SINGLE CHANNEL

ANALYZER MODEL 2030

DOCUMENT NUMBER TD C070.0050

RECORD OF REVISIONS

TITLE OF DOCUMENT

SINGLE CHANNEL
ANALYZER MODEL 2030

REVISION NUMBER	DATE	DESCRIPTION OF REVISION	REVISED BY
0	03-03-88	ORIGINAL	

TD C070.0050

CANBERRA

SINGLE CHANNEL ANALYZER
Model 2030

SINGLE CHANNEL ANALYZER
Model 2030

CANBERRA INDUSTRIES, INC.
45 Gracey Avenue
Meriden, Connecticut 06450

Telephone: (203) 238-2351

BASIC WARRANTY

CANBERRA - MANUFACTURED EQUIPMENT

Equipment manufactured by Canberra Industries, Inc. is warranteed against defects in materials and workmanship for a period of twelve months from date of shipment, provided that the equipment has been used in a proper manner as detailed in the instruction manuals. During the warranty period, repairs or replacement will be made at Canberra's option on a return to factory basis. The transportation cost, including insurance, to and from Canberra, is the responsibility of the Customer. Except for defects discovered upon initial operation, shipping expense to Canberra is to be paid by the customer; shipping expense to return the repaired equipment will be paid by Canberra.

The customer must obtain shipping instructions, including an Authorized Return Number (ARN), before returning any equipment to the Canberra factory. *Compliance with this provision by the customer shall be a condition of this warranty.* In giving shipping instructions, Canberra shall not be deemed to have assumed any responsibility or liability in connection with the shipment. If, upon receipt of the equipment, Canberra determines that such equipment is not defective within the terms of this warranty, the customer shall pay to Canberra, upon invoice, the cost of diagnosis at the then prevailing Canberra repair rate and the cost of return transportation.

The Canberra Basic Warranty applies only to equipment manufactured by Canberra which is returned to the factory. If equipment must be repaired at the customer's site, the actual repair labor and parts will be provided at no charge during the warranty period. However, travel expenses to and from the customer's site, and living expenses while on site, shall be paid by the customer unless an On-Site Warranty Option has been purchased. This option may only be purchased prior to shipment of the equipment to the customer.

This warranty shall not apply to Canberra equipment that has been modified or serviced by other than Canberra Service Personnel, or to failures of Canberra equipment caused by defective equipment not manufactured by Canberra.

The Express warranties set forth herein are the only warranties with respect to the products, or any materials or components purchased from others and furnished by Canberra, and there are no other warranties, expressed or implied. The warranty of merchantibility is expressly limited as herein provided and all warranties of fitness are expressly disclaimed and excluded. Canberra shall have no liability for any special, indirect or consequential damages, whether from loss of production or otherwise, arising from any breach of warranty hereunder or defect or failure of any product or products sold hereunder.

EXCLUSIONS

Warranty service is contingent upon the proper use of all equipment and does not cover equipment which has been modified without Canberra's written approval or which has been subjected to unusual physical or electrical stress as determined by Canberra Service personnel. Canberra Industries shall be under no obligation to furnish warranty service (preventive or remedial): (1) if adjustment, repair or parts replacement is required because of accident, neglect, misuse, failure of electrical power, air conditioning, humidity control, transportation, or causes other than ordinary use: (2) if the equipment is maintained or repaired or if attempts to repair or service equipment are made by other than Canberra personnel without the prior approval of Canberra.

This warranty does not cover detector damage caused by warm-up or by neutrons or heavy charged particles. Damage from these causes is readily identifiable as described in the manual accompanying each detector.

EQUIPMENT NOT MANUFACTURED BY CANBERRA

Canberra's basic one-year warranty applies only to equipment manufactured by Canberra. Although Canberra may frequently supply, as part of systems, equipment manufactured by other companies, the only warranty that shall apply to such non-Canberra equipment is that warranty offered by the original manufacturer if any.

Canberra will, upon request, offer, as an option, warranty coverage for non-Canberra equipment such as computers and peripherals sold as part of a system supplied by Canberra. Quotations on this coverage may be obtained by contacting Canberra Nuclear Systems Division.

SOFTWARE

Canberra warrants proper system operation *only* with programs developed by Canberra using the operating system supplied to the customer. Canberra assumes no responsibility for user-written programs or programs published as part of information exchange in Canberra periodicals.

