Model 142PC
Preamplifier
Operating and Service Manual

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Manual Revision B

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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NOTICE

This preamplifier has been shipped to you with its protection circuit connected into the input circuit. the protection circuit prevents destruction of the input FET due to large transients that may occur during abnormal operating conditions and serves as an impedance matching termination for the input cable from the proportional counter. The presence of the protection circuit imposes only a slight resolution degradation. With the protection circuit installed, the preamplifier is immune to almost anything the operator is likely to do that causes transients at either the detector input or the bias input connector.

The protection circuit does not protect the proportional counter, but even if the proportional counter breaks down as a result of over-voltage, the preamplifier will survive the resulting large transients if the protection circuit is in. This, of course, would not be true if the protection circuit were taken out, in which case the input FET is very susceptible to destruction by transients at the input connector on the preamplifier.

If the input protection circuit must be taken out for any reason, this involves disconnecting one transistor lead and installing a jumper across two series resistors. The Warranty on the 142PC is void if the protection circuit is taken out unless all of the following precautions are taken:

1. **COMPLETELY DISCHARGE** the bias circuit before connecting a low impedance, a cable, or any other capacitive device to the Input connector on the preamplifier.

2. Discharge the bias circuitry before making **any** connections to the Input connector and before disconnecting the preamplifier from the proportional counter.

3. To discharge the bias circuitry, connect a low impedance (shorting cap is preferred) for at least one minute across the Bias connector on the preamplifier.

4. Do not short the Input connector to ground, as the voltage-carrying center pin can become pitted or burned and form an area where corona discharge will then develop under normal use.

The Input circuit will be destroyed if the Input connector is shorted while the bias components are charged, and the quality of these capacitors is such that they will retain a charge through a long period of time. Such a short could result from connecting a detector, cable, or other capacitive device such as a voltmeter probe. A short circuit, either short term or continuous, will cause the applied bias (stored on C2) to be coupled directly to the input transistor, causing a catastrophic breakdown.

If a variable bias supply is used, merely turn down the voltage control to zero and leave it for at least one minute. This will suffice since the bias circuitry can discharge itself through the output of the bias supply.

Sometimes it is necessary to simply disconnect the bias supply, such as is the case when using batteries for bias. This situation leaves no discharge path, so a path must be provided by placing a short circuit or low impedance across the Bias connector on the rear panel of the preamplifier. **DO NOT SHORT THE INPUT CONNECTOR** on the front panel of the instrument unless the input circuitry has been completely discharged.

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.

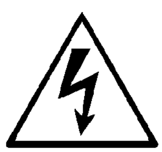
WARNING Indicates a hazard that could result in bodily harm if the safety instruction is not observed.

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
142PC
PREAMPLIFIER
INPUT
ORTEC
BIAS
±5KV MAX
TIMING
ENERGY
TEST
142PC
PREAMPLIFIER

ORTEC MODEL 142PC PREAMPLIFIER

1. DESCRIPTION

The ORTEC 142PC Preamplifier is a charge-sensitive unit that is designed for use with proportional counters in applications such as soft x-rays or low-energy gammas for spectroscopy where resolution approaching the theoretical limit is desired. It has been designed to provide the ultimate in both energy and timing resolution. The gain provided by the 142PC allows the counter to be operated at substantially lower voltages, thus reducing peak position shifts and peak broadening due to space charge effects in the tube and simultaneously extending the tube life.

A bias circuit is included to accept the operating voltage that is required. for the proportional counter. The bias circuit in the preamplifier includes about 29.5 megohms of resistance, and any detector leakage current will have to pass through this high resistance. A voltage drop is expected across this load resistance, proportional to the detector leakage current, and this must be added to the bias value to determine the adjustment level for the bias supply.

An input protection circuit is built into the preamplifier. It protects the input FET from any large transient voltages that would otherwise damage the transistor. This is discussed in the Notice (inside front cover). The protection circuit also provides a damping resistance on the input so that relatively long cable lengths can be used between the proportional counter and the preamplifier without disrupting the system stability.

An internal risetime compensation adjustment is accessible through a hole in the case of the unit. See Section 4.5 for adjustment information.

A Test Pulse connector with a built-in charge terminator is provided for use with a pulse generator such as the ORTEC 419, 448, or 480 to simulate the signal from the proportional counter. This allows a check of the system performance while an experiment is in progress.

