PREAMP/AMP/DISC
Model 814/A

1285

Instruction Manual

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PREAMP/AMP/DISC

MODEL 814

CONTENTS

SECTION 1
INTRODUCTION

The Canberra Model 814 contains a charge sensitive bipolar input preamplifier, a linear amplifier with a maximum gain of 600 and an integral discriminator. It accepts the positive or negative charge output of scintillation detectors or gas proportional counters, and provides, at the AMP OUT connector, a near-Gaussian bipolar output pulse.

Amplifier gain is established by front panel controls; a five position switch provides a 16:1 range in 2:1 steps; a front panel single-turn continuous control provides a 3:1 fine gain range.

The module can accept either a positive or negative preamplifier (or amplifier) input signal by use of a front panel polarity selection switch. An integral discriminator provides a positive eight volt rectangular pulse at the DISC OUT connector for each amplifier output which exceeds a selected threshold. The amplifier output can be obtained separately. Discriminator threshold is selected by a ten-turn front panel control and spans a range from 50 millivolts to 10 volts.

SECTION 2
SPECIFICATIONS

2.1 PREAMP AND AMPLIFIER

PREAMP INPUT	Front panel BNC connector accepts negative or positive charge signals from scintillation counters and gas proportional counters; input sensitivity, 3.3mV/picocoulomb
AMP INPUT	Front panel BNC connector accepts tail pulses from an external preamplifier
GAIN STABILITY	0.075%/°C
DC LEVEL STABILITY	Better than 2mV/°C (0 to 50°C)
GAIN CONTROLS	COARSE: 16:1 range in binary steps FINE: 3:1 continuous range
PULSE SHAPING	1.25 microsecond time constant, near-Gaussian bipolar output
NOISE CONTRIBUTION	Less than 9.8mV referred to the input for amplifier gains greater than 100
AMP OUTPUT	Saturation Levels: ±10.0 volts Integral Linearity: better than 0.5% from 0.05 to 10 volts Impedance: less than 1 ohm Output Connector: front panel BNC

2.2 DISCRIMINATOR

SENSITIVITY	50 millivolts to 10 volts, selected by front panel ten-turn potentiometer
LINEARITY	±0.5%, 50 millivolts to 10 volts
DISCRIMINATOR STABILITY	5mV/°C
OUTPUT	Front panel BNC connector
IMPEDANCE	10 ohms
OUTPUT PULSE SHAPE	Duration: 1 microsecond rectangular pulse Rise Time: 50 nanoseconds Polarity: positive Amplitude: 8 volts

2.3	CONNECTORS	
	INPUTS	BNC UG/1094-U
	OUTPUTS	BNC UG/1094-U
2.4	POWER	+24V – 30mA +12V – 75mA -24V – 25mA -12V – 60mA
2.5	PHYSICAL	
	SIZE	Standard single-width module (1.35 inches wide) per TID-20893
	WEIGHT	1.4 lb.

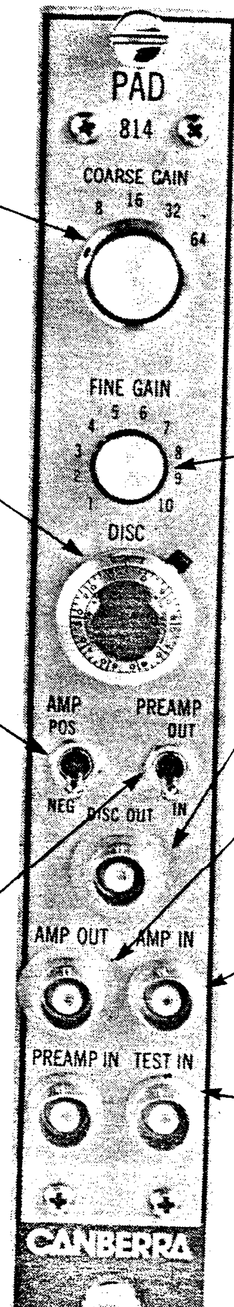
SECTION 3

CONTROLS AND CONNECTORS

3.1 GENERAL

This section describes the functions of the controls and connectors located on the module. It is recommended that this section be read carefully before proceeding with the operation of the module.

3.2 FRONT PANEL



COARSE GAIN CONTROL
Front panel rotary switch selects the factor by which the signal at the PREAMP IN (or AMP IN, depending on the PREAMP IN/OUT switch position) is to be amplified. Gain positions are 4, 8, 16, 32, and 64.

