ScintiPack™
Model 296
Photomultiplier Base with Preamplifier and High Voltage Power Supply
Operating and Service Manual

WARNING

This equipment generates, uses, and can radiate radio frequency energy, and if not installed and used in accordance with the instruction manual, may cause interference to radio communications. As temporarily permitted by regulation it has not been tested for compliance with the limits for Class A computing devices pursuant to subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against such interference. Operation of this equipment in a residential area is likely to cause interference, in which case the user, at his own expense, will be required to take whatever measures may be required to correct the interference.

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Manual Revision D

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.

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.

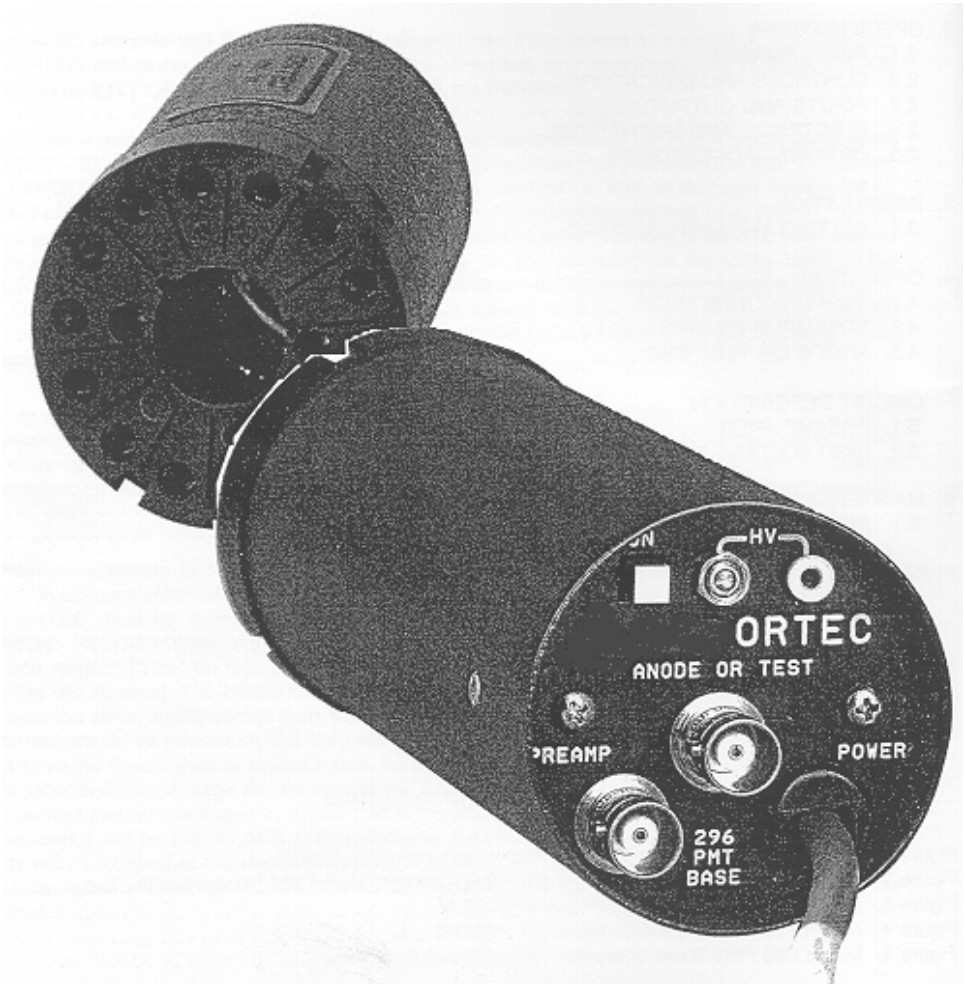
Cleaning Instructions

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.


HV
ORTEC
ANODE OR TEST
PREAMP
POWER
296
PMT
BASE

ORTEC ScintiPack™ (Model 296) Photomultiplier Base with Preamplifier and High-Voltage Supply

1. DESCRIPTION

The ScintiPack Photomultiplier Base (Model 296) includes everything needed for scintillation detectors in one compact package: a low-power, adjustable, high-voltage supply, an active bias network, and a spectroscopy preamplifier. Incorporating the bias supply in the photomultiplier base eliminates high-voltage cable connections to bulky, external HV supplies. As a result, ScintiPack operates with extremely low power consumption (240 mW). This makes the ScintiPack attractive for portable applications, as well as for high-density detector arrays.