The 142PC will accommodate up to ±3000 V bias for the proportional counter. The output pulse polarity is the same as the applied bias polarity. The 142PC Preamplifier output can be connected to a shaping main amplifier such as the ORTEC 451, 485, or 572 for energy spectroscopy, or to a timing filter amplifier such as the ORTEC 474 for time spectroscopy.

If it is necessary to open the case for any reason, observe the following instructions carefully to prevent serious injury to yourself and/or damage to the instrument.

Observe the steps that are included in the Notice at the front of the manual to discharge the high voltage and prevent shock: **the voltage levels that can be used are lethal** and the capacitors are very high quality so they retain a charge much longer than normally expected.

Do not touch the high-megohm resistors. R4 and R7, with your bare fingers; the presence of skin oil can reduce the resistance of the component and alter operating characteristics.

See Section 4 for instructions that involve the protection circuit.

2. SPECIFICATIONS

2.1. PERFORMANCE

NOISE Increases with increasing input capacitance. Typical performance values, based on silicon equivalent of $\epsilon = 3.6$ eV at $\tau = 2$ µs, are 2.9 keV at 0 pF and 4.1 keV at 100 pF; the typical slope is 20 eV/pF.

RISETIME Based on a +0.5-V signal through either output into a 93Ω circuit and measured from 10% to 90% of peak amplitude; risetime compensation adjustment optimized; 25 ns at 0 pF and 150 ns at 100 pF.

SENSITIVITY Nominal, measured through either output, 300 mV/MeV Si.

ENERGY RANGE 0 to 20 MeV Si.

ENERGY RATE 3×10^4 MeV/s.

DYNAMIC INPUT CAPACITANCE 1000 pF

INTEGRAL NONLINEARITY ≤0.05% for 0 to ±7 V open circuit or ±3.5 V terminated.

TEMPERATURE INSTABILITY ≤±50 ppm/°, 273 to 323 K (0 to 50°C)

DETECTOR BIAS ISOLATION ±3000V

OPEN LOOP GAIN ≥40,000

2.2. INPUTS

INPUT Accepts input signals from a proportional counter and extends operating bias to the proportional counter.

BIAS Accepts the bias voltage for the proportional counter from a bias supply.

TEST PULSE Accepts input voltage pulses from a pulse generator for instrument and system check and calibration; $R_{in} = 93\Omega$.

2.3. OUTPUTS

E and T (For Energy and Timing) Two connectors furnish identical signals through two output paths; either or both outputs can be used as required, and they are interchangeable; $R_o = 93\ \Omega$ through each connector and the output polarity is opposite from the input pulse polarity (output pulse polarity is the same as bias polarity).

2.4. CONNECTORS

INPUT AND BIAS Type SHV.

TEST PULSE, E AND T Type BNC.

POWER CABLE 10-ft (3-m) captive power cable, ORTEC 121-C1; longer lengths available from ORTEC on special order.

2.5. ELECTRICAL AND MECHANICAL

POWER REQUIRED Furnished from NIM bin and power supply through any ORTEC, main amplifier, or from an ORTEC 114 Preamplifier Power Supply; built-in captive cable is compatible with either source.

+24 V, 30 mA; -24 V, 10 mA;
+12 V, 15 mA; -12 V, 15 mA.

DIMENSIONS 1.75 X 5.2 X 4 in., plus 10-ft cable (44.5 x 132 x 100 mm, plus 3-m cable).

3. INSTALLATION

3.1. CONNECTION TO PROPORTIONAL COUNTER

A direct connection with shielded cable should be made between the proportional counter and the Input SHV connector on the preamplifier. The performance of the 142PC Preamplifier, like that of all other such low-noise preamplifiers, is degraded as the capacity at the input increases. Therefore it is important that the length of coaxial cable used between the proportional counter and the preamplifier be kept at the minimum length that is necessary. Also it is preferable to use 93Ω or 100Ω characteristic impedance cable rather than 75Ω or 50Ω cable because the capacity per foot is less for the cable with the higher characteristic impedance. Type RG-62/U cable is recommended; this has a 93Ω impedance and a capacitance of 13.5 pF/ft (40.1 pF/m). An AMP 51426-2 connector mates with the SHV connector on the 142PC Preamplifier.

Once the input cable installation has been made, the electronic noise performance of the 142PC can be predicted by calculating the cable capacity from the above information and adding the capacity expected from the proportional counter.

