Model 2022
Spectroscopy Amplifier

2022-USR 3/98
9231208A

User's Manual

ISO 9001
SYSTEM
CERTIFIED

CE

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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 2022 Spectroscopy Amplifier offers the resolution performance of Canberra's popular Model 2020 Spectroscopy Amplifier in a single width NIM module. Canberra's well known filter shaping provides improved pulse symmetry, minimum sensitivity of output amplitude to variations in detector rise time, and maximum signal to noise ratio. Unipolar shaping is achieved with one differentiator and two active filter integrators. The differentiator is placed early in the amplifier to insure good overload recovery. The integrators are placed late to minimize noise contribution from the gain stages. The amplifier offers six front panel selectable pulse shaping time constants: 0.5, 1, 2, 4, 8 and 12 µs.

The Model 2022 employs Canberra's unique baseline restorer for optimum performance with high resolution detector systems. The gated baseline restorer automatically adjusts the restoration rate and threshold optimizing performance to the incoming count rate and system noise level.

Simultaneous unipolar and bipolar outputs are available at both front and rear panel BNC connectors. The unipolar signal can be delayed by 2 µs with option 2022-2 or by 4 µs with option 2022-4. The bipolar output can be used for counting, timing, or gating.

The Model 2022 borrows the Model 2020's dc stability and low noise to provide a high performance spectroscopy amplifier in a single width NIM module.

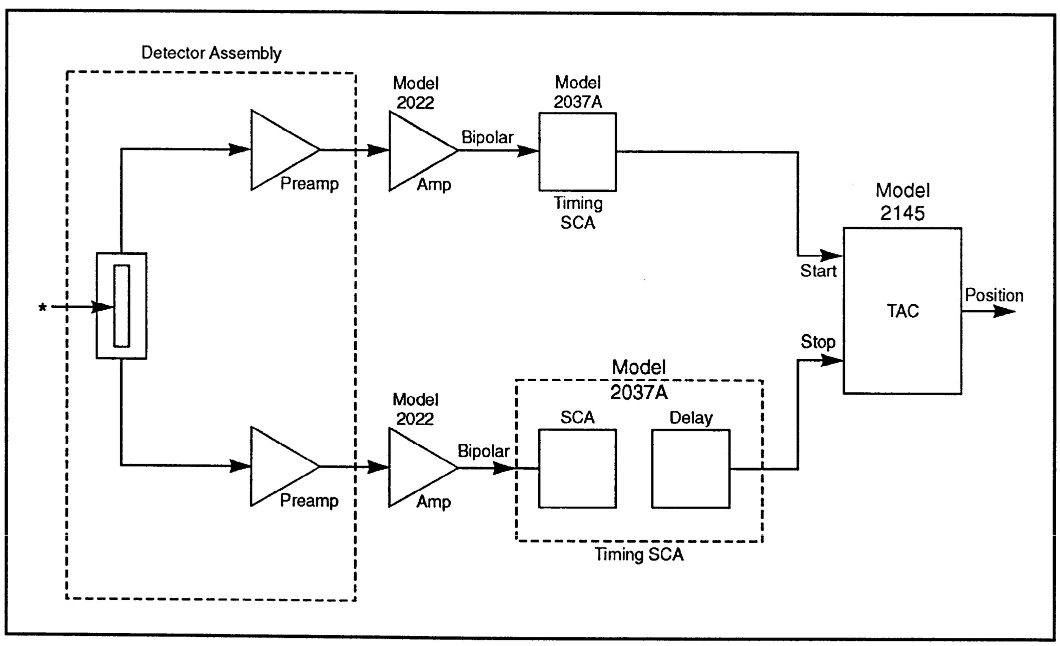


Figure 1.1 Position Sensitive Detector System

2. Controls and Connectors

For input and output signal specifications, refer to Appendix A.