DISCRIMINATOR CONTROL
This front panel ten-turn control is used to select a threshold level for the AMP OUTPUT above which a positive eight volt, one microsecond rectangular pulse will be generated at the DISC OUTPUT connector. This control can be adjusted for sensitivities from 50 millivolts to ten volts.

AMP POS/NEG SWITCH
Front panel two-position toggle switch used to set the polarity which will be accepted by the main amplifier section of the Model 814. Note that the preamp section inverts the signal found at the PREAMP INPUT, so this switch is set at the opposite polarity from the signal presented at the PREAMP INPUT.

PREAMP IN/OUT SWITCH Front panel two-position toggle switch used to connect or disconnect the preamplifier from the amplifier. When the preamp is switched OUT, an external preamp must be used, and its output is connected to the AMP INPUT connector.

FINE GAIN
Front panel single-turn potentiometer which permits a range of 1:1/3 of the output selected by the COARSE GAIN control.

DISC OUT CONNECTOR
Located on the front panel, this connector provides a positive eight volt, one microsecond pulse each time the amplifier output exceeds the discriminator threshold setting.

AMP OUT CONNECTOR
A front panel connector which provides a bipolar positive-lobe leading, near-Gaussian pulse of up to ten volts. The amplitude is adjustable by the COARSE and FINE GAIN controls. The output impedance is less than one ohm. (See Figure 1 page 4-2).

AMP IN CONNECTOR
This front panel connector accepts negative or positive tail pulses from an external preamplifier. The input signal specifications are: amplitude, 7 volts max; rise time, 10-200 nsec; fall time constant 50 μsec nominal; impedance 1000 ohms.

TEST IN CONNECTOR
Located on the front panel, this input is used to check the operation, charge sensitivity and noise calibration of the module. The nominal test capacitance value is 1 pf, corresponding to 1 volt/picocoulomb. Input to this connector is normally from a test pulse generator such as the Canberra Models 807, 1407, 1407P or 1407R.

SECTION 4

OPERATING INSTRUCTIONS

4.1 GENERAL

The purpose of this section is to familiarize the user with the controls of the Model 814 Preamp/Amp/Disc and to check that the unit is operating 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 familarity with this instrument to permit its proper use in the system at hand.

4.2 SET UP

1. Insert the Model 814 PAD module in an AEC compatible bin such as the Canberra Model 2000.
2. Connect the positive output from a tail pulse generator such as the Canberra Model 807 to the TEST IN connector of the Model 814 PAD.
3. Set the AMP POS/NEG switch at NEG since the preamplifier inverts the signal to the amplifier stage.
4. Set the PREAMP IN/OUT switch at IN.
5. Connect an oscilloscope to the AMP OUTPUT. Set the oscilloscope sensitivity at 5V/cm and 2 microseconds/cm. Terminate the output with a 100 ohm load.
6. Set the COARSE GAIN control at 64.
7. Set the FINE GAIN control at 10.

4.3 CHECKOUT PROCEDURE

4.3.1 INITIAL CHECKOUT

1. Having performed the operations in Section 4.2, increase the pulser output and note that the waveform is as shown in Figure 1.
2. Set the COARSE GAIN control at 32. Observe that the output is attenuated by a factor of 2. Rotate the FINE GAIN control and note that the output ranges from about 5 volts to about 1.6 volts, a nominal 3:1 range.
3. Switch the COARSE GAIN CONTROL to 4, 8, 16, and 64, noting that the output increases by factors of 2. Rotate the FINE GAIN control at each setting of the COARSE GAIN control and note that the output is variable from 1/3 maximum to full maximum at each COARSE GAIN setting.
4. Set the gain controls at their maximum settings. The overall gain of the Amplifier is approximately 600. The preamp has a gain of X 0.03. Observe an output of approximately ten volts for 400-500 millivolt input.

