ORTEC®

INSTRUCTION MANUAL
MODEL 420
TIMING SINGLE CHANNEL ANALYZER

Serial No. ____________________

Purchaser ____________________

Date Issued ____________________

ORTEC
INCORPORATED

P. O. BOX C
OAK RIDGE, TENNESSEE 37830
Telephone (615) 483-8451
TWX 810-572-1078

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ADDENDUM

All ORTEC 420 Timing Single Channel Analyzers with serial numbers 824 and above have been modified to provide greater experimental flexibility. The modifications are:

The ΔE DISCRIMINATOR level can now be normalized to zero via an internal trimpot, R70.

A rear panel BNC connector labeled UL DISCR. OUTPUT has been added. This allows monitoring of the pulses which were over the upper (ΔE) discriminator level and therefore not processed by the 420. This signal may be counted and added to the number of counts within the window to obtain the total.

This output also allows the 420 to be used as an integral discriminator with the upper level (ΔE) discriminator information taken on the <u>leading</u> edge of the input signal. (The information from the E discriminator, when used in INTEGRAL mode, is derived from the trailing edge — see section 5.)

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STANDARD WARRANTY FOR ORTEC ELECTRONIC INSTRUMENTS

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Shipments should be examined immediately upon receipt for evidence of external or concealed damage. The carrier making delivery should be notified immediately of any such damage, since the carrier is normally liable for damage in shipment. Packing materials, waybills, and other such documentation should be preserved in order to establish claims. After such notification to the carrier, notify ORTEC of the circumstances so that we may assist in damage claims and in providing replacement equipment when necessary.

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REPAIR SERVICE

ORTEC instruments not in warranty may be returned to the factory for repairs or checkout at modest expense to the customer. Standard procedure requires that returned instruments pass the same quality control tests as those used for new production instruments. Please contact the factory for instructions before shipping equipment.


ORTEC®
MODEL 420
TIMING
SINGLE CHANNEL
ANALYZER
"E"
"ΔE"
DISC.
0 – 1 μ sec.
DELAY
DIFF.
INT.
WALK
Adj.
BIPOLAR
UNIPOLAR
INPUT
NEG.
POS.
OUTPUT

Introduction to Fast Timing With Linear Signals

Precise determination of the time of occurrence of nuclear events is often complicated. Detection of these events usually results in a voltage pulse whose amplitude is a function of the energy loss in the detector, and whose rise time is a function of the conversion process from detector energy to charge. When time determination is derived from the leading edge of such a pulse (by means of a discriminator, e.g., a Schmitt trigger), there is a time shift of the discriminator output that depends on the pulse rise time and the range of pulse amplitudes involved. (See Figure 1(a).) The rise time of these pulses is usually limited by the linear amplifier which is necessary for pulse height analysis; such amplifiers are the ORTEC 410, and 435, older versions such as the ORTEC 203, the A-8 and the DD2, etc. For those amplifiers which have variable RC shaping, e.g., the 410, the rise time and fall time will vary directly with the integration and differentiation time constants chosen; therefore, the zero crossing time will vary in real time. The time of zero crossing in real time is approximately 2 time constants after the detector event when the double RC differentiation is used, provided equal integrating and differentiating time constants are selected.

Figure 1(b) shows a series of idealized output pulses from a double delay line clipped amplifier, superimposed upon each other. All of the pulses pass through the baseline at the same time. This is true because in the amplifier clipping process, the voltage which is forming the pulse shape goes from a positive value (+E) to an equal negative value (-E) in the same time that was required for the voltage to go from 0 to +E, i.e., one rise time. The pulses, therefore, pass through the baseline (zero volts) at a time corresponding to $T_r/2$, but displaced along the time axis by the one clipping time, τ. Thus, it is evident that the time $T_r/2$ corresponds to the point at which the pulses attain half-height. Since in linear amplifiers the rise time is constant and therefore independent of pulse height, the time at which the pulses reach half-height is also constant and independent of pulse height. The discriminator in the ORTEC 420 is designed to trigger on the leading edge of the pulse, at a selected voltage, and is forced to reset when the pulse passes through zero volts. The discriminator output pulse is then differentiated, and the reset edge is used to furnish an output pulse.

