UNCLASSIFIED

TECHNICAL MANUAL

for

ELECTRONIC PROGRAMMER

MODEL RTPH - 1

WORLD WIDE SUPPLIERS OF ELECTRONIC COMMUNICATIONS EQUIPMENT

THE TECHNICAL MATERIEL CORPORATION

MAMARONECK, N.Y. OTTAWA, ONTARIO

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NOTICE

THE TECHNICAL MATERIEL CORPORATION
COMMUNICATIONS ENGINEERS
700 FENIMORE ROAD MAMARONECK, N. Y.

Warranty

The Technical Materiel Corporation, hereinafter referred to as TMC, warrants the equipment (except electron tubes,* fuses, lamps, batteries and articles made of glass or other fragile or other expendable materials) purchased hereunder to be free from defect in materials and workmanship under normal use and service, when used for the purposes for which the same is designed, for a period of one year from the date of delivery F.O.B. factory. TMC further warrants that the equipment will perform in a manner equal to or better than published technical specifications as amended by any additions or corrections thereto accompanying the formal equipment offer.

TMC will replace or repair any such defective items, F.O.B. factory, which may fail within the stated warranty period, PROVIDED:

1. That any claim of defect under this warranty is made within sixty (60) days after discovery thereof and that inspection by TMC, if required, indicates the validity of such claim to TMC's satisfaction.
2. That the defect is not the result of damage incurred in shipment from or to the factory.
3. That the equipment has not been altered in any way either as to design or use whether by replacement parts not supplied or approved by TMC, or otherwise.
4. That any equipment or accessories furnished but not manufactured by TMC, or not of TMC design shall be subject only to such adjustments as TMC may obtain from the supplier thereof.

Electron tubes*furnished by TMC, but manufactured by others, bear only the warranty given by such other manufacturers. Electron tube warranty claims should be made directly to the manufacturer of such tubes.

TMC's obligation under this warranty is limited to the repair or replacement of defective parts with the exceptions noted above.

At TMC's option any defective part or equipment which fails within the warranty period shall be returned to TMC's factory for inspection, properly packed with shipping charges prepaid. No parts or equipment shall be returned to TMC, unless a return authorization is issued by TMC.

No warranties, express or implied, other than those specifically set forth herein shall be applicable to any equipment manufactured or furnished by TMC and the foregoing warranty shall constitute the Buyers sole right and remedy. In no event does TMC assume any liability for consequential damages, or for loss, damage or expense directly or indirectly arising from the use of TMC Products, or any inability to use them either separately or in combination with other equipment or materials or from any other cause.

***Electron tubes also include semi-conductor devices.**

PROCEDURE FOR RETURN OF MATERIAL OR EQUIPMENT

Should it be necessary to return equipment or material for repair or replacement, whether within warranty or otherwise, a return authorization must be obtained from TMC prior to shipment. The request for return authorization should include the following information:

1. Model Number of Equipment.
2. Serial Number of Equipment.
3. TMC Part Number.
4. Nature of defect or cause of failure.
5. The contract or purchase order under which equipment was delivered.

PROCEDURE FOR ORDERING REPLACEMENT PARTS

When ordering replacement parts, the following information must be included in the order as applicable:

1. Quantity Required.
2. TMC Part Number.
3. Equipment in which used by TMC or Military Model Number.
4. Brief Description of the Item.
5. The *Crystal Frequency* if the order includes crystals.

PROCEDURE IN THE EVENT OF DAMAGE INCURRED IN SHIPMENT

TMC's Warranty specifically excludes damage incurred in shipment to or from the factory. In the event equipment is received in damaged condition, the carrier should be notified immediately. Claims for such damage should be filed with the carrier involved and not with TMC.

All correspondence pertaining to Warranty Claims, return, repair, or replacement and all material or equipment returned for repair or replacement, within Warranty or otherwise, should be addressed as follows:

THE TECHNICAL MATERIEL CORPORATION
Engineering Services Department
700 Fenimore Road
Mamaroneck, New York

RECORD OF CORRECTIONS MADE

Change No.	Date of Change	Date Entered	Entered By

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Figure 1-1. Electronic Programmer, Model RTPH-1

SECTION 1

GENERAL DESCRIPTION

1-1. FUNCTIONAL DESCRIPTION.

Model RTPH Electronic Programmer is a teletype code generator with a key-board for the remote tuning of TMC's TechniMatiC transmitters or receivers by wire or FSK radio transmission. Features include keying output for teletype transmission, a pulse output for a card/tape puncher, a pulse input for reading from a card/tape reader and controls for a re-punch operation. Five operations are possible with the RTPH. These are:

a. Manual remote tuning of the receiver by pushbutton keyboard.

b. Pre-programming of tuning message on card or tape through the associated puncher.

c. Rapid remote tuning of the receiver by the pre-programmed punched card or tape from the associated card/tape reader.

d. Simultaneous remote receiver tuning by pushbutton with a recording made on tape or card by the associated puncher.

e. Repunching a copy of a previously punched message by the associated puncher.

One RTPH may be used, with an associated TMC recognition code generator, to control an array of transmitters or receivers. The generator code input is processed into teletype transmission through the RTPH in the same manner as codes generated by RTPH pushbuttons.

1-2. VARIATIONS IN MODELS.

Variations of the RTPH Programmer (RTPH-1, etc.) exist in the pushbutton keyboard design. The design is dependent on whether the RTPH is to control a transmitter or a receiver; more variations exist within these two categories, depending on type and amount of control. These variations are in the front-panel lettering of the buttons only; the pattern of the buttons is the same through all models, as shown in figure 1-2 and code output per button is the same. There are 15 buttons available for the addressal FUNCTION (control selector) codes row. There are 39 buttons available in three additional action (control position) codes rows. In the FUNCTION row the MC thru .1KC buttons are in all models; of the action code rows, the entire MEGACYCLE row, the 0-9 buttons of the KILOCYCLES row and the TUNE code button are in all models. These are used for tuning the transmitter or receiver to a 2-32 mc frequency and the codes generated by them are listed in table 1-1. The buttons identified as #1 through #23 in figure 1-2 represent those varying from model to model and their letterings, panel identifications and codes are listed in table 1-2 against the RTPH model dash number. A button referred to as "blank" in table 1-2 is present on the panel but is not used in the model configuration and is not wired to the circuitry.

1-3. PHYSICAL DESCRIPTION.

The RTPH (see figure 1-1) is a 19-inch rack modular unit. The front panel is 19 inches wide x 8-3/4 inches high x 3/16 inch thick and is finished in gray enamel. The chassis extends 13 inches behind the panel.

The pushbutton keyboard employs switches for coding. Binary logic circuitry is made up of plug-in printed circuit cards with encapsulated transistor/diode logic modules mounted on them.

1-4. TECHNICAL SPECIFICATIONS.

SIGNAL OUTPUT: Dry contact keying for serial pulses in 7.42-unit teletype transmission pattern with 22 millisecond (60 WPM)* or 13.7 millisecond (100 WPM)* pulse widths.

CARD/TAPE PUNCH OUTPUT: 0 to -10V parallel pulses in 5-bit code. See table 1-1 for code vs. pushbuttons.

CARD/TAPE READER INPUT: 0 to -10V parallel pulses in 5-bit code. See table 1-1 for adaptability to ASCII 7-bit codes.

RECOGNITION CODE GENERATOR INPUT: Keying into RTPH power supply in 5-bit code.

*As specified on order.

TABLE 1-1. STANDARD PUSHBUTTON CODES.

PUSHBUTTON (Figure 1-2)	5-BIT CODE	TELETYPE CHARACTERS	
		CCIT	ASCII*
KILOCYCLES:			
0	01000	Line Feed	H
1	00100	Space	D
2	00010	Carriage Return	B
3	01001	L	I
4	01100	I	L
5	00110	N	F
6	01011	G	K
7	01101	P	M
8	01110	C	N
9	00111	M	G

*With first 5 bits of 7-bit code transmitted in reverse.

TABLE 1-1. STANDARD PUSHBUTTON CODES (CONT)

PUSHBUTTON (Figure 1-2)	5-BIT CODE	TELETYPE CHARACTERS	
		CCIT	ASCII*
MEGACYCLES			
17 MC 2	01001	L	I
18 MC 3	01000	Line Feed	H
19 MC 4	00100	Space	D
20 MC 5	01100	I	L
21 MC 6	01010	R	J
22 MC 7	01110	C	N
23 MC 8	01101	P	M
24 MC 9	01111	V	O
25 MC 10	00110	N	F
26 MC 11	00111	M	G
27 MC 12	01011	G	K
28 MC 13	00011	O	C
29 MC 14	00101	H	E
30 MC 15	00001	T	A
31 MC 16	00010	Carriage Return	B
FUNCTION:			
MC 2-16	11001	W	Y
MC 17-31	10001	Z	Q
100 KC	10011	B	S
10 KC	10010	D	R
1 KC	10111	X	W
.1 KC	10101	Y	U
TUNE	10000	E	P

*With first 5 bits of 7-bit code transmitted in reverse.

TABLE 1-2. PUSHBUTTON CODES AND MARKING VS. MODEL.

BUTTON # (Figure 1-2)	5-BIT CODE	TELETYPE CHARACTERS		MARKING		
		CCIT	ASCII*	RTPH-1 (receiver control)		
1	00001	T	A	BLANK		
2	01000	Line Feed	H	IF BANDWIDTH: 1		
3	00100	Space	D	6		
4	00010	Carriage Return	B	15		
5	01001	L	I	3.5U		
6	01100	I	L	3.5L		
7	00110	N	F	7.5U		
8	01011	G	K	7.5L		
9	01101	P	M	BLANK		
10	00011	O	C	RF GAIN: ** 10		
11	00001	T	A	AGC		
12	01000	Line Feed	H	AFC/DET: ON/AM		
13	00010	Carriage Return	B	OFF/SSB		
14	00100	Space	D	CW		

TABLE 1-2. PUSHBUTTON CODES AND MARKING VS. MODEL (CONT).

BUTTON # (Figure 1-2)	5-BIT CODE	TELETYPE CHARACTERS		MARKING		
		CCIT	ASCII*	RTPH-1 (receiver control)		
15	11111	Letters	←	FUNCTION: CH A IFBW		
16	11011	Figures	[	CH A DET		
17	10110	F	V	CH B IFBW		
18	11110	K	↑	CH B DET		
19	11100	U	\	AFC		
20	11101	Q	]	RF GAIN		
21	11000	A	X	BLANK		
22	11010	J	Z	BLANK		
23	10100	S	T	BLANK		

*With first 5 bits of 7-bit code transmitted in reverse.
**RF GAIN buttons include utilization of 0-9 KILOCYCLES buttons with the "10" and "AGC" buttons for selection from the RF GAIN FUNCTION button.

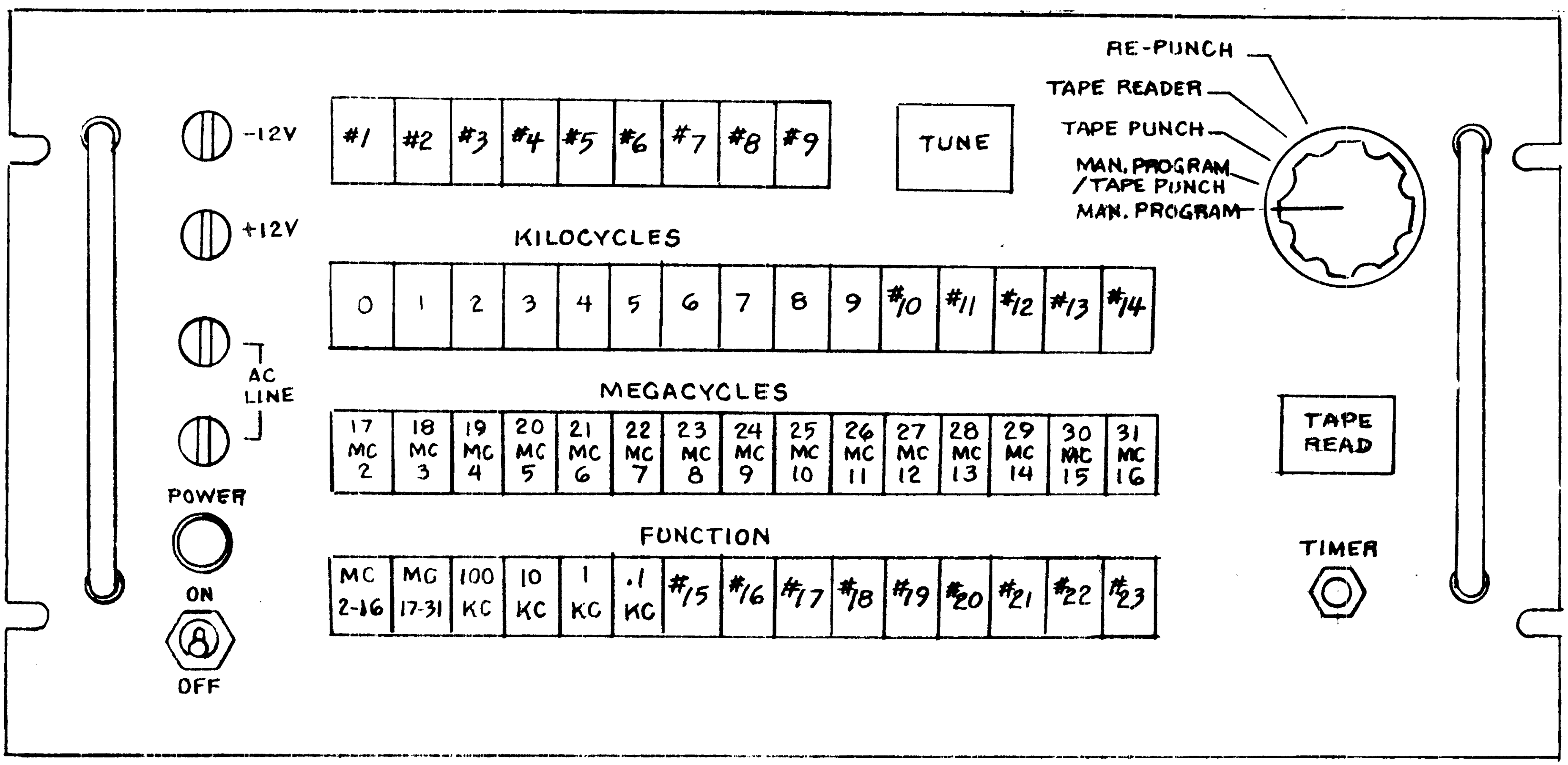

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Figure 1-2. Panel Keyboard Pattern, RTPH

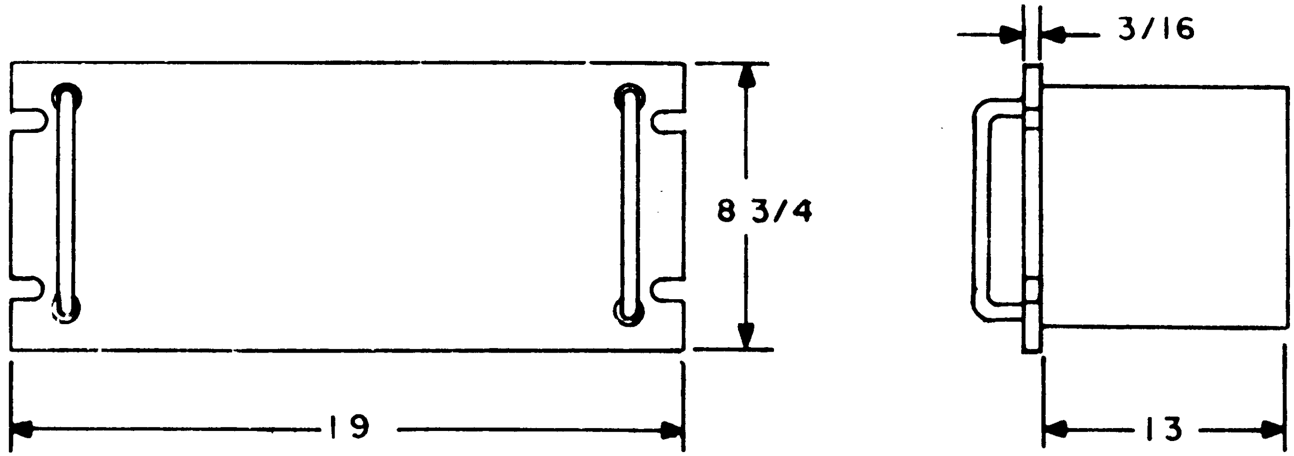

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Figure 2-1. Dimensional Outline, RTPH

SECTION 2

INSTALLATION

2-1. INITIAL INSPECTION.

Each RTPH has been thoroughly checked and tested at the factory before shipment. Upon arrival at the operating site, inspect case and its contents immediately for possible damage. Unpack the equipment carefully. Inspect all packing material for parts which may have been shipped as "loose items". Card Extender A4412, TP128 Desoldering Tool, TP132 Connector Extractor and TP139 Cleaning Brush are included as maintenance tools.

With respect to damage to the equipment for which the carrier is liable, The Technical Materiel Corporation will assist in describing methods of repair and the furnishing of replacement parts.

2-2. MECHANICAL INSTALLATION.

Overall dimensions and mounting data are shown in figure 2-1. If the RTPH is to be used in a TMC rack system, refer to system manual for location and mounting instructions. The unit is designed to be mounted by its front panel, with or without chassis drawer slides. When shipped as part of a system, the drawer slides are shipped premounted in the rack. When the RTPH is shipped alone, no slides are included unless specified on the order; however, the chassis sides contain threaded mounting holes for TMC TK-115 slides, if required.

2-3. ELECTRICAL INSTALLATION.

If the RTPH arrives as part of the shipment of a TMC rack system, refer to the system manual for connection of cables to associated equipment within the rack. When the RTPH is to be used separately, however, make the following connections:

a. Line voltage input at J1001 receptacle, using CA555-3 cable supplied.

b. Signal output to remote transmitter or receiver at J1004 receptacle. (See figure 2-2.)

c. Connection to card/tape puncher at J1003 receptacle (refer to figure 7-1 for details).

d. Connection to card/tape reader at J1003 receptacle (refer to figure 7-1 for details).

e. Connection to recognition code generator (see paragraph 2-6) at J1002 receptacle (refer to figure 7-1 for details).

f. Connect associated timer at TIMER jack on front panel, using PJ309 plug supplied.

When shipped separately, mating plugs are furnished for these connections.

2-4. 60 WPM VS. 100 WPM OPERATION.

Codes may be generated from the RTPH at any rate of speed at regular or irregular intervals. The pulse widths of bits within the codes, however, depend upon the clock generator circuit in printed circuit plug-in card Z1007. Cards are available for pulse widths corresponding with 60 wpm or 100 wpm speeds, based on the standard 7.42-unit teletype transmissions pattern. The RTPH is shipped with the 60 wpm card installed unless specified as otherwise on the order. The Z1007 cards are marked "60 wpm" or "100 wpm" to distinguish them.

2-5. CCIT AND ASCII CODES.

Although the RTPH is generally operated with a TMC card/tape puncher-reader, it can be operated to send a message punched by CCIT or ASCII teletype equipment. As long as the codes correspond with those shown in tables 1-1 and 1-2, a message may be sent that has been previously

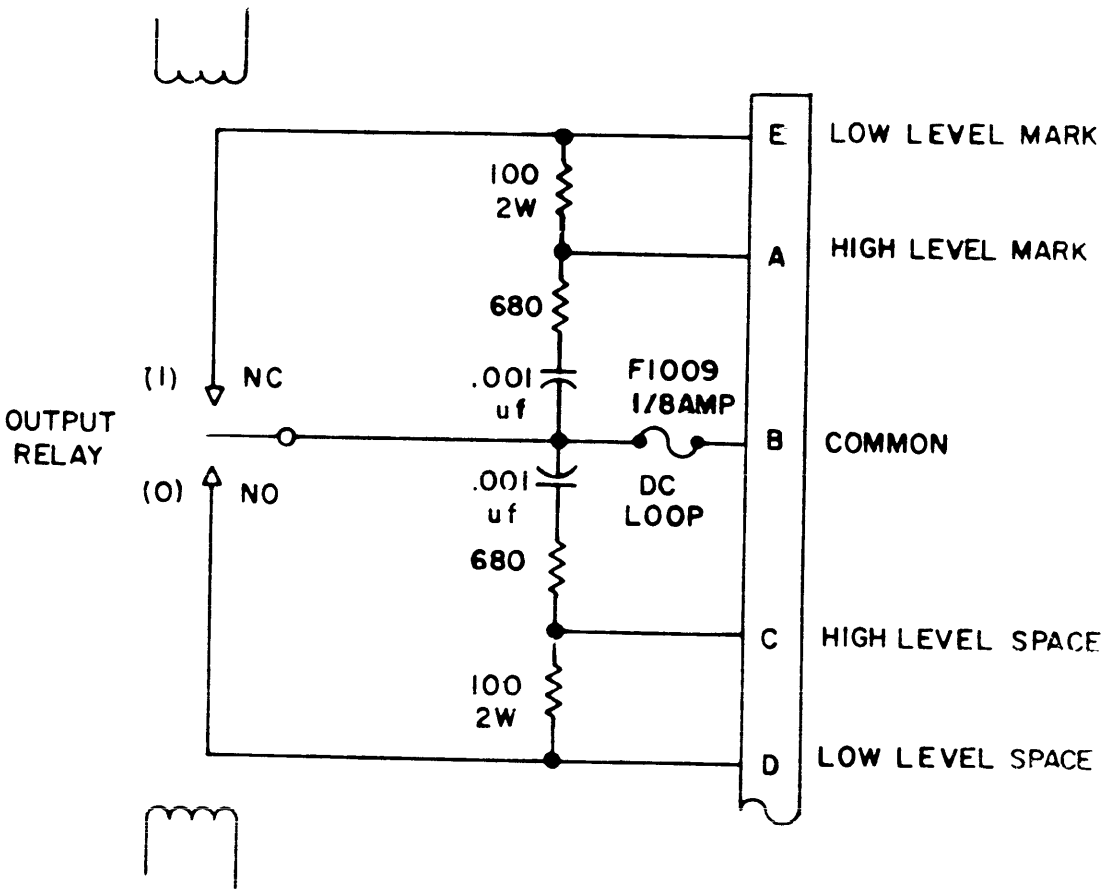

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Figure 2-2. Signal Output Variation Diagram punched by CCIT 5-bit code equipment. Reference is included in tables 1-1 and 1-2 to the CCIT character for each code. In using ASCII 7-bit code equipment, however, the characters are punched as shown in tables 1-1 and 1-2 and the tape is then flipped over as it is fed into a 5-bit reader in order that the first 5 bits of the 7-bit code may be transmitted in reverse, with the sprocket holes properly aligned. Manuals on TMC's 5-bit readers contain more detailed information on this method.

2-6. RECOGNITION CODE GENERATOR.

In all operations in which the message is sent to TMC transmitters or receivers, an additional recognition code generator is required. The recognition code, sent as the first code in the message, selects a specific transmitter (or receiver) by opening the code storage input gate in that equipment. TMC code generators are currently made with a code capacity to select up to 100 equipments. For a list of TMC recognition codes, see table 2-1. The table includes references to letters and numerals appearing on TMC code generator pushbuttons, and equivalent CCIT and ASCII characters. To open an equipment it is required to send a letter followed by a numeral.

TABLE 2-1. RECOGNITION CODES.

TMC GENERATOR PUSHBUTTON	5-BIT CODE	TELETYPE CHARACTERS	
		CCIT	ASCII*
A	10101	Y	U
B	10110	F	V
C	11010	J	Z
D	11001	W	Y
E	10011	B	S
F	11100	U	\
G	10100	S	K
H	10010	D	R

*With first 5 bits of 7-bit code transmitted in reverse. See paragraph 2-6.

TABLE 2-1. RECOGNITION CODES (CONT).

TMC GENERATOR PUSHBUTTON	5-BIT CODE	TELETYPE CHARACTERS	
		CCIT	ASCII*
I	10001	Z	Q
J	11000	A	X
1	01010	R	J
2	01001	L	I
3	00101	H	E
4	00110	N	F
5	01100	I	L
6	00011	O	C
7	01011	G	K
8	01101	P	M
9	01110	C	N
10	00111	M	G

*With first 5 bits of 7-bit code transmitted in reverse. See paragraph 2-6.