2.1. Front Panel Controls and Connectors

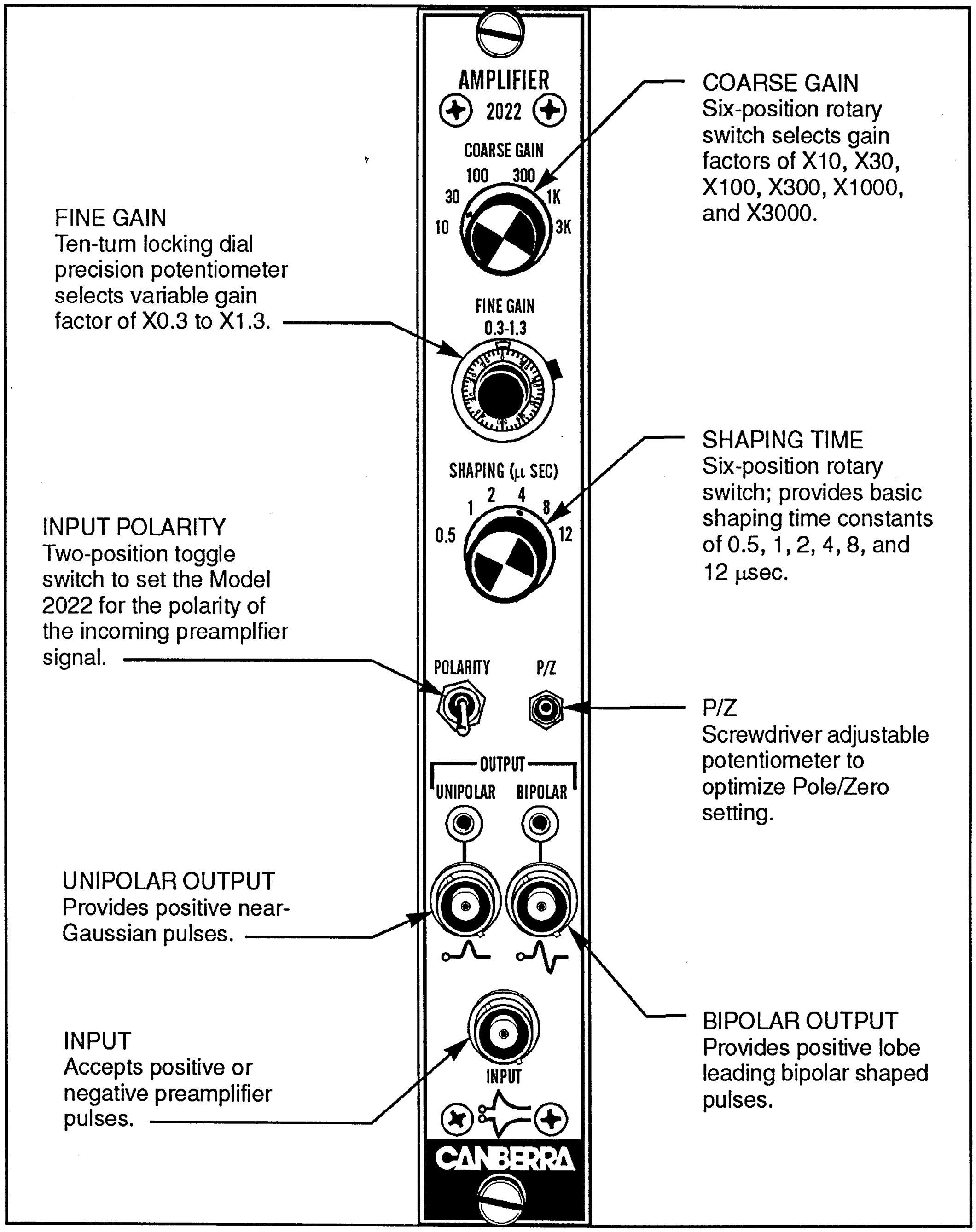


Figure 2.1 Front Panel

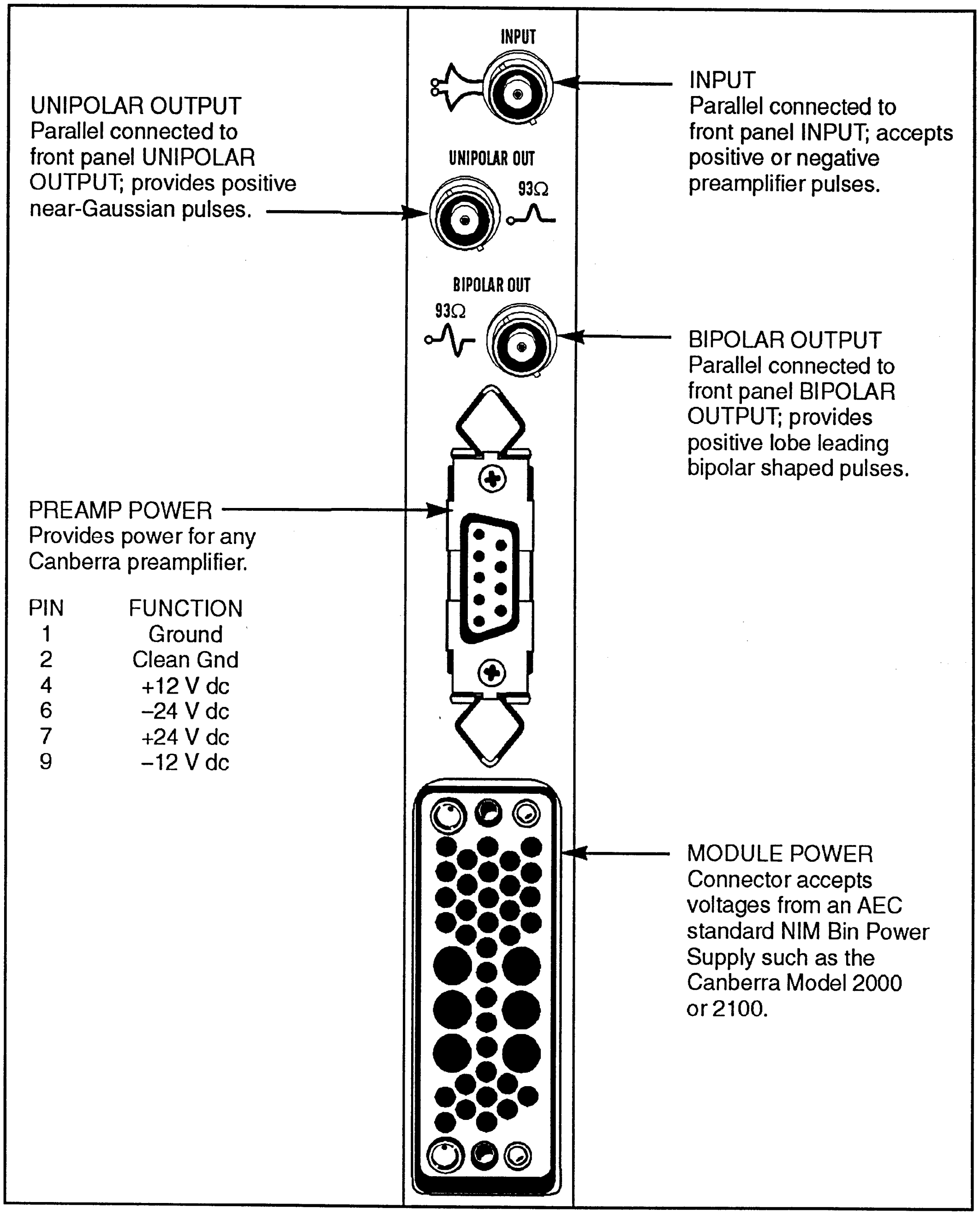


Figure 2.2 Rear Panel

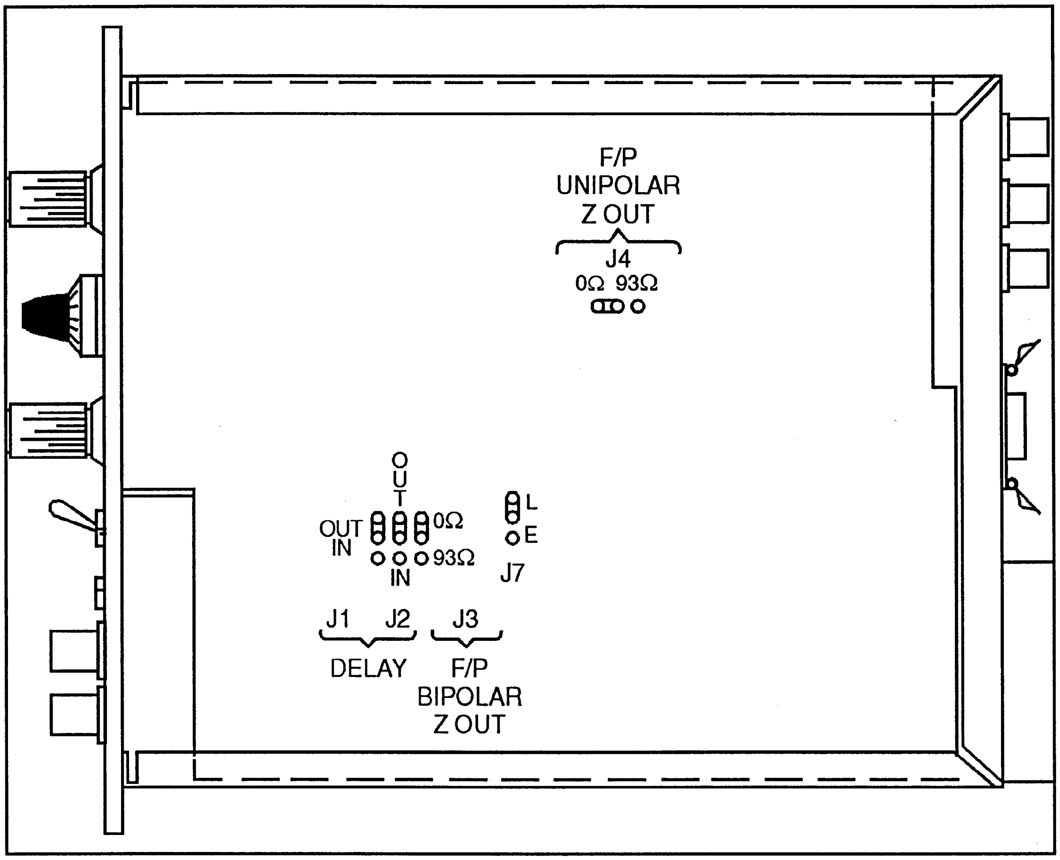


Figure 2.3 Internal Controls (Right Side Cover Removed)

Note: For proper operation of the Model 2022, jumpers J1 and J2 must be placed in the OUT position *unless* option 2022-2 or option 2022-4 is present.

3. Operating Instructions

The purpose of this section is to familiarize the user with the operation of the Model 2022 Amplifier and to check that the unit is functioning correctly. Since it is difficult to determine the exact system configuration in which the module will be used,explicit operating instructions cannot be given. However, if the following procedures are carried out, the user will gain sufficient familiarity with this instrument to permit its proper use in the system at hand.

3.1. Installation

The Canberra Model 2000 bin and power supply, or other bin and power supply systems conforming to the mechanical and electrical standards set by AEC Report TID-20893 (rev.) will accommodate the Model 2022. 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 fingertight. It is recommended that the NIM bin power switch be OFF whenever the module is installed or removed.

The Model 2022 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 sufficient air flow through both the perforated top and bottom covers of the NIM bin.

3.2. Spectroscopy System Operation

A block diagram of a typical Canberra gamma spectroscopy system is shown in Figure 3.1.