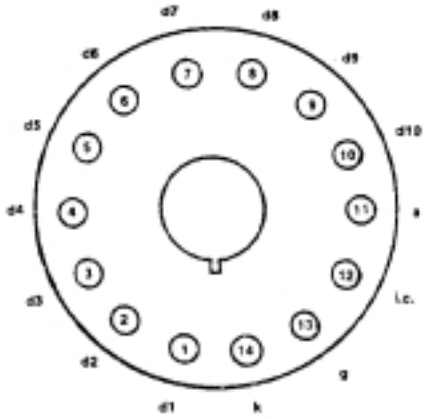
Because the preamplifier output signal is bundled into the power cable, only a single cable is required between the photomultiplier base and the main amplifier location. For example, the ORTEC µACE™ Analyzer accomplishes all signal interfacing with ScintiPack via the preamplifier power connector. The optional Signal Break-Out Adaptor can be used with amplifiers that do not offer signal interfacing through the preamplifier power plug. The adaptor attaches to the preamplifier power plug at the amplifier, and supplies the preamplifier signal on a coaxial cable for connection to the front-panel input of the amplifier. This approach maintains a single-cable connection from the ScintiPack to the amplifier location.

The ScintiPack biases the cathode of the associated photomultiplier tube at ground potential, and the anode at a positive voltage. The voltage applied to the anode can be optimized within the range of +600 V to +1100 V via a 20-turn screwdriver adjustment. This provides a cost-effective means of adjusting and matching photomultiplier gains in large arrays of scintillation detectors. The dynode bias network applies 1/6 of the anode voltage between the cathode and first dynode, and 1/12 of the anode voltage between the remaining pairs of electrodes. To provide excellent gain stability at high counting rates, the voltages applied to dynodes 8, 9, and 10 are transistor regulated. Feedback regulation is also applied to the anode voltage to achieve optimum gain stability for the entire photomultiplier tube.

The signal from dynode 10 is integrated on a 500-pF capacitor at the preamplifier input, amplified by the preamplifier gain, and presented as a positive-polarity pulse at the PREAMP output. A jumper on the printed circuit board allows selection of a preamplifier gain of X1 or X6. The preamplifier output signal can be accessed on pin 3 of the power connector, or at the BNC connector on the rear panel of the ScintiPack.

The anode signal is available on a rear-panel BNC connector to facilitate high-resolution timing in coincidence measurements. This output is intended to drive a 50-Ω coaxial cable to a timing amplifier or a timing discriminator. By moving a jumper on the printed circuit board, the anode output connector can be converted to a test input for the preamplifier. A pulser can be applied to the test input to check the operation of the entire chain of electronics, starting from the preamplifier input.

The PMT socket is a standard JEDEC B14-38 socket that fits 10-stage photomultiplier tubes with 14 pins. Figure 1 defines the pin assignments and Figure 2 illustrates the connections. The Model 296 ScintiPack Photomultiplier Base is compatible with the photomultiplier tubes listed in Table 1. Compatibility with tubes not listed in Table 1 can be checked by reference to Figures 1 and 2, and by comparison with the photomultipliers listed in the table.



d1-d10	Dynodes 1 to 10
a	anode
i.c.	internal connection
g	grid
k	cathode

Figure 1. JEDEC B14-38 PMT Pin Base, with Pin Assignments.

Table 1. Compatible Photomultiplier Tubes.

Burle (formerly RCA)	Hamamatsu	Philips
4900	PM55	XP2202B
5819	R208	XP2203B
6342A	R550	XP2412B
6655A	R594	
S83006E	R877	
S83013F	R878	
S83019F	R1507	
S83020F	R1512	
S83021E	R1513	
S83022F	R1612	
S83025F	R1791	
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	7696	

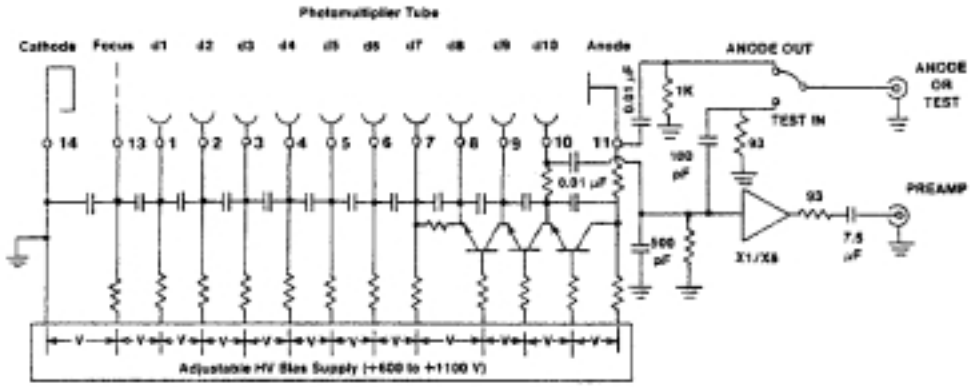

Figure 2. Simplified Schematic Diagram of the ORTEC Model 296 Photomultiplier Base.