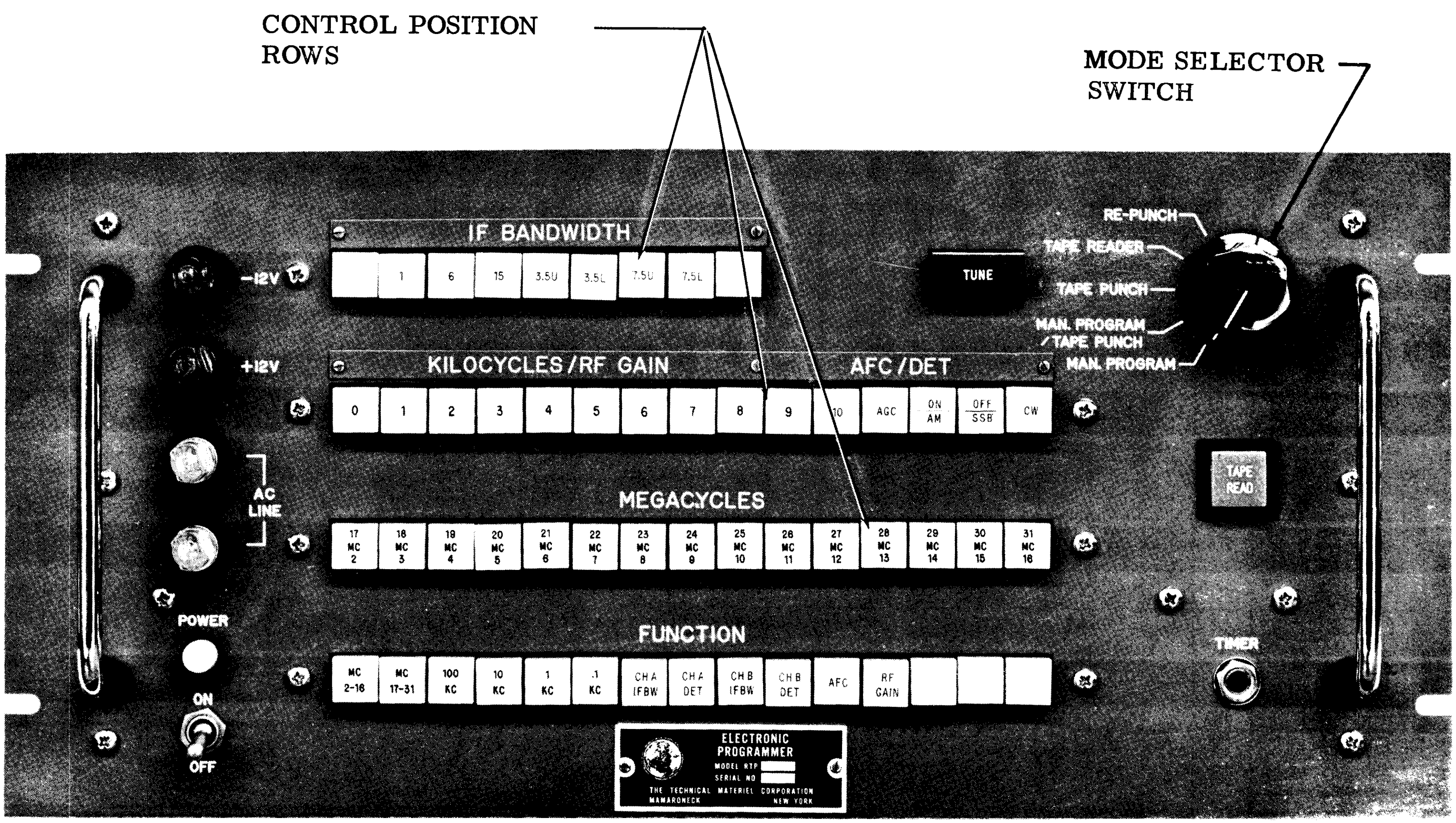

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Figure 3-1. Front Panel Controls, RTPH - 1

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SECTION 3

OPERATOR'S INSTRUCTIONS

3-1. GENERAL.

There are five operations possible with the RTPH. These operations are selected by the mode selector switch in the upper righthand corner of the control panel (see figure 3-1). Description of the operations is as follows:

SWITCH POSITION	OPERATION
MANUAL PROGRAM	Manual remote tuning of the transmitter or receiver by pushbuttons.
TAPE PUNCH	Pre-programming a transmitter or receiver tuning on punched card or tape by pushbuttons.
TAPE READER	Rapid remote tuning of the transmitter or receiver from the pre-programmed punched card or tape.
MANUAL PROGRAM/ TAPE PUNCH	Manual remote tuning of the transmitter or receiver by pushbuttons with simultaneous recording on punched card or tape.
RE-PUNCH	Energization of associated card/tape puncher to make a copy of a previously punched message.

The last four card/tape operations require an associated card/tape puncher or reader. The MANUAL PROGRAM operation requires no puncher or reader. All remote tuning operations of TMC transmitters or receivers require an associated recognition code generator (see paragraph 2-6).

3-2. MANUAL PROGRAM OPERATION.

Set mode selector switch at MANUAL PROGRAM. Set POWER ON/OFF switch at ON. POWER lamp will light. The keyboard buttons are marked to correspond with TMC's TechniMatiC transmitters or receivers. Specific sequence of remote tuning is spelled out in the TMC manual for the system in which the RTPH is employed. However, some generalizations may be made on procedure here.

Refer to figure 3-1. Buttons in the FUNCTION row represent controls on the remote unit. Buttons in the other three rows represent control positions. The TUNE button is pushed at the end of the message. When a button is pushed in, it stays in momentarily until the next button is pushed, releasing it. When a FUNCTION button is pushed in, the appropriate row of control position buttons light up to indicate that one button in that row must be selected. When one button is selected and pushed in, the lights in that control position row are extinguished and the FUNCTION row lights up again, to indicate that the next FUNCTION button must be pressed. When the next FUNCTION button is pressed, the FUNCTION row extinguishes and the appropriate control position row lights up again. The FUNCTION buttons and the corresponding rows of control positions that light up (on all models of the RTPH) are shown in table 3-1.

TABLE 3-1. FUNCTION AND CONTROL POSITION BUTTONS, STANDARD

FUNCTION Button	Control Position Row
MC 2-16	MEGACYCLES
MC 17-31	MEGACYCLES
100 KC	KILOCYCLES (0-9)
10 KC	KILOCYCLES (0-9)
1 KC	KILOCYCLES (0-9)
.1 KC	KILOCYCLES (0-9)

Other FUNCTION buttons and control position button relationships vary with each model of the RTPH. Table 3-2 lists these relationships for each model.

TABLE 3-2. FUNCTION AND CONTROL POSITION BUTTONS, MODEL VARIATIONS

RTPH-1 (receiver control) (see figure 3-1)			
FUNCTION button	Control Position buttons		
CH A IFBW	IF BANDWIDTH row		
CH A DET	AFC/DET: ON/AM OFF/SSB CW		
CH B IFBW	IF BANDWIDTH row		
CH B DET	AFC/DET: ON/AM OFF/SSB CW		
AFC	AFC/DET: ON/AM OFF/SSB		
RF GAIN	KILOCYCLES/ RF GAIN: 0 thru 10 and AGC		

Whenever a control position button is pushed in, the TUNE button also lights; when a FUNCTION button is consequently pushed, the TUNE button extinguishes. This is to serve as an indication that equipment may be tuned to the message as programmed at any time after a control position button has been pushed.

A coded character appears at the RTPH output each time a button is pushed. Pushing the TUNE button, at the end of the message, presents the "E" code at the output. The TUNE button is a momentary contact type and acts to release the last previous button and extinguish all button lights. The "E" character is generally used in the transmitter or receiver to energize the tuning mechanisms, the equipment having previously stored the message in its memory section. The first two codes in the message, however, must be generated by the recognition code generator.

Example: To tune a receiver, using the RTPH-1, for a 26.5781 megacycles carrier (suppressed or partial), SSB transmission, with an upper sideband 3.5-kc wide, to be routed to audio channel A, with the AFC (automatic frequency control) feature and an r-f gain setting of 8, after sending the recognition code, press the following buttons:

MC 17-31, 26 MC 11; 100 KC, 5; 10 KC, 7; 1 KC, 8; .1 KC, 1; CH A IFBW, 3.5U; CH A DET, SSB; AFC, ON; RF GAIN, 8; TUNE.

3-3. TAPE PUNCH OPERATION.

Set mode selector switch at TAPE PUNCH. Set POWER switch at ON; POWER lamp will light. Push buttons in the same manner as that described for MANUAL PROGRAM operation, including the TUNE button at the end. Each button punches the 5-bit code (see tables 1-1 and 1-2) on the card or tape. A hole represents a "1"; no hole represents "0". When finished, set the POWER switch to OFF.

3-4. TAPE READER OPERATION.

Set mode selector switch at TAPE READER. Set POWER switch at ON. If the card/tape reader does not have an automatic starter, press TAPE READ button to start message transmission from pre-programmed punched tape. If a series of messages are to be sent, employing a timer, plug timer into TIMER jack on front panel and switch off the timer automatic starter. The timer will then control the message transmission.

3-5. MANUAL PROGRAM/TAPE PUNCH OPERATION.

Set mode selector switch at MAN PROGRAM/TAPE PUNCH. Set POWER switch at ON. Then proceed to send message in the same manner as for MANUAL PROGRAM. Message will be recorded on the punched card or tape at the same time. The punched card or tape may then be used at some future date to tune the transmitter or receiver in a TAPE READER operation.

3-6. RE-PUNCH OPERATION.

After a card or tape has been punched in a TAPE PUNCH or MANUAL PROGRAM/ TAPE PUNCH OPERATION, a copy may be made on another card or tape. Set mode selector switch at RE-PUNCH. Set POWER switch at ON. Feed previously punched card or tape into reader input and new card or tape into punched input. Press TAPE READ button to start copy.

The RE-PUNCH operation is included in TechniMatiC systems to provide two particularly useful features. One feature is the renewing of a worn tape or card. The other is generation of a tape of a series of tuning messages made from selected pre-punched cards. Such a tape can then be used in a TAPE READER operation with an associated timer to set up a scheduled automatic tuning of transmitters or receivers throughout the day.

SECTION 4

PRINCIPLES OF OPERATION

4-1. INTRODUCTION

The Programmer operates through a push-button keyboard and binary logic circuitry. A 5-position mode selector switch makes the necessary connections between circuits for the 5 modes of operation (MANUAL PROGRAM, MANUAL PROGRAM/TAPE PUNCH, TAPE PUNCH, TAPE READER and RE-PUNCH). The logic circuitry is contained in four plug-in printed circuit cards. Individual logic circuits on the cards are transistor/diode type and in the form of encapsulated modules. Cards are mounted in a bin (see figure 5-1), the cards plugged into receptacles in the floor of the bin. Cards are referred to in figure 7-1 by Z1000 series circuit numbers and their "A" (assembly) numbers. The encapsulated logic modules are identified by Z1-and-up series of circuit within each card.

Circuitry is the same for all model variations of the Programmer (RTPH-1, RTPH-2, etc.) except for details in the keyboard lamp circuit. Functional identification of keyboard buttons varies at the panel (as described in paragraph 1-2) from model to model and the variations in the lamp circuits are a direct result of these functional variations. The following text describes the circuitry of the Programmer in general, without reference to specific button functions.

4-2. FUNCTIONAL ANALYSIS (figure 4-1)

a. MANUAL PROGRAM OPERATION. - In MANUAL PROGRAM operation, codes are transmitted by the operator directly from the push-button keyboard (S1004) and a keyboard on the associated recognition code generator. Each code enters Gating Circuit Z1005 and, triggering Timing Circuit Z1007, becomes shifted over to an output relay in Relay Circuit Z1008 via Shift Register Z1006.

Z1007 functions with Z1006 to change the parallel-pulse 5-bit code from the keyboard into the necessary serial-pulse form (with start and stop pulses)

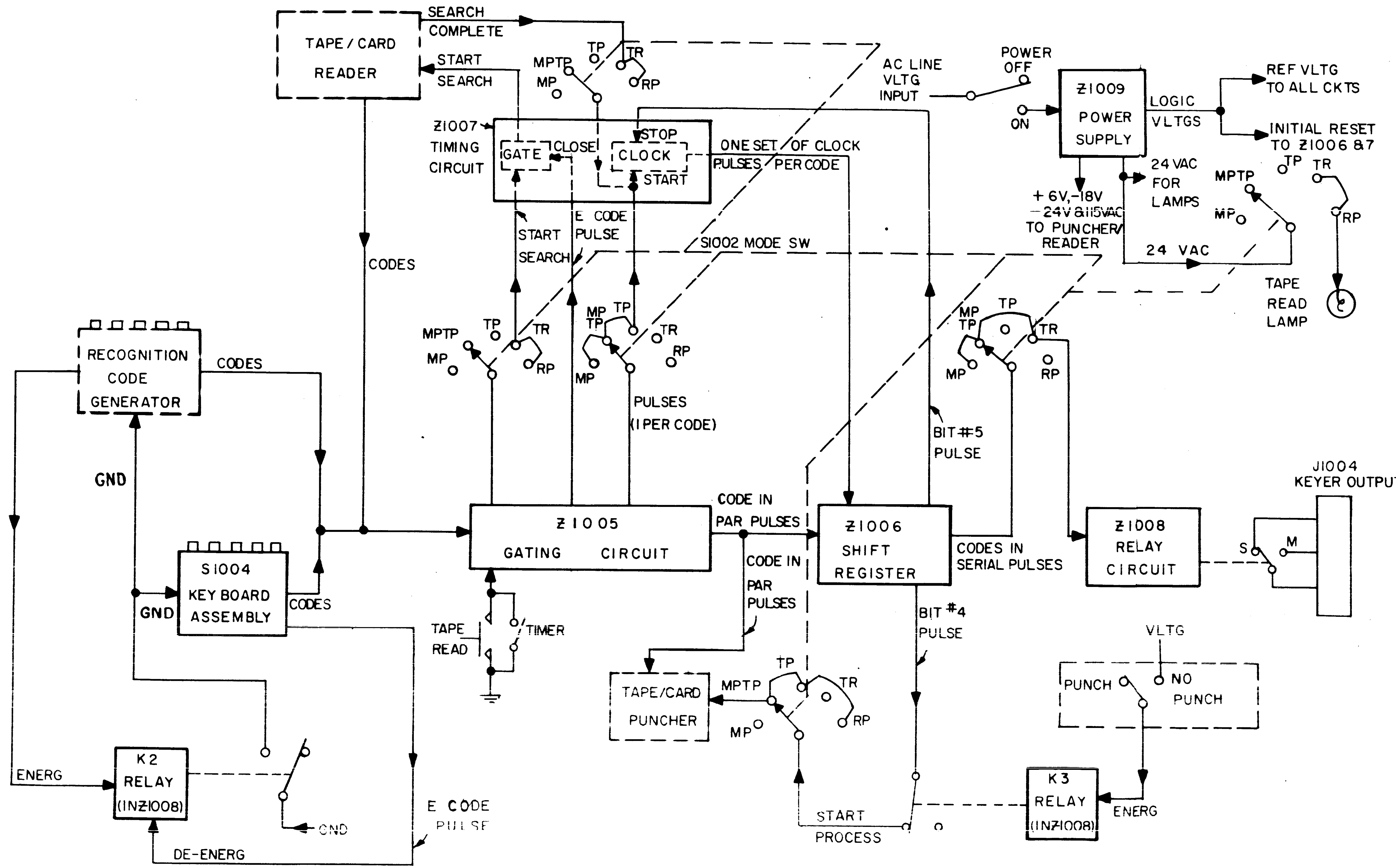

Figure 4-1 Functional Block Diagram, RTPH-1

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for teletype transmission. As each code enters Z1005, Z1005 issues a pulse to a clock in Z1007. The clock starts and proceeds to issue a series of regularly-timed pulses to Z1006. Each pulse into Z1006 causes the shift-register to shift out one bit of the 5-bit code to an output relay keyer in Z1008. According to the polarity of the bit pulse (1 or 0) the keyer goes into a mark (M) or space (S) condition, respectively. The first pulse from the clock causes the relay to go into its space condition for transmission of the "start" pulse. The next 5 pulses from the clock then transmit the code bits; the 7th pulse causes the relay to go to mark condition for transmission of the "stop" pulse. At this instance, the progress of bit #5 through Z1006 has caused a pulse to issue from Z1006 through a delay circuit (not shown) to stop the clock in Z1007.

The associated recognition code generator is wired to relay K2 in Z1008 to prevent transmission of codes in a message without a recognition code preceding the message. This is to ensure that the message will tune the correct transmitter (or receiver). When a button is pushed in on the recognition code generator, K2 relay is energized, supplying the necessary ground reference for its own keyboard and that of the Programmer. When the TUNE (E) code button is pushed on the Programmer keyboard at the end of the message, a pulse is created, de-energizing K2 and disabling both keyboards.

b. MANUAL PROGRAM/TAPE PUNCH OPERATION. - In this operation, a copy of a message sent by MANUAL PROGRAM mode is punched on tape or card simultaneously with the transmission. The mode switch, positioned for this operation, makes all the same connections as for MANUAL PROGRAM with two extra connections: (1) the "start process" signal from shift-Register Z1006 to an associated puncher and (2) connection (not shown) of Programmer power supply voltages to the puncher. In all modes, the code output from Gating Circuit Z1005 is routed to the puncher. However, the puncher will not punch the code without a "start process" signal (originating from Z1006 as bit #4 of that code is shifted to the output keyer).

An associated PUNCH/NO PUNCH switch, in the remote control system, de-energizes relay K3 in Z1008 in the switch's PUNCH position. The de-energized K3 completes the path for the "start process" signal to the puncher. In this way, erroneous codes may be cut out of the recorded message, if desired.

c. TAPE PUNCH OPERATION. - In this operation, a message is punched on tape (or card) by the operator at the Programmer keyboard and no transmission occurs. The tape (or card) may be used later to tune the remote equipment in a TAPE READER operation. The mode switch, set at TAPE PUNCH, connects the "start process" signal to the puncher and makes a connection (not shown) for Programmer power supply voltages to the puncher. S1002 also disconnects Shift Register Z1006 code output from Relay Circuit Z1008 code input, thereby preventing transmission. The associated PUNCH/NO PUNCH switch is set at PUNCH and the de-energized relay K3 completes the path of the "start process" signal to the puncher. Mode switch S1002 makes a connection (not shown) of Programmer power supply voltages to the puncher.

d. TAPE READER OPERATION - In this operation, the Programmer is made to transmit a message from a previously punched tape (or card) through an associated reader. Code input is from the reader, rather than from the keyboard, and triggering of the clock in Timing Circuit Z1007 occurs from the reader in order to maintain a reciprocating action between reader and Programmer. Mode switch S1002 makes a connection (not shown) of Programmer power supply voltages to the reader. After the reader has scanned the first code, it delivers a "search complete" pulse that starts the clock in Z1007. The clock then proceeds to shift the first code out of the Programmer via Relay Circuit Z1008 and bit #5 pulse from Z1006 stops the clock. Gating Circuit Z1005 then originates a "start search" pulse to the reader (via a gate in Z1007) energizing the reader to read the next code. This action is repeated until the "E" code is read by the reader. As the E code enters Z1005, an "E" gate (not shown) in Z1005 issues a pulse, closing the "start search" gate in Z1007 and thereby preventing the next "start search" signal to the reader. This stops the reciprocating action between reader and Programmer.

In this operation, the mode switch and thePUNCH/NO PUNCH switch (set at NO PUNCH position) combine to break the path of the "start process" signal to the puncher. The puncher, therefore, does not operate, although receiving codes and power voltages from the Programmer in a common supply to puncher and reader.

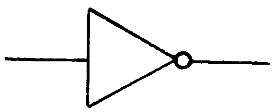
When using a reader that does not include a self-starter, the first "start search" signal must originate from the Programmer to generate the first code from the reader. This is done by pressing the TAPE READ button or by a switch closure from an associated timer.

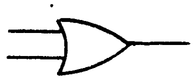
e. RE-PUNCH OPERATION - In this operation, the Programmer is used with reader and puncher to punch a duplicate message from a previously punched message; no transmission of codes occurs. Code input is from the reader and the reciprocating action occurs ("start search" and "search complete" signals) as in the TAPE READER mode. With the PUNCH/NO PUNCH switch in the PUNCH position and the mode switch set at RE-PUNCH, the "start process" signal path to the puncher is completed as in the PUNCH mode and codes issuing from Z1005 become punched. Since this is not a transmitting mode, the mode switch disconnects Z1006 code output from Z1008 code input.

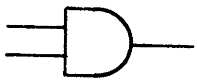
4-3. DETAILED ANALYSIS

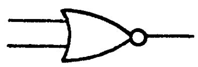
a. INTRODUCTION - Figure 7-1 shows the overall schematic wiring for the Programmer and includes wiring up to the logic card receptacles. Figures 7-2 through 7-5 are individual logic diagrams of the four cards. Figures 7-6 through 7-8 cover the schematic wiring of the keyboard. This wiring covers all of the configurations of the Programmer (-1,-2,etc) regardless of push-button functions.

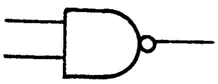
On each card, each encapsulated logic module is identified by a Z number, numbered in series within the card. The TMC part numbers of the modules are listed in Section 6, Parts List, under their Z numbers which, in turn, are listed under the Z number of the card. Figures 7-2 through 7-5 show the logic module, its Z number, and indicates by symbol and/or logic function letters its particular function in the card circuit. Symbols indicate functions as follows: -


inverter


orgate


andgate


norgate


nandgate

Logic function letters indicate functions as follows: -

- CF complimentary emitter-follower
- FF flip-flop
- NA non-inverting amplifier
- SS single-shot (or delay circuit)
- TG timing generator (or clock)

To see the equivalent transistor/diode logic circuit of an encapsulated logic module, refer to its Z number, in Section 6 Parts List, for its TMC part number. Then refer to the schematic shown for its part number in figure 7-9.

b. PROGRAMMER KEYBOARD - The entire keyboard switch assembly (assigned switch #S1004 in figure 7-1) consists of all of the code generating push-buttons (see figure 1-2). Each button is a multi-contact switch and contains a built-in lamp. Mechanical linkage is such that when any button is pushed in, it stays in* and the previously-pushed button pops out, breaking the previous connection. Each push-button accomplishes three functions: - (1) it closes connections to generate a specific code, (2) it completes a path to ground for code "bit common" reference (via relays in Relay card Z1008) and (3) it causes a specific row of buttons to light up for the next selection (see paragraph 3-2).

Connections for code generation are shown in figure 7-6. Code output for bits 1,2,3,4 and 5 is at terminal block TB1001, terminals 3,4,5,6 and 7, respectively. A connection with the "bit common" wire (at terminal 10 of TB1001) represents a "1" binary digit for that bit position in the code. Connections not made with the common wire represent a "0" binary digit for that code at terminals 3 through 7. All code contacts are "A" type (normally open).

Connections for the "bit common" reference path are shown in figure 7-7. This connection, referred to as the "delayed A" connection in figure 7-1, is an "A" type connection that closes at a short time interval after the "A" code contacts close, due to the mechanical structure of the switch. Closure of these contacts works through relays in Relay card Z1008 to connect a ground to pin 10 (the "bit common" terminal) of TB1001.

The lamp connection circuit is shown in figure 7-8. A 24 VAC source exists across terminals 1 and 2 of TB1001. When a button is pushed in, the 24 VAC circuit is completed through a specific row of button lamps. When the next button (in the illuminated row) is pushed, the previous button is mechanically released breaking that 24 VAC circuit and extinguishing the row; the new button, at the same time, completes the 24 VAC circuit through a new row

* Except for the momentary-contact TUNE button.

of buttons. When the TUNE button is finally pushed at the end of the message, no new connection is made for the 24VAC circuit and all lamps are therefore extinguished.

The TUNE button (see figure 7-6), besides generating the "E" code, also serves to disable the keyboard. Contacts 5 and 6 are "B" type (normally closed) and when the momentary button is pushed, the +12V appearing at terminal 12 of TB1001 is momentarily disconnected. This action results in the de-energization of relays in Relay card Z1008 and the removal of the ground connection at terminal 10 of TB1001 (see paragraph 4-3c (3)).

c. LOGIC ANALYSIS (figures 7-1 through 7-5)

(1) INTRODUCTION - The parantheses ( ) in the following logic analysis refer to schematic or logic card figure numbers in the group of 7-1 through 7-5 diagrams. For example, (7-2) indicates a reference to figure 7-2.

"Positive" and "negative" inputs and outputs to logic circuitry are relative descriptions, indicating the two logic states: 0V (or ground) and -12V, respectively. The exception to this is the +12V required for initial reset.

(2) INITIAL RESET - Initial resetting of various flip-flops in the Programmer is accomplished by application of a-c line voltage to Power Supply card Z1009 (7-1) via POWER switch S1001. Z1009, besides furnishing logic voltages (+12V, -12V and ground reference) to all the cards also applies +12V to pin 20 of Timing Circuit card Z1007. The +12V at Z1007 pin 20 (7-4) is dropped through resistor R2, resetting flip-flops Z2 and Z3 at pin 1 of each module. The same positive voltage is routed (via pin L of Z1007) to pin Y of Shift Register card Z1006 (7-1) where it resets flip-flops Z2,6,1,3,7,4 and 10 (7-3).

Subsequent resetting of these flip-flops (in Z1006 and Z1007) for each new code is accomplished by the progression of the previous code through the Programmer.

(3) MANUAL PROGRAM OPERATION - In MANUAL PROGRAM operation, the operator first pushes a recognition code button and then a series of Programmer buttons, followed by the TUNE button.

The recognition code button, besides generating a code, also enables its keyboard and the Programmer keyboard by supplying both with a "bit common" ground. A typical recognition code button is protrayed (7-1) as "RTRS-216". When the button is pushed, pins K and F of Relay card Z1008 are shorted, via connections at receptacle J1002. Z1008 pin F obtains +12V from pin 15 of Power Supply Z1009, via the normally closed contacts of S1004 TUNE button. Pin K of Z1008 (7-5) is connected to pin 4 of relay K2 coil via resistor R9. Since the other side of the coil is receiving a constant -12V from Z1009, this supplies the necessary 20.5 VDC across the coil to energize K2. Contacts 6 and 7 then close so that, when the recognition code button is subsequently released, a connection still exists across pins F and K of Z1008, locking up relay K2 for the duration of the message. The energized K2 routes the constant -12V supply at pin 4 of Z1008 back to pin H. Pins H and 11 of Z1008 are shorted whenever a recognition code or Programmer code button is pushed in, via the button's "delayed A" contacts (7-1). Therefore, each time a button is pushed, pin 11 of Z1008 is supplied with -12V. The -12V (7-5) is connected to pin 4 of one of two coils in polar relay K4. Pin 1 of the other coil is receiving a constant negative voltage from pin 4 of Z1008; the voltage is somewhat less than -12V due to the effect of dropping resistor R10. The imbalance thus created by applying the full -12V to the first coil causes K2 relay to pull towards that coil and connect a ground to pin T of Z1008. This ground is then extended to terminal 10 of TB1001 (the "bit common" terminal of the programmer) and pin N of J1002 (the "bit common" connection for the recognition code generator).

