DUAL DISCRIMINATOR
Model 2032

Instruction Manual

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Section 1
INTRODUCTION

1.1 GENERAL DESCRIPTION

The Canberra Model 2032 offers two independent discriminators which analyze the peak amplitude of energy pulses from nuclear pulse shaping amplifiers, and generates logic outputs for input analog pulses exceeding the levels referenced by the DISCriminator LEVEL front panel ten-turn controls Timing of these logic outputs is set as the trailing edge of the input signal crosses the reference set for each.

The logic outputs may be used together or individually to assist in a wide variety of applications from simple noise removal, to extraction of a narrow energy range from a wide spectrum of signals for energy analysis. The sharp, precise threshold discrimination levels are exceptionally stable (drift less than ± 0.005%/°C, full scale). The DC coupled input allows excellent baseline stability limited only by the shaping amplifier's restorer. These significant features permit excellent amplitude discrimination, even in high count rate spectra.

The DISCriminator LEVEL threshold is calibrated by reference to the regulated NIM supply voltages, and is usable over the range from +0.04VDC to +10 0VDC. Linearity of control is limited only by the specified ± 0 25% maximum nonlinearity of the front panel potentiometer

All output logic signals are positive logic, and are adjustable in peak amplitude for compatibility with interfacing instruments. All outputs are source matched with 50 ohm series resistive terminations to prevent ringing due to reflections on unterminated cables, and the resulting multiple counting frequently experienced. The instrument is shipped with a socketed resistor which limits the output to +5V nominal (open circuit) for direct interface with common TTL circuitry. The user may remove the resistor (1 for each output) to obtain a +8V nominal open circuit voltage for instruments requiring the NIM pulse level, or +4V nominal into the 50 ohm load termination which some other instruments provide. This flexibility allows the user to adapt the output signal to his needs without risking the problem encountered with improperly driven cables.

Careful attention has been paid to minimize reflections of the fast logic pulses back onto the analog input Thus all logic outputs are isolated from chassis to prevent circulating pulse currents in the instrument Bin.

1.2 APPLICATIONS

The Model 2032 Dual Discriminator is most useful in Spectroscopy systems requiring precise, stable discrimination of detected nuclear events.

The two independent logic outputs may be used in counting or noise stripping where specific timing of successive events is of secondary significance. A common application of the dual discriminator unit is in conjunction with either dual NaI, proportional or geiger counting devices for gross counting of total energy events. When used with one NaI or proportional counter adjusted to detect two or more energy levels, the detector output may be simultaneously fed into both discriminators to determine the ratio of one selected energy to the total energies available.

The dual discriminator may also be useful in energy coincidence determinations by discriminating two independent energy levels from different detectors viewing the same source, and providing outputs from each discriminator into a slow coincidence analyzer.

Combinations of outputs may also be useful for monitoring or control purposes (e.g. detection of cosmic overloading pulses in a sensitive experiment), or other needs of the creative experimenter.

Section 2
SPECIFICATIONS

2.1 INPUTS

SIGNAL INPUT 1, 2	Amplitude. positive unipolar or bipolar (positive lobe leading), 0.04 to 10.0VDC. Pulse Width. 0.2 to 40 microseconds at half maximum (equivalent to active RC shaping of 0.1 to 20 microseconds). Input impedance: 1 K ohms.

2.2 OUTPUTS

OUTPUT 1, 2	Amplitude: positive logic +5VDC nominal Adjustable to +8VDC nominal by removing socketed resistor. Pulse width. 0.5 microseconds nominal. Rise and fall time: less than 25 nanoseconds. Output impedance: 50 ohms, series connected. Timing reference. trailing edge of input signal crossing reference.

2.3 PERFORMANCE

DISCRIMINATOR NONLINEARITY	Less than ± 0.25% of full scale.
DISCRIMINATOR STABILITY	Better than ± 0.005%/°C (± 50ppm/°C) of full scale averaged over 0-50°C ambient range, referenced to NIM class A supply +12.0V line.
DISCRIMINATOR RANGE	Better than 250.1.
DISCRIMINATOR PULSE PAIR RESOLUTION	Less than 0.65 microseconds, typical.

