Model 426
Linear Gate
Operating and Service Manual

This manual applies to instruments marked
“Rev 23" on rear panel

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ORTEC® Part No. 733200
Manual Revision B

1202

Advanced Measurement Technology, Inc.

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

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

Repair Service

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

Damage in Transit

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

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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.

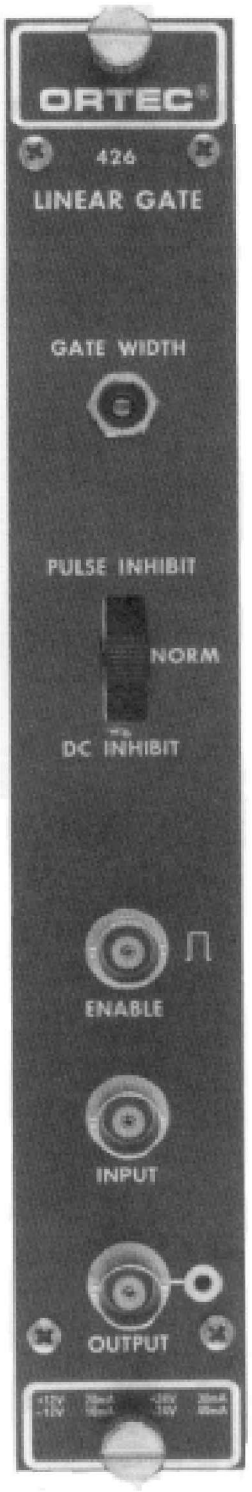
Cleaning Instructions

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
426
LINEAR GATE
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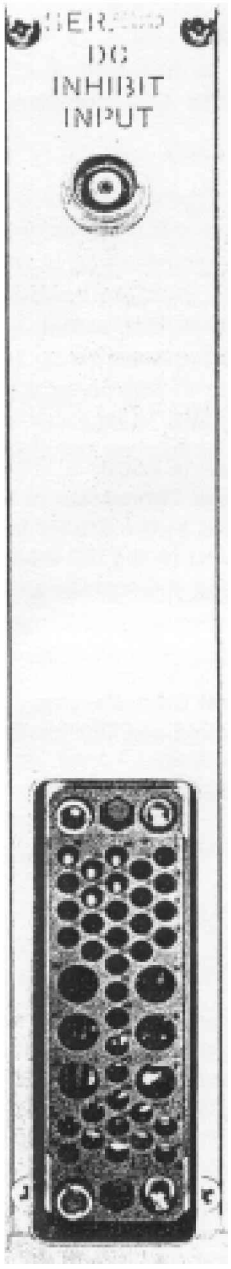
DC
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ORTEC 426 LINEAR GATE

1. DESCRIPTION

The ORTEC 426 is a modular Linear Gate that provides a variable gate duration whose width is controlled by a single-turn front-panel-mounted potentiometer. The nominal gate duration range is from 0.3 to 4 μsec. Operation of the Linear Gate is controlled by the application of a positive Enable pulse. The Linear Gate is useful in applications that require inhibiting a linear signal according to chosen coincidence or timing requirements, e.g., reducing the counting rate in subsequent linear analysis equipment.

The 426 is designed to meet the recommended interchangeability standards of USAEC Report TID-20893 (Rev.) An ORTEC 4001/4002 Series Bin and Power Supply provides all necessary power through the rear module power connector. All signal levels and impedances are compatible with other modules in the ORTEC 400 series.

The basic function of the 426 is to accept all pulse shapes existing in the ORTEC 400 Series linear function modules. If the input signal is bipolar, the negative portion will not be passed through the Linear Gate. The input impedance is greater than 5000Ω, and the input is normally sent from the factory ac-coupled. The input can be operated dc-coupled if desired (refer to Section 4.4). A dc-restoration network at the input reduces baseline shift at high counting rates. The restoration network works on both unipolar and bipolar input pulse shapes. The Linear Gate proper consists of a series-parallel saturated transistor switch. This switch network incorporates an adjustment that allows the Linear Gate to operate with no pedestal. The series-parallel transistor switch is activated by a transistor-pair current switch. This latter switch is activated by the gate control pulse which is generated with the application of an externally generated Enable pulse. The output of the Linear Gate circuit is fed into a cascode emitter-follower cable driver.