With the "bit common" ground supplied to the keyboards, the first code precipitates action in Gating Circuit Z1005. The five bit wires from a typical button in S1004 in the Programmer (7-1) and the five bit wires from a typical button in the recognition code generator are connected, in parallel, to pins D,V, T, 21 and U of Z1005. Whichever button is pushed first presents the code connections at these pins in Z1005; a "1" bit presents a connection to ground (+) and a "0" bit contains no connection. Z1005 (7-2) contains five code input andgates (two in triple-andgate assembly Z2 and three in Z6) and the code appears at one leg of each andgate. The other legs of the andgates are connected to the associated tape reader, via pins E,F,H,J and K of J1003 (7-1) and pins M,Y,P,N and W of Z1005. Since there is now no reader output each of these legs is receiving a negative voltage from a constant source at pin 4 of Z1005 (7-2). Therefore, if the bit from the push-button is a "1", the output of the gate is positive; if the bit is a "0", the output is negative. These five outputs then appear at pins E, K,H,R and S of Z1005 and at input pins M,E,D,B and C of Shift Register Z1006 (7-1). Pins M,E,D,B and C of Z1006 (7-3) are each connected to one leg of an andgate of a group of five in triple-andgates Z8 and Z11. The other leg of each andgate awaits a negative charge from a shift-register in Z1006.

Shift-register action for each code is triggered by a norgate in Gating Circuit Z1005. Between codes, all the inputs at norgate Z8 in Z1005 (7-2) are positive and Z8 output is negative. When a code comes through the gates in Z2 and Z6, however, the code contains at least one "1" bit. The positive output of the gate passing the "1" bit is changed to a negative charge through an inverter (of five inverters in Z1,4 and 9) and at least one negative charge appears at the inputs of norgate Z8. Since one or more negative inputs cause a norgate output to go positive, a positive output is produced from Z8 (and pin 8 of Z1005) for each code passage through Z1005. With mode switch S1002 (7-1) in MANUAL PROGRAM position, wafer S1002C routes the positive charge from pin 8 of Z1005 to pin W of Timing Circuit card Z1007. This charge at pin W of Z1007 (7-4) sets flip-flop Z3 and the resulting negative swing at pin 6 of Z3 starts Z1 clock. Z1 proceeds to issue regularly timed positive pulses at 22-ms intervals (for 60 WPM transmission). or 13.5-ms intervals (for 100 WPM transmission). The positive excursion of each pulse fires single-shot Z4 and Z4 issues positive pulses (at the same intervals) to pin V of Z1007 and pin N of Shift-Register Z1006. These are the energizing pulses for the shift-register circuit.

The first pulse at pin N of Z1006 (7-3) creates the "start" pulse output from the Programmer. This pulse resets Z6,1,3,7,4 and 10 flip-flops and sets flip-flop Z2, all via amplifier Z5. The set flip-flop Z2 emits a positive charge at pin 11 that sets Z6. The resulting negative voltage from pin 6 of Z6 travels to pin 5 of an andgate in Z8. This andgate is used, at this instance, as a buffer to prevent a loading of flip-flop Z6 by norgate Z12 and, with no input at pin 12, does not serve a logic function. Therefore its output also goes negative, causing norgate Z12 output to go positive. This positive output becomes changed to negative through an inverter in Z13 and arrives at the base of Q1 transistor relay driver. Q1, in this case, does not conduct and the charge at pin 3 of Z1006 remains positive (or ground). The ground is connected from pin 3 of Z1006 to pin V of Relay card Z1008 via wafer S1002B of mode switch S1002 (7-1). The ground at pin V of Z1008 (7-5) is connected to pin 3 of output polar relay K5 "mark" coil. Since the other side of the coil is also connected to ground, no current travels through the coil and the constant -12V source at pin 4 of Z1008 causes the "space" coil to continue drawing current, holding the relay in its "space" (or 0) condition during this interval. Pin R and X of Z1008 short, producing a short at pins D and B of receptacle J1004, the Programmer output. This is the "start" keyer position output for the code.

The second pulse at pin N of Z1006 (7-3) shifts the first bit of the 5-bit code out of the Programmer. This pulse again resets flip-flops Z6,1,3,7,4 and 10. Z2 remains in its set condition. Z6, going from set to reset, sets Z1.

The resulting negative output from Z1 travels to pin 9 of the bit #1 andgate in Z8. The other leg of the andgate (pin 1) holds bit #1 information, as previously described; this information is a positive charge for a "1" or a negative charge for a "0". As a result, if the pin 1 charge is positive (1), pin 10 output goes positive; if pin 1 is negative (0), pin 10 output goes negative. If bit #1=1, the positive charge places all positive inputs at norgate Z12 and its output goes negative. The negative output changes to positive (or ground) through inverter Z13 and, presented at the base of transistor Q1, causes Q1 to conduct. This causes pin 3 of Z1006 to go negative and this charge, appearing at pin V of Z1008 (7-5) energizes the "mark" coil of relay K5, shorting pins X and 21 of Z1008 and pins B and E of J1004. This is the "1" keyer position output for bit #1. If bit #1=0, pin 10 of Z8 andgate, in Z1006 (7-3), goes negative and, causing norgate Z12 output to go positive, acts on K5 relay in the same manner as for the "start" pulse. In this case the K5 relay remains in its space (or "0") condition.

The third, fourth, fifth and sixth pulses at pin N of Z1006 (7-3) succed in shifting out bits #2,3,4 and 5 of the code in the same manner as for bit #1. The third clock pulse again resets flip-flops Z6,1,3,7,4 and 10. Z1, going from set to reset, sets Z3. The negative output from Z3 travels to pin 7 of Z8, bit #2 andgate. The bit #2 information then proceeds to bring K5 relay in Z1008 into either the 1 or 0 condition in the same manner as for bit #1. This procedure continues until bit #5 is transmitted by the 6th clock pulse and the setting of flip-flop Z10 by Z4.

The seventh clock pulse at pin N of Z1006 (7-3) creates the "stop" pulse at the Programmer output and feeds back to stop the clock itself. This pulse, at pin N, resets flip-flop Z10 and pin 6 of Z10 goes positive. The positive output (a) resets flip-flop Z2 for the next code, (b) becomes inverted to a negative output at pin R of Z1006 via inverter Z13, (c) presents a positive output at pin V of Z1006 and (d) places a positive input at pin 7 of bit #5 andgate in Z11. The negative output at Z1006 pin R is utilized in a TAPE READER operation (see paragraph 4-3c (6)). The positive output at Z1006 pin V travels to pin U of Z1007 (7-1), resetting flip-flop Z3 (7-4). This causes the output of Z3 to go positive, stopping Z1 clock. The positive input at pin 7 of bit #5 andgate in Z11, in Z1006 (7-3), causes the andgate output to go positive (regardless of the polarity of the other leg) and this places all positive, inputs at norgate Z12, a condition of a "1" bit Transmission. As for the "1" bit, this action succeeds in bringing relay K5 in Z1008 into its "mark" condition for transmission of the "stop" pulse in the code. The keyer then remains in this position until the next code button is pushed, bringing the keyer into its "space" condition for transmission of the "start" pulse for that code.

Pushing the TUNE button, at the end of the message, besides transmitting the E code (10000), also disables the keyboard in such a way as to prevent further transmission until a recognition code button is pushed for the next message. When the momentary TUNE button is pushed (7-1) a set of normally closed contacts in the button open briefly disconnecting the normal short across terminals 11 and 12 of TB1001 while the button is held down. This interrupts the +12V supply to pin F of Relay card Z1008. At that instance, the +12V at Z1008 pin F (7-5) is keeping relay K2 energized through closed contacts 6 and 7. After an interval, determined by the discharge time of capacitor C2 through resistor R9, the +12V is cut off from pin 4 of the relay coil and the relay de-energizes. This delay allows time for the transmission of the "E" code out of the Programmer. The de-energized K2 opens contacts 9 and 10, disconnecting the -12V from pin H of Z1008. Any consequent pushing of a Programmer keyboard alone will fail to energize K4 (the "bit common" supply relay) with no -12V at pin H. It is then necessary to push a recognition code button first, in order to lock up relay K2 for the new message.

(4) TAPE PUNCH OPERATION - In this operation, an associated tape puncher records a message, programmed by buttons on the recognition code and Programmer keyboards; no transmission takes place from the Programmer keyer output.

The progression of codes from the keyboards into Gating Circuit card Z1005 occurs in the same manner as that for the MANUAL PROGRAM operation, with bit charges appearing at pins L,13,J,10 and 9 of Z1005 (7-2). Due to five inverters in Z1,4 and 9 dual-inverter assemblies, a "1" appears as a negative charge and a "0" appears as a positive charge. These charges are connected to pins R,P,M,N and L of receptacle J1003 (the Programmer code output to the puncher). However, action does not occur in the puncher without power supply voltages and a "start process" signal from the Programmer.

Wafer S1002A of the mode switch (7-1) completes the 115 VAC supply to the puncher, in the TAPE PUNCH position, via pins W and X of receptacle J1003. Other d-c voltages (+6V,-18V and -24V) are continually supplied at pins A,B,C and D of J1003 to serve as logic and relay reference voltages in the puncher. Energization for the puncher drive mechanism, however, is derived from the 115 VAC supply.

Wafer S1002C of the mode switch, working together with relay K3 in Relay card Z1008 and an external PUNCH/NO PUNCH switch, makes the connection for the "start process" signals from Shift-Register card Z1006 to the puncher. The PUNCH/NO PUNCH switch (7-1) used with the Programmer is wired across pins C and S of receptacle J1002 in such a way that, in the NO PUNCH position, the pins are shorted and, in the PUNCH position, the short is removed The switch controls a -12V supply, at pin S of J1002, back into pin J of Relay card Z1008 via pin C of J1002. Pin J of Z1008 (7-5) is attached to pin 1 of relay K3 coil (a coil that requires 20.5V across it to energize). The other side of the coil is receiving a constant +12V from pin 20 of Z1008. In the TAPE PUNCH mode, the PUNCH/NO PUNCH switch is set at PUNCH and, since the -12V is cut off from pin

J of Z1008, K3 remains de-energized. K3 contacts 5 and 6 remain closed and this shorts pins C and 2 of Z1008, providing a path for the forthcoming "start process" signal origniating at pin 21 of Shift-Register card Z1006 and finishing at pin U of receptacle J1003 (7-1).

The "start process" signal from Z1006 originates from the shift-register action of the code through that circuit as it shifts bit #4 of the code. In TAPE PUNCH mode, the shift-register is not utilized in its usual manner (i.e., to shift the code, in serial pulses, out of the Programmer). Here the time interval is used; this time interval is between the time that the puncher has received the bit charges of the code and the time that the shift-register takes to arrive at bit #4, thereby producing the "start process" signal. The delay is calculated to allow various relays and mechanisms in the puncher to position themselves for each code. As flip-flop Z4 in Z1006 (7-3) becomes set (in the processing of bit #4), pin 11 of Z4 produces a positive (or ground) output. This ground appears at pin 21 of Z1006 and, as described previously, at pin U of receptacle J1003 (7-1), starting the punching mechanism in the puncher. When bit #5 is processed through Shift-Register card Z1006, the usual pulse is produced from pin V (7-3) to stop the clock in Timing Circuit card Z1007.

Each successive code issuing from the keyboard becomes punched in the same manner as the first code.

No transmission of codes occurs out of the Programmer, due to the position of mode switch S1002 (7-1). In position #3, wafer S1002B disconnects the code output from pin 3 of Shift-Register card Z1006 to pin V of Relay card Z1008.

In some control systems, the associated PUNCH/NO PUNCH switch also includes, with it, PUNCH and NO PUNCH indicating lamps; relay K3 in Z1008 also lights the PUNCH lamp, in this case. The de-energized relay K3 in Z1008 (7-5) closes contacts 8 and 9, thereby shorting pins D and 3 of Z1008 card. This results in placing the 24 VAC source from pins 5 and 6 of transformer T1001

(7-1) across the PUNCH lamp. The PUNCH lamp (not shown in figure 7-1) is wired across pins A and P of receptacle J1002.

(5) MANUAL PROGRAM/TAPE PUNCH OPERATION - This operation is a combination of MANUAL PROGRAM and TAPE PUNCH operations, in which tape is punched simultaneously with the transmission of control codes by the operator at the keyboard.

Mode switch S1002 makes the same connections as for TAPE PUNCH except that it reconnects the code output to the keyer, in order to allow transmission. Wafer S1002B in position #2 (7-1) re-connects the code output pin 3 of Shift-Register card Z1006 to pin V of Relay Card Z1008.

(6) TAPE READER OPERATION - In this operation, the Programmer is used to transmit a tuning message from an associated tape reader, reading a previously punched tape (or card). The keyboard is not used in this mode.

The process of the bits of each code through the Programmer may be compared with that in the MANUAL PROGRAM operation with the exception that (a) the code input is from the reader rather than from the keyboard, (b) the reader starts the clock rather than code passage through Gating Circuit card Z1005, and (c) a "start search" signal is originated from the Programmer to the reader to energize the reader for each code.

Mode switch wafer S1002A connects the 115 VAC source required for the reader drive mechanism to the same two pins (W and X) of receptacle J1002 (7-1) as it did for the puncher mechanism in the TAPE PUNCH operation. This is due to the fact that the puncher and reader generally used with the programmer are one unit, utilizing a common power supply.

Code input from the reader into Gating Circuit card Z1005 generates the same action through Z1005 as does code input from the keyboard. Code input of the first code occurs as soon as the mode switch is set at TAPE READER, for readers containing a self-starter. Procedure for readers without a starter are discussed later. The first code then appears at pins K, E, H, J and F of receptacle J1003 (7-1) and at pins M,Y,P,N and W of Gating Circuit card Z1005.

The code at Z1005 (7-2) is in the form of a connection to ground (hole in tape) for a "1" bit and no connection (no hole) for a "0" bit. These bits then appear at one leg of each of the five code input andgates in Z2 and Z6. The other leg of each gate is connected to the keyboard output and, since the keyboard is disabled, these inputs represent opened connections and draw a constant negative charge from pin 4 of Z1005 card. As in MANUAL PROGRAM, a "1" bit (+) from the reader causes the andgate output to go positive and a "0" bit causes a negative output. The code appears at pins E,K,H,R and S of Z1005 and at pins M,E,D,B and C of Shift-Register card Z1006 (7-1). In Z1006 (7-3) the code bits sit on one leg of each of the five code input andgates in Z8 and Z11, awaiting clock pulses to shift them out of the Programmer.

The clock in Timing Circuit card Z1007 is started by the first "search complete" signal from the reader. The usual start signal from Z1005 card is cut off by mode switch wafer S1002C in TAPE READER position (7-1). The "search complete" signal, in the form of a ground, is extended into the Programmer via pin S of J1003 (7-1) and pin X of Timing Circuit card Z1007. The ground at pin X of Z1007 (7-4) fires single-shot Z8 via amplifier Z9. Z8 issues at 4 ms positive pulse which, inverted through Z5 inverter, appears as a negative pulse at pin 3 of nandgate Z7 and pin 3 of nandgate Z6. Pin 1 of Z7 is, at that instance, receiving a positive input from pin Y of Z1007 card and pin 1 of Z6 is receiving its inverted version (a negative charge) through another inverter in Z5. (Pin Y of Z1007 is getting the positive input from the usual positive output, for each code, from pin 8 of Gating Circuit card Z1005). Therefore, with two negative inputs (during the 4ms pulse) Z6 produces a positive 4ms pulse at pin B of Z1007. The negative input at pin 3 of Z7, on the other hand, produces no change in its negative output. The positive pulse from Z1007 pin B is connected back to pin W of the same card via wafer S1002C of the mode switch (7-1). This pulse at pin W (7-4) sets flip-flop Z3, causing its output to swing negative and starting clock Z1. Z1 then proceeds to work through single-shot Z4 to energize the shift-register in Z1006 card and, as in MANUAL PROGRAM mode, the code is shifted out of the Programmer keyer.

The clock, in Timing Circuit card Z1007, is stopped in the same manner as for all other modes (i.e., a positive output at pin V of Z1006, upon bit #5 shift, to pin U of Z1007).

The bit #5 shift, in Shift-Register Z1006, also triggers the "start search" signal to the reader for the next code. When bit #5 is shifted out by flip-flop Z10 in Z1006 (7-3), as it goes from set to reset, it produces a negative 22 ms pulse. The pulse, inverted through an inverter in Z13, appears as a positive pulse at pin R of Z1006 card and (7-1) at pin 5 of Gating Circuit card Z1005. Pin 5 of Z1005 (7-2) is connected to one leg of nandgate Z7 (pin 1). Pin 3 of Z7 is held negative by the steady negative output from nandgate Z7 in Z1007 (7-4) via Z1007 pin 3 and Z1005 pin C (7-1). The positive pulse at nandgate Z7 pin 1, in Z1005 (7-2), then produces a negative 22 ms pulse at the nandgate output and this pulse travels (1) to pin B of Z1005 card and (2) to pin 7 of an andgate in Z2. Pin B of Z1005 is connected to pin C of Timing Circuit card Z1007 (7-1). At pin C of Z1007 (7-4), the positive upswing of the negative pulse resets flip-flop Z2, causing its output to swing negative at this instance. In Z1005 (7-2), meanwhile, the negative 22 ms pulse at pin 7 of the andgate in Z2 causes the andgate output to go negative for 22 ms, since the other leg of the andgate is kept negative by the steady negative output of "E" nandgate Z5. The negative pulse from the andgate travels to the CR2 input of the CR1/CR2 orgate. Since the other input (CR1) is kept at a constant + charge via the -12V (at pin 4 of Z1005) inverted through inverter Z1, the orgate output produces a negative pulse and this is connected to single-shot Z3 via amplifier Z10. The positive upswing of the pulse fires Z3 and a negative 20 ms pulse is produced at pin 3 of Z1005 card and (7-1) at pin E of Timing Circuit card Z1007. The positive upswing of the negative pulse at pin E of Z1007 (7-4) sets flip-flop Z2 and its output swings positive at a time 20 ms after it had been reset from pin C of Z1007. The positive upswing of this negative 20 ms pulse from flip-flop Z2 is the "start search" signal to the reader via pin 2 of Z1007 and (7-1) pin T of J1003.

The "start search" signal, in the reader, causes the reader to advance the tape (or card) by one position and scan the next code; in this way, a reciprocating action is set up, between Programmer and reader. The next code and "search complete" signal are presented to the Programmer, causing another cycle and another "start search" signal to the reader from the Programmer for the third code. This action continues until the punched "E" code is read by the reader.

When the "E" code (10000) enters Gating Circuit card Z1005, reciprocating action is stopped by the blocking of the next "start search" signal. In Z1005 (7-2) the 10000 code, appearing at the five andgate outputs in Z2 and Z6, causes a positive output at pin 11 of Z2 and four negative outputs at the other four andgates. Pin 11 output, inverted through an inverter in Z1, appears as a negative charge at pin 11 of "E" nandgate Z5. The other four negative bit outputs are routed directly to Z5. With all negative inputs, Z5 output goes positive, placing a positive charge on pin 3 of an andgate in Z2. When the other leg of the andgate receives the negative 22 ms pulse from nandgate Z7 (as a result of the E code shifting out of the programmer) the andgate output now remains at a steady positive, thus blocking the formation of the "start search" signal for the next code.

Mode switch S1002, in TAPE READER position, switches in the Programmer transmission output and cuts off the "start process" signal to the puncher. Wafer S1002B (7-1) connects code output pin 3 of Shift Register card Z1006 to pin V of Relay card Z1008. Wafer S1002C disconnects pin 2 of Z1008 ("start process" output) from pin U of receptacle J1003 to the puncher.

When the reader does not include a self-starter, the first "start search" signal must be originated by pushing TAPE READ button S1003 on the Programmer front panel (7-1). This is a momentary contact button and supplies ground, while it is held down, to pin 2 of Gating Circuit card Z1005. Pin 2 of Z1005 (7-2) is connected to one leg of the orgate (formed by CR1 and CR2 diodes) via an inverter in Z1. The other leg of the orgate (at TP3) receives a steady positive input at this time. Pin 2 of Z1005 is also connected to a steady -12V supply. Before the TAPE READ button is pushed, this -12V (inverted through Z 1) forms another positive input to the orgate and the orgate output remains positive. When the button is pushed, the input swings negative and the orgate output swings negative; when the button is released the orgate output returns to positive. Therefore, pushing the TAPE READ button creates a negative pulse from the orgate to single-shot Z3 via amplifier Z10. On the positive upswing of the pulse, Z3 fires, producing the required 20 ms pulse that (as described previously) ultimately results in the "start search" signal.

In a TAPE READER operation utilizing an associated timer, the timer originates the triggering of the first "start search" signal for each message. In this case the self-starter (if any) in the reader is disconnected. The timer accomplishes the triggering in the same way as does the operator with the TAPE READ button. Plugged into TIMER jack J1009 (7-1), the timer supplies the necessary brief connection to ground for pin 2 of Z1005 card.

A TAPE READ lamp, built into the TAPE READ button, lights when mode switch wafer S1002A (7-1) is in TAPE READER position. This places 24 VAC from pins 5 and 6 of transformer T1001 across the lamp.

Relay K3, in Z1008 (7-5), energized by the associated NO PUNCH switch, connects 24 VAC across the associated NO PUNCH lamp (not shown) by closing contacts 9 and 10 and shorting pins 3 and E of card Z1008.

When a blank (no code) is encountered on the tape after a "start search" signal from the Programmer, nandgates in Timing Circuit card Z1007 create another "start search" signal from the "search complete" signal received from the reader, after scanning the blank. In doing this, Programmer shift-register action is by-passed, saving time--particularly in the series of blanks usually found when a tape is started into a reader. The "search complete" signal entering the Programmer results in the usual negative 4 ms pulse at pins 3 of nandgates Z6 and Z7 of card Z1007 (7-4). However, since no code has appeared at Gating Circuit Z1005, pin Y of Z1007 is now a steady negative charge, creating a negative charge at pin 1 of Z7 and a positive charge (via inverter Z5) at pin 1 of Z6. The negative pulse at pin 3 of Z6 then has no effect on the Z6 output and the shift register clock is not started. On the other hand, with two negative inputs, Z7 output goes positive for 4 ms. This positive pulse travels through pin 3 of card Z1007 to pin C of Gating Circuit card Z1005 (7-1). Pin C of Z1005 (7-2) is connected to one leg (pin 3) of nandgate Z7; the other leg (pin 1) is getting a steady negative charge from the shift-register via pin 5 of Z1005. Nandgate Z7 output goes negative for 4 ms and the negative pulse appears at (a) pin 7 of andgate Z2 and pin B of card Z1005. Pin B of Z1005 is connected to pin C of card Z1007 (7-1) and the end of the negative pulse resets flip-flop Z2. Z2 output then goes negative. The negative 4 ms pulse at pin 7 of andgate Z2 in Z1005 (7-2), meanwhile, produces the usual negative output, ultimately resulting in the firing of single-shot Z3. Z3 then issues the required 20 ms negative pulse resulting in the next "start" search signal to the reader from pin 2 of Z1007.

(7) RE-PUNCH OPERATION - In RE-PUNCH operation, a copy is made of a previously punched message and there is no transmission from the Programmer. This operation essentially combines the action of a TAPE READER operation (without transmission) and a TAPE PUNCH operation.

Mode switch S1002, in RE-PUNCH position, makes all the necessary connections for the tape read-and-punch automatic sequence. Wafer S1002A connects the 115VAC from transformer T1001 primary coil to pins W and X of J1003, power output for reader and puncher mechanisms; S1002B also connects 24 VAC from pins 5 and 6 of T1001 secondary across the TAPE READ lamp, lighting it. Wafer S1002B disconnects the code output from pin 3 of Z1006 to pin V of Z1008, interrupting transmission, and connects "start search" output to the puncher from pin 3 of Z1005 to pin E of Z1007. Wafer S1002C connects the clock starting signal from pin B of Z1007 to pin W of Z1007 (to perpetuate the reader-programmer reciprocating action) and connects the "start process" signal, for the puncher,from pin 2 of Z1008 to pin U of J1003. In the RE-PUNCH operation, the associated PUNCH/NO PUNCH switch is set at PUNCH, completing the path of the "start process" signal through relay K3 in Z1008, in the same manner as for TAPE PUNCH operation.

The process starts, as in TAPE READER, by a self-starter in the reader or by pushing the TAPE READ button, if no self-starter exists. Codes proceed from the tape in the same manner as that described for TAPE READER operation.

Delay circuits in the Programmer work to allow time between the reception of the code by the Programmer from the reader and the movements in the puncher to come into position to punch the code. The bits of the code, from the reader, appear at pins 9,10,J,13 and L of Z1005 (7-2) and, simultaneously, at pins R,P,M,N and 11 of J1003 to the puncher. At the same time, the reader supplies its first "search complete" signal from pin S of J1003 (7-1) to pin X of Timing Circuit card Z1007. This signal results in starting the shift-register in Z1006 in the same manner as in the TAPE READER mode. When Shift-Register card Z1006 (7-3) has reached bit #4 of the code, flip-flop Z4 becomes set, issuing the positive charge (ground) from pin 11 to pin 21 of Z1006 card. Pin 21 of Z1006 (7-1) is connected to pin C of Relay card Z1008. The "start process" signal then becomes connected to pin U of J1003 via a short across pins C and 2 of

Z1008 produced by closed contacts 5 and 6 of de-energized relay K3 in Z1008 (7-5). At a time interval of 22 ms after the bit #4 shift, bit #5 flip-flop Z10 in Z1006 (7-3) sets and resets. This 22 ms pulse (from the bit #5 shift) triggers the next "start search" signal to the reader for the next code, in the same manner as for the TAPE READER operation. The aggregate time delay between the "start process" signal to the puncher for thr first code and the "start search" signal to the reader for the second code is the result of three delay pulses. These are the 22 ms pulse from Z1006 bit #4 flip-flop, the 22 ms pulse from bit #5 flip-flop and the 20 ms pulse from single-shot Z3 in Z1005--a nominal total of 62 ms.

