESSEE 37830
FRAC.	DECIMAL	ANG.	FRACTION	
±10%	±0.001	±10'	±1/16"	MODEL 404A FILE-UP INSPECTOR DEXTER BATES 5/2/68 MGA 5-2-68 404A-0101-SI
±1%	±0.0005	±5'	±1/32"	