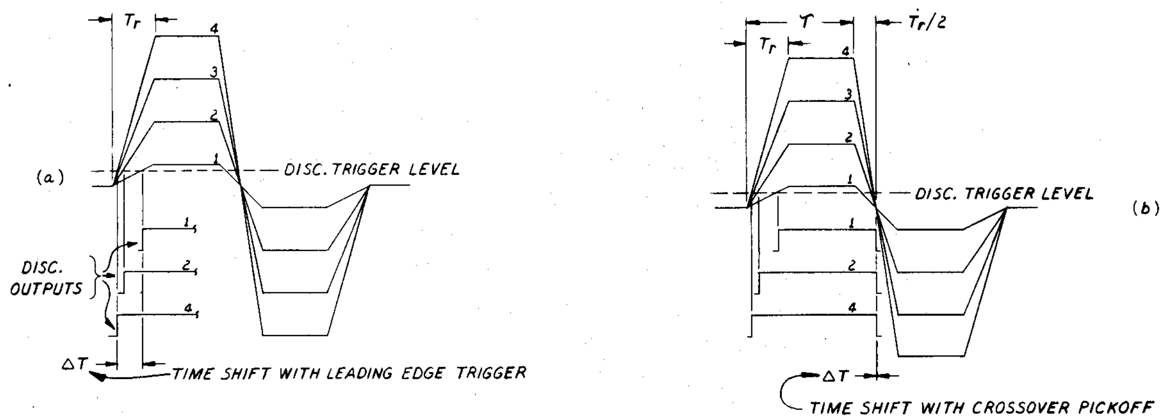


Figure 1. Timing From Linear Amplifier Output Pulses

ORTEC 420
TIMING SINGLE CHANNEL ANALYZER

1. DESCRIPTION

The ORTEC 420 Timing Single Channel Analyzer, as indicated by its title, performs two functions. First, it is a single channel analyzer, with both the lower level and the window width variable over the pulse height range. For input signals which are doubly differentiated, it furnishes an output which occurs at the time these signals go through zero. This time, as explained in the preceding introduction, is a precisely known time and therefore the output time from the 420 is a precise time. The unit will accept single or double delay line differentiated signals or single or double RC differentiated signals with pulse widths from 200 nanoseconds to 20 microseconds. When the unit is fed a unipolar pulse, the crossover time is not fixed in time and therefore the input selector switch should be set to the unipolar position. This will cause the discriminator to reset at the same pulse height at which it was triggered, and therefore the time of output pulse will depend upon the fall time of the signal input. The unit is provided with a variable delay, selectable by a front panel control, of approximately 1000 nanoseconds to allow time balance in coincidence circuitry and analyzer gating. The unit provides two outputs whose leading edges contain the same timing information. One is a negative spike used for very fast timing such as time to pulse height converters, and the other is a positive 5-volt, 500-nanosecond-wide pulse for slower applications such as coincidence circuits and analyzer gating. These output pulses are the two standard forms of logic pulses in the ORTEC 400 Series modular instruments, and are compatible with all related input signal requirements.

2. SPECIFICATIONS

INPUT SIGNAL REQUIREMENTS:

Amplitude Range	100 mV to 10V
Pulse Width Range	200 nsec to 20μsec
Polarity	Positive (Unipolar) or Positive Portion leading (Bipolar)

CONTROLS:

Lower Level ("E")	100 mV to 10V, 10-turn control
Window Width ("ΔE")	100 mV to 10V, 10-turn control
Delay	0 to 1000 nsec, 10-turn control
Differential - integral Mode	Switch, integral position disables "ΔE" Discriminator
Unipolar - Bipolar Mode	Switch

LINEARITY (as percent of full span):

"E"	<±0.25%
"ΔE"	<±0.25%
Delay	<±2%

TEMPERATURE STABILITY (as percent of full span):

"E"	<±0.015%/°C
"ΔE"	<±0.015%/°C
Delay	<±0.4 nsec/°C

TIME SHIFT VS. PULSE HEIGHT*	<±2 nsec for a factor of (X10) or ± 10 nsec for (X50) *Specified with the ORTEC 410 Amplifier, Double-Delay-Line Mode, Integrate 0.2μsec
OUTPUT SIGNALS	Both occur simultaneously and may be delayed 0 to 1.0μsec by means of a 10-turn DELAY control
Fast	Negative, 0.6V (min), T_r <5 nsec, Width <20 nsec
Slow	Positive, 5V, T_r <20 nsec, Width ~500 nsec
POWER REQUIRED	30 mA at +24V, 30 mA at -24V 50 mA at +12V, 40 mA at - 12V
WEIGHT	~2.5 pounds net
SIZE	Standard double width module (2.70 inches wide) per TID-20893

3. INSTALLATION INSTRUCTIONS

3.1 General

The ORTEC 420, used in conjunction with the ORTEC 401/402 Bin and Power Supply, is intended for rack mounting, and therefore it is necessary to ensure that vacuum tube equipment operating in the same rack has sufficient cooling air circulating to prevent any localized heating of the all-transistor circuitry used throughout the 420. The temperature of equipment mounted in racks can easily exceed the recommended maximum unless precautions are taken; The 420 should not be subjected to temperatures in excess of 120°F (50°C).

3.2 Connection to Power — AEC Standard Nuclear Instrument Module, ORTEC 401/402

The 420 contains no internal power supply, and therefore must obtain power from a Nuclear Standard Bin and Power Supply such as the 401/402. It is recommended that the Bin power supply be turned off when inserting or removing modules. The ORTEC 400 Series is designed so that it is not possible to overload the Bin power supply with a full complement of modules in the Bin; however, this may not be true when the Bin contains modules other than those of ORTEC design. In this case, power supply voltages should be checked after the insertion of modules. The 401/402 has test points on the power supply control panel to monitor the dc voltages.

3.3 Connection to a Linear Amplifier

The input to the 420 is via a front panel BNC connector and is compatible with all linear amplifiers capable of producing 10-volt unipolar or bipolar output signals onto a 2000-ohm load, with the positive excursion of a bipolar signal leading the negative excursion in real time. The input operating range is from threshold, typically 100 millivolts, to 10 volts. This unit may be used with vacuum tube amplifiers which are capable of output signals of 100 volts, if the output signal from the amplifier is attenuated so that it cannot exceed 10 volts. Simple resistive attenuators installed in the vacuum tube amplifiers will make them compatible with related transistor equipment.