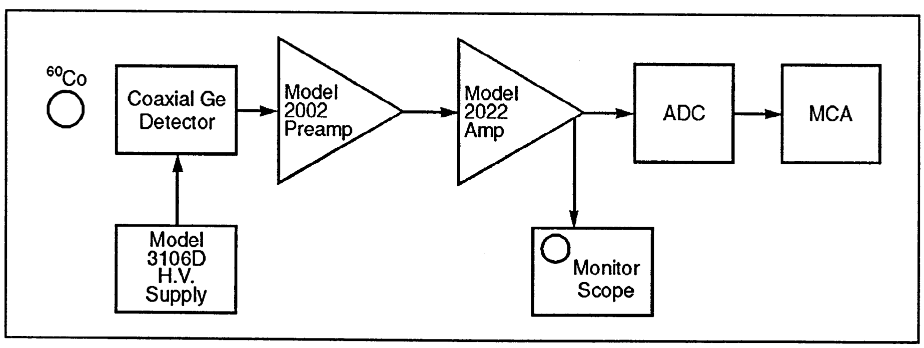


Figure 3.1 Typical Gamma Spectroscopy System

3.2.1 System Setup

Internal Controls

1. Prior to installation, the internal controls should be set to their desired positions. See Figure 2.3 for the locations of the controls.

   There are two jumper plugs (J1 and J2) that set the UNIPOLAR output to the prompt (OUT) mode or the optional delayed (IN) mode. With option 2022-2 the delay is 2 µsec, or with option 2022-4 the delay is 4 µsec. The jumper plugs must remain in the OUT position when the option is not present to assure correct operation of the Model 2022.

   There are two jumper plugs which select the output impedance of the front panel (only) UNIPOLAR (J4) and BIPOLAR (J3) outputs. The output impedances can be changed from 0 ohms to approximately 93 ohms. The Model 2022 is shipped with the output impedance set for 0 ohms. The rear panel 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 meters. 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.

   Another jumper plug (J7) is provided to select a linear or an exponential restorer response. The linear response is optimum for the faster shaping-time constants and their associated noise spectra. The slower shaping-time constants produce noise spectra having proportionately lower frequency components, requiring a different restorer response. The exponential response is better suited to these shapings.

   The Model 2022 is shipped with the restorer response jumper plug in the linear (L) response position, which will give the best restorer response for shaping-time constants of 0.5, 1, 2, and 4 µs. These are the time constants generally used with Ge, proportional counter, surface barrier, and scintillation photomultiplier detectors.

   The exponential (E) response position yields optimum restorer performance with shaping-time constants of 8 and 12 µs. These time constants are most often used with Planar Ge and Si(Li) detectors. The exponential response may also be used with the other shaping time constants without loss of resolution performance, provided that the input count-rate remains below 20 kcps.

2. Insert the Model 2022 into a standard NIM bin. Preamp power is provided by means of a connector located on the rear panel of the Model 2022 amplifier. Allow the entire system to warm up and stabilize.

3. Set the Model 2022 controls as follows:

Shaping:	2 µsec
Coarse Gain:	100
Fine Gain:	7.2

4. Set the INPUT POLARITY switch to match the output polarity of the preamp (positive, +, for a Canberra Model 2001 Preamp). This will give approximately a 9V output when using a preamp gain of 100 mV/MeV and a ^{60}CO source.

5. Install a "Tee" connector on the Model 2022 UNI POLAR output. Connect one end to the ADC's INPUT. The ADC must be direct coupled for linear input signals to fully exploit the rate capabilities of the Model 2022. All Canberra ADCs are dc coupled.

6. Connect the other end of the "Tee" connector to an oscilloscope to monitor the UNIPOLAR output.

3.2.2 Performance Adjustments

Pole/Zero Using Ge Detector and ^{60}Co

1. The pole/zero trim is extremely critical for good high count-rate resolution performance. Adjust the radiation source count between 2 kcps and 25 kcps. While observing UNIPOLAR output on the scope, adjust the pole/zero so that the trailing edge of the unipolar pulse returns to the baseline with no over- or undershoots. Figure 3.2a shows the correct setting of the P/Z control, with Figure 3.2b and 3.2c showing under- and over-compensation for the preamplifier decay time-constant. Notice some small amplitude signals with long decay times in Figure 3.2a. These are due to charge trapping in the detector and cannot be corrected by the P/Z control.

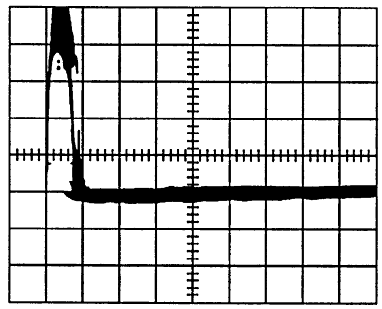


Figure 3.2a Correct Pole/Zero Compensation

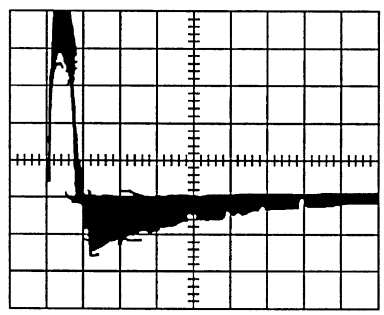
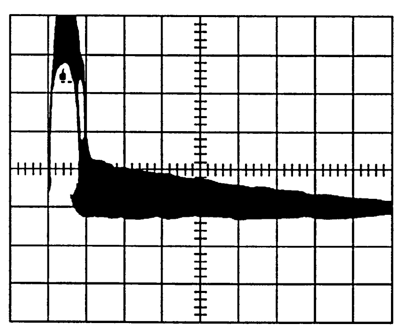


Figure 3.2b Undercompensated Pole/Zero



Oscilloscope
Vert.: 50 mV/div
Horiz.: 10 μs/div
Source ^{60}Co
1.33 MeV peak: 7 V amplifier
Count Rate: ≈ 2 kcps
Shaping: 2μs.

