Model 579
Fast-Filter Amplifier
Operating and Service Manual

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ORTEC® Part No. 733530
Manual Revision C

1202

Advanced Measurement Technology, Inc.

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

WARRANTY

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, 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
579
FAST
FILTER AMP
COARSE GAIN
25
50
125
250
15
500
FINE GAIN
0.5
1.0
(ns)
INT
DIFF
20
50
100
10
200
OUT
500
CLIP
BLR ADJ P/Z
NON
INV
INPUT
OUTPUT


BUSY
PREAMP
POWER

ORTEC MODEL 579
FAST-FILTER AMPLIFIER

1. DESCRIPTION

The ORTEC Model 579 wideband Fast-Filter Amplifier with Gated Baseline Restorer is a state-of-the-art hybrid-circuit instrument (Fig. 1.1). It is designed to enhance fast-timing measurements by improving the slope-to-noise ratio and providing ultra-high count rate spectroscopy capability.

The experimenter will recognize ORTEC's firm commitment to fulfill the most demanding experimental needs with quality instrumentation. Fast (5 ns) rise time (Fig. 1.2), high output drive (±5 V into 50Ω), and wide voltage gain range (X0.9 - X500) make the 579 useful for many timing applications, including those utilizing low-gain photomultiplier tubes. The 579 is particularly suited for use with ORTEC Constant Fraction Discriminators such as the 583,584,934, or 473A in timing applications with High-Purity Germanium (HPGe) or Surface Barrier Detectors (Figs. 1.3, 1.4, and Table 1). Excellent dc and gain stability (±50μV/°C and ±0.05%/°C respectively) eliminates the need for a dc-level adjustment (Figs. 1.5 and 1.6), and, to further improve the human interface, a Busy LED and Busy Output are included to aid in BLR adjustment and system interfacing.

In addition, the wideband gated baseline restorer and pole-zero cancellation network permit ultra-high output counting rates (Fig. 1.7). A wide variety of pulse filtering is available for improved signal processing. The 579 combines continuously, variable gain, independently selectable integration and differentiation time constants (Figs. 1.8 and 1.9), and cable clipping capability (external cable delay), making this versatile unit an important asset for advanced time and energy spectroscopy.

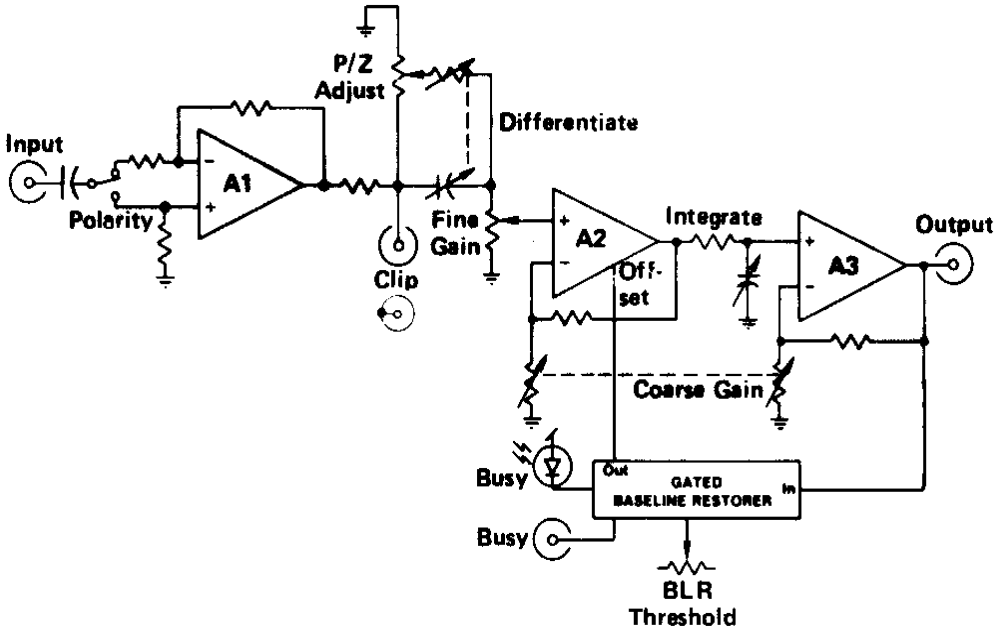

Fig. 1.1. Block Diagram of the 579 Fast-Filter Amplifier.