The "E" code, entering Gating Circuit card Z1005, results in stopping the reciprocating programmer-reader action in the same manner as that for TAPE READER operation. With no further codes issuing, the puncher action stops also.

d. POWER SUPPLY SECTION - The power supply section of the Programmer not only furnishes the power and reference voltages for Programmer operation but also those for the associated puncher and reader. Components for the power supply section are mostly contained in Power Supply card Z1009 (7-1). Power Supply design is a conventional transistorized type, supplying d-c outputs from a line voltage input. +12 and -12 volts are supplied for the Programmer logic circuitry and 24 VAC is supplied for Programmer lamps and lamps in associated EQUIPMENT (recognition code generator and PUNCH/NO PUNCH lamps). +6V, -18V, -18V "delayed", -24V and 115 VAC are supplied for logic reference, relay and power voltages for the associated reader and puncher.

The "delayed" -18V is obtained by action of a relay in Z1008 Relay card. The original -18V (appearing at pin 5 of Z1009 card) is connected to pin M of Z1008 (7-1) and to one side of relay K1 coil in Z1008 (7-5). The other side of the K1 coil is grounded. The -18V (appearing as soon as Programmer POWER switch S1001 is set at ON) energizes relay K1 and two sets of contacts close to connect the -18V back to pin B of Z1008 and (7-1) to pin C of receptacle J1003.

Details on the utilization of the power voltages to the puncher-reader mechanisms may be found in the modular instruction manuals accompanying their shipment.

SECTION 5

MAINTENANCE

5-1. COMPONENT LOCATIONS

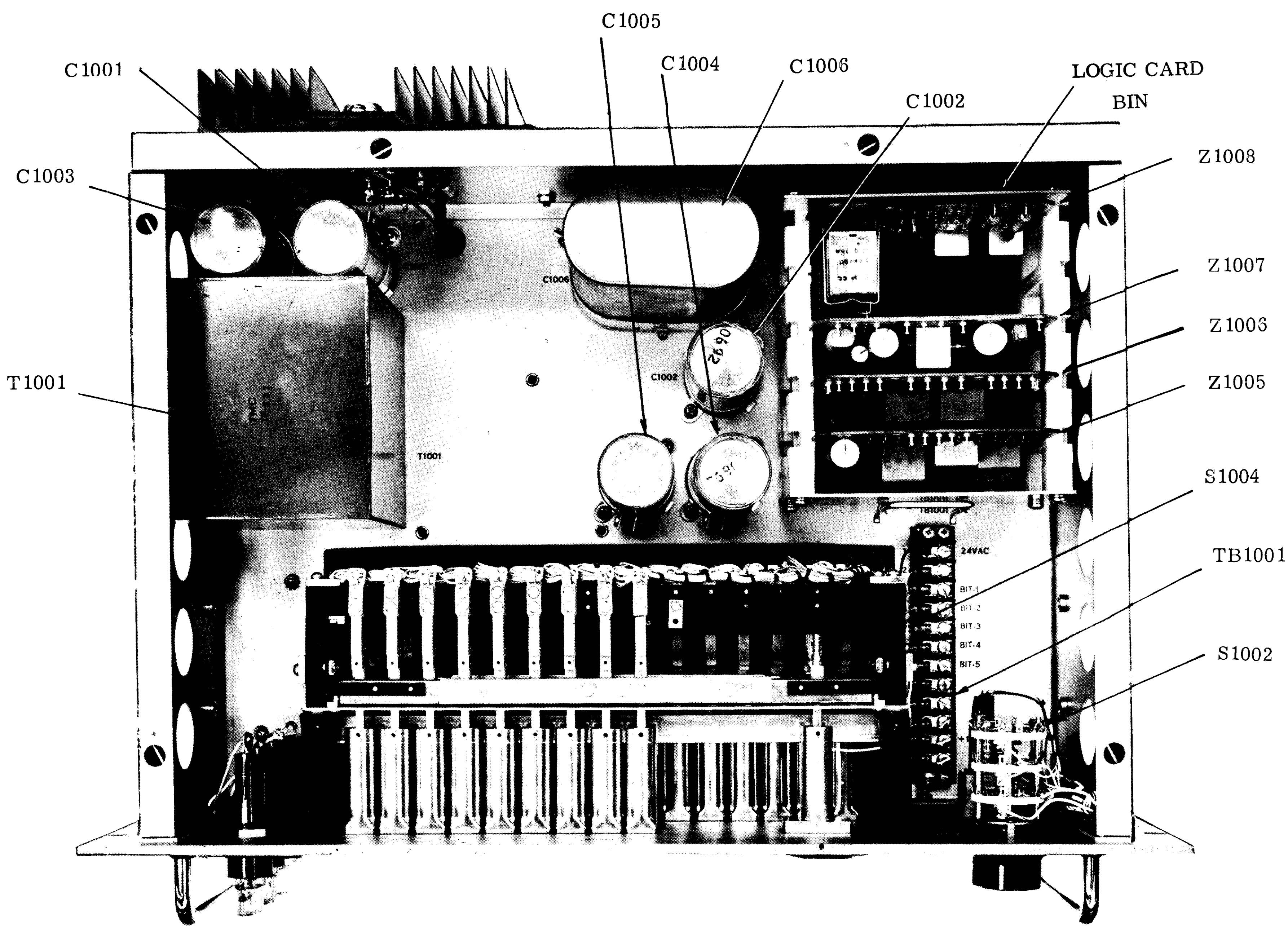
The logic circuits in the Programmer are contained in four printed circuit plug-in cards mounted in a bin on the top side of the chassis (see figure 5-1). The card Z1000 numbers are the circuit reference symbol numbers; "A" numbers are the card assembly part numbers by which they are identified and ordered. The "A" number appears printed on the card and again on the chassis wall adjacent to the card's receptacle, along with the card Z1000 number. The plug end of each card contains keying notches and its receptacle, in the bin floor, contains matching blocks to prevent inserting a card into the wrong receptacle. Some cards in the Programmer and in other TMC logic equipment, although they are assigned different "Z" numbers, have the same "A" numbers and are identical and interchangeable. These cards have similar keying at their plug ends and in their receptacles. The larger power supply circuit components are mounted on the top side of the Programmer chassis; smaller components are contained in printed circuit card Z1009, on the bottom side of the chassis (see figure 5-2). Transistors Q1001 and Q1002 are mounted on a heat sink on the chassis rear (see figure 5-3).

The keyboard, S1004 (as described in paragraph 4-3b) is one assembly consisting of all code buttons. This assembly is mounted on the rear surface of the front panel.

5-2. SPECIAL TOOLS AND TEST EQUIPMENT

Special tools included in the shipment* and required for Programmer testing and repair are shown in figure 5-4. Table 5-1 lists standard laboratory equipment required but not supplied. Also, of particular value in speedy troubleshooting is a set of spare logic cards for card-substitution procedures.

* Shipment of system in which Programmer is used.



4094-7-1

Figure 5-1. Top View, RTPH

667.13-5

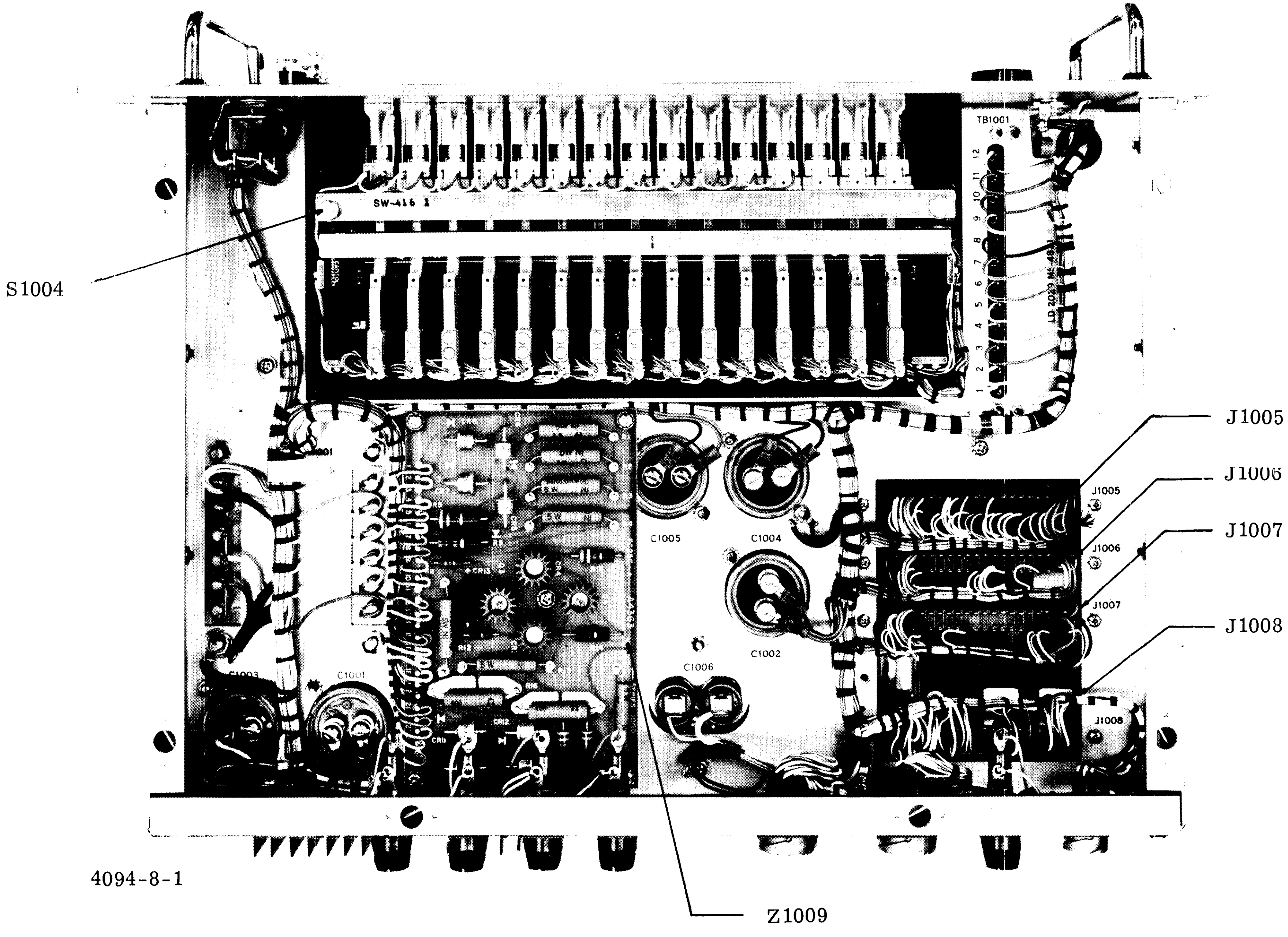


Figure 5-2. Bottom View, RTPH

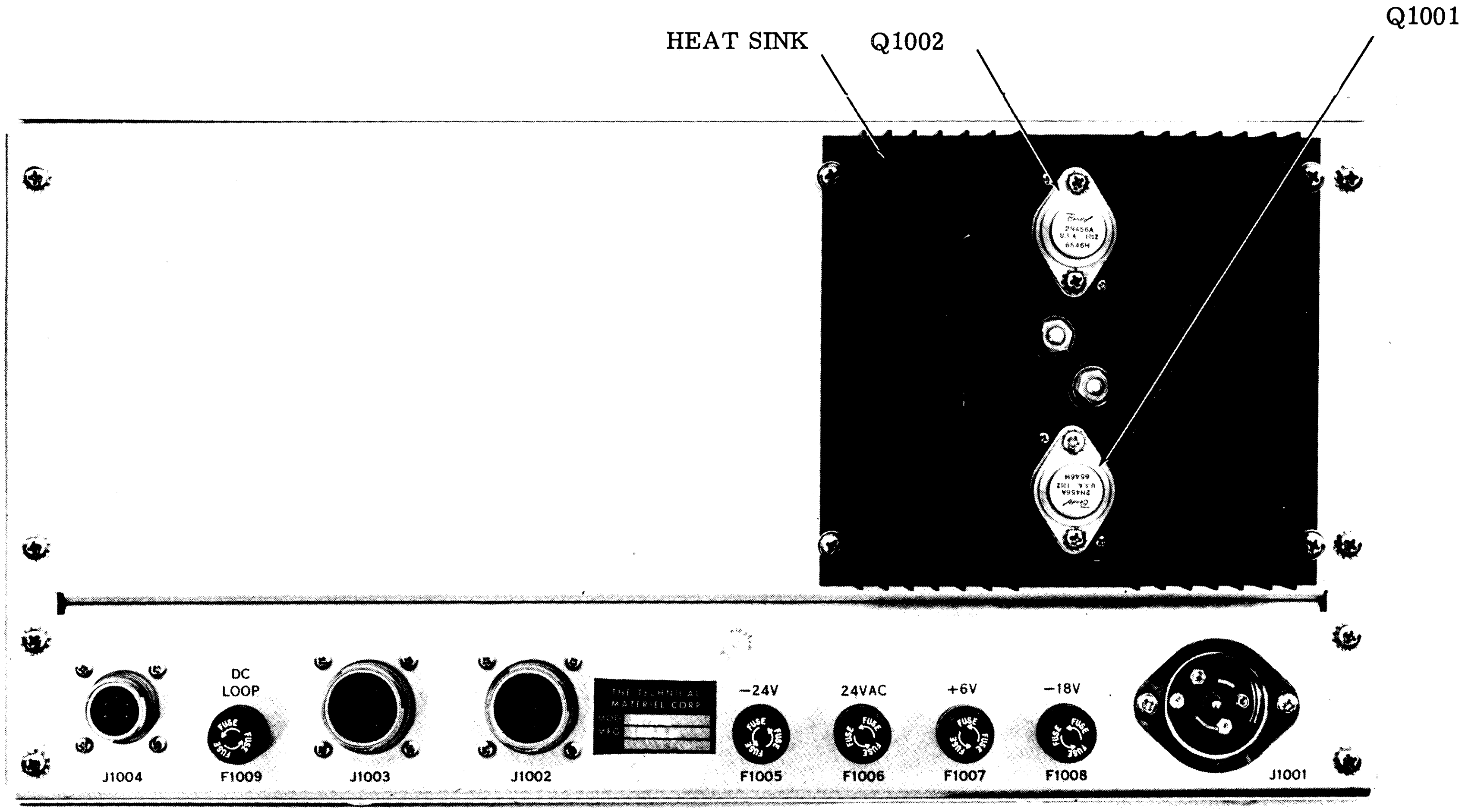
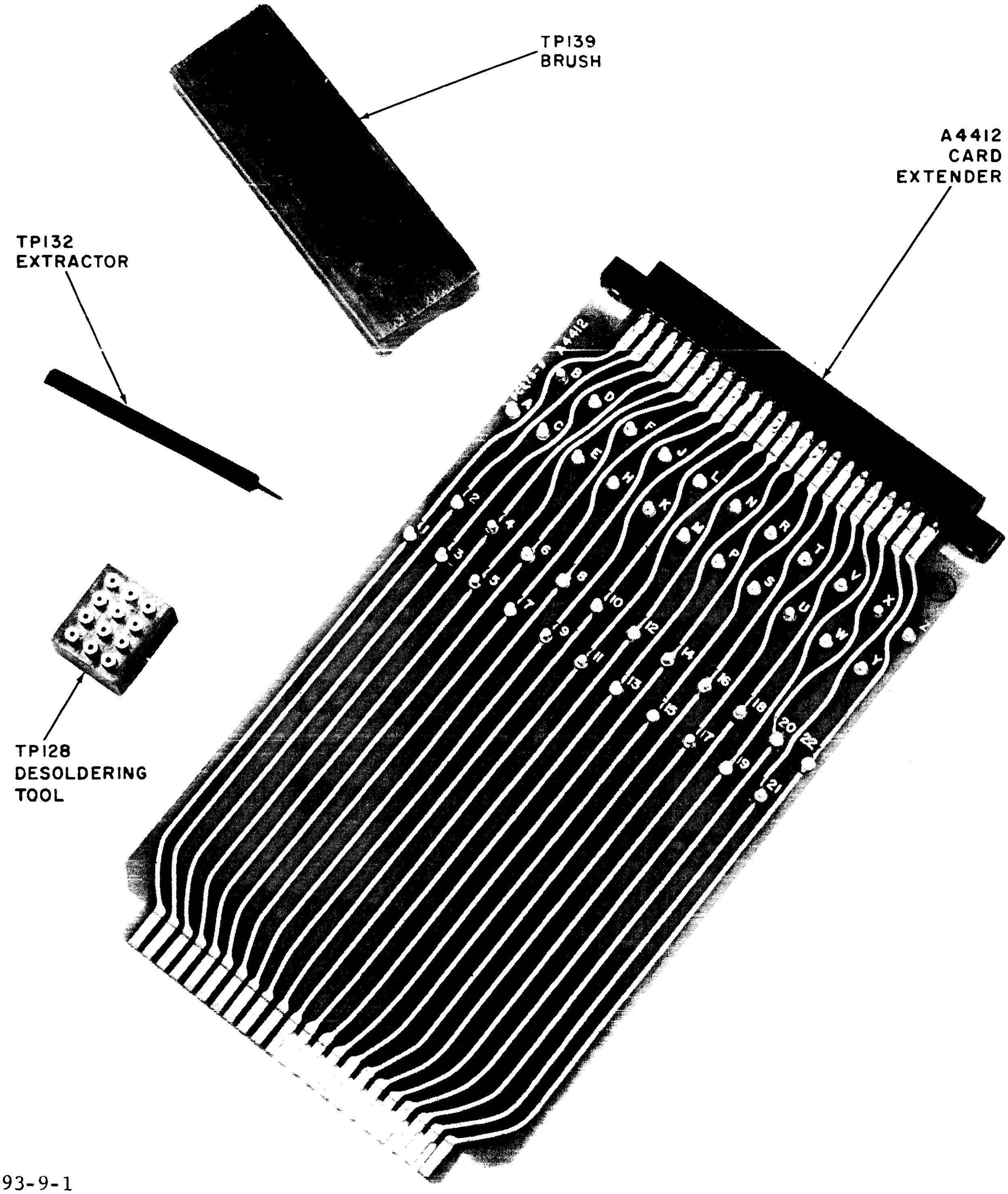


Figure 5-3. Rear View, RTPH

667.13-4



672.14-5

4093-9-1

Figure 5-4. Maintenance Tools, Logic Circuit

TABLE 5-1. TEST EQUIPMENT

ITEM	MANUFACTURER
Vacuum Tube Voltmeter	Hewlett Packard, Model 524C, or equivalent
Oscilloscope	Tecktronic Model 545, or equivalent
Teletypewriter Set (with keyboard, tape puncher, tape reader and 7.42 serial CCIT 5-level code electrical output)	Smith-Corona Marchant (Kleinschmidt Div.) AN/FGC-25 or equivalent

5-3. PREVENTIVE MAINTENANCE

a. In order to prevent equipment failure due to dust, dirt and other destructive elements, it is suggested that a schedule of preventive maintenance be be set up and adhered to.

b. At periodic intervals, the equipment should be removed from its mounting for cleaning and inspection. All accessible covers should be removed and the wiring and all components inspected for dirt, corrosion, charring, discoloring or grease. Remove dust with a soft brush or vacuum cleaner. Remove dirt or grease from other parts with any suitable cleaning solvent. Use of carbon tetrachloride should be avoided due to its highly toxic effects. Trichlorethylene or methylchloroform may be used, providing the necessary precautions are observed.

WARNING

When using toxic solvents, make certain that adequate ventilation exists. Avoid prolonged or repeated breathing of the vapor. Avoid prolonged or repeated contact with skin. Flammable solvents shall not be used on energized equipment or near any equipment from which a spark may be received. Smoking, "hot work", etc. is prohibited in the immediate area.

CAUTION

When using trichlorethylene, avoid contact with painted surfaces, due to its paint removing effects.

5-4. TROUBLESHOOTING

a. INTRODUCTION - This section includes a voltage table and timing charts for checking normal voltages and pulse patterns in the Programmer. Before proceeding to take any readings, however, the technician is advised to read this section, with particular reference to paragraph 5-4b (following), describing techniques to be used in order to prevent damage to the miniaturized circuits.

b. CARD SETUP FOR TEST READINGS - To bring the test points on a card or on its receptacle pins up for accessibility, remove the card and insert an A-4412 Card Extender (see figure 5-5) in the card receptacle. Then plug the card into the top of the Card Extender.

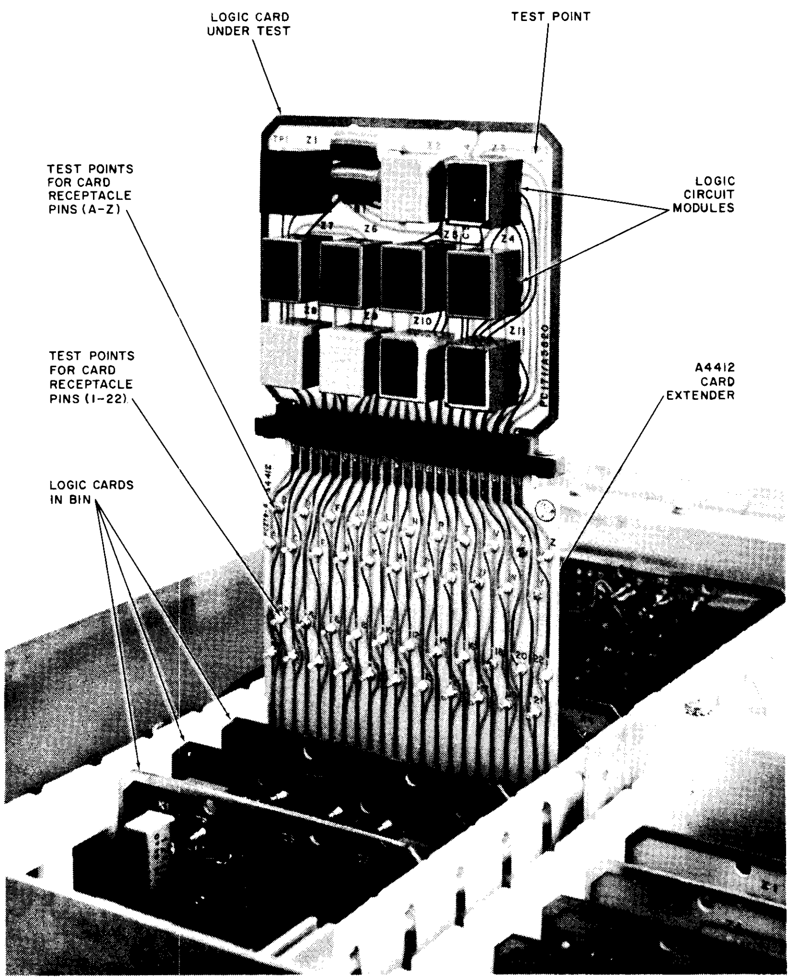
NOTE

Check to ensure that "A" number on card matches "A" number printed on side of bin adjacent to bin receptacle. Because the Card Extender is keyed to fit into all receptacles, it is possible to connect a card to the wrong receptacle.

Figure 5-5 shows a typical card in test position. For each test point, listed in the timing charts in figures 5-6 through 5-8, there is a numbered "TP" test point terminal on the card or a card receptacle pin test point on the Extender. Receptacle pins are identified by letters and numbers. Test points for the lettered pins are arranged in two rows on the Extender near the top; test points for numbered pins are located in two rows beneath the lettered rows.

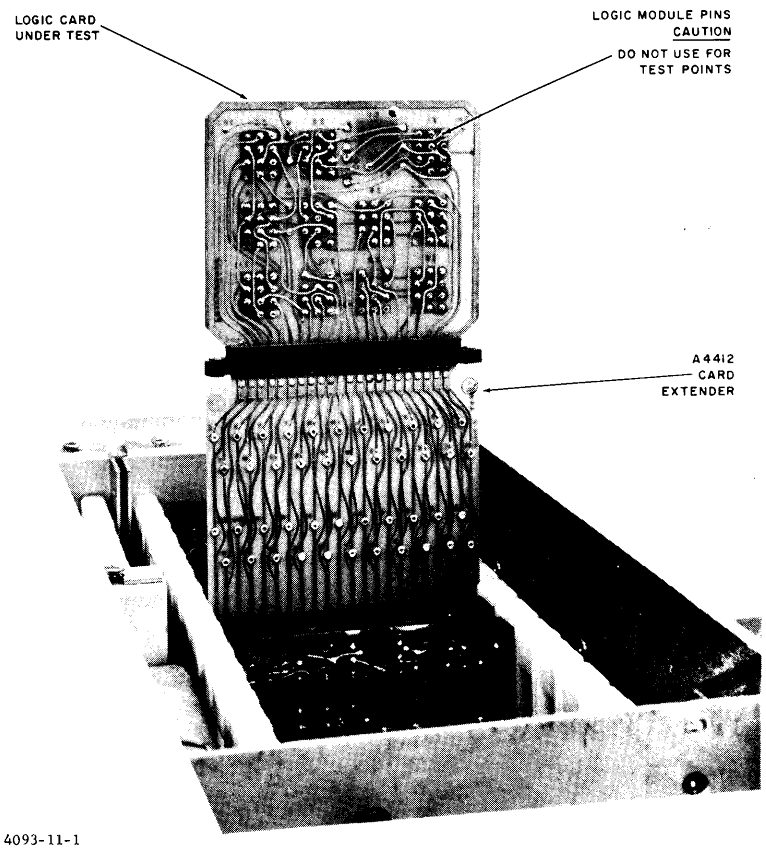
CAUTION

Do not apply test probe to pins of encapsulated logic modules! Apply probe only to "TP" test points on card or receptacle pin test points on the Extender. It is difficult to touch the probe to the miniature pins on the module without shorting it out and destroying the module.