2. SPECIFICATIONS*

2.1. PERFORMANCE

2.1.1. PMT BIAS

Cathode-to-Anode Voltage Adjustable from +600 V to +1100 V (grounded cathode, positive anode) with feedback regulation.

Bias Distribution 1/12 of the cathode-to-anode voltage is applied between: the cathode and focus electrode, the focus electrode and the first dynode, each pair of dynodes, and between the tenth dynode and the anode. Voltages on dynodes 8, 9, and 10 are transistor regulated for improved stability at high counting rates.

Temperature Sensitivity The cathode-to-anode voltage changes <100 ppm/°C over the operating temperature range of 0 to 50°C.

Bias Voltage Decay Time Nominally 3 minutes, when the HV switch is turned off.

2.1.2. PREAMPLIFIER

Output Polarity Positive.

Output Rise Time <100 ns for a fast pulser at the TEST input, or for a fast scintillator.

Output Decay Time Constant Nominally a 50-µs exponential time constant.

Conversion Gain Typically 1 µV/eV or 6 µV/eV (jumper selectable) for a 3-in. × 3-in. NaI(Tl) crystal and a PMT gain of 10^6.

Output Noise <300 µV RMS. Measured using and ORTEC Model 671 Amplifier under the following conditions: HV on, no PMT installed, X6 pre-amplifier gain, and a 1-µs amplifier shaping time constant.

Integral Nonlinearity <±0.1% from 0 to +6.5 V into a 1-kΩ load; measured via the TEST input. Maximum output is +7 V into an open circuit, or +3 V into a 93-Ω load. Overall linearity depends on the nonlinearity of the scintillator/photomultiplier combination.

Temperature Sensitivity Gain changes <±50 ppm/°C from 0 to 50°C, measured via the TEST input. Overall temperature sensitivity depends on the scintillator/photomultiplier combination and the bias supply.

Spectrum Shift Limited by the photomultiplier. Typically <±2% shift of the 662-keV peak position from a ^{137}Cs source for a change in counting rate form 0 to 100,000 counts/s in the entire spectrum. Measured using an ORTEC Model 671 Amplifier set to a 0.5-µs shaping time constant, and an ORTEC Model ACE™-4K-W3 Multichannel Analyzer.

Spectrum Broadening Limited by the scintillatior/ photomultiplier combination. Typically <10% broadening of the FWHM of the 662-keV peak from a ^{137}Cs source for a change in counting rate from 0 to 100,000 counts/s. Measured under the same conditions as Spectrum Shift.

2.2. CONTROLS AND INDICATORS

HV Rear-panel, 22-turn potentiometer provides adjustment of the HV bias voltage from +600 V to +1100 V. The adjacent test jack permits monitoring of the actual bias voltage with a digital voltmeter. A digital voltmeter reading of 1.000 V corresponds to an actual bias voltage of 1000 V. The output impedance of the test jack is <14 kΩ.

ON Rear-panel, push-button switch turns on the preamplifier and HV bias power when depressed. Pushing a second time releases the button and turns the power off.

X1/X6 A two-position jumper, located on the preamplifier printed circuit board, selects the preamplifier gain to be X1 or X6. Shipped set to X1.

ANODE OUT/TEST IN A two-position jumper, located on the preamplifier printed circuit board, selects the function of the rear-panel, ANODE or TEST connector. With the jumper in the ANODE OUT position, the anode signal is routed to the BNC connector for timing applications. Testing of the preamplifier function can be accomplished by moving the jumper to the TEST IN position and applying an external pulser to the rear panel connector. Shipped in the ANODE OUT position.

*Specifications subject to change without notice.

2.3. INPUTS AND OUTPUTS

ANODE OR TEST Rear-panel, BNC connector functions as either the anode output for timing applications, or as a test input for inserting test pulses into the preamplifier input. (See ANODE OUT/TEST IN jumper description).

ANODE OUTPUT With the internal jumper set to ANODE OUT, the negative-polarity anode signal is ac-coupled to the rear-panel BNC output, with an output impedance of 1 kΩ. Intended for driving a 50-Ω coaxial cable terminated in 50 Ω.

