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NRAO MECHANICAL SCANNER COUPLER FOR SERIAL TAPE

By James Oliver and Fred Crews

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DESCRIPTION

NRAO has built a Data Converter for Serial Tape to be adaptable to our needs for a moderate speed scanner. These scanners are designed to work with the Beckman/Berkeley solid state counters and to be used in parallel with the Beckman Digital Printer or to be used alone.

Punch-out time is not adjustable and is basically 14 characters per second. The scanner is stepper switch operated and is interlocked to the tape punch with which it is used.

The logic used with this scanner is binary "1" = 0 to plus 20 volts and binary "0" = minus 12 to minus 20 volts.

SPECIFICATIONS

Power Requirement: 117 VAC 60 cycles, 25 watts idling, 50 watts punching

Input Connector: Cannon DPX40-33P

	8	4	2	1	
Pin	25	26	27	28	Most significant digit.
	1	2	3	4	2nd most significant digit.
	5	6	7	8	3rd most significant digit.
	9	10	11	12	4th most significant digit.
	13	14	15	16	5th most significant digit.
	17	18	19	20	6th most significant digit.
	21	22	23	24	7th most significant digit.
	29	30	31	32	Least significant digit.

Pin	38	Ground
	35	Ground
	39	Readout Control (DC voltage change from 0 to minus 15 volts to start the scanning sequence - initiated by the attached counter.)
	40	Inhibit Reset Control during count (normally grounded -- lifted from ground to permit reset).

Input Digits	8		In cases where fewer than 8 digits are needed, it is possible to pre-wire a skip code into the input cable. (This means that all scanners are interchangeable. It is not recommended that changes be made inside the scanner for specific applications.)
Output Connector			Cannon RNK-27-31SL
	Pin	1 thru 8	Code channel outputs c nnect to tape channel magnets inside tape punch.
		9	Clutch Drive
		23	B plus from punch.
		16	B plus return to punch.
		24	B minus from punch.
		12	B minus return to punch.
		22	Cam controlled B minus from punch. (Contacts closed from approximately 345 degrees to 75 degrees of punch shaft rotation.)
Format			The standard format of the scanner is 8 digits plus an end of line character.

CONTROLS

Power	OFF ON	AC power
Control	OFF ON	Enables the scanner to perform all its functions except commanding the tape punch. The Start Scan Control section, pulsing relays, stepper switch and binary readers all operate. Normal operation is ON.
Punch	OFF ON	Enables both scanner and punch to perform. Normal operation is ON.

