Model 2025
AFT Research Amplifier

2025-USR 4/98
9231227A

User's Manual

ISO 9001
SYSTEM
CERTIFIED

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The information in this manual describes the product as accurately as possible, but is subject to change without notice.

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1. Introduction

The Model 2025 represents the latest in spectroscopy amplifier design and includes all the features associated with a research grade signal processor: differential inputs for common mode noise rejection, wide gain range with Super Fine Gain (SFG) control, choice of semi-Gaussian or semi-triangular pulse shaping to meet most detector applications and requirements, a flexible Baseline Restorer and an integral Pile Up Rejector and Live Time Corrector.

Although some of the features of the 2025 are available in other amplifiers, the 2025 goes a step further with Automatic Fine Tuning (AFT) which makes the unit easy to set up and use. With the AFT circuit activated, critical performance adjustments are automatically optimized eliminating the subjectiveness and guesswork normally associated with manual fine tuning. The results are consistent and repeatable, and nearly operator independent.

With the 2025 there is no need for an oscilloscope to optimize pole/zero (P/Z) matching. The operator simply starts the optimization process by pressing the AUTO SET button. The BUSY LED lights and the P/Z matching circuit begins converging on the optimal setting required for good high count rate resolution, peak stability and overload recovery. When the process is complete the BUSY LED turns off.

As an added convenience, the BUSY indicator will blink to prompt the operator to start the auto P/Z matching sequence when the unit is first powered up or if power is momentarily interrupted. The BUSY LED will also blink if the preamplifier signal fall time constant exceeds the P/Z matching range or if convergence is not achieved within two minutes.

With AFT invoked, the PUR threshold is also automatically set just above the system noise level, insuring PUR efficiency and minimal spectral distortion due to pile up at high count rates. With NORM restoration selected, the restoration rate and threshold are automatically fine tuned for all shapings, gain and count rate conditions.

For Reset Preamp applications, set the AFT switch to RESET PREAMP, which automatically optimizes the amplifier P/Z at infinity, independent of the MANUAL P/Z potentiometer setting. The PUR THREShold must be set manually.

For the discriminating researcher who wants to retain manual control, the AFT can be switched off. P/Z matching and PUR THRESHold now require manual control and optimization.

The 2025 employs three active complex-pole filters for improved pulse symmetry, reduced pulse dwell time and high throughput. For additional flexibility, semi-Gaussian or semi-triangular pulse shaping are front panel selectable.

Triangular shaping offers superior energy resolution due to its inherently longer rise time, better signal to noise ratio and reduced sensitivity to detector rise time variations. The amplifier offers six front panel switch-selectable shaping time constants, which effectively doubles to 12 when the choice of Gaussian and triangular are both considered, allowing optimum matching for most detector and count rate requirements.

The gated baseline restorer with automatic rate and threshold assures the best possible low and high count rate resolution performance. The flexibility of the baseline restorer is further enhanced with the ASYMmetrical and SYMmetrical restorer modes. The asymmetrical mode virtually eliminates charge accumulation and correlated noise on the restorer holding capacitor and is especially suited for use with high resolution detector systems. The symmetrical mode allows performance optimization for detector systems which exhibit baseline discontinuities resulting from excessive noise, microphonics, high voltage effects and preamp secondary time constants.

The 2025 has a differential input stage which can be used to suppress noise caused by ground loops, laboratory environment EMI and the resultant noise pick-up on cables and so forth. It is especially useful for applications which require long cables between the detector/preamplifier and amplifier. As with most other Canberra amplifiers, cable transformers are included in the 2025 to suppress high frequency noise normally associated with personal computer and MCA raster-type displays. A front panel Common Mode Balance (CMB) control allows common mode rejection optimization for the specific application.

Simultaneous UNIpolar and BIpolar output signals are available at both the front and rear panel BNC connectors. The bipolar output can be used for counting, timing or gating.

The Live Time Corrector and Pile Up Rejector circuit allows quantitative gamma analysis nearly independent of system count rate. Special circuitry interrogates for pile up and permits the ADC to convert only those detector signals resulting from single energy events. To compensate for rejected pulses and pulse processing times, the 2025 generates a system dead time which extends the collection time by the appropriate amount.

The front panel ACCEPT/REJECT LED indicates pile up rejector status. As the count rate and the number of pulses rejected due to pile-up increase, the LED changes color.

2. Controls and Connectors

This is a brief description of the 2025's front panel controls and connectors. For more detailed information, refer to Appendix A, Specifications.

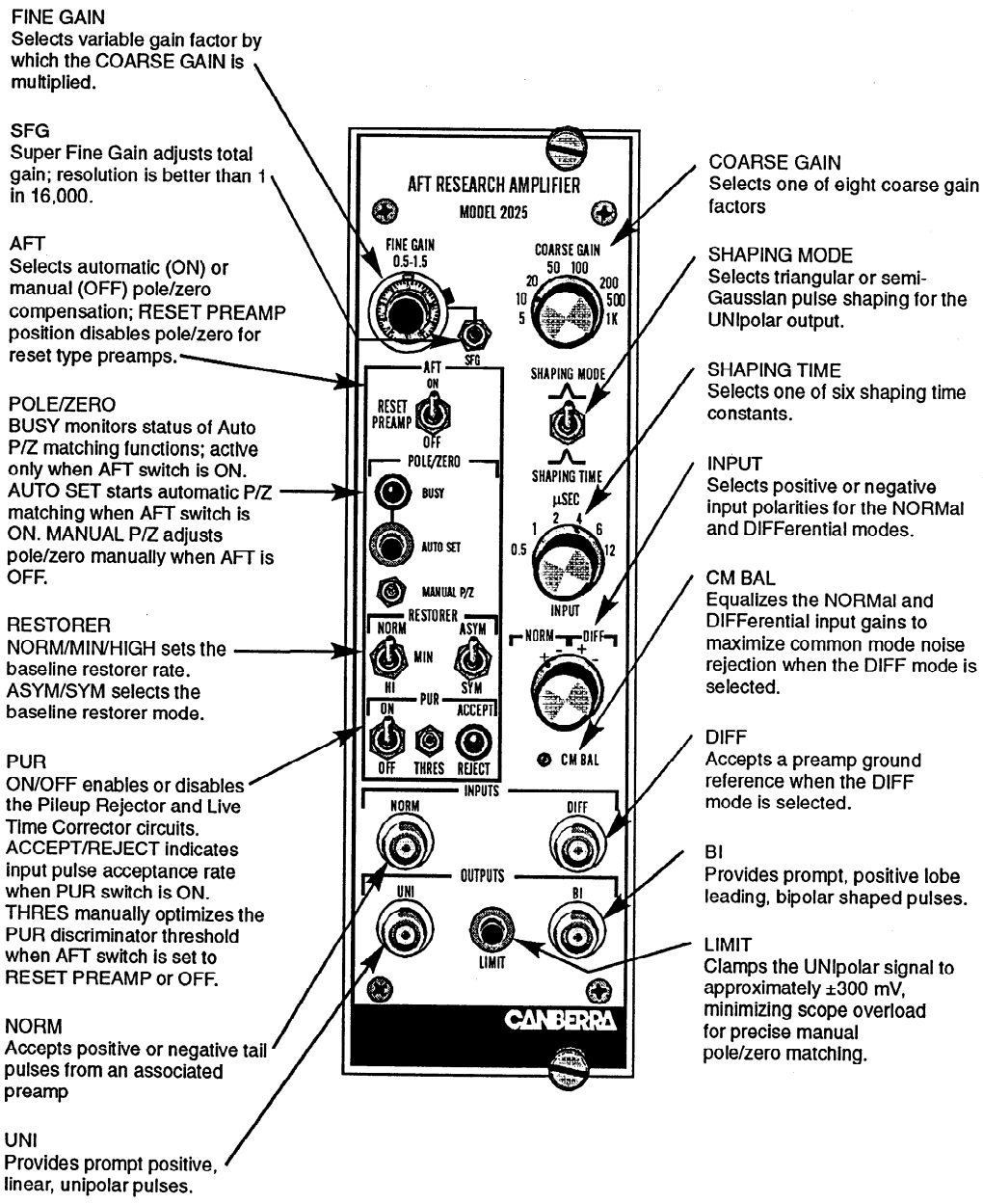

Figure 2.1 Front Panel Controls and Connnectors

This is a brief description of the 2025's rear panel connectors. For more detailed information, refer to Appendix A, Specifications. Appendix B describes the internal jumper plug controls which you should set for your specific requirements before applying power to the module.

