

TAPE CONTROL UNIT
MODEL ND-305
OPERATING INSTRUCTIONS

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TAPE CONTROL UNIT

INTRODUCTION

The purpose of this unit is to permit the ND-302 Tally Tape Perforator and ND-303 Tally Tape Reader to be controlled by the Nuclear Data ND-120 or ND-130 analyzer.

The system is designed to handle paper tape using eight levels or less. In these instructions, "levels" refer to the eight rows of holes punched parallel to the axis of the tape, and "channels" refer to the memory channels of the analyzer.

By means of the ND-305 Control Unit and associated Punch and Reader, the following operations are possible.

1. Data stored in the analyzer memory may be punched out, at approximately 6 channels per second, in a format suitable for reading back into the analyzer. In this format, numerical data is presented in binary 1, 2, 4, 8 code, and a hole is punched in the eighth level for every data digit position. Thus these eighth level holes provide convenient beginning and end of word signals.

2. The above operation may be carried out at type speed, i.e. approximately one channel per second. At this speed it is possible to type and punch simultaneously.

3. Data punched on tape may be read back into the analyzer cleared memory, either at a rate of six channels per second or one channel per second. Data is read-in positively, i.e. data will be stored exactly as it is punched on the tape.

SETTING UP THE EQUIPMENT

The Model ND-305 Control Unit has four cables emanating from the rear deck of the unit. These should be connected as follows:

1. The cable marked PUNCH should be connected to the rear deck of the Punch by means of the 34-pin Winchester connector at the end of the cable.

2. The cable marked READER should be connected to the rear deck of the Reader by means of the 34-pin Winchester connector at the end of the cable.

3. The cable marked ANALYZER should be connected to the 24-pin Amphenol connector marked "Typewriter or Tape Control" on the analyzer rear deck.

4. The fourth cable is the a.c. line cord, and this should not be connected until the following setting-up operations have been completed.

Connect the 10-pin Amphenol connector on the end of the analyzer d.c. power cable into the 10-pin Amphenol socket on the rear deck of the control unit.

If a typewriter is being used, connect it into the 24-pin Amphenol socket on the rear deck of the control unit.

Then, having first made sure that the a.c. power toggle switches marked "Analyzer", "Punch", and "Reader" are all OFF, connect the a.c. line cord to a 115 volt 60 cycle a.c. supply.

The switching sequences for various operations are given below.

A. To Punch a Tape Leader (i.e. a series of sprocket holes alone).

Put the analyzer mode switch at STOP "1", and the "form of readout" switches at PUNCH, and DIGITAL. On the control unit front panel, switch on the ANALYZER and PUNCH toggle switches. Press the BUZZ pushbutton, and a leader will be punched as long as the button is depressed.

B. To Punch Out Data Stored in the Analyzer Memory (At 6 channels per second.)

Having accumulated the required data in any selected channel group, buzz out a few inches of tape leader. Then, after releasing the BUZZ button, turn the analyzer mode switch to READOUT. Data stored in the memory will now be punched out. Readout will stop automatically when the whole channel group has been read out. To make a tail leader at the end of the readout, just press the BUZZ button after readout has stopped.

C. To Punch and Type Simultaneously (At 1 channel per second.)

All operations are as explained in sections A and B above, with the exception that the TYPE-PUNCH-DUMP switch on the analyzer front panel should be set at TYPE, the READER toggle on the control unit front panel must be ON, as well as the PUNCH toggle, and the 34-pin WINCHESTER connector must be disconnected from the READER. The READER toggle switch controls certain d.c. logic signals as well as controlling a.c. power to the reader, and for this reason the toggle must be ON, but the READER must be disconnected. This is necessary only when it is desired to type and punch simultaneously. For punching alone at 6 channels per second, the READER switch need not be on, nor need the READER be disconnected.

D. To Read Back into the Analyzer.

Insert tape into the READER as explained in the TALLY TAPE READER MANUAL, and switch on the READER toggle on the control unit front panel. Clear the analyzer memory for the particular channel group into which it is required to read-in the data. Then turn the analyzer mode switch to STOP "1", the DIGITAL-ANALOG switch to DIGITAL, and the TYPE-PUNCH-DUMP switch to PUNCH. Then press the BUZZ button and keep it pressed until the tape stops automatically. It is now in the correct position for starting read-in, and the buzz button may now be released. Then turn the analyzer mode switch to READOUT. Data will now be read into the analyzer memory, and the operation will stop automatically at the end of readout. At the end of readout, the mode switch should be turned to STOP "1", and the READER toggle should be switched OFF in order to make the analyzer independent of the READER.

