CONTROL DATA 161 TYPEWRITER UNIT

CONTROL DATA
161 TYPEWRITER
UNIT

073e
REV 12/62

This revision contains ECO 9, permitting encoded backspace, upper case, and lower case keyboard operations to be sent to the computer. Use this revision instead of publication 073d for 161 serial numbers 129 and above, and for earlier serial numbers having ECO 9 installed as an optional field modification.

RECORD OF CHANGE NOTICES

C. N. NO.	DATE ORIGINATED	DATE ENTERED	INITIALS	REMARKS

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CONTROL DATA

CHAPTER 1
DESCRIPTION

The Control Data 161 Typewriter Unit is an optional input-output device for the 160/160-A Computer System. The typewriter unit consists of an IBM electric typewriter modified by Soroban Engineering, Inc. and a control chassis. The typewriter, which operates at a rate of approximately 10 to 12 output characters per second, may be used as a keyboard input device or as an output device for producing printed copy.

The unit is 30 inches long, 30 1/2 inches wide, 37 1/2 inches high and weighs 350 pounds. A fan at the bottom of the cabinet air-cools the components by circulating air-conditioned room air. Cooling requirements are approximately 2300 BTU/Hr. Power requirements are 115v, 60 cps, 14 amp.

The unit has a self-contained d-c power supply. The control circuits are contained in a single logic chassis (30100) (figures 1-1 and 1-2). The chassis is hinged for easy access to the wiring side.

Control panel switches and indicators allow the operator to monitor and manually control the operations.

Information passes between the typewriter unit and the computer via two cables which connect at the bottom wiring side of the logic chassis. Wires jumper these two cable connectors to allow other equipment to communicate with the computer on the same communication paths. If more than one typewriter is included in the system, internal biasing changes are required.

TYPEWRITER UNIT CHARACTERISTICS

The typewriter unit provides the computer with a flexible monitoring input-output device. Through this medium, data may be entered manually into the computer, or, in the output mode, monitoring information in a printed form may be received from the computer. Typewriter character and function codes are listed in table 1.