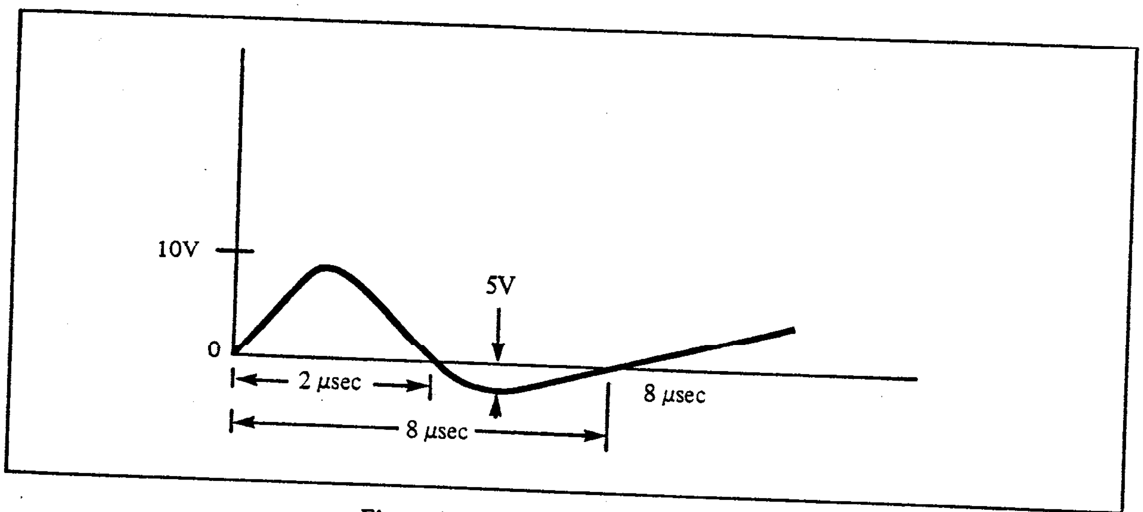


Figure 4-1. AMP OUTPUT Waveform

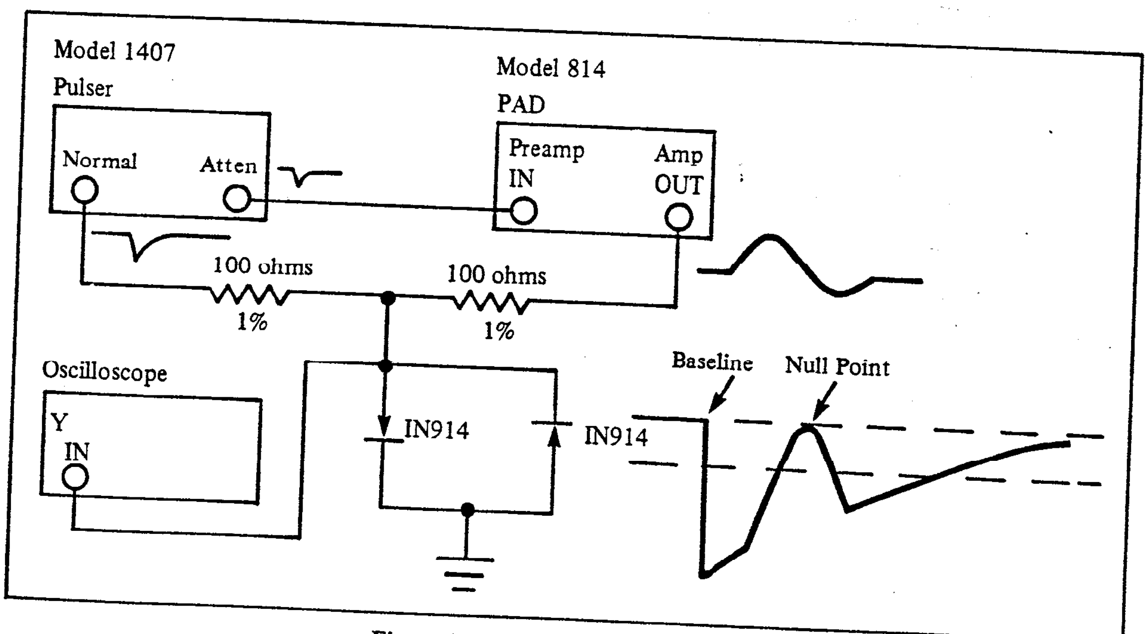


Figure 4-2. Linearity Test Setup

4.3.2 LINEARITY TEST

1. Set up the system as shown in Figure 2.

2. This test is performed by adjusting the pulser attentuators and amplifier gain so that with a ten volt high level (Direct) output from the pulser, the output from the amplifier is also exactly ten volts. This may be ascertained by adjusting the pulser attenuators and amplifier gain so that the null point observed on the oscilloscope (using the highest vertical gain) is at exactly the same level as the baseline.

3. When the condition described in step 2 is obtained, rotate the pulser pulse height control slowly to the lowest level that will still trigger the oscilloscope; observe the maximum difference between the baseline and null point. The integral linearity of the amplifier is then equal to

$$\frac{(\text{Maximum deviation in volts}) \times 2 \times 100\%}{10 \text{ volts}}$$

The maximum deviation must be less than 25mV in order to meet the 0.5% specification. The additional factor of two is added to compensate for the voltage division performed by the test circuitry.