INSTALLATION AND OPERATION

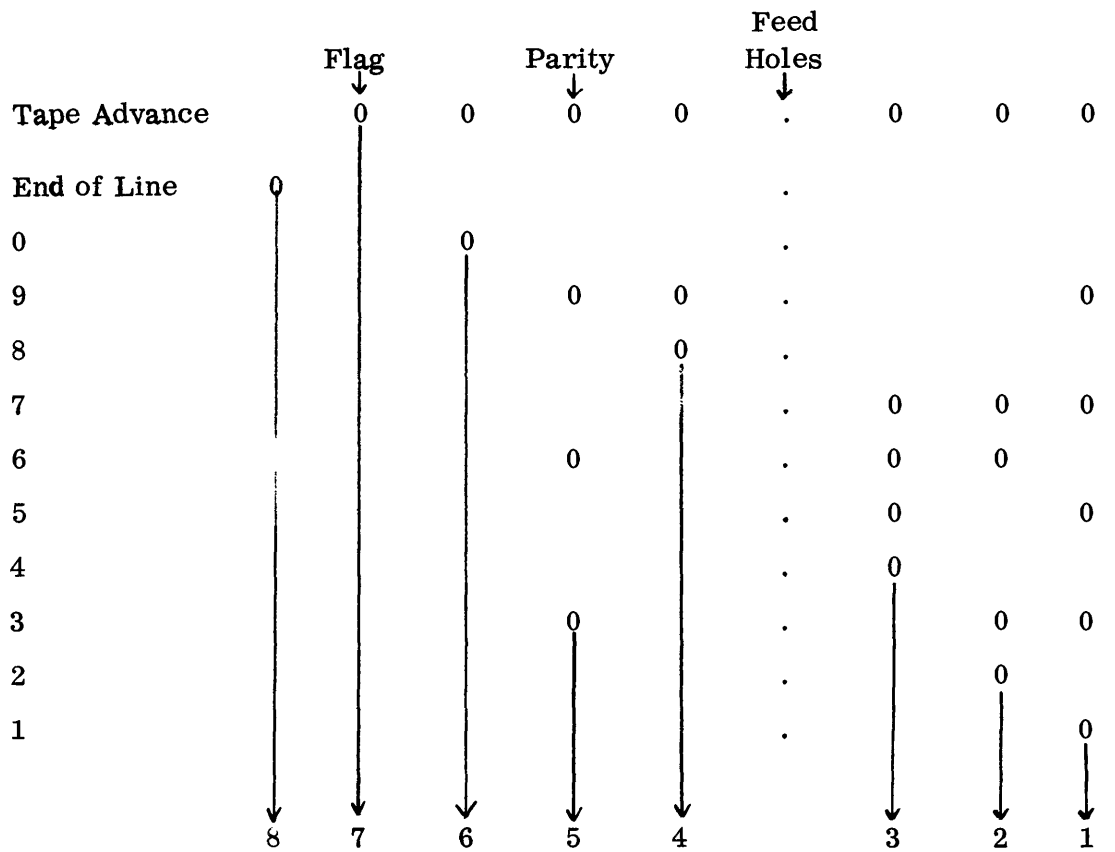
1. Place all front panel controls to off.
2. Connect punch to output and Beckman counter to input.
   a. Present to the input a skip code if punching less than 8 digits. This should be done by pre-wiring the input cable, setting up the skip code using the plus 20 and minus 20 volt jacks on the back of the scanner.
   b. If it is desirable to punch leading or trailing zeroes, do so by pre-wiring as in 2a above.
3. Turn on power to scanner and punch.
4. Allow counter to count several times.
5. Switch scanner control switch to "OPERATE". The scanner should scan one time and stop. Allow counter and scanner to count and scan several times by gating counter.
6. Advance tape on tape punch.
7. Put scanner punch switch to "ON". The counter should now control both scanning and punching.

CIRCUIT THEORY

The scanner coupler in essence takes up to 8 digits of 8-4-2-1 BCD paralled input data and converts the information to a suitable serial form to operate a Friden Model 2 Tape Punch. Input coding logic requires binary "0" to equal minus 12 to minus 20 volts, and binary "1" equals 0 to plus 20 volts.

Output coding may be changed to a number of codes by simply replacing the plug-in diode matrix board, since the input data at this point is ten line decimal. The matrix board (as built) converts 10 line decimal to the IBM 1620 Code.