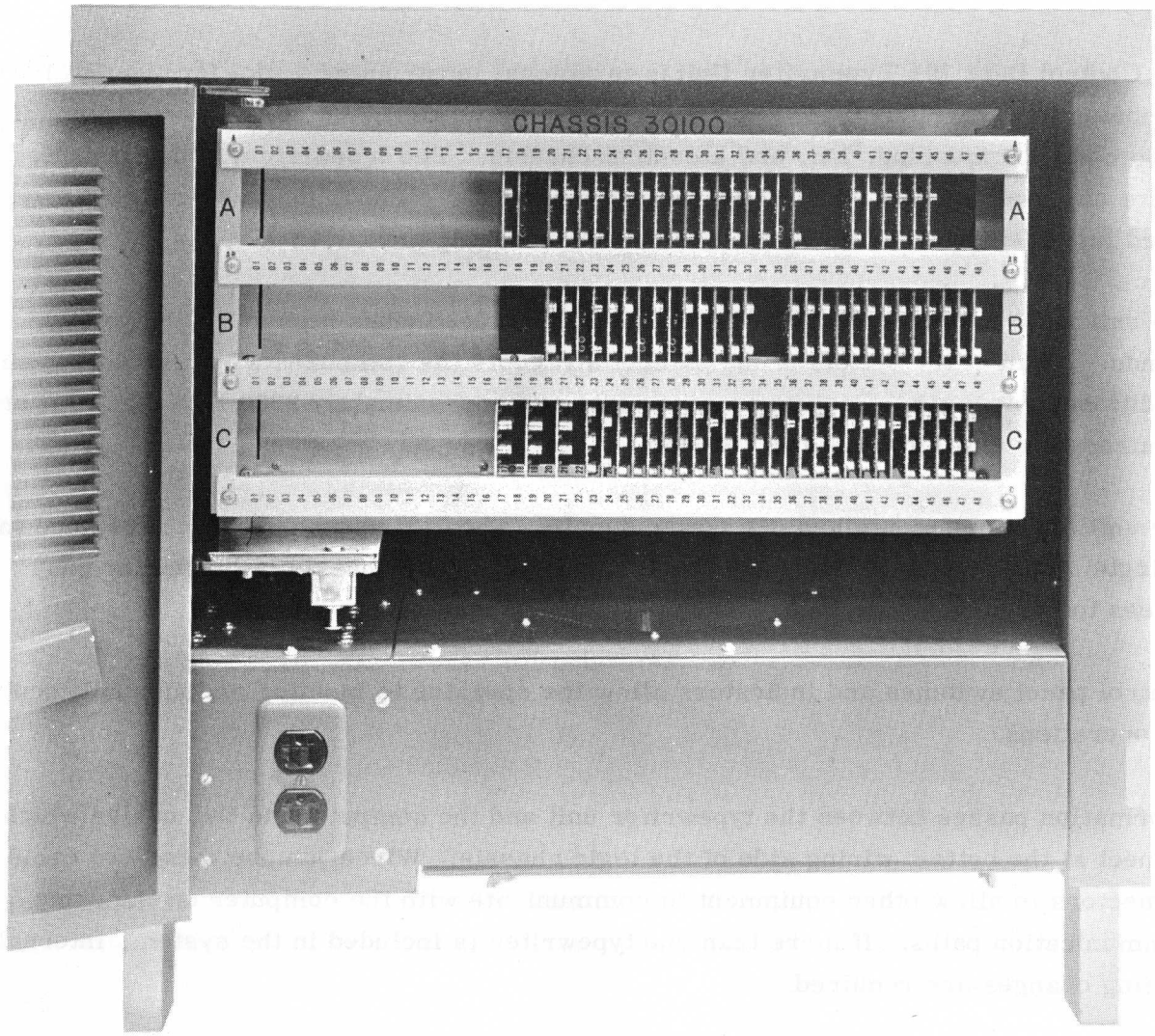


Figure 1-1. Chassis 30100

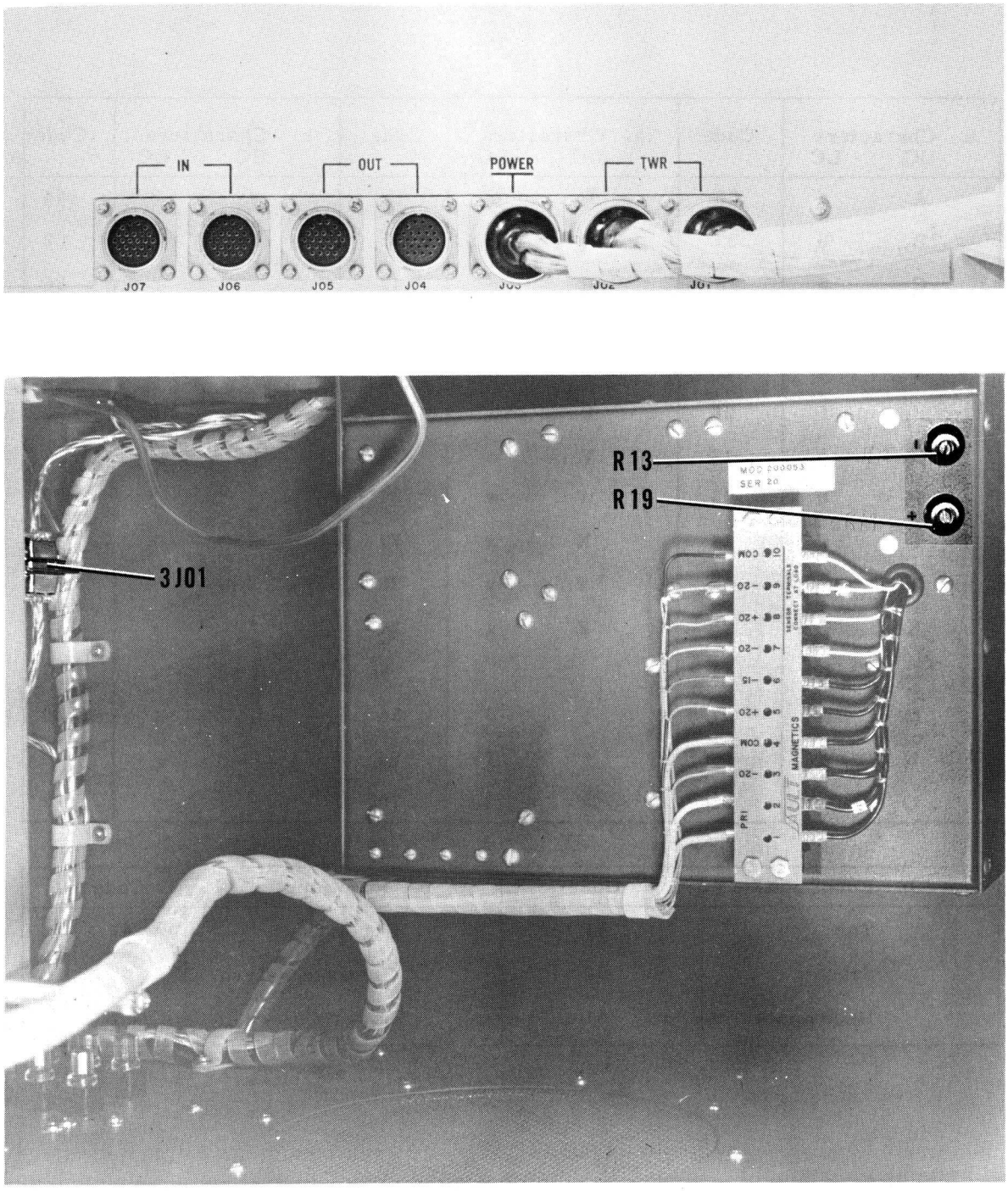


Figure 1-2. Rear View Typewriter Unit

TABLE 1. TYPEWRITER CODES

a. Characters UC	LC	Code	a. Characters UC	LC	Code	a. Characters UC	LC	Code
A	a	30	P	p	15	#	3	64
B	b	23	Q	q	35	$	4	62
C	c	16	R	r	12	%	5	66
D	d	22	S	s	24	¢	6	72
E	e	20	T	t	01	&	7	60
F	f	26	U	u	34	½	8	33
G	g	13	V	v	17	(	9	37
H	h	05	W	w	31	_	-	52
I	i	14	X	x	27	?	/	44
J	j	32	Y	y	25	"	'	54
K	k	36	Z	z	21	°	+	46
L	l	11				.	.	42
M	m	07	)	0	56	:	;	50
N	n	06	*	1	74	,	,	40
O	o	03	@	2	70	÷	=	02

b. Functions	Code	b. Functions	Code
Tab	51	Upper Case	47
Space	04	Carriage Return	45
Back Space	61	Lower Case	57

COMPUTER INSTRUCTIONS
and
TYPEWRITER OPERATIONS

The computer communicates with the typewriter unit on one input and one output cable. Each cable is a self-contained unit with its own control lines. The control and data lines are activated by the following instructions:

External Function	(EF 75)	Input	(INP 72)
Output	(OUT 73)	Input to A	(INA 76)
Output Direct	(OTN 74)		

COMPUTER INSTRUCTIONS

EF (75) The typewriter unit is selected and placed in the input or output mode. An EF instruction sends a 12-bit code on the output cable to all equipment connected to the computer. The upper 6 bits of the code specify the equipment, the lower 6 bits specify the operation requested. An accompanying function ready signal enables the external equipment to interpret the information as an EF code according to the following list.

Typewriter Unit Select Codes:

4210 Select Typewriter Output
4220 Select Keyboard Input
4240 Request Typewriter Status
43XX Alternate Unit Selection

The control circuit interprets and stores the EF code and initiates the operation requested. It also sends an output resume signal to the computer to acknowledge acceptance of the EF code. For all operations, after the output resume is returned to the computer, the control circuits establish a lockout so that further computer EF requests will be ignored until the current operation is complete.