TEST IN With the internal jumper set to TEST IN, the rear-panel BNC connector is connected to the preamplifier test input. Input impedance is nominally 93 Ω in parallel with 83 pF.

PREAMP A rear-panel, BNC connector delivers the preamplifier output signal for applications where a separate signal cable is desired. The same signal is also available on pin 3 of the power cable connector for systems that accommodate a single-cable connection to the spectroscopy amplifier. Both outputs have a common, ac-coupled, 93-Ω output impedance, and are short-circuit protected. The signal from dynode 10 is integrated on a 500-pF capacitor at the preamplifier input, amplified by the preamplifier gain, and presented as a positive-polarity pulse at the PREAMP output.

PMT SOCKET TRW 3B14. Fits the standard JEDEC B14-38 photomultiplier tube pin base for 14-pin, 10-stage PMTs. See Figures 1 and 2 for pin assignments.

2.4. ELECTRICAL AND MECHANICAL

POWER REQUIRED +12 V AT 20 mA. Supplied via a captive power cord terminated in a standard preamplifier power plug (9-pin, D connector). Power cord length is nominally 3 m. The preamplifier power plug is compatible with the standard preamplifier power connector provided on most nuclear spectroscopy amplifiers. The preamplifier output signal is also delivered on pin 3 of this connector for use with the ORTEC µACE. An optional Signal Break-Out Adaptor is available for extracting the preamplifier signal at the power connector.

WEIGHT
Net 0.5 kg (1.1 lb).
Shipping 1.2 kg (2.6 lb).

DIMENSIONS 5.6 cm (2.2 in.) diameter x 17 cm (6.7 in.) length.

2.5. OPTIONAL ACCESSORIES

296-ADAPT SIGNAL BREAK-OUT ADAPTOR
Connects to the end of the power cable from the Model 296 and separates the preamplifier signal cable from the power cable. The 9-pin D connector on the adaptor plugs into the standard preamplifierr power connector on the rear of most spectroscopy amplifiers. The 60-cm-long preamplifier signal cable from the adaptor terminates in a BNC connector for connection to the input of a spectroscopy amplifier.

C-24-12 93-Ω, coaxial cable for connecting the PREAMP output to an amplifier input. (Not necessary when the Model 296 is used with the µACE, or when the 296-ADAPT is employed.)

RG-62A/U 93-Ω cable (3.7-m length) with two BNC connectors.

C-25-12 50-Ω, coaxial cable for connecting the ANODE output to timing instruments. RG-58/U 50-Ω cable (3.7-m length) with two BNC connectors.

3. INSTALLATION

3.1. SETTING THE HIGH VOLTAGE

The only adjustment on the ScintiPack PMT Base is the HV control, which adjusts the high-voltage output from +600 V to +1100 V.

Before applying power to the unit:
1. Adjust the HV potentiometer fully counter-clockwise (this is a 22-turn pot).
2. Connect a digital voltmeter to the HV test jack and ground.
3. Push the “ON” button on the rear panel to apply power to the ScintiPack. The digital voltmeter should indicate approximately +0.600 V. The DVM reading is the actual high voltage divided by one thousand. The 0.600 V reading indicates the high voltage is adjusted to 600 V.

4. Slowly increase the high voltage by adjusting the HV potentiometer clockwise, until the desired high voltage is obtained.

One the steps outlined in this section are performed, the unit is ready for connection to the system.

4. OPERATION

CAUTION

REMOVAL OF THE SCINTIPACK (MODEL 296) COVER EXPOSES COMPONENTS THAT OPERATE AT VOLTAGES UP TO 1100 V. ALWAYS UNPLUG THE CAPTIVE CABLE FROM THE POWER SOURCE, TURN THE POWER OFF, AND WAIT AT LEAST 3 MINUTES FOR THE HIGH VOLTAGE TO DISCHARGE BEFORE REMOVING THE COVER.

4.1. SYSTEM CONNECTION

ScintiPack is suitable for a variety of spectroscopy applications. Three of the most often used systems are illustrated.

Figure 3 shows ScintiPack connected directly to the ORTEC µACE card and computer via the captive cable on the ScintiPack. This configuration is very convenient since the preamplifier output and power connections are made through a single cable, eliminating multiple cable connections. The multichannel analyzer function is provided by the µACE card.

A portable spectroscopy system is shown in Figure 4. The ScintiPack is connected to the ORTEC NOMAD™ using the captive cable and the Model 296-ADAPT Signal Break-Out Adaptor. The multichannel analyzer function is provide by the NOMAD.