A sample of tape channels for the IBM 620 code is shown below. Parity must be odd and the flag channel when used is always used with a digit, and not alone. Adding the flag will require the addition, or the deletion, of the parity channel.



Binary coded decimal 8-4-2-1 and the logic used in the scanner is shown below for those not familar with it.

Digit	8	4	2	1 (Bits)	8	4	2	1 (Volts)
0	0	0	0	0	-12	-12	-12	-12
1	0	0	0	1	-12	-12	-12	0
2	0	0	1	0	-12	-12	0	-12
3	0	0	1	1	-12	-12	0	0
4	0	1	0	0	-12	0	-12	-12
5	0	1	0	1	-12	0	-12	0
6	0	1	1	0	-12	0	0	-12
7	0	1	1	1	-12	0	0	0
8	1	0	0	0	0	-12	-12	-12
9	1	0	0	1	0	-12	-12	0

There are 16 possible ways to arrange 1's and 0's with four bits, all of which are not used. However, two additional codes are used, one of which is the end of line code which has been assigned the code 1110 starting with the 8 bit. A skip code of 1010 has also been assigned resulting in a contact configuration of the coding relays which does not go into the diode matrix board immediately. However, a flagged zero relay has been placed in the scanner so that with an external 48 volts applied to its coil the skip code serves to indicate ends of blocks of data by putting in a series of flagged zeroes.