Engineering assistance for software development is available and can be contracted through the Canberra Nuclear Systems Division Sales Department.

INSTALLATION

Installation of equipment purchased from Canberra shall be the sole responsibility of the customer unless the installation is specifically contracted for at the prevailing Canberra field service rates. To insure timely installation after receipt of equipment, it is recommended that installation be contracted for at the time the equipment is ordered.

ON-SITE WARRANTY OPTION

The On-Site Warranty Option provides for free on-site warranty work (Canberra pays all travel and living expenses) within the first 90 days after delivery of equipment to the customer. If installation is ordered from Canberra, the 90 day period commences upon completion of the initial installation. After the 90 day period, labor and materials used on site will still be covered by the basic warranty, but the customer shall pay for all travel and living expenses incurred for any on-site service.

A maintenance contract may be purchased covering the period after the 90 days on-site warranty period, or after initial installation of the equipment. This is to be contracted through Canberra's Nuclear Systems Division.

REPAIRS

Any Canberra-manufactured instrument no longer in its warranty period may be returned, freight prepaid, to our factory for repair and realignment. When returning instruments for repair, contact the Customer Service Department for shipping instructions and an Authorized Return Number (ARN).

All correspondence concerning repairs should include Model Number and a description of the problem observed.

Once repaired, all equipment passes through our normal pre-shipment checkout procedure. Return shipping expense on out-of-warranty repairs will be charged to the customer.

For instruments out of warranty, the customer must supply a purchase order number for the repair before the item will be returned to him.

SHIPPING DAMAGE

Shipments should be carefully examined when received for evidence of damage caused by shipping. If damage is found, immediately notify Canberra and the carrier making delivery, as the carrier is normally responsible for damage caused in shipment. Carefully preserve all documentation to establish your claim. Canberra will provide all possible assistance in processing damage claims.

Due to the delicate nature of cooled detectors [Ge(Li) and Si(Li)] Canberra requires that delivery to and from air freight terminals be handled with special care. Do not ship such Detectors without first obtaining advice from our Traffic Department.

REVISION B
July 1, 1978

SINGLE CHANNEL ANALYZER
MODEL 2030

CONTENTS

SINGLE CHANNEL ANALYZER
MODEL 2030

Section 1
INTRODUCTION

1.1 GENERAL DESCRIPTION

The Canberra Model 2030 analyzes the peak amplitude of energy pulses from nuclear pulse shaping amplifiers, and generates its primary logic output (SCA) for input analog pulses between the levels referenced by the LOWER LEVEL (E) and WINDOW (Δ E) front panel ten-turn controls. Auxiliary outputs from the Lower Level Discriminator (LLD) as set by (E), and the Upper Level Discriminator (ULD) as set by (E) + Δ E) are also provided. Timing of these logic outputs is set as the trailing edge of the input signal crosses the (E) reference.

The several 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 $\pm$ 0.005%/^{o}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 LOWER LEVEL (E) threshold is calibrated by reference to the regulated NIM supply voltages, and is usable over the range from +0.01VDC to +10.0VDC. Linearity of control is limited only by the specified $\pm$ 0.25% maximum nonlinearity of the front panel potentiometer. A front panel mounted LED is useful in visually monitoring the setting of the LOWER LEVEL (E) reference just above the shaping amplifier's noise level (the LED will fade off).

The WINDOW (ΔE) threshold is also calibrated by reference to the regulated NIM supply voltages, and is usable over the range from the LOWER LEVEL (E) setting to +10.0VDC. A front panel ΔE RANGE switch allows use of a 1.0 volt full scale range for very fine adjustments of the desired window.

An external Lower Level Discriminator (LLD) input on the rear panel may be used in lieu of the front panel control for applications requiring a ratioed or sweeping baseline reference over the energy range. This input requires a positive polarity reference voltage, and is linear over the full scale of 0 to +10.0VDC. A locking toggle switch is used to select this input.

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 socketed resistors which limits the outputs 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 problems 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 2030 SCA is most useful in Spectroscopy Systems requiring precise, stable energy discrimination of detected nuclear events.

The multiple logic outputs may be used in counting, noise stripping or narrow window analysis where specific timing of successive events is of secondary significance. A common application of the SCA is in conjunction with a counter/timer, where the energy discrimination function will confine the counter to a desired spectrum.