3.2. CONNECTION TO AMPLIFIERS

Either or both the E and T outputs of the 142PC can be connected to an amplifier input for further processing. The output impedance through either of these connectors is 93Ω providing series termination for 93Ω cable so that long unterminated cable lengths can be driven easily. Although the outputs are marked E (for Energy) and T (for Timing), the pulse characteristics are identical and the circuits are interchangeable.

In an energy spectrometer system, the preamplifier output is furnished into a shaping main amplifier. In a timing spectrometer system, the preamplifier output is furnished into a timing filter amplifier. With the dual output connections on the 142PC, the signals can be furnished simultaneously to both types of spectrometer systems. If either the E or T output connector is not being used, it should simply be left open-circuited (unterminated).

3.3. INPUT POWER

Power for the 142PC is supplied through the Power Cable that is captive through the rear panel of the unit. The normal connection for this power cable is included on the rear panel of the mating ORTEC amplifier, furnishing ±12 V and ±24 V from the bin and power supply in which the amplifier is operating. If this facility is not available or if such a connection would increase the loading on the bin and power supply beyond its maximum rated capacity, use an ORTEC 114 Preamplifier Power Supply to furnish the operating power requirements through the captive cable. The ORTEC 114 can furnish power for two preamplifiers simultaneously if desired.

3.4. TEST PULSE

A voltage test pulse for energy calibration can be accepted through the Test Pulse input connector on the 142PC without the use of an external charge terminator. The test input of the preamplifier has an input impedance of 93Ω and its circuitry provides charge injection to the preamplifier input. The shape of this pulse should be a fast risetime (less than 40 ns) followed by a slow exponential decay back to the baseline, (200 to 400 µs). While the test pulses are being furnished, connect either the detector (with bias applied) or the equivalent capacitance (without bias applied) to the Input connector on the 142PC.

The Test Pulse input may be used for the output of a pulser such as the ORTEC 419 or 448 to calibrate the preamplifier E output amplitude in terms of energy for multichannel analyzer calibration. However, due to stray coupling between the test circuit and other portions of the preamplifier circuitry, the transient performance of the preamplifier is best determined by connecting the actual proportional counter signal through the Input connector instead of using the pulse generator output signals for this calibration.

A voltage test pulse for transient response in the 142PC can be accepted through a charge terminator and into the Input connector on the 142PC. If external capacitance is to be included for these tests. an SHV tee can be inserted between the Input connector and the charge terminator, and this will then accommodate the test capacitances. Do not furnish any bias during these tests.

3.5. DETECTOR BIAS INPUT

Operating bias for the proportional counter detector is supplied to the Bias connector on the 142PC and, through a filter and a large bias resistance, to the Input signal connector. From there it is furnished out through the signal input cable to the proportional counter.

Connect a cable from the detector bias supply (ORTEC 459 is typical) to the Bias connector on the 142PC. Type SHV connectors are used in this high-voltage circuit and the mating cable should be furnished with the bias supply module.

4. OPERATION

4.1. GENERAL

When the 142PC is installed according to the appropriate information in Section 3, it operates at all times when power is applied from the power source; this is either from the bin and power supply through a mating amplifier or from an ORTEC 114 Preamplifier Power Supply. The only adjustment that will be made in or on the pre- amplifier is an internal risetime adjustment that is accessible through the case of the unit.

Figure 4.1 is a simplified block diagram of the circuits in the 142PC Preamplifier. When the protection circuit is in, the diode clamp to ground from a point between two resistors in the input circuit will protect the input FET transistor from large transients, which are not a part of the input pulse information. When the protection circuit is out, there is no clamp to ground and the two series input resistors are shorted by a jumper.