OUT (73) Output words are transferred from the computer over the output cable to an external device selected previously by an EF instruction. For the typewriter unit, the lower 6 bits contain the information to be typed out; the higher 6 bits are ignored. An information ready signal accompanies each computer output

word (one typewriter character or function code) and the logic circuits return an output resume when the word is accepted.

OTN (74) — One word of output data is transferred over the output cable to the external device selected previously by an EF instruction. A data word consists of zeros in the upper 6 bits and the E portion of the OTN instruction in the lower 6 bits. The typewriter recognizes this as a single character which it types out. An information ready accompanies the word and the logic circuits of the 161 return an output resume to the computer when the word is accepted.

INP (72) — Data words (lower 6 bits) are transferred over the input cable to the computer from an external device selected previously by an EF instruction. An input ready signal is sent to the computer. The computer issues an input request signal to the typewriter unit prior to receipt of the first word and after storage of each word except the last.

INA (76) — The response of an external device to a previous EF status request instruction is placed in the computer A register. The response is a 12-bit quantity which is interpreted by the computer. The computer instruction causes one input request signal to be issued. The equipment responding sends an input ready to the computer with the response.

TYPEWRITER OPERATIONS

Input

An input operation is initiated by a 4220 EF code followed by an INP instruction. The control circuits store the keyboard select command and the function ready signal; an output resume signal is sent to the computer. The computer executes the INP instruction, issues the input request signal, and turns on the INPUT signal light on the control panel of the typewriter unit. As each character is typed, its code appears on the data lines to the computer and an input ready signal is produced. The computer accepts the character and returns an input request if it requires more information.

The computer returns to the program when an input disconnect signal is issued by the first carriage return following absence of the input request signal. The operator may also generate an input disconnect signal by placing the Auto/Manual (Input Disconnect) switch in MANUAL position. The choice of either of these two methods of terminating an input operation is left to the programmer.

Output

An output operation is initiated by a 4210 EF code followed by an OUT instruction. The control circuits store the print select command and the function ready signal and the typewriter returns the output resume signal. The computer executes the OUT instruction and sends 6-bit character codes and information ready signals to the typewriter unit. The information enters the translator register, the translator magnets are actuated, and the character is printed. An output resume signal is returned to the computer and the computer responds with the next character and an information ready signal if more characters are to be printed.

Status Request Signals

The status request, 4240 EF code, and the five status response signals allow the computer to determine the operating condition of the typewriter. The typewriter unit responds to a 4240 code followed by the INA instruction with the following codes.

0000	Typewriter Ready	Power has been applied to the typewriter, the mode switch is set to COMPUTER, and the typewriter is not being used by the computer.
0004	Power Off	The typewriter power switch has not been turned on.
0010	Typewriter Not in Computer Status	The mode switch is not set to COMPUTER.
0020	Input Character Ready	An input character is available to the computer.
0040	Output	The typewriter is performing a character output operation.

CHAPTER 2

OPERATION

To prepare the typewriter unit for use, apply power from the computer (indicated by the Ready light) and insert paper. All power and control cables must be connected.

APPLICATION OF POWER

Primary power, applied to the typewriter unit by the computer, is controlled by the On/Off switch under the right front corner of the machine. When power is applied to the unit, the fan located in the bottom of the cabinet should start immediately, forcing air through the grille above the fan. If the fan is inoperative, call maintenance.

MANUAL OPERATION

The typewriter may be removed from computer control by placing the Computer/Clear switch in the unmarked center position. The functions of the manual controls and indicators (mounted on the control panel) are listed in table 2.

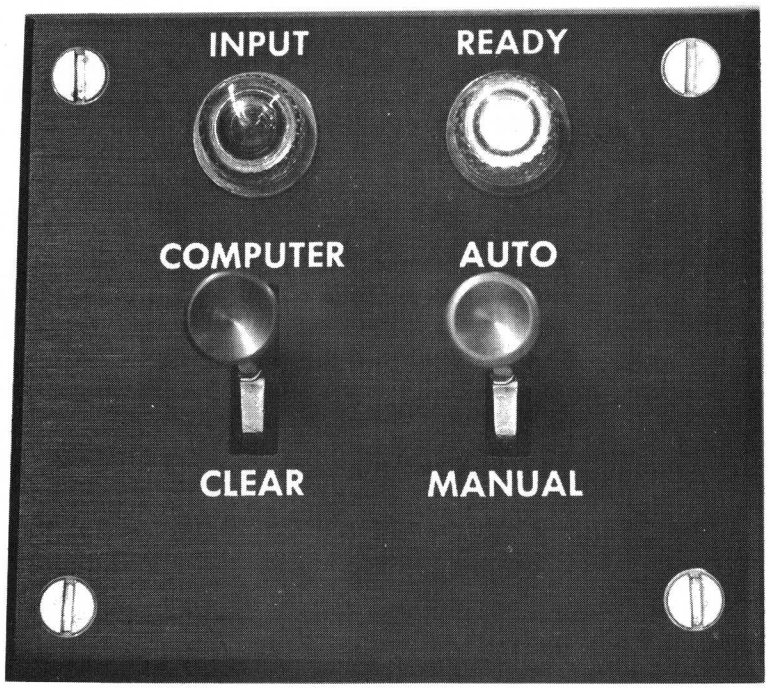


Figure 2-1. Typewriter Control Panel

TABLE 2. INDICATORS AND SWITCHES

Name	Function
Ready Light	Lit when power has been applied to logic circuits.
Input Light	Lit when computer requests input information
Computer/Clear Switch:	
Up (lock)	COMPUTER Places the unit under computer control for input and output operations.
Center	Unmarked position Removes the unit from computer control. If an input or output operation involving the unit is initiated when the switch is in this position, the SEL light in the computer status window is illuminated until the switch is moved to COMPUTER. If the switch is moved from COMPUTER to neutral during operation the status window will display IN or OUT and the computer must be re-started by the Run-Step switch.
Down (mom.)	CLEAR Momentary position resets the unit logic circuits. Sets control circuits after power is applied to the cabinet. This position will also drop an external function selection for input or output.
Auto/Manual Switch:	
Up (lock)	AUTO Allows the input disconnect signal to be sent to the computer each time a carriage return is typed during an input operation. The carriage return code (45) precedes the disconnect signal.
Center	No disconnect is effected.
Down (mom.)	MANUAL Provides for immediate termination of an input operation at any time by sending a disconnect signal to the computer.