In addition to converting the BCD parallel information into BCD serial information, the scanner must send pulses to the punch of a certain duration, and the scanner must accept and interlock timing pulses from the punch.

A block diagram of the scanner is attached,with a brief description.

The start scan control section senses that the counter associated with the scanner input is counting and anticipates the end of the counting period. At the same time the Counter Inhibit prevents the counter from resetting until the recording of the data is entirely finished.

The stepper switch accepts the 32 input lines from the counter (8 digits) on its contacts. As the wiper arms of the stepper switch move, they pick up these contacts, 4 bits or one digit at a time in order of significance. This wiper information is connected to the grids of tubes (BINARY READERS), whose plate circuits contain a relay tree to convert BCD to 10 line decimal.

Ten line decimal next goes to the MATRIX BOARD which gives a conventional translation from decimal to BCD plus parity. The MATRIX BOARD also provides a pulse to energize the punch clutch.

The PULSING AND INTERLOCKING CIRCUITRY section of the diagram is controlled by START SCAN CONTROL to initiate the start of a recording cycle, cam contacts on the punch signal readiness to receive the next digit, and the PULSING AND INTERLOCKING CIRCUITRY commands the stepper switch and the coding relays in the proper time relationship.

EXTERNAL SYSTEM CONTROL WHILE RECORDING and EXTERNAL SYSTEM CONTROL AFTER RECORDING are two blocks whose purpose is to control external

circuitry with the scanner. These two circuits consist of tubes whose plate circuits contain relays with their contacts brought to the rear of the chassis of 8 pin octal chassis connectors. The tubes are normally biased to cut off and one level of the stepper switch is used to feed a voltage to their grids which will cause them to conduct.

ANALYSIS OF SCAN SEQUENCE

In the interest of trouble shooting, the following detailed analysis of a scan of 8 digits plus an end of line code follows.

Assume that the scanner and associated equipment have been set-up as described under INSTALLATION AND OPERATION. All equipment has been turned on and operation is normal.

The counter, having been reset, feeds over line 39 of the DPX connector, a voltage near zero volts. This, through the action of V101 causes K101 to energize, and be latched through its latch contacts and the latch contacts of K102. The energized step off relay contacts of K101 energize K102 and it gets latched by its own latching contacts. The reset inhibit contacts of K101 serve to inhibit the counter from resetting by controlling line 40. The step off control contacts of K101 have no function as yet.

Energization of K102 again inhibits reset, removes the latch on K101, putting it back under the control of the counter. The step off contacts of K102 are closed, but have no effect on the circuit until the conclusion of counter gate time.

Before any more action takes place, one should look at the diagram and find that through the normally closed off normal contacts (home control) of the stepper switch, B plus is applied to the latch contacts of K102. Circuit tracing will show that neither K103, K104, K105, or the stepper switch SS101 is energized.

At the end of the counter gate time, line 39 switches from K101 to drop out. The step off control contacts of K101 now feed B plus to the closed step off control contacts of K102, which puts B plus through the stepper switch power sequence latch contacts of K104. Through the stepper switch power contacts of K103, the coil of SS101 receives B plus and its armature pulls in, but it does not move since it is a move on release of armature type of stepper switch.