Figure 3.2c Overcompensated Pole/Zero

Pole/Zero Adjustment Using a Square Wave and Preamp Test Input

1. Driving the preamp test input with a square will allow a more precise adjustment of the amplifier P/Z.

2. The amplifier's controls should basically be set for its intended application: COARSE GAIN. SHAPING, INPUT POLARITY.

3. Adjust the square wave generator for a frequency of approximately 1 kHz.

4. Connect the square wave generator's output to 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 mssec/ div. Monitor the Model 2022 UNIPOLAR output and adjust the square wave generator's amplitude control (attenuator) for output signals of ± 8 V.

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

7. Reduce the scope vertical sensitivity to 50 mV/div. See the note below.

Note At high count rates, the Pole/Zero adjustment is extremely critical for maintaining good resolution and low peak-shift. For a precise and optimum setting for the Pole/Zero, a scope vertical sensitivity of 50 mV/div should be used. Higher scope sensitivities can also be used. but result in a less precise Pole/Zero adjustment. However, most scopes will over load for a 10 V input signal when vertical sensitivity is set for 50 mV/div. Overloading the scope input will distort the signals' recovery to the baseline. Thus the Pole/Zero will be incorrectly adjusted, thereby resulting in a loss of resolution at high count-rates. To prevent overloading the scope, a clamping circuit, such as Canberra Model LB1502 Schottky Clamp Box, should be used.

Figure 3.3a shows the correct setting of the Pole Zero control. Figures 3.3b and 3.3c show under- and over-compensation for the preamplifier decay-time constant. As illustrated in Figure 3.3a, the UNIPOLAR output signal should have a clean return to the baseline with no bumps, overshoots or undershoots.

Note When adjusting the P/Z 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 vertical gain and probe compensation. Connect the scope CALIBRATION Output through an attenuator to the preamp input and repeat steps one through six in Section 3.2.2, "Performance Adjustments".

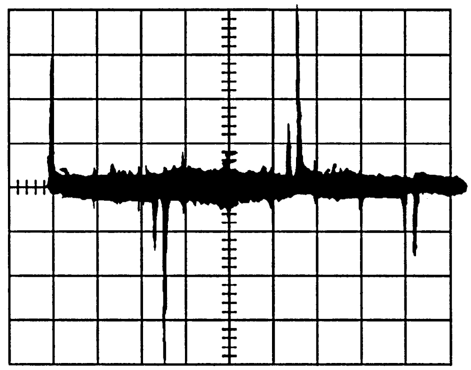


Figure 3.3a Correct Pole/Zero Compensation

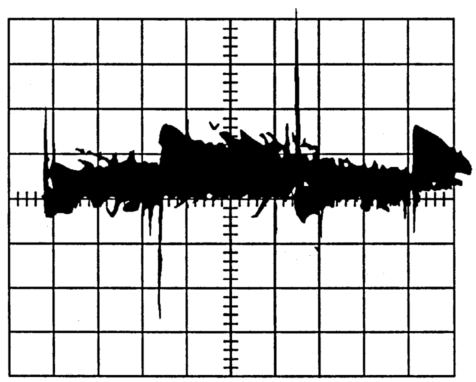


Figure 3.3b Undercompensated Pole/Zero

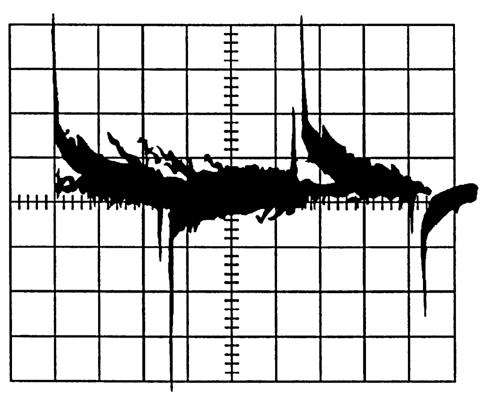


Figure 3.3c Overcompensated Pole/Zero

Restorer Response

Faster shaping-time constants (0.5 through 4 μs) give rise to output noise spectra having different frequency components than the slower shaping-time constants (5 through 12 μs). The Model 2022 provides a restorer response for each of the two conditions: linear (L) response for the faster time constants and an exponential (E) response for the slower time constants. Jumper plug J7 (see figure 2.3) selects the required response. Shipped in the linear (L) position. See Section 3.2.1, "System Setup, Internal Controls" for more information.

MCA Controls

To obtain optimum resolution, the Lower Level Discriminator (LLD) on the MCA/ADC should be set just above the noise so that the effects of pileup a minimized.

3.2.3 Resolution Versus Count Rate and Shaping

The 2 μs shaping-time constant is near-optimum for Ge detector systems over a wide range of incoming count rates. For high resolution, larger shaping-time constants offer a better signal-to-noise (S/N) ratio, resulting in better resolution. However, as the count rate increases, the effects of pileup will degrade the resolution much sooner. The optimum shaping-time constant depends on the detector characteristics (such as its size, configuration, and collection characteristics), preamplifier, and incoming count rate.

