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GENERAL DESCRIPTION

LRS Model 334 contains four extremely high-speed pulse amplifiers which provide fixed, non-inverting gains of X3. The amplifiers are designed for use with either linear or logic signals of either polarity. The fast risetime (< .9 ns), low time slewing and high stability make the 334 an excellent amplifier for use with high performance photomultiplier/discriminator combinations. The circuit of the Model 334 is completely direct coupled and thus provides freedom from any baseline shift at high rates. Both input and output DC levels are at ground potential for easy interconnection with other direct coupled circuits. An input protection circuit prevents damage from transient overloads to ± 10 volts. DC stability is less than 0.1 mV/°C at the output, better than an order of magnitude improvement over previously available performance. Stage delay nominally 1.5 ns, input to output. The direct-coupled design, unique in an amplifier of such wide bandwidth, affords the rapid overload recovery (< 2 ns for 20-fold overload), stable baseline, and general freedom from spurious rate effects that characterizes the performance of this amplifier. The excellent linearity (better than 1% integral) and temperature stability are achieved through heavy feedback. The amplifiers are packaged in a single-width Nuclear Instrument Module (NIM) which conforms to the standards set forth in AEC Report TID-20893 (Rev.).

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SPECIFICATIONS

Input Characteristics:

Impedance:	50 Ω.
Input Protection:	Widthstands pulse inputs to ± 10 V without damage; DC limited by 250 mW terminating resistors.
Reflection Coefficient:	Less than 5% over input dynamic range.
Quiescent Voltage:	Ground.

Output Characteristics:

Impedance:	Approximately 6 Ω.
Linear Range:	+ 800 mV to - 800 mV.
Maximum Amplitude:	+ 2 V to - 1.1 V;
Overshoot:	Less than 15% with 0.8 ns input risetime.
Quiescent Voltage:	Ground, adjustable with internal potentiometer.

General:

Gain:	Fixed gain of 3, non-inverting. Long term stability ± 1%. Gain tolerance ± 5%. Temperature dependence approximately 0.1%/°C.
Linearity:	1% integral.

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Coupling:	Direct.
Risetime:	0.9 ns typical, 10% to 90%. 1.0 ns maximum, 10% to 90%.
Delay:	In linear range, 1.5 ns, const.
Overshoot:	< 15% with 0.8 ns risetime; less with slower inputs.
Overload Recovery:	Less than 100 microvolts rms, referred to input, total.
Power Requirements:	± 24 V at 50 mA, - 12 V at 160 mA, + 12 V at 150 mA.
Packaging:	AEC #1 module.
Weight:	Module, approximately 1 lb.

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OPERATING INFORMATION

The Model 334, with its subnanosecond risetime, is the fastest commercially available direct coupled amplifier. Because of its speed, greater than normal care must be taken with input and output impedance match. Two precautions should be observed in using the Model 334.

(1) Unused outputs should be kept terminated. If this is not done, an unused channel may oscillate. The oscillation will be in the neighborhood of 300 - 500 MHz and will be invisible on most real-time oscilloscopes. A small amount of this signal will appear in adjacent channels, producing the effect of a slight smearing in the output of these channels. This effect would probably go unnoticed unless the outputs of the channels being used were observed on a sampling oscilloscope.

(2) Always check the final output of cascaded channels on a sampling oscilloscope. Coupling between channels should usually be done using cables of five feet or longer to prevent excessive ringing and possible oscillation.

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As indicated by the two foregoing comments, Model 334 stages are not unconditionally stable for all combinations of input and output load characteristics. In general, there will be certain cable lengths which, combined with particular termination characteristics, may cause the amplifier to oscillate. When this occurs, a change of either the nature of the termination or the length of the cable will solve the problem. The most offensive cable lengths are on the order of a few feet.

