



**MIRION**  
TECHNOLOGIES

# Model 2025 AFT Research Amplifier

## Features

- Automatic fine tuning of critical parameters: Pole/Zero Matching, BLR Rate, BLR Threshold, PUR Threshold
- Gaussian and triangular shaping
- Differential input
- Front panel common mode balance control
- Super Fine Gain (SFG) control
- Pileup rejector and live time corrector
- Automatic reset preamplifier mode

## Description

The Model 2025 Automatic Fine Tuning (AFT) Research Amplifier 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 Pileup Rejector and Live Time Corrector.

Although some of these features are available in other amplifiers, the Model 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 Model 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 shaping, gain and count rate conditions.

For Reset Preamplifier 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.



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The Model 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 twelve 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 Model 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 Model 2025 to suppress high frequency noise normally associated with personal computer and MCA raster-type displays. The 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 (LTC) and Pileup Rejector (PUR) 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 Model 2025 generates a system dead time which extends the collection time by the appropriate amount.

The Model 2025 is compatible with the Model 599 Loss Free Counting Module, which provides real-time correction of system counting losses. The losses are corrected as they occur, rather than extending the measurement time as in conventional correction by extending the live time. The front panel ACCEPT/REJECT LED indicates pileup rejector status.

## Specifications

### INPUTS

- NORM – Accepts positive or negative tail pulses from an associated preamplifier; amplitude  $\pm 10$  V divided by the selected gain,  $\pm 25$  V maximum; rise time: less than shaping time constant; decay time constant: 40  $\mu$ s to  $\infty$ ; polarity set by INPUT switch.  $Z_{in}$  changes with COARSE GAIN and POLARITY setting, 2.1 k $\Omega$   $> Z_{in}$   $> 0.5$  k $\Omega$ ; 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.  $Z_{in}$  changes with COARSE GAIN and POLARITY setting, 2.1 k $\Omega$   $> Z_{in}$   $> 0.5$  k $\Omega$ ; 9 V maximum common mode; 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 k $\Omega$  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 k $\Omega$  pull up resistor to +5 V; accessible through pin 1 of the rear panel PUR connector.

### 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 $\pm$ 5 mV, front panel  $Z_{out}$   $< 1$   $\Omega$  or 93  $\Omega$ , internally selectable; rear panel  $Z_{out}$  is 93  $\Omega$ ; 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  $< \pm 10$  mV; front panel  $Z_{out}$   $< 1$   $\Omega$  or 93  $\Omega$ ; internally selectable; rear panel  $Z_{out}$  is 93  $\Omega$ ; 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 k $\Omega$  pull up resistor through a 47  $\Omega$  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.

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- **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 Model 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 k $\Omega$  pull up resistor through 47  $\Omega$  output resistor; rear panel BNC connector.

## 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; reset ability 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  $\mu$ s to  $\infty$ .
- **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** – Indicates pileup status when PUR is selected.
- **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  $\mu$ s 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  $\Omega$ .
- **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  $\pm 300$  mV, which minimizes oscilloscope overload for precise manual preamp matching.

## 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.

## PERFORMANCE

- **GAIN RANGE** – Continuously variable from X2.5 to X1500.
- **TEMPERATURE COEFFICIENTS** – UNipolar: Gain  $-0.005\%/^{\circ}\text{C}$ , dc level  $-\leq \pm 7.5 \mu\text{V}/^{\circ}\text{C}$ ; BIpolar: Gain  $-\leq \pm 0.007\%/^{\circ}\text{C}$ , dc level  $-\leq \pm 30 \mu\text{V}/^{\circ}\text{C}$ .
- **INTEGRAL NONLINEARITY** –  $-\leq \pm 0.04\%$  over total output range for 2  $\mu$ s shaping.
- **CROSSOVER WALK** – BIpolar output:  $\leq \pm 3$  ns for 50:1 dynamic range and 2  $\mu$ s shaping when used with CANBERRA Model 2037A Edge/Crossover Timing SCA.
- **OVERLOAD RECOVERY** – UNipolar (BIpolar) output recovers to within  $\pm 2\%$  (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** –  $\leq 4.5 \mu\text{V}$  (7.0  $\mu\text{V}$ ) true RMS, UNipolar (BIpolar) output referred to input, 2  $\mu$ s shaping, and amplifier gain  $\geq 100$ .

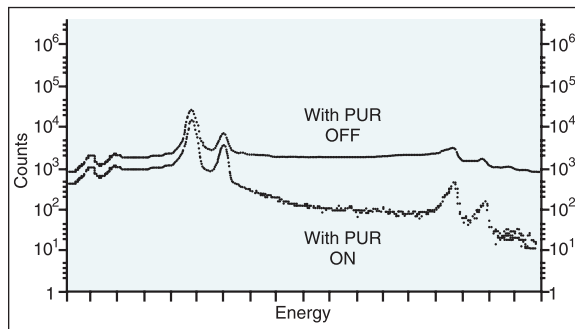
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- **PULSE SHAPING** – Near-Gaussian or near-triangular shape; one differentiator (two for bipolar); three active filter integrators realizing eight-pole shaping network; shaping time parameters referenced to 1  $\mu$ s are listed in following table:

Parameter	Shaping Time Multiplier		
	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 one-tenth maximum	5.6	5.0	
Pulse width at maximum	6.7	6.2	
Bipolar crossover/ Unipolar peak delay			0.8

- **RESTORER** – Active gated.
- **SPECTRUM BROADENING** – The FWHM of  $^{60}\text{Co}$  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  $\mu$ s 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  $^{60}\text{Co}$  1.33 MeV gamma peak for an incoming count rate of 2 kcps to 100 kcps and a 9 V pulse height will typically shift less than 0.02% for 2  $\mu$ s 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.