CHAPTER 3

PRINCIPLES OF OPERATION

EXTERNAL FUNCTION CODE

The EF instruction reads a 12-bit external function code within the computer which is then sent to the typewriter accompanied by a function ready. Acceptance of this signal prepares the three Select flip-flops (FFs) for recognition of one of the three external function codes (figure 3-1). If the typewriter unit is already engaged in an output operation, this circuit stores the fact that a function ready has been received until the current operation is concluded. With one exception, the typewriter itself clears the Select FF upon the completion of an operation. The Print Select FF is not cleared by a status request because that request may come during a print operation, and clearing Print Select would terminate the current print cycle.

The 42XX code sets one of the three Select FFs (figure 3-2). The Set FF ($K^{106/107}$) must be energized for a selection to be made. As seen in figure 3-1, a status request will set $K^{106/107}$ immediately; on a print or keyboard selection this action must wait until the current typewriter operation is completed.

TYPEWRITER CODES

All typewriter characters and functions (table 1) are represented by unique combinations of 6 bits.

During keyboard input, striking a character key causes the coder to produce, as input to the computer, the code for that key. Space, carriage return, and tab are typewriter functions for which the keyboard control circuits form codes.

During output, 6-bit characters and functions from the computer are sent to the decoder where the decoder actuates the related key or function contact.

KEYBOARD OPERATION

The keyboard control circuit (figure 3-3) loads characters or functions from the coder into the keyboard register. During input this circuit enables the sampling of the keyboard common contacts and allows the circulation of data in the keyboard register. The circuit prevents the return of an input ready signal to the computer except when a request for keyboard input or status response has been made.