2.4 CONTROLS

DISC 1 LEVEL DISC 2 LEVEL	Front panel ten turn dial potentiometers. Control range +0.04VDC to +10.0VDC

2.5 CONNECTORS

All signal connectors are BNC, UG-1094/U. Outputs are isolated from chassis panels.

2.6 POWER REQUIREMENTS

+12V	–	110mA
-12V	–	5mA

2.7 PHYSICAL

SIZE	Standard single width module 1.35 inches wide by 8.714 inches high (3.42 cm x 22.13 cm) per TID-20893 (rev.).
WEIGHT	1.3 lb (0.8 kg)

Section 3
CONTROLS AND ADJUSTMENTS

3.1 GENERAL

This section describes the functions of the controls, and the adjustments which the user can make, in the Model 2032 Dual Discriminator It is recommended that this section be read before proceeding with operation of the instrument.

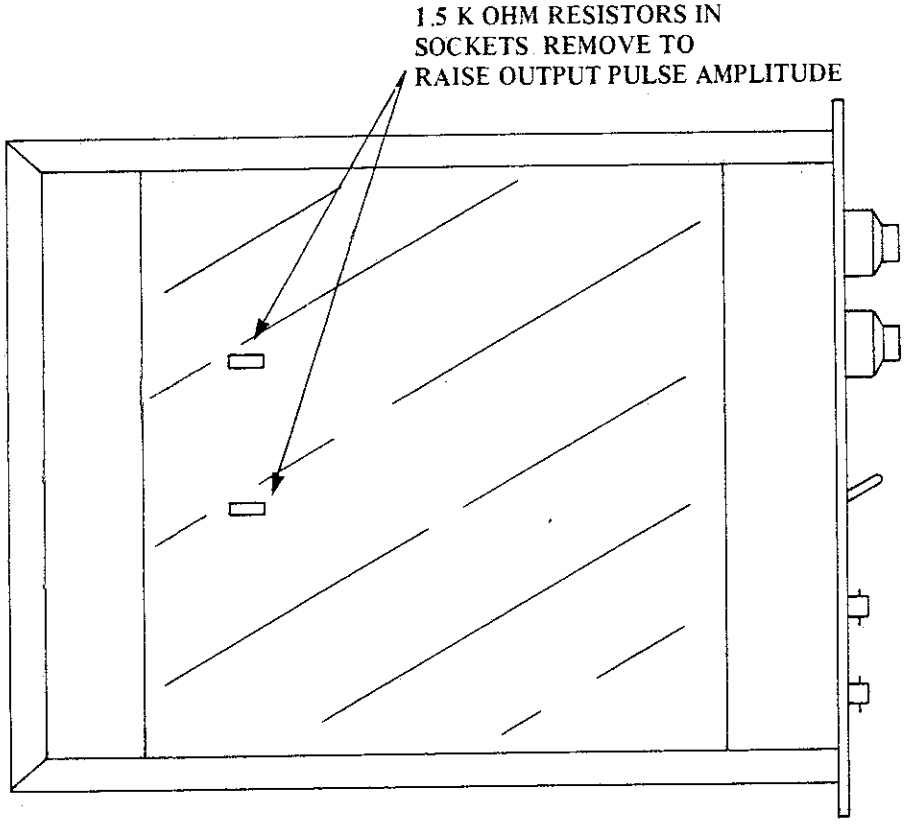
3.2 FRONT PANEL CONTROLS

Each DISCriminator LEVEL control is a ten turn dial potentiometer which provides the reference voltage for the related discriminator. When the input pulse signal exceeds this baseline level, a logic pulse is generated as the input signal decays thru the level. The indicator is scaled linearly for the 0-10VDC rated input signal range of the instrument.

3.3 INTERNAL ADJUSTMENTS

The trimming potentiometers internal to the instrument are carefully calibrated during factory test to provide the precise low end and full scale limits for the front panel controls. The user should normally have no need to readjust these but if adjustments are necessary, the setup and general procedure given in Section 4 should be followed. The trimming potentiometers RV1 and RV2 control the full scale range of the DISCriminator LEVEL controls for Channels 1 and 2 respectively.