The stepper switch interrupt contacts close, putting B plus to K103, energizing it and it latches through its own latch contacts. Since power is now removed from the stepper switch, it releases, moving to the first position off home. Its off-normal reset inhibit now takes over counter inhibit for the duration of the scanning and punching cycle. K102 is unlatched by the stepper switch home control contacts and drops out. K102 is unlatched by the stepper switch home control contacts and drops out. K102 no longer has control of the operation.

The normally open side of off-normal contacts (home control) are now closed and remain so for the duration of the scanning-punching cycle. These contacts put B plus on the line feeding K103 latch (holding it latched) through K104 stepper switch power contacts and the line feeding K105 sequence interlock contacts, which feeds energize sequence contacts of K103 (energizing K104) and the unlatch sequence contacts of K105. The unlatch sequence contacts of K105 feed B plus to the latch contacts of K104 and the latch is complete. K103 is unlatched by virtue of the stepper switch power contacts on K104 now being open.

When K103 drops out, its matrix gate contacts put the cam-controlled minus side of the 90 volt supply from the punch through the matrix gate contacts of K104 through CR101 to energize K105 and onto the input to the BCD reader relay contacts.

Let us now see what the stepper switch and binary readers are doing. The stepper so far has moved from home to the first position. On level A is found the "1" bit of the most significant digit to be punched, the "2" bit on B, the "4" bit on C, and the "8" bit on D. The voltages on these contacts are fed to the grid of the binary readers V301 and V302. Suppose the most significant digit is a 2. V301A would not conduct, V301B would conduct, V302A and V302B would not conduct. K401 is not energized, K402 is, K403 and K404 are not. It can be seen that the cam-controlled minus side of the punch 90 volt supply arrives at 2 on the input to the matrix board. Following line 2 through the translating diodes of the matrix board puts voltage on channel two of the tape punch and also a voltage if fed through a diode to punch line 9 to release the punch clutch.

Briefly in the punch, channel two solenoid is energized, its punch pin is unlatched if the shaft of the punch starts to turn. The channel two punch pin and feed hole punch pin go through the paper and back again.

At about 75 degrees mechanical rotation of the punch shaft, the cam-controlled contacts open which ultimately through the scanner allows the punch channel two pin to be relatched.

Now before we open the cam-controlled line, let's return to the scanner and K105. K105 has latched its own latch contacts and the unlatch escape contacts of K104. The matrix gate contacts of K105 parallel those of K104 insuring voltage to the BCD coding relays after K104 has been released. The K105 unlatch sequence contacts drop out K104 and stepper switch power contacts apply stepper switch power to K103 stepper switch power contacts, energizing the stepper switch armature again.

By now the punch cam-controlled voltage has been opened and K105 is unlatched by K104.

K103, K104, and K105 are now de-energized and the stepper armature is pulling in resulting in closing interrupt contacts, the cam-controlled voltage appears again at about 345 degrees and the entire cycle starts over. The sequence repeats until the stepper switch reaches its home position at which time the off-normal contacts normally open are again opened and the source of B plus to relays K103, K104 and the stepping switch is removed.

All unused points on the stepper switch are wired to the skip code.

One level of the stepper switch is used to control external circuitry by the action of K301 and K302 whose circuit operation should be obvious.

The flagged zero transfer relay may be energized at any time and sets up the skip code to punch a series of flagged zeroes.

TROUBLESHOOTING

Since these scanners have now been in operation for over a year, a good bit is known about what troubles are apt to crop up.

One source of trouble is the matrix board socket, which has not held up too well. These sockets have been shimmed, but the shims may eventually work loose.

The off-normal contacts take a rather severe beating and need rather frequent cleaning or replacement.

K101, 102, 103, 104, 105, 301, 302, 401, 402, 403, and 404 are plug in relays. K103, 104, 105, 401, 402, 403, 404 have given some trouble by the fact that their operate-release time changes, resulting in either improper timing or complete failure of the system.

The 6DJ8 tubes were chosen for their frame grid construction and sharp cut off characteristics. There have been several failures of these tubes -- a surprising number of grid to cathode shorts and low emission.