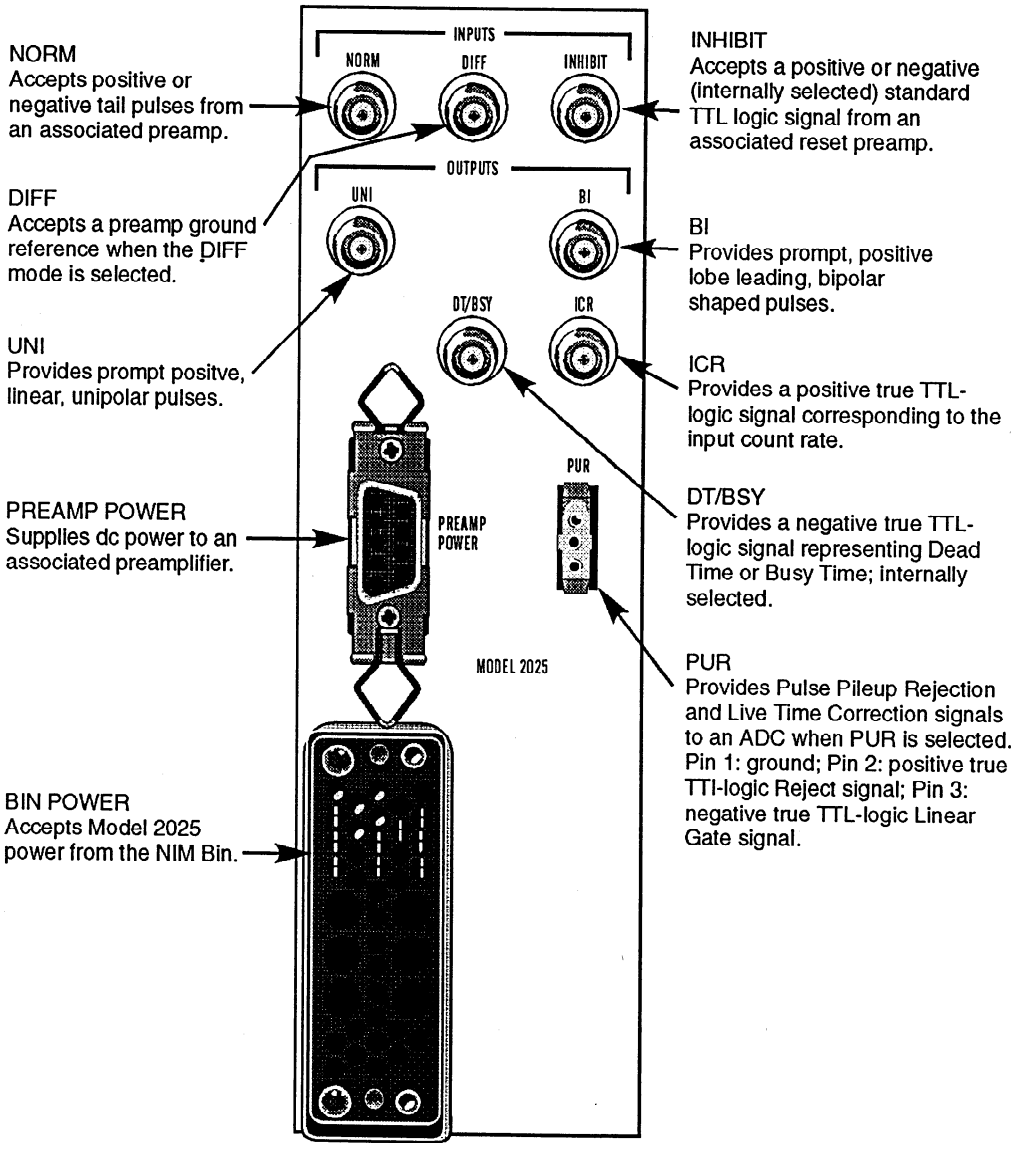

Figure 2.2 Rear Panel Connectors

3. Amplifier Operation

This section outlines the operation of the Model 2025 Spectroscopy Amplifier. Following these procedures will make you familiar enough with the instrument to be able to use it effectively in any situation.

3.1 Installation

The Canberra Model 2000 Bin and Power Supply, or other bin and power supply systems conforming to the mechanical and electrical standard set by DOE/ER-0457T will accommodate the Model 2025. The right side cover of the two-width NIM module acts as a guide for insertion of the instrument. The module is secured in place by turning the two front panel captive screws clockwise until finger tight. It is recommended that the NIM bin power switch be OFF whenever the module is installed or removed.

The Model 2025 can be operated where the ambient air temperature is between 0 °C and +50 °C (+120 °F maximum). Perforations in the top and bottom sides permit cooling air to circulate through the module. When relay rack mounted along with other heat generating equipment, adequate clearance should be provided to allow for sufficient air flow through both the perforated top and bottom covers of the NIM bin.

3.2 Spectroscopy System Setup

Prior to installation, the internal controls should be set to their desired positions. Please refer to Appendix B.

1. Insert the Model 2025 into a standard NIM bin. Preamp power is provided by means of a connector located on the rear panel of the Model 2025 amplifier. Allow the total system to warm up and stabilize.

2. Set the Model 2025's controls to:

AFT	OFF
SHAPING TIME	4 µs
SHAPING MODE	Gaussian
COARSE GAIN	100
FINE GAIN	8.0
PUR ON/OFF	OFF
RESTORER MODE	ASYM
RESTORER RATE	AUTO
INPUT	NORM +

3. This will give approximately a 9 V output when using a preamp gain of 100 mV/MeV and a ^{60}Co radioactive source.

4. Connect the Model 2025 UNIpolar output to the ADC INPUT. The ADC must be direct coupled for linear input signals to fully exploit the count rate capabilities of the Model 2025. All Canberra ADCs are dc coupled.

3.3 Preamp Fall Time Matching

Pole/zero (P/Z) compensation is extremely critical when using resistive feedback preamplifiers.

P/Z compensation must be readjusted whenever the shaping is changed. When a reset type preamp is used, P/Z compensation is not required and must be set to infinity; set the AFT switch to RESET PREAMP, or with AFT set to OFF, set the MANUAL P/Z potentiometer fully counterclockwise. To adjust the pole/zero compensation manually, please refer to Appendix C.

3.3.1 Automatic Pole/Zero Matching

The automatic mode will give good results for most detectors and count rates. However, it may be necessary to optimize the P/Z compensation manually at extreme high count rates or for applications that result in a unipolar output signal that does not return to the baseline in a clean monotonic manner.

1. Set the AFT Switch ON.

   When AFT is selected, P/Z compensation will default to match a nominal 50 μs preamp fall time constant.

   The BUSY LED will blink, prompting the operator to press the AUTO SET button to initiate a P/Z compensation convergence sequence.

Note The 2025 retains the last P/Z setting as long as NIM power has not been interrupted. Thus, if AFT is switched OFF, the BUSY LED will not blink when AFT is switched ON again. However, P/Z convergence can be reinitiated at any time by pressing the AUTO SET button.

2. Adjust the radioactive source for an incoming count rate between 1 and 10 kcps.
3. Press the AUTO SET button, the BUSY LED will now glow continuously while the P/Z compensation is converging to the optimal setting.

   The BUSY LED will extinguish when proper P/Z compensation is achieved.

The precision of the Auto P/Z operation can be verified by observing the trailing edge of the unipolar output signal on an oscilloscope. Set the oscilloscope vertical range to an appropriate sensitivity. Press the UNI LIMIT switch to prevent scope overload.

For a more detailed explanation of P/Z compensation verification and manual adjustment, please refer to Appendix C.

Note: Auto P/Z compensation *must* be re-initialized after any of the following events:

- Amplifier SHAPING TIME is changed.
- The Model 2025 is connected to a different detector/preamp.
- If NIM power is interrupted or cycled on and off.

3.3.2 Blinking Busy LED

The BUSY LED will blink for the following reasons:

1. When AFT is first selected prompting the operator to initiate the Auto P/Z compensation sequence.

Note If the Auto P/Z was previously set and the NIM power has not been interrupted, the BUSY LED will not blink when AFT is switched off and on.

2. If NIM Power is interrupted or cycled on and off. P/Z compensation data may be lost or corrupted when NIM power is interrupted. When NIM power is restored, the BUSY LED will blink to indicate the need to perform a P/Z compensation sequence.

3. If the preamp signal's fall time constant exceeds the P/Z adjustment range of 40 μs to ∞.

4. If P/Z convergence is not achieved within two minutes of the time it was started. This may be due to to extreme low or high count rates, excessive noise or abnormal variations of the unipolar output signal's baseline. This could result from excessive detector microphonics, high voltage arching, multiple secondary time constants, or a damaged detector.

   For this case, P/Z compensation must be performed manually. Please refer to Appendix C.

4. Operation with ADC and MCA

For a detailed discussion of tradeoffs regarding Base Line Restorer settings, Shaping Selection and Shaping Mode, please refer to Appendix C.

Figure 4.1 shows a typical gamma spectroscopy system.

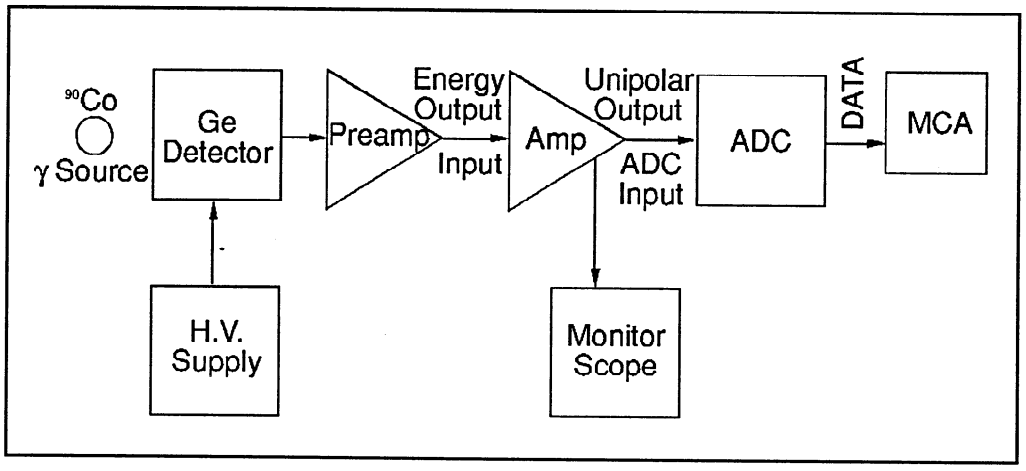

Figure 4.1 A Typical Gamma Spectroscopy System

4.1 ADC Setup

Please refer to the ADC Operator's Manual for specific ADC operating instructions.

Set the ADC GAIN and RANGE equal to the MCA memory group size. For instance, set the GAIN and RANGE to 4096 for an MCA with 4096 memory size.

Set the ADC controls to:

LLD (Lower Level Discriminator) . . . 0.02 V (ccw)

ULD (Upper Level Discriminator) . . . 10.5 V (cw)

Digital Offset . . . . . All OFF

4.2 Spectroscopy Operation

Please refer to the MCA Operator's Manual for specific operating instructions for your MCA.

Start MCA COLLECT with the ^{60}Co radioactive source previously placed near the detector. A spectrum should begin to appear on the MCA's display.

Adjust the Amplifier's GAIN so that the spectrum is positioned conveniently on the display.

Use the Amplifier's Super Fine Gain (SFG) when matching gains of several detectors, or when establishing a specific gain (energy per channel). This control provides 100 times more resolution than the Fine Gain control.

5. PUR/LTC Operation

The Model 2025 and associated ADC work together as an integral system to perform pileup rejection and live time correction. The associated ADC can be an MCA's internal ADC or any current Canberra NIM. Older Canberra MCAs and ADCs can be adapted for use with the 2025's PUR/LTC circuits. The installation procedure is available from Canberra's Customer Service Department.

