Model 266
Photomultiplier Base
Operating and Service Manual

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Manual Revision B

Advanced Measurement Technology, Inc.

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

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Quality Control

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

Repair Service

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

Damage in Transit

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

CONTENTS

SAFETY INSTRUCTIONS AND SYMBOLS

This manual contains up to three levels of safety instructions that must be observed in order to avoid personal injury and/or damage to equipment or other property. These are:

DANGER Indicates a hazard that could result in death or serious bodily harm if the safety instruction is not observed.

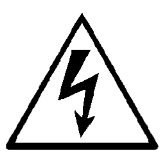
WARNING Indicates a hazard that could result in bodily harm if the safety instruction is not observed.

CAUTION Indicates a hazard that could result in property damage if the safety instruction is not observed.

Please read all safety instructions carefully and make sure you understand them fully before attempting to use this product.

In addition, the following symbol may appear on the product:

ATTENTION–Refer to Manual



DANGER–High Voltage

Please read all safety instructions carefully and make sure you understand them fully before attempting to use this product.

SAFETY WARNINGS AND CLEANING INSTRUCTIONS

DANGER	Opening the cover of this instrument is likely to expose dangerous voltages. Disconnect the instrument from all voltage sources while it is being opened.

WARNING	Using this instrument in a manner not specified by the manufacturer may impair the protection provided by the instrument.

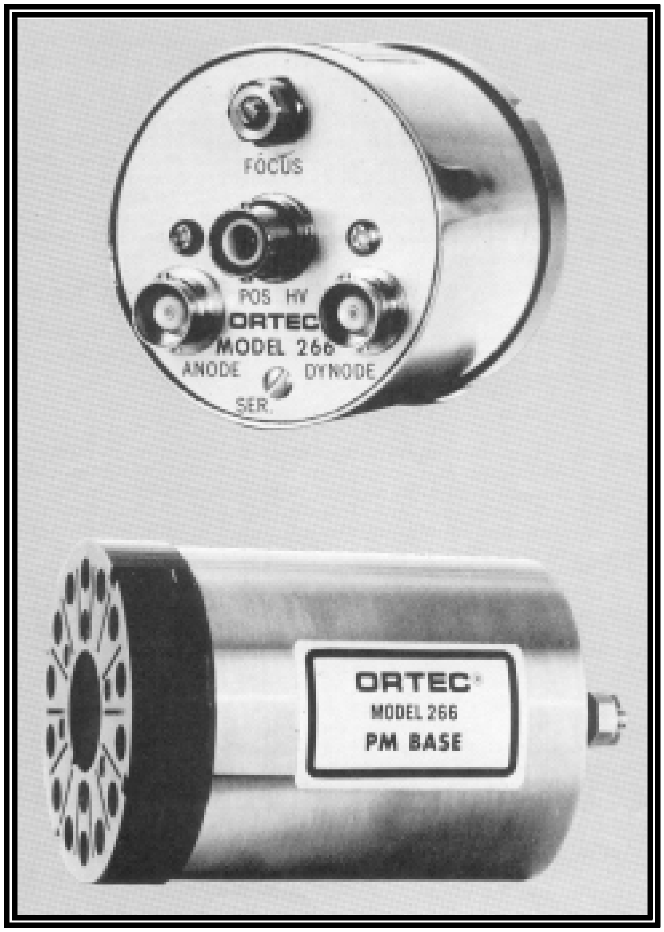
Cleaning Instructions

To clean the instrument exterior:

- Unplug the instrument from the ac power supply.
- Remove loose dust on the outside of the instrument with a lint-free cloth.
- Remove remaining dirt with a lint-free cloth dampened in a general-purpose detergent and water solution. Do not use abrasive cleaners.

CAUTION	To prevent moisture inside of the instrument during external cleaning, use only enough liquid to dampen the cloth or applicator.

- Allow the instrument to dry completely before reconnecting it to the power source.