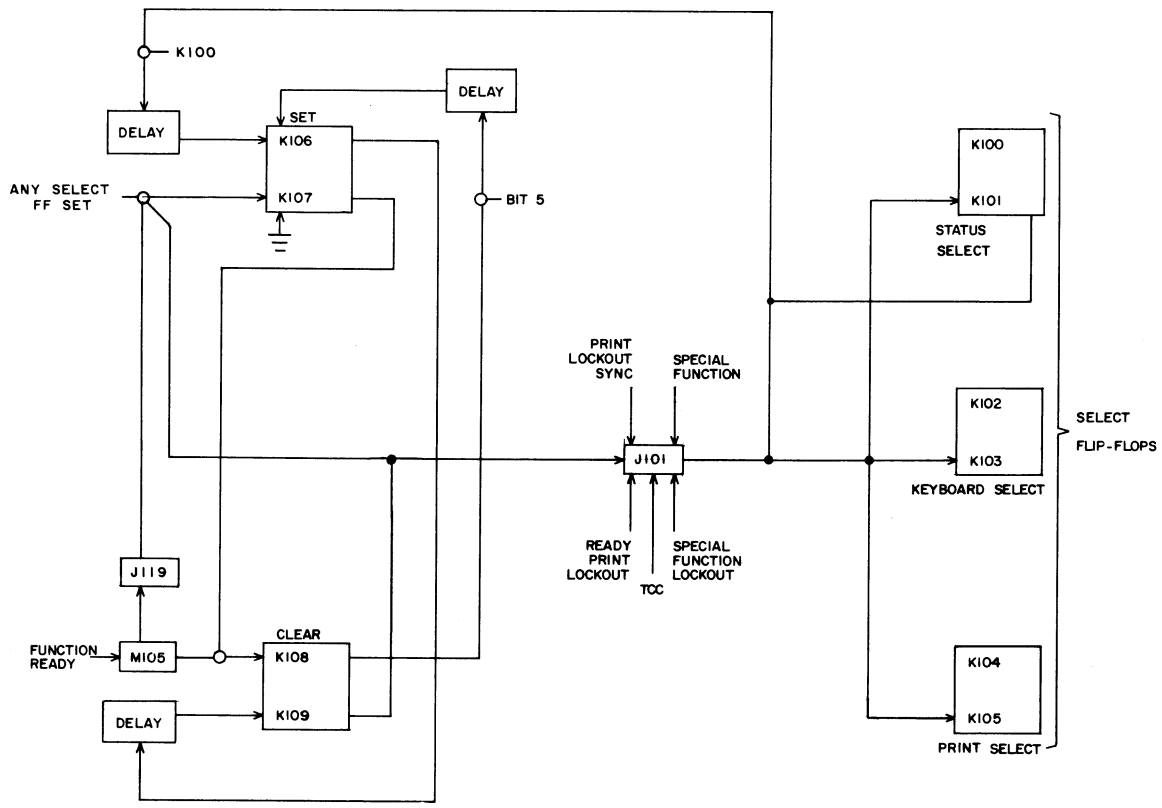


Figure 3-1. Typewriter Selection

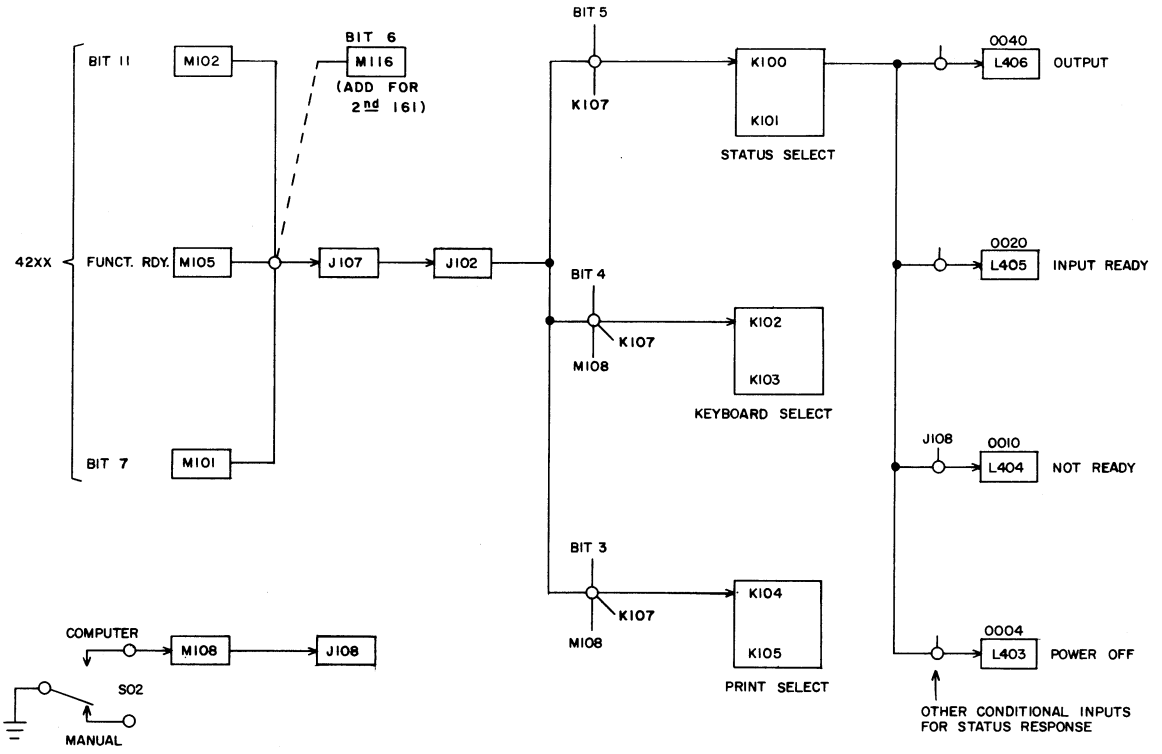


Figure 3-2. Select Function and Status Response

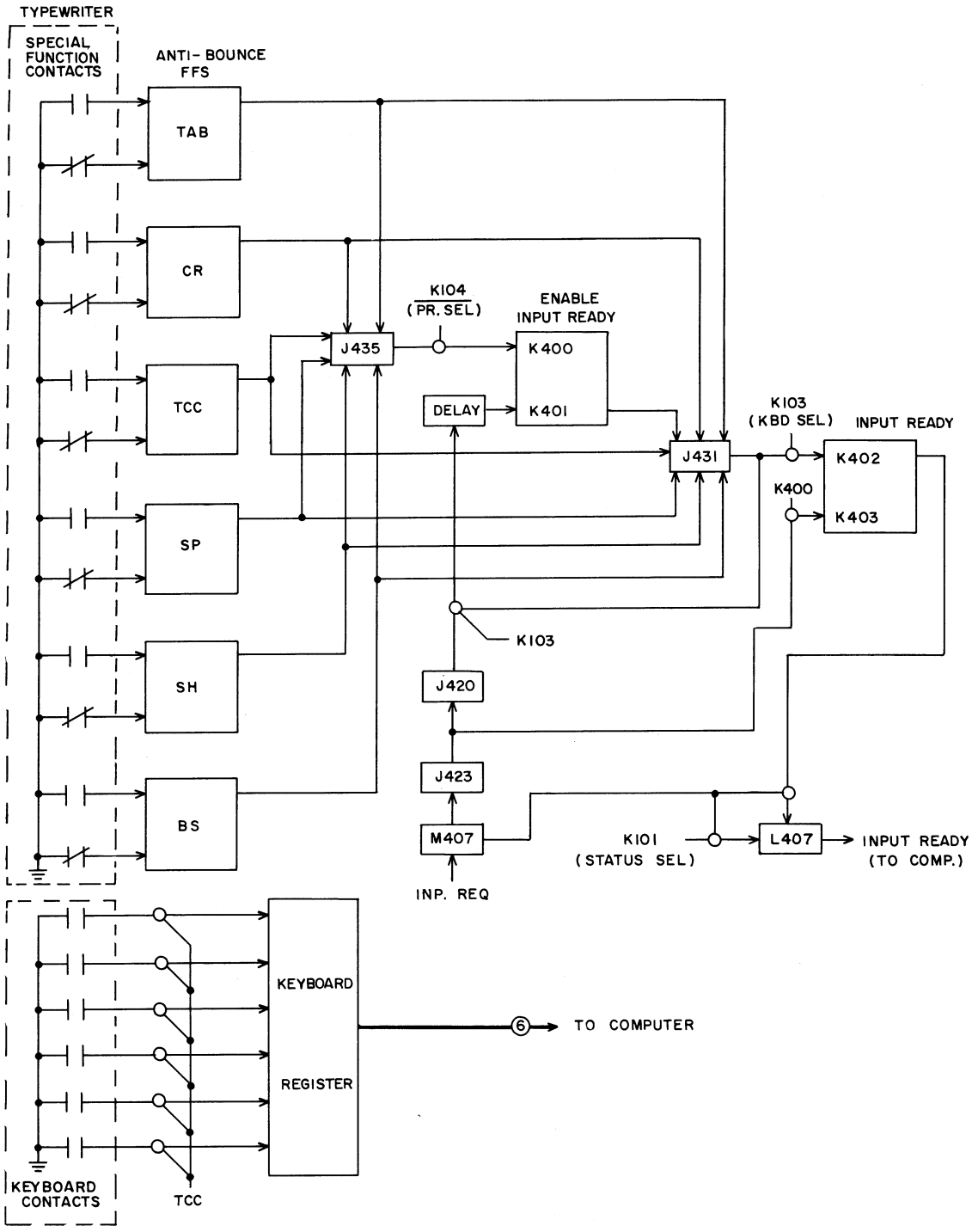


Figure 3-3. Keyboard Control

A typewriter key selection activates the TCC contacts. The NC contacts open. The NO contacts close, setting the TCC Anti-bounce FF. This allows the Enable Input Ready FF to be set, prohibits setting of the Input Ready FF, and introduces the character code into the recirculating stages of the keyboard register.