THEORY OF OPERATION

INTRODUCTION. (Refer to Tape Control Schematics, page D100 of ND 120 and ND 130 Instruction Book.)

The mechanical operation of the punch is described in detail in the Tally Tape Perforator Manual. The solenoids that actuate the punches, tape feed capstan, and reader advance mechanism each require a pulse of 48 volts amplitude and 4.5 milliseconds width. These pulses are provided by a series of amplifiers, one of which is shown in the diagram as 'Tape Control Standard Amplifier'.

The amplifier input pulses are obtained from a series of logical gates. The input signals to the gates for the various levels, punch sprocket, and reader and punch tape feed solenoids, are shown in the table adjacent to the amplifier diagram.

In addition to the logical signals at each gate, a timing pulse, 4.5 milliseconds wide, is required for correct punch operation. These timing pulses are provided by two trigger pairs, shown in the diagram above the heading of 'Tape Control Pulser'. The first trigger pair provides pulses for the Punch tape feed capstan solenoid and the Reader tape feed capstan solenoid. The second trigger pair provides pulses for all punch solenoids, including the punch sprocket solenoid.

The first trigger pair is triggered from two sources. During "buzz" operation, i.e. punching a tape leader, consisting of a length of tape with sprocket holes only, or advancing a punched tape into the reader, triggering pulses are provided by an oscillator mounted on the tape control board. The frequency of this oscillator is approximately 60 cps, and it is shown in the diagram above the heading of "Tape Control Oscillator". During buzz operations, the analyzer is in the STOP position, and so the only pulses reaching the first trigger pair come from the tape control oscillator.

When punching out information stored in the analyzer memory, or reading in from the tape into the analyzer memory, the analyzer mode switch is in the READOUT position, and triggering pulses are provided by the analyzer. The actual triggering pulse is a signal called TWS. This signal is the output of an AND gate whose inputs are PHI and TWS. PHI is one of the outputs of the phase flip-flop; TWS is the signal that triggers the SO20 trigger pair in the analyzer that provides the input pulses to the typewriter solenoid drive amplifiers. Except for small details, the logic used in punch operation is identical to that used for typewriter operation. When the "Form of Readout" switch is in the punch

position, the frequency of TWS is approximately 60 cps. When the switch is in the TYPE position, the frequency of TWS is approximately 10 cps. At this frequency of 10 cps it is possible to punch and type simultaneously.

In the analyzer, the pulse that initiates TWS also initiates a memory cycle. The number read out of the memory into the M register then determines the level in which holes will be punched. Since the memory cycle time is very short compared with the time required for a punch cycle, there is plenty of time to read data out of the memory into the M register before the punch actually starts moving.

SPROCKET PUNCH AND TAPE FEED.

As explained in the Tally Tape Perforator Manual, in order to punch a sprocket hole and advance the tape, the sprocket punch solenoid requires a pulse of 48 volts amplitude and 4.5 milliseconds width, to be followed, after a delay of 16% milliseconds, by a similar pulse applied to the tape feed solenoid. The 16% millisecond delay gives time for the punch to operate and then be fully retracted before the paper is moved. These pulses are shown in Figure 7(A) on page 14 of the Tally Tape Perforator Manual. In the standard Tally punch, as manufactured by the Tally Register Corporation, this delay is obtained by electro-mechanical means through the use of a leaf type switch and a mechanical delay in the switch clutch control sleeve. In order to reduce the number of mechanical parts, and thus increase dependability, this electro-mechanical delay is not used in the punches controlled by the ND305 Tape Control Unit.

MODIFICATION TO TALLY TAPE PERFORATOR UNIT.

Two modifications are made by Nuclear Data Inc. to the standard Tally Tape Perforator. One is the replacement of the electro-mechanical delay described above by a completely electronic delay, and the other is the substitution of a buzz switch on the front panel of the ND-305 Tape Control Unit for the buzz switch on the front panel of the Tally Tape Perforator. The switch has not been removed from the perforator panel, but the wiring arrangement in the cable between the punch and the ND-305 is such that the switch no longer has any effect on punch operation.

BUZZ OPERATION FOR PUNCH AND READER

The method used to obtain correct punch and tape feed operation with the modified perforator is described below.

