

**NATIONAL RADIO ASTRONOMY OBSERVATORY
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**THE 40/50 CHANNEL
INTEGRATOR/MULTIPLEXER**

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1.1 Introduction

The need exists for a compact pulsar analog recording system. To meet this need the main processing unit herein referred to as the 40/50 channel integrator/multiplexer has just been completed. This new system was built employing knowledge gained from a breadboard system using the sync detector integrator system referred to in Mr. Kok Chen's Electronics Division Internal Report No. 79 and some other components constructed in the digital lab. The new system was constructed with greatly improved electronic design and packaging.

I wish to thank Mr. R. Weimer for many thoughtful suggestions concerning the circuits and also J. Turner for the construction.

This report will give a brief outline of a typical recording system arrangement followed by a complete description of the main processing and control unit, namely, the 40/50 channel integrator/multiplexer.

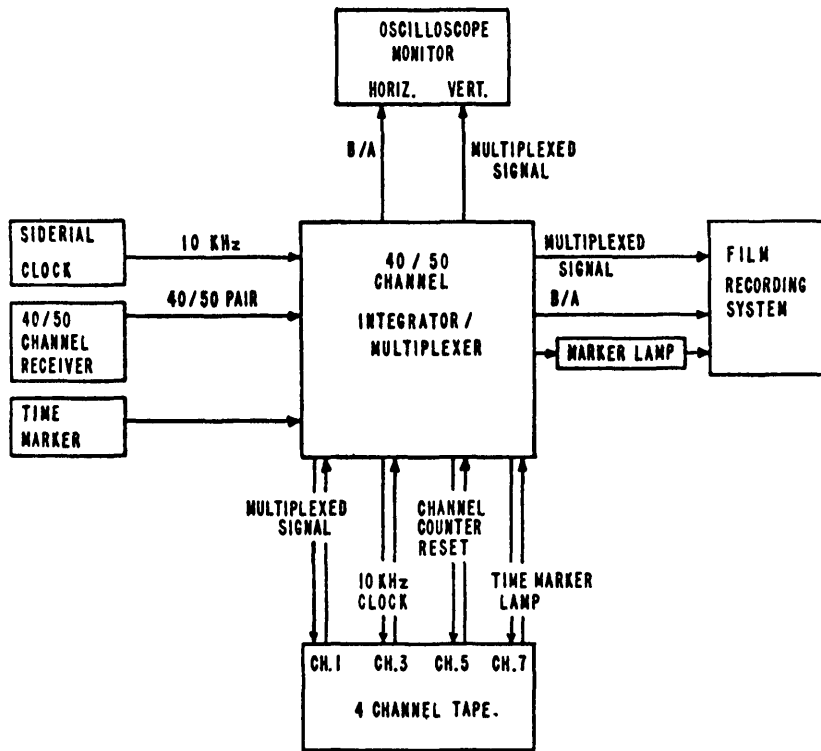
2.1 General

The recording system must be capable of

- (1) Accepting 40 or 50 channel receivers,
- (2) Inserting a time constant,
- (3) Amplifying the signal in each channel, and
- (4) Multiplexing the channels into a single output line to be read out serially to a visual display and recording medium.

The time constant in each channel serves as storage between samples and should be equal to the time required to sample all channels once. In the system described herein, the time required to sample all channels once is 5 milliseconds since the time spent on each of 50 channels is 100 microseconds.

A block diagram of an overall pulsar recording system is shown below.



BLOCK DIAGRAM OF RECORDING SYSTEM

FIG. I

3.1 General Description of 40/50 Channel Integrator/Multiplexer

The 40/50 channel integrator/multiplexer is the main processing and control unit for the pulsar recording system described in 2.1. It has the capability of accepting, via front panel selector switch, either 40 or 50 channel telescope front-end receivers and multiplexing the signals into a serial output line. By referring to Figures I and II, it can be seen that this multiplexed output signal goes to a film recording system and oscilloscope monitor. The horizontal sweep signal is derived from a binary-to-analog converter that operates from the channel counter in the logic control card. The clock for the counter is derived from the 10 kHz sidereal oscillator when this system is operated in record function and from the tape recorder in the play function.