Front View

672.14-3



Rear View

672.14-4

Figure 5-5. Card in Test Position

c. CHECKING PRINTED CIRCUIT CONDUCTORS - Breaks in the conducting strip (foil) on a printed circuit card can cause permanent or intermittent trouble. In many instances, these breaks will be so small that they cannot be detected by the naked eye. These almost invisible cracks (breaks) can be located only with the aid of a powerful magnifying glass.

To check out and locate trouble in the conducting strips of a printed circuit board, set up a multimeter (one which does not use a current in excess of 1 ma) for making point-to-point resistance tests, using needle point probes. Insert one point into the conducting strip, close to the end of terminal, and place the other probe on the terminal or opposite end of the conducting strip. The multimeter should indicate continuity. If the multimeter indicates an open circuit, drag the probe along the strip (or if the conducting strip is coated, puncture the coating at intervals) until the multimeter indicates continuity. Mark this area; then use a magnifying glass to locate the fault in the conductor.

CAUTION

Before using an ohmmeter for testing a circuit containing transistors or other voltage-sensitive semiconductors, check the current it passes under test on all ranges. DO NOT use a range that passes more than 1 ma.

d. TROUBLESHOOTING PROCEDURE - Troubleshooting time is greatly shortened if a set of spare plug-in cards are available. If the trouble is located in the logic circuitry (rather than in the power supply or keyboard), card substitution will determine this and, also, point out the faultv card. Furthermore, subsequent checking of pulse-forms to establish the faulty component (or broken conductor) on the card is locallized to that one card. To do this, refer to paragraph 5-4e, USE OF TIMING CHARTS.

If card substitution fails to locate the trouble, it may be generally assumed that a power supply voltage is missing. Set POWER switch at ON and check voltage points as indicated in table 5-2, using a VTVM.

If power supply voltages check out, check wiring continuity through keyboard, referring to figures 7-6 and 7-7. Also check wire runs between card receptacles for broken or loosened wires, referring to figure 7-1.

If Z1008 card (Relay circuit card) proves to be faulty, a visual check of relay operation may be made to single out the malfunctioning relay. Setting the POWER switch at ON should energize relay K1 and polar relays K4 and K5. Pushing a code button in the recognition code generator should then energize relay K2 ; K2 should remain energized on release of the button. With K2 energized, pushing a Programmer button should energize polar relays K4 and K5 into their alternate positions. Relay K3 should be energized by closing the associated NO PUNCH switch or button.

e. <u>USE OF TIMING CHARTS</u> - Figures 5-6 through 5-8 are timing charts depicting necessary coincident pulses in a properly performing Programmer. Voltage changes (between -12V and OV) are plotted for each test point in a chart against a common time base. The three charts show the test points in the Programmer for the three basic modes of operation.

When using a chart (whether for checking the entire Programmer or only one card) proceed in the order as presented by the listing (top to bottom) within the chart.

It is seldom necessary to check through all 3 charts and all 3 cards. The quickest way to reveal the one malfunctioning card is the card substitution method. However, if spare cards are not available for this method, observations may be made on the specific nature of the trouble and specific mode/s of operation giving trouble in order to narrow down the search. Reference to figure 4-1, Block Diagram, and its accompanying text will sometimes point out the card.

Check coinciding pulse edges (voltage changes) for pairs of test points,

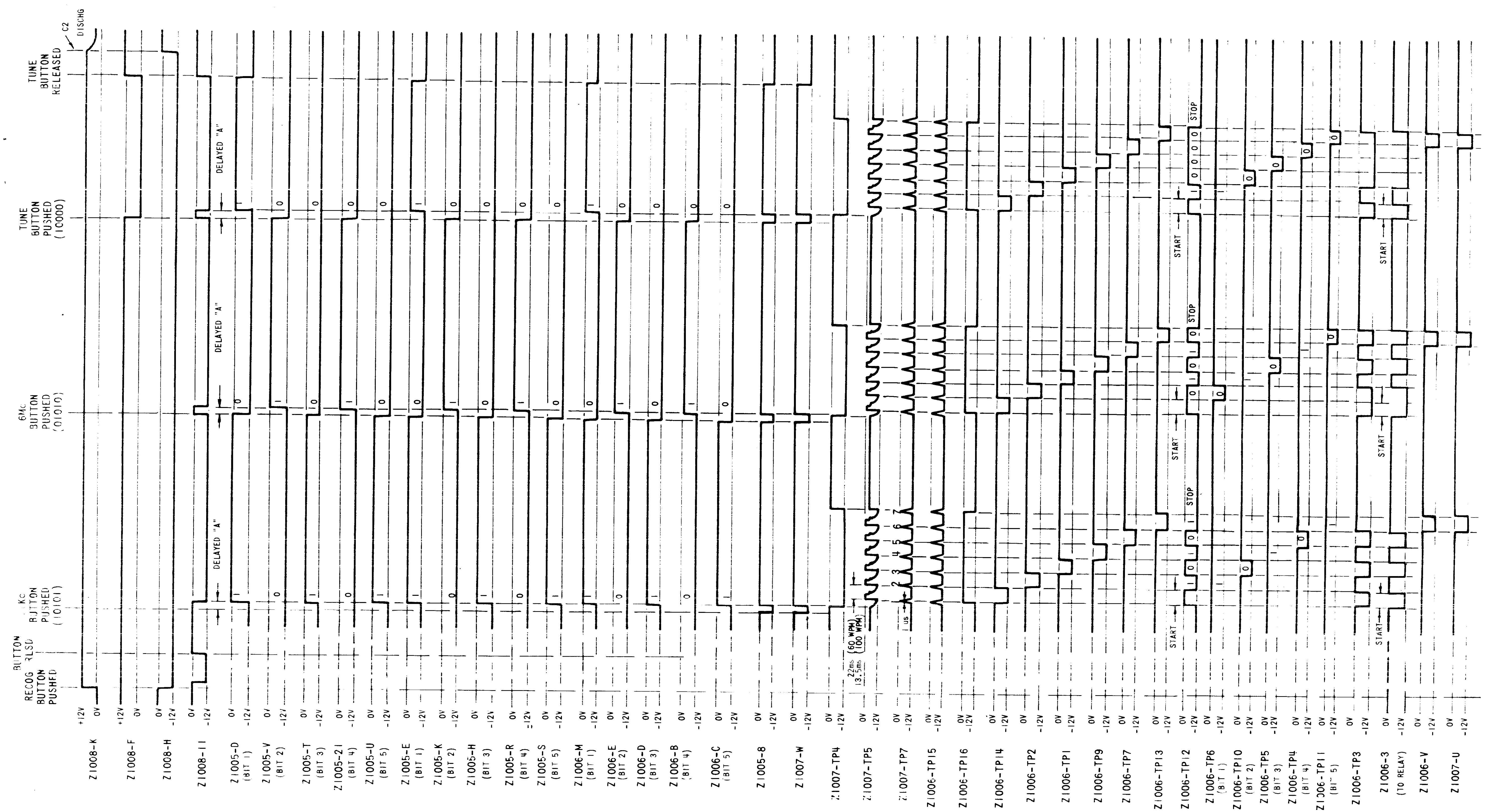


Figure 5-6. Timing Chart, MANUAL PROGRAM Operation

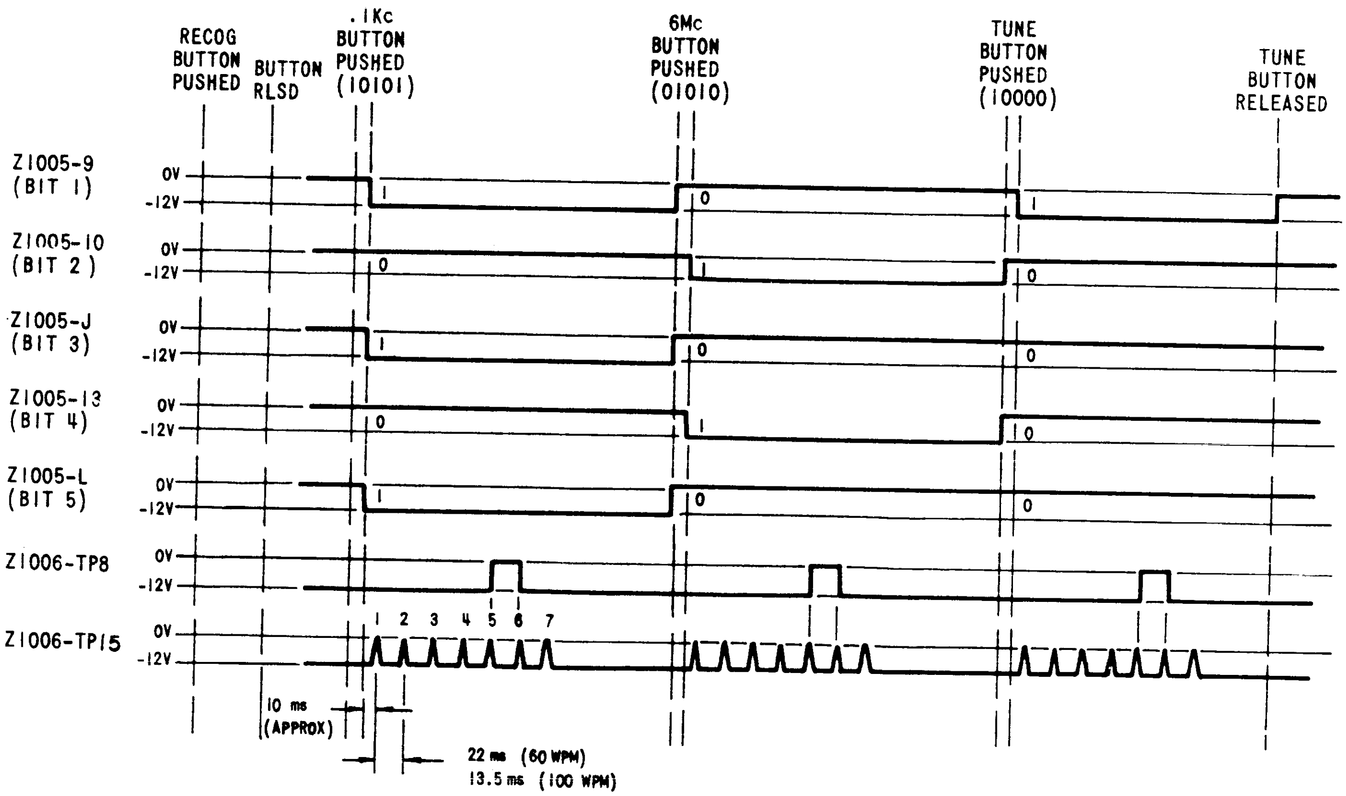
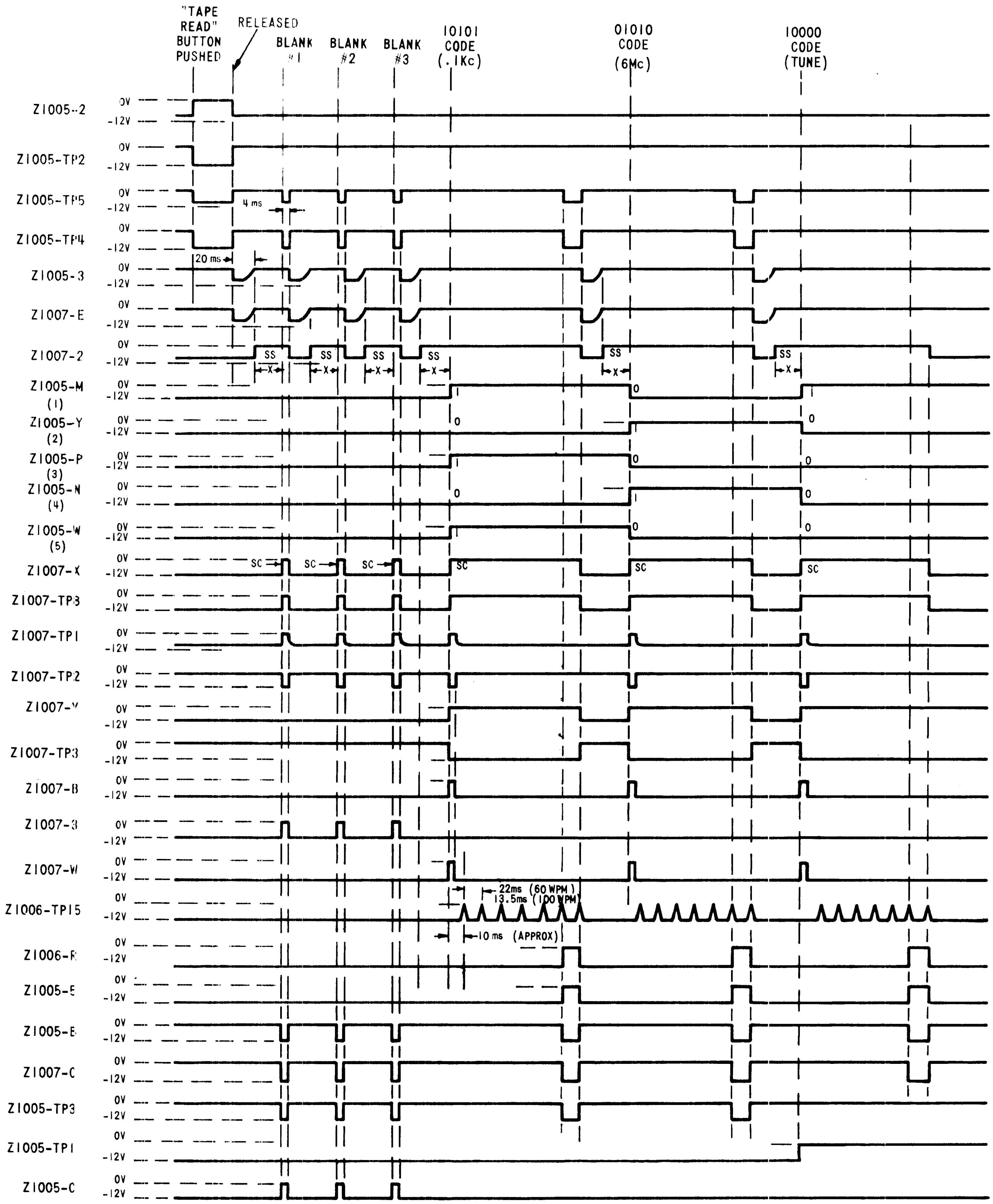


Figure 5-7. Timing Chart, TAPE PUNCH Operation



LEGEND:

SS " START SEARCH" SIGNAL TO READER
SC " SEARCH COMPLETE" SIGNAL FROM READER
X TIME VARIES WITH TYPE OF READER USED

4094-12

Figure 5-8. Timing Chart, TAPE READER Operation starting at the top of the listing for that card in the chart. Use time bases A and B on the oscilloscope to do this. Set the oscilloscope for an external triggering mode, with a negative triggering slope and level for the negative-going changes and a positive triggering slope and level for the positive-going changes. The exact shape of a pulse is not an important factor in troubleshooting the Programmer. Very often, different attenuator lines into the oscilloscope will produce pulse shape distortions that are not present in the Programmer. The critical fact is whether or not the expected voltage changes occur in the polarities and patterns as indicated.

For MANUAL PROGRAM operation, check pulses indicated for faulty card in table 5-6. A recognition code generator is necessary, since a button on this unit must be pushed to unlock the Programmer Circuitry. Check each pair of points through their phases by pushing the recognition code button, the ".1KC" button, the "6MC" button and the "TUNE" button.

For TAPE PUNCH operation, first check pulses for the faulty card indicated in table 5-6, as described for MANUAL PROGRAM. If the trouble is not revealed, check pulses shown in table 5-7.

For MANUAL PROGRAM/TAPE PUNCH operation, perform both MANUAL PROGRAM and TAPE PUNCH checks.

For TAPE READER operation, first check pulses for the card indicated in table 5-6, using the Programmer keyboard for the test codes. If the trouble is not revealed, check pulses for the card as indicated in table 5-8, using a pre-punched tape in the reader. Use a tape with the three codes (10101, 01010, and 10000) punched, as indicated, preceded by three blanks. If the reader does not have a self-starter, push the Programmer TAPE READ button to start the sequence; if the reader includes a self-starter, it is not necessary to push this button and the first pulse on the first four lines will not appear.

For RE-PUNCH operation, refer to all three tables. First, check pulses for the faulty card indicated in table 5-6, using Programmer keyboard for the test codes. If the trouble is not revealed, check pulses for the card as indicated in table 5-8, using a pre-punched tape in the reader. If the trouble is not yet revealed, check pulses for the card as indicated in table 5-7, using the Programmer keyboard for the test codes again.

5-5. REPAIR AND REPLACEMENT

a. INTRODUCTION.- Repair of the Programmer chassis-mounted power supply circuitry follows standard lab procedures. Repair of printed circuit cards and card receptacle wiring, however, require the special tools and techniques as outlined here. Section 6, Parts List, lists all replaceable parts by their circuit symbol numbers. Encapsulated logic circuit modules (mounted on the cards) are nonrepairable items and are replaced with new ones when damaged.

NOTE

Replacement of logic modules on the printed circuit cards requires the special tools and technique described in paragraph 5-5b.

b. REPLACEMENT OF LOGIC MODULES.- When replacing logic circuit module on a card, it is necessary to remove the old module from the card by a simultaneous melting of the solder on all the logic pins. TP128 Desoldering Tool (see figure 5-4) is included in the RTPH shipment* for this purpose. Soldering the new module to the card is done pin-by-pin with conventional methods.

To remove a module from a card, fasten a 100-watt soldering iron (with 3/8-inch tip) in a vertical position with a vise as shown in figure 5-9. Remove the 3/8-inch tip and re-install it into the iron in the inverted position, with approximately 1-1/2 inches extending. Slip the TP128 Desoldering Tool onto the end of the tip (as shown in figure 5-9) and secure with an 8-32 set screw.

Refer to figure 5-10. Clean old solder out of TP128 cups with TP139 suede brush included in shipment* (figure 5-4). Plug iron extension cord into power outlet and allow to heat for 15 minutes. Lower card onto TP128 with pins

* Shipment of system in which Programmer is included.

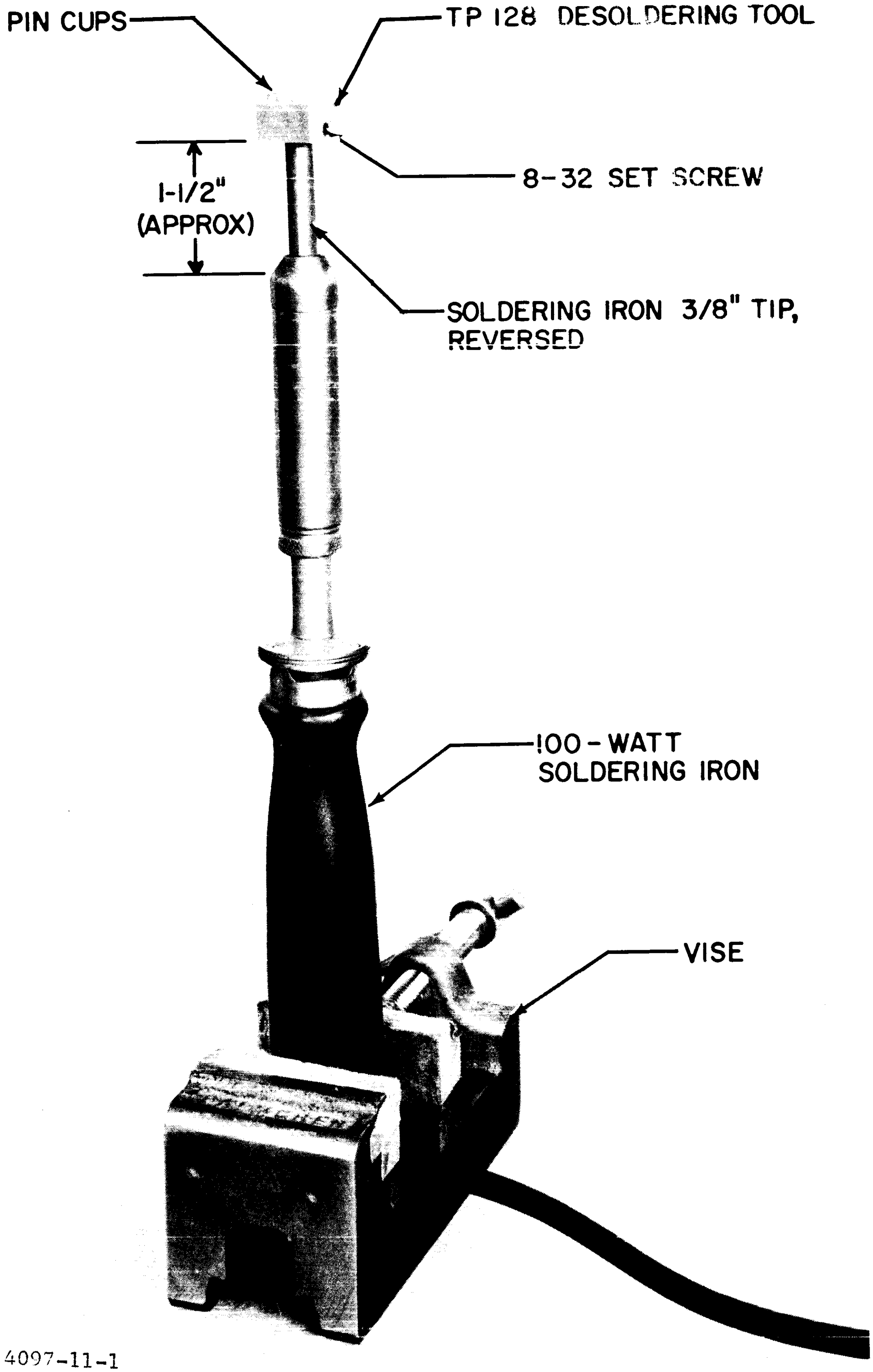
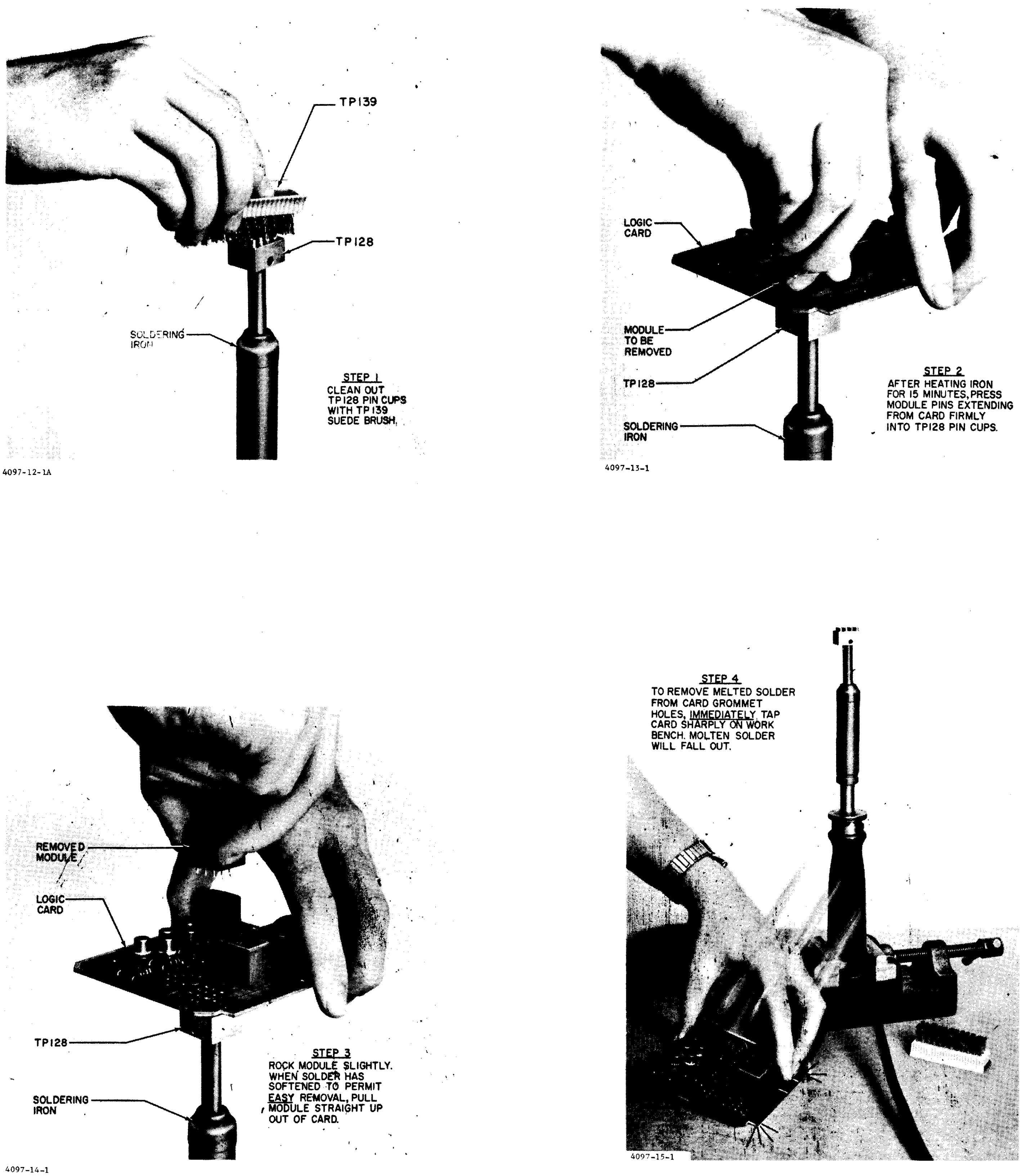


Figure 5-9. TP128 in Position

664.18-9



664.18-10-13

Figure 5-10. Removing Logic Module From Card of module to be removed nesting into TP128 solder cups. Press firmly on module to insert pins into cups while solder melts. When solder has melted sufficiently, it will be possible to pull the module straight up out of the card easily. Usually, about 2 seconds are enough. Do not try to pull module out forcibly before this point is reached. To do so may dislodge eyelets from pin holes in card. If it is possible to rock the module slightly, this is an indication that the solder has softened enough. This motion also helps to separate the pins from the eyelets. As soon as the module has been drawn out, tap the card sharply, edge slightly down, on the work bench. The molten solder remnants in the eyelets will fall out on bench surface, eliminating the problem of cleaning them out to receive the new module.

c. REPAIR OF PRINTED CONDUCTORS. - If the break in the conductor strip is small, lightly scrape away any coating covering the area of the conducting strip to be repaired. Clean the area with a firm-bristle brush and approved solvent. Then repair the cracked or broken area of the conducting strip by flowing solder over the break. Considerable care must be exercised to keep the solder from flowing onto an adjacent strip.