Below is a list of the optimum shaping-time constant ranges for other common detectors:

Scintillation Photomultiplier	0.5
Gas Proportional Counters	0.5 through 2
Silicon Charged Particle	0.5 through 2
Coaxial Germanium	2 through 4
Planar Germanium	4 through 12
Cooled Silicon	8 through 12

3.2.4 Resolution Destroying Interferences

Vibration Transmitted to Detector and Cryostat

This can be through the floor or mounting, as well as direct audio coupling through the air. Vibration isolators in the mounting and sound absorbing covers around the detector can reduce this problem.

Close Proximity of a Radio Station Picked Up by the Cryostat's "Dipstick"

Good contact between the dipstick and the cryostat can often help solve this problem. Beware of grounding the cryostat and dipstick because this may increase power line frequency (50 or 60 Hz) ground loops.

Ground Loops and Power Line Frequency Interference Caused by Long Cable Connections Between Detector, Preamplitier and Shaping Amplifier

There is no general solution for this problem. As a first step, the preamp should use the power supplied by the main shaping amplifier. Second, the system should have a single point house ground. For example, on a general system connect the NIM bin to house ground via the ac line cord. Isolate all other equipment requiring ac voltage from the house ground. Connect all the chassis in the system to the grounded NIM bin using heavy braided wire.

High Voltage Power Supplies (HVPS)

Generally, an ac line powered HVPS should float from power line ground with the only ground being made at the preamplifier through the high voltage connecting cable.

Analyzer EMI

If the detector is located within three to five meters (10 to 15 feet) of a multichannel analyzer containing ferrite CORE memory, it can receive EMI (electromagnetic interference). This is due to high memory-core-currents during the memory cycle of the analyzer. The only practical cure for this problem is to operate the analyzer in the "Live" Mode of accumulation. That way, the memory cycle operates only while no signal is being analyzed.

Amplifier Parasitic Oscillations

If the cable connecting the front panel outputs of the amplifier to the ADC exceed three to six meters (10 to 15 feet) in length, oscillations can occur. The cure is to use RG-62 cable (93 ohm impedance) and terminate the ADC end of the cable with a 93.1 ohm metal film resistor. Alternatively, the 93 ohm output impedance of the amplifier can be used with no terminator.

Trouble Isolated to Ground Loops and or RF EMI

If trouble is isolated to ground loops and or RF EMI, detector-system loop-buster accessories are available to help minimize these effects. An application note entitled "System Considerations with High Resolution Detectors" is available from the factory.

4. Theory of Operation

The following is a description of the circuitry used in the Model 2022 Spectroscopy Amplifier. Components are referred to reference designations such as Q2, C5, and R10 as marked on the schematic diagram.

4.1. Gain Amplifiers

For optimum signal-to-noise ratio, most of the gain is accomplished before integration. To avoid excessive attenuation between gain stages and maintain low output noise, only amplifiers Amp 1 and Amp 3 are used at low gains. As a result, the input amplifier Amp 1 is always the dominant noise source. Amp 2 is added to the circuit at high gains. This enables each of the three gain stages to operate at relatively low closed-loop gains, thereby providing stable operation with time and temperature.

Amplifiers Amp 1 (Q1 through Q6), Amp 2 (Q7 through Q11) and Amp 3 (Q13 through Q18) are all basically the same configuration; therefore, only Amp 1 will be fully described.

4.2. Input Amplifier Amp 1

The differential input pair Q1 drives the common base transistors Q2 and Q3. Transistors Q2 and Q3 are operated at low current levels, providing a high output impedance drive output transistors Q5 and Q6, through the common source FET Q4. The necessary current to drive the FET and circuit capacitors at high frequencies is derived from input transistor Q1, through the low impedance of Q2 and Q3. This gives a typical slew-rate for the amplifier of 140 V per microsecond. C15 provides feedback for closed low stability and allows the amplifier to follow a 100 nanosecond rise time input signal with very low distortion. Because the gain amplifiers do not require dc stability and a operated as inverting amplifiers, a constant current sour is not needed in the emitters of Q1. Transistors Q5 and Q6 are biased on by D51 and R22 respectively, with the junction of R26 and R28 providing a low impedance output.

The differentiation network and pole/zero cancellation circuitry are both located at the inverting input of Amp 1. SHAPING switch S4 selects the passive differentiator capacitors C5 through C11, passive differentiator resistor R6 and R7, and pole/zero compensating resistors R77, R78 R80, and R82 hr the ~elected time constant. The pole;zero control RV7 sets the degree of pole/zero compensation. The dc balance control RV1 is factory set so that changes of the FINE GAIN control RV6 will not shift the output dc level of Amp 1 and to minimize the dc offset that appears at the output of Amp 2. D49 is a fast-switching overload protection diode, enhancing good overload recovery.

4.3. Gain Amplifiers Amp 2 and Amp 3

Amp 2 is non-inverting, with a gain of 30 determined by R30, R31, R50, and R51. It is switched into the amplification chain by COARSE GAIN switch S1 only for gains above 300. Diode D3 prevents charge accumulation on C27 during overload conditions, enhancing good overload recovery.