As explained in the introduction, the pulses for punch and tape feed operation are provided by two separate trigger pairs. The first trigger pair, (transistors 5 and 6) whose output from emitter follower

(transistor 7) is P^1 , provides the 4.5 millisecond pulse for the tape feed solenoid amplifier for the punch and also for the reader. The end of this pulse triggers the second trigger pair (transistors 8 and 9) whose output from emitter follower (transistor 10) is P, provides the pulse for all punch solenoid amplifiers, including the sprocket punch.

Referring to the diagram above the title "Tape Control Pulser", it will be seen that gate S is an OR gate, providing a positive output signal when either TWS is positive, or when gate N is positive. As explained previously, TWS signals are provided by the analyzer in the READOUT mode. When the analyzer mode switch is in the STOP position (which is the position it should always be in for buzzing) TWS is negative, and the output of gate N provides triggering pulses for buzz operation. It will be seen that N is an AND gate, whose inputs are M and the output of OR gate H. As the diagram shows, the buzz button applies the output of the tape control oscillator to point M, while the output of gate H depends on the signals PAC or \bar{r}^8 . PA is a d.c. signal derived from the punch power switch. When the punch switch is ON, the signal PAC is positive 4 volts. When the punch switch is OFF, the signal PAC is negative 4 volts. Thus for buzzing a tape leader, the punch power switch must be ON, and the buzz button pressed before oscillator pulses can trigger the P^1 and P trigger pairs. For reader operation, the signal \bar{r}^8 must be positive before a tape can be buzzed into the reader, and the derivation of this signal will be explained in the section on reader operation.

In order to provide beginning and end of word signals on punched tape, the tape control logic is arranged so that a hole is punched in the eighth level for each data digit. The first of these eighth level holes also plays an important part in synchronizing the start of read-in as is explained in the following section.

READER OPERATION

The mechanical operation of the reader is described in detail in the Tally Tape Reader Manual. The ND-305 Tape Control Unit permits only forward operation of the reader tape feed capstan. The solenoid controlling the escapement actuator for forward rotation of the tape feed capstan requires a pulse of 48 volts amplitude and 4.5 milliseconds width. This pulse is provided by the output of the Reader Tape Feed amplifier, whose input pulse is the output of the first trigger pair P^1 .

In the following description, the combination of star wheels, sensing arms, and movable and fixed contacts described on page 5 of the Tally manual are referred to as the reader toggles.

For use with the ND-305 Control Unit, only the first four and the eighth toggles are used. The first

four toggles are used to control the analyzer M register by means of the signals R^0, R^1, R^2, R^3 , shown in the diagram above the heading "Tape Control Reader Outputs". Referring to this diagram, the method of operation is as follows. If, for example, the first tape level has a punched hole, but the remaining three levels do not, then the first level star wheel will drop into the hole, thus closing switch ab, while the remaining switches ac, ad and ae will remain open. If the reader power switch is ON, signal RAC is 4 volts positive (when the reader power switch is OFF, RAC is 4 volts negative). Thus every TWS pulse from the analyzer will cause R^0 to go positive, thus setting the M^0 stage of the M register to the "1" state. The remaining three stages will be unaffected, since R^1, R^2 , and R^3 will remain negative.

BUZZING A TAPE INTO THE READER

Since data is read from the tape into the analyzer a digit at a time, it is important that at the beginning of read-in, the starting address on the tape corresponds to the starting address of the analyzer.

This coincidence of analyzer address and tape address is obtained by using the first eighth level hole as a synchronizing hole in the following manner. Referring back to gate H in the Tape Control Pulser diagram, it will be seen that if the punch power switch is OFF, the signal \bar{r}^8 must be positive before the output of gate H, and therefore of gate N, can be positive. Now the eighth level reader toggle is connected in such a manner that when tape is in the reader and there is no hole in the eighth level, the signal \bar{r}^8 is positive, but when there is a hole in the eighth level, \bar{r}^8 is negative. Thus when a tape leader is placed in the reader, the tape will be buzzed in until the first eighth level hole reaches the reader head. When it does, \bar{r}^8 goes negative, thus holding the output of gates H and N negative, in spite of the buzz button being pressed, and so the tape remains in the correct starting position until the analyzer mode switch is turned to the READ-OUT position. Once read-in starts, TWS provides the triggering pulses and since point M is now permanently negative, the output of gate N remains negative regardless of the polarity of \bar{r}^8 .

CABLE HARNESS TABULATIONS

FOR

ND-305 TAPE CONTROL UNIT

Note: On the Tape Control board, connector titles (TAB, TRB, etc.) are shown on the copper side of the board. For each connector, pin #1 is the pin closest to the connector title.