Detector: CANBERRA Model GC2020  
Amplifier: CANBERRA Model 2025



**Figure 1**  
Comparison of Pileup Region Background  
and Sum Peaks With PUR On and Off  
 $^{57}\text{Co}$  Spectrum at 80 cps and 4  $\mu$ s Shaping

## PILEUP REJECTOR/LIVE TIME CORRECTOR

- **PULSE PAIR RESOLUTION** –  $\leq 500$  ns.
- **MINIMUM DETECTABLE SIGNAL** – Limited by detector/preamp noise characteristics.

## POWER REQUIREMENTS

- +24 V dc – 120 mA
- +12 V dc – 220 mA
- 24 V dc – 160 mA
- 12 V dc – 160 mA

## ACCESSORIES

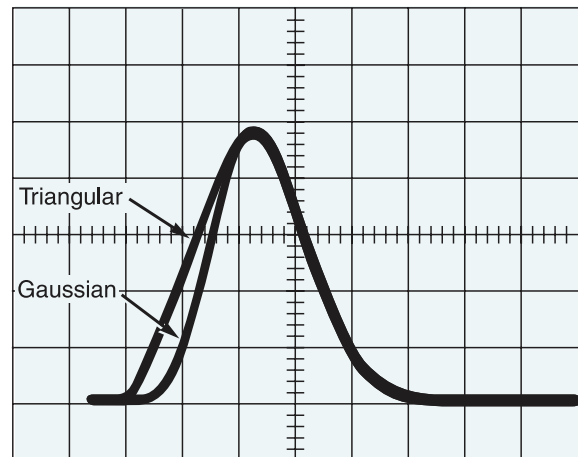
- C1514 PUR/LTC and DT cable set.

## 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).

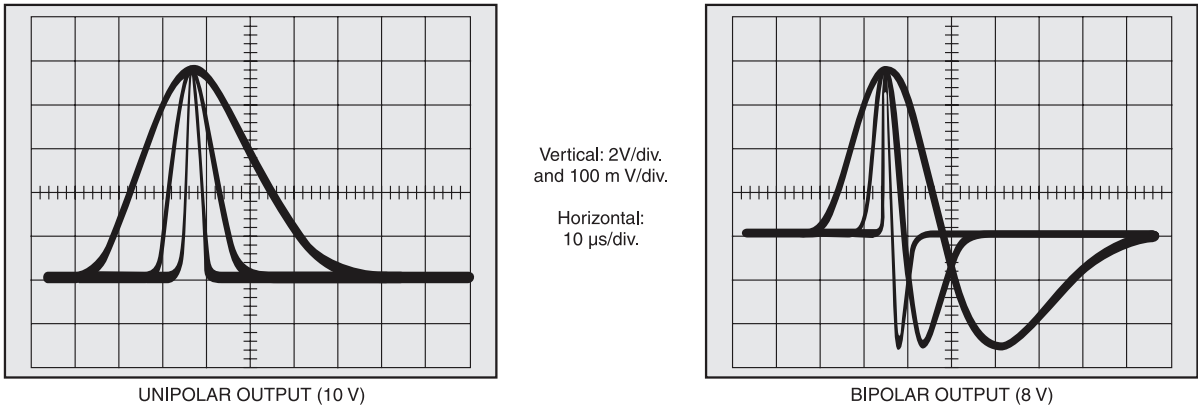
## ENVIRONMENTAL

- **OPERATING TEMPERATURE** – 0 to 50  $^{\circ}\text{C}$ .
- **OPERATING HUMIDITY** – Up to 95%, non-condensing.
- Meets the environmental conditions specified by EN 61010, INSTALLATION Category I, Pollution Degree 2.

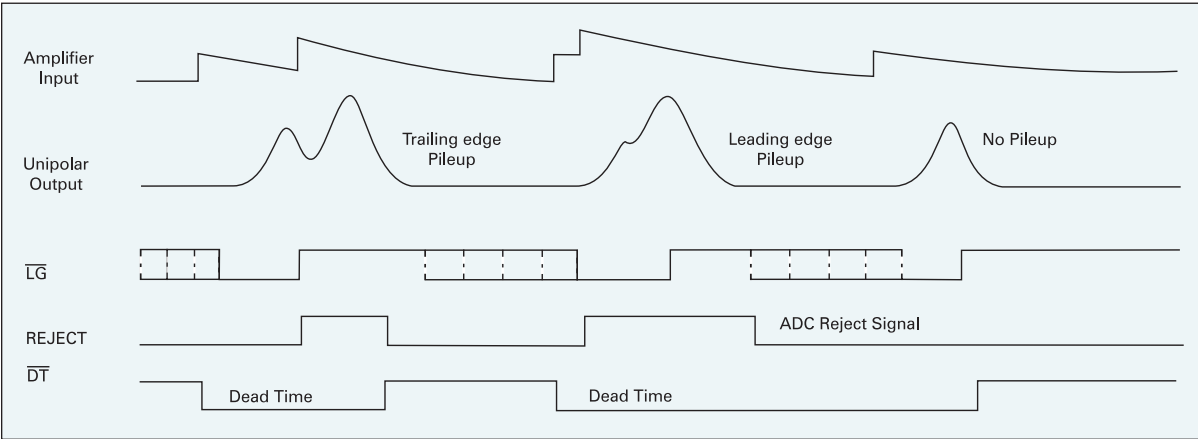


**Figure 2**  
Comparison of Triangular and Gaussian Shaping  
Model 2025 Shaping Selected for 2  $\mu$ s

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**Figure 3**  
Comparison of Output Pulse Shapes Model 2025 Shaping Selected for 1, 4, and 12  $\mu$ s



**Figure 4**  
Relationship of Amplifier and Pileup Rejector Signals