With its additional ULD and LLD as well as SCA outputs, the Model 2030 SCA offers the extra capability of discriminating between two different particles or energies from the same detector while providing output signals necessary to count or ratio the counts of these different energies. For example, when used with a proportional counter on the β plateau, an α - β plastic detector or any dual particle/dual energy detector, the Model 2030 would be helpful in distinguishing the counts provided by each particle or energy separately by the proper selection of individual discriminator level.

The ULD could be set to be above the highest β energy (or higher than the lower energy peak of interest) but below the lowest α energy (or lower than the higher energy peak of interest); the LLD could be set lower than the lowest β energy (or first energy of interest), but above the noise level; thus, the ULD output would provide only α (or higher) energy counts, the LLD output would provide $\alpha + \beta$ (or total) energy counts and the SCA output would provide only β (or lower) energy counts.

The Model 2030 SCA might be used to control a linear or multichannel analyzer gate by any one of its three outputs, each representative of a different condition of energy discrimination, Also, the Model 2030 might be used to count one output (ULD) while gating the counting device with an event on another output (SCA).

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	Amplitude: positive unipolar or bipolar (positive lobe leading), 0.01 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.
EXTERNAL LLD REFERENCE	Amplitude: positive 0 to 10VDC. Input impedance: 1 K ohms.

2.2 OUTPUTS

SCA	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 LLD reference.
LLD	same characteristics as SCA.
ULD	same characteristics as SCA.

2.3 PERFORMANCE

DISCRIMINATOR NONLINEARITY	less than ± 0.25% of full scale.
DISCRIMINATOR STABILITY	better than ± 0.005%/°C (± 50 ppm/°C) of full scale averaged over 0-50°C ambient range, referenced to NIM class A supply +12.0VDC line.
DISCRIMINATOR RANGE	better than 1000:1
DISCRIMINATOR PULSE PAIR RESOLUTION	less than 0.65 microseconds, typical

2.4 CONTROLS

LOWER LEVEL (E)	Front panel ten turn dial potentiometer. Control range +0.01VDC to +10.0VDC.
WINDOW (ΔE)	Front panel ten turn dial potentiometer. Control range from setting of LOWER LEVEL (E) control to +10.0VDC.
ΔE RANGE	Front panel toggle switch to set 1v or 10v window width

LLD REF MODE	Rear panel locking toggle switch to select internal or external voltage for LLD.

2.5 CONNECTORS

All signal connectors are BNC, UG-1094/U. SCA, LLD and ULD outputs are isolated from chassis panels.

2.6 POWER REQUIREMENTS

+12VDC	–	155mADC
-12VDC	–	5mADC

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 2030 SCA. It is recommended that this section be read before proceeding with operation of the instrument.

3.2 FRONT PANEL CONTROLS

The LOWER LEVEL (E) control is a ten turn dial potentiometer which provides the reference voltage for the Lower Level Discriminator. When the input pulse signal exceeds this baseline level, an LLD output 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.

The WINDOW (ΔE) control is also a ten turn dial potentiometer. Its voltage is summed with that provided by the LOWER LEVEL (E) control to provide the reference voltage for the Upper Level Discriminator. An input signal exceeding this level generates a ULD output pulse, timed as the signal decays thru the level referenced by the LOWER LEVEL (E) control. An input signal which exceeds the LLD but not the ULD generates the logical SCA output.

The ΔE RANGE switch simply sets the full rotation range of the WINDOW (ΔE) control as 1.0VDC or 10.0VDC.

3.3 REAR PANEL CONTROLS

The rear panel LLD REF MODE switch permits use of an externally sourced voltage for the baseline reference (LLD). In the EXT position the switch will completely disable the LOWER LEVEL (E) control. The externally sourced voltage will then be summed with the D.C. voltage set by the WINDOW (ΔE) control to set the reference for the ULD.

3.4 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 functions of the trimming potentiometers are as follows:

RV1:	Full Scale Adjust for WINDOW (ΔE)
RV2:	Full Scale Adjust for LOWER LEVEL (E)
RV3:	Full Scale Adjust for 1V Range (ΔE)
RV4:	Low End Adjust for WINDOW (ΔE)
RV5:	Transfer Gain Adjust for (E) + (ΔE)
RV6:	Low End Adjust for LOWER LEVEL (E)

The adjustments for output pulse voltage level can be found on a printed circuit board at the rear of the unit (see figure on Page 3-2). The unit is shipped with a socketed 1.6K ohm carbon resistor. With the resistor installed the output pulse is clamped at +5VDC nominal, open circuit. The user may remove any or all 3 of the socketed resistors for the LLD, ULD or SCA outputs as needed. With the resistor removed, the output voltage will be +8VDC nominal open circuit, and +4VDC nominal into a 50 ohm load.