The adjustments for output pulse voltage level can be found on the printed circuit board at the rear of the unit (see sketch below) The unit is shipped with socketed 1.5 K ohm carbon resistors. With the resistor installed the output pulse is clamped at +5VDC nominal, open circuit. The user may remove either or both socketed resistors as needed With the resistor removed, the output voltage will be +8VDC nominal open circuit, and +4VDC nominal into a 50 ohm load.



INTERNAL VIEW, LEFT SIDE

Section 4
OPERATING INSTRUCTIONS

4.1 GENERAL

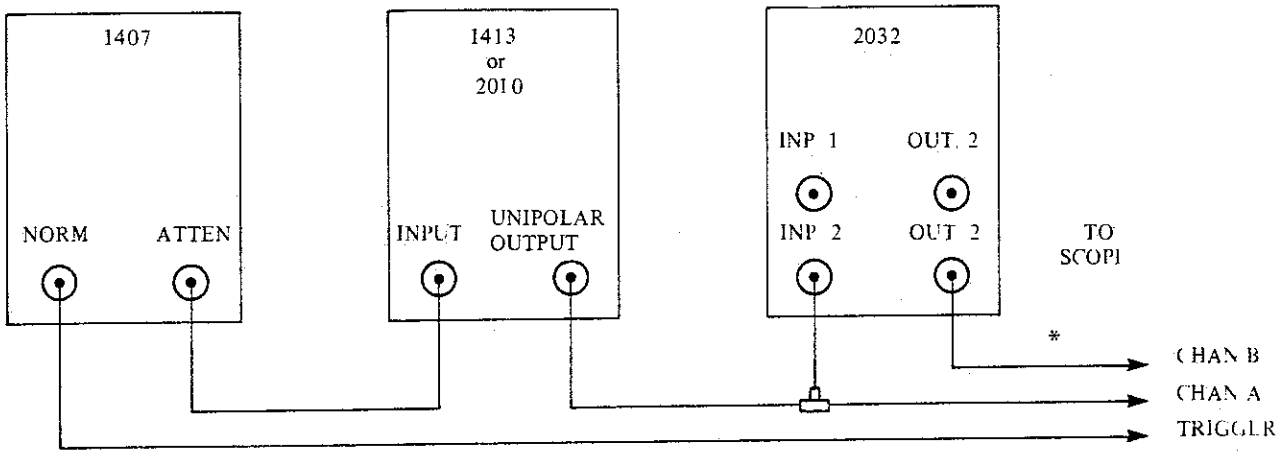
The purpose of this section is to familiarize the user with the Model 2032 Dual Discriminator, and to check that the unit is operating correctly. Since it is difficult to determine the exact system configuration in which the unit will be used, explicit operating instructions cannot be given. However, if the following procedure is carried out, the user will gain sufficient familiarity with this instrument to permit its proper use in the system at hand.

4.2 INITIAL SETUP

In order to perform the bench checkout procedure below, the following equipment (or equivalents) will be required:

Canberra Model 2000 Bin/Power Supply
Canberra Model 1407 Tail Pulse Generator
Canberra Model 1413 or 2010 Spectroscopy Amplifier
Calibrated Dual trace oscilloscope (Tektronix 453, 465, etc.)

Install the Models 2032, 1407, and 1413 or 2010 in the Bin, with the power initially OFF.



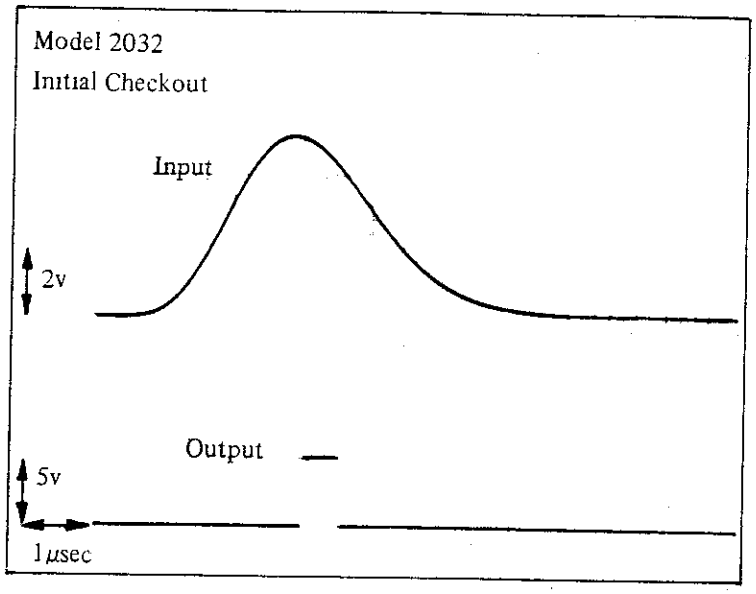
Cables are RG 62/U, except * is RG-58/U

Reference control settings.