If a strip is burned out, or fused, cut and remove the damaged strip. Connect a length of insulated wire across the breach or from solder-point to solder-point.

After the repairs are completed, clean the repaired area with a stiff brush and solvent. Allow the board to dry thoroughly, and then coat the repaired area with an epoxy resin or similar compound. This coating not only will protect the repaired area, but will help to strengthen it.

CAUTION

After repairs, check the board for solder drippings; they may cause shorts.

Frequently, a low-resistance leakage path will be created by moisture and/

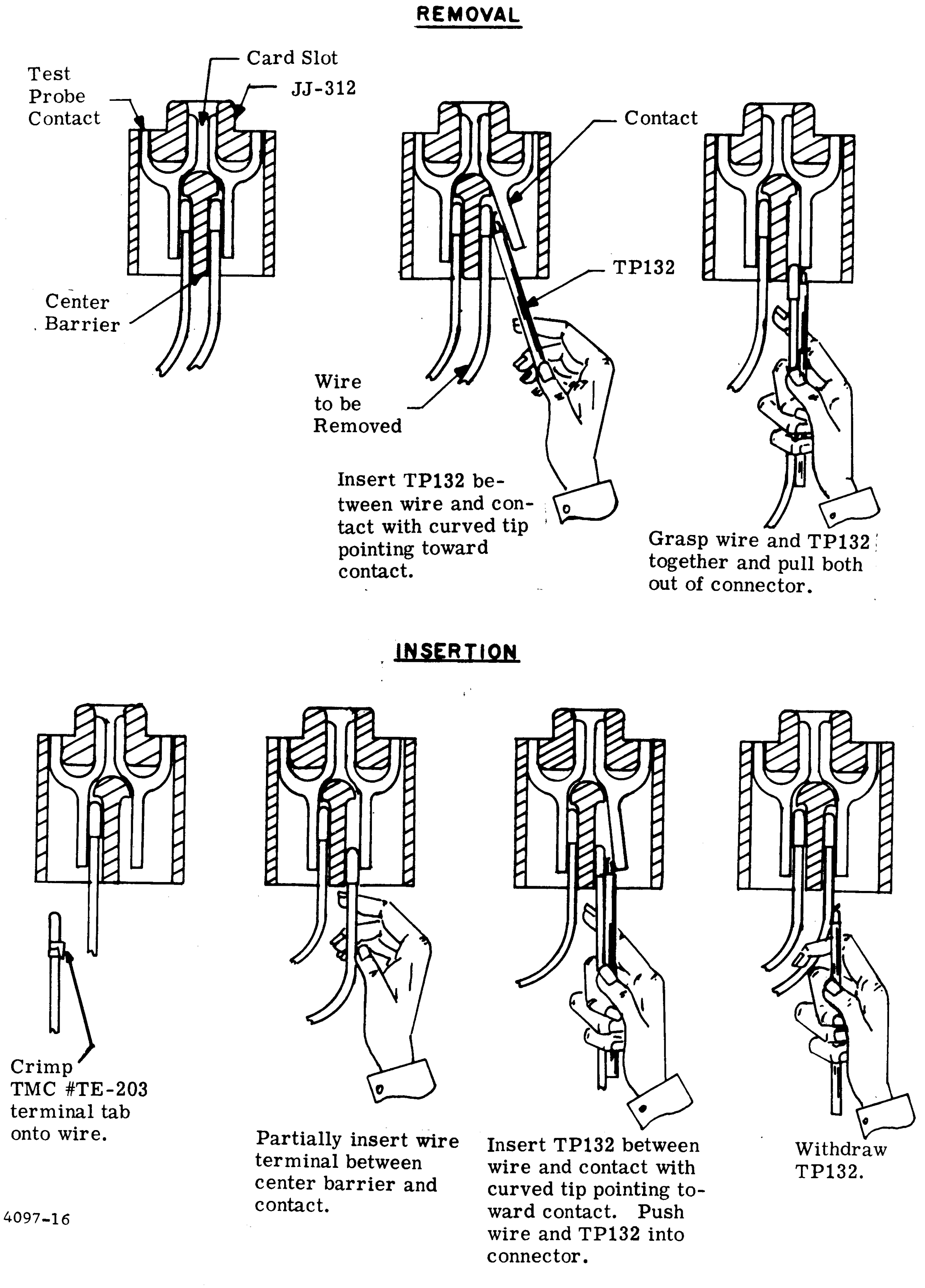


Figure 5-11. Using TP132 Conductor Extractor

or dirt that has carbonized onto the phenolic board. This leakage can be detected by measuring the suspected circuit with a multimeter. To overcome this condition, thoroughly clean the carbonized area with solvent and a stiff brush. If this does not remove it, use a scraping tool (spade end of a solder-aid tool or its equivalent) to remove the carbon, or drill a hole through the leakage path to break the continuity of the leakage. When the drilling method is used, be careful not to drill into a part mounted on the other side.

d. REPLACEMENT OF WIRE IN CARD RECEPTACLES. - TP132 Connector Extractor is included in the shipment* (see figure 5-9) for removing and installing wire in J1005 through J1008 card receptacles. These receptacles take an insertion type of wire connection, rather than solder type. Figure 5-11 shows methods of wire removal and insertion using TP132. It will be noticed that TP132 serves to (a) give added rigidity to the wire as it is inserted or removed and (b) spring back the retention finger on the wire contact.

e. REPLACEMENT OF LAMPS IN FRONT PANEL. - All lamps in panel push-buttons and the POWER light are TMC P/N BI-110-7, type T-1-3/4, single contact. To replace a lamp in a push-button, pull out button cap, pull out old lamp, insert new lamp and replace button cap. To replace lamp in POWER light, unscrew cap, pull out old lamp, insert new lamp and replace cap.

TABLE 5-2. POWER SUPPLY VOLTAGES

NOMINAL VOLTAGE & FUNCTION	LOCATIONS OF TEST POINTS
-12V Logic reference and relay supply	Z1009-7 Z1005-4 Z1006-4 Z1007-4 Z1008-4 J1002-S
+12V Logic reset and relay supply	TB1001-11 Z1008-F Z1007-20 TB1001-12 Z1005-20 Z1008-20 J1002-T Z1006-20

* Shipment of system in which Programmer is included.

TABLE 5-2. POWER SUPPLY VOLTAGES (Cont)

NOMINAL VOLTAGE & FUNCTION	LOCATIONS OF TEST POINTS
Ground for logic reference	Z1005-1,22,A & Z Z1008-1,22,A, & Z Z1006-1,22,A & Z Z1008 K5 PIN 4 Z1007-1,22,A & Z Z1008 K4 PIN 3
+6V for puncher-reader	J1003-A Z1009-9
-18V for puncher-reader	Z1009-5 J1003-B J1003-C
-24V for puncher-reader	J1003-D Z1009-18
115 VAC for puncher-reader	S1002A 9 & 8 J1003 W & X*
24 VAC lamps	TB1001-1,2 J1002-A,B

* With mode switch in all positions but MANUAL PROGRAM.

SECTION 6

PARTS LIST

6-1. INTRODUCTION

The parts list presented in this section is a cross-reference list of parts identified by a reference designation and TMC part number. In most cases, parts appearing on schematic diagrams are assigned reference designations in accordance with MIL-STD-16. Wherever practicable, the reference designation is marked on the equipment, close to the part it identifies. In most cases, mechanical and electro-mechanical parts have TMC part numbers stamped on them.

To expedite delivery when ordering any part, specify the following:

a. Generic name.

b. Reference designation.

c. TMC part number.

d. Model and serial numbers of the equipment containing the part being replaced; this can be obtained from the equipment nameplate.

For replacement parts not covered by warranty (refer to warranty sheet in front of manual), address all purchase orders to:

The Technical Materiel Corporation
Attention: Sales Department
700 Fenimore Road
Mamaroneck, New York

PARTS LIST
for
ELECTRONIC PROGRAMMER, RTPH-1

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
C1001	CAPACITOR, FIXED, ELECTROLYTIC: 2,600 uuf, 50 WVDC; polarized; clear plastic insulated case.	CE112-6
C1002 thru C1005	Same as C1001.	
C1006	CAPACITOR, FIXED, PAPER DIELECTRIC: 20 uf, ±10%; 370 WVDC; hermetically sealed seamless case, oval drawn steel.	CP113-3
C1007	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 2 x 10,000, GMV; 1,000 WVDC.	CC100-23
CR1001	SEMICONDUCTOR DEVICE, DIODE: silicon; nominal voltage 13 volts; max. power dissipation 10 watts at 25°C; max. operating temperature 100°C; hermetically sealed case.	1N2977B
CR1002	SEMICONDUCTOR DEVICE, DIODE: silicon; nominal ref. voltage 18 volts; max. power dissipation 10 watts at 25°C; max. operating temperature 175°C; JEDEC type DO-4 case.	1N2982B
CR1003	SEMICONDUCTOR DEVICE, DIODE: silicon; nominal ref. voltage 13 volts; max. dynamic impedance 8.0 ohms; max. power dissipation 1.5 watts at 25°C; max. operating temperature 175°C; hermetically sealed metal case.	1N3792B
CR1004	SEMICONDUCTOR DEVICE, DIODE: silicon; nominal reference voltage 6.8V; max. power dissipation 1.5 watts at 25°C; maximum storage temperature 175°C.	1N4721
CR1005	SEMICONDUCTOR DEVICE, DIODE: silicon; max. peak inverse voltage 200 volts; max. forward voltage drop 1.0 volts; max. reverse current 2.0 ma at 175°C; max. operating temperature 175°C; hermetically sealed case.	
CR1006 thru CR1012	Same as CR1005.	
CR1013	SEMICONDUCTOR DEVICE, DIODE: rectifier bridge; peak reverse voltage 200V; output current 1.5 amps DC at 50°C or 1.0 amps DC at 100°C; one cycle surge current 15 amps peak, recurrent forward current 5 amps peak; max. forward voltage frop 1 volt at 100°C; molded plastic case.	DD130-200-1.5

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
DS1001	LAMP, INCANDESCENT: 28.0 volts AC/DC; 0.04 amps; single contact, T-1-3/4 bulb.	BI110-7
DS1002	NON-REPLACEABLE ITEM. (Part of XF1003)	
DS1003	NON-REPLACEABLE ITEM. (Part of XF1004)	
DS1004	NON-REPLACEABLE ITEM. (Part of XF1001)	
DS1005	NON-REPLACEABLE ITEM. (Part of XF1002)	
DS1006-1 thru DS1006-50	Same as DS1001.	
ECR1001	NOT USED	
ECR1002	NOT USED	
ECR1003	HEAT SINK: heat dissipating element.	HD101-1
ECR1004	Same as ECR1003.	
EQ1001	NOT USED	
EQ1002	NOT USED	
EQ1003	Same as ECR1003.	
EQ1004	Same as ECR1003.	
F1001	FUSE, CARTRIDGE: 1 amp; 1-1/4" lg. x 1/4" dia.; quick acting.	FU100-1.0
F1002	FUSE, CARTRIDGE: 1/8 amp; 1-1/4" lg. x 1/4" dia.; quick acting.	FU100-.125
F1003	FUSE, CARTRIDGE: 2 amps; time lag; 1-1/4" lg. x 1/4" dia.; slow-blow.	FU102-2
F1004	Same as F1003.	
F1005	FUSE, CARTRIDGE: 1-1/2 amp; 1-1/4" lg. x 1/4" dia.; quick acting.	FU100-1.5
F1006	Same as F1001.	

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
F1007	FUSE, CARTRIDGE: 2/10 amp; 1-1/4" lg. x 1/4" dia.; quick acting.	FU100-.200
F1008	FUSE, CARTRIDGE: 3/4 amp; 1-1/4" lg. x 1/4" dia.; quick acting.	FU100-.750
F1009	Same as F1002.	
J1001	CONNECTOR, RECEPTACLE, ELECTRICAL: AC power; 2 male contacts rated for 10 amps, 250 volts or 15 amps, 125 volts; polarized; twist lock type; black bakelite.	JJ175
J1002	CONNECTOR, RECEPTACLE, ELECTRICAL: 24 number 20 socket type contacts; nominal current rating 7.5 amps, 500 V RMS.	JJ200-3
J1003	Same as J1002.	
J1004	CONNECTOR, RECEPTACLE, ELECTRICAL: 5 number 20 pin type contacts; nominal current rating 7.5 amps, 500 V RMS.	JJ200-8
J1005	CONNECTOR, RECEPTACLE, ELECTRICAL: 44 female contacts rated for 5 amps at 1,800 V RMS; polarized; floating bushing type; accommodates 1/16" printed circuit board.	JJ319-22DFE
J1006 thru J1008	Same as J1005.	
J1009	JACK, TELEPHONE: tip and sleeve; bushing mounted.	JJ034
Q1001	TRANSISTOR: germanium, hi-current; collector to base voltage 40 V; collector to emitter and emitter to base voltage 20 V; collector current 7 amps; base current 3 amps; max. power dissipation 85 watts at 25°C; operating storage and junction temperature range -65°C to +110°C; JEDEC type TO-3 case.	2N456A
Q1002	Same as Q1001.	
Q1003	TRANSISTOR: silicon, NPN; collector to base voltage 60 V; collector to emitter voltage 40 V; emitter to base voltage 6.0 V; collector current 1 ma at 25°C JEDEC type TO-5 case.	2N1700

PARTS LIST (CONT)
ELECTRONIC PROGRAMMER, RTPH-1

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
Q1004	Same as Q1003.	
R1001	RESISTOR, FIXED, WIREWOUND: 1.5 ohms, ±5%; 5 watts; non-inductive.	RR114-1R5W
R1002	Same as R1001.	
R1003	Same as R1001.	
R1004	RESISTOR, FIXED, WIREWOUND: 30 ohms, ±5%; 5 watts; non-inductive.	RR114-30W
R1005	RESISTOR, FIXED, COMPOSITION: 470 ohms, ±5%; 2 watts.	RC42GF471J
R1006	RESISTOR, FIXED, COMPOSITION: 3.3 ohms, ±5%; 1 watt.	RC32GF3.3J
R1007	Same as R1006.	
R1008	RESISTOR, FIXED, WIREWOUND: 75 ohms, ±5%, 5 watts; non-inductive.	RR114-75W
R1009	RESISTOR, FIXED, COMPOSITION: 150 ohms, ±5%, 2 watts.	RC42GF151J
R1010	RESISTOR, FIXED, WIREWOUND: 10 ohms, ±5%; 5 watts; non-inductive.	RR114-10W
R1011	RESISTOR, FIXED, COMPOSITION: 560 ohms, ±5%; 1/2 watt.	RC20GF561J
R1012	RESISTOR, FIXED, COMPOSITION: 2,200 ohms, ±5%; 1/2 watt.	RC20GF222J
R1013	Same as R1004.	
R1014	RESISTOR, FIXED, COMPOSITION: 150 ohms, ±5%; 1 watt.	RC32GF151J
R1015	RESISTOR, FIXED, COMPOSITION: 390 ohms, ±5%; 1 watt.	RC32GF391J
R1016	RESISTOR, FIXED, WIREWOUND: 200 ohms, ±5%; 5 watts; non-inductive.	RR114-200W
R1017	NON-REPLACEABLE ITEM. (Part of XF1001)	

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
R1018	NON-REPLACEABLE ITEM. (Part of XF1002)	
R1019	NON-REPLACEABLE ITEM. (Part of XF1003)	
R1020	NON-REPLACEABLE ITEM. (Part of XF1004)	
S1001	SWITCH, TOGGLE: DPST; bat type handle.	ST22K
S1002	SWITCH, ROTARY: 3 sections, 5 positions, 30° angle of throw; shorting type contacts, sections 1 thru 3; ceramic wafer insulation.	SW420
S1003	SWITCH, PUSHBUTTON, MOMENTARY: 1 contact; green lens, high temperature polycarbonate; bulk head mounting.	SW394-4G9P
S1004	SWITCH, PUSHBUTTON, STAND TYPE: 4 rows, rows 1 thru 3, 15 positions, row 4, 10 positions; 5/8" center to center at button position; supplied with white translucent, red translucent type buttons as required; for lamp replacement order TMC PART NO. BI110 type lamp; screw type lamp terminals.	SW416
T1001	TRANSFORMER, POWER, STEP-DOWN: primary 115, 230 V, 50/60 cps, single phase; secondary 24 V RMS at 800 MA RMS, 23 V DC at 30 MADC, 25 V DC at 1.6 ADC; 12 solder lug type terminals; stud-mounted; fully enclosed hermetically sealed grey steel case.	TF337
TB1001	TERMINAL BOARD, BARRIER: 12 number 6-32 thd x 1/4" lg. binding head machine screws; black phenolic body.	TM100-12
XDS1001	LIGHT, INDICATOR: white translucent lens, sub-miniature type.	TS153-5
XF1001	FUSEHOLDER, LAMP INDICATING: accommodates cartridge fuse 1-1/4" lg. x 1/4" dia.; 22 V to 33 V, 20 amps; incandescent lamp type with a 330 ohm lamp resistor transparent amber flat sided knob; brown body. (consists of DS1004, R1017)	FH104-11
XF1002	Same as XF1001. (consists of DS1005, R1015)	
XF1003	FUSEHOLDER, LAMP INDICATING: accommodates cartridge fuse 1-1/4" lg. x 1/4" dia.; 90 V to 300 V, 20 amps; neon lamp type with a 220K ohm lamp resistor; transparent clear flat sided knob; black body. (consists of DS1002, R1019)	FH104-3

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
XF1004	Same as XF1003. (consists of DS1003, R1020)	
XF1005	FUSEHOLDER: extractor post type; accommodates cartridge fuse; o/a length 2-17/64"; bushing mounted, tapped 1/2" dia. 24 thd. per in. with stationary end terminals.	FH100-2
XF1006 thru XF1009	Same as XF1005.	
XQ1001	SOCKET, TRANSISTOR: 7 pin contact accommodation; 0.040 or 0.050 dia.; polarized; 1 terminal lug grounding strap; o/a dim. 1-27/64" x 1" max.	TS166-1
XQ1002	Same as XQ1001.	
Z1001 thru Z1004	NOT USED	
Z1005	GATING CIRCUIT MODULE. (SEE SEPARATE PARTS LIST FOR BREAKDOWN)	A4366
Z1006	SHIFT REGISTER MODULE. (SEE SEPARATE PARTS LIST FOR BREAKDOWN)	A4361
Z1007	TIMING CIRCUIT MODULE. (SEE SEPARATE PARTS LIST FOR BREAKDOWN)	A4365
Z1008	RELAY BOARD MODULE. (SEE SEPARATE PARTS LIST FOR BREAKDOWN)	A4367

PARTS LIST
for
GATING CIRCUIT MODULE

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
C1	CAPACITOR, FIXED, METALIZED PLASTIC: 2.0 uf, ±5%; 50 WVDC; epoxy encapsulated case.	CN114-2RD-5J
CR1	SEMICONDUCTOR DEVICE, DIODE: germanium; peak inverse voltage 100 V; min. forward current 200 ma at 1.0 V; max. reverse current 100 ua at 25°C; power dissipation 80 mn at 25°C; max. operating temperature 90°C; JEDEC type DO-7 case.	1N270
CR2	Same as CR1.	
R1	RESISTOR, FIXED, COMPOSITION: 5,600 ohms, ±5%; 1/2 watt.	RC20GF562J
R2	RESISTOR, FIXED, COMPOSITION: 2,200 ohms, ±5%; 1/2 watt.	RC20GF222J
R3	RESISTOR, FIXED, COMPOSITION: 4,700 ohms, ±5%; 1/2 watt.	RC20GF472J
R4 thru R13	Same as R2.	
TP1	TERMINAL, STUD	TE127-2
TP2 thru TP5	Same as TP1.	
Z1	NETWORK, DIGITAL INVERTER: operating temperature range -35°C to +85°C; 12 male contacts, epoxy case.	NW105-11
Z2	NETWORK, GATE AMPLIFIER: operating temperature range -35°C to +85°C; 12 male contacts, epoxy case.	NW108-26
Z3	NETWORK, ONE SHOT GENERATOR: operating frequency 100 Kc; operating temperature range -35°C to +65°C; 12 male contacts, epoxy case.	NW111-1
Z4	Same as Z1.	
Z5	NETWORK, NAND GATE AMPLIFIER: operating temperature range -35°C to +85°C; 12 male contacts, epoxy case.	NW104-22
Z6	Same as Z2.	

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
Z7	NETWORK, NAND GATE AMPLIFIER: operating temperature range -35°C to +85°C; 12 male contacts, epoxy case.	NW104-21
Z8	NETWORK, NOR GATE AMPLIFIER: operating temperature range -35°C to +85°C; 12 male contacts, epoxy case.	NW119-22
Z9	Same as Z1.	
Z10	NETWORK, BUFFER AMPLIFIER: operating frequency 100 Kc; operating temperature range -35°C to +85°C; 12 male contacts, epoxy case.	NW109-11

PARTS LIST
for
SHIFT REGISTER MODULE

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
Q1	TRANSISTOR: silicon, PNP; collector to base and collector to emitter voltage 25 V; emitter to base voltage 4 V; collector current 500 ma; max. power dissipation 0.7 watts at 25°C; storage temperature range -55°C to +125°C; hermetically sealed case.	2N3638
R1	RESISTOR, FIXED, COMPOSITION: 3,300 ohms, ±5%; 1/2 watt.	RC20GF332J
TP1	TERMINAL, STUD	TE127-2
TP2 thru TP16	Same as TP1.	
Z1	NETWORK, FLIP-FLOP AMPLIFIER: operating frequency 100 Kc; operating temperature range -35°C to +65°C; 12 male contacts, epoxy case.	NW107-4X
Z2 thru Z4	Same as Z1.	
Z5	NETWORK, BUFFER AMPLIFIER: operating frequency 100 Kc; operating temperature range -35°C to +85°C; 12 male contacts, epoxy case.	NW109-11
Z6	Same as Z1.	
Z7	Same as Z1.	
Z8	NETWORK, GATE AMPLIFIER: operating temperature range -35°C to +85°C; 12 male contacts, epoxy case.	NW108-26
Z9	NETWORK, EMITTER FOLLOWER: operating temperature range -35°C to +85°C; 12 male contacts, epoxy case.	NW118-11
Z10	Same as Z1.	
Z11	Same as Z8.	
Z12	NETWORK, NOR GATE AMPLIFIER: operating temperature range -35°C to +85°C; 12 male contacts, epoxy case.	NW119-22
Z13	NETWORK, DIGITAL INVERTER: operating temperature range -35°C to +85°C; 12 male contacts, epoxy case.	NW105-11
Z14	Same as Z9.	