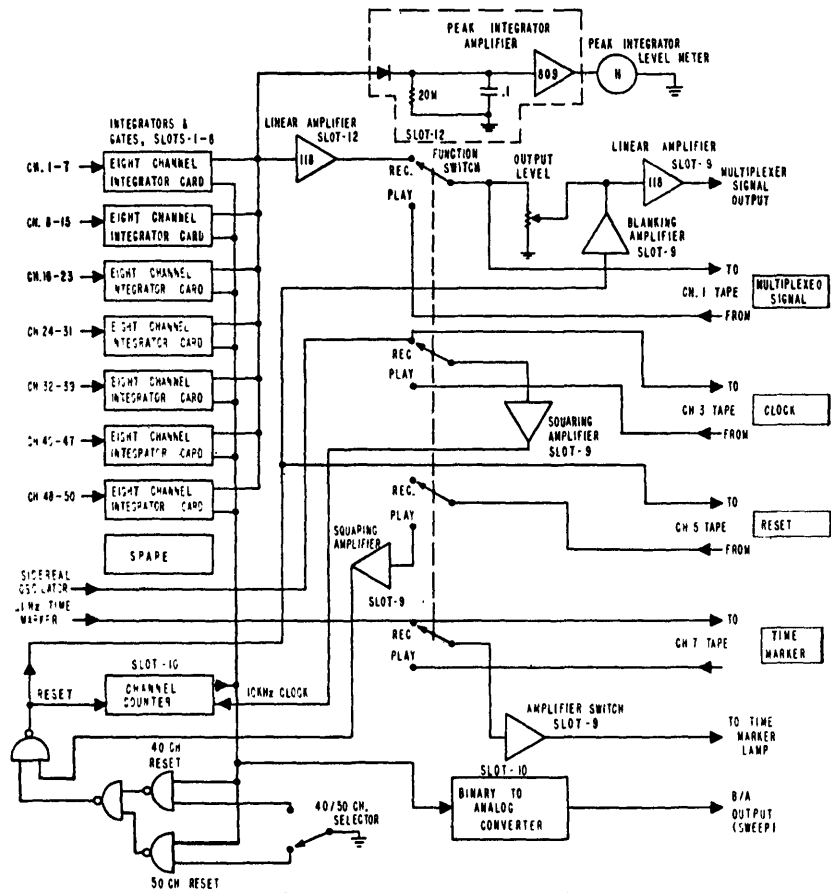
A block diagram of the 40/50 channel integrator/multiplexer is presented in Figure II. The circuit cards are arranged as follows:

- Eight channel integrator cards ... Slots 1-8
- Interface electronics card Slot 9
- Control logic card Slot 10
- Power supply and amplifier card .. Slot 12