FOCUS
POS HV
ORTEC
MODEL 266
ANODE
DYNODE
SER.
ORTEC
MODEL 266
PM BASE

ORTEC MODEL 266
PHOTOMULTIPLIER BASE

1. DESCRIPTION

1.1. GENERAL

The ORTEC 266 Photomultiplier Base is designed to provide a voltage distribution to essentially all 10-stage photomultiplier tubes that fit the standard 14-pin tube socket. This unit provides output signals capacitively coupled from the anode and the 10th dynode for use in coincidence timing or linear pulse height analysis. The access to both the last dynode and the anode allows a selection of signal polarity without the need of an inverting amplifier. Signal quality is such that these outputs may feed 50Ω terminated coaxial cables or linear preamplifiers such as the ORTEC 113 Scintillation Preamplifier. Some of The photomultiplier tubes with which this PM base is compatible are as follows:

RCA: 8053, 8054, 8055, 7326, 6655A, 6342A
Philips: XP-1000 to 1005, XP-1031 through 1033
EMI: 9656K, 9708K, and 9709K
CBS: 7817, 7818, 7819, and CL-1004 to 1012
Dumont: 6292, 6363, 6364

The 266 is also compatible with other tubes not listed above. Compatibility may be inferred by comparison with those listed.

2. SPECIFICATIONS

Note: All photomultiplier specifications are given by the manufacturer.

High Voltage Positive, 2.5 kV maximum.

Bleeder Resistance 1.5 MΩ total.

Controls Focus Electrode Voltage Adjust available externally.

Signals Anode, negative, Z_o ~1.1 MΩ, capacitively coupled; Dynode (10^{th}), positive, Z_o ~1.1 MΩ, capacitively coupled.

Connectors BNC.
High Voltage Connector SHV.

3. INSTALLATION INSTRUCTIONS

3.1. DETECTOR MOUNTING

Normally with 10-stage photomultipliers the amount of signal current pulled through the tube is small; therefore it is quite practical to run positive high voltage on the tube, i.e., run the cathode at ground potential. This means that when the detector is mounted to the photocathode, very little attention need be paid to the probability of leakage currents being created across the glass envelope, since the voltage potential should be zero. In many cases where the 266 is used, the detector will be mounted to the photomultiplier in an integral package, When this is the case, the photomultiplier tube can simply be plugged into the 266 and a positive high voltage of the desired value applied.

3.2. INITIAL ADJUSTMENTS

The only adjustment with this unit is that of the focus electrode, which optimizes the photocathode-first dynode geometry. Once the photomultiplier is plugged into the socket and the tube detector assembly is made light-tight, high voltage should be applied in accordance with the specifications of the particular tube involved and in line with the gain desired from the photomultiplier tube. Then the focus adjustment potentiometer should be adjusted to that value which produces the maximum output signal as monitored with an oscilloscope, either directly or after a linear amplifier. Note: When either the anode or dynode output is not being utilized, it should be terminated in a low impedance, e.g., 100-Ω, terminator.

3.3. CONNECTING INTO A SYSTEM

Either the dynode or anode signal may be coupled by way of an ORTEC 113 preamplifier into a linear amplifier for pulse preparation when scintillation spectrometry is to be performed. When a time signal is desired, either the dynode or anode signal may be utilized for this purpose. The output signal should be transmitted over high quality coaxial cable that is terminated at the receiving end into the timing electronics; the latter will usually be some type of fast amplifier and discriminator combination such as the ORTEC 260, etc.

4. OPERATING INSTRUCTIONS

Once the steps outlined in Section 3 of this manual are performed, the unit is ready for use. High voltage may be applied and adjusted for the appropriate gain associated with the specific experiment. The gain will vary by a factor of ~2 for each high voltage change of 100 V.

Note: It is advisable to operate the high voltage at the minimum practical value when high count rates are to be experienced, since count rate tolerance is a direct function of the photomultiplier gain.

4.1. TIMING WITH PHOTOMULTIPLIERS

Timing with photomultipliers implies some type of coincidence measurement. This measurement may be performed with standard coincidence circuits such as those of the pulse overlap type, which are essentially single channel time analyzers, or with time to pulse height converters, which are differential or multichannel time analyzers.

The response of the coincidence system to I a Prompt cascade always has a finite width that comes from a variety of sources. The most important of these are as follows:

1. variation of time of interaction of radiation with the scintillator and the amount of energy deposited therein,

2. finite decay time of light-emitting states in the phosphor and variation of times of photon arrival at the multiplier cathode,

3. variation of transit time of photoetectrons in the photomultiplier due to different path lengths and to variation of initial energy and angle of the secondary electrons,

4. jitter and uncertainties of times of triggering of the associated electronics.