PARTS LIST
for
TIMING CIRCUIT MODULE

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
C1	CAPACITOR, FIXED, PLASTIC DIELECTRIC: 0.47 uf, ±10%; 200 WVDC; straight wire leads.	CN112A474K2
C2	CAPACITOR, FIXED, METALIZED PLASTIC: 3.0 uf, ±5%; 50 WVDC; epoxy case.	CN1143R0-5J
C3	Same as C2.	
C4	CAPACITOR, FIXED, ELECTROLYTIC: 100 uf, -10% +150% at 120 cps at 25°c; 25 WVDC; polarized; insulated tubular case.	CE105-100-25
L1	COIL, RADIO FREQUENCY: fixed; 470 uh, ±5%; 10.0 ohms DC resistance; current rating 180 ma; molded case.	CL275-471
R1	RESISTOR, FIXED, COMPOSITION: 1,200 ohms, ±5%; 1/2 watt.	RC20GF122J
R2	RESISTOR, FIXED, COMPOSITION: 2,700 ohms, ±5%; 1/2 watt.	RC20GF272J
R3	RESISTOR, VARIABLE, COMPOSITION: 10,000 ohms, ±10%; 1/2 watt.	RV121-1-103
R4	RESISTOR, FIXED, COMPOSITION: 2,200 ohms, ±5%; 1/2 watt.	RC20GF222J
R5	RESISTOR, FIXED, COMPOSITION: 10,000 ohms, ±5%; 1/2 watt.	RC20GF103J
TP1	TERMINAL, STUD	TE127-2
TP2 thru TP7	Same as TP1.	
Z1	NETWORK, CLOCK GENERATOR: operating temperature range -35°C to +85°C; 12 male contacts, epoxy case.	NW113-2X
Z2	NETWORK, FLIP-FLOP AMPLIFIER: operating frequency 100 Kc; operating temperature range -35°C to +65°C; 12 male contacts, epoxy case.	NW107-4X
Z3	Same as Z2.	
Z4	NETWORK, ONE SHOT GENERATOR: operating frequency 100 Kc; operating temperature range -35°C to +65°C; epoxy case.	NW111-1

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
Z5	NETWORK, DIGITAL INVERTER: operating temperature range -35°C to +85°C; 12 male contacts, epoxy case.	NW105-11
Z6	NETWORK, NAND GATE AMPLIFIER: operating temperature range -35°C to +85°C; 12 male contacts, epoxy case.	NW104-21
Z7	Same as Z6.	
Z8	Same as Z4.	
Z9	NETWORK, BUFFER AMPLIFIER: operating frequency 100 Kc; operating temperature range -35°C to +85°C; 12 male contacts, epoxy case.	NW109-11

PARTS LIST
for
RELAY BOARD MODULE

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
C1	CAPACITOR, FIXED, MICA DIELECTRIC: 1,000 uuf, ±5%; 500 WVDC; straight wire leads.	CM112E102J5S
C2	Same as C1.	
C3	CAPACITOR, FIXED, ELECTROLYTIC: 50 uf, -10% +150% at 120 cps at 25°C; 25 WVDC; polarized; insulated tubular case.	CE105-50-25
CR1	SEMICONDUCTOR DEVICE, DIODE: germanium; peak inverse voltage 100 V; min. forward current 200 ma at 1.0 V; max. reverse current 100 ua at 25°C; power dissipation 8 mw at 25°C; max. operating temperature 90°C; JEDEC type DO-7 case.	1N270
CR2 thru CR7	Same as CR1.	
K1	RELAY, ARMATURE: DPDT; 2,500 ohms, ±10% DC resistance; operating voltage 14.5 V DC; current rating 5.8 ma, 700 mw at 25°C; 8 contacts rated for 5 amps at 29 V DC; clear high impact styrene dust cover case.	RL156-14
K2	RELAY, ARMATURE: DPDT; 5,000 ohms, ±10% DC resistance; operating voltage 20.5 V DC; current rating 4.1 ma, 85 mw at 25°C; 8 contacts rated for 1 amp at 29 V DC; clear high impact styrene dust cover case.	RL156-4
K3	Same as K2.	
K4	RELAY, MERCURY-WETTED CONTACT: SPDT; windings number 1 and 2 rated for 250 ohms, ±10% 7 contacts rated for 2 amps, 500 V max.; polarized; relay adjusted for 1% max. unbalance at 60 cps, AC, 120 volts, 4,000 ohms in series with coil.	RL167-1
K5	Same as K4.	
R1	RESISTOR, FIXED, COMPOSITION: 680 ohms, ±5%; 1/2 watt.	RC20GF681J
R2	Same as R1.	
R3	RESISTOR, FIXED, COMPOSITION: 4.7 ohms, ±5%; 1/2 watt.	RC20GF4R7J

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
R4	Same as R3.	
R5	RESISTOR, FIXED, COMPOSITION: 100 ohms, ±5%; 2 watts.	RC42GF101J
R6	Same as R5.	
R7	RESISTOR, FIXED, COMPOSITION: 560 ohms, ±5%; 1/2 watt.	RC20GF561J
R8	RESISTOR, FIXED, COMPOSITION: 820 ohms, ±5%; 1/2 watt.	RC20GF821J
R9	Same as R8.	
R10	RESISTOR, FIXED, COMPOSITION: 1,000 ohms, ±5%; 1/2 watt.	RC20GF102J
R11	RESISTOR, FIXED, COMPOSITION: 470 ohms, ±5%; 1/2 watt.	RC20GF471J
XK1	SOCKET, RELAY: with retainer; 6 beryllium copper gold plated contacts; black phenolic body.	TS171-5
XK2	Same as XK1.	
XK3	Same as XK1.	

SECTION 7
SCHEMATIC DIAGRAMS

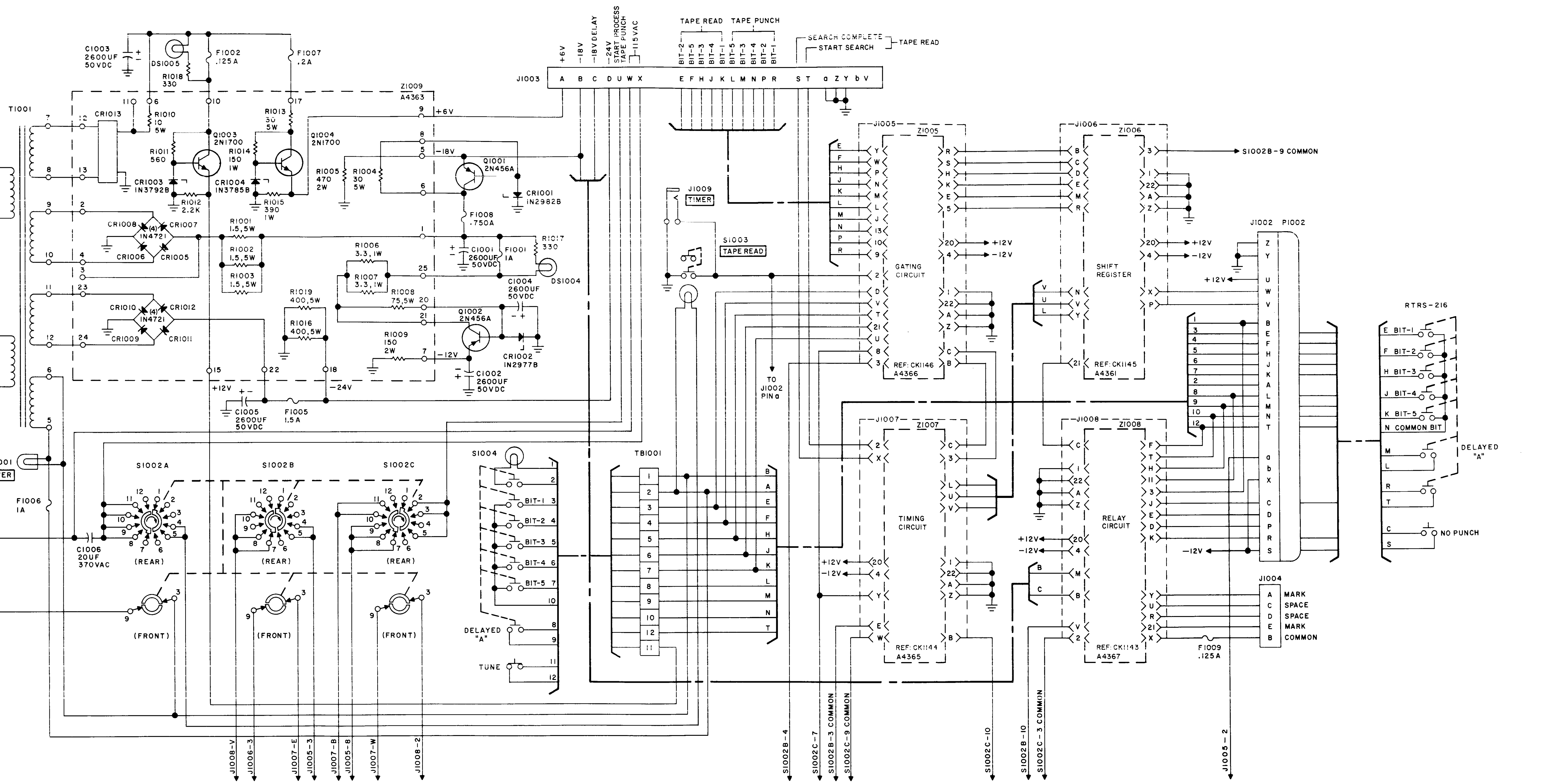
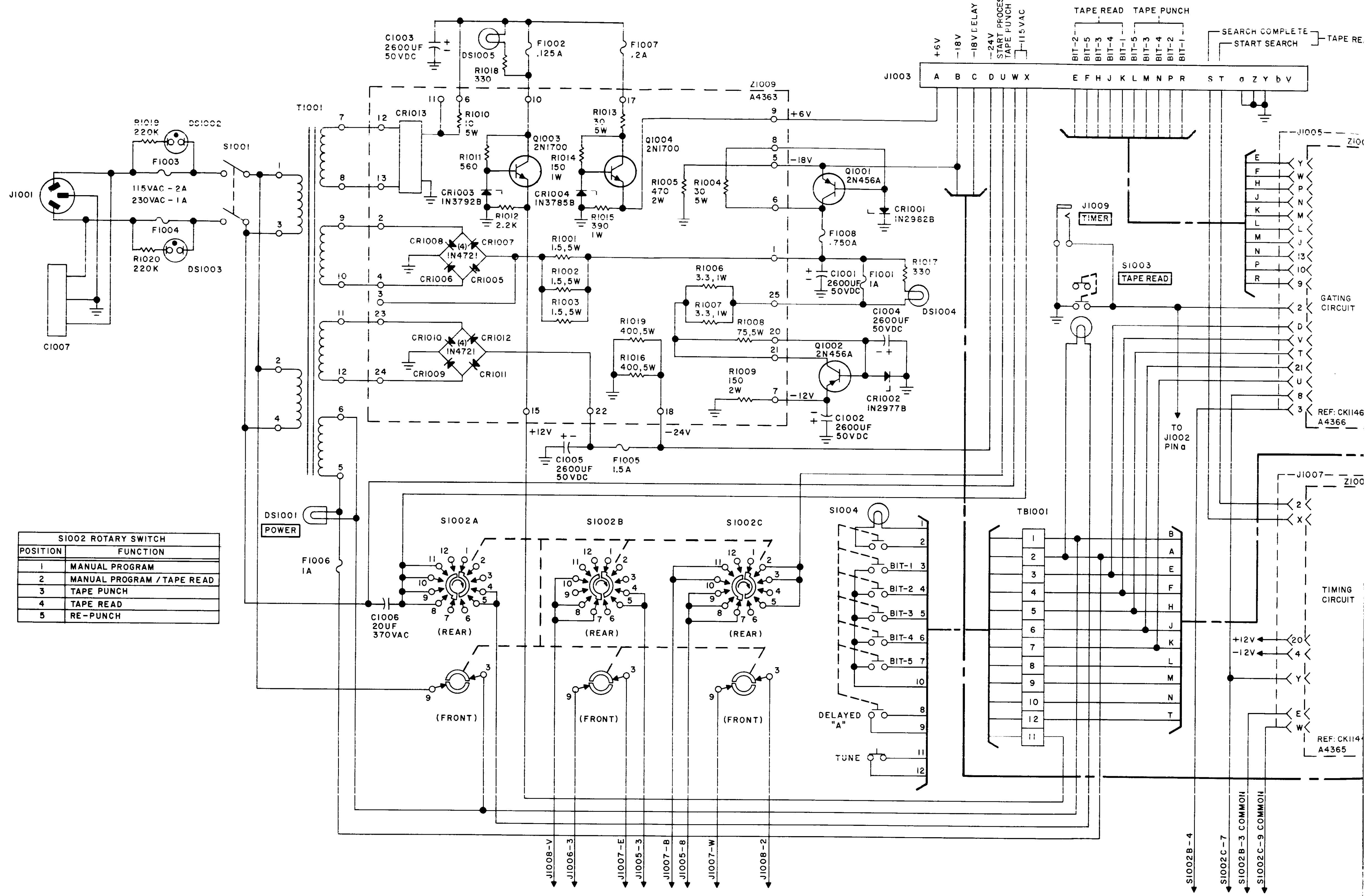


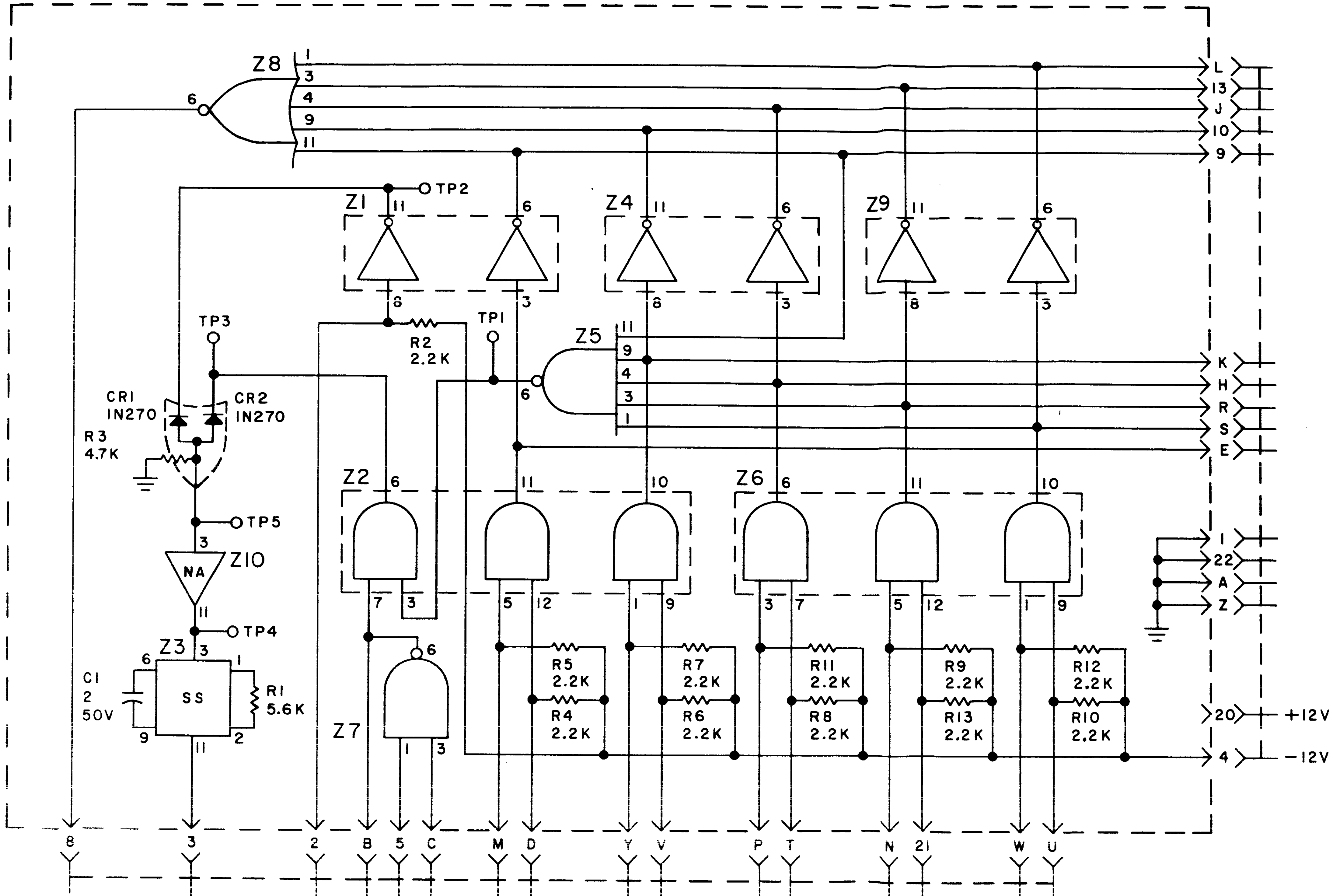
Figure 7-1. Overall Schematic Diagram, RTPH-1