Model 1407	To positive polarity, 50μsec, fall time, PULSE HEIGHT and attenuation as necessary.
Model 1413 or 2010	To X10 coarse gain, 1 microsecond shaping, restorer low. Pole/Zero trimmed to 1407.
Model 2032	DISC 2 LEVEL to 5.00
SCOPE:	Channel A: 2V/cm Channel B: 5V/cm Time base 1μsec/cm, externally triggered.

4.3 INITIAL CHECKOUT

Apply power to the Bin, and set the 1407 to 90Hz rate. Increase the amplifier output slowly until an output pulse appears. Verify the peak amplitude of the input signal to be approximately 5V. Typical scope waveforms are shown in the photo below.

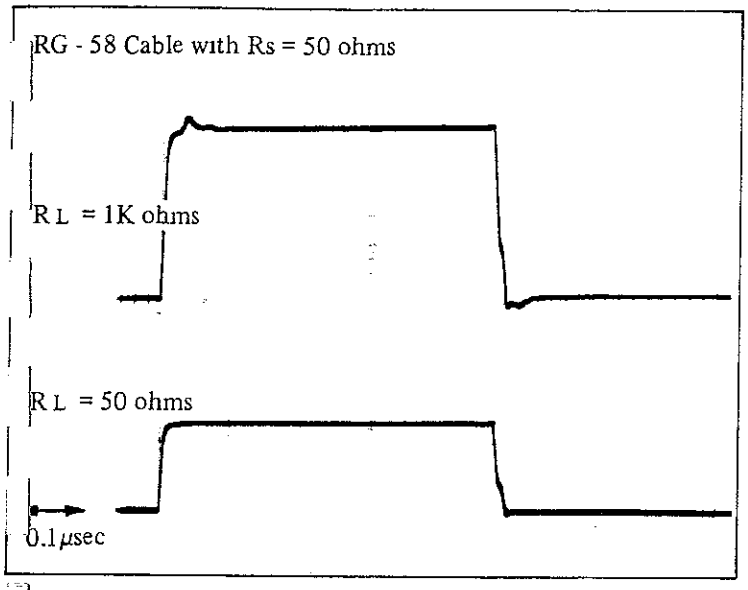


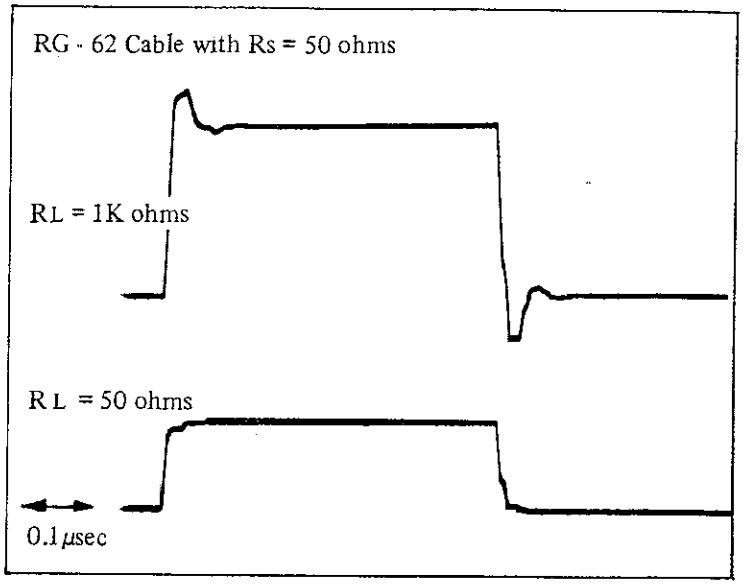
As the 2032 has been carefully calibrated in factory test, the precision of this casual examination is limited by the calibration of the user's oscilloscope. The instrument may be exercised over its full rated range with this setup if the user wishes, but adjustments of internal trimpots should not be attempted without a more exacting test technique.