To compensate for dead times associated with rejected pulses and amplifier processing times, the Model 2025 generates a dead time (DT) signal which extends the collection time by the appropriate amount.

The following instructions apply to obtain maximum performance when utilizing the Model 2025 and 8075 ADC and apply only to these two instruments. For a complete germanium detector system, refer to the system's instructions.

The front panel Accept/Reject indicates pile up rejector status. For low count rates and low losses due to pile up, the multi-color LED flashes green. As the count rate and the number of pulses rejected due to pile up increases (40-70%), the LED turns proportionately yellow. When pile up losses become significant, the LED turns red.

Note that the RED indicator is NOT intended to be interpreted as a safety indicator.

5.1 System Setup

With a nuclear counter connected to the 2025's rear panel ICR output and with the PUR set ON, the average total input count rate can be monitored. Connect the system as shown in Figure 5.1.

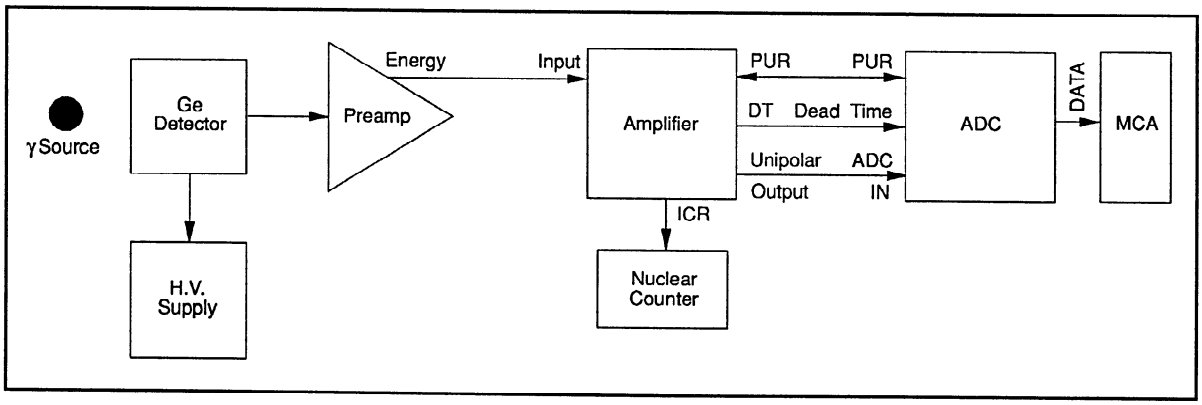

Figure 5.1 Gamma Spectroscopy System with PUR/LTC

1. Set the Model 2025 as follows:

AFT	ON
COARSE GAIN	1K
FINE GAIN	8.0
INPUT	NORM +
SHAPING TIME	4 µs
SHAPING MODE . . .	Gaussian
PUR ON/OFF	ON
RESTORER RATE . . .	NORM
RESTORER MODE . .	ASYM

2. Set the Model 8075 controls as follows:

CONVERSION GAIN .	8K
RANGE	Set as required by MCA
OFFSET	Equal to the MCA's memory size

3. Set the MCA to Collect and adjust the 2025's gain to allow collection of the ^{57}Co peaks at 90% of the active MCA memory.

4. Start an Auto P/Z compensation sequence by pressing the AUTO SET button. Please refer to Section 3.3.1 or to Appendix C for manual optimization.

5. With AFT set to ON, the PUR discriminator is optimized automatically. For manual adjustment, please refer to Appendix C.3

5.2 Pileup Rejecton With a Live Source

1. Bring a source such as ^{57}Co near the detector. Adjust the ^{57}Co source for an input count rate of approximately 50 kcps.

2. Set the MCA's memory to first half.

3. Set the MCA to Collect. Reduce the COARSE GAIN to x500 and adjust the FINE GAIN to allow collection of the primary and sum peaks.

4. Set the MCA's preset to 60 Live seconds.

5. Turn Collect off, Clear Data, then turn Collect on again. Accumulate a spectrum.

6. Set the MCA's memory to second half.

7. Accumulate a spectrum with the Model 2025 PUR ON/OFF switch OFF. Enable the MCA's OVERLAP function and compare the first half of the memory (PUR ON) to that of the second half (PUR OFF), see Figure 5.2.

   Note the reduction in amplitude of both the sum peaks and background. Also note the improved resolution of the sum peaks. The background reduction and improved resolution are directly indicative of the Pileup Rejector's capabilities, since only sum peak pulses which are indeed 100% in coincidence should be processed.

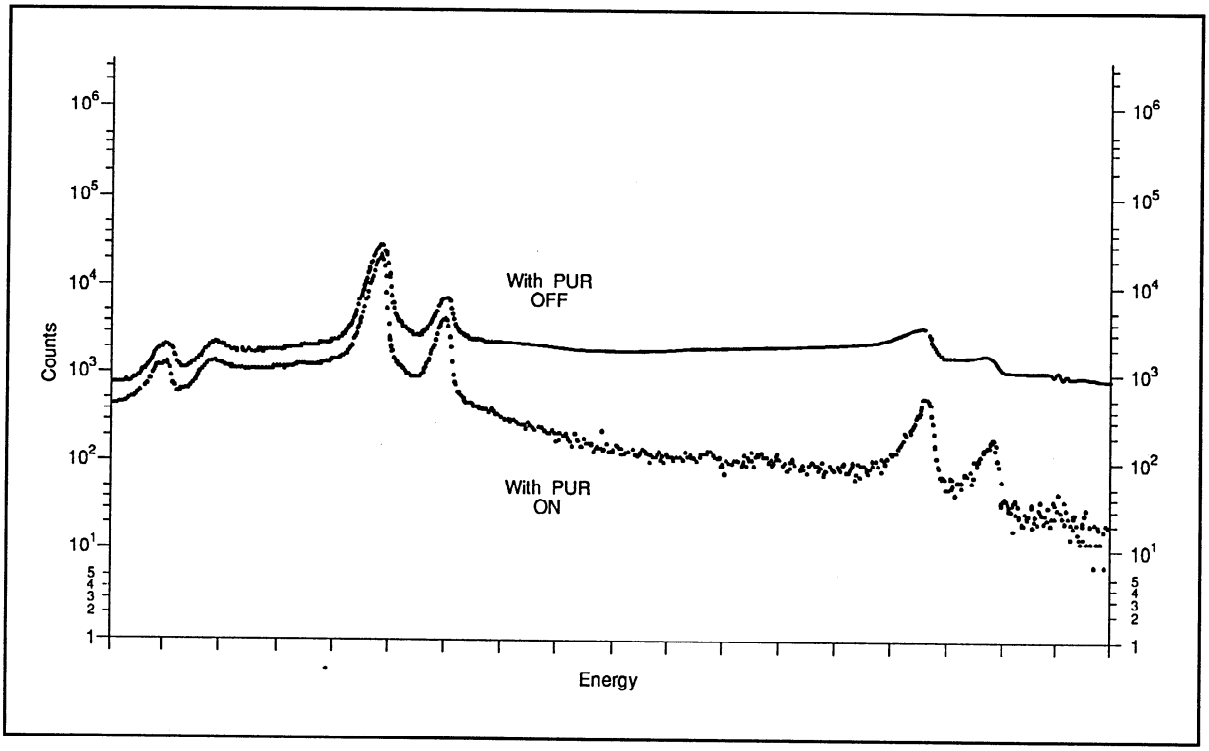

Figure 5.2 ^{57}Co at 50 kcps and 4 μs Shaping

5.3 Live Time Correction With a Live Source

Live time correction (LTC) may vary and is dependent on factors such as ADC type, ADC calibration, spectrum energy distribution and detector characteristics such as geometry, size and ballistic deficit.

To achieve the highest performance of the Live Time Corrector, it may be necessary to adjust the LLD control.

The amplifier and ADC work together, forming an integral system when performing PUR/LTC. As a result, performance is very dependent on the ADC and in particular on the ADC's LLD setting.

Normally, the ADC's LLD control is set just above the system noise level. This is required so that the ADC and the amplifier's PUR discriminator operate over the same signal dynamic range. Note that setting the ADC's LLD control too low can cause undercorrection and setting it too high can result in overcorrection.

The reference peak area deviation should remain under 5% for system dead times up to 50%. If you want to improve the results, adjust the LLD control slightly and repeat the test outlined below in steps 3 through 8.

The following LTC optimizing process assumes that source *A* is ^{60}CO, and source *B* is ^{137}Cs. The 1173.2 keV peak of ^{60}Co will be used as a reference. The upper peak, at 1332.5 keV, is not a good choice because a sum peak of ^{137}Cs at 2x661.6=1323.2keV would interfere with the measurement.

1. Set up the equipment as indicated in step 5.1.
2. Set the 2025's COARSE GAIN to x100.
3. Set the MCA's preset to 500 Live seconds.
4. Position radioactive source *A* near the Ge detector and adjust for an incoming count rate of 2 to 5 kcps. The 1173.2 keV ^{60}Co reference peak (source A) should be approximately 80% of the spectral full scale range. If necessary, adjust the 2025's gain control to move the peak to that location. If the AFT is set OFF or RESET PREAMP, re-adjust the PUR THRES Control as described in Section C.3, Manual PUR Threshold. Once in place, source A should not be moved or altered in any way for the remainder of the experiment.
5. Collect a spectrum for 500 Live seconds. Record the net area of the 1173.2 keV ^{60}Co peak (source A).
6. To source *A*, add approximately 25 kcps of Source *B* to make the total incoming rate 30 kcps.
7. Collect a new spectrum for 500 Live seconds, and record the net area of source *A*.
8. Compare the net area in steps 5 through 7 and compute the percentage change.
9. If you feel improvement is desirable, try adjusting the LLD control 1% or 2% higher. Repeat steps 4-8 until an optimum setting is achieved.
10. Set the PUR ON/OFF switch to Off. Repeat steps 3 through 8.
11. Compare the deviation of source *A*'s spectrum when the PUR is *on* and the PUR is *off*.