The variation in the time of interaction can be minimized by appropriate geometry and small scintillators with a corresponding loss in efficiency and average energy deposition.

For a complete discussion of timing with photomultipliers the reader is referred to some of the excellent literature available on the subject.[1-4]

4.2. TIMING APPLICATIONS

The various applications for the ORTEC 266 are essentially limitless, but since the unit is designed for timing is well as spectroscopy, two of the most often used coincidence systems are discussed and block diagrams given. From these two block diagrams, other applications may be formulated by extension.

Typical Fast-Slow Coincidence System Using Nal(TI) The block diagram of Fig. 4.1 outlines a fast-slow coincidence system. The words "fast-slow" mean that these are essentially two channels of information retrieval operating in parallel. The fast channel sets the ultimate resolving time of the coincidence circuitry, and the slow channel selects the pulse-height range to be accepted from each detector. By means of a slower coincidence requirement, the slow channel requirement is combined with the fast coincidence requirement to yield information having the criteria of the fast

[1]A. Schwarzschild, ***NuoL tnstr. Methods* 21**,1 (1963).
[2]G. Present ***et al., NucL Instr. Methods* 31**(l), 71 (1964).
[3] E. Gatti and V. Svelto, ***Nucl. Instr. Methods* 30**, 213 (1964).
[4] ***The Single-Photon Technique for Measuring Light Intensity and Decay Characteristics***, ORTEC Application Note 35 (1971).

resolving time of the fast channel and the energy selection of the slow channel simultaneously.

In the fast channel, the amplifiers indicated may be a combination of fast amplifier-fast discriminator, e.g., the ORTEC 260 Time Pickoff Unit with the 403A Time Pickoff Control as a means of extracting fast timing information.

As shown in Fig. 4.1, the time spectrum from the time to pulse height converter is analyzed as the information channel. Of course, the output of the time to pulse height converter could be fed to the single channel analyzer to form the ultimate in a fast coincidence channel, which could then feed the coincidence circuit and allow pulse height analysis of either detector channel as desired.

Figure 4.2 outlines a simple conventional crossover pick-off coincidence system. This is probably the easiest and most versatile method of doing coincidence where the resolving time desired is not the ultimate. This method is very easy to use; however, it results in a 2τ coincidence resolving time which is theoretically a factor of ~12 worse than may .be achieved by leading edge timing such as was indicated in Fig. 4.1.