Other problems have been stepper switches, which have had to be completely replaced to clear the trouble.

The best way to troubleshoot the scanner is to set it up in a system and check the tapes, replacing plug in parts until satisfactory operation is attained. In rare cases will one have to make a systematic measurement of voltages.

If the counter is replaced with a BCD switch arrangement wherein the levels of binary one and binary zero are adjustable, one can perform a marginal operation test.

A scanner in good condition will start to malfunction when binary one is greater than minus one volt and binary zero is less than minus eleven volts.

PARTS LIST

Resistors

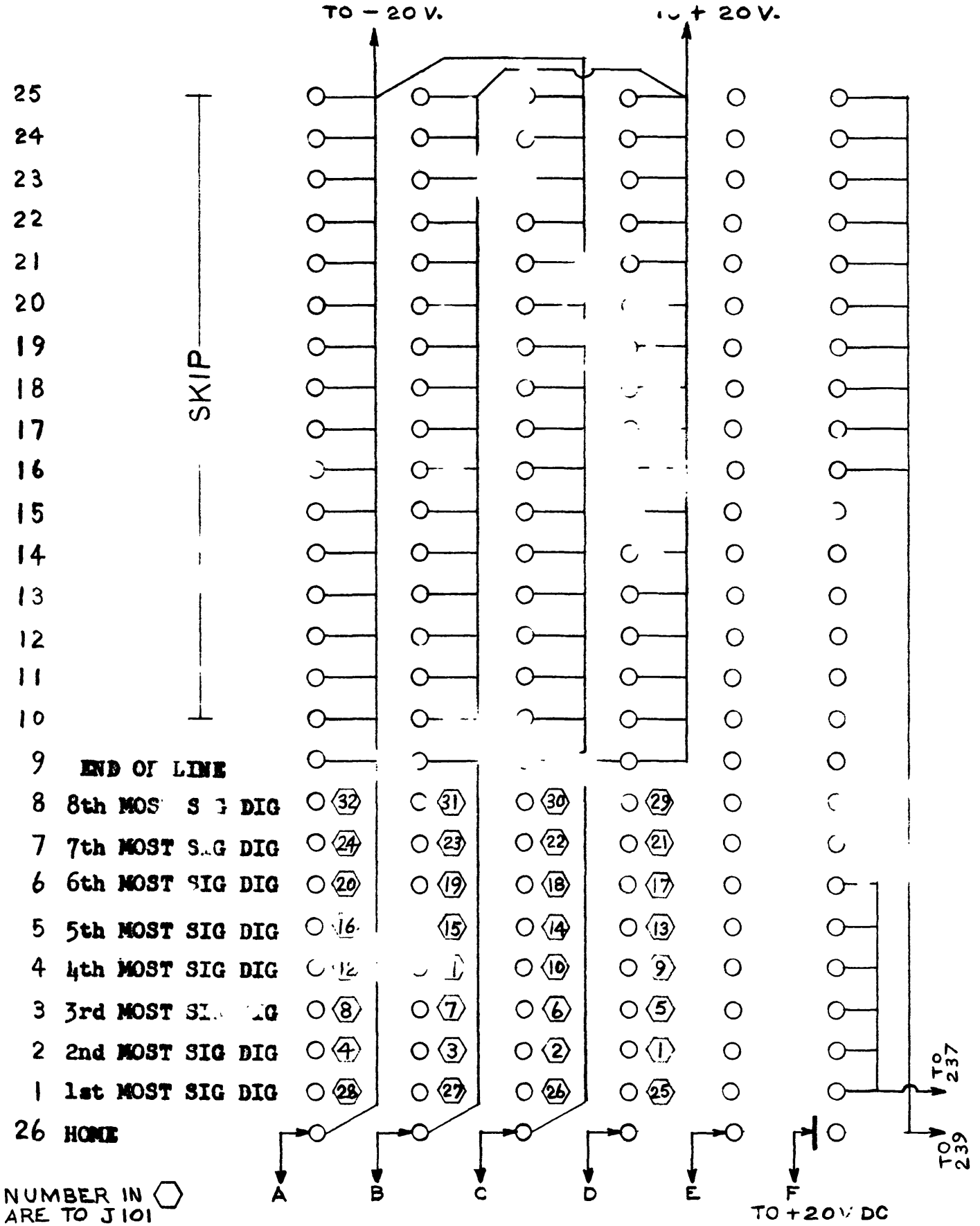
Symbol	Values		
R-201, 202	10 Ω	10%	1 w.
R-203, 204	100 K	10%	1/2 w.
R-205	10 K	10%	1/2 w.
R-206	47 K	10%	1/2 w.
R-207	2.2 K	10%	1/2 w.
R-208	120 K	10%	1/2 w.
R-209	10 Ω	10%	1/2 w.
R-210, 211, 212	150 Ω	5%	1/2 w.
R-213	6.8 K	5%	2 w.
R-214	5.6 K	5%	1 w.
R-215	200 Ω	5%	10 w.
R-216	180 Ω	5%	1/2 w.
R-217	1.2 K	5%	1/2 w.
R-218, 219	6.8 K	5%	1 w.
R-220, 222	1.2 K	5%	1/2 w.
R-221	6.8 K	5%	1 w.
R-223 through 231	100 Ω	5%	1/2 w.
R-232	10 Ω	5%	1/2 w.
R-233, 234, 235, 236, 237, 239	1 meg.	5%	1/2 w.
R-238, 240	22K	5%	1/2 w.
R-241	470 Ω	5%	2 w.