CONNECTOR PSB ON POWER SUPPLY HEAT SINK

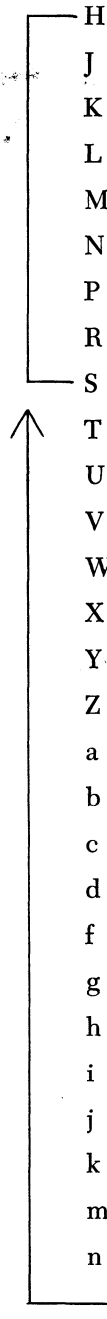
PIN #	WIRE COLOR	WIRE DESTINATION	DESIGNATION
1	Brown/Yellow	FUSE (end)	115V, Hot, Fused, Switched
2			
3	Grey/Yellow	FUSE (end)	115V, Cold, Fused, Switched
4			
5	Black	PSC 1	+50
6			
7	Brown	TPSB 2	-50
	Brown	PSC 2	-50
8			
9	Blue	TPSB 7	-4
	Blue	PSC 7	-4
10	White	TPSB 8	G
	White	PSC 8	G
11	Green	TPSB 6	+4
	Green	PSC 6	+4
12	Red	TPSB 4	+8
	Red	PSC 4	+8
13			
14	Orange	TPSB 5	-8
	Orange	PSC 5	-8
15			

Connector PSC ON REAR DECK, TAPE CONTROL CABINET

PIN #	WIRE COLOR	WIRE DESTINATION	DESIGNATION
1	Black	PSB 5	+50
2	Brown	PSB 7	-50
3			
4	Red	PSB 12	+8
5	Orange	PSB 14	-8
6	Green	PSB 11	+4
7	Blue	PSB 9	-4
8	White	PSB 10	G
9	Violet/White	TAB 4	PHI
10			
11			
12			
13			
14			

PUNCH (WINCHESTER 34 PIN CONNECTOR)

PIN #	WIRE COLOR	WIRE DESTINATION	DESIGNATION
A			
B	Yellow/Grey	TPB 5	8L
C			
D			
E	Yellow	TPB 14	SKT
F	Yellow/Violet	TPB 11	7L
H	Brown	TPB 15	-50
J			
K			
L	Yellow/Blue	TPB 6	6L
M			
N			
P			
R	Yellow/Green	TPB 7	5L
S			
T			
U			
V	Yellow/Orange	TPB 4	4L
W			
X			
Y	Yellow/White	TPB 8	PTF <i>paper tape feed</i>
Z	Yellow/Red	TPB 3	3L
a			
b			
c			
d	Yellow/Brown	TPB 2	2L
f			
g			
h			
i	Yellow/Black	TPB 1	1L
j	White	CHASSIS	GND
k			
m	Grey/Green	FUSE (end)	115V, Cold, Fused, Switched
n	Brown/Green	FUSE (end)	115V, Hot, Fused, Switched



Tie together at Socket

T.9

*TPB 10
TPB 12
TPB 13*

READER (WINCHESTER 34 PIN CONNECTOR)

PIN #	WIRE COLOR	WIRE DESTINATION	DESIGNATION
A	Blue	TRB 14	-4
B	Orange/Grey	TRB 3	\bar{r}^8
C			
D	Green	TRB 13	+4
E			
F			
H	Brown	TRB 15	-50
J			
K			
L			
M	Orange/Violet	TRB 4	RTF
N			
P			
R			
S			
T			
U	Orange/Green	TRB 8	e
V			
W			
X			
Y	Orange/Yellow	TRB 9	d
Z			
a			
b			
c	Orange/Red	TRB 10	c
d	Orange/Black	TRB 12	a
f			
g			
h	Orange/Brown	TRB 11	b
i			
j	White	CHASSIS	GND
k			
m	Grey/Orange	FUSE (end)	115V, Cold, Switched, Fused
n	Brown/Orange	FUSE (end)	115V, Hot, Switched, Fused

↑
Tie together at Socket

CONNECTOR TAB—ON TAPE CONTROL BOARD

PIN #	WIRE COLOR	WIRE DESTINATION	DESIGNATION
1	Green/Black	TTC 4	-48V
2			
3	Orange/Red	TSP 24	TWS
4	Violet/White	PSC 9	PHI
5	Green/Brown	TSP 19	M ⁰
6	Yellow/Brown	TSP 20	M ¹
7	Orange/Brown	TSP 22	M ²
8	Red/Blue	TSP 23	M ³
9	Red/Orange	TSP 7	$\overline{D5}$
10			
11			TWS/
12	Violet/Red	TSP 12	R ³
13	Grey/Red	TSP 11	R ²
14	White/Red	TSP 10	R ¹
15	Black/Orange	TSP 9	R ⁰