The standard system configuration using a conventional shaping amplifier and MCA is shown in Figure 5. A 93-Ω coaxial cable connects the preamplifier output signal to the amplifier input. The Model 296-ADAPT Signal Break-Out Adaptor shown in Figure 4 can also be used in Figure 5.

4.2. PREAMPLIFIER GAIN

The preamplifier has provisions for two gain settings. Jumper W2 on the preamplifier PWB, selects either X1 or X6 preamplifier gain. In the X1 position, the preamplifier has a conversion gain of nominally 1 µV/eV. In the X6 position, conversion gain is nominally 6 µV/eV. These numbers are typical for a 3-in. x 3 in. Nal (TI) crystal and a PMT gain of 10^6. The ScintiPack is shipped in X1 position.

4.3. ANODE OR TEST BNC

The ANODE or TEST BNC on the rear panel allows access to the anode output for use in timing applications, or connections of an external pulser to the preamplifier input. Jumper W2 on the preamplifier PWB selects either anode output or test pulser input. When the jumper is in the ANODE OUT position, the anode output signal is present at the rear-panel connector. The anode is internally terminated in a 1-kΩ impedance, with ac coupling to the anode. When the jumper is in the TEST IN position, test pulses from an external pulser can be fed to the preamplifier. This input is internally terminated with 93Ω. The ScintiPack is shipped in the ANODE OUT position.

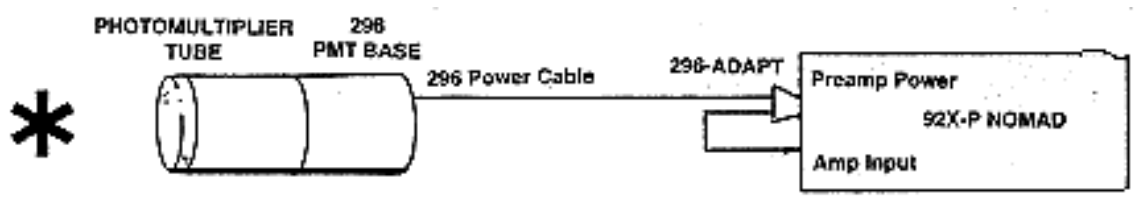

Figure 4. Model 296 PMT Base Connection to NOMAD.

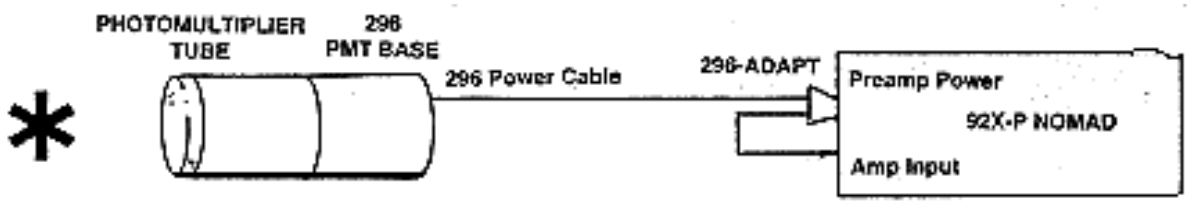

Figure 4. Model 296 PMT Base Connection to NOMAD.

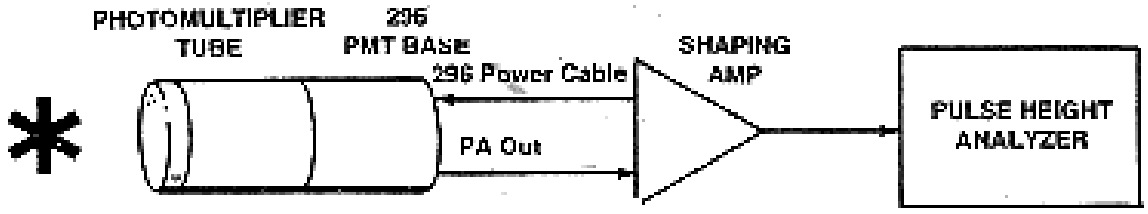

Figure 5. Model 296 PMT Base Connection to a Typical Amplifier.

5. MAINTENANCE

5.1. FACTORY REPAIR SERVICE

This instrument can be returned to the ORTEC factory for service and repair at a nominal cost. Our standard procedure for repair ensures the quality control and checkout that are used for a new instrument. Always contact ORTEC Customer Service at (865) 482-4411, before sending 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.