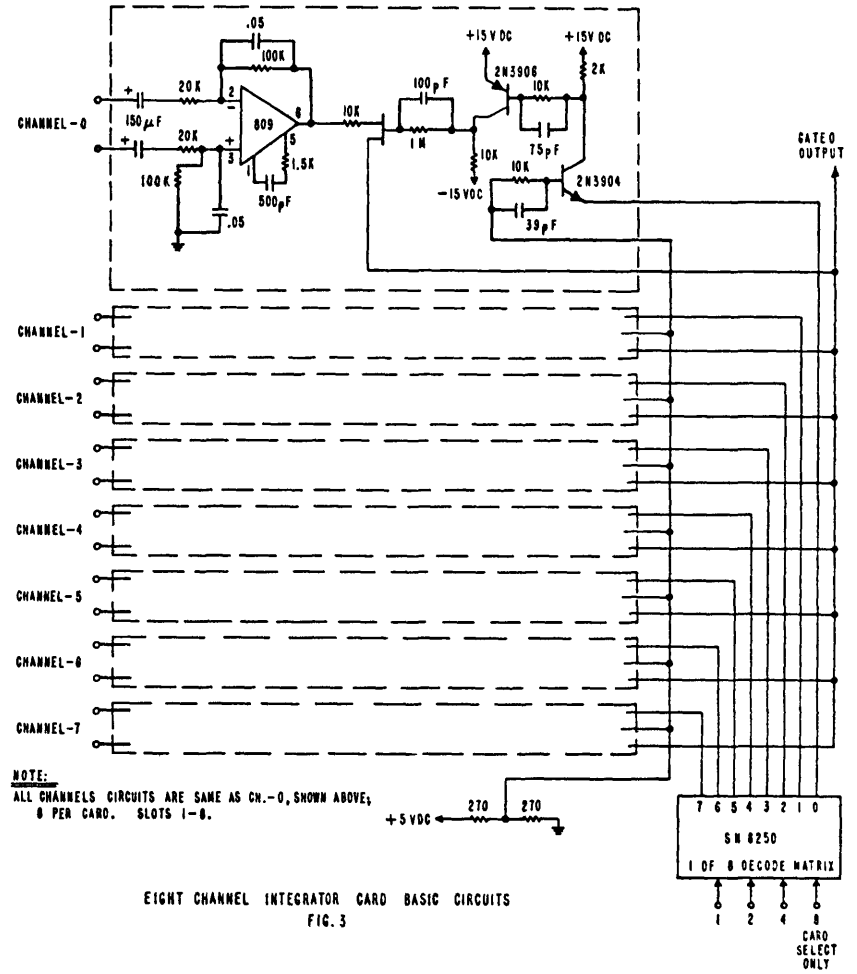
3.2 Eight Channel Integrator Card

There are 7 eight-channel integrator cards and one spare. These cards contain the time constants, analog gates, and channel decoders. The basic circuits are shown in Figure III. The integrator amplifiers have unbalanced line inputs that offer good common mode noise rejection characteristics. The input impedance is 20 K ohms.

Each card contains a decode matrix that accepts an octal input and decodes this to select a channel within the card. The channel is selected by closing the FET gate to that channel. A fourth input to the decode matrix designated as "8" acts as a card enable line such that the cards 1-7 are selected in succession similar to the channel within a card select.



BLOCK DIAGRAM OF 40/50 CHANNEL INTEGRATOR/MULTIPLEXER
FIG. 2



EIGHT CHANNEL INTEGRATOR CARD BASIC CIRCUITS
FIG. 3

3.3 Control Logic Card

The control logic is located on the circuit card in slot 10. (Refer to Figure IV.) This logic consists of a 6-bit binary counter that selects the channels sequentially, thus performing the multiplex operation. The counter is clocked from the 10 kHz sidereal oscillator at the telescope site. The oscillator output is also recorded on channel 3 of the analog tape recorder to provide the clock when the tape is replayed. The reset for the counter is provided by an "R-S" type flip-flop that is set by the last channel gate and reset by the next clock pulse. The binary channel counter reset pulse is also recorded on the tape recorder on channel 5 for use in synchronizing the multiplexer when the tape is replayed.

The last channel gate mentioned above is selected by the 40/50 channel selector switch. There are two last channel gates, one for 40-channel operation and one for 50-channel operation.