Since the detector-source geometry was maintained and the preset Live Collection time was held constant, the ^{60}Co (1173.2keV) net area can be used as a standard when comparing the effect of background (^{137}Cs) count rate.

With the PUR OFF, large changes will be observed in the reference net peak area as a function of count rate. With the pileup rejector set *on*, changes in the reference peak net area will be significantly reduced. The Live Time corrector extends the collection time compensating for amplifier processing time and events rejected due to pileup.

Note Performance may vary and is dependent on factors such as ADC type, ADC calibration, spectrum energy distribution and detector characteristics such as geometry, size, and ballistic deficit.

6. Circuit Description

The 2025 is a signal processor which amplifies and shapes signals from conventional resistive feedback (RC) or reset type preamplifiers.

The amplifier includes a differential input stage for common mode noise suppression, followed by a differentiator, three low noise gain amplifier stages, three complex pole active filter stages (optimized for improved pulse symmetry), a gated active baseline restorer and a unipolar output amplifier providing semi-gaussian or semi-triangular output pulse shaping. A bipolar output is provided for crossover timing applications.

Also included is a high performance pile up rejector/live time corrector and associated fast signal recognition circuits.

AFT (automatic fine tuning) performs critical performance adjustments which automatically optimizes pole zero compensation, baseline restoration rate and noise discriminator thresholds for the baseline restorer and pile up rejector.

The following is a description of the circuitry used in the model 2025 AFT Research Amplifier. Throughout the circuit description please refer to the block diagram and the specific schematic page number when noted.

6.1 Input Mode Switch

The INPUT MODE switch (schematic sheet 1) selects Normal or Differential operation and input signal polarity. With NORM mode selected, the preamplifier signal is accepted by the front or rear panel NORM BNC connectors, the DIFF BNC connectors are non-functional. The signal passes through the cable transformer assemblies for high frequency noise suppression and then to the INPUT MODE switch. With Differential mode selected the front and rear panel DIFF input BNC's are activated for acceptance of a ground reference signal for common mode noise suppression. The differential reference signal also passes through a cable transformer for additional high frequency noise suppression. The INPUT MODE switch routs the input signals to the appropriate input of the differential input amplifier.

6.2 Differential Input Amplifier

Amplifier A1 (schematic sheet 1) is a discreet low noise differential amplifier comprised of transistors Q1 through Q5, Q7, Q28 and Q29. This amplifier gain is selected by the coarse gain switch and is X1 for a coarse gain of 5 and X2 for coarse gains of 10 and higher. With NORM input mode selected the non-driven input is terminated into 93 ohms. When used in the differential mode, the amplifier utilizes both the NORM and DIFF inputs and provides common mode rejection to suppress noise caused by ground loops, laboratory EMI and noise pick up induced on the input signal coax cables. The negative output signal provided by this stage drives the Auto Pole/Zero circuit and the first differentiator.

6.3 Differentiator and Gain Stages

The signal provided by the differential amplifier (schematic sheets 2 and 3) is differentiated by C13 through C18 and resistor R25. With AFT switched OFF, Pole/Zero compensation is performed manually by potentiometer RV1 and resistors R45 through R49 and R26. The time constants are selected by sections SD1-A and SD1-B of the shaping switch. With AFT selected, Pole/Zero compensation is provided by the automatic Pole/Zero circuit that is consistent, repeatable and nearly operator independent. With AFT set to RESET PREAMP, Pole Zero compensation is automatically set to infinity as required by most reset type preamps.

The differentiated and pole/zero compensated signal is next amplified by gain AMPs 2, 3 and 4 or gain AMPs 2 and 4 depending on the COARSE GAIN switch (sections CGD2 and CGD3) selection. FINE GAIN and SFG (super fine gain) are performed in concert with gain AMP 2 and potentiometers RV2 and RV3 respectively. The gain adjustment range of gain AMPs 2 through 4 is continuously adjustable from X1.65 to X750. Limiters in the feedback path of each gain amplifier eliminate op-amp saturation maintaining good overload recovery. The output signal of gain AMP 4 is normally negative and drives the PUR/LTC FAST DISCriminator circuits and active filter integrators A4, A5 and A6.

6.4 Gain Stage Stabilizer

A dc stabilizer (schematic sheet 2) is provided around the gain stage amplifiers to maintain the dc output at gain AMP 4 near zero volts over a wine range of temperatures and count rates. Transconductance amplifier A23 monitors the output of gain AMP 4 with respect to zero volts and generates a correction voltage that is summed it at the input of gain AMP 2. Op-amp A31 is a high input impedance buffer. The stabilization loop time constant is determined by the transconductance current programming resistors R14 and R276 and capacitors C2 and C26 resulting in a time constant sufficiently long so as not to have an effect on the overall amplifier shaping transfer function.

6.5 Active Filters

Three active filter stages, ICs A4, A5 and A6 (schematic sheet 4), produce complex pole pairs providing a near gaussian pulse shape and a sharp cutoff frequency characteristic for optimal signal to noise ratio. The filter time constant is selected by the shaping switch sections SD4 through SD6 and associated resistors and capacitors. The output signal from the third integrator is normally negative and drives the bipolar and unipolar output amplifiers.

6.6 Bipolar Output

The signal provided by the third complex pole integrator is differentiated by C55 through C60 and resistors R140 and R141, producing a bipolar signal (schematic sheet 6). The bipolar signal is inverted, amplified and buffered by IC7 and transistors Q11 through Q13. The bipolar shaping time constant is selected by switch section SD7-A.

6.7 Unipolar Output

The signal provided by the third complex pole integrator also drives the unipolar output amplifier (schematic sheet 5) and associated driver, IC A8 and transistors Q21, Q22 and Q31. The unipolar output amplifier includes a single pole filter provided by feedback resistor R163 and capacitors C81 through C86; the time constant is selected by switch section SD7-b of the

shaping switch. For Gaussian shaping the unipolar output provides a semi-gaussian pulse shape. However, if Triangular shaping is selected, relays K2 and K3 are activated which allows the signals from complex pole integrators A4, A5 and A6 to be summed at the input of the unipolar output amplifier, in the correct proportion, producing a semi-triangular output signal.

6.8 Baseline Restorer

The baseline restorer (schematic sheet 5) maintains the unipolar output signal baseline at ground reference, with precision, over a wide range of count rates. Transconductance amplifier A10 monitors the unipolar output signal and develops a correction voltage, having the correct amplitude and polarity, which is summed at the input of the unipolar output amplifier to reference the unipolar output signal baseline at zero volts. The baseline restorer is gated and operates only in the absence of or in between output pulses providing superior baseline control over a very wide range of count rates.

Restorer symmetry is selectable by the ASYM/SYM switch. For the symmetrical restorer mode, positive and negative restoration slew rates are equal. When the asymmetrical is selected, the negative restorer slew rate is reduced substantially providing a softer restorer response for positive output signals.

6.9 Restorer Gate, Auto Threshold and Auto Rate

Baseline correction (schematic sheet 5) is prevented during unipolar output signal intervals that exceed the baseline restorer threshold. Comparators A10a and A10b monitor the unipolar output signal and disable or gate off the baseline restorer for signals that exceed the automatic positive or fixed negative thresholds.

The auto baseline restorer threshold circuit, comprised of IC's A9 and A24, peak detects the negative noise excursions of the unipolar output signal and generates a positive dc reference voltage equal to the average value of the unipolar output noise level. This voltage serves as the baseline restorer gating reference that maintains precision for a wide range of amplifier conditions and applications.

Transistors Q14, Q16, capacitor C92 and the baseline restorer gate signal (PBLR) produce a count rate dependent voltage that programs the restorer rate when the BLR RATE switch is set to NORM. The restorer rate is set to a fixed low rate with the BLR RATE set to MIN and a fixed high rate when set to HIGH.

6.10 Automatic Pole/Zero

With AFT set ON, Pole/Zero compensation is optimized automatically. The correct pole zero compensation signal is provided by the auto pole/zero circuit.

Basically the manually operated pole/zero potentiometer is replaced with a multiplying digital to analog converter (MDAC) and operational amplifier arrangement serving as an electronic attenuator or potentiometer. The electronic attenuator is controlled by digital control circuitry to provide the exact proportion of pole/zero signal for precise compensation.

A box car averager or integrating sample and hold circuit samples the tail of the unipolar output signal and a comparator compares the sampled unipolar signal with respect to ground. If the unipolar signal is properly pole/zeroed, the unipolar signal tail and the box car averager output will be at zero volts. The conditions for proper pole/zero are satisfied and the circuit needs to make no adjustments. However if the pole/zero is not correct, the box car averager will produce an error voltage that is proportional to the amount of miscompensation.

When an auto pole/zero sequence is initiated, the comparator interrogating the unipolar signal tail via the box car averager directs the digital control circuity to increment or decrement the MDAC one LSB at a time, in the appropriate direction, until correct pole/zero compensation is achieved. Convergence is obtained and the process stops when the unipolar tail and the box car averager outputs attain zero volts.

When AFT is first activated the BUSY led blinks prompting the operator to initiate the auto pole/zero sequence by pressing the AUTO SET button. When initiated the BUSY LED illuminates continuously for the duration of the sequence and extinguishes when convergence is achieved. Normally it takes only a short period of time to achieve convergence. However if convergence requires more than two minutes, the sequence is halted and the BUSY LED will again blink indicating convergence was not achieved. Possible causes might be the preamp signal fall time is outside the pole/zero adjustment range (40 μs to infinity), a significant portion of the unipolar pulses exceed 10 volts or the count rate is too low or high. If at any time NIM power to the 2025 is interrupted, the BUSY LED will also blink prompting the operator that the auto pole/zero sequence must be re-initiated.

6.11 Pile Up Rejection

Please refer to the PUR/LTC Timing Diagram shown in Figure 6.1.

The Pile Up Rejector (PUR, schematic sheet 7) monitors the number of amplifier input events during a pulse processing sequence; initiated with an amplifier input signal and ends when the unipolar signal returns to the baseline. If two or more events occur during a processing sequence and the ADC is in the acquisition mode, Linear Gate (LG) set true, the events are piled up and pending ADC conversion is aborted.