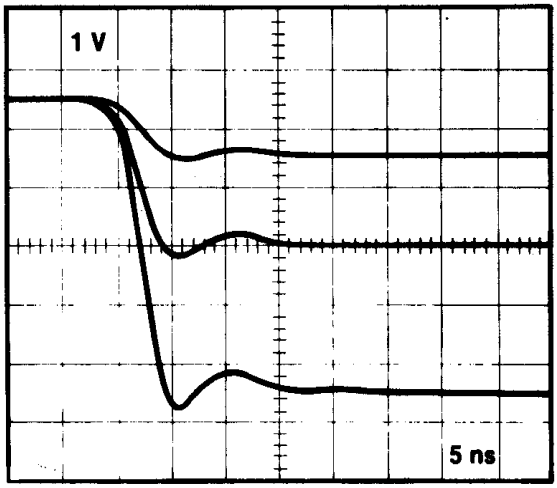

Fig. 1.2. 579 Output Signals for $T_i = T_D$ = Out at 1, 2.5, and 5V.

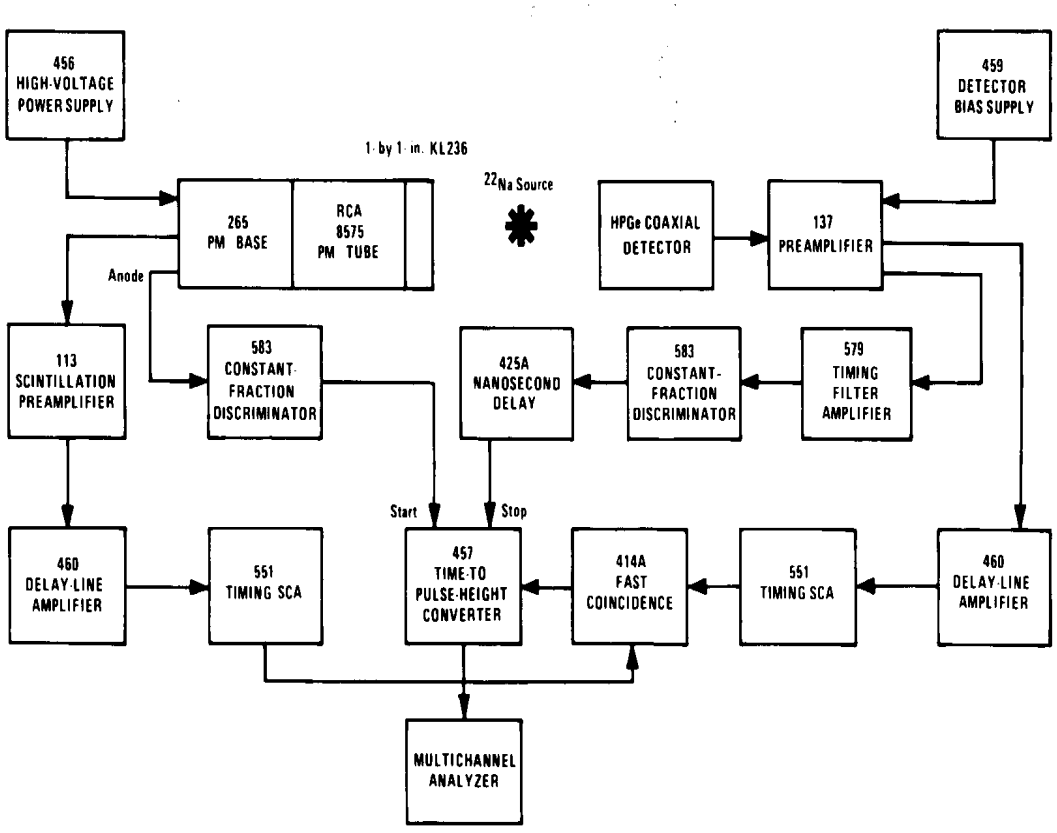

Fig. 1.3. Gamma-Gamma Coincidence System Using a Plastic Scintillator and a Large HPGe Coaxial Detector.

Table 1. Timing Resolution (ns) as a Function of Energy for an Energy Window of ±50 keV.