When the action for that character is completed (TCC contacts restored to normal), the TCC Anti-bounce FF is cleared, and the set inhibit (J431) to the Input Ready FF is removed. An input ready is returned to the computer and clears Enable Input Ready, which in turn clears the Input Ready FF, preparing the circuit for the next input request signal.

Although for special functions (Tab, CR, etc.) the function contacts replace the action of TCC, the analysis is the same; the action terminates by setting the Input Ready FF.

A status response bypasses the anti-bounce network and the input ready is returned to the computer when the status (input) request is received.

The sequence involved in the transmission of one character from the typewriter to the computer is:

1) Computer supplies the input request signal.
2) Character key is struck.
3) Encoder closes TCC and related keyboard contacts KC 1 through KC 6.
4) Character code is stored in keyboard register.
5) Restoration of TCC initiates an input ready to the computer and clears the network for the next input request signal.

The input disconnect circuit (figure 3-4) produces an input disconnect signal at the end of a keyboard operation. When the typewriter is in the automatic mode, this signal occurs following the transmission of the carriage return code to the computer. This short signal may be produced manually at the end of keyboard operation.

PRINT OPERATION

The print control circuit (figure 3-5) accepts character codes from the computer and sends them to the translator magnets (TM1 through TM6) of the typewriter decoder. The translator cam magnetic (TCM) is energized to start the print cycle.

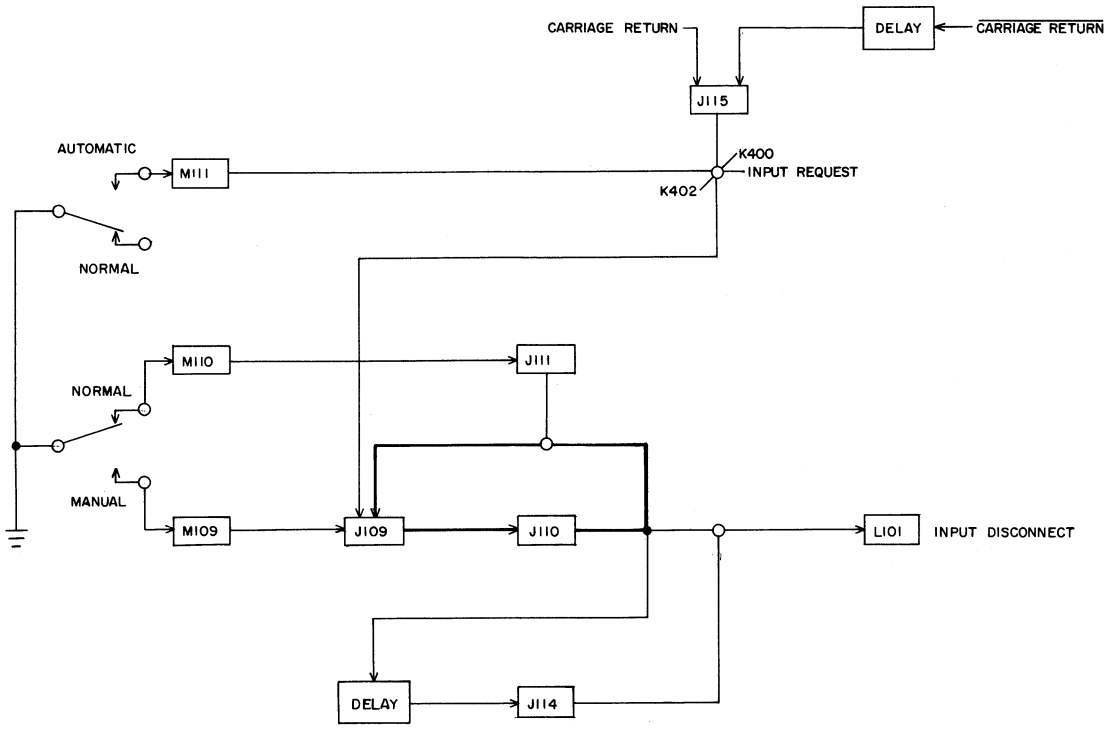


Figure 3-4. Input Disconnect Control

The cycle consists of:

1) Code Set (pull permutation bars)
2) Print (pull type bars)
3) Code Release (release permutation bars)

Initiation of each successive phase terminates the preceding phase.

To type a character, the computer produces an output information ready. An I → TR signal gates the character code to the translator register; translator magnets (TM 1 through TM 6) are energized. Print Lockout Sync establishes normal circulation in TR and the Terminate Set Code FF is energized.

Initiate Input is set which pulls TCM and starts the print cycle. Initiate Input is cleared by TBS which is actuated by TCM. The circuit is ready to receive another information ready but the Ready Print Lockout FF prevents new data from entering TR until the end of the print cycle.

The sequence of events for typing a character is: (figure 3-5)

1) Computer loads Z register and sends information ready.
2) Translator register is loaded.
3) Output resume signal is returned to the computer.
4) Computer drops information ready, clearing Resume FF.
5) Character is transferred to TM1 - TM6.
6) TCM energizes and causes character to be printed or function to be performed.
7) If code is for typewriter character, ribbon feed closes.
   If Back Space or Shift Code is involved, these contacts close.
8) Monitor Typewriter contacts open.
9) Ready Print lockout drops.
10) Step 1 can occur immediately after Step 4 but Step 2 will not proceed until Step 9 is complete.