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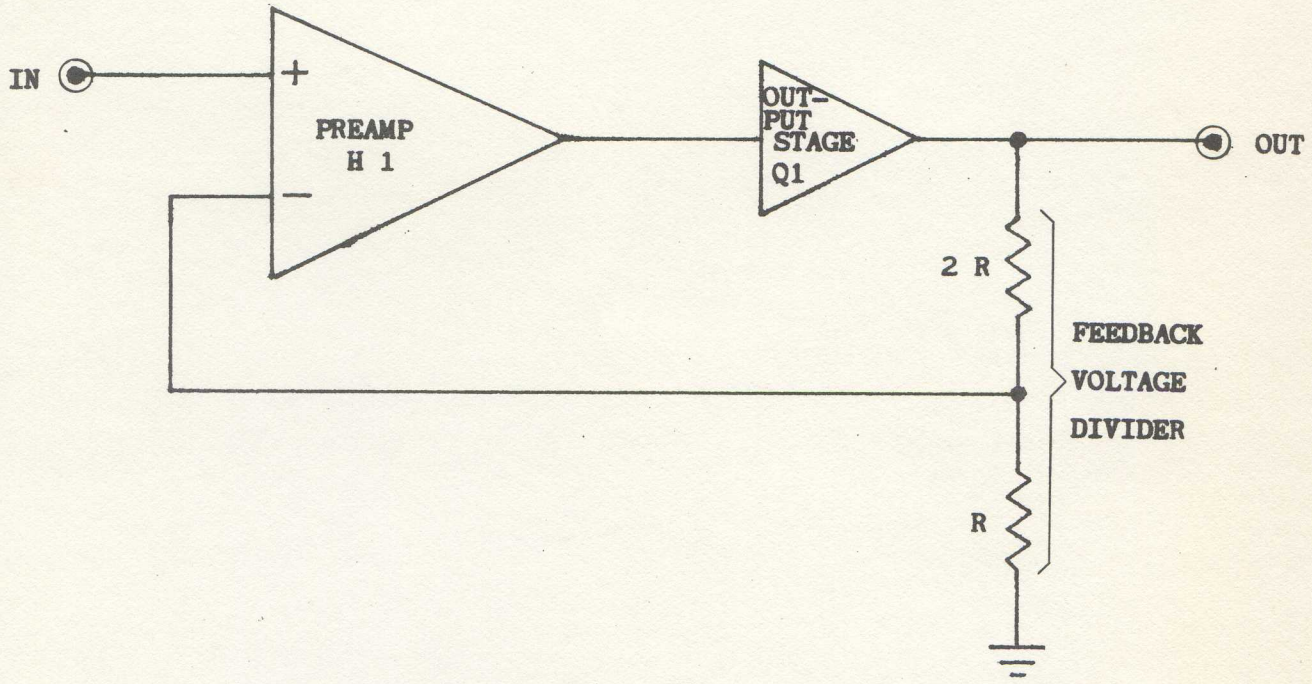

BLOCK DIAGRAM

MODEL 334

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CIRCUIT DESCRIPTION

As indicated by the block diagram, each Model 334 amplifier channel consists of two stages of amplification with overall voltage feedback. The input signal is presented to the non-inverting input of preamp H1. The output of the preamp drives emitter follower output stage Q1. The gain of the amplifier is set by the voltage division ratio of the feedback voltage divider.

The input impedance at the noninverting input of preamplifier H1 is approximately 10 Ω shunted by 3 pf. Terminating network R1, L1 provide an approximate 50 Ω input match to the incoming signal. Diodes D1 and D2 begin to conduct at ± 600 millivolts and provide a measure of protection against large transient inputs. The internal input protection of preamp H1 is ± 5 volts. Such voltage levels cannot appear at the preamp input unless the protective diodes have opened.

Output emitter follower Q1 is biased at 30 mA collector current by resistor R7. Output short circuit protection is provided by collector resistor R8 which limits the positive output current to a maximum of approximately 40 mA. Zener diode D4 provides dc level shifting from the emitter of Q1 which is at approximately 6 volts to the output which is at ground.

The feedback network consists of R5, R2, C1 and L2. Resistors R5 and R2 adjust the dc feedback ratio and establish the dc gain of the amplifier. C1 and L2 control the transient response of the amplifier. The overshoot of the amplifier in response to a fast step input (< 500 picosecond risetime) can be adjusted with C1. This adjustment is best made using a sampling oscilloscope having a risetime of 100 picoseconds or less.

The quiescent dc level of the output is set to zero using variable resistor R9, which adjusts the input offset of preamplifier H1. This setting is stable with time and temperature to within a few millivolts short term and a few tens of millivolts long term; however, the output dc level will be affected slightly by connection of a dc reverse terminated input system, e.g., a photomultiplier anode with a 50 Ω resistor to ground and no coupling capacitor. This occurs because the voltage developed by the small input current of the preamplifier stage is proportional to the net dc resistance in the preamplifier input circuit. Therefore, if the output dc level of the amplifier is critical in a particular application, it is well to make the adjustment with the same type of input system with which the amplifier is to be used. The magnitude of the effect involved here is on the order of 8 mV.