Section 4
OPERATING INSTRUCTIONS

4.1 GENERAL

The purpose of this section is to familiarize the user with the Model 2030 SCA, 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.

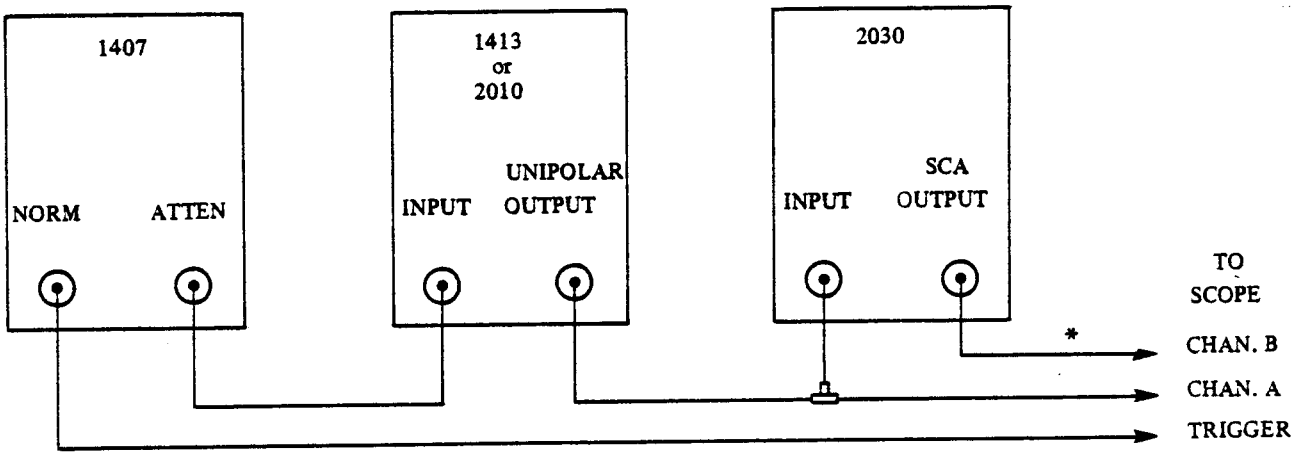
4.2 INITIAL SETUP

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 2030, 1407, and 1413 or 2010 in the Bin, with the power initially OFF.

Interconnect the units as shown below:



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

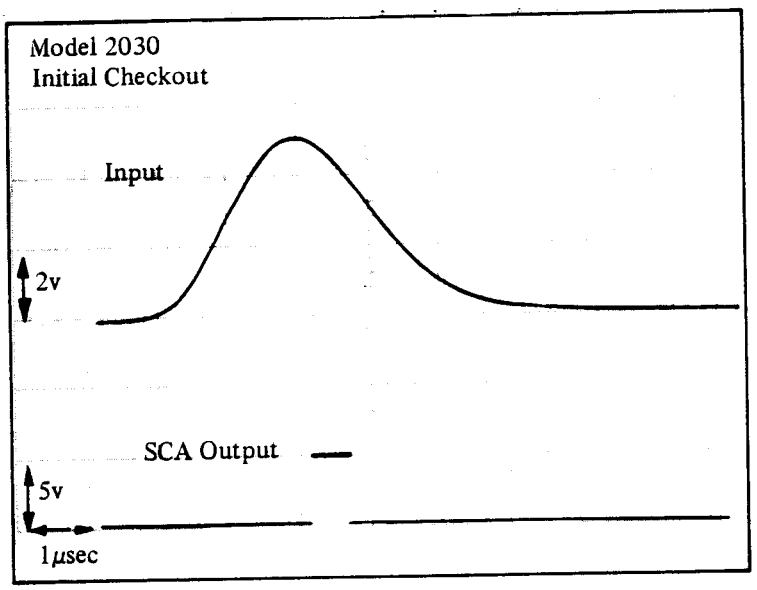
Reference control settings:

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 2030:	LOWER LEVEL (E) to 5.00, WINDOW (ΔE) to 1.00, ΔE RANGE switch to 10V. LLD REF MODE switch to INT.

