CI 800 SERIES

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Instruction Manual
RC AMPLIFIER
MODEL 815

Canberra 800 Series of
Modular Nuclear Instruments

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MODEL 815 RC AMPLIFIER

1.0 GENERAL

1.1 Description

Main amplification and pulse shaping have two primary objectives: amplification of the signal to an extent sufficient for accurate energy analysis, and shaping of the signal so that accurate timing discrimination can be accomplished.

The Model 815 is used where energy analysis is the principal consideration, and where the most accurate timing accuracy can be sacrificed, as in nuclear spectroscopy experiments. Its low cost justifies its use as the workhorse amplifier in simple or complex nuclear counting experiments.

The Model 815 offers a low noise level of less than 10 microvolts RMS referred to the input, integral linearity of better than 0.5%, a gain of more than 600, and a long-term gain stability of better than 0.05%.

1.2 Applications

The Model 815 may be used with proportional counters, scintillation detectors, or semiconductor detectors for the amplification and shaping of signals coming from associated preamplifiers.

The output of a preamplifier in most nuclear experiments is a signal which is proportional to the energy lost by an incident particle or ray striking a detector. This signal from the preamplifier must then be amplified and shaped before any counting, timing, or energy analysis can be performed.

The RC shaping mode is used where the researcher's concern is high resolution and low noise. Double differentiated RC shaping improves the counting rate capability of the amplifier by hastening the baseline recovery, thus avoiding pulse pileup at high count rates. The Model 815 is well-suited for such applications, as double RC shaping with 1.25 microsecond time constants is a built-in feature.

2.0 SPECIFICATIONS

2.1 Performance

- Noise: less than 10 microvolts RMS referred to input

- Integral Nonlinearity: less than 0.5%, 0.3 to 10 volts output; less than 0.1%, 0.5 to 8 volts output

- Gain Stability: better than 0.05% long term, 0.01%/°C

- Rise Time: less than 100 nsec without pulse shaping

- Overload Capability: recovery to 2% within 2 nonoverloaded pulse widths from 100X overload

2.2 Controls, Inputs, Outputs

2.2.1 Controls

- Coarse Gain: 4-8-16-32-64 rotary switch

- Fine Gain: 2 - 10, continuously adjustable

- Input Polarity: positive or negative, switch selected

- Input Attenuation: internal jumper allows ÷ 10 or ÷ 1 of input signal

2.2.2 Input

- Positive or negative 0 - 4 volts from charge sensitive preamplifier, selectable by front panel switch; input impedance 1000 ohms; rise time less than 250 nanoseconds, fall time greater than 40 microseconds

2.2.3 Output

- Positive lobe leading, double RC differentiated, 0 to 10 volts; output impedance less than 1 ohm

3.0 INITIAL OPERATION

3.1 Setup

- Insert module in AEC compatible base unit/power supply such as Canberra Model 800; turn on power switch

- Connect 20mv output from test pulse generator to input connector of module (amplifier has been calibrated for optimum performance when input tail pulse has a 70 microsecond fall time; use this value if available)

- Connect oscilloscope to output (5v/cm, 1 microsec/cm); terminate amplifier output with 100 ohms at oscilloscope input - this must always be done when driving a very high load impedance with a long coaxial cable to prevent spurious ringing

- Set Input Mode switch to POS or NEG to match the polarity of the input signal

- Set Coarse Gain to 64

- Set Fine Gain to approximately 7 (until observed output just reaches saturation)

3.2 Initial Checkout

- Observe double RC shaped output on an oscilloscope

- Disconnect input to amplifier; connect output to Hewlett-Packard 400H or 400D (or other RMS voltmeter); observe RMS reading of less than 6.0 millivolts (10 microvolts referred to input)