The signal from gain AMP 4 is differentiated by the fast differentiator C330 and R408, pole/zero compensated by R271 through R275 and R409, amplified and limited by IC A34. Amplifier/limiter A34 is baseline restored by a fast gated baseline restorer comprised of transconductance amplifier A35 and transistors Q36 and Q37. The fast discriminator, IC A21, monitors the amplifier/limiter output signal and generates a fast timing pulse (system trigger) whenever the fast signal exceeds the fast channel noise level referenced by the PUR discriminator threshold.

With AFT set to RESET PREAMP or OFF the PUR threshold is set manually just above the fast channel noise level using the front panel PUR THRES potentiometer RV5. With AFT set to ON the PUR threshold is optimized automatically. The AUTO PUR threshold circuit is comprised of IC's A22, A20 and A33. The circuit and its operation is very similar to the auto baseline restorer threshold described in section 5.10.

The system trigger simultaneously clocks the Busy (A32a) and Reject (A13a) flip-flops. For the case of no pile up, only the Busy flip-flop will get set since the "D" input of the Reject flip-flop was initially false.

However, if a subsequent amplifier input signal arrives prior to the conclusion of the processing sequence (pile up) the Reject flip-flop and REJECT signal will be set true. If the ADC is in the acquisition mode, (LG true), a Reject will initiate an ADC reject sequence, the pending ADC conversion will be aborted and the events thrown away. At the conclusion of the processing sequence, the unipolar output signal returns to the baseline and the trailing edge of the restorer gate signal clears the busy and Reject flop-flops.

6.12 Live Time Correction

Please refer to the PUR/LTC Timing Diagram shown in Figure 6.1.

Live time correction (schematic sheet 7) is accomplished by extending the collection time (stopping the MCA live time clock) for the unipolar signal processing time, as determined by the amplifier busy and the Dead Time Extension (DTE) flip-flop (A13b), to allow replacement of events thrown away in the event of pile up.

The amplifier provides a DT (dead time) signal which is received by the ADC, it in turn adds it's dead time contribution producing a composite dead time signal for gating off the MCA live time clock.

Pile up events will produce multiple system triggers within the processing sequence. As described in section 6.12, the first trigger sets the Busy flip-flop, and the second trigger sets the Reject flip-flop. Reject is set true and the ADC aborts the conversion in process. The ADC Linear Gate (LG) ends prematurely and its positive transition clocks the DTE (Dead Time Extension) flip-flop true, adding a dead time component to the BSY+BLR signal via OR gate A17c producing the composite DT signal.

When the unipolar output signal returns to the baseline, the Busy and Reject flip-flops are cleared as before. However, the DTE flip-flop remains set and its Dead Time contribution continues.

For the next non-piled up processing sequence, the Reject flip-flop will not be set and the positive transition of the associated ADC LG signal will clock the DTE flip-flop reset ending its dead time contribution. At the conclusion of the unipolar output signal, the Busy flip-flop is cleared ending its dead time component. The sequence has concluded, the DT signal returns false and the MCA LIve Time clock resumes.

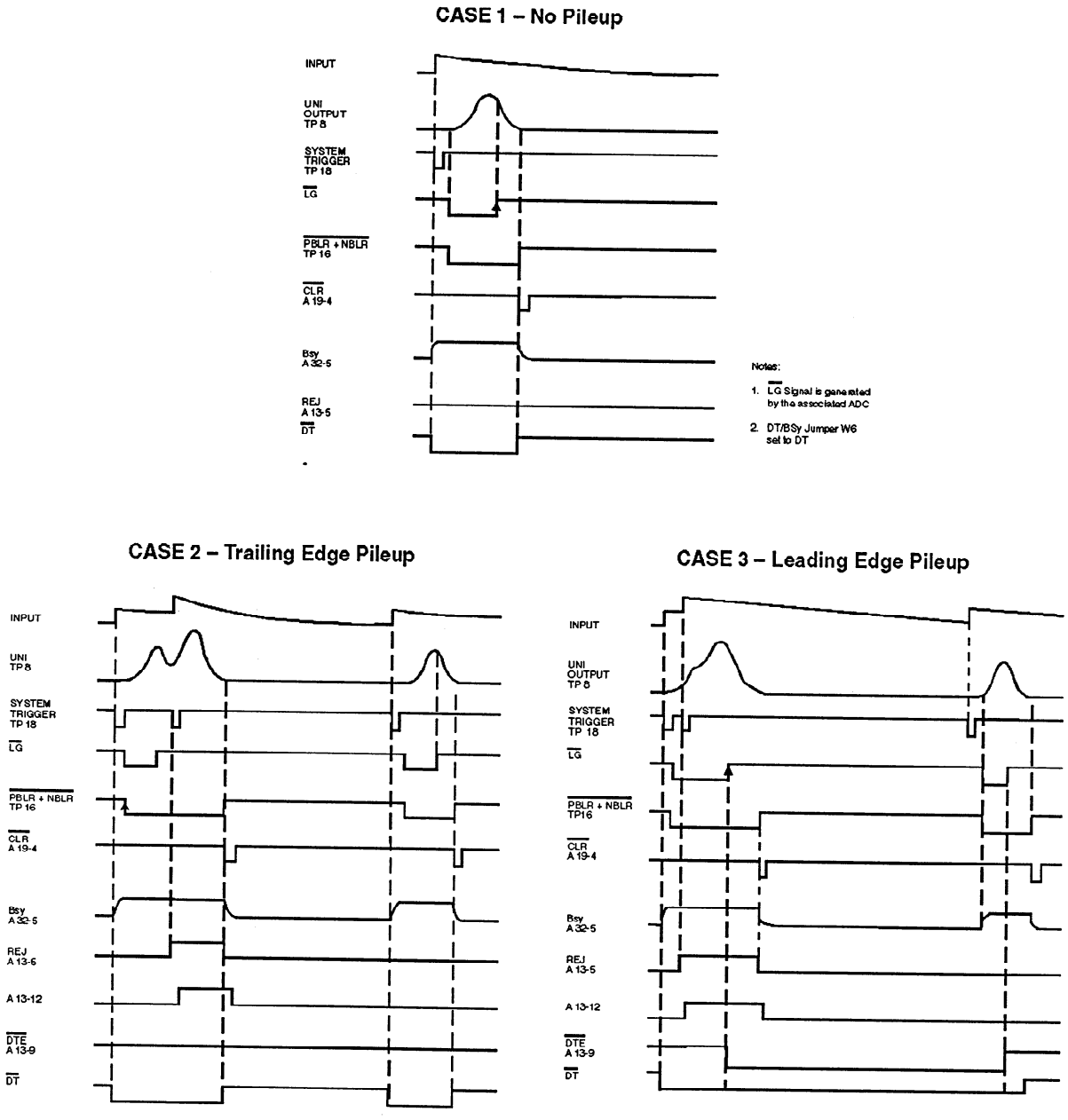

Figure 6.1 PUR/LTC Timing Diagram

A. Specifications

A.1 Inputs

NORM – Accepts positive or negative tail pulses from an associated preamplifier; amplitude ±10 V divided by the selected gain, ±25 V maximum; rise time: less than shaping time constant; decay time constant: 40 μs to ∞; polarity set by INPUT switch. For the (+) INPUT switch setting, $Z_{in} \approx 1$ kΩ for COARSE GAIN of 5 and 500 Ω for COARSE GAIN setting ≥10; for the (–) INPUT switch setting, $Z_{in} \approx 2$ kΩ for COARSE GAIN of 5 and 1.5 kΩ for COARSE GAIN settings ≥10; front and rear panel BNC connectors.

DIFF – Accepts a preamplifier ground reference when using the differential input mode; operates only when the DIFF mode is selected. Dynamic specifications: same as for NORM input. For the (+) INPUT DIFF switch setting $Z_{in} \approx 2$ kΩ for COARSE GAIN of 5 and 1.5 kΩ for COARSE GAIN settings ≥10; for the (–) INPUT DIFF switch setting, $Z_{in} \approx 1$ kΩ for COARSE GAIN of 5 and 500 Ω for COARSE GAIN settings ≥10; front and rear panel BNC connectors.

INHIBIT – Accepts a standard TTL logic signal from associated reset preamplifier; used to extend the Dead Time signal, inhibit and reset the pileup rejector during the preamplifier's reset cycle; positive true or negative true signal polarities, internally selectable; Loading: 4 kΩ resistor connected to +5 V for positive true or ground for negative true; rear panel BNC connector.

LG (LINEAR GATE) – Accepts a standard TTL Logic signal from associated ADC. Indicates to the Model 2025 that the ADC is acquiring an event; Logic Low during ADC acquire, returns high at conclusion; Loading: 4.7 kΩ pull up resistor to +5 V; accessible through pin 1 of the rear panel PUR connector.

A.2 Outputs

UNIPOLAR – Provides positive, linear actively filtered shaped pulses; amplitude linear to +10 V, 12 V max.; dc restored; output dc level factory calibrated to 0±5 mV, front panel Z_{out} <1 Ω or 93 Ω, internally selectable; rear panel Z_{out} is 93 Ω; short circuit protected; front and rear panel BNC connectors.

BIPOLAR – Provides prompt positive lobe leading linear active filter bipolar shaped pulses; amplitude linear to +10 V, 12 V max., negative lobe is approximately 70% of positive lobe; dc coupled; output dc level <±10 mV; front panel Z_{out} <1 Ω or 93 Ω; internally selectable; rear panel Z_{out} is 93 Ω; short circuit protected; front and rear panel BNCs.

DT/BSY – Rear panel BNC with two functions: Dead Time or Busy Time, internally selected; shipped in DT position; TTL output with 1 kΩ pull up resistor through a 47 Ω series resistor.

DT – Provides a negative true TTL logic signal and when ORed with ADC dead time, provides Live Time correction for the amplifier and pileup rejector; active only when PUR is selected.

BSY – Provides a negative true TTL logic signal that represents the amplifier busy time; logic low during amplifier processing time or from external INHIBIT; active with PUR ON or OFF.