PARTS LIST

Resistors

Identification	Value	Manufacturer
R1	56 Ω, 1/4 W, 5%	Allen Bradley
R2	51 Ω, 1/4 W, 5%	Allen Bradley
R3	620 Ω, 1/4 W, 5%	Allen Bradley
R4	47 Ω, 1/4 W, 5%	Allen Bradley
R5	120 Ω, 1/4 W, 5%	Allen Bradley
R6	220 Ω, 1/4 W, 5%	Allen Bradley
R7	390 Ω, 1/2 W, 5%	Allen Bradley
R8	56 Ω, 1/4 W, 5%	Allen Bradley
R9	500 Ω pot	

Diodes

D1	1N914	TI
D2	1N914	TI
D3	1N706A	IR
D4	1N706A	IR

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Transistors

Q1	LRS Part No. 270 017 000

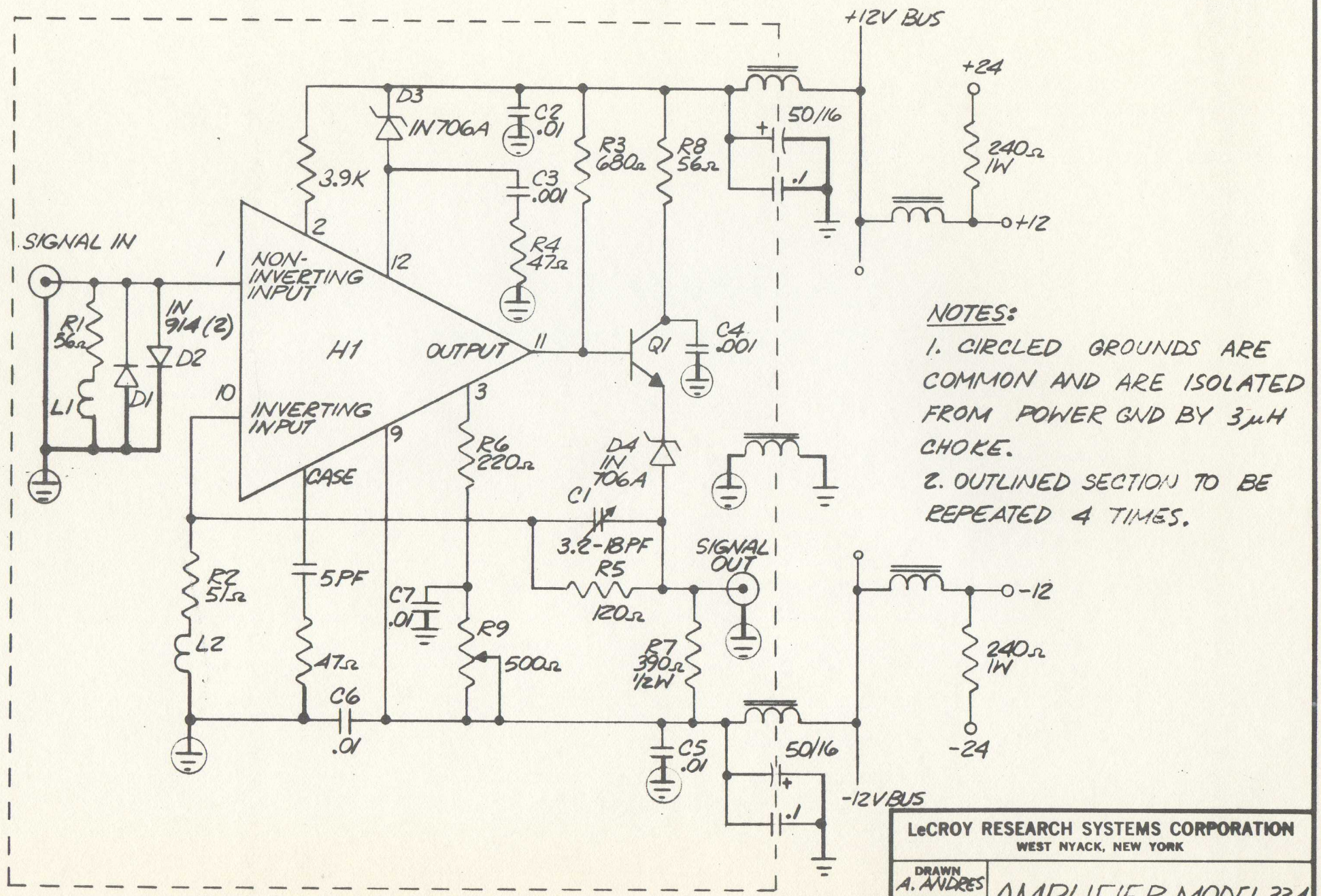
Integrated Circuits

H1	LRS Part No. 208 010 950

Capacitors	Value	Manufacturer
C1	3.2-18 pf trimmer	Centralab
C2	.01 Ceramic	
C3	.001Ceramic	
C4	.001Ceramic	
C5	.01 Ceramic	
C6	.01 Ceramic	
C7	.01 Ceramic	

Chokes

L1	Resistor lead
L2	Resistor lead



NOTES:

1. CIRCLED GROUNDS ARE COMMON AND ARE ISOLATED FROM POWER GND BY 3μH CHOKE.
2. OUTLINED SECTION TO BE REPEATED 4 TIMES.

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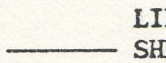
WEST NYACK, NEW YORK

DRAWN A. ANDRES	AMPLIFIER, MODEL 334 (1 SECTION OF FOUR)
CHECKED	
DATE 5-6-71	
DRAWING No. 334-S2	REV. 0

Technical Information

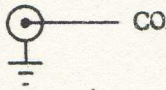
STANDARD DRAFTING SYMBOLS, ELECTRONIC

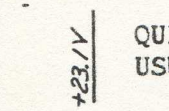

CONNECTION TO ANY GIVEN VOLTAGE.


LINE ENDING AT THE EDGE OF THE SHEET INDICATES CONTINUANCE ON ANOTHER SHEET.


MALE PIN OR CARD EDGE CONTACT.


FEMALE PIN, SOCKET OR CARD EDGE CONNECTOR.