3.4 Linear Output Signal Connections and Terminating Impedance Considerations

The source impedance of the 0-10 volt standard linear outputs of most 400 Series modules is approximately 1 ohm. Interconnection of linear signals is, thus, non-critical since the input impedance of circuits to be driven is not important in determining the actual signal span, e.g., 0-10 volts, delivered to the following circuit. Paralleling several loads on a single output is therefore permissible while preserving the 0-10 volt signal span. Short lengths of interconnecting coaxial cable (up to approximately 4 feet) need not be terminated. However, if a cable longer than approximately 4 feet is necessary on a linear output, it should be terminated in a resistive load equal to the cable impedance. Since the output impedance is not purely resistive, and is slightly different for each individual module, when a certain given length of coaxial cable is connected and is not terminated in the characteristic impedance of the cable, oscillations will generally be observed. These oscillations can be suppressed for any length of cable by properly terminating the cable either is series at the sending end or in shunt at the receiving end of the line. To properly terminate the cable at the receiving end, it may be necessary to consider the input impedance of the driven circuit, choosing an additional parallel resistor to make the combination produce the desired termination resistance. Series terminating the cable at the sending end may be preferable in some cases where receiving and terminating is not desirable or possible. When series terminating at the sending end, full signal span, i.e., amplitude, is obtained at the receiving end only when it is essentially unloaded or loaded with an impedance many times that of the cable. This may be accomplished by inserting a series resistor equal to the characteristic impedance of the cable internally in the module between the actual amplifier output on the etched board and the output connector. It must be remembered that this impedance is in series with the input impedance of the load being driven, and in the case where the driven load is 900 ohms, a decrease in the signal span of approximately 10% will occur for a 93-ohm transmission line. A more serious loss occurs when the driven load is 93 ohms and the transmission system is 93 ohms. In this case, a 50% loss will occur. BNC connectors with internal terminators are available from a number of connector manufacturers in nominal values of 50, 100, and 1000 ohms. ORTEC stocks in limited quantity both the 50 and 100 ohm BNC terminators. The BNC terminators are quite convenient to use in conjunction with a BNC tee.

4. OPERATING INSTRUCTIONS

4.1 Front Panel Control Functions

"E" DISC.

The function of the "E" (or energy) discriminator is the same as with any discriminator, i.e., to prevent discriminator triggering by those signals which are below the selected threshold. The threshold range of this discriminator is from approximately 100 millivolts to 10 volts direct reading on the dial.

"ΔE" DISC.

The "ΔE" Discriminator forms the upper level of the single channel analyzer. The dial of this discriminator reads the difference in voltage or energy between the "E" discriminator and the upper level; therefore, it reads "ΔE". Since this forms the upper level of the single channel analyzer, the output from this discriminator is placed in anticoincidence with an output from the lower level or "E" discriminator so that when triggered, there is no output. Therefore, to obtain an output from this unit a signal must be bigger than the "E" setting but less than "E" + "ΔE". (When the Differential/Integral (DIFF./INT.) switch is set to the INT. position, the "ΔE" function is disabled, and the unit becomes an integral discriminator which is controlled by the "E" dial.)

Delay Control

When the bipolar signal passes from a positive to a negative value, or when the unipolar signal recrosses the "E" discriminator setting (depending upon the selection of unipolar or bipolar operation by means of switch S1), a logic signal to be used for timing or counting operation is generated. The delay control allows the output logic signal to be delayed in time from this reference time, t_o + a constant propagation delay, over a range of 0 to 1000 nanoseconds. This delay is continuously variable by means of a 10-turn potentiometer.

UNIPOLAR/BIPOLAR Switch (S1)

Switch S1 selects the mode of operation of the timing unit, and should be set to correspond to unipolar or bipolar signals at the input; i.e., if the input signal is a singly differentiated pulse this switch should be in the UNIPOLAR position, and if the input signal is a bipolar signal the swtich should be in the BIPOLAR position. Precise timing is available only when the signal is a bipolar signal.

DIFF./INT. Switch (S2)

Switch S2 determines whether the unit shall be an integral timing discriminator or a timing single channel analyzer. When this switch is in the DIFF. position all signqls which trigger the ΔE discriminator will prevent the logic signal created by the timing discriminator from reaching the output, and therefore there will be no output from the unit. When the switch is in the INT. position, the ΔE discriminator is disabled, and all signals which exceed the lower level threshold will create an output signal.

WALK Adj.

Due to minor circuit differences, various amplifiers will have a true crossover at different values of voltage, but very near zero. For this reason, a WALK adjustment is provided on the front panel. This is a screwdriver adjustment and is adjusted to an optimum value with a 410 Amplifier before the unit leaves the factory. For information concerning the method of adjustment, refer to "Calibration Adjustment," Section 6.1 of this manual.

4.2 Initial Testing and Observation of Waveforms

Refer to Section 6.1 for information on testing performance and observing waveforms.

4.3 Connector Data

CN1 — INPUT (BNC) CONNECTOR

CN1 has input impedance of 2000 ohms, ac-coupled, and a maximum input of 10 volts. To minimize reflections when driving into CN1 from a low impedance voltage source such as the output of the 410, etc., CN1 should be externally terminated in the characteristic impedance of the connecting coaxial cable.

CN2 — OUTPUT NEG. (BNC) Connector

Output driving source impedance is less than 10 ohms. The signal is dc coupled starting from zero volts; it is the standard ORTEC Fast Negative logic signal and is used for optimum timing resolution.

CN3 — OUTPUT POS. (BNC) Connector

Output driving impedance is less than 10 ohms. The signal is dc coupled starting from zero volts; it is the standard ORTEC positive logic pulse whose application is normally coincidence timing and analyzer gating.

OUTPUT Test Points

Oscilloscope test points for monitoring output signals are available at each OUTPUT BNC. Each test point has a 470-ohm series resistor connecting it to the respective OUTPUT BNC connector.

4.4 Typical Operating Conditions

The realization of both optimum timing and optimum energy resolution are mutually exclusive when using the crossover pickoff method of timing; however, a satisfactory compromise of timing and resolution is usually not difficult to obtain.

Optimum timing is realized with wide bandwidth capabilities in the linear amplifier, resulting in fast rise and fall times. Optimum energy resolution is realized with narrow bandwidth so that the bypass of the noise spectrum can be selectively chosen at a particular location in the frequency spectrum.

The method of compromise is illustrated with reference to the 410 Amplifier when used in conjunction with the 420 Timing Single Channel Analyzer. To optimize timing, the 410 would be operated: 1) with a minimum of integration and double delay line differentiation; or 2) in the double RC shaping mode with the integration and differentiation time constants set on 0.1 microsecond. The optimization of timing would be at the expense of energy resolution. If it is desired to optimize the energy resolution, the 410 should be operated: 1) with an integration time constant of 1 or 2 microseconds and double delay line differentiation; or 2) in the double RC shaping mode with the integration and differentiation time constants set at 1 or 2 microseconds. In the latter case, it is observed that the rate of change of voltage when the linear amplifier output crosses through zero is very much less than in the former case. With the lower rate of change, the noise modulation of the linear amplifier output signal causes a larger time jitter of the timing output signal. In the former case, the rate of change of voltage with respect to time is quite high and the jitter in the timing output due to linear amplifier noise modulation is quite small.