REJECT – Provides a positive-true TTL logic signal that is used to initiate an ADC reject sequence. When the PUR is set ON, the REJECT signal is set true for piled up events (determined by the 2025), negative unipolar output signals that exceed –500 mV and while the rear panel INHIBIT is true. When the PUR is set to OFF, REJECT is set to true while the INHIBIT signal is true, and for negative unipolar output signals that exceed –500 mV.

ICR (Incoming Count Rate) – Provides a standard TTL logic signal corresponding to input count rate when PUR is selected; disabled by INHIBIT; positive true; width nominally 150 ns, TTL output with 1 kΩ pull up resistor through 47 Ω output resistor; rear panel BNC connector.

A.3 Front Panel Controls

COARSE GAIN – Eight-position rotary switch selects gain factors of X5, X10, X20, X50, X100, X200, X500, and X1000.

FINE GAIN – Ten-turn locking dial precision potentiometer selects variable gain factor of X0.5 to X1.5; resetability 0.03%.

SFG (Super Fine Gain) – Multi-turn screwdriver potentiometer to select gain with an adjustment resolution of better than 0.0063% (1 in 16 000).

AFT – Three-position toggle switch to select Automatic or Manual Fine Tuning. ON: Auto P/Z, Auto BLR and threshold, and AUTO PUR THRESHold are enabled and automatically optimized. RESET PREAMP: optimizes the pole/zero at infinity, independent of the MANUAL P/Z setting; PUR THRESHold must be set manually. OFF: manual setting required for both P/Z and PUR THRESHold.

BUSY – LED active only when AFT switch is ON; monitors status of Auto P/Z matching functions, lights during Auto P/Z convergence, off when proper matching is achieved; blinks once a second for the following conditions:

1. To indicate an Auto P/Z cycle needs to be initiated when AFT is first selected, at unit power up, or if power interruption is detected.
2. If the preamp signal fall time exceeds the Auto P/Z matching range.
3. If optimal P/Z matching isn't achieved within two minutes of initiation.

AUTO SET – With AFT switch ON, pressing the AUTO SET button initiates automatic P/Z matching. The BUSY LED lights during Auto P/Z convergence.

MANUAL P/Z – Multi-turn screwdriver adjustable P/Z matching potentiometer to optimize amplifier baseline recovery and overload performance for the preamplifier's fall time constant and the amplifier's chosen shaping time; operates only when AFT is OFF; range: 40 μs to ∞.

RESTORER NORM/MIN/HIGH – Three-position toggle switch to set the baseline restorer rate (slew rate); NORM: when selected, the baseline restorer rate is automatically optimized by internal circuitry as a function of unipolar output signal duty cycle and count rate; HIGH: sets the baseline restorer to a fixed high rate; MIN: sets the baseline restorer to the lowest fixed rate.

RESTORER ASYM/SYM – Two-position toggle switch to select SYMmetrical or ASYMmetrical baseline restorer modes.

PUR ON/OFF – Two-position toggle switch to enable (ON) or disable (OFF) the pileup rejector and live time corrector.

PUR THREShold – Multi-turn screwdriver adjustable potentiometer for optimizing the pileup rejector discriminator threshold level; provides a variable range of 0 to 500 mV; operates only with AFT switch set to RESET PREAMP or OFF.

PUR ACCEPT/REJECT – Multi-color LED indicates pileup status when PUR is selected. Appears green for approximately up to 40% of pulses rejected, yellow for 40-70%, and red for 70% and above. Also used as a visual aid in setting the PUR Threshold manually.

SHAPING MODE – Two-position toggle switch selects semi-triangular or semi-Gaussian pulse shaping for the unipolar (UNI) output.

SHAPING – Six-position rotary switch; providing 0.5, 1, 2, 4, 6 and 12 μs shaping time constants.

INPUT – Four-position rotary switch to select positive or negative input polarities and normal (NORM) or differential (DIFF) modes. In the DIFF positions, both NORM and DIFF inputs are active; in the NORM positions, only the NORM input is active. The Differential mode is used to reduce common mode noise by referencing the preamp ground through a resistor which matches the preamp ENERGY output impedance, usually 93 Ω.

CM BAL – Multi-turn potentiometer to equalize the NORM and DIFF input gains to maximize the common-mode noise rejection. Operates only when the DIFF mode is selected.

LIMIT – Momentary pushbutton switch; clamps the UNI signal to approximately ±300 mV, which minimizes oscilloscope overload for precise manual preamp matching.

A.4 Performance

GAIN RANGE – Continuously variable from X2.5 to X1500.

TEMPERATURE COEFFICIENTS – UNIpolar: Gain - 0.005%/°C, dc level - ≤±7.5 μV/°C; BIpolar: Gain - ≤±0.007%/°C, dc level - ≤±30 μV/°C.

INTEGRAL NONLINEARITY – ≤±0.04% over total output range for 2 μs shaping.

CROSSOVER WALK – BIpolar output: ≤±3 ns for 50:1 dynamic range and 2 μs shaping when used with Canberra Model 2037A Edge/Crossover Timing SCA.

OVERLOAD RECOVERY – UNIpolar (BIpolar) output recovers to within ±2% (1%) of full scale output from X1000 overload in 2.5 (2.0) non-overloaded pulse widths at full gain, at any shaping time constant, and with preamp matching properly set.

NOISE CONTRIBUTION – ≤4.5 μV (7.0 μV) true RMS, UNIpolar (BIpolar) output referred to input, 2 μs shaping, and amplifier gain ≥100.

PULSE SHAPING – Near-Gaussian or near-triangular shape; one differentiator (two for bipolar); three active filter integrators realizing eight-pole shaping network; shaping time parameters referenced to 1 μs are listed in following table:

	Shaping Time Multiplier		
Parameter	Triangular	Gaussian	Bipolar
Time to peak	2.7	2.9	2.3
0.1% full scale output to peak	2.5	2.2	
Pulse width at half maximum	2.5	2.1	1.4
Pulse width at tenth maximum	5.6	5.0	
Pulse width at $1/100$ maximum	6.7	6.2	
Bipolar crossover/Unipolar peak delay			0.8

RESTORER – Active gated.

SPECTRUM BROADENING – The FWHM of ^{60}Co 1.33 MeV gamma peak for an incoming count rate of 2 kcps to 100 kcps and a 9 V pulse height will typically change less than 6% for 2 μs shaping; AUTO restorer rate, AUTO restorer threshold, ASYM restorer mode, and manual P/Z matching. These results may not be reproducible if the associated detector exhibits an inordinate amount of long rise time signals.

COUNT RATE STABILITY – The peak position of a ^{60}Co 1.33 MeV gamma peak for an incoming count rate of 2 kcps to 100 kcps an 9 V pulse height will typically shift less than 0.02% for 2 μs shaping; AUTO restorer rate, AUTO restorer threshold, ASYM restorer mode, and manual P/Z matching.

COMMON MODE REJECTION – 60 dB at 60 Hz; 20 dB at 1 MHz.

A.5 Pileup Rejector/Live Time Corrector

PULSE PAIR RESOLUTION – ≤500 ns.

MINIMUM DETECTABLE SIGNAL – Limited by detector/preamp noise characteristics.

A.6 Power Requirements

+24 V dc – 120 mA +12 V dc – 330 mA

–24 V dc – 160 mA –12 V dc – 160 mA

A.7 Connectors

With the exception of the PUR and PREAMP POWER connectors, all signal connectors are BNC type.

PUR – Rear panel, Molex plug 03-06-1031.

PREAMP POWER – Rear panel, Amphenol, type 17-10070.

A.8 Accessories

C1514 PUR/LTC and DT cable set.

A.9 Environmental

OPERATING TEMPERATURE – 0 to 50 °C.

RELATIVE HUMIDITY – Up to 95%, non-condensing.

A.10 Physical

SIZE – Standard double-width NIM module 6.86 x 22.12 cm (2.70 x 8.71 in.) per DOE/ER-0457T.

NET WEIGHT – 1.6 kg (3.5 lb).

SHIPPING WEIGHT – 2.5 kg (5.5 lb).

B. Internal Controls

Internal jumpers have been factory set for optimum performance in the most common spectroscopy applications, but may easily be changed for a custom application. The jumpers should be set as required before installing the 2025 in the NIM Bin. See Figure B.1 for jumper locations.

B.1 Main Board Internal Controls

The jumpers on the main board can be changed by removing the module's right side-cover.

B.1.1 Output Impedance

The front panel UNIpolar and BIpolar OUTput impedances are factory set for ≤1 ohm. Either one can be changed to Z_{out} of 93 ohms.

Jumper W4 – Unipolar Output Impedance

Position 1/2: ≤1 ohm

Position 2/3: I93 ohms

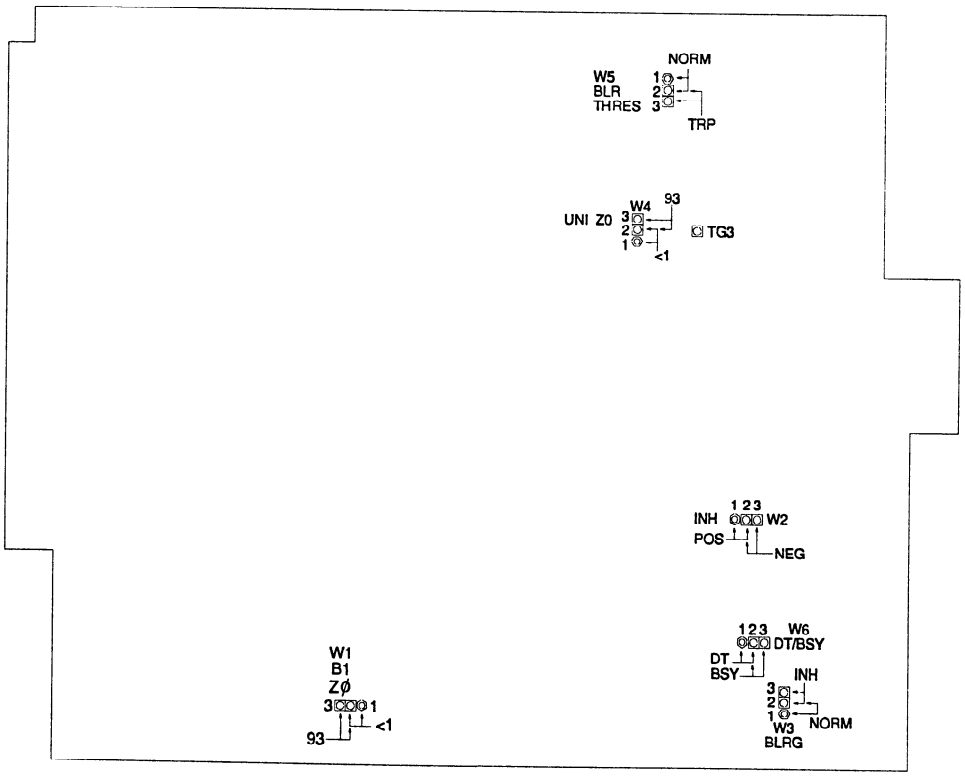

Figure B.1 Main Board Jumpers
Right Side-Cover Removed

Jumper W1 – Bipolar Output Impedance

Position 1/2:	≤1 ohm
Position 2/3:	93 ohms

The rear panel UNIpolar and BIpolar outputs have a fixed impedance of 93 ohms, series connected.