S1002 ROTARY SWITCH	
POSITION	FUNCTION
1	MANUAL PROGRAM
2	MANUAL PROGRAM / TAPE READ
3	TAPE PUNCH
4	TAPE READ
5	RE-PUNCH

CK1136

006674094



UNLESS OTHERWISE SPECIFIED

1-ALL RESISTOR VALUES ARE IN OHMS 1/2 WATT.
2-ALL CAPACITOR VALUES ARE IN UF

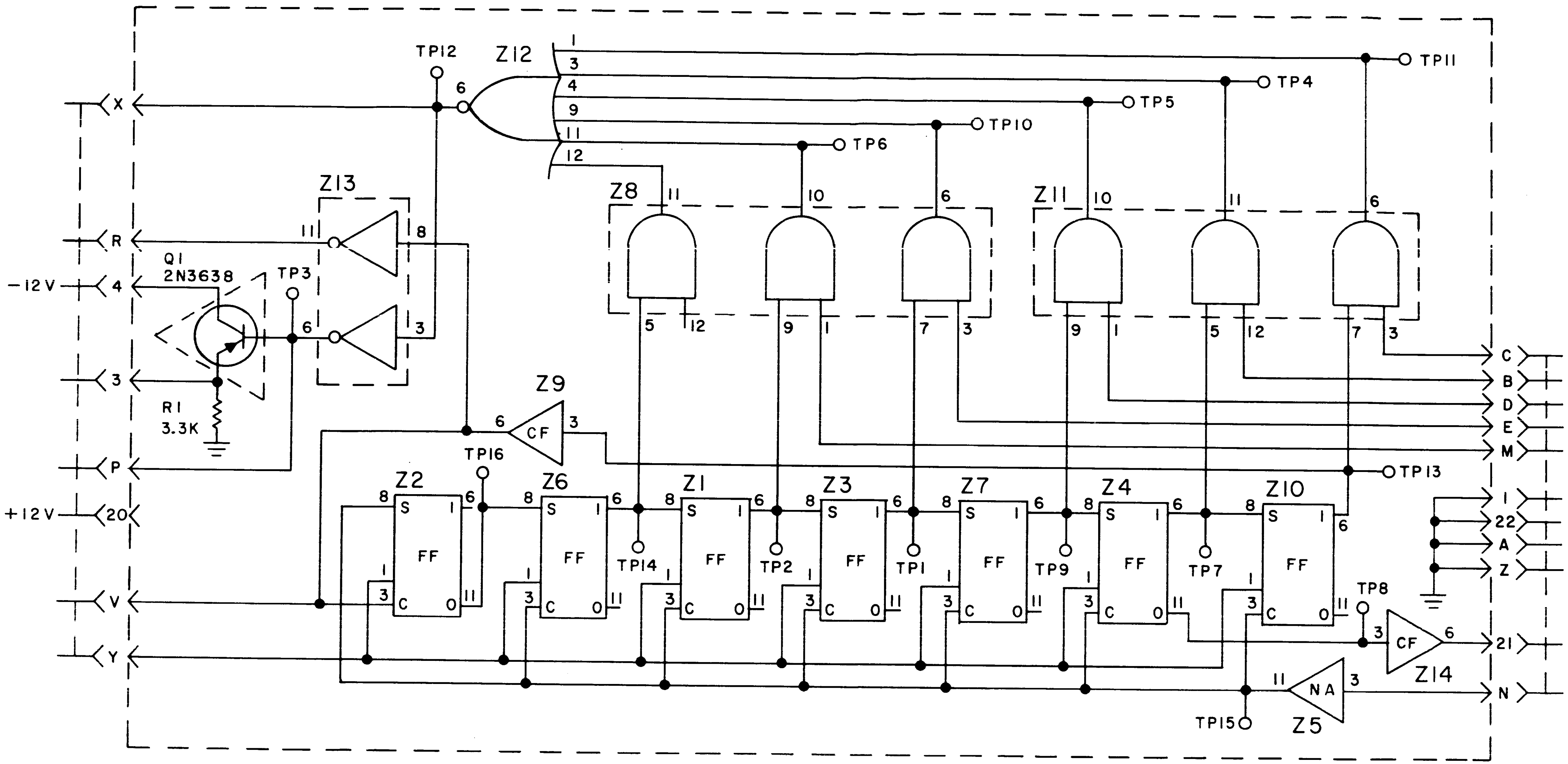
CK1146

MODULE VOLTAGE & GRD CHART

SYMBOL	PIN CONNECTIONS		
	+12V	-12V	GRD
Z3, Z5, Z7, Z8, Z10	10	2	5
Z1, Z4, Z9	10	2 & 9	4 & 5
Z2, Z6		2	

Figure 7-2. Logic Diagram P/C Card Z1005, Gating Circuit

006674094



UNLESS OTHERWISE SPECIFIED

1-ALL RESISTOR VALUES ARE IN OHMS 1/2 WATT

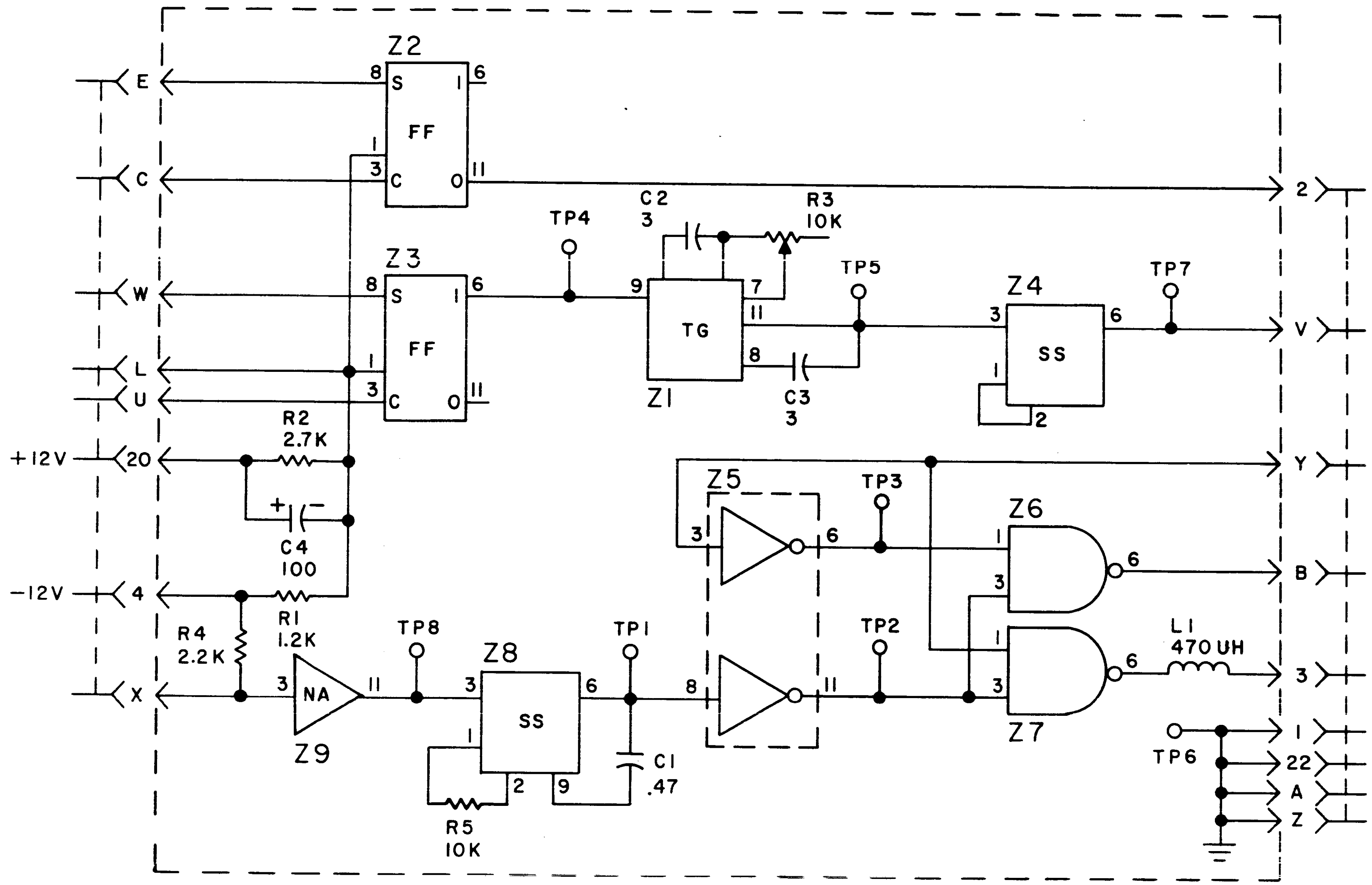
MODULE VOLTAGE & GRD CHART

SYMBOL	PIN CONNECTIONS		
	+ 12 V	- 12 V	GRD
Z1 THRU Z7 Z10, Z12	10	2	5
Z13	10	2 & 9	4 & 5
Z8, Z11		2	
Z9, Z14		2	5

CK1145

006674094

Figure 7-3. Logic Diagram P/C Card Z1006, Shift Register



UNLESS OTHERWISE SPECIFIED

1-ALL RESISTOR VALUES ARE IN OHMS 1/2 WATT
2-ALL CAPACITOR VALUES ARE IN UF

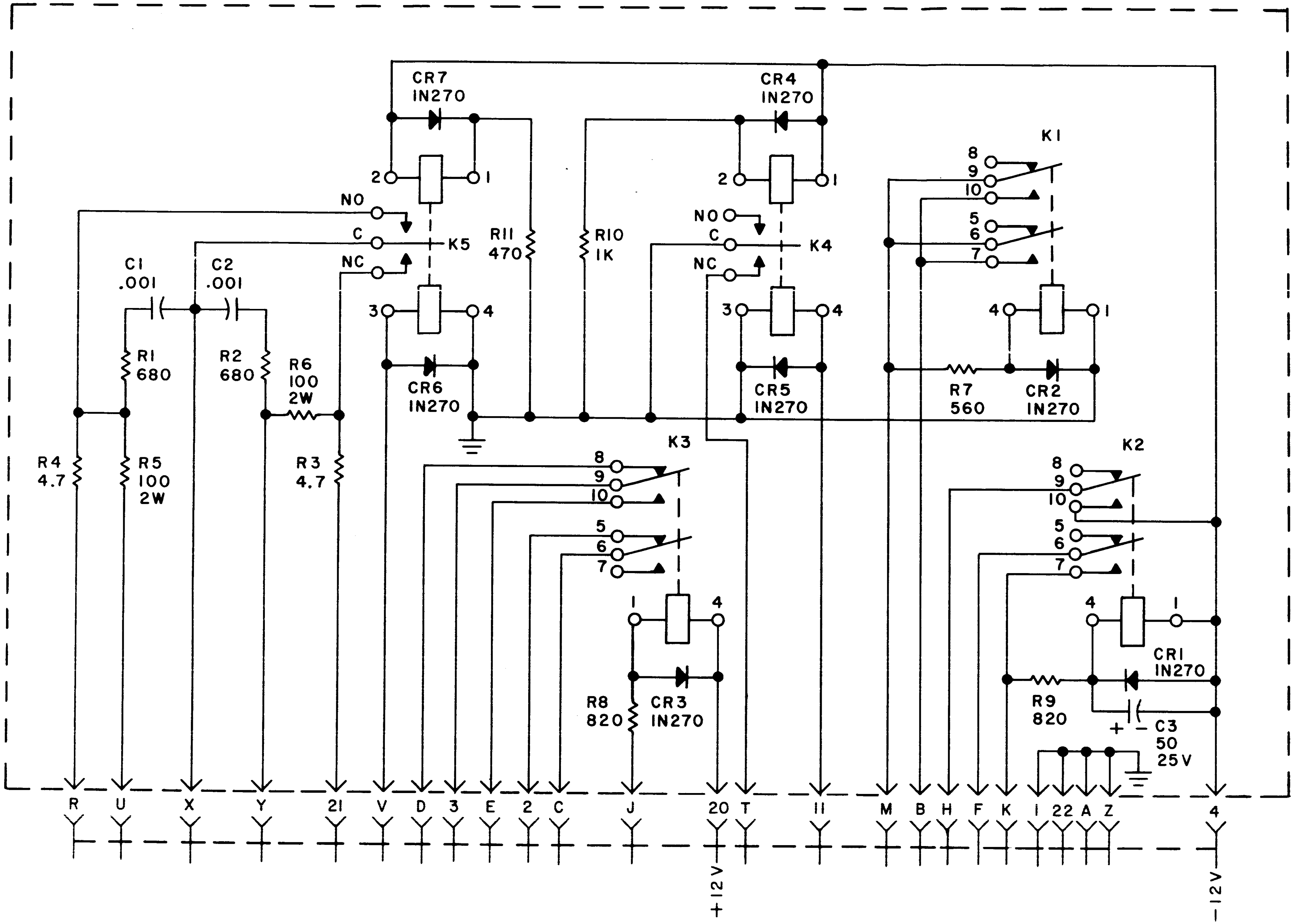
CK1144

MODULE VOLTAGE & GRD CHART

SYMBOL	PIN CONNECTIONS		
	+12 V	-12 V	GRD
Z1 THRU Z4 Z6 THRU Z9	10	2	5
Z5	10	2 & 9	4 & 5

006674094

Figure 7-4. Logic Diagram P/C Card Z1007, Timing Circuit

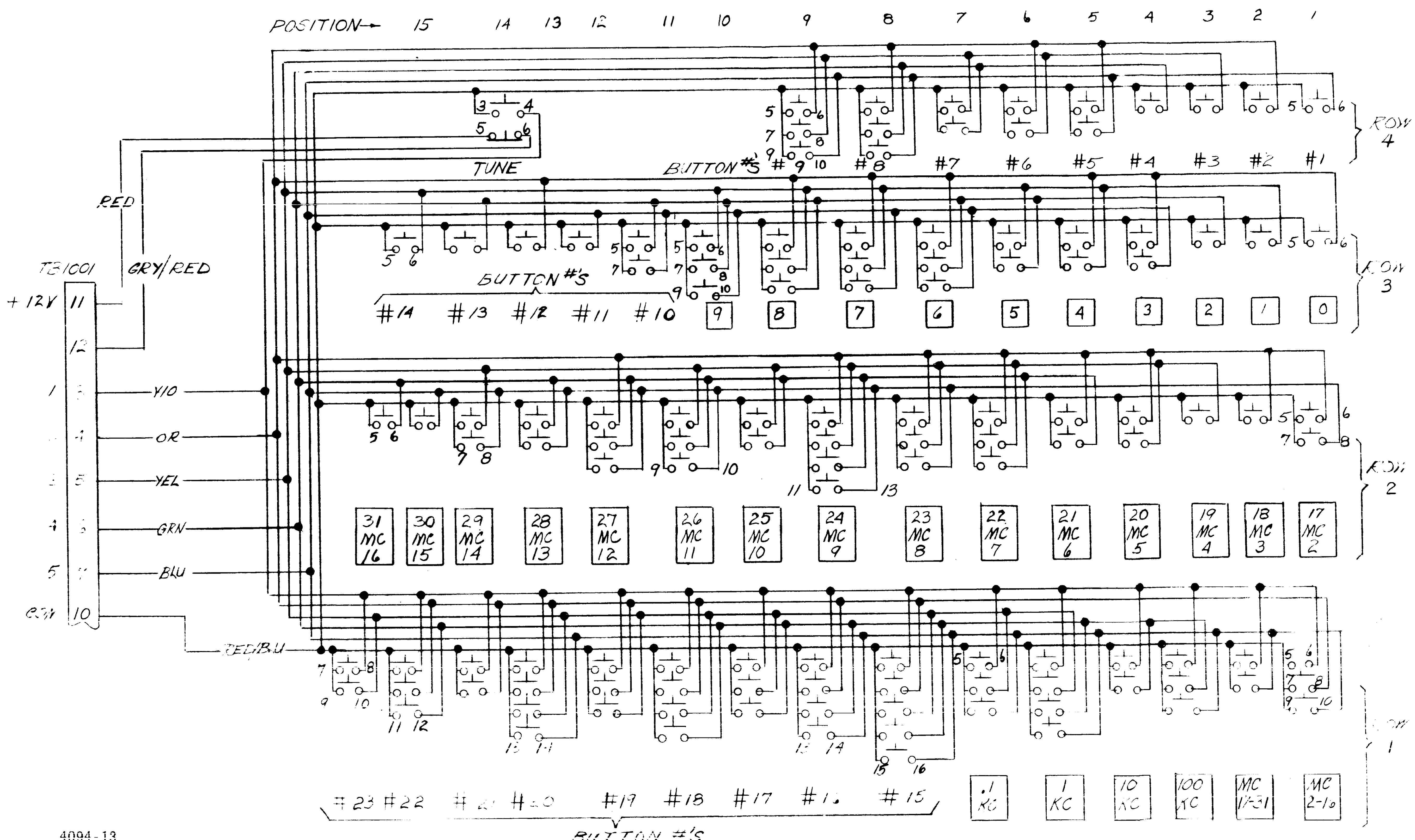


UNLESS OTHERWISE SPECIFIED

1-ALL RESISTOR VALUES ARE IN OHMS 1/2 WATT.
2-ALL CAPACITOR VALUES ARE IN UF.

CK1143

Figure 7-5. Schematic Diagram, P/C Card Z1008, Relay Circuit



4094-13

Figure 7-6. Wiring Schematic, S1004 Code Circuit, RTPH

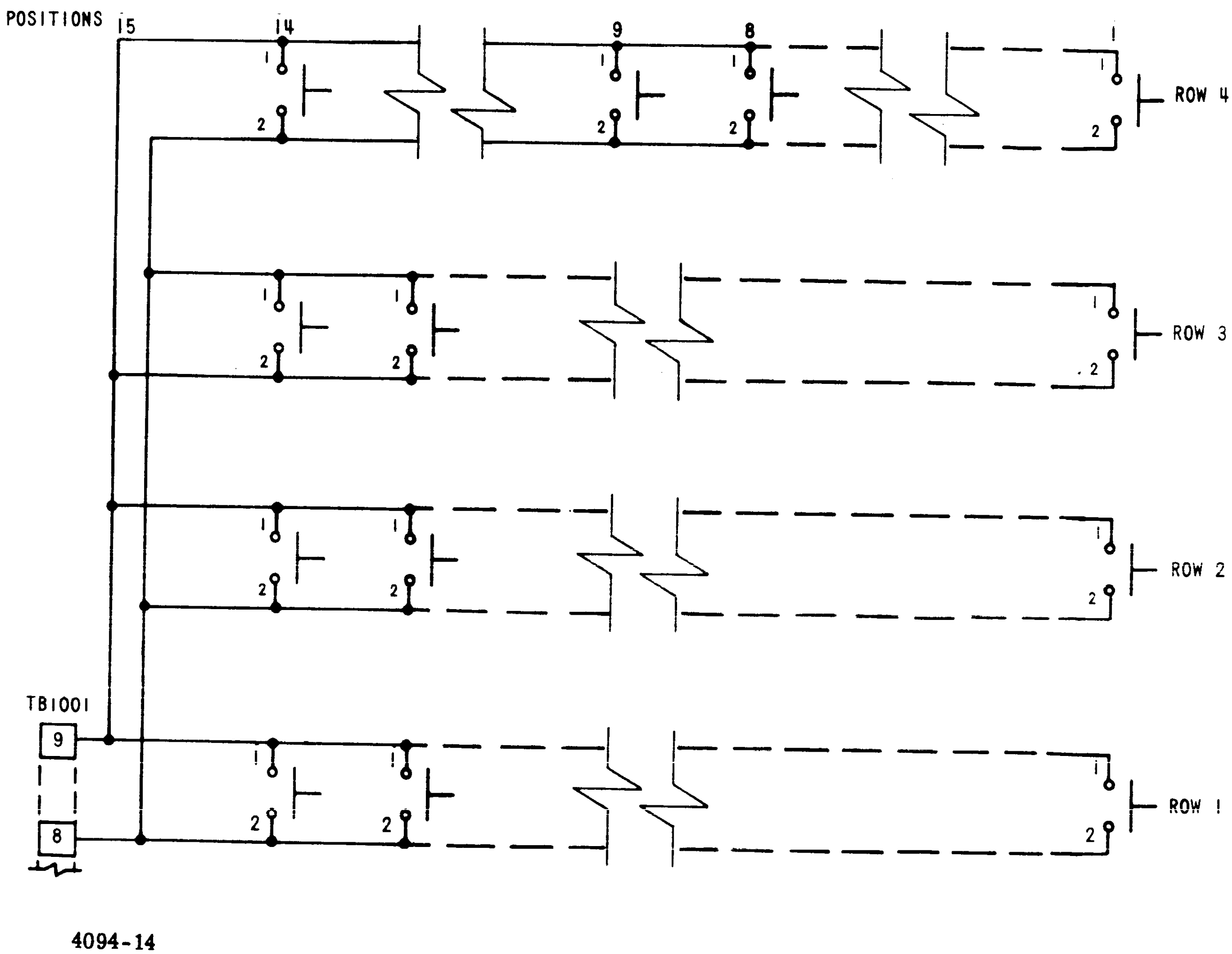


Figure 7-7. Wiring Schematic, S1004
"Delayed A" Contacts RTPH

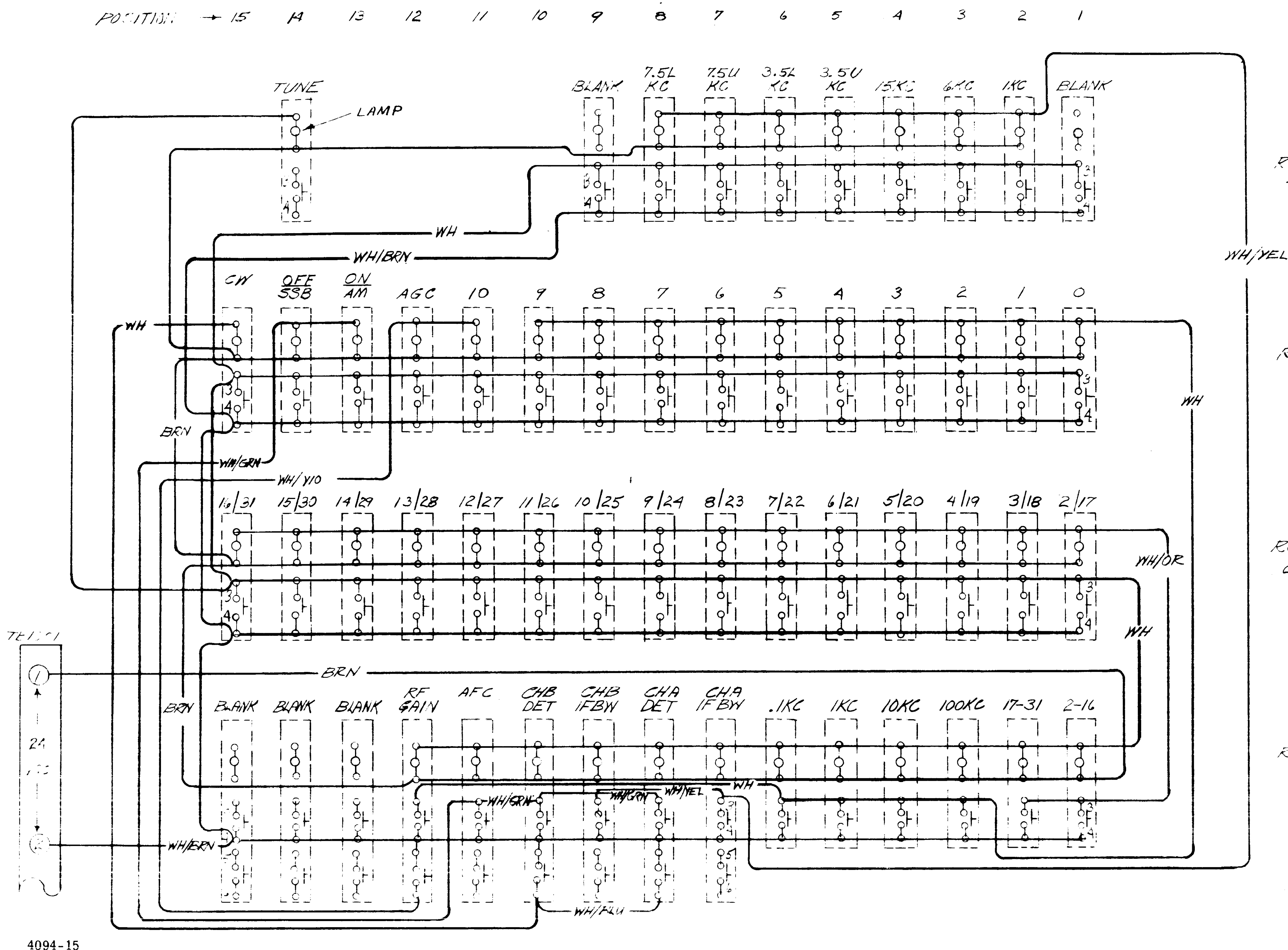
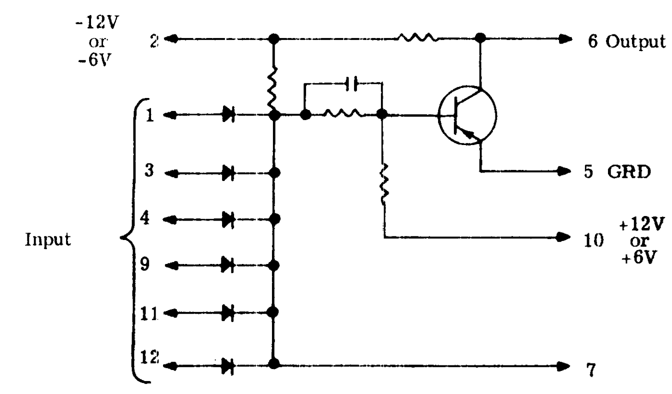


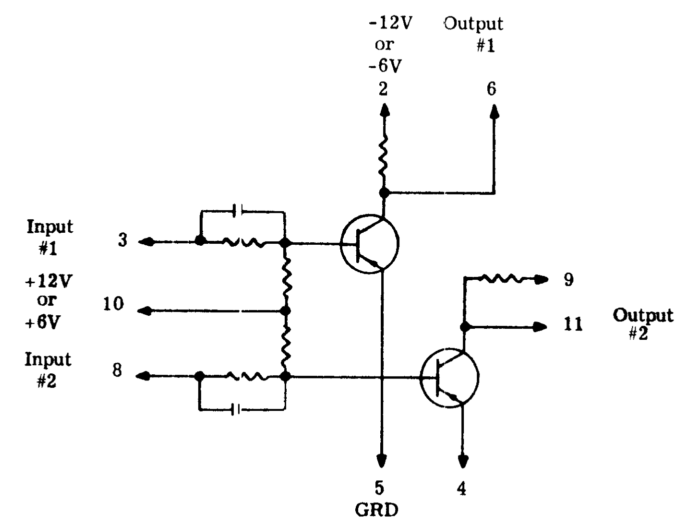
Figure 7-8. Wiring Schematic, S1004 Lamp Circuit, RTPH-1



Polarizing Pin = #8

4097-17A

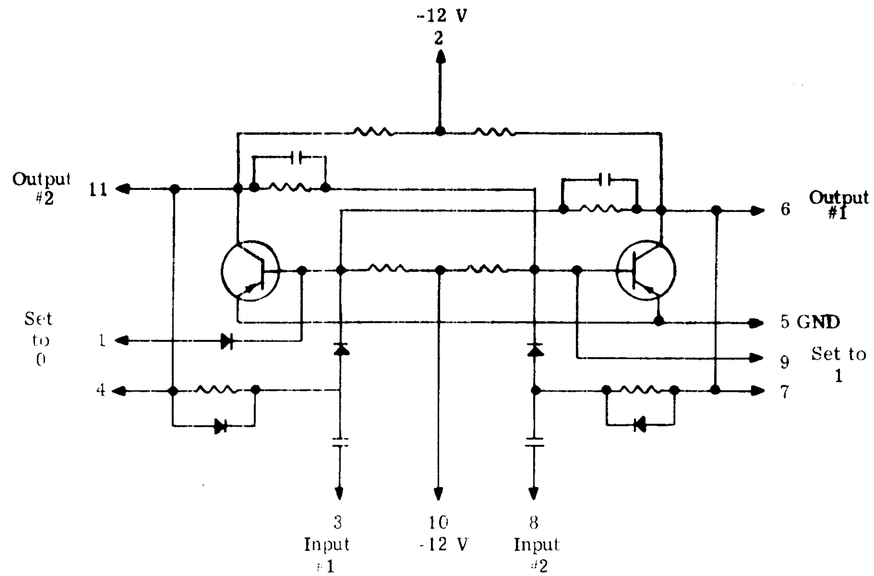
NANDGATES NW104-2, -21, -22



Polarizing Pin = #12

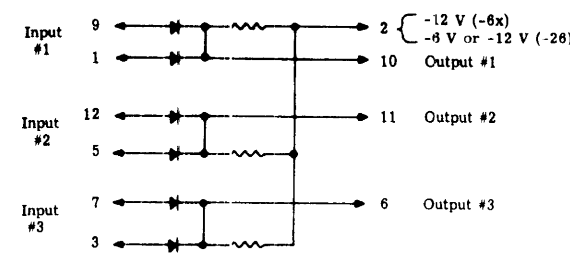
4097-17B

INVERTERS NW105-1, -11, -21



Polarizing Pin = #12

FLIP-FLOPS NW107-4X, -14, -24

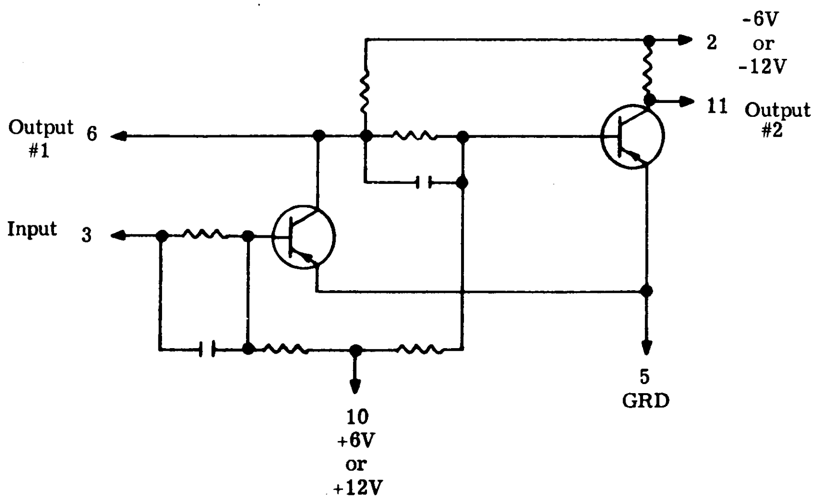


Polarizing Pin = #8

4097-17D

TRIPLE ANDGATES NW108-6X, -26

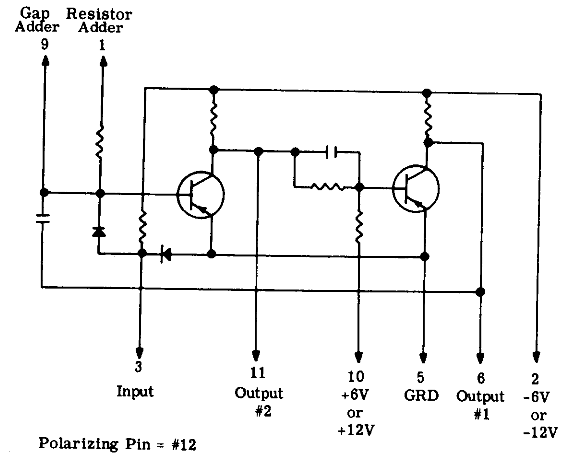
Figure 7-9. Wiring Schematic, Encapsulated Logic Modules (Sheet 1 of 3)



Polarizing Pin = #12

4097-17E

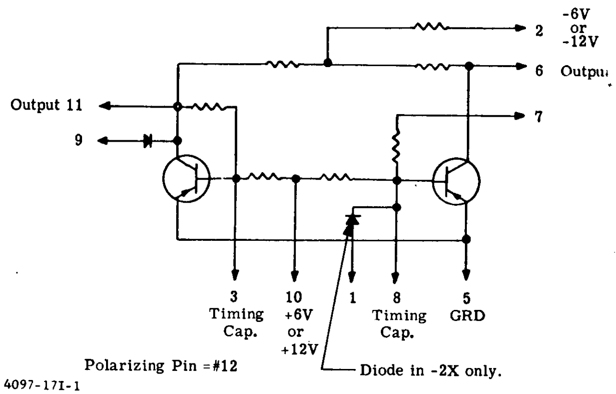
BUFFER AMPLIFIERS NW109, 109-11, -21



Polarizing Pin = #12

4097-17G

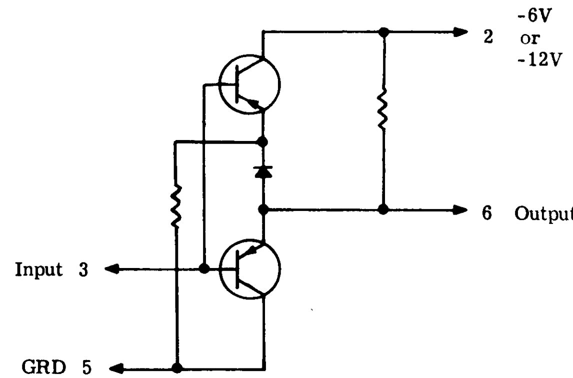
ONE-SHOTS NW111-1, -11, -21



Polarizing Pin = #12

4097-17I-1

CLOCK GENERATOR NW113-1X, -2X

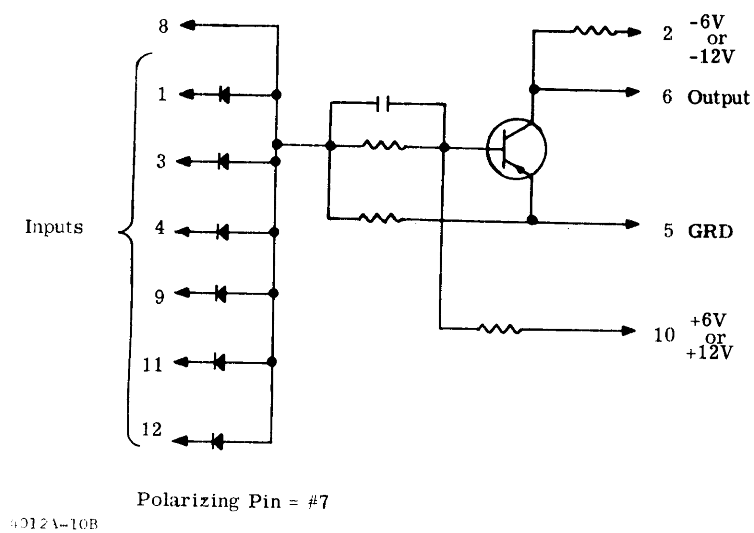


Polarizing Pin = #10

4097-17K

COMPLIMENTARY EMITTER FOLLOWERS
NW118, NW118-11, NW118-21

Figure 7-9. Wiring Schematic, Encapsulated Logic Modules (Sheet 2 of 3)



NORGATES NW119-2, -22

Figure 7-9. Wiring Schematic, Encapsulated Logic Modules (Sheet 3 of 3)