5. CIRCUIT DESCRIPTION (See Drawings 420-0001-S1 and 420-0002A-B1)

Resistors Rl and R5 form a resistive voltage divider which divides the input signal from a maximum of 10 volts to a maximum of 5 volts at the base of Q1 and Q9. Q1 and Q2 form a long-tail pair which is the lower level discriminator. Transistors Q3 through Q8 are necessary to obtain the control desired on the hysteresis of the circuit. Q3 and Q5 are normally on in the absence of an input signal and hold the base of Q2 at zero volts. When an input signal exceeds the threshold level set by the "E" discriminator, R2, the trigger pair, Q1 and Q2, regenerates and triggers another trigger pair formed of Q7 and Q8. Q7 turns on and Q8 turns off. When Q8 turns off, this allows the emitter of Q4 to fall toward -12 volts and it is caught at -E. When the emitter of Q4 and base of Q6 fall negative, Q6 turns on and Q5 turns off, which sets the base of Q2 at -E. Since the base of Q1 has a baseline voltage equal to -E and the base of Q2 has a baseline voltage of -E in the presence of the signal, the trigger pair will reset when the signal makes the transition from the positive condition to the negative condition, i.e., zero crossing point. The signal at the collector of Q7 is differentiated by means of L3 and is fed to the base of Q15. The negative portion of the signal will cause Q15 to conduct if the upper level discriminator has not been triggered. A signal from the collector of Q6 is used to reset the upper discriminator when it has been triggered, and this signal is fed to the base of Q11. R14, the zero adjust trimpot, is used to zero the "E" pulse height dial. The adjustment of the walk adjust potentiometer, R6, will be explained in Section 6.1. Switch S1 is used to obtain operation in either bipolar or unipolar mode. In the bipolar position, transistor Q4 has the value of -E imposed on its base at all times; however, in the unipolar position this base sees a constant -75 mV dc voltage. This dc voltage is the amount of hysteresis on the lower level discriminator in the unipolar mode.

The upper level discriminator is formed by Q9 and Q10. The output from Q10 is differentiated and fed to the base of Q12. When switch S2 is in the differential position, this signal is sufficiently large to trigger the multivibrator composed of Q12 and Q13. If, however, S2 is in the integral mode, this pulse cannot trigger the multivibrator composed of Q12 and Q13. Once this multivibrator is triggered, it could recover with an RC recovery time of approximately 100 microseconds; however, it is reset at essentially zero crossing time by means of the reset pulse which is present by way of Q11. Due to the long time constant involved with this multivibrator, this circuit can handle pulse widths which are very wide, e.g., 20 microseconds.

As output from Q13 will cause Q14 to inhibit any signal that appears at the base of Q15; thus, the anticoincidence function is performed between the "ΔE" discriminator and the "E" discriminator. This anticoincidence function assures that the input pulse must be within the selected window to obtain an output. Q16, Q17, Q18, and Q19 form a delay generator. The delay control, R46, will vary the delay of the output logic signal over a range of approximately 1000 nanoseconds. This delay should be quite linear. The delay generator triggers with an input pulse from Q15 and then resets when the signal at the base of Q17 recovers to the zero voltage level. The recovery time constant is set by capacitor C19 and the constant current generator, Q19. The pulse from the collector of Q17 is differentiated and the negative portion is fed out through Q20 as a fast output signal. An inversion of this same signal appears at the collector of Q20 and triggers the multivibrator composed of Q21 and Q22. The signal from the collector of Q22 is emitter-follower buffered to the output as a positive 5-volt signal, 0.5 microsecond wide.

6. MAINTENANCE INSTRUCTIONS

6.1 Testing Performance

6.1.1 Introduction

The following paragraphs are intended as an aid in the installation and checkout of the 420. These instructions present information on front panel controls, waveforms and test points, and output connectors.

6.1.2 Test Equipment

The following or equivalent test equipment is needed:

(1) ORTEC 419 Pulse Generator

(2) Tektronix 545 Series Oscilloscope

(3) 100-ohm BNC terminators

(4) ORTEC 410 Amplifier

(5) Schematics and Block Diagrams for the 420 Timing Single Channel Analyzer

6.1.3 Preliminary Procedures

(1) Visually check module for possible damage due to shipment.

(2) Connect ac power to Nuclear Standard Bin, e.g., ORTEC 401/402

(3) Plug module into Bin and check for proper mechanical alignment.

(4) Switch on ac power and check the dc power voltages at the test points on the 401 Power Supply control panel.

6.1.4 Testing the Single Channel Function

(1) Connect the direct output of the pulse generator to the scope trigger. Connect the attenuated output of the pulse generator to the input of the 410 Amplifier. Place all attenuator switches on the pulse generator to the out position except one switch, which should be an X10 switch. Set the 410 Amplifier DIFFERENTIATION control to double delay line. Set the INTEGRATION control to the .1 μsec position. Adjust the pulse generator output and/or amplifier gain control to achieve an amplifier output pulse height of approximately 10 volts.

(2) Connect the amplifier output to the single channel analyzer input. Set the 420 DIFF./INT. switch to the INT. position, and set the BIPOLAR/UNIPOLAR switch to the BIPOLAR position. Adjust the "ΔE" dial to read 500/1000 divisions. There should now be an output from both fast and slow outputs of the single channel analyzer.