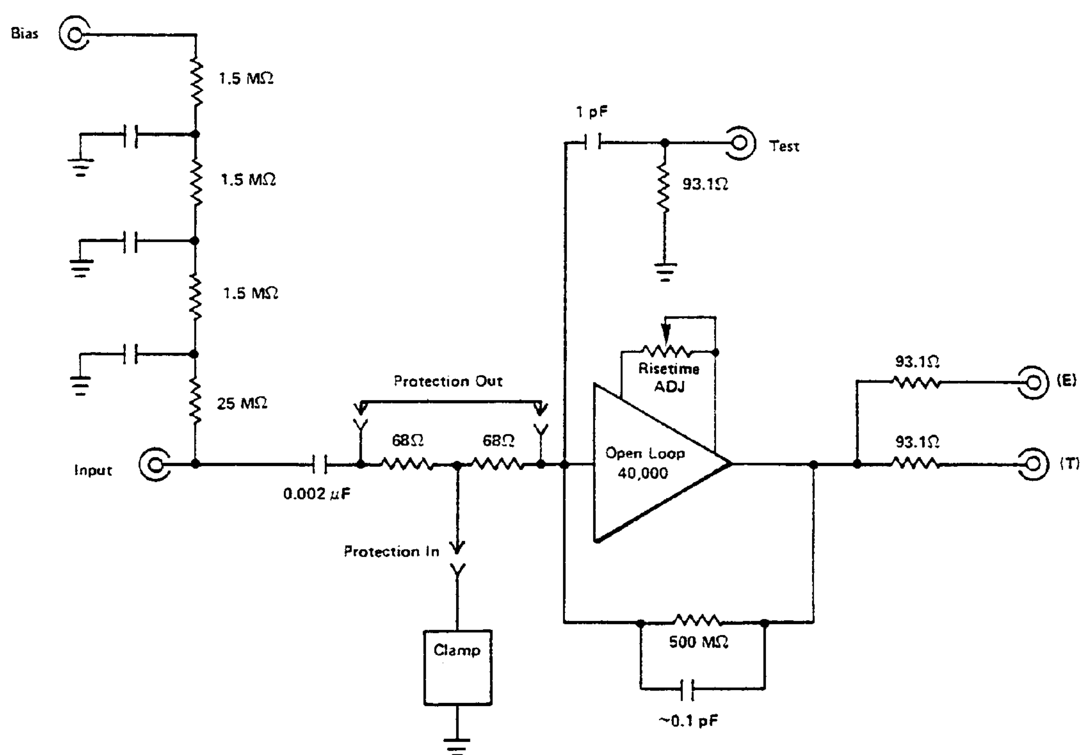


Fig. 4.1. Simplified Block Diagram of the 142PC Preamplifier.

4.2. DETECTOR BIAS

The amount of bias required to operate the proportional counter is specified in the data that are furnished with it. The bias that is accepted into the preamplifier through the SHV Bias connector is furnished through the load resistance (about 30 megohms) to the Input SHV connector of the preamplifier. If the leakage current through the proportional counter is appreciable, a notable voltage drop will occur across the series load resistance in the preamplifier, and this must be added to the detector requirement when the bias supply level is adjusted.

With the protection circuit in, the input cable can be removed and reconnected without catastrophic damage to the preamplifier even when bias is applied to the circuit; but the user must be very cautious to prevent touching the interior of the connector with anything other than a good insulator because potentially lethal high voltage can be present on the center pin of the Input connector under these conditions.

With the protection circuit out, the operating bias level **must be reduced gradually to zero** before the proportional counter is either connected to or disconnected from the Input connector on the 142PC.

4.3. ENERGY OUTPUT

The charge-sensitive loop is essentially an operational amplifier with a capacitive feedback that depends on the stray capacitance of the feedback resistor; the value of this feedback is approximately 0.15 pF. The conversion gain is approximately 300 mV/MeV. If less conversion gain is desired, a capacitor can be added across the feedback resistor. Up to 2 pF may be added without seriously affecting the stability of the preamplifier. If the feedback is increased to about 1 pF, the conversion gain is reduced to around 45 mV/MeV.

The energy output signal from the preamplifier is a fast risetime voltage step with an exponential return to the baseline in about 75 µs. The polarity of signals through the E output is inverted from the signal polarity at the output of the proportional counter. When the (normal) positive bias polarity is used for the detector, its output pulses are negative and the E output of the preamplifier is positive.

4.4. TIMING OUTPUT

The T output connector provides an alternate path for the same output pulses that are furnished through the E output connector. The intent is to provide both connections for convenience when the 142PC Preamplifier is used to drive two systems - one for energy spectroscopy and the other for timing spectroscopy.

4.5. COMPENSATION ADJUSTMENT

A bandwidth compensation control is accessible to the user of the 142PC. This control can be adjusted through the bottom of the case without opening the unit. It is used to tune the preamplifier to the particular proportional counter that is connected in order to obtain the fastest risetime for the best time resolution. Although a fast risetime is not necessary for energy measurements, a typical timing experiment will provide the best timing resolution when the rise time is optimized with this control. Because of the high voltages that are present inside the case when the preamplifier is operating, a small plastic screwdriver or a TV tuning tool should be used for this adjustment.