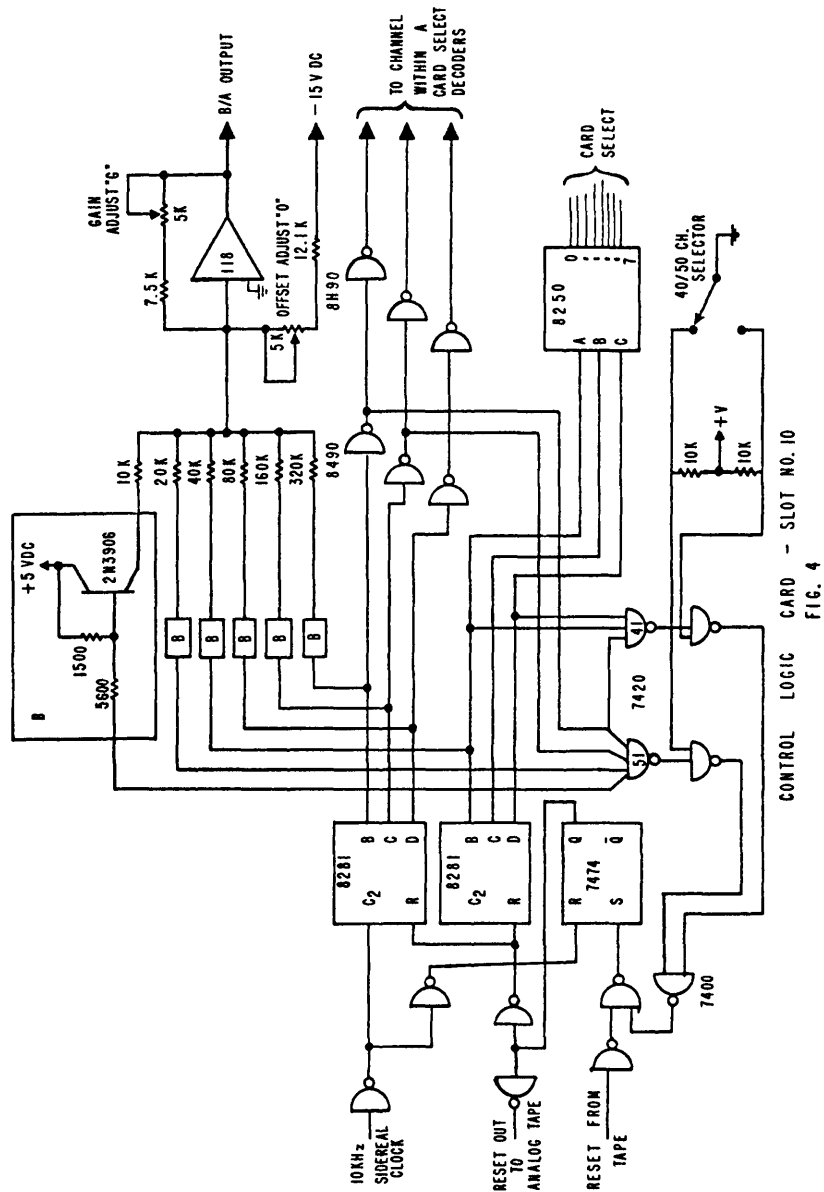
One other signal is developed on the control logic card, namely, the binary to analog converter herein designated as the B/A. The B/A derives inputs from the 6-bit channel counter and outputs a staircase signal used for sweeping the monitor scope and film recorder. The minimum load resistance to this B/A output is about 3,000 ohms.