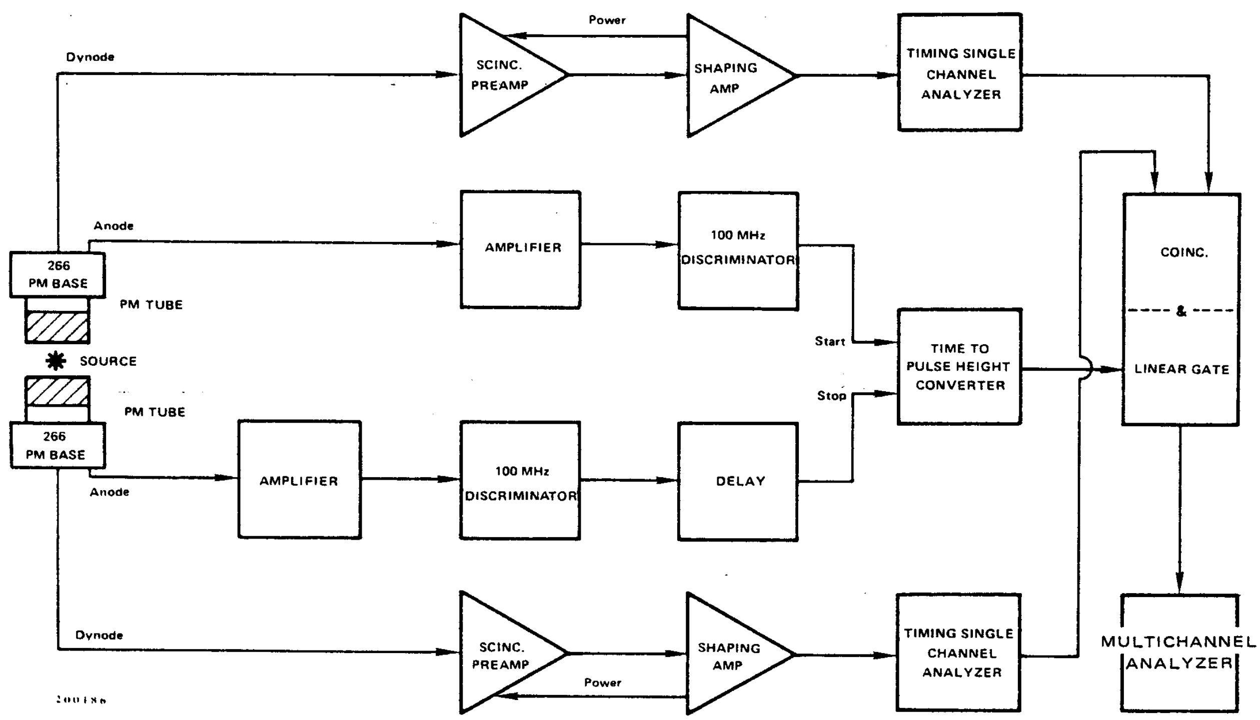


Fig. 4.1. Typical Fast-Slow Coincidence System Using Scintillators.

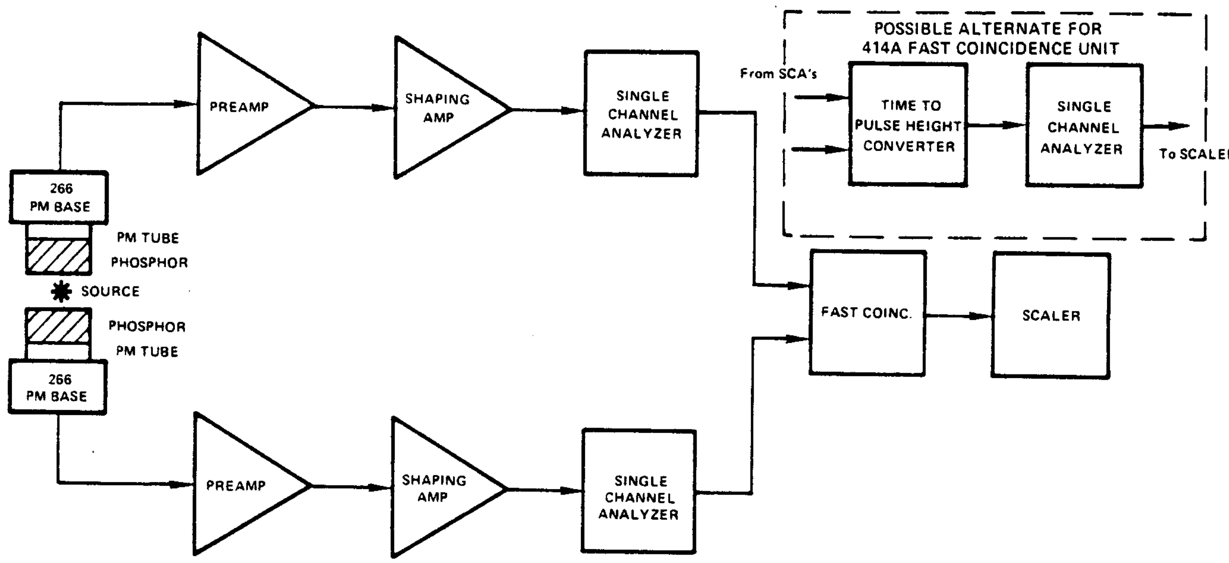


Fig. 4.2. Conventional Crossover Pickoff Coincidence System.