Detector System	Detector Type	Efficiency (%)	Constant-Fraction Delay (ns)	Measure	Timing Resolution (ns)								
					Mean Energy (keV) Using ^{22}Na				Mean Energy (keV) Using ^{60}Co				
					150	250	350	511	511	750	950	1170	1330
1	HPGe-P	17.7	26	FWHM	9.2	6.9	5.6	4.2	4.2	3.7	2.8	2.6	2.2
				FWTM		41.2	12.8	9.0	9.9	8.6	7.6	6.0	5.8
2	HPGe-P	28.0	34	FWHM	11.3	8.8	7.7	5.6	6.2	5.7	4.0	3.6	3.4
				FWTM		55.8	27.1	12.8	13.4	12.3	11.8	9.8	9.0
3	HPGe-P	11.0	24	FWHM	9.2	6.7	5.8	4.0	3.9	3.0	2.60	2.0	1.7
				FWTM		45.3	22.2	9.9	10.2	8.4	7.5	5.6	5.1
4	HPGe-N	11.6	23	FWHM	8.0	5.9	4.7	3.6	3.5	2.8	2.1	1.9	1.6
				FWTM	78	27.5	12.3	7.9	8.8	6.7	5.8	4.6	4.1
5	HPGe-N	19.8	23	FWHM	12.5	8.6	7.0	4.5	4.9	3.7	3.1	2.2	2.0
				FWTM	84	33	18.1	10.2	11.8	8.6	7.7	5.5	4.9
6	HPGe-N	16.4	24	FWHM	8.6	6.7	5.6	4.1	4.2	3.1	2.7	2.3	2.0
				FWTM	77.3	22.5	16.2	9.7	10.7	8.1	7.4	5.5	5.1

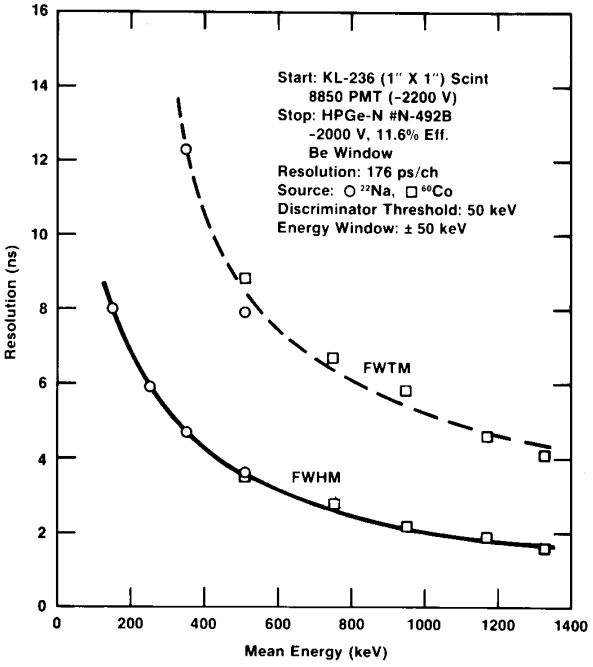

Fig. 1.4. Timing Resolution FWHM and FWTM as a Function of Energy for an Energy Window of ±50 keV.

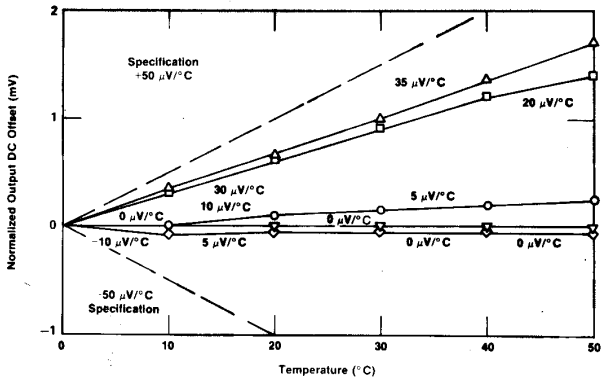

Fig. 1.5. DC Output Offset vs Temperature Measured on Five Typical Units.