Amp 3 is an inverting amplifier with its gain controlled by the ratio of the parallel combination of R56 and R58 and input resistor R52, R53, and R54, selected by the COARSE

GAIN switch. Diodes D8 and D9 provide overload protection, enhancing good overload recovery. Capacitor C37 allows the gain stage to be ac coupled with a time constant of C37 and R58. This very long time constant contributes to the effectiveness of the dc restorer.

4.4. Integrators

The first integrator comprises A6, R83 through R94, C46, C47, C50, and C51. The second integrator includes A8, R107 through R118, C68, C69, C73, and C74. These are low-pass active filters that provide complex pole pairs which have the locus of the poles equidistant from the abscissa on the S-plane. The real part of the complex poles is equal to the pole of the input differentiator. The active filter networks are selected by SHAPING switch S4.

4.5. Polarity Amplifier

The polarity amplifier is situated between the two integrators and includes A7, Q23, Q24, and associated resistors. Amplifier A7 is a wide band, high slew-rate, operational amplifier. When the INPUT POLARITY switch is set to negative (-), the gates of FETs Q23 and Q24 are driven to approximately -17 V, turning them off. Since pin 3 of A7 is not tied to ground, it is allowed to follow the integrated input signal, the amplifier acts as a voltage follower with unity gain. When the INPUT POLARITY switch is set positive (+), both FETs 023 and Q24 turn on, shorting pin 3 of A7 to ground. With A7 pin 3 grounded, the amplifier has an inverting gain of 1.

4.6. Unipolar Output Amplifier

A4 and a power output driver, Q28 through Q30, constitute the output amplifier. Integrated circuit A4 is a wide-band, high slew-rate operational-amplifier. The overall amplifier (op-amp and driver) provides an inverting gain of 3.3 with single-pole integration to minimize noise introduced by amplifier A4. The integration time-constant is derived from R125 plus R126 and capacitors C86 through C91 as selected by the SHAPING switch.

The output driver transistors are biased Class "AB". Diodes D21, D24, resistor R266, and current source Q28 form the biasing network for the output transistors. Diodes D22 and D23 provide short-circuit protection. With an improper load connected to the output the voltage drop across-R131 or R132 forward-biases diode D22 or D23, respectively. For this condition, the respective output transistor is bypassed, the output current is derived directly from the op-amp and limited to approximately $\pm$ 200 mA.

Diode D20 provides limiting so that the output transistors do not go into saturation, preventing base emitter charge storage and enhancing good overload recovery.

4.7. Bipolar Output Amplifier

The bipolar output amplifier is composed of A3, Q25, Q26, and Q27. The negative unipolar signal from the second integrator is differentiated to produce the bipolar sign The time constants for the differentiator are determined by the selection of R184, R185, and C75 through C80. The bipolar signal is then amplified and inverted by A3, which is a high slew-rate operational-amplifier. The output driver circuit, Q25, Q26, and Q27, is of the same design as the unipolar output driver circuit.

4.8. Restorer Gate Threshold Circuits

The automatic reference threshold circuit consists of A9, Q34, and Q35, which form a closed-loop circuit whose operation resembles an op-amp. The circuit monitors the unipolar output noise level. Diode D26 causes this circuit to have a unidirectional response, so that it responds only to negative excursions of the unipolar output noise positive reference equal to the average value of the unipolar output noise is generated at TP17.

The restorer gate circuit is comprised of A10, A11, Q37 and Q38. When a positive signal (greater than the threshold) appears at TP7, the output of comparator A11 goes low, shutting off Q37. C112 ac couples the signal to transistor A5c, preventing restorer latchup. The negative restorer gate A10 operates in the same manner for large negative signals such as preamp reset pulses. The negative threshold is set to approximately -500 mV by resistive divider R174 and R175. Q38 is turned on by large negative signals and brings the positive threshold at TP18 to approximately 0 V. Both comparator signal inputs are protected by diode clamps D36 and D37.

4.9. Restorer

The restorer circuit consists of transistor array A5, Q31 through Q33, Q48, Q51, and Q52. The restorer is a transconductance amplifier which develops a current of the correct polarity as its output (junction of Q32 collector and A5 pin 15). The correction voltage developed on C110 is buffered by FET Q31 and summed in at A4 pin 3, forcing TP7 to 0 V, maintaining the baseline.

Jumper plug J7 selects the Linear or Exponential restorer response. In the L mode, the restorer operates with maximum gain and provides the hard response necessary for faster shaping time constants. When J7 is in the E position, the restorer gain is greatly reduced and provides a softer response necessary for the slower shaping time constants. The source and sink currents for holding capacitor C110 are set by R156. As the count rate increases, extra source and sink current is provided by C106 and D30.

A. Specifications

A.1. Inputs

INPUT - Accepts positive or negative pulses from an associated preamplifier; amplitude: 10 V divided by the selected gain for linear response; ±12 V maximum; rise time: less than SHAPING time constant; decay time constant; 40 μs to ∞ for 0.5, 1, 2, 4 and 8 μs shaping time constants, 100 μs to ∞ for 12 μs shaping time constant; $Z_{in} \approx 1\ k\Omega$; front and rear panel BNC connectors.

A.2. Outputs

UNIPOLAR OUTPUT - Provides positive linear active-filtered near-Gaussian shaped pulses; amplitude linear to +10 V, 12 V max.; dc restored; output dc level factory calibrated to 0±5 mV, front panel $Z_{out} <1\ \Omega$ or ≈ 93 Ω, internally selectable; rear panel $Z_{out} \approx 93\ \Omega$; short circuit protected; prompt or delayed 2 μs with option 2022-2 or 4 μs with option 2022-4; front and rear panel BNC connectors.