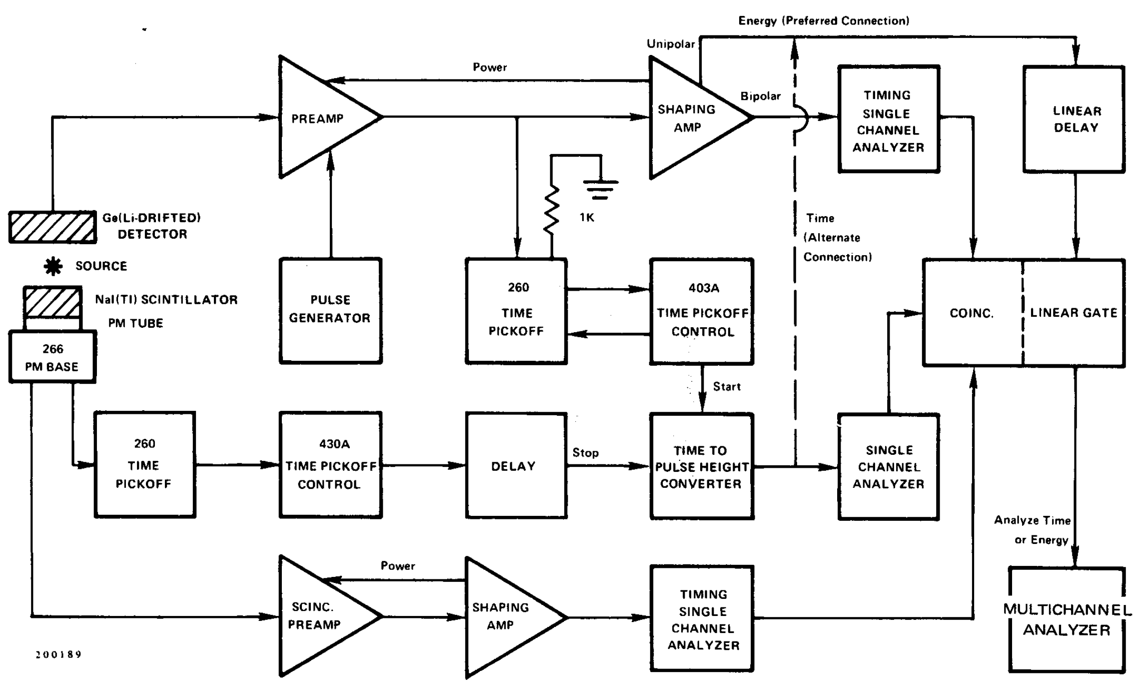


Fig. 4.3. Gamma-Gamma Coincidence System Using Ge(Li) Detector.

Gamma-Gamma Coincidence System for the Germanium (Li-Drifted) Detector Shown in Fig. 4.3 is a block diagram of an experimental setup that is quite versatile for studying decay schemes and transitional levels by means of coincidence between a lithium-drifted germanium detector and a scintillation detector. With this block diagram the experimenter may study either energy information or time information associated with the coincidence events.

4.3. SCINTILLATION SPECTROSCOPY

Scintillation spectroscopy implies the measurement of energy by the direct conversion of energy to light in a scintillator and the detection thereof by the photomultiplier. The system to perform this function is one of the most simple; i.e., it requires only the phosphor, the photomultiplier, a base structure for

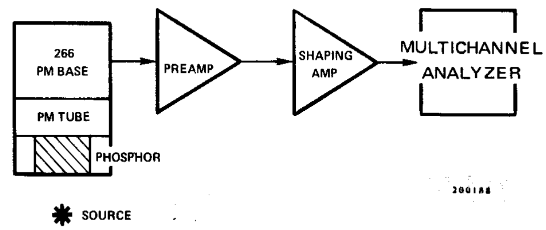


Fig. 4.4. Scintillation Spectroscopy System.

same, a preamplifier, and a linear amplifier with some type of measuring device such as a multichannel analyzer. Such a block diagram is shown in Fig. 4.4. With this, one may study directly the energy released in the phosphor by some incident radiation.

5. MAINTENANCE

Since the ORTEC 266 is composed only of passive components, very little maintenance is expected, entailing only such things as replacement of components that have failed with age. Table 6.1 lists the approximate dynode voltages for comparative purposes. In such a case almost all failures of the dynode string may be isolated by removing the PM tube and making these measurements.

Table 6.1. Typical dc Voltages

HV = +2000V

PM SOCKET PIN	VOLTAGE
1	+330
2	+500
3	+660
4	+830
5	+1000
6	+1170
7	+1350
8	+1520
9	+1690
10	+1840
11	+2000
12	NC
13	0 - +330
14	Ground