Turn the "E" dial to read 1000, then adjust the pulse height dial on the pulse generator so that the single channel half-triggers. Now set the X2 attenuator switch on the pulse generator. The single channel should again half-trigger at 500 dial divisions. Next, set the DIFF./INT. switch to the DIFF. position, and turn the "E" dial to 400 divisions. Turn the "ΔE" dial toward zero and observe when the single channel again begins to half-trigger. This should be approximately 100 dial divisions on the "ΔE" dial. We are now certain that the single channel analyzer is operating as a single channel in the bipolar mode. These same steps may be repeated for the unipolar mode if desired, and other points of the pulse height vs dial curves may be observed.

6.1.5 Testing the Timing Function

(1) It is assumed for this test that the steps in 6.1.4 have been performed and that switch S1 is in the BIPOLAR position. Connect the direct output of the pulse generator to the trigger input to the "B" sweep on the scope and set the scope for "A" triggered by "B". Obtain such triggering of the "A" sweep that the delay control in the "B" sweep section may be used.

(2) Turn the DELAY control on the 420 to 0 and observe the output pulse either at TP1 or at TP2, then adjust the scope sweep speed and "B" sweep delay to observe the leading edge of this pulse with a sweep speed of 20 nanoseconds/cm or less. Set the DIFF./INT. switch to the INT. position on the 420. Set the pulse generator switches as described in Section 6.1.4, step (4). Place the "E" discriminator at 10 divisions. Attenuate the pulse height by factors of 2, 5, and 10 by means of the attenuator switches on the pulse generator, and observe the time shift of the output pulse; the time shift should be less than 4 nanoseconds over this pulse height range. It may be necessary to trim the time shift by means of the WALK Adj. screwdriver adjustment (R69) on the front panel. For those users who have critical dynamic range problems, the single channel may be checked and adjusted to achieve less than ±10 nanoseconds time shift over a dynamic range of 50:1, i.e., from 200 mV to 10 volts. Operation with this wide a range becomes quite critical and R69 may have to be slightly readjusted to achieve this characteristic. Of course, at very low pulse heights the amount of jitter observed will be large; this is due to the amplifier noise modulation of the crossover point.

(3) Set the scope sweep speed at 50 nanoseconds/cm. Observe the output signal and turn the DELAY control (R46) through its range. The output should shift approximately 1000 nanoseconds.

6.1.6 Timing in the Unipolar Mode

When switch S1 is set in the UNIPOLAR position, the lower level discriminator is forced to fire and reset at essentially the same voltage; thus, the time of the output pulse will vary directly with the signal amplitude and fall time of the input pulse. This means that timing in the unipolar mode can be no better than the fall of the pulse times the proportion of the dynamic range used.

6.2 Calibration Adjustment

It is assumed for this adjustment thal all the steps outlined in Section 6.1 have been completed. To force the lower lever, i.e., the "E" discriminator, to extrapolate to zero, an adjustment is provided on the printed circuit board. To perform this adjustment, set the pulse generator controls as given in Section 6.1.4, step (3). Set the 420 DIFF./INT. switch to the INT. position. Adjust the pulser to achieve half-triggering with the "E" dial placed at 1000, then, adjust the pulse height dial of the pulse generator to 100 and set the 420 "E" dial to 100, adjusting the zero potentiometer (R14) to achieve half-triggering. Other points at lower pulse heights may be checked if desired.

6.3 Troubleshooting Suggestions

In situations where the 420 is suspected of malfunction, it is essential to verify such malfunction in terms of simple pulse generator pulses at the input and output. For this reason, the 420 must be disconnected from its position in any system, and routine diagnostic analysis performed with a test pulse generator and oscilloscope. It is imperative that testing not be performed with a source and detector until the amplifier and single channel analyzer system perform satisfactorily with a test pulse generator. The testing instructions in Section 6.1 of this manual and the circuit descriptions in Section 5 should provide assistance in locating the region of trouble and repairing the malfunction. The guide plate and shield cover may be completely removed from the module to enable oscilloscope and voltmeter observation with a minimal chance of accidentally short-circuiting portions of the etched board. The 420 may be returned to ORTEC for repair service at nominal cost; our standardized procedure requires that each repaired instrument receive the same extensive quality control tests that a new instrument receives.

6.4 Tabulated Test Point Voltages on Etched Boards

The following voltages are intended to indicate typical dc voltages measured on the etched circuit board and are intended to serve as an aid in troubleshooting.

Table 6.1 Typical DC Voltages

NOTES:
1. All voltages are measured from ground with vtvm having impedance of 10 megohms or greater.
2. All voltages are dc values with no input signals.
3. Set all dials to read 100 divisions.
4. Set DIFF./INT. switch to DIFF., and BIPOLAR/UNIPOLAR switch to BIPOLAR.

Pin No.	Test Point	Voltage
A	+24 bus	24.0
B	+12 bus	12.0
C	-12 bus	-12.0
D	-24 bus	-24.0
E	Junction of R2 & R3	- 4.9
F	Junction of R30 & R31	5.0
G	Q1-C	11.8
H	Q4-E	1.7
I	Junction of R21 & R22	- 0.080
J	Q9-C	11.5
K	Q12-C	11.6
L	Q15-C	0.0
M	Q16-C	16.6
N	Q19-B	17.7
O	Q21-C	0.0
P	Q22-C	0.54
Q	Q23-E	0.0