CONNECTOR TACB—ON TAPE CONTROL BOARD

PIN #	WIRE COLOR	WIRE DESTINATION	DESIGNATION
1	Grey/Yellow	Analyzer Fuse (end)	115V, Cold, Switched, Fused
2	Brown/Yellow	Analyzer Fuse (end)	115V, Hot, Switched, Fused
3	White	Terminal Strip	115V, Cold, Raw
4	Black	Terminal Strip	115V, Hot, Raw
5	White/Orange	Reader Fuse (side)	115V, Cold, Switched
6	Black/Orange	Reader Fuse (side)	115V, Hot, Switched
7	White/Yellow	Analyzer Fuse (side)	115V, Cold, Switched
8	Black/Yellow	Analyzer Fuse (side)	115V, Hot, Switched
9	Black/Green	Punch Fuse (side)	115V, Hot, Switched
10	White/Green	Punch Fuse (side)	115V, Cold, Switched

CONNECTOR TPB—ON TAPE CONTROL BOARD

PIN #	WIRE COLOR	WIRE DESTINATION	DESIGNATION
1	Yellow/Black	Punch i	1L
2	Yellow/Brown	Punch d	2L
3	Yellow/Red	Punch Z	3L
4	Yellow/Orange	Punch V	4L
5	Yellow/Grey	Punch B	8L
6	Yellow/Blue	Punch L	6L
7	Yellow/Green	Punch R	5L
8	Yellow/White	Punch Y	PTF
9			
10			
11	Yellow/Violet	Punch F	7L
12			
13			
14	Yellow	Punch E	SKT
15	Brown	Punch H	-50

CONNECTOR TPSB—ON TAPE CONTROL BOARD

PIN #	WIRE COLOR	WIRE DESTINATION	DESIGNATION
1			
2	Brown	PSB 7	-50
3			
4	Red	PSB 12	+8
5	Orange	PSB 14	-8
6	Green	PSB 11	+4
7	Blue	PSB 9	-4
8	White	PSB 10	G
9			
10			