SCOPE: Channel A: 2 v/cm
Channel B: 5/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 SCA output pulse appears. Verify the peak amplitude of the input signal to be approximately 5v. Typical scope waveforms are shown in the photo below.



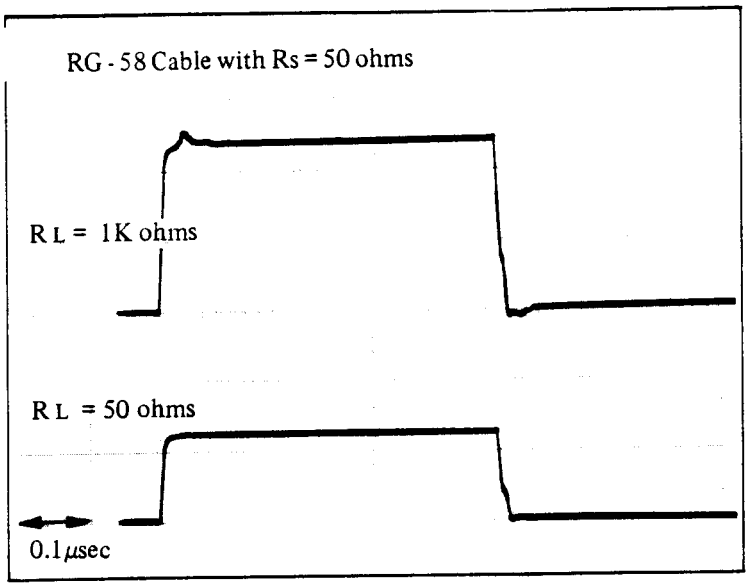
Now increase the amplifier output further until the SCA output pulse disappears. Verify the peak amplitude of the input signal to be approximately 6v.

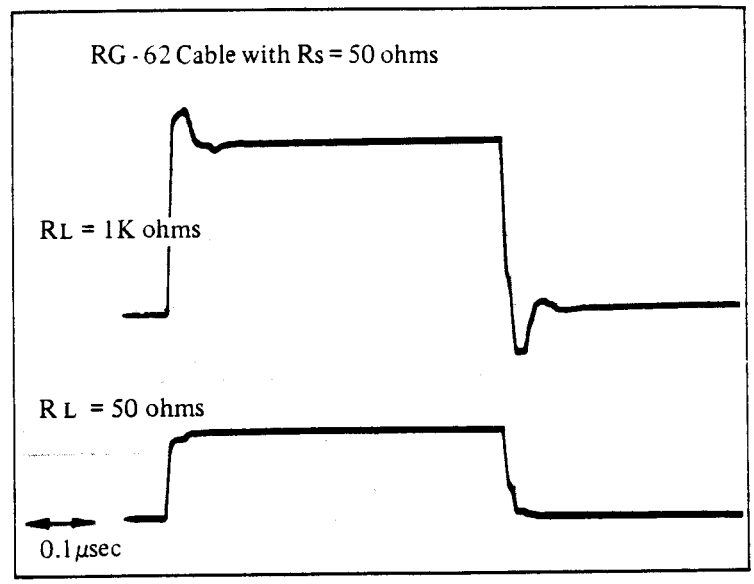
The user may also verify that the ULD output pulse just appears at the same point where the SCA pulse disappears above, and that the LLD output pulse appears as the input signal peak exceeds 5v.

As the Model 2030 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.