3.4 Interface Electronics Card

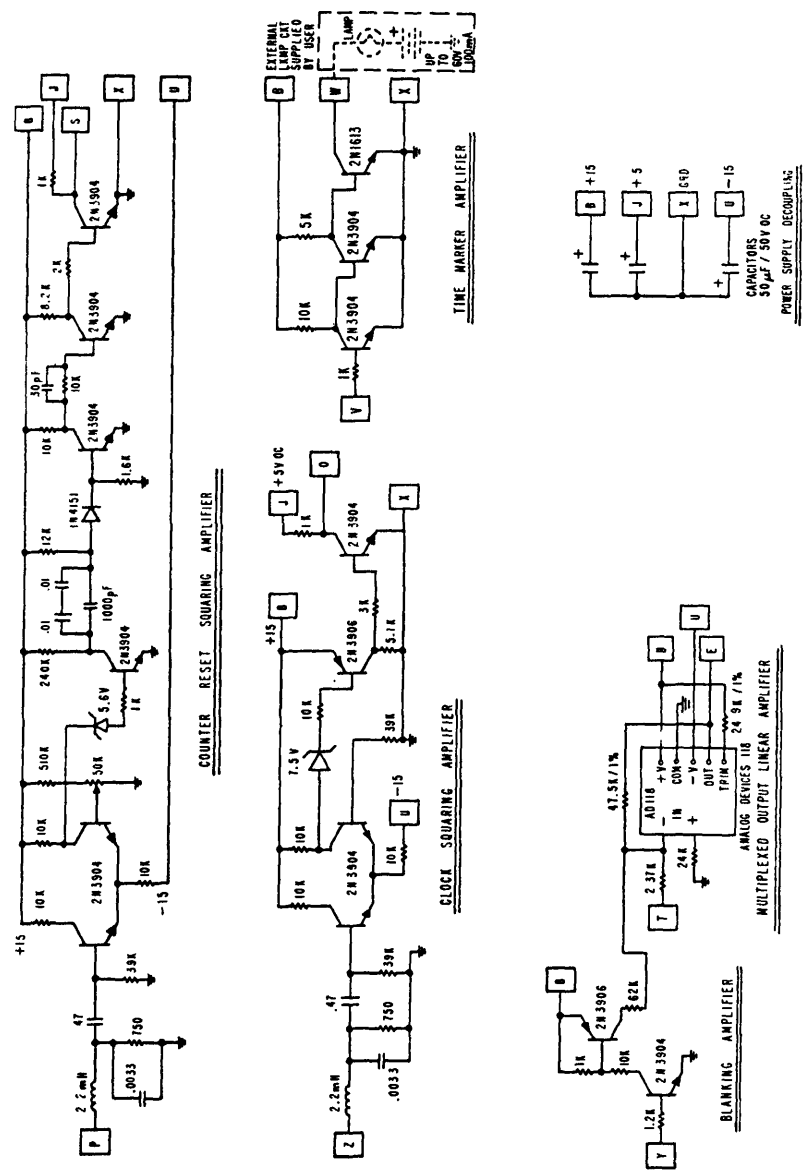
The interface card contains all electronics required to interface the 40/50 channel integrator/multiplexer with the analog magnetic tape recorder. The following circuits are contained within this card:

1. The clock squaring amplifier.
2. The counter reset squaring amplifier.
3. Multiplexed output linear amplifier.
4. The blanking amplifier.
5. The time marker amplifier.

Refer to Figures II and V for these circuits.



CONTROL LOGIC CARD - SLOT NO. 10
FIG. 4



INTERFACE CARD NO. 14
SLOT NO. 9
FIG. 5

3.5 Power Supply and Amplifier Card

This card contains the peak integrator level amplifier, intermediate gated output linear amplifier, and logic 5 volt power supply.

The peak integrator level amplifier is essentially a peak detector adjusted to operate accurately from an input pulse train with a 2 percent on-time duty cycle. The RC time constant is 2 seconds. The indicator shows the level of the highest modulated channel on a front panel meter. The maximum allowed level is 10 volts.

The intermediate gated output linear amplifier was incorporated into the new system to improve the negative slewing rate of the type 809 operational amplifiers used in the integrator cards. The intermediate amplifier offers a 10 K ohm input impedance to the 809, allowing better negative slew.

The 5 volt power supply is an Analog Devices type 903 rated at 1/2 amp.