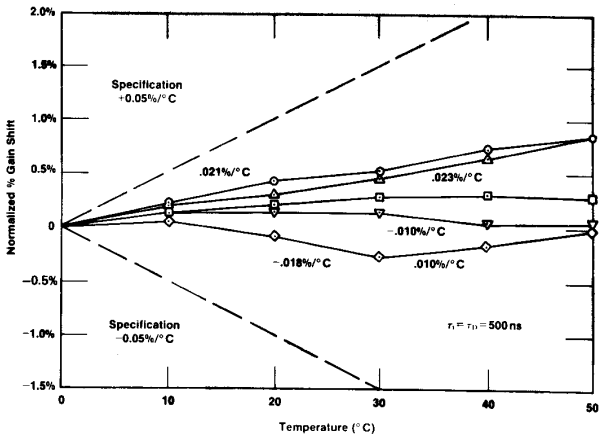

Fig. 1.6. Percentage Gain Shift vs Temperature Measured on Five Typical Units.

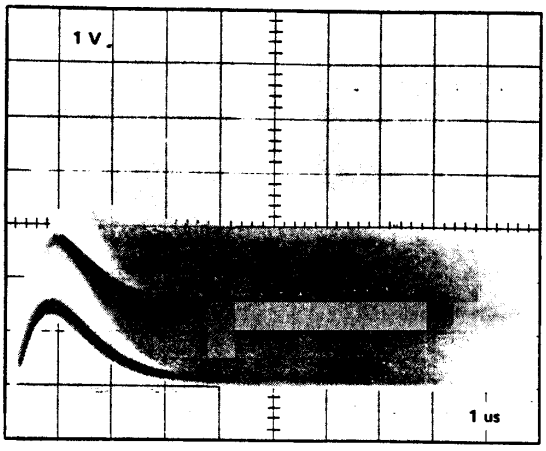

Fig. 1.7. Example of 579 Ultra-High Output Count Rate Capability.
Input signal from a BNC Random Pulse Generator at approximately 1 million counts per second. Fast-Filter Amplifier $\tau_r = \tau_D = 500$ ns.

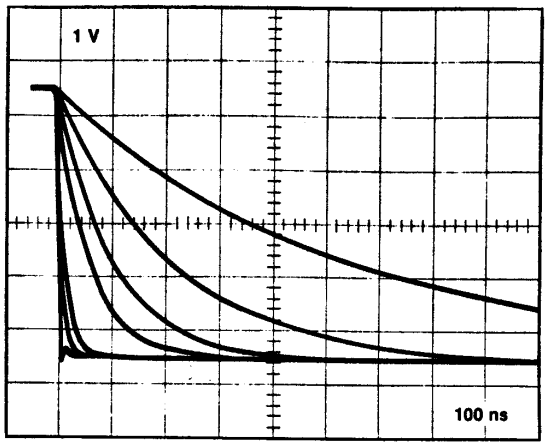

Fig. 1.8. 579 Output Signals for τ_D = Out and τ_r = Out, 10, 20, 50, 100, 200, and 500 ns.

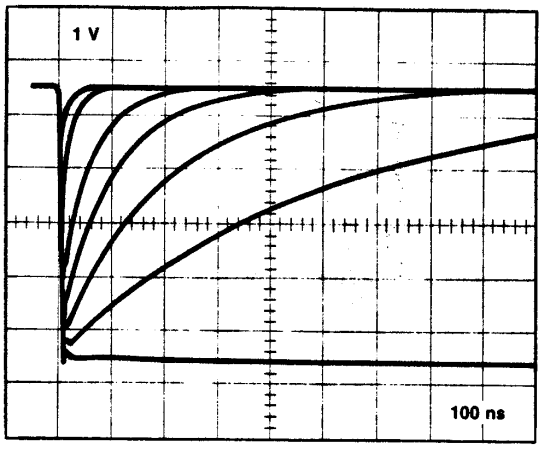

Fig. 1.9. 579 Output Signals for τ_r = Out and τ_D = Out, 10, 20, 50, 100, 200, and 500 ns.

2. SPECIFICATIONS

2.1. PERFORMANCE

INPUT SIGNAL AMPLITUDE RANGE ±1.0 V ac, ±5.0 V ac with X5 internal Attenuator; ±35 V dc; input impedance 100Ω; 50Ω optional.

OUTPUT AMPLITUDE RANGE 0 to ±5 V linear into a 50Ω load.

RISE TIME <5 ns with Integrate and Differentiate Out, or ≈2.2 τ_i for other integrate settings and Differentiate Out.

OVERSHOOT Typically 10% with Integrate Out, or <2% for any selected integration.