The ORTEC 426 has two operating modes: normally blocks all input signals not accompanied by an Enable pulse and normally passes all signals unless accompanied by an Inhibit signal. The Inhibit signal can be fed into the front panel Enable connector for Pulse Inhibit operation or into the DC Inhibit Input connector for dc or continuous inhibit operation.

2. SPECIFICATIONS

2.1. PERFORMANCE

Gain Unity.

Integral Nonlinearity <0.15% from 0.2 to 10 V.

Pulse Feedthrough <10 mV with a 10 V input pulse.

Temperature Stability <0.015%/°C, 0 to 50°C.

Counting Rate The gain shift of a 4-V reference pulse is <0.25% with the application of an additional count rate of 65,000 counts/sec of 6.0 V random pulses.

2.2. CONTROLS

Gate Width Continuously variable from 0.3 to 4 μs.

Output Pedestal Adjustable to <1 mV.

Pulse Inhibit/Norm/DC Inhibit 3-position mode switch that permits selection of the function of any pulse or dc level furnished through the Enable input connector, which is on the front panel, or the DC Inhibit connector on the rear panel:

Norm Input pulse will be gated through to the output during a gate width interval following the leading edge of each Enable input pulse.

Pulse Inhibit Input pulses will be inhibited from passing through the output during a gate width interval following each Enable input pulse.

DC Inhibit Input pulses will be inhibited from passing through the output during intervals of pulses or dc level through the DC Inhibit Input connector on the rear panel.

2.3. INPUTS

Input Unipolar or bipolar with positive portion leading. Rated range 0.2 to 10 V, 12 V maximum. Input impedance >5000Ω. BNC connector on front panel.

Enable (or Inhibit) Any positive input >2 V, maximum input 20 V. Enable impedance 1000Ω, dc-coupled; Inhibit impedance 650Ω, dc-coupled. Front panel BNC connector for each.

DC Inhibit Rear panel BNC connector; inhibits input pulses from passing through the output during intervals of pulses or dc levels; impedance 650Ω, dc-coupled.

2.4. OUTPUT

Rated output range 0.2 to 10 V positive; 12 V maximum. Output impedance ~2Ω, short-circuit protected. BNC connector.

2.5. ELECTRICAL AND MECHANICAL

Power Requirements
+24 V, 30 mA; +12 V, 16 mA;
-24 V, 49 mA; -12 V, 4.9 mA.

Weight (Shipping) 4.0 lb (1.82 kg).

Weight (Net) 2.1 lb (0.96 kg).

Dimensions Single-width module (1.35 by 8.714 in.) per TID-20893 (Rev.).

2.6. RELATED EQUIPMENT

The input to the linear gate of the 426 can be from any of the linear circuitry in the ORTEC NIM-standard modules. In typical applications, the output of the linear gate feeds a multichannel analyzer directly. The output is also compatible with any of the linear modular circuitry in the ORTEC NIM-standard modules.

3. INSTALLATION

The ORTEC 426 contains no internal power, but is used in conjunction with an ORTEC 4001/4002 Series Bin and Power Supply, which is intended for rack mounting. Therefore if vacuum tube equipment is operated in the same rack with the 426, there must be sufficient cooling air circulating to prevent any localized heating of the all-transistor circuitry used throughout the 426. The temperature of equipment mounted in racks can easily exceed 120°F (50°C) unless precautions are taken. The 426 should not be subjected to temperatures in excess of 120°F (50°C).

3.1. 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 the case when the Bin contains modules of other than 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.