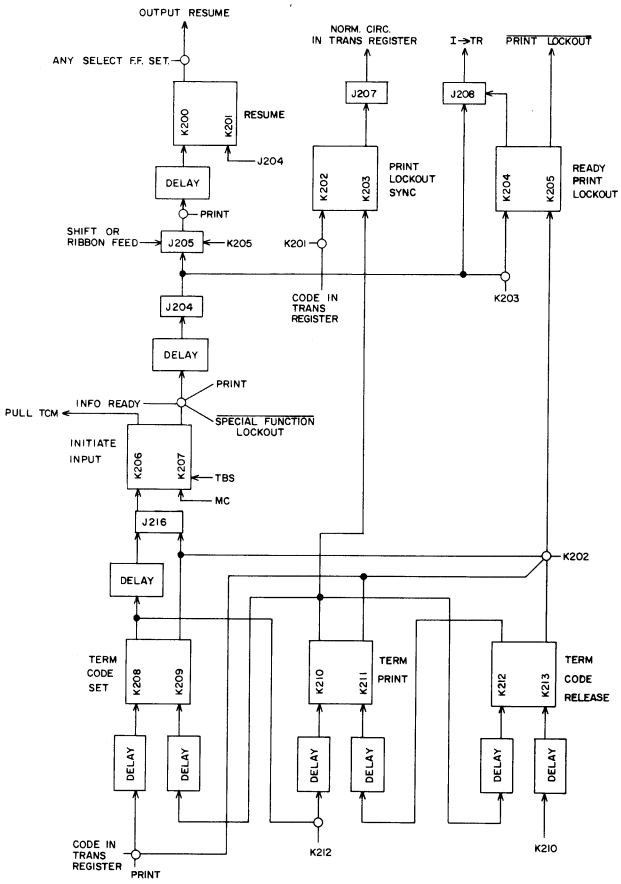


Figure 3-5. Print Control

A simplified diagram of the print cycle timing is shown in figure 3-6. The 100 ms interval will be extended for special function operations.

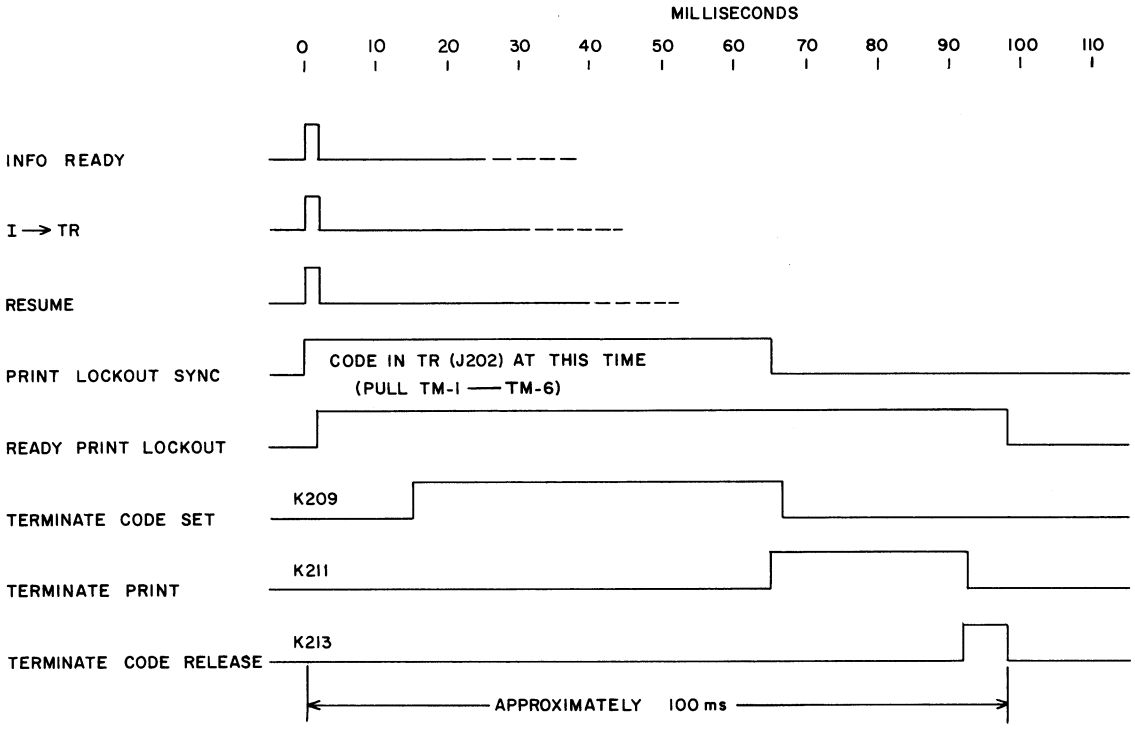


Figure 3-6. Simplified Typewriter Print Timing

CHAPTER 4

MAINTENANCE

This chapter provides general information for maintaining the typewriter unit control circuits. Maintenance personnel are assumed to be familiar with computer maintenance procedures and to have completed the maintenance training course provided by Control Data Corporation. The file of equations, Chapter 5, is the ultimate source of information on control circuits. The Monitor Typewriter Description, Operation and Maintenance manual (Control Data Publication 082) is also an aid to maintenance personnel.

Furnished as supplemental information and not as part of the typewriter unit instruction book is a listing of replaceable parts.

TEST EQUIPMENT AND TOOLS

Test equipment and tools for maintaining the typewriter unit are:

Control Data 151 Card Tester (check performance of printed circuit cards - this is optional equipment)
Oscilloscope (Tektronix 543 or equivalent)
VTVM (Hewlett - Packard HP-400D or equivalent)
Voltohmmeter
Taper pin insertion tool
Crimping tools
Printed circuit card extender
Hand tools commonly employed in electrical and mechanical maintenance

IDENTIFICATION NUMBERING SYSTEM

A coordinate numbering system is used in the typewriter unit. The basic typewriter unit number is 30000. The single logic chassis located within the cabinet is 30100. The basic component numbering system is:

Component Type	Cabinet	Chassis	Component
XX	3	XX	XX

Standard symbols (T - transformer, R - resistor, etc.) identify the type of component; components are numbered consecutively on printed circuit card schematics. The cabinet and chassis digits are omitted in identification if they are understood from the context or appear elsewhere on the diagram (e.g. J01, T01 etc).