NOISE For maximum gain, rms noise referred to the input is <10 µV (typically 5 µV), with $\tau_i = \tau_D$) = 200 ns, measured with an HP3400A true rms voltmeter. Wideband (200 MHZ) noise for $\tau_i = \tau_D$ = Out is <50 µV (typically 40 µV).

INTEGRAL NONLINEARITY <1% (typically 0.5%) over ±5 V range into 50Ω load.

TEMPERATURE INSTABILITY DC level <±50 µV/°C referred to the output. DC level factory-set to ±5 mV. Gain instability <0.05%/°C (Figs. 1.5 and 1.6).

OPERATING TEMPERATURE RANGE 0°C to 50°C (273 to 323 K).

2.2. CONTROLS AND INDICATOR

COARSE GAIN Front panel 6-position switch to select X15, X25, X50, X125, X250, and X500 gain factor. When internal X5 Attenuator is used, the coarse gain factors represent X3, X5, X10, X25, X50, and X100 respectively. A continuously variable voltage gain of X0.9 to X500 can be obtained. (Gain reduced by factor of two when cable clip is used.)

FINE GAIN Front panel single-turn potentiometer, continuously adjustable from 0.3 to 1.0.

P/Z Front panel screwdriver adjustable potentiometer to adjust pole-zero cancellation for decay time constants from 25 µs to ∞.

DIFF Front panel 7-position switch selects a differentiation time constant to control the decay time of the pulse. Decay time ≡2.2 τ_D with τ_i = Out. The τ_D settings include Out, 10, 20, 50, 100, 200, and 500 ns.

INT Front panel 7-position switch selects an integration time constant to control the rise time of the output pulse. The rise time is ≡2.2 τ_i with τ_D = Out. The τ_i settings include Out, 10, 20, 50,100, 200, and 500 ns. Rise time in the Out position is <5 ns, equivalent to a τ_i <2.3 ns.

INV/NONINV Front panel locking toggle switch selects inversion or noninversion of the input signal.

BLR ADJ Front panel screwdriver adjustment to set the Gated BLR threshold from ±50 mV to ±500 mV referred to the output.

BLR GATED/UNGATED PCB jumper select for gated or ungated BLR operation. Factory-set in gated position.

BLR LED This feature enables the user to quickly adjust the BLR threshold setting near the noise peak. Front panel LED indicates an output amplitude has exceeded the BLR threshold. The BLR LED can be used as a visual indicator of the output count rate.

COUNT RATE

High/Low PCB jumper selects minimum BLR deadtime of typically 400 ns in high position and typically 1 µs in low position. Factory-set in low position.

ATTENUATOR PCB jumper select to pass with unity Gain or Attenuate by a factor of 5. Jumper select B to C and A to F will pass with unity Gain. Jumper select C to D and E to F will attenuate by a factor of 5. Factory-set at unity Gain.

2.3. INPUTS

INPUT Front panel BNC accepts input signals of either polarity, ±1.0 V ac or ±5.0 V ac with X5

Attenuator. Maximum dc voltage ±35 V. Input impedance 100Ω (to match preamplifiers); 50Ω optional.

CLIP Two front panel BNC connectors to provide delay line clipping of the input pulse. Cable impedance must be 50Ω. Delay line clip is 2X the cable propagation delay. Gain is reduced by factor of 2 when using cable clip.

2.4. OUTPUTS

OUTPUT Front panel BNC connector furnishes the amplified and shaped signal through Z_{out}, <lΩ. Amplitude 0 to ±5V into 50Ω; risetime and decay time constants controlled by the integrate and differentiate filter settings.

BUSY Rear panel BNC furnishes NIM-standard positive logic signal during the BLR busy time.

PREAMP POWER Rear panel standard ORTEC power connector, Amphenol 17-80090-15.

2.5. ELECTRICAL AND MECHANICAL

POWER REQUIRED +24V, 80 mA; -24V, 80mA; +12V, 160 mA; -12 V, 140 mA. NIM-standard single-width module.

WEIGHT
Net 1.5 kg (3.3 lb).
Shipping 3.0 kg (7.0 lb).

DIMENSIONS Standard single-width NIM module (1.35 X 8.714 in.) per TID-20893 (Rev).