When using the ORTEC 426 outside the Bin and Power Supply, take care to ensure that the power jumper cable used properly accounts for the Power Supply grounding circuits provided in the recommended standards of AEC TID-20893 (Rev.). Both clean and dirty ground connections are provided to ensure proper reference voltage feedback into the Power Supply, and these must be preserved in remote cable installations. Be careful to avoid ground loops when the module is operated outside the Bin.

3.2. INPUT SIGNAL CONNECTION TO LINEAR GATE

The linear input to the ORTEC 426 is on the front panel BNC connector and is directly compatible with the output of all linear amplifiers, biased amplifiers, pulse stretchers, and delay amplifiers with all linear circuitry found in the ORTEC 400 Series. The Linear Gate passes only positive unipolar signals and/or the positive portion of bipolar signals. This must be kept in mind when putting in linear signals from other than ORTEC products. The linear input to the 426 is ac-coupled as normally supplied, but may be dc-coupled if desired.

If the linear input to the 426 is driven from a low driving impedance, such as the output from an ORTEC 410 Linear Amplifier, the 426 linear input should be terminated in the characteristic impedance of the connecting coaxial cable.

3.3. LOGIC INPUT TO THE ENABLE INPUT

The input pulses to the Enable input may come from any source of logic pulses. The input impedance of the Enable input is 1000Ω, dc-coupled, and some care must be given to ensure that reflections do not occur in the driving transmission cable. This probably can best be avoided by terminating the driving cable at the Enable input with the characteristic impedance of the driving cable. The amplitude and width of the Enable input signal are specified in Section 2.

The maximum width of the Enable input is not specified in Section 2 and indeed may be any width since the Enable signal is regenerated to allow gate width duration to be independent of the pulse shape of the Enable input. The minimum recommended width of the Enable input is 50 nsec measured at 50% amplitude, although narrower pulses with larger amplitude will trigger the Enable circuitry.

3.4. LOGIC INPUTS TO THE DC INHIBIT INPUT

The same considerations of Section 3.3 apply to input pulses to the DC Inhibit Input connector. This input provides the facility to block the passage of signals through the Linear Gate by the application of a dc voltage either in the basic form of a battery and switch contact or by the application of a pulse waveform between dc voltage levels. The input is dc-coupled and has an impedance of approximately 650Ω. A maximum dc voltage of 20 V is allowed on this input. A DC Inhibit control is not regenerated internally, but exists throughout the duration of the inhibiting signal.

3.5. LINEAR OUTPUT SIGNAL CONNECTIONS AND TERMINATING IMPEDANCE CONSIDERATIONS

The source impedance of the 0- to 10-V standard linear outputs of most 400 Series modules is approximately 1Ω. Interconnection of linear signals is thus noncritical, since the input impedance of circuits to be driven is not important in determining the actual signal span, e.g., 0-10 V, delivered to the following circuit. Paralleling several loads on a single output is therefore permissible while preserving the 0-10 V signal span. Short lengths of interconnecting coaxial cable (up to approximately 4 ft) need not be terminated. If, however, a cable longer than approximately 4 ft is necessary on a linear output, it should be terminated in a resistive load equal to the cable impedance. Since the output impedance is not purely resistive and is slightly different for each individual module, when a certain given length of coaxial cable is connected and is not terminated in the characteristic impedance of the cable, oscillations will generally be observed. These oscillations can be suppressed for any length of cable by properly terminating the cable either in series at the sending end or in shunt at the receiving end of the line. To properly terminate the cable at the receiving end, it may be necessary to consider the input impedance of the driven circuit, choosing an additional parallel resistor to make the combination produce the desired termination resistance. Series terminating the cable at the sending end may be preferable in some cases where receiving-end terminating is not desirable or possible. When series-termination at the sending end, full signal span, i.e., amplitude, is obtained at the receiving end only when it is essentially unloaded or loaded with an impedance many times of the cable. This may be accomplished by inserting a series resistor equal to the characteristic impedance of the cable internally in the module between the actual amplifier output on the etched board and the output connector. Remember that this impedance is in series with the input impedance of the load being driven, and in the case where the driven load is 900Ω a decrease in the signal span of approximately 10% will occur for a 93Ω transmission line. A more serious loss occurs when the driven load is 93Ω and the transmission system is 93Ω; in this case, a 50% loss will occur. BNC connectors with internal terminators are available from a number of connector manufacturers in nominal values of 50, 100, and 1000Ω. ORTEC stocks in limited quantity both the 50 and 100Ω BNC terminators. The BNC terminators are quite convenient to use in conjunction with a BNC tee.