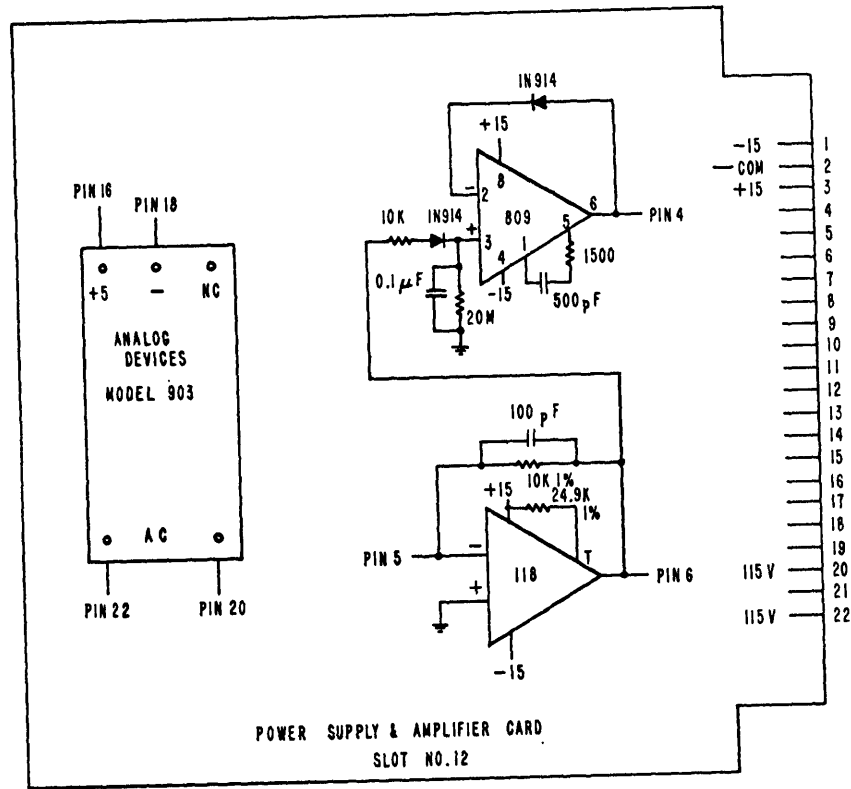
3.6 Power Supplies

Two power supplies are incorporated into the 40/50 channel integrator/multiplexer. The 5 volt power supply is described in section 3.5. The other power supply is a dual Acopian, rated at ±15 V DC at 1 amp, each side.

4.1 Operation

The front panel controls should be adjusted to the operator's needs. Turn power switch on. Select 40 or 50 channel operation, according to number of channels available from telescope standard receiver. The output level is adjusted such that the signal level output as shown on scope monitor does not exceed 10 volts. The play record function selector should be set to the desired function. If the signals originate from the telescope standard receiver, then the switch is set to record and, if desired, an analog tape can be made for reusable storage. If it is desired to recover data from the analog tape, then the function switch is set to play, thus disconnecting the system from telescope receivers.

The peak integrator level meter shows the modulation of the highest modulated integrator. The integrators saturate at 10 volts output. It is not possible to adjust this level externally. However, an indication of signal level is available for reassurance.



POWER SUPPLY & AMPLIFIER CARD
FIG. 6

All input/output connections to the unit are made through jack on back of the cabinet. J1 and J2 are inputs and J3 and J4 are outputs. J5 is the power connection and is 115 V AC, 60 cycles at 1 amp.

A table showing the jack connections follows. In the case of J1 and J2, the channel number and signal polarity referred to the output is shown. Normally, the + terminals are grounded and - terminals are signal for balanced connections. These inputs should be wired with twisted pair cables.

The time marker lamp output is a switch closure to ground. The user must supply a lamp and power supply for this circuit. The lamp and power supply form a series circuit between ground and the marker lamp connection on J3/J4. The power supply (-) terminal must be grounded. The circuit is rated 60 V DC at 100 mA maximum.

The 40/50 channel integrator/multiplexer is designed to interface with the Ampex model SP300 analog tape recorder which (1) is operable in both direct and FM modes, (2) has separate record and play electronics, (3) has 7 tracks divided such that 4 tracks are on one record-play head set and 3 tracks are on the other record-play head set. If another type of tape machine is used, then it must have (1) at least 4 tracks, (2) both direct and FM modes, (3) pulse skew of less than 10 microseconds from any channel to any other channel, (4) its record levels set using an oscilloscope to insure that no saturation occurs in any channel.

The controls of the analog tape machine are set according to the following table.

Channel*	Signal	Mode	Meter Indication
1	Multiplexed output	Direct	-6 dB using 3 volt calibrator
3	Clock	Direct	+2 dB in record function
5	Counter reset	Direct	Maximum
7	10 sec marker	FM	Deflect to solid black line

* Odd channels are used because all four are on the same head, thus improving pulse skew response.