4.3.3 DISCRIMINATOR CHECK

1. Connect an oscilloscope to the DISC OUT connector (5V/cm, 1 microsecond/cm).

2. Set the DISC control at 8.0

3. Connect the positive output of the pulser to the TEST IN connector.

4. Set the AMP POS/NEG switch at NEG since the preamplifier inverts the signal to the amplifier.

5. Set the PREAMP IN/OUT switch at IN.

6. Increase the pulse height of the pulser until an output just appears at the DISC OUT connector. The AMP OUT pulse should be 8.00 ±0.1 volts. The DISC OUT signal should be a positive eight volt pulse with a maximum rise time of 50 nanoseconds, and a pulse width of one microsecond.

NOTE

If it is desired to change the width of the discriminator output, adjust RV-10, located on the printed circuit card, to the value desired. The adjustment range is approximately 0.5 microsecond to 2.5 microseconds.

7. Set the DISC control at other settings and note that the DISC OUT signal appears when the AMP OUT voltage is the same as that indicated on the DISC control.

4.3.4 CONNECTION TO A DETECTOR

1. The Model 814 PAD may be used with a gas proportional counter, a silicon surface barrier detector, or a lithium drifted germanium or silicon detector, as well as with a scintillation detector for which it was designed.

2. When the Model 814 is used with a detector other than a scintillation detector (for which it was designed), apply the bias to the detector as shown in Figure 3. The bias resistor should typically be between one and 100 Megohms. As the detector leakage current increases, the bias resistance must be decreased. The resistor is selected so that the voltage drop across it is approximately 100-200 volts or less, if possible. To reduce hum and noise pickup, shield the bias resistor, all connecting cables, and the connections to the bias supply, detector, and Model 814 with coaxial cable or metal shielding.

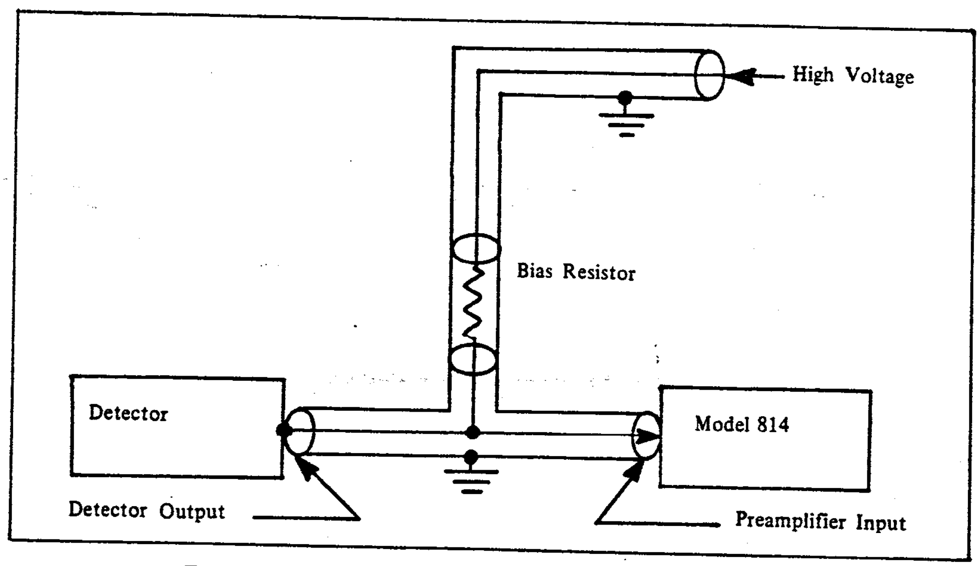


Figure 4-3. Typical Detector Interconnections for Detectors other than Scintillation Detectors

SECTION 5

THEORY OF OPERATION

5.1 GENERAL

The circuitry for the following descriptions can be found on schematic drawing D-11969.

5.2 PREAMPLIFIER

The preamplifier in the Model 814 converts charge impulses from a photomultiplier or other detectors to a voltage pulse (a tail pulse). The charge sensitivity is determined by feedback capacitor C4. R8 and C4 determine the time constant (50 microseconds, nominal) of the tail pulse. Q1 and Q2, which are in a Darlington configuration, provide a low output impedance for the preamplifier output.