Capacitors

Symbols	Values		
C-101	200 mf	10%	350 v.
C-102	150 mf	10%	250 v.
C-103	12 mf	10%	250 v.
C-104	.25 μf	10%	600 v.
C-105	.01 μf	10%	600 v.
C-106	250 μμf	10%	500 v.
C-107, 108	.1 μf	10%	600 v.
C-109, 110	1 μf	10%	600 v.
C-111, 112	.1 μf	10%	600 v.
C-113	8 μf	10%	250 v.
C-114 through 122	.1 μf	10%	600 v.
C-123 through 126	.075 μf	10%	600 v.
C-127, 129	250 μμf	10%	500 v.
C-128, 130	.075 μf	10%	600 v.

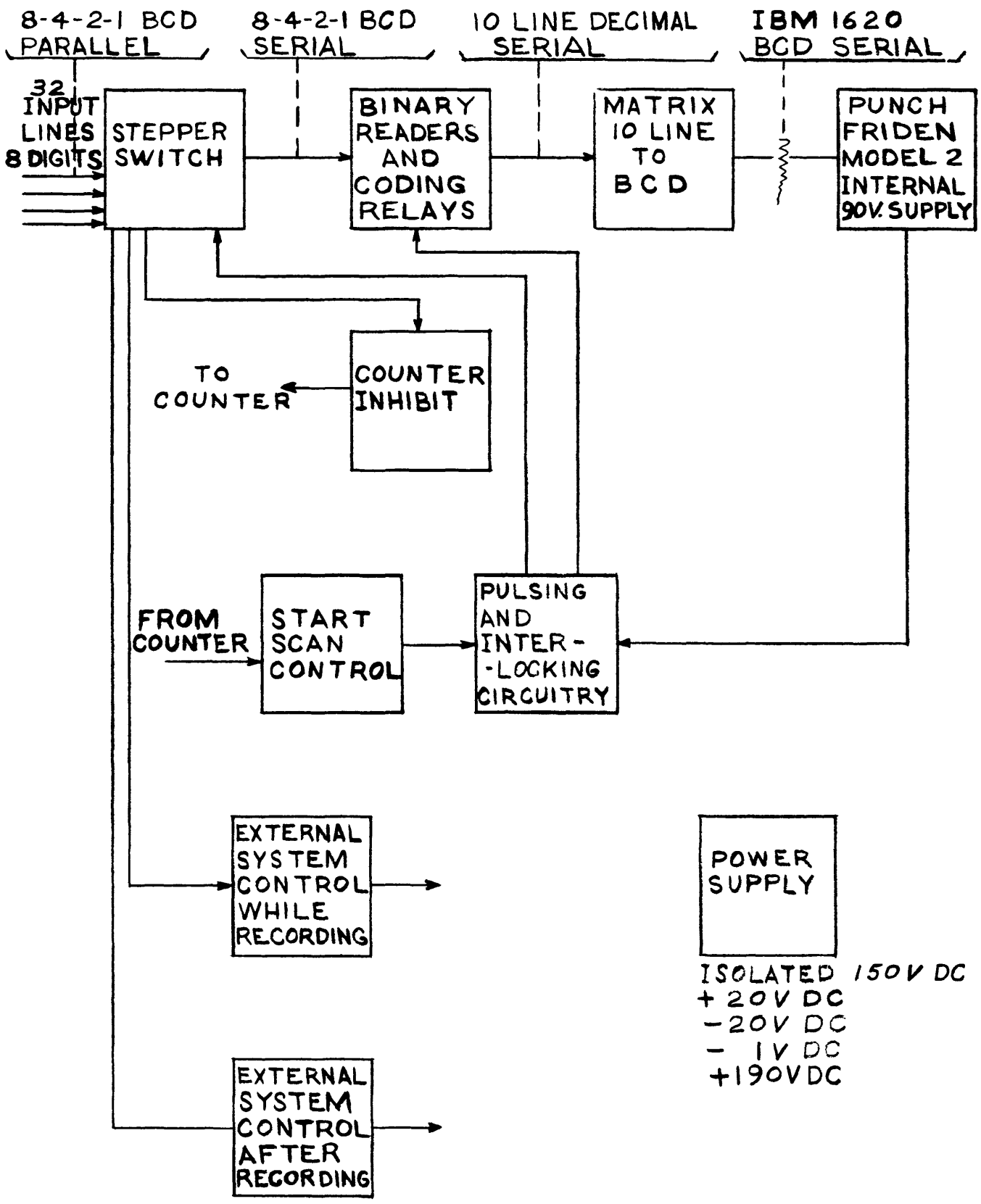
Miscellaneous

Symbol	Description	Part No.	Manufacturer
D1-D6	Rect. M-500		
F-201, 202	1 1/2 A SLOBLO		
SW 101, 103	SPST		
SW 102	DPDT		
T-301	Power transformer	T201-ON-DW-G21029B2	Ridgeway Assoc.
V-101, 301, 302			
V-301	6DJ8		
K-101,102, 103	Relays		
K, 104, 105	Relays		
K-401, 402, 403	Relays		
K-404, 310, 302	Relays	MH 6061	Potter, Brumfield
K-1	Relays	PE-101-B13	Automatic Electric
SS 302	Type 45 stepping switch	PW106-105-GFAB	Automatic Electric
D7-D8	1N67A		
All other diodes	1N540		
RY-57	Varistor		Automatic Electric
P-1	NE51 Pilot		
J-101	DPX-40-33P - input		Cannon
J-102	RNK-27-31SL - output		Cannon