The other discriminator channel may be exercised similarly, and the user may verify that the controls and outputs of the 2 channels are completely independent.

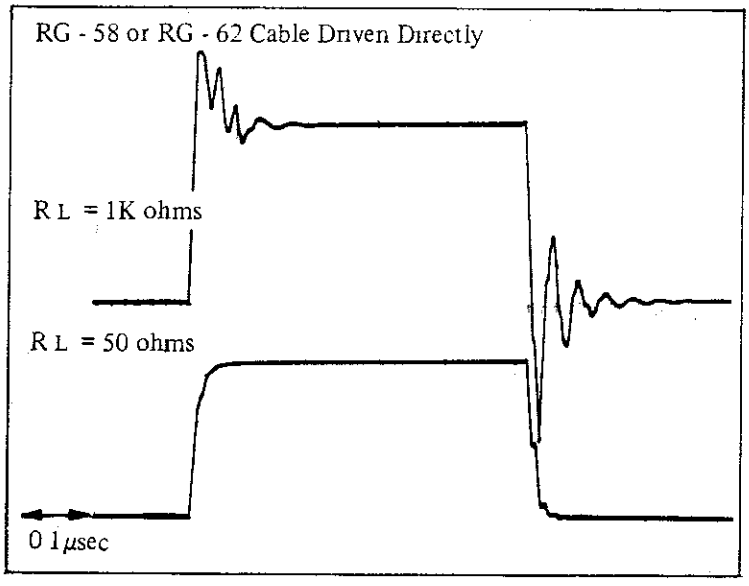
4.4 REFERENCE DATA ON CABLES

The following photographs depict a typical output pulse at the load end of the designated RG-58/U cable, and the same point using RG-62 cable. In each case the photographs illustrate high impedance (1 K ohm) and 50 ohm termination conditions. Clearly the fastest, cleanest pulse is realized with the RG-58/U cable. With the source match provided, loading effects are limited to amplitude changes only. RG-58/U cable is therefore recommended for best compatibility with the outputs.





The picture below illustrates the same pulses with a source mismatch caused by driving the cables with the transistor switches directly. The waveforms indicate how important and effective source matching is in eliminating instabilities which cause phenomena such as multiple counting or triggering. For this reason the Model 2032 provides source matched outputs, and load end terminations are not necessary.



Section 5
THEORY OF OPERATION

5.1 GENERAL

The Model 2032 Dual Discriminator analyzes energy pulses from spectroscopy shaping amplifiers by comparing the peak voltage levels of those input pulses against stable D.C. reference voltages set by the front panel controls. Pulses exceeding the levels generage the logic output pulse.

5.2 DISCRIMINATORS

The pulse discrimination takes place in the precision dual comparator A5. The reference voltages for the comparator are of course set by the DISCriminator LEVEL front panel controls. The RV adjustments are for full scale range corrections.

The Channel 2 output is taken at pin 12 of A5, which yields a positive pulse whose width represents the time span in which the input signal exceeds the reference.

The Channel 1 output is taken at pin 7 of A5, which also yields a positive pulse whose width represents the time span in which the input signal exceeds that reference.

Both input signals are DC terminated, and divided to a voltage consistent with the differential rating of the comparator. Over-voltages are diode clamped to +6V and - 1V nominal.

5.3 LOGIC AND TIMING

The trailing edge of the signal on A5 pin 5 is used to initiate the one-shot A3. This one-shot is set for a 0.5 microsecond nominal pulse, and enables the output gate as pin 12 of A3 pulses low.

In similar fashion, the trailing edge of the pulse on pin 7 of A5 initiates the second one-shot in A3, as outputted on A3 pin 4.

5.4 OUTPUT CIRCUITS

The output circuit design is a variant on the conventional totem pole which permits limiting the output pulse amplitude simply without affecting speed of response. The active high-active low circuit also permits proper output termination for driving 50 ohm cable with fast pulses with minimal radiation and reflection problems, and assures protection of the circuit from accidental load faults.

As described in Section 3.3 the user may adjust the output pulse voltage to his requirements quite simply by using the socketed resistors.