3. INSTALLATION

3.1. GENERAL

The ORTEC Model 579 operates on ±12 V and ±24V power that must be furnished from a nuclear-standard bin and power supply such as the ORTEC 4001C/4002Series. The bin and power supply is designed for relay rack mounting. If the equipment is to be rack mounted, be sure that there is adequate ventilation to prevent any localized heating of the components that are used in the 579. The temperature of the equipment mounted in racks can easily exceed the maximum limit of 50°C (323 K) unless precautions are taken.

3.2. CONNECTION TO POWER

The 579 contains no internal power supply and must obtain the necessary dc operating power from the bin and power supply in which it is installed for operation. Always turn off power for the power supply before inserting or removing any modules. ORTEC modules are designed so that a full complement of modules installed in the bin will not overload the NIM-standard power supply. Since, however, this may not be true when the bin contains modules other than those of ORTEC design, the dc power levels should be checked after all of the modules have been installed. The ORTEC bins and power supplies have convenient test points on the power supply control panel to permit monitoring these dc levels.

3.3. INPUT/OUTPUT CONNECTIONS

The input impedance of the 579 is 100Ω and provides a suitable termination for cable with a characteristic impedance of 93Ω. If the cable that is used for the input signals has a characteristic impedance of 50Ω, use a BNC Tee at the 579 Input to accommodate the cable and a 100Ω terminator; the terminator and the input impedance, which are in parallel, will then match the 50Ω cable impedance.

The low output impedance of the 579 requires that the output cable be terminated by the characteristic impedance of the cable at its remote end. This can be accomplished at the input of a high-input impedance instrument or by using an instrument with an input impedance equal to the impedance of the cable.

4. OPERATING INSTRUCTIONS

Two principal functions may be furnished by the ORTEC Model 579 wideband Fast-Filter Amplifier, depending on the details of the system in which it is installed. The 579 may be used to linearly amplify a small amplitude range into one that is better suited to the requirements of a subsequent instrument in the system; the gain can be set at any level from X0.9 to X500 for this purpose. The shaping time constants that select integration and differentiation circuits in the 579 can be set to normalize a pulse rise and decay time to optimize timing measurements. In addition to these basic functions, the 579 can also be used to invert the pulse polarity if desired and to correct for the pole-zero effect from the preamplifier in the system.

There are no typical control settings that can be suggested for operation, since each application of the 579 will require a different combination of functions. After the system has been installed, use an oscilloscope to observe the waveforms at the input and output of the 579 and adjust its controls to optimize its operation, considering the functions that are required of it.

Generally speaking, the Integrate time constant can be selected so that the rise time of the output pulses is normalized at a rate that is slower than the rise times of the input pulses. This function is of greatest value when the pulses originate in a large detector so that they generate a wide variety of rise times and are difficult to observe for timing measurements. The Differentiate time constant is also selectable and determines the total interval before the pulse returns to the baseline and allows a new pulse to be observed. The combination of integration and differentiation time constants also contributes to the amount of electronic noise that is seen in the system, so the resulting waveforms should be considered from each of these points of view and adjusted for best results.

Care must be used to determine the best BLR threshold. The Busy LED on the front panel and Busy Output on the rear panel facilitate adjustment. The best way to adjust the BLR threshold is to first select the desired gain and filter settings and adjust the P/Z (pole-zero) with the detector connected to the 579 input. Next, remove or block the radiation source so that only background radiation strikes the detector. Lower the BLR threshold by turning the potentiometer counterclockwise until the BLR LED begins to flicker.

A more accurate BLR threshold adjustment can be made by connecting the 579 Busy Output to a counter/timer, such as the ORTEC Model 871, and adjusting the BLR threshold for approximately 200 cps at the Busy Output. The Busy Output indicates the time when the output signal is not being sampled by the gated baseline restorer.

If the BLR threshold is too low, there is a possibility of excessive noise on the baseline and a baseline shift at low counting rates. When the BLR threshold is set too high, a premature baseline shift will occur as count rate increases. These comments are generally true for any instrument having a gated baseline restorer.

5. MAINTENANCE

5.1. CORRECTIVE MAINTENANCE

The ORTEC Model 579 should require no regular maintenance other than replacement of components that have failed due to age. Always ensure that the replacement components are equivalent to the original parts. No internal trimming or adjustment is necessary for the 579.

5.2. FACTORY SERVICE

This instrument can be returned to the ORTEC factory for service and repair at a nominal cost. The ORTEC standard procedure for repair ensures the same quality control and checkout that are used for a new instrument. Always contact Customer Services 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. This number should be written 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.