4. OPERATION

4.1. FRONT PANEL CONTROLS

Gate Width A single-turn potentiometer provided to adjust the gate width to the desired value within the nominal range of 0.3 to 4 µsec. This control is recess-mounted and as such is a screwdriver adjustment, but it may be panel-mounted so that a knob may be added to the potentiometer shaft to allow finger-thumb adjustment if this seems desirable.

Mode Switch A 3-position switch used to set the Linear Gate into one of the following operation modes:

Normal In this mode the Linear Gate normally blocks all input signals unless the Enable signal sets the Linear Gate to pass signals for a selected duration (as set by the Pulse Width control) after receiving an Enable pulse.

Pulse Inhibit The reciprocal of the Normal mode is available with the switch in this position, i.e., the Linear Gate passes all signals except when a pulse is applied to the Enable input. The pulse on the Enable input causes the gate to block the passage of signals through the Linear Gate for a duration set by the Pulse Width adjustment.

DC Inhibit This mode is identical to the Pulse Inhibit mode except that the application of an inhibit or block input must be made on the rear panel BNC connector, and the Linear Gate will remain blocked for the duration that the dc signal is applied to the DC Inhibit Input connector.

For applications where the Linear Gate is desired to be switched for Normal, i.e., selectively passing, to a condition of passing all signals, the switch should be operated between Normal and DC Inhibit position and there should be no connection on the DC Inhibit Input rear panel connector.

4.2. INITIAL TESTING AND OBSERVATION OF PULSE WAVEFORMS

See Sections 5.1 and 5.2 for test performance data.

4.3. CONNECTOR DATA

CN1 Input, BNC Connector AC-coupled linear gate input; input impedance >5000Ω; input rated voltage range 0.2 to 10 V; maximum input 12 V. To minimize reflections when driving from low impedance sources into this connector, a terminator equal to the characteristic impedance of the driving cable should be shunted from this connector to ground.

CN2 Linear Gate Output, BNC Connector DC-coupled output; output impedance <2Ω; positive output signals only with rated range of 0.2 to 10 V; maximum output 12 V.

TP2 Linear Gate Output Test Point Oscilloscope test point for monitoring signal on linear gate output BNC connector CN2. This test point has 470Ω series resistor connecting it to CN2.

CN3 Enable Input, BNC Connector DC-coupled; input impedance 1000Ω; requires a positive 2-V pulse; maximum input 20 V.

CN4 DC Inhibit Input, BNC Connector DC-coupled; input impedance 650Ω; requires a positive 4-V pulse or dc level; maximum input 20 V.

4.4. TYPICAL OPERATING CONSIDERATIONS

In the Normal mode the Linear Gate is opened, i.e., passes input signals, with the application of a positive pulse on the Enable input. The duration that the Linear Gate will remain open is normally continuously variable from 0.3 to 4 µsec with the front panel control. For other pulse widths refer to Section 6.2.

Figure 4.1 illustrates the gating action of the Linear Gate. Notice that only the positive portion of the input signal is passed through the Linear Gate. The Linear Gate has an internal pedestal adjustment that allows the pedestal to be reduced to a negligible value (refer to Section 6.2 for adjustment procedure). Figure 4.2 shows the output of the Linear Gate with the pedestal properly adjusted and improperly adjusted.