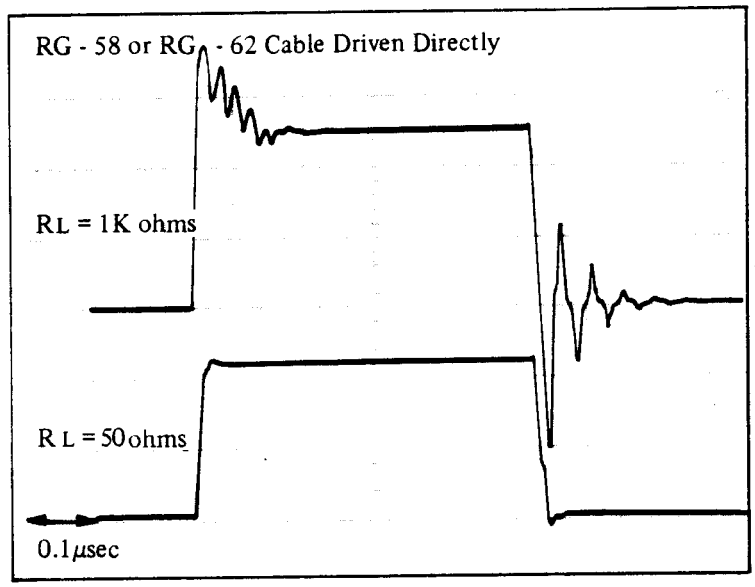
4.4 REFERENCE DATA ON CABLES

The following photos 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 LLD, ULD, and SCA 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 2031 provides source matched outputs, and load end terminations are not necessary.



Section 5
THEORY OF OPERATION

5.1 GENERAL

The Model 2030 SCA 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. Comparisons are made for a lower level discrimination (LLD), and an upper level discrimination (ULD). Pulses between the two levels (within the window) are recognized as the primary or SCA output.

5.2 DISCRIMINATORS

The pulse discrimination takes place in the precision dual comparator A5. The LLD reference voltage for the comparator is of course set by the LOWER LEVEL (E) front panel control. A4, as a voltage follower, prevents loading of the potentiometer or the EXTERNAL BASELINE input. A2 sums the voltages set by the LOWER LEVEL (E) and WINDOW (ΔE) front panel controls and provides the ULD reference voltage. RV5 adjusts the summing gain precisely to allow correct adjustment of the window. The other RV adjustments are for full scale range or low end (offset) corrections.

The LLD 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 LED display is driven on by this pulse, as switched thru Q11 and stretched by C22.

The ULD 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.

The input signal to both comparator sections is DC terminated, and divided to a voltage consistent with the differential rating of the component. Over-voltages are diode clamped to +6v and - 1v nominal.

5.3 LOGIC AND TIMING

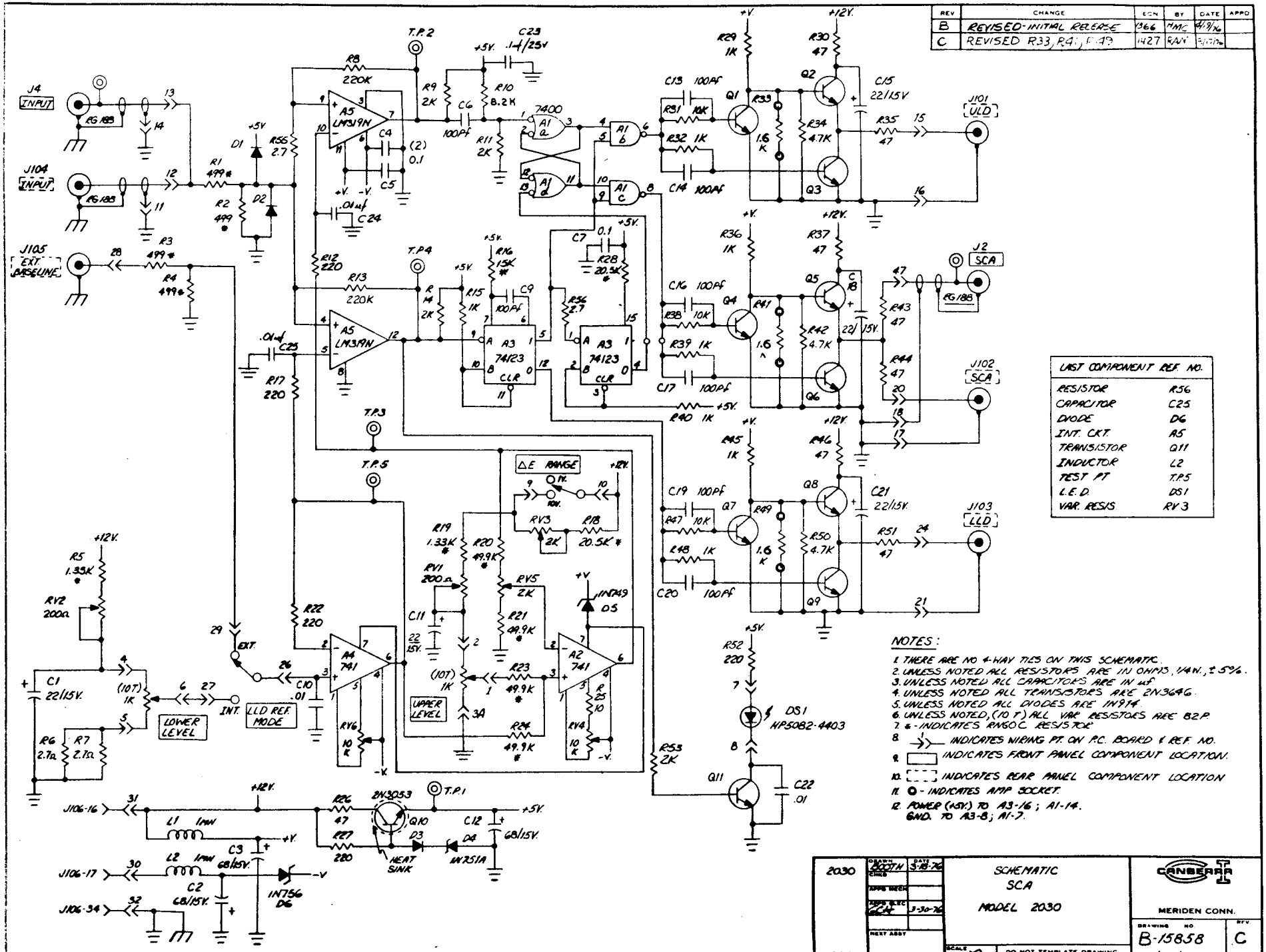
The trailing edge of the LLD signal on A5 pin 12 is used to initiate the one-shot A3. This one-shot is set for a 0.5 microsecond nominal pulse, and enables the LLD, and ULD or SCA outputs synchronously. The direct output on pin 12 of A3, pulsing low, yields the LLD output pulse. The complementary output on pin 5, pulsing high, is gated with the outputs of the R-S latch formed by A1a and A1d. If the latch was just tripped because the input pulse exceeded the ULD threshold as output at A5 pin 7, then A1b would logically AND to a low pulse at A1 pin 6, and yield the ULD output pulse. If the latch was not tripped, the logical AND would occur thru A1c pulsing low at A1 pin 8, thereby yielding the SCA output pulse.