5.3 FIRST AMPLIFIER

The tail pulse output of the preamplifier goes through C9 to the PREAMP IN/OUT switch (S3), which switches the preamplifier in or out of the circuit. The output of S3 is connected to the AMP POS/NEG switch (S1). If the preamp is not used, a signal may be fed to the AMP IN BNC which is also connected to the PREAMP switch. The first amplifier is made up of Q3, Q4, and Q5. This amplifier circuitry has a gain of 4.2. DC balance, for a positive input, is achieved by RV-1 which adjusts the current through Q3. Negative input is achieved by adjusting the bias by use of RV-2. Q3 is basically an impedance matching stage. Q4 is a gain stage. It is followed by Q5 which is an emitter follower for impedance matching of the first amplifier output (TP-3).

The Model 814 preamplifier shaping occurs in the preamp at C4 and R8. This network has as time constant of 50 microseconds. The first amplifier is followed by another differentiation network (C23 and R28 in parallel with the input resistors R29, 30, and 31 of the second amplifier). These components form the pole-zero compensation network. It has a time constant of 1.2 microseconds. Pole-zero is adjusted by RV-3.

5.4 SECOND AMPLIFIER

The pole-zero network output is connected to the second amplifier through the COARSE GAIN switch (S2a). The second amplifier consists of an input impedance stage (Q6), a gain stage (Q7), and an output impedance stage (Q8). The DC balance of the second amplifier is adjusted by RV-4 which varies the current through Q6. The second amplifier has a maximum gain of 4.

The overall gain of the PAD is controlled by the gain of the second amplifier in addition to the input/output amplitudes. The gain of the second amplifier is controlled by the front panel FINE GAIN control (RV-5) which varies the second amplifier gain from 2.6 to 8.4. The COARSE GAIN switch (S2a), along with R29, R30, and R31, controls the input amplitude. S2b and R32-38 control the output amplitude to TP-2 (third amplifier input).

5.5 THIRD AMPLIFIER

The third amplifier is an integrating amplifier composed of an I.C. operational amplifier (A1) and integrating networks (R57, R58, R55, C37, C39, and C33). This amplifier has a gain of approximately 6. The output of the third amplifier (TP-4) goes to a final differentiation network (C40 and R64) which is also the input to the final amplifier.

5.6 OUTPUT AMPLIFIER

The output amplifier consists of Q9 and Q10, which form an emitter coupled input stage, a gain stage (Q11), and complementary emitter followers (Q12 and Q13). In this way a low output impedance for the AMP OUT BNC and the DISC input can be obtained. DC balance is obtained by RV-6 which is used to adjust the bias of Q9 and Q10. The final amplifier has a gain of 7.8 and can produce a 10 volt output into 93Ω.

5.7 DISCRIMINATOR

The output amplifier is connected to the discriminator section of the Model 814. The discriminator consists of four basic sections: an I.C. discriminator, a reference voltage generator, an output monostable, and an output driver.

The I.C. discriminator is a μA710 voltage comparator (A2) which yields a positive pulse when the positive input (pin 2) is more positive than the negative input (pin 3). The positive input of the μA710 is driven by the amplifier output signal via Q17.

Q17 is an emitter follower which prevents the input impedance of the μA710 from loading down the amplifier section. R89 and R90 divide the input signal by 0.4. The negative input of the μA710 goes through Q18 from the reference voltage generator. Q18 is an emitter follower and prevents loading of the reference voltage generator by the negative input.

5.8 REFERENCE VOLTAGE GENERATOR

The reference voltage generator provides the voltage to which the input signal is compared by the μA710. This voltage is developed by R80, RV-7, and the front panel DISC potentiometer (RV-8) in series across +12 volts. The voltage on the wiper of RV-8 is fed through two emitter followers (Q14 and Q15), one NPN and the other PNP. Therefore, the voltage at the emitter of Q15 is the same as the voltage at the RV-8 wiper. Q16 is a constant current source for keeping the voltage drop across RV-9 constant. RV-9 is used to calibrate RV-8 at the low end while RV-7 calibrates the high end of RV-8.

5.9 OUTPUT MONOSTABLE

The output of A2 is connected to the output monostable, which is made up of Q19 through Q22. Q20 and 21 are used to speed up the switching time of the monostable so that the rise and fall times are minimized. RV-10 adjusts the length of the monostable output pulse from 0.5 to 2.5 μsec.

5.10 OUTPUT DRIVERS

The output monostable is followed by output drivers (Q23 and 24). These drivers provide a very low output impedance and prevent any output load from ruining the fast rise and fall times of the discriminator output.