The Linear Gate is usually operated in the normally closed mode with both input and output ac-coupled. Two variants of this mode are possible: gate operating normally open, i.e., normally passes all input signals except when accompanied by an enable or inhibit pulse, and gate dc-coupled operating either normally closed or normally open.

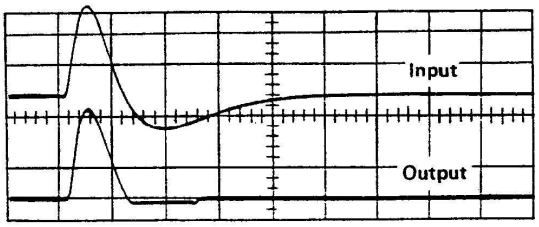
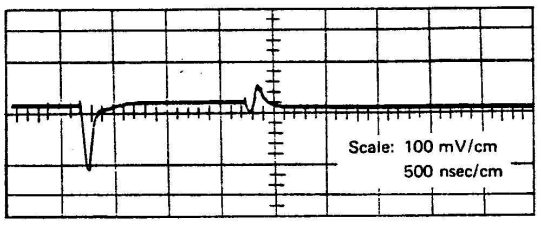
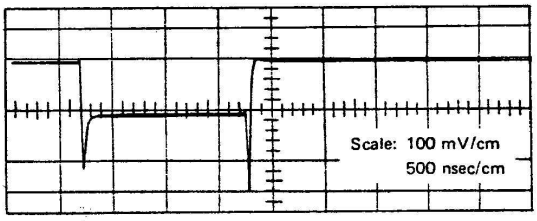


Fig. 4.1. Gating Action of Linear Gate.



(a) Pedestal Properly Adjusted.



(b) Pedestal Improperly Adjusted.

Fig. 4.2. Output of Linear Gate.

Operation in the second mode requires modification to the actual etched circuit board. For dc operation the input and output capacitors C1 and C6 must be replaced with jumper wires for a dc connection. With this arrangement a small dc offset voltage from input to output will be observed, approximately 160 mV, and must be considered in the connection of the gate to the input and output equipment.

For operation in the Inhibit mode, all input signals will be passed except when an inhibit signal is applied to either the Enable input or to the DC Inhibit Input. The particular input depends on the position of the mode switch, Enable input depends on the position of the mode switch, Enable input for Pulse Inhibit position and DC Inhibit Input for the D C Inhibit position (refer to Section 4.1). With the mode switch set to DC Inhibit and no input to the DC Inhibit Input connector, the linear gate will pass *all* input signals. This can be a very useful mode for setting up experiments since the proper timing of the input signal to the Enable input is not necessary to get an output signal. A slight difference in the pedestal magnitude may be noticed when changing modes from Normal to DC Inhibit. The pedestal is normally adjusted for minimum in the Normal mode, but may be adjusted to suit the experiment in mode desired.

Notice that, as supplied, C6 is shorted with a jumper wire and the output is dc-coupled. There will be a small dc offset voltage that is dependent on the saturation properties of the gate transistors that will have to be considered when going into an ADC or other dc-coupled units. Capacitor C6 is provided to allow ac-coupling in these cases, but polarity of the offset must be determined to properly connect the solid tantalum electrolytic capacitor, C6.

5. MAINTENANCE

5.1. TESTING THE PERFORMANCE OF THE LINEAR GATE

The following paragraphs are intended as an aid in the installation and checkout of the ORTEC 426. 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 Pulse Generator
Tektronix Model 580 Series Oscilloscope
100Ω BNC Terminators
Vacuum Tube Voltmeter
ORTEC 410 Linear Amplifier
ORTEC 427 Delay Amplifier
ORTEC 407 Crossover Pickoff

Table 5.1.

Pin No.	Test Point	Voltage (V)
1	Q7e	+ 0.2
2	Q4b	– 0.61
3	Q5b	– 1.7
4	Q9c	+ 10 .9
5	Q12c	+ 11 .4
6	Q13B	+ 0.6

Note: All voltages were measured from ground with vtvm having input impedance of 10 mΩ or greater. Voltages are dc values with no input pulses.