TABLE

Terminals	Inputs		Outputs	Power Input
	J1	J2	J3 and J4	J5
A	--	28-	Multiplexed signal	
B	--	28+	B/A (sweep)	1 - 115 V AC
C	1-	29-	Multiplexed signal	2 - 115 V AC
D	1+	29+	B/A (sweep)	3 - Earth Ground
E	2-	30-	Common	
F	2+	30+		
H	3-	31-	Sidereal oscillator - 10 kHz	
K	4-	32-	0.1 Hz Time marker	
L	4+	32+	Marker lamp (closure to ground)	
M	5-	33-		
N	5+	33+	Common	
P	6-	34-	Multiplexed signal to tape	Ch. 1
R	6+	34+	Multiplexed signal from tape	
S	7-	35-	Clock signal to tape	Ch. 3
T	7+	35+	Clock signal from tape	
U	8-	36-	Reset signal to tape	Ch. 5
V	8+	36+	Reset signal from tape	
W	9-	37-	Marker signal to tape	Ch. 7
X	9+	37+	Marker signal from tape	
Y	10-	38-		
Z	10+	38+		
a	11-	39-		
b	11+	39+		
c	12-	40-		
d	12+	40+		
e	13-	41-		

Continued --

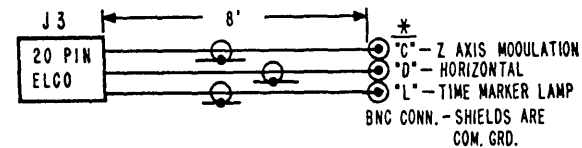
TABLE (CONTINUED):

Terminals	Inputs		Outputs	Power Input
	J1	J2	J3 and J4	J5
f	13+	41+		
h	14-	42-		
j	14+	42+		
k	15-	43-		
l	15+	43+		
m	16-	44-		
n	16+	44+		
p	17-	45-		
r	17+	45+		
s	18-	46-		
t	18+	46+		
u	19-	47-		
v	19+	47+		
w	20-	48-		
x	20+	48+		
y	21-	49-		
z	21+	49+		
AA	22-	50-		
BB	22+	50+		
CC	23-	51-		
DD	23+	51+		
EE	24-	52-		
FF	28+	52+		
HH	25-	53-		
JJ	25+	53+		
KK	26-	54-		
LL	26+	54+		
MM	27-	---		
NN	27+	---		

The table on page 11 gives a good approximation to the correct level settings, but for precise settings an oscilloscope should be connected to the recorder outputs so that with the equipment recording there should be no saturation.

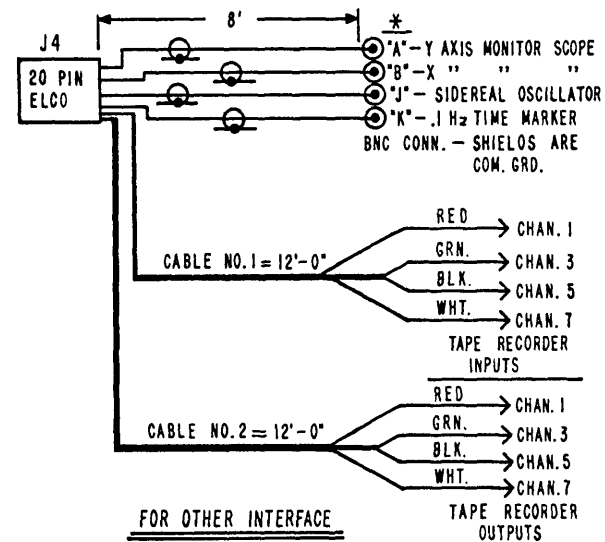
A picture of the front panel controls of the 40/50 channel integrator/multiplexer is presented on the back page.

There are 5 cables available to fit the 5 jacks on the back of the equipment. They consist of two 27-pair 20-foot cables with 56-pin Elco connectors on each end for J1 and J2, two cable fanouts from 20-pin Elco connectors for J3 and J4, and one Belden power cable for J5. The fanouts for J3 and J4 are shown in Figure VII.