CAUTION

Do not use a metal screwdriver for this adjustment; there is a possibility of high-bias leakage on the printed circuit that could cause a severe shock.

When the 142PC Preamplifier is shipped from the factory, the compensation adjustment has been set for the specified rise time for a 0-pF input capacitance; For optimum results for other input capacities, the control should be adjusted under actual operating conditions.

If the control has been adjusted for optimum bandwidth for a specific input capacity and the input circuit is then changed to provide less capacity, control readjustment is necessary so that the preamplifier will not oscillate. If the input capacity is increased from the value for which the adjustment has been made, the preamplifier should be stable and should not oscillate.

4.6. INPUT PROTECTION

A provision is built into the preamplifier to protect the input FET stage from damage when high-voltage transients are applied to its input. These transients can result from any one or more of many causes, including detector breakdown, moisture condensation on the input connector, short circuits or uncharged capacitance connected across the input while bias is being applied through the preamplifier, or disconnection of a bias voltage without first reducing it gradually to zero.

The protection circuit is installed in the preamplifier when the unit is shipped from the factory. Although it offers protection to the FET, it also causes some degradation of the noise performance of the preamplifier, which increases as detector capacity increases.

With the protection circuit in, the collector lead of Q11 is attached to the center tap of the two series input resistors to the FET, R39 and R5. Transistor Q11 is connected as a diode, with both the base and the emitter tied through R8 to ground. This prevents the voltage in the input circuit from rising beyond the safe limit for the FET input. To take the protection circuit out, simply remove the collector lead of Q11 from its circuit connection and install a wire jumper across R39 and R5.

Inherent to all high-speed charge-sensitive preamplifiers is the problem of keeping the total system stable while interconnecting the detector and preamplifier with long cables. To help ease this problem and permit more flexibility for installations, the protection circuit is designed to serve not only as a protection for the FET input but also to terminate the input cable in a nominal 100Ω. So it is recommended that the protection circuit be left in whenever possible.

In order to take full advantage of the risetime capabilities of the 142PC for timing experiments (typical risetimes of 25 to 150 ns for detector capacities from 1 to 100 pF), the total cable length should be kept as short as possible, even though it is terminated. Due to vagaries in the system installation – ground loops, stray inductances, etc.– and since the maximum cable length is a factor in the input capacitance to the preamplifier, it is not possible to give absolute numbers. Generally, two feet is a typical maximum length to obtain fastest risetimes for low detector capacities. Of course, the system can be compensated for cable lengths of up to 5 or 6 feet but slower risetimes will be obtained. The screwdriver adjustment inside the case can be used to stabilize the system and minimize the pulse risetime.

5. MAINTENANCE INSTRUCTIONS

5.1. TESTING PERFORMANCE

As ordinarily used in a counting or spectroscopy system, the preamplifier is one part of a series system involving the source of particles to be analyzed, the detector, the preamplifier, the main amplifier, and the pulse height analyzer. When proper results are not being obtained and tests for proper performance of the preamplifier and the other components are indicated, it is important to realize that rapid and logical testing is possible only when the individual components are separated from the system. In proving the performance of the preamplifier, it should be removed from the system and be dealt with alone, by providing a known electrical input signal and testing for the proper output signals with an oscilloscope as specified in the following steps.

1. Furnish a voltage pulse to the Test Pulse connector as outlined in Section 3.4. The polarity of the test pulse signal should agree with the expected signal input polarity from a proportional counter.

2. Using a calibrated pulser, the 142PC output, either E or T, should be inverted from the input and have a nominal scale factor of 300 mV per 1 MeV equivalent energy (Si).

3. The noise contribution of the preamplifier may be verified by two basic methods. In either case, the

normal capacity of the detector and associated cables should be replaced by a capacity of equal value placed across the input connector, and no bias should be applied. This is necessary because the noise contribution of the preamplifier is dependent upon input capacity. The only meaningful statement of the noise level is one that relates to the spread caused by the noise in actual spectra. This can be measured and expressed in terms of the full width at half maximum (FWHM) of a monoenergetic signal after passing through the preamplifier and main amplifier system.