As the 0.5 microsecond nominal pulse terminates, the second one-shot in A3 is triggered (pin 1). This pulse is nominally 0.1 microsecond wide (pin 4 low), sufficient to reset the ULD latch prior to the next pulse input. Pulse pair resolution is of course limited directly by the sum of these two periods.

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.



REV	CHANGE	ECN	BY	DATE	APPD
B	REVISED-INITIAL RELEASE	1366	MMC	4/8/76	
C	REVISED R33, R41, R49	1427	RAN	9/17/76	

LAST COMPONENT REF. NO.	
RESISTOR	R56
CAPACITOR	C25
DIODE	D6
INT. CKT.	A5
TRANSISTOR	Q11
INDUCTOR	L2
TEST PT	T.P.5
L.E.D.	DS1
VAR. RESIS	RV3

NOTES:

1. THERE ARE NO 4-WAY TIES ON THIS SCHEMATIC.
2. UNLESS NOTED ALL RESISTORS ARE IN OHMS, 1/4W., ± 5%.
3. UNLESS NOTED ALL CAPACITORS ARE IN μf.
4. UNLESS NOTED ALL TRANSISTORS ARE 2N3646.
5. UNLESS NOTED ALL DIODES ARE IN914.
6. UNLESS NOTED, (10T) ALL VAR. RESISTORS ARE B2P.
7. * - INDICATES RNC60C RESISTOR
8. ⟩ INDICATES WIRING PT. ON P.C. BOARD & REF. NO.
9. ▭ INDICATES FRONT PANEL COMPONENT LOCATION.
10. ▭ INDICATES REAR PANEL COMPONENT LOCATION
11. O - INDICATES AMP SOCKET.
12. POWER (±5V.) TO A3-16; A1-14, GND. TO A3-8; A1-7.

2030	DRAWN: BOOTH 5-18-76	SCHEMATIC SCA MODEL 2030	CANBERRA MERIDEN CONN.
USED ON	CHKD		DRAWING NO. B-15858 REV. C
	APPD MECH		SHT / OF /
	APPD ELEC 9-30-76		
	NEXT ASSY	SCALE ~ DO NOT TEMPLATE DRAWING	