BIPOLAR OUTPUT - Provides prompt positive lobe leading linear active-filtered bipolar-shaped pulses; amplitude linear to +10 V, 12 V max., negative lobe is approximately 70% of positive lobe; dc coupled; output dc level ±25 mV; front panel $Z_{out} <1\ \Omega$ or ≈ 93 Ω, internally selectable; rear panel $Z_{out} \approx 93\ \Omega$; short circuit protected; front and rear panel BNC connectors.

A.3. Front Panel Controls

COARSE GAIN - Rotary switch selects gain factors of X10, X30, X100, X300, X1000 and X3000.

FINE GAIN - Ten-turn locking-dial precision potentiometer selects variable gain factor of X0.3 to X1.3; resetability ≤0.03%.

INPUT POLARITY - Toggle switch selects the polarity of the incoming preamplifier signal.

P/Z - Multi-turn screwdriver adjustable pole/zero potentiometer optimizes amplifier baseline recovery and overload performance for the preamplifier fall time constant and the 2022s pulse shaping chosen; 40 μs to ∞ for 0.5, 1, 2, 4 and 8 μs SHAPING time constants, 100 μs to ∞ for 12 μs SHAPING time constant.

SHAPING TIME - Rotary switch provides 0.5, 1, 2, 4, 8 and 12 μs basic shaping time constants.

A.4. Internal Controls

UNIPOLAR DELAY - Two jumper plugs select UNIPOLAR output for prompt (OUT) or delayed (IN) by either 2 μs with option 2022-2 or 4 μs with option 2022-4. Shipped in the prompt (OUT) position.

UNIPOLAR Z_{out} - Jumper plug provides $Z_{out} \leq 1\ \Omega$ or $\approx 93\ \Omega$ for the front panel UNIPOLAR output. Shipped in the $\leq 1\ \Omega$ position.

BIPOLAR Z_{out} - Jumper plug provides $Z_{out} \leq 1\ \Omega$ or $\approx 93\ \Omega$ for the front panel BIPOLAR output. Shipped in the $\leq 1\ \Omega$ position.

L/E - Jumper plug selects a linear or exponential restorer response. Shipped in the L (linear) position.

A.5. Performance

GAIN RANGE - Continuously variable from X3 to X3900, product of COARSE and FINE GAIN controls.

OPERATING TEMPERATURE RANGE - 0 to 50 °C.

GAIN DRIFT - ±0.0075%/°C.

DC LEVEL DRIFT - UNIPOLAR output: ±10 µV/°C; BIPOLAR OUTPUT: ±50 µV/°C.

INTEGRAL NON-LINEARITY - ±0.05%, 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 Single Channel Analyzer.

OVERLOAD RECOVERY - UNIPOLAR (BIPOLAR) output recovery to within ±2% (1%) of full scale output from X1000 overload in 2.5 (2.0) non-overloaded pulse widths, at full gain, any shaping time constant and pole/zero cancellation properly set.

NOISE CONTRIBUTION - ≤4.0 µV true RMS UNIPOLAR (7.1 µV BIPOLAR) output referred to input, 2 µs shaping and amplifier gain ≥100.

PULSE SHAPING - Near-Gaussian shape; one differentiator (two for bipolar), two active filter integrators; UNIPOLAR time to peak: 2.35X shaping time; pulse width: 7.3X shaping time BIPOLAR time to crossover: 2.8X shaping time, time to peak, pulse width and crossover times measured at 0.1% of full scale output; 1 µs SHAPING center frequency: 150 kHz; band width: 180 kHz; f_c and BW for other shaping are multiples of that given for 1 µs.

RESTORER - Active gated.

SPECTRUM BROADENING - The FWHM of a ^{60}Co 1.33 M-10eV gamma peak for an incoming rate of 2 kcps to 100 kcps and a 9 V pulse height will typically change <14% for 2 µs shaping. These results may not be reproducible if associated detector exhibits an inordinate amount of long rise time signals.

COUNT RATE STABILITY - The peak position of a ^{60}Co 1.33 M-10eV gamma peak for an incoming count rate of 2 kcps to 100 kcps and a 9 V pulse height will typically shift <0.024% for 2 μs shaping.

A.6. Environmental

Operating Temperature: 0 - 50 °C.

Operating Humidity: 0 - 80% relative, non-condensing.

Tested to the environmental conditions specified by EN61010, Installation Category I, Pollution degree 2.

A.7. Connectors

All signal connectors are BNC type.

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

A.8. Power Requirements

+24 V dc – 125 mA

+12 V dc – 75 mA

–24 V dc – 150 mA

–12 V dc – 65 mA

A.9. Physical

SIZE - Standard single-width NIM module 3.43 x 22.12 cm (1.35 x 8.71 in.) per DOE/ER-0457T.

NET WEIGHT - 0.9 kg (2.0 lb).

SHIPPING WEIGHT - 1.9 kg (4.1 lb).

A.10 Environmental Considerations

This unit complies with all applicable European Union requirements. Care should be taken to maintain full compliance by the use of CE compliant detectors and NIM.

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 with the specified EU requirements.