COAXIAL CONNECTOR.



QUIESCENT VOLTAGE (EXAMPLE). USUALLY WRITTEN SIDEWAYS.


NO CONNECTION.

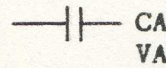

CONNECTION.

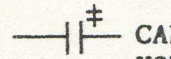

RESISTOR, $\frac{1}{4}$W, $\pm$5%, VALUE IN OHMS (UNLESS SPECIFIED OTHERWISE).


RESISTOR, $\frac{1}{4}$W, $\pm$1%, VALUE IN OHMS (UNLESS SPECIFIED OTHERWISE).


RESISTOR, VARIABLE, ANY TYPE.


RESISTOR, VARIABLE, ANY TYPE.


CAPACITOR, CERAMIC DISC, 1KV. VALUE IN MICROFARADS (UNLESS SPECIFIED OTHERWISE).


CAPACITOR, COMPOSITION AND VOLTAGE GIVEN. VALUES IN MICROFARADS (UNLESS SPECIFIED OTHERWISE).


CAPACITOR, POLARIZED, VALUES IN MICROFARADS/VOLTS (UNLESS SPECIFIED OTHERWISE).

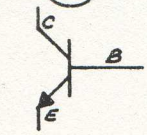

DIODE, 1N914 (UNLESS OTHERWISE INDICATED).


DIODE, ZENER, TYPE GIVEN.

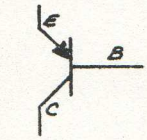

DIODE, TUNNEL, TYPE GIVEN.


DIODE, SNAP, TYPE GIVEN.


LIGHT EMITTING DIODE (LED).

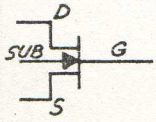


NPN TRANSISTOR, TYPE GIVEN

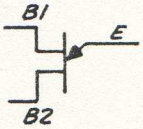


PNP TRANSISTOR, TYPE GIVEN

NOTE: SOME TRANSISTORS MAY BE COLOR CODED AS FOLLOWS
WHT - 2N4275
YEL - 2N3563
BLU - 2N3565
RED - 2N4258
TAN - SE 3005
GRN - 2N 4250



FIELD EFFECT TRANSISTOR, TYPE GIVEN



TRANSISTOR, UNIJUNCTION


AIR CHOKE ($1\frac{1}{2}$" WIRE).


FERRITE BEAD


FERRITE CORE CHOKE, 3 μH, UNLESS OTHERWISE INDICATED.


FERRITE CORE CHOKE, 40 μH, UNLESS OTHERWISE INDICATED.

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