When using the front panel low impedance output, short lengths of interconnecting coaxial cable need not be terminated. To prevent possible oscillations, longer cable lengths should be terminated at the receiving end in a resistive load equal to the cable impedance (93 ohms for type RG-62 cable).

The 93 ohm output may be safely used with RG-62 cable up to a few hundred feet. However, the 93 ohm impedance is in series with the load impedance, and a decrease in the total signal range may occur. For example, a 50% loss will result if the load impedance is 93 ohms.

B.1.2 DT/BSY

The rear panel DT/BSY BNC is factory set to provide Dead Time (DT), but may be selected to provide BUSY TIME (BSY). For a detailed description of signals, please refer to Appendix A.2.

Jumper W6 – DT/BSY

Position 1/2:	Provides a negative true dead time signal for live time correction with Canberra ADCs.
Position 2/3:	Provides a negative true Busy signal for compatibility with 599 loss free counting module.

B.1.3 Baseline Restorer Gate (BLRG)

The baseline restorer normally gates off when the unipolar signal exceeds the positive or negative gating thresholds. For applications involving reset preamps, it may be desirable to also gate off the BLR for external Inhibit signals provided by reset preamps. Factory set for NORM.

Jumper W3 – BLRG

Position 1/2:	Normal - the baseline restorer is gated off only when the unipolar signal exceeds the gating thresholds.
Position 2/3:	INH - in addition to the above conditions, also gates off the baseline restorer for the duration that an external Inhibit is present on the rear panel INHIBIT BNC.

B.1.4 BLR THRES

Some Reset Preamps produce objectionable secondary effects following the preamp reset. It may be desirable to prevent BLR gating on these events by elevating the BLR gating threshold higher than that supplied by the automatic threshold circuit. For additional details, please refer to Appendix C.5.3. Factory set to NORM.

Jumper W5 – BLR THRES

Position 1/2: NORM - Threshold provided automatically by auto threshold circuit.

Position 2/3: TRP - Adds 50 mV offset to automatic threshold.

B.1.5 Inhibit Polarity

The logic sense of the pileup rejector's incoming inhibit (INH) signal is factory set for positive true logic, but may be set for negative true logic.

Jumper W2 – Inhibit Polarity

Position 1/2: INH; positive true logic

Position 2/3: INH/; negative true logic

C. Performance Adjustments

C.1 Manual Pole/Zero Matching

At high count rates, the pole/zero (P/Z) matching adjustment is extremely critical for maintaining good resolution and low peak shift. For a precise and optimum setting of the P/Z matching, a scope vertical sensitivity of 50 mV/div should be used.

With correct P/Z, spectral peaks will appear symmetrical.

Undercompensated P/Z will produce low energy tailing.

Overcompensated P/Z will produce high energy tailing.

Higher scope sensitivities can also be used, but result in a less precise P/Z matching adjustment. However, most scopes will overload for a 10 V input signal when the vertical signal returns to the baseline. Thus the P/Z matching will be incorrectly adjusted resulting in a loss of resolution at high count rates.

When performing the following manual P/Z matching adjustments, set the scope's vertical sensitivity to 50 mV/div, and press the LIMIT momentary switch. The UNIpolar output signal will now be clamped, eliminating potential scope overload, and allowing precise manual P/Z matching adjustment.

C.1.1 Manual P/Z Matching Using a Ge Detector and ^{60}Co

1. Set AFT OFF. The MANUAL P/Z matching control is active only with AFT OFF!

2. Adjust the radiation source count rate to be between 2 kcps and 25 kcps. Observe the UNIpolar output on the scope and adjust the manual control so that the trailing edge of the unipolar pulse returns to the baseline with no overshoots or undershoots.

Figure C.1 shows the correct setting of the MANUAL P/Z control. Figures C.2 and C.3 show under- and over-compensation for the preamplifier decay time constant. As illustrated in Figure C.1, the UNIpolar output signal should have a clean return to the baseline with no bumps, overshoots or undershoots.

Notes Some amplifier shapings may exhibit small undershoots. These arise primarily from amplifier shaping component tolerances and secondary time constants associated with the detector/preamp system. If an undershoot is present and is less than 20 mV, its impact on performance is insignificant. However, if small shaping undershoots are present, they should not be confused with preamp

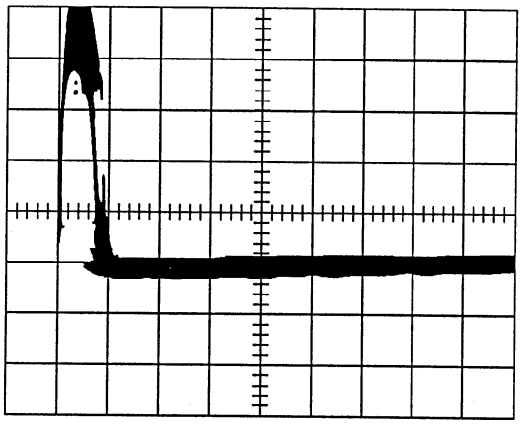

Figure C.1 Correct Pole/Zero Compensation

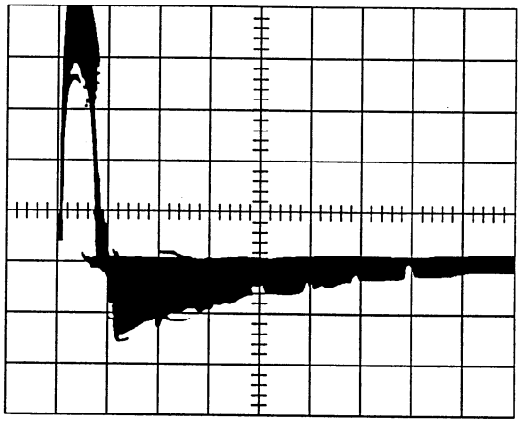

Figure C.2 Undercompensated Pole/Zero

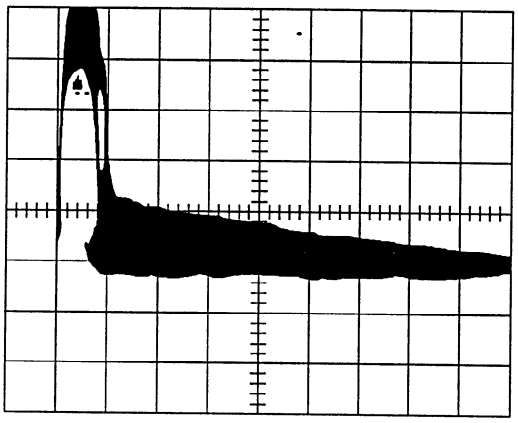

Figure C.3 Overcompensated Pole/Zero

Scope
Vertical: 50 mV/division
Horizontal: 10 μs/division

Source ^{60}Co
1.33 MeV peak: 7 V amplitude
Count rate: ≈ 2 kcps
Shaping: 2 μs

matching misadjustments undershoots, which exhibit a much longer time constant and have a larger performance impact.

At high count rates, P/Z matching misadjustment will affect spectral peak shape and resolution.

C.1.2 Manual P/Z Matching Using a Square Wave Generator

1. Driving the preamp test input with a square wave will allow a more precise adjustment of the preamp matching.
2. The amplifier's COARSE GAIN, SHAPING, and INPUT POLARITY controls should be set for the intended application.
3. Adjust the square wave generator for a frequency of approximately 1 kHz.

4. Connect the square wave generator's output to the Preamp's TEST INPUT.
5. Remove all radioactive sources from the vicinity of the detector.
6. Set the scope's Channel 1 vertical sensitivity to 5 V/div, and adjust the main time base to 0.2 ms/div.

Monitor the Model 2025's UNIpolar output. Do not press the LIMIT switch at this time. Adjust the square wave generator's amplitude control (attenuator) for a UNIPOLAR output of ±8 V.

Notes Both positive and negative unipolar pulses will be observed at the output.

Reduce the scope vertical sensitivity to 50 mV/div. To prevent scope overload, clamp the UNIpolar output signal by pressing the LIMIT momentary switch. With the UNIpolar output signal clamped, adjust the manual control as illustrated in FIgure C.4.

When adjusting the P/Z matching using the square wave technique, the calibration square wave generated by the oscilloscope can be used. Most scopes generate a 1 kHz square wave used to calibrate the vertical gain and probe compensation. Connect the scope Calibration Output through an attenuator to the preamp test input and perform the steps in this section again.

Figure C.4 shows the correct setting of the MANUAL P/Z control. Figures C.5 and C.6 show under- and over-compensation for the preamplifier decay time constant. As illustrated in Figure C.4, the UNIpolar output signal should have a clean return to the baseline with no bumps, overshoots or undershoots.

C.2 Baseline Restorer Mode and Rate

The baseline restorer in the Model 2025 is flexible in that both the SYMmetrical and ASYMmetrical modes are offered. In the SYMmetrical mode, the restoration currents are identical for above and below the baseline. For the ASYMmetrical mode the restorer current above the baseline (referenced to a positive output), is much less than that below the baseline.

The ASYMmetrical restorer mode offers superior high count rate performance for high resolution Ge spectroscopy. The SYMmetrical mode is used on Ge systems with low quality preamps, scintillation and proportional counting, and Si systems.