FOR FILM RECORDING CAMERA

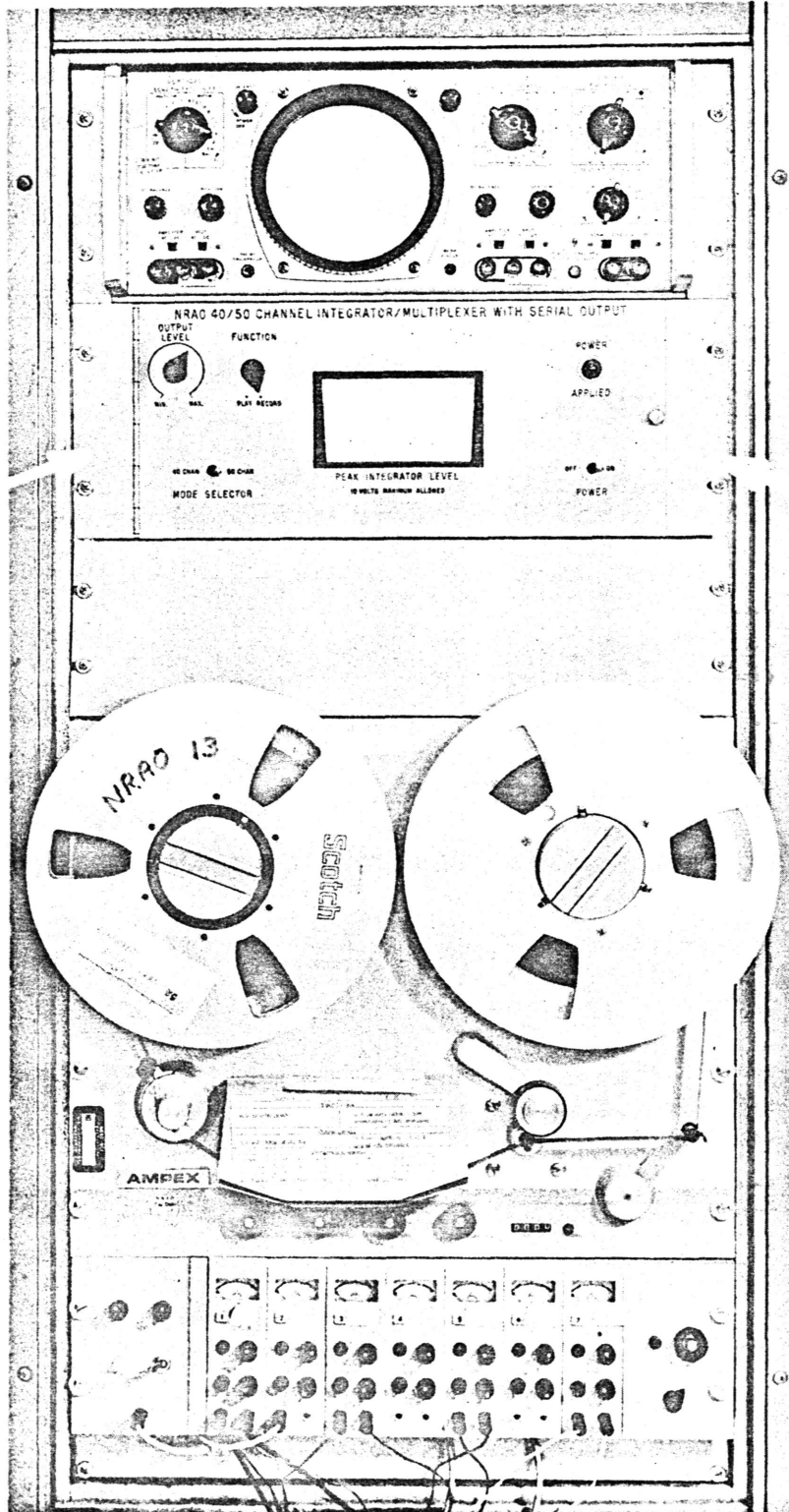
* NOTE:
LETTERS REFER TO TERMINALS
IN 20 PIN ELCO CONN., J3 OR J4.



FOR OTHER INTERFACE

CONN. ARE MIN. PHONE PLUG.
CHAN. -1 SHIELDS ARE COM.

OUTPUT CABLE FANOUTS
FIG. 7



40/50 CHANNEL ANALOG RECORDING SYSTEM INCLUDING FRONT PANEL CONTROLS OF THE 40/50 CHANNEL INTEGRATOR/MULTIPLEXER