The noise performance referenced in Section 2 is stated in these terms, and verification methods will be described. If desired, the preamplifier can be tested with no external capacity on the Input connector, in which case the noise width should be approximately that shown for zero external capacity. In any case, the input connector and capacitors, when used, should be completely shielded electrically. A wrapping of aluminum foil around the Input connector or a shielding cap attached to the connector will suffice for testing at zero capacity.

4. The preamplifier must be tested in conjunction with an associated main amplifier that provides the required pulse shaping. The typical noise performance given in Section 2 is obtained using an ORTEC 572 Spectroscopy Amplifier on which 2-µs time constants have been selected as specified. For comparison of these tabulated values, it is preferable to test the preamplifier under identical pulse-shaping conditions. It is also important to ensure that the noise level of the input stage of the associated main amplifier does not contribute materially to the total noise. This is usually no problem provided that input attenuators, if any, on the main amplifier are set for minimum attenuation.

5. If a multichannel analyzer is used following the main amplifier, testing of the noise performance can be accomplished by merely using a calibrated test pulse generator with charge terminator. With only the charge terminator connected to the the 142PC Input, the spread of the pulser peak thus analyzed will be due only to the noise contribution of the preamplifier and main amplifier. The analyzer can be calibrated in terms of keV per channel by observing two different pulser peaks of known energy, and the FWHM of a peak can be computed directly from the analyzer readout.

6. It is also possible to determine the noise performance of the preamplifier by the use of a wide-bandwidth rms ac voltmeter such as the Hewlett-Packard 3400A, reading the main amplifier output noise level and correlating with the expected pulse amplitudes per keV of input signal under the same conditions. Again, a calibrated test pulse generator is required for an accurate measurement.

In this method the preamplifier and main amplifier are set up as they would be used normally, but with a dummy capacitor (or no capacity) on the Input connector of the 142PC, and with the ac voltmeter connected to the main amplifier output. The noise voltage indicated on the meter, designated E_{rms}, is read and noted. Then a test pulse of known energy, E_{in} (in keV), is applied to the Input and the amplitude of the resulting output pulse, E_{out} is measured in volts with an oscilloscope. The noise spread can then be calculated from the formula

$$\text{FWHM (keV, Si det)} = \frac{2.35\ (E_{rms})\ (E_{in})}{E_{out}},$$

where E_{rms} is output noise in volts on the 3400A meter, E_{in} is input signal in keV particle energy, and E_{out} is output signal in volts corresponding to the above input. If the gain of the shaping amplifier is adjusted so that the output pulse height is 2.35 V for an input of 1 MeV equivalent charge, then the rms meter will be calibrated directly in energy (1 mV = 1 keV).

7. The noise performance of the preamplifier, as measured by these methods, should not differ significantly from that given in the specifications in Section 2.

8. If, during testing of the preamplifier and detector, the noise performance of the preamplifier has been verified as outlined in the preceding section or is otherwise not suspected, a detector may be tested to some extent by duplicating the noise performance tests with the detector connected in place and with normal operating bias applied. The resulting combined noise measurement, made either with an analyzer or by the voltmeter method, indicates the sum in quadrature of the separate noise sources of the amplifier and the detector. In other words, the total noise is given by

$$(N_{tot})^2 = (N_{det})^2 + (N_{amp})^2.$$

9. Each quantity is expressed in keV FWHM. The quantity N_{det} is known as the "noise width" of the detector, and is included as one of the specified parameters. By use of the above equation and with a knowledge of the noise of the preamplifier, the noise width of the detector can be determined. The significance of this noise width in evaluating the detector is subject to interpretation, but generally the actual resolution of the detector is related directly to the noise width in its normal applications. The most useful purpose for determining this quantity for the detector is occasional monitoring of the detector noise width to verify that its characteristics have not undergone any significant change during use.

10. Use an ORTEC 419 Precision Pulse Generator with a matched charge termination to measure the rise time of the 142PC through the T or E output connector. Connect the 419 output through the charge terminator to the input of the 142PC and use an oscilloscope with a fast (1 ns if possible) rise time. The rise time of the preamplifier can then be computed by:

$$(\text{Total risetime})^2 = (\text{Preamp risetime})^2 + (\text{Pulser risetime})^2 + (\text{Oscilloscope risetime})^2.$$

The risetime of the 419 is typically 3 ns.

5.2. FACTORY REPAIR

This instrument can be returned to ORTEC 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 the Customer Service Department 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 factory.