- Reconnect input to amplifier and oscilloscope to output

- Reduce Coarse Gain to 32

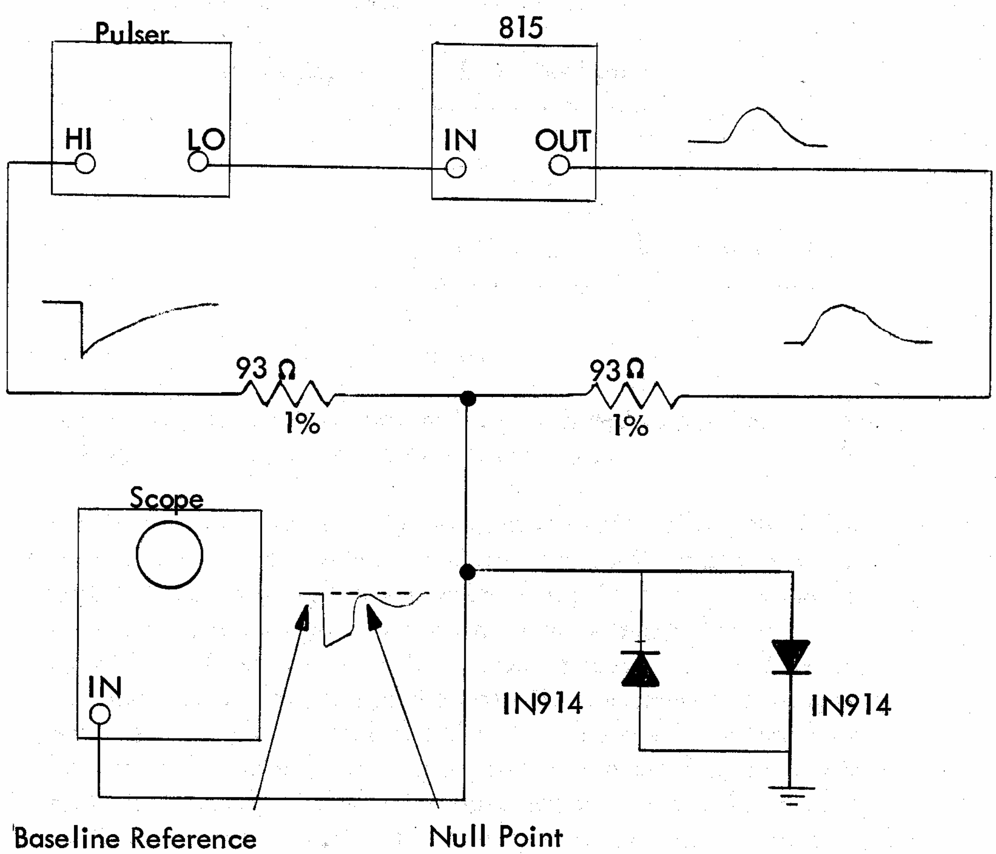
- Switch internal Input Attenuation jumper to ÷ 10 (rotate upper portion of jumper to right of two upper pins, while keeping bottom or common pin fixed), observe resulting change in output; return to ÷ 1

- Switch Coarse Gain to 4, 8, 16, 32; observe effect on output; return to 64

- Rotate Fine Gain control; observe effect on output

- With gain controls at maximum, observe recovery from up to 100 times overload in less than 2 nonoverloaded pulse widths

- Using a negative output from the pulser, set up the following circuit:



. Adjust pulser output so high output is nearly 10 volts; adjust amplifier gain so its output is nearly 10 volts; observe difference on oscilloscope using test circuit; adjust amplifier Fine Gain so null point is at baseline reference level. The linearity of the amplifier may now be tested by increasing the oscilloscope sensitivity to maximum, adjusting the Model 815 Fine Gain to reposition the null point at baseline reference, and then turning the pulser output from maximum down to zero.

The difference between the null point and the baseline reference point (both of which will shift) is a measure of the integral nonlinearity). For example, suppose the maximum difference between the null point and the baseline reference (between 10 volts and 0.3 volts amplifier output) is 10 millivolts. This gives an integral nonlinearity of approximately 20/10,000 or 0.2%. During this test, it may be necessary to readjust the oscilloscope trigger level or stability to see the trace as the input level is changed.

The theoretical explanation of this test is:

$$\text{Nonlinearity} = \frac{E_o - E_i \times \text{ideal gain}}{E_{o_{max.}}}$$

$$= \frac{E_i \times \text{actual gain} - E_i \times \text{ideal gain}}{E_{o_{max.}}}$$

- An additional factor of two must be included to account for the voltage division performed by the test circuit

- The test circuit electrically performs the subtraction; the initial setup procedure of nulling the difference establishes the pulser gain between high and low outputs as the ideal gain, which is set equal to actual gain at the maximum output point of the amplifier. Then, as the pulser output is reduced, the difference between the actual gain of the amplifier throughout its range, and the ideal gain (which is defined by the passive attenuation circuit in the pulser), is clearly seen on the oscilloscope. Note that the linearity of the pulser does not enter the calculation, as the input to the amplifier and the input to the test circuit cancel out any nonlinearity in the pulser.

4.0 MODULE OPERATION

4.1 Control Functions

- Coarse Gain Switch: selects the factor by which the input (or 1/10 the input with internal jumper set for ÷ 10) is to be amplified. Gain positions are 4, 8, 16, 32, and 64.

- Fine Gain Potentiometer: selects the factor by which the coarse gain is to be further multiplied. This single-turn potentiometer allows selection of gain settings from 2 to 10.

- Attenuation Control: internal jumper allows selection of X1 or X10 attenuation of the input signal.

- Input Polarity: front panel toggle switch allows selection of positive or negative input polarity.

4.2 Input Requirements

- Signal: 0 to 10 volt tail pulses, positive or negative, with a rise time from 10 to 250 nanoseconds and a fall time with 40 microseconds minimum time constant; BNC connector.

4.3 Output Specifications

- Signal: 0 to 10 volts, bipolar (double RC differentiated) with positive lobe leading; RC time constants 1.25 microseconds; rise time normally 1.2 microseconds (less than 100 nanoseconds without pulse shaping) unless limited by a slower input pulse rise time; output impedance less than 1 ohm.