The SYMmetrical mode should always be used for detector systems which exhibit baseline discontinuities resulting from excessive noise and/or high voltage effects, preamp reset pulses and preamp secondary time constants. Secondary preamp fall time constants result in unipolar output undershoots making it difficult to optimize the amplifier preamp matching.

With the Restorer Rate switch set to AUTO, the restorer is automatically set for optimum performance throughout the usable input count rate range for the shaping selected.

The MIN position significantly reduces the restoration rate. This may prove to be advantageous in some low count rate, low energy applications. With the MIN rate selected,

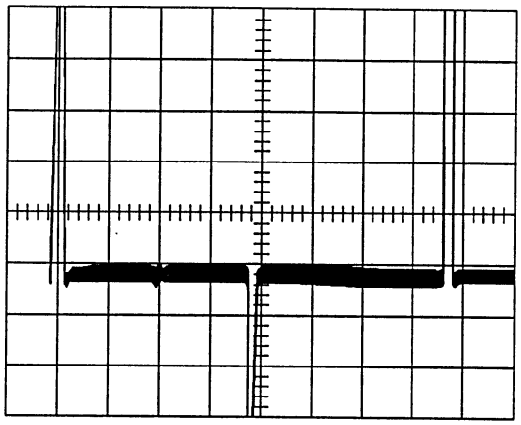

Figure C.4 Correct Pole/Zero Compensation

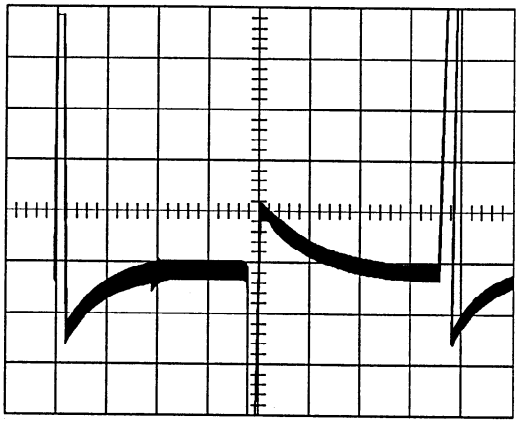

Figure C.5 Undercompensated Pole/Zero

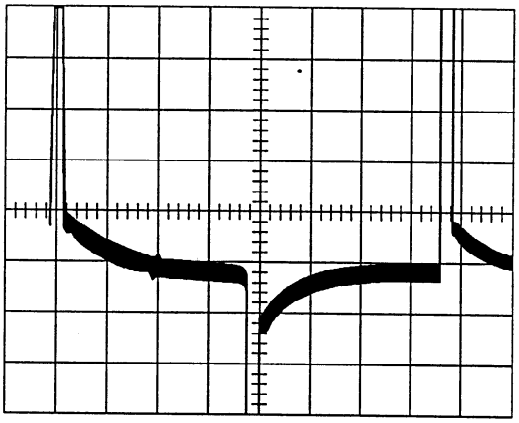

Figure C.6 Overcompensated Pole/Zero

Scope
Vertical: 50 mV/division
Horizontal: 50 µs/division

the Baseline Restorer's low frequency noise suppression effectiveness is greatly reduced. The ambient low frequency noise and the implementation of noise reduction techniques regarding setup can easily be assessed and tested.

For situations where a higher than normal restoration rate is required, the restorer rate may be set to HIgh, which increases the restoration current approximately 4 times. This can improve amplifier performance at extreme high input counting rates or where more control is required to maintain the baseline, such as with some NaI(Tl) scintillation detector systems. The HIgh restoration rate is normally not used since there will be a loss of resolution due to increased correlated noise inherent in dc restoration.

C.3 Manual PUR Threshold

In some cases, you may want to set the PUR threshold manually. For best performance, set the PUR threshold just above the system noise level.

1. Set the AFT switch OFF. The manual PUR Threshold control is active only with AFT set to RESET PREAMP or to OFF.

2. Set the Amplifier Gain and shaping as required.

3. Remove all excitation sources from the vicinity of the detector.

4. Set the PUR ON/OFF switch ON.

5. The following step is to optimize the discriminator sensitivity to insure the threshold is at its lowest setting, just above the noise level.

   Adjust the 2025 PUR THRES control fully counter clockwise. The ACCEPT/ REJECT LED indicator continuously glows red.

   Next, adjust the PUR THRES control clockwise until the ACCEPT/REJECT LED indicator begins to occasionally blink green. The PUR THRES is now properly set.

Note With AFT off and in the manual mode, the PUR Threshold must be rechecked and adjusted if the Detector/Preamplifier or the Amplifier's GAIN or SHAPING are changed.

C.4 Amplifier Shaping Selection

Shaping time constant selection generally is a compromise between optimizing throughput and resolution.

For germanium detectors, 4 μs shaping provides optimum resolution at low count rates, but 2 μs provides better performance over a wider range of count rates and at high count rates.

For high resolution detectors, longer shaping time constants offer better signal to noise (S/N) ratio and reduced sensitivity to the effects of detector ballistic deficit. However, as the system count rate increases, resolution will degrade rapidly as a result of the amplifier's long processing time and the effects of pulse pile-up.

The optimum shaping-time constant depends on the detector characteristics (such as size, noise characteristics and collection characteristics), preamplifier and incoming count rate. Below is a list of 2025 shaping-time constant ranges for other common detectors.

Detector	Shaping (μs)
Scintillation Photomultiplier [NaI(Tl)]	0.5 or 1
Planar Implanted Passive Silicon (PIPS)	0.5, 1 or 2
Gas Proportional Counter	0.5, 1 or 2
Lithium Drifted Silicon [Si(Li)]	6 or 12
Lithium Drifted Germanium [Ge(Li)]	2 or 4
Planar Germanium	4, 6 or 12
Silicon Surface-Barrier (SSB)	0.5

Refer to the specific Detector Operator's Manual for the recommended shaping time. This will be a good starting point.

Further refinements may be realized through experimentation. Collect spectra using shaping times above and below the recommended to find the one that provides optimal resolution performance for your particular detector and application.

Note The P/Z matching must be recalibrated each time the shaping is changed.

C.5 Operation With Reset Preamps

The Model 2025 is fully compatible with most reset type preamps.

Reset preamps use an electronic circuit, as opposed to a feedback resistor to restore the preamp output back to a reference level. As a result, the reset preamp output is a succession of step functions that staircase or ramp up to an upper limit that initiates a preamp reset.

Since the reset preamp signal does not have the characteristic exponential fall time as with RC preamps there is no requirement for Pole/Zero compensation.

C.5.1 P/Z Compensation With Reset Preamps

Reset Preamps do not require pole/zero compensation. When using the Model 2025 with a reset preamp, set the AFT switch to RESET PREAMP, the center position, or OFF. With AFT set to RESET PREAMP, pole/zero compensation is automatically reduced to zero. The Manual P/Z potentiometer is inactive.

With AFT set to OFF, the manual P/Z potentiometer is active and must be manually set to infinity, full counter clockwise.

Note With AFT set to RESET PREAMP or OFF, the PUR threshold must be set manually. See Appendix C.3.

C.5.2 Using the Reset Preamp Inhibit Signal

The preamp reset event produces a large signal to the amplifier driving it into a severe overload condition. The Model 2025 recovers from overload events rapidly and monotonically requiring approximately two non-overload pulse widths to fully recover.

Converting events during amplifier overload may produce spectral distortion and it is recommended that the ADC be gated off during this time using the preamp INHIBIT signal. The preamp INHIBIT signal width should be adjusted to encompass the full unipolar signal recovery. Please consult the Detector/Preamp Operator's Manual for this adjustment. The INHIBIT signal from the Model 2101 Transistor Reset Preamp or Model 2008 Optical Reset Preamp is positive true, the ADC should be set for Late Coincidence gating; please consult the ADC Operator's Manual for more information.

C.5.3 Overload Recovery

Some preamps produce undesirable secondary effects following the preamp reset. The secondary effects may result from long time constants or non-linearities producing excessive unipolar output signal recovery time. System throughput may be compromised and in extreme cases premature baseline instability may result at high count rates.

The 2025 amplifier automatically gates off the baseline restorer (BLR) for normal detector signals and preamp reset events to maintain signal precision. However, it may be desireable to have the baseline restorer suppress unipolar output anomalies that are reset preamp induced.

This can be done by elevating the BLR gating threshold to a level higher than normal. Moving internal jumper plug W5 from the NORM position to the TRP position elevates the BLR threshold by 50 mV. The BLR does not gate off for events lower than the gating threshold and will attempt to suppress irregularities below the elevated threshold set by jumper plug W5. A small loss of spectral resolution may be experienced with the higher BLR gating threshold.

D. Environmental Considerations

This unit complies with all applicable European Union requirements.

Compliance testing was performed with application configurations commonly used for this module; i.e. a CE compliant NIM Bin and Power Supply with additional CE compliant application-specific NIM were racked in a floor cabinet to support the module under test.

During the design and assembly of the module, reasonable precautions were taken by the manufacturer to minimize the effects of RFI and EMC on the system. However, care should be taken to maintain full compliance. These considerations include:

- a rack or tabletop enclosure fully closed on all sides with rear door access
- single point external cable access
- blank panels to cover open front panel Bin area
- compliant grounding and safety precautions for any internal power distribution
- the use of CE compliant accessories such as fans, UPS, etc.

Any repairs or maintenance should be performed by a qualified Canberra service representative. Failure to use exact replacement components, or failure to reassemble the unit as delivered, may affect the unit's compliance to the specified EU requirements.

Operating Temperature: 0-50 degrees Centigrade
Operating Humidity: 0-80% Relative, Non-condensing
Tested to the environmental conditions specified by EN 61010, Installation Category I, Pollution degree 2

Preventative Maintenance

This unit does not require preventative maintenance.

When needed, the front panel of the unit may be cleaned. Remove power from the unit before cleaning. Use only a soft cloth dampened with warm water and make sure the unit is fully dry before restoring power. Because of access holes in the NIM wrap, DO NOT use any liquids to clean the wrap, side or rear panels.