The following preliminary procedures should be observed:

1. Visually check module for possible damage due to shipment.
2. Plug module into Bin and check for proper mechanical alignment.
3. Connect ac power to ORTEC 4001/4002 Bin and Power Supply.
4. Switch ac power on and check the dc power supply voltages at the test points on the Power Supply control panel on the 401.

Use the following procedure to check the performance of the 426:

1. Feed the 419 Pulse Generator output into the 410 Linear Amplifier. Feed the Bipolar Output of the 410 into the 407. Crossover Pickoff. Feed the Output from the 407 into the Enable input of the 426. Set the 410 pulse shaping mode to Double RC (DRC), i.e., Integrator, First Differentiator, and Second Differentiator to 0.2 µs.
2. Also feed the Bipolar Output of the 410 into the ORTEC 427 Delay Amplifier. The output of the 427 should be approximately 0.5 V.
3. Observe the output of the 426. Adjust the trim potentiometer at the **top** of the board for a minimum pedestal.
4. The amplitude of both the initial and final transient negative spikes should not exceed 300 mV.
5. Feed the Output of the 427 into the linear Input of the 426. Measure the input and output of the 426. The input should not differ from the output by more than 80 mV.
6. Adjust the 410 gain controls to give a +8 V pulse into the linear Input of the 426. The Linear Gate Output should be 8 ± 0.4 V. Load the 426 Output with 100Ω. The output pulse amplitude should not decrease more than 0.15 V.
7. Adjust the 410 Linear Amplifier gain controls to give a +11 V pulse into the Input of the Linear Gate. The Linear Gate Output should saturate at greater than 20 V.
8. Remove the 427 Output from the linear Input on the 426. Rotate the Gate Width control over its entire range and measure the resultant gating period. The minimum should be 0.3 µsec or less and the maximum should be 4 µsec or greater.

5.2. ADJUSTMENT OF LINEAR GATING DURATION

The linear gating period is continuously variable from approximately 0.3 µsec to 4 µsec. The pulse width is controlled by capacitor C8 and resistors R34 and R35. To change the gating duration, simply adjust the control R35, which is recess-mounted on the front panel.

In the event that gating durations different from 0.3 to 4 µs are desirable, the capacitor C8 may be replaced with a capacitor of different value to change the range of gating duration. R35 will provide continuously adjustable pulse width within the new range.

5.3. ADJUSTMENT OF LINEAR GATE PEDESTAL

The Linear Gate has a trim potentiometer, R11, to allow the pedestal on the Linear Gate Output to be reduced to a negligible value, typically 1 mV. R11 is located near the top of the etched circuit board. To adjust the pedestal it is necessary to open the Linear Gate, with no input signal feeding into the Linear Gate input CN1 while observing with an oscilloscope the output of the Linear Gate. Observing the Linear Gate output, adjust the pedestal trim potentiometer until the pedestal is reduced to a negligible amount.

5.4. TABULATED TEST POINT VOLTAGES

The following voltages are intended to indicate the typical dc voltages measured on the etched circuit board. In some cases the circuit will perform satisfactorily even though, due to component variations, some voltages may measure outside the given limits. Therefore the voltages given should not be taken as absolute values, but rather as an aid in troubleshooting.

5.5. SUGGESTIONS FOR TROUBLESHOOTING

In situations where the 426 is suspected of malfunction, it is essential to verify such malfunction in terms of simple pulse generator impulses at the input and output. In consideration of this, the 426 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-Linear Gate system and the logic system perform satisfactorily with the test pulse generator.

The testing instructions in Section 5.1 of this manual provides assistance in locating the region of trouble and repairing the malfunction. The guide plate and shield cover can be completely removed from the module to enable oscilloscope and voltmeter observations with a minimal chance of accidentally short circuiting portions of the etched board.

5.6. 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, (865) 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.

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.