C — Collector

B — Base

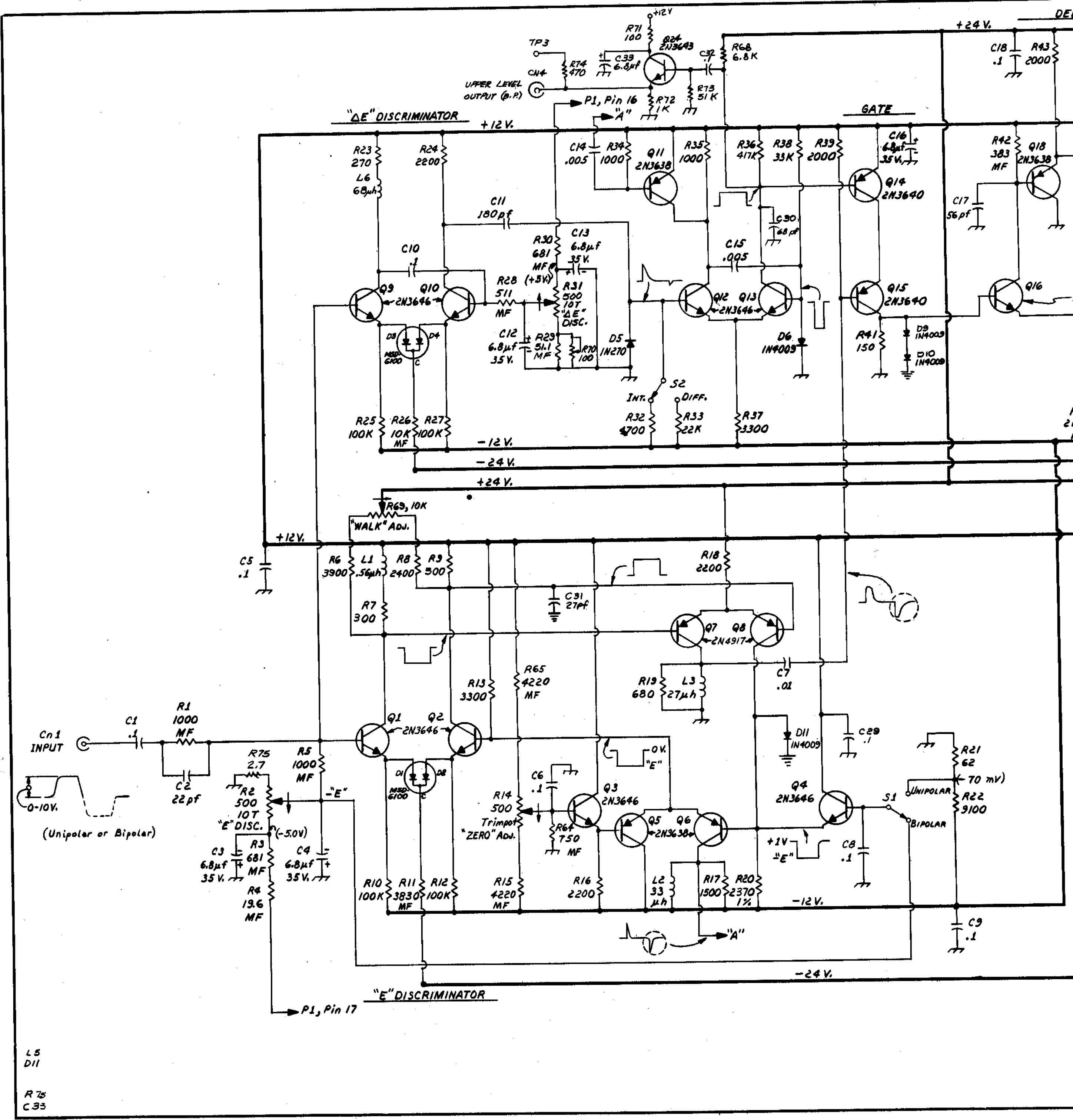
E — Emitter

BIN/MODULE CONNECTOR PIN ASSIGNMENTS FOR AEC STANDARD NUCLEAR INSTRUMENT MODULES PER TID-20893

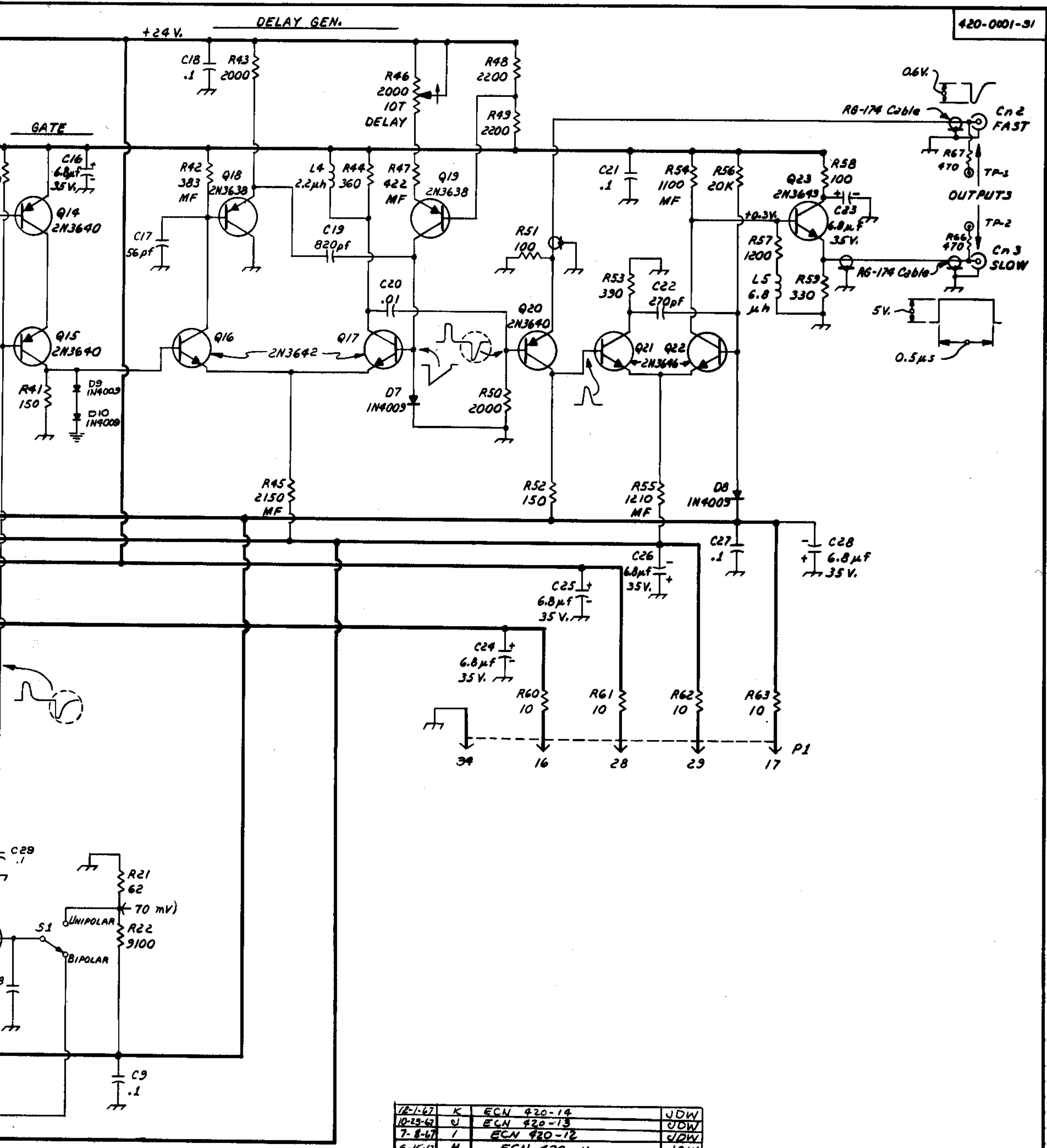
Pin	Function	Pin	Function
1	+3 volts	23	Reserved
2	−3 volts	24	Reserved
3	Spare Bus	25	Reserved
4	Reserved Bus	26	Spare
5	Coaxial	27	Spare
6	Coaxial	*28	+24 volts
7	Coaxial	*29	−24 volts
8	200 volts dc	30	Spare Bus
9	Spare	31	Carry No. 2
*10	+6 volts	32	Spare
*11	−6 volts	*33	115 volts ac (Hot)
12	Reserved Bus	*34	Power Return Ground,
13	Carry No. 1	35	Reset
14	Spare	36	Gate
15	Reserved	37	Spare
*16	+12 volts	38	Coaxial
*17	−12 volts	39	Coaxial
18	Spare Bus	40	Coaxial
19	Reserved Bus	*41	115 volts ac (Neut.)
20	Spare	*42	High Quality Ground
21	Spare	G	Ground Guide Pin
22	Reserved		