FUNCTION STEPPER WIRING

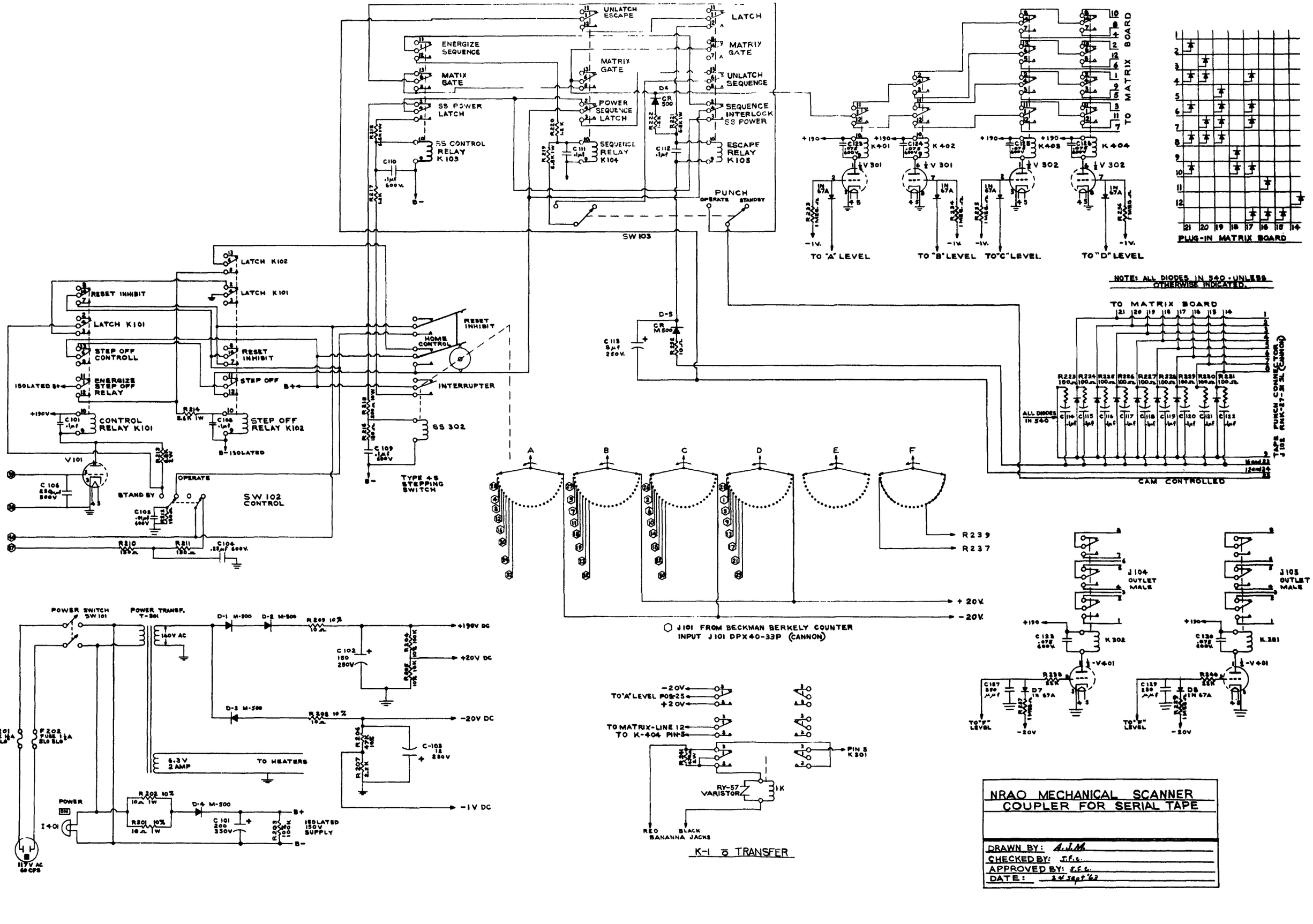
NO SCALE 6-18-63 T.M.



BLOCK DIAGRAM

NRAO SCANNER COUPLER

NO SCALE 6-17-63 - T.M.



NRAO MECHANICAL SCANNER COUPLER FOR SERIAL TAPE

DRAWN BY: A.J.M.
CHECKED BY: T.F.C.
APPROVED BY: T.F.C.
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