CONNECTOR TRB—ON TAPE CONTROL BOARD

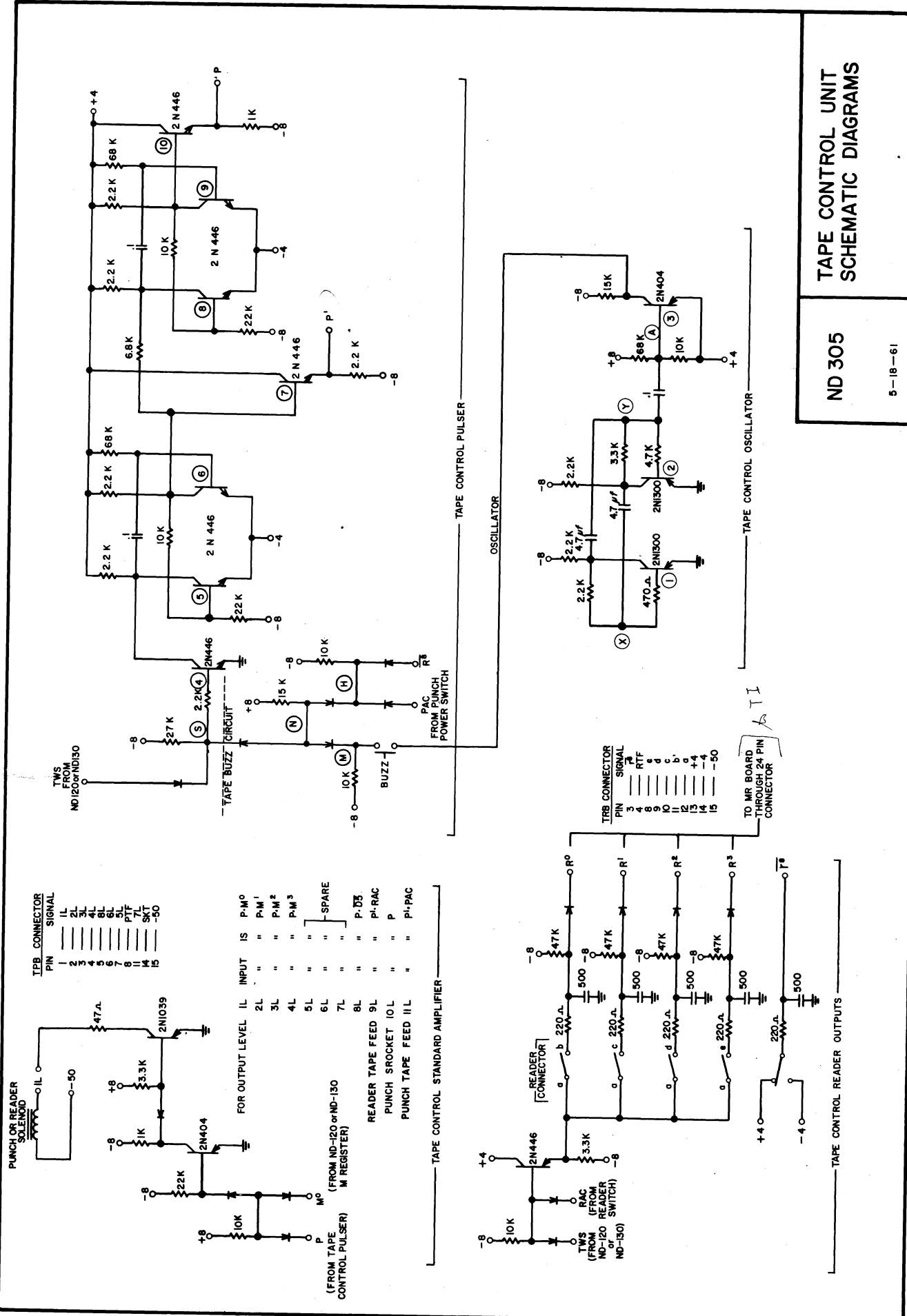
PIN #	WIRE COLOR	WIRE DESTINATION	DESIGNATION
1			
2			
3	Orange/Grey	Reader B	\bar{r}^8
4	Orange/Violet	Reader M	RTF
5			
6			
7			
8	Orange/Green	Reader U	e
9	Orange/Yellow	Reader Y	d
10	Orange/Red	Reader c	c
11	Orange/Brown	Reader h	b
12	Orange/Black	Reader, d,i,Z,V	a
13	Green	Reader D	+4
14	Blue	Reader A	-4
15	Brown	Reader H	-50

**CONNECTOR TSP (24-PIN AMPHENOL BLUE RIBBON CONNECTOR MATING WITH
SOCKET ON ANALYZER REAR DECK)**

PIN #	WIRE COLOR	WIRE DESTINATION	DESIGNATION
1	Black/White	TTC 1	"0"
2	Violet	TTC 2	"2"
3	Green	TTC 3	"4"
4			
5	Brown	TTC 5	"8"
6	Brown/White	TTC 6	SPACE
7	Red/Orange	TAB 9	$\overline{D5}$
8	Orange	TTC 8	"6"
9	Black/Orange	TAB 15	R ⁰
10	White/Red	TAB 14	R ¹
11	Grey/Red	TAB 13	R ²
12	Violet/Red	TAB 12	R ³
13	Grey	TTC 13	"1"
14	Blue	TTC 14	"3"
15	Yellow	TTC 15	"5"
16	Red	TTC 16	"7"
17	Black	TTC 17	"9"
18	Red/White	TTC 18	CR
19	Green/Brown	TAB 5	M ⁰
20	Yellow/Brown	TAB 6	M ¹
21	White	TTC 21	G
22	Orange/Brown	TAB 7	M ²
23	Red/Blue	TAB 8	M ³
24	Orange/Red	TAB 3	TWS

CONNECTOR TTC (REAR DECK, TAPE CONTROL CABINET)

PIN #	WIRE COLOR	WIRE DESTINATION	DESIGNATION
1	Black/White	TSP 1	"0"
2	Violet	TSP 2	"2"
3	Green	TSP 3	"4"
4	Green/Black	TAB 1	-48V
5	Brown	TSP 5	"8"
6	Brown/White	TSP 6	SPACE
7			
8	Orange	TSP 8	"6"
9			
10			
11			
12			
13	Grey	TSP 13	"1"
14	Blue	TSP 14	"3"
15	Yellow	TSP 15	"5"
16	Red	TSP 16	"7"
17	Black	TSP 17	"9"
18	Red/White	TSP 18	CR
19			
20			
21	White	TSP 21	G
22			
23			
24			



**TAPE CONTROL UNIT
SCHEMATIC DIAGRAMS**

ND 305

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