**These pins are installed and wired in parallel in the ORTEC Model 401 Modular System Bin.*

The transistor types installed in your instrument may differ from those shown in the schematic diagram. In such cases, necessary replacements can be made with either the type shown in the diagram or the type actually used in the iinstrument.



"ΔE" DISCRIMINATOR
GATE
"E" DISCRIMINATOR
UPPER LEVEL OUTPUT (B.P.)
TP3
CN4
P1, Pin 16
P1, Pin 17
Cn1 INPUT
0-10V.
(Unipolar or Bipolar)
"WALK" ADJ.
"ZERO" ADJ.
Trimpot
UNIPOLAR
BIPOLAR
INT.
DIFF.
S1
S2
+12V.
+24V.
-12V.
-24V.
R69, 10K
R14 500
R2 500 10T "E" DISC.
R31 500 10T "ΔE" DISC.
2N3646
2N3638
2N3640
2N4917
2N3643
MSD 6100
1N4009
1N270
L5
D11
R75
C33



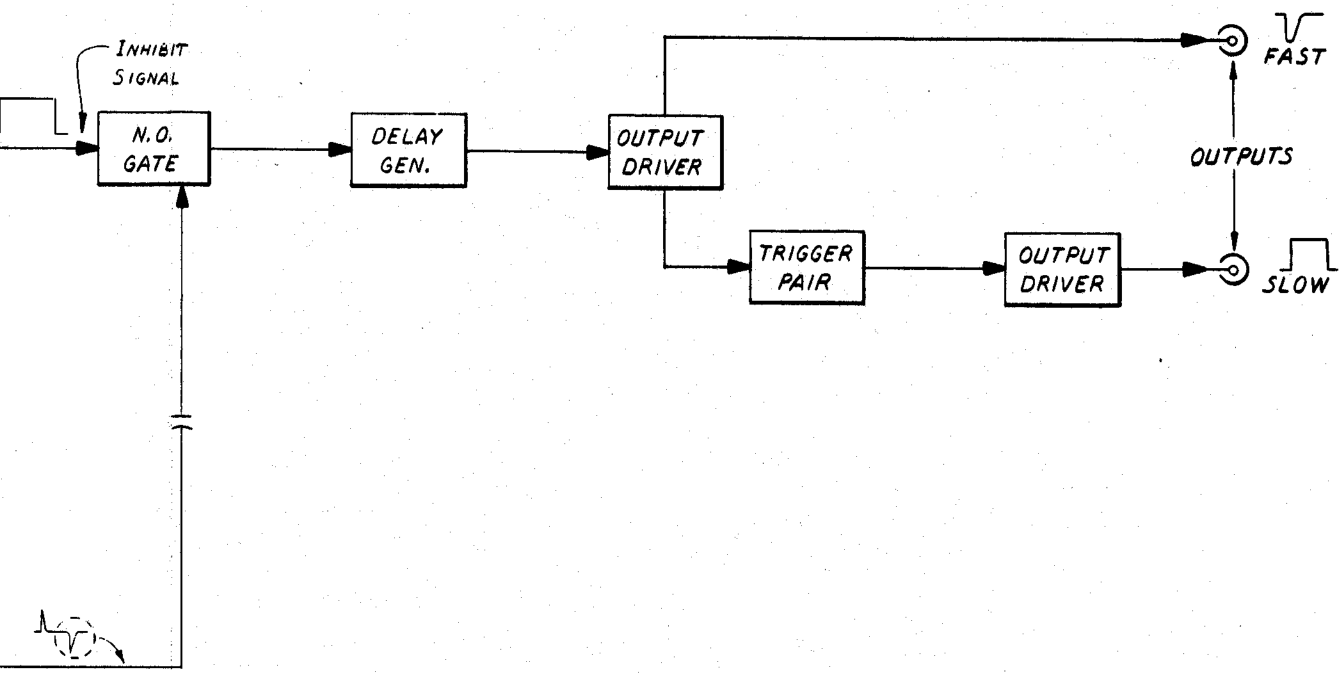
DATE	NO.	REVISION	BY
12-1-67	K	ECN 420-14	JDW
10-23-67	J	ECN 420-13	JDW
7-8-67	I	ECN 420-12	JDW
5-16-67	H	ECN 420-11	JDW
12-6-66	G	ECN 420-8	JDW
10-15-66	F	ECN 420-7	JDW
5-17-66	E	ECN 420-5	
3-11-66	D	ECN 420-4	JDW
3-9-66	C	ECN 420-3	
1-3-66	B	ECN 420-1	JRP