Printed circuit cards in the logic chassis are located by a coordinate system:

Chassis	Ordinate (row)	Abscissa (column)	Test Point
X	X	XX	X

Because the control circuit equations are unique to this equipment, the cabinet number is omitted. The ordinate has a range of A through C; the abscissa a range of 01 through 48. Test point locations are identified by letter as the card is viewed from the wiring side (A through D, top to bottom).

POWER AND COOLING

The typewriter unit derives its power from a 115v, single phase convenience outlet at the site. Power is available to the Monitor Typewriter and the convenience outlet in the rear of the cabinet whenever the 161 is connected to the site power source. However, the 161 power supply and blower can only be energized by pressing the Power On switch on the computer console. Table 3 lists all replaceable fuses in the typewriter cabinet.

TABLE 3. REPLACEABLE FUSES

Input Power Requirements	Fuse No.	Rating	Protects
60 Cycle: 115 vac 60 cps	F01 F02 F03 F04 F05 F06	8A, 125v 5A, 125v 2A, 125v 5A, 125v 3A, 125v 5A, 125v	Convenience outlet Typewriter Fan -20 +20 -15

POWER SUPPLY

The computer system operates from one basic power input (115 vac, 60 cps taken directly from the line) which operates such equipment as the convenience outlets, fan motors, punch motor, reader motor and the input to the power supply unit. The +20v and -20v supplies are identical; only the -20v is described. Groups of circuit components are represented by blocks.

The power transistors in this supply unit operate in the (saturated) switched mode, for greater efficiency. The power transistors switch on and off approximately 1200 times per second. Automatic control of the duty cycle provides constant output voltage at any required level of load current within the rating or any variation of source voltage between the limits of 90 and 130v rms.

In the off position of the regulator (figure 4-1) Q1 is biased off by PS2. The amount of bias on Q1 is limited to the forward drop across the silicon diode CR2. In the off condition, power from PS1 is blocked by Q1 and a zero voltage drop appears across RL.

The magnetic amplifier (figure 4-2) is a pulse width modulator controlled by the value of E_c. Negative pulses from this amplifier are applied to the base of Q1. Resistor R4, being ten times the value of R5, causes the positive off bias voltage from PS2 to appear at Q1 only during the absence of pulses from the magnetic amplifier. Flow of excessive reset current from PS2 through the gate windings of the magnetic amplifier would reduce gain. CR2 prevents this.

Triggering the magnetic amplifier causes Q1 to turn on. Current is released from PS1 into the filter circuit and RL. The end of the magnetic amplifier pulse removes the bias from Q1 and stops the flow of current from PS1. Energy stored in L1 continues to flow into RL and the damping diode CR1 until the next pulse from the magnetic amplifier occurs.

A voltage detector and stabilization network (figure 4-3) completes the regulating loop. Adjusting the voltage detector by varying R9 provides a constant voltage of 20v across RL. Oscillation is prevented by the stabilizing network consisting of the secondary winding on L1 together with R6, R7 and C2. This circuit generates currents of the correct amplitude and phase and applies them to the feedback winding on the magnetic amplifier. A filter (R6 and C2) removes 1200 cps noise from the feedback signal. The voltage detector operates only on the -20v section. A sense circuit, connected between

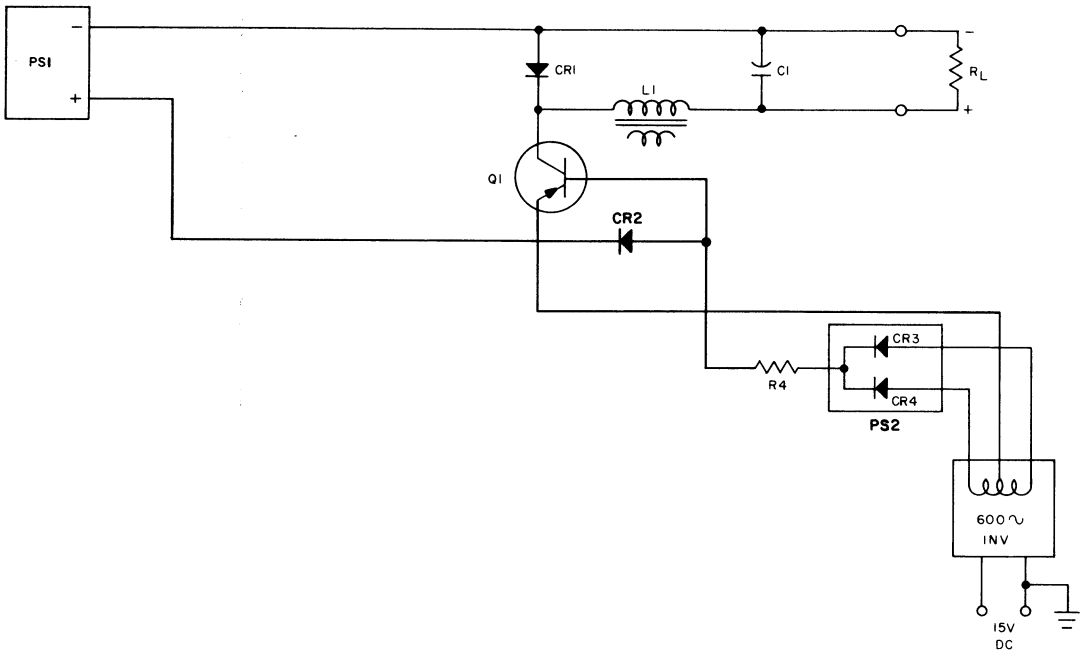


Figure 4-1. Steady-State OFF Condition