OAK RIDGE TECHNICAL ENTERPRISES CORP.
OAK RIDGE, TENN.

MODEL 420
TIMING SINGLE-CHANNEL ANALYZER
CIRCUIT

DESIGN	DRAWN	DATE	RESP. ENGR.	APPR.	SCALE	DRAWING NO.
C.W. Williams	E.C. Keith	7-31-65	C.W. Williams	C.A.	~	420-0001-S1

420-0002A-B

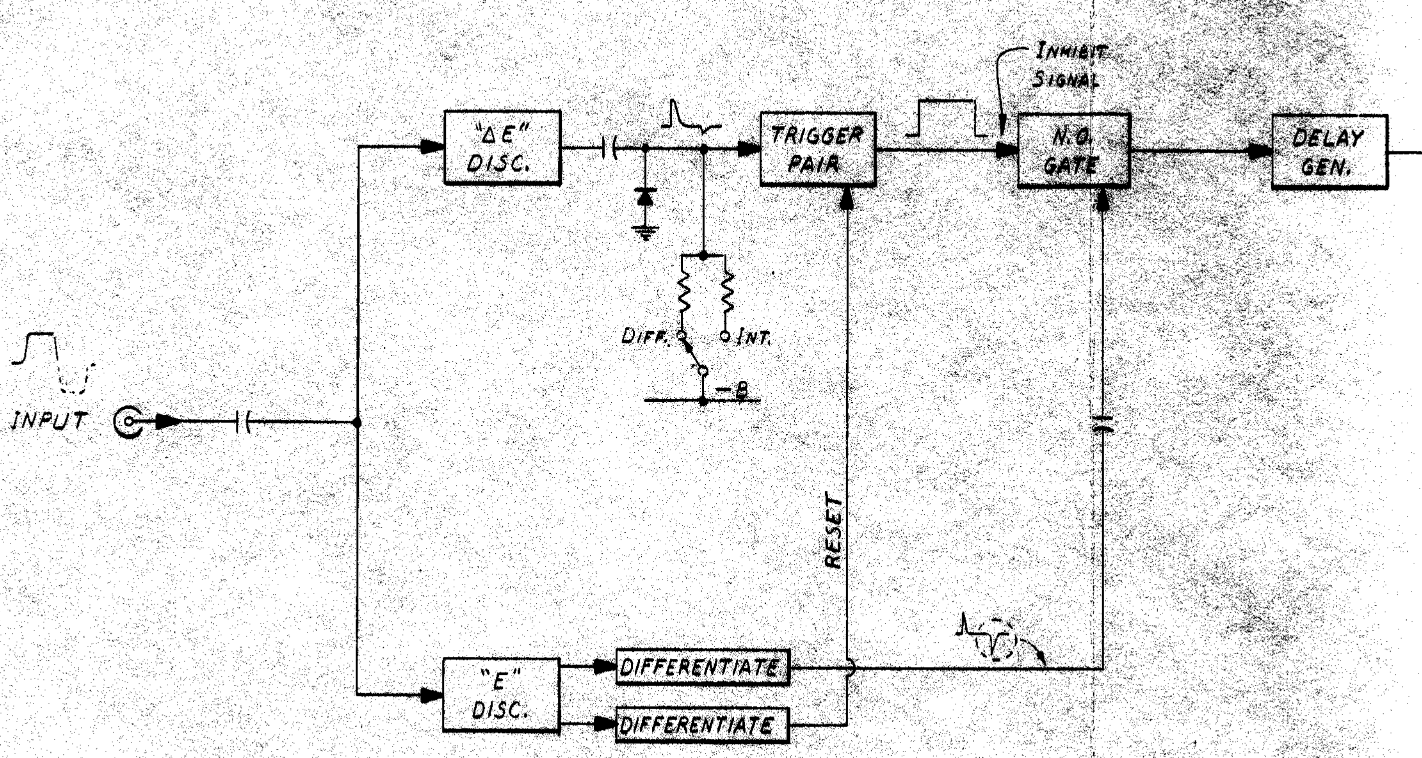


DATE	NO.	REVISION	BY

OAK RIDGE TECHNICAL ENTERPRISES CORP.
OAK RIDGE, TENN.

MODEL 420
TIMING SINGLE-CHANNEL ANALYZER
BLOCK DIAGRAM

DESIGN	DRAWN	DATE	RESP ENGR.	APPR	SCALE	DRAWING NO
C.W. Williams	E. C. Keith	8-7-65				420-0002A-B



DATE	NO.	REVIS
DESIGN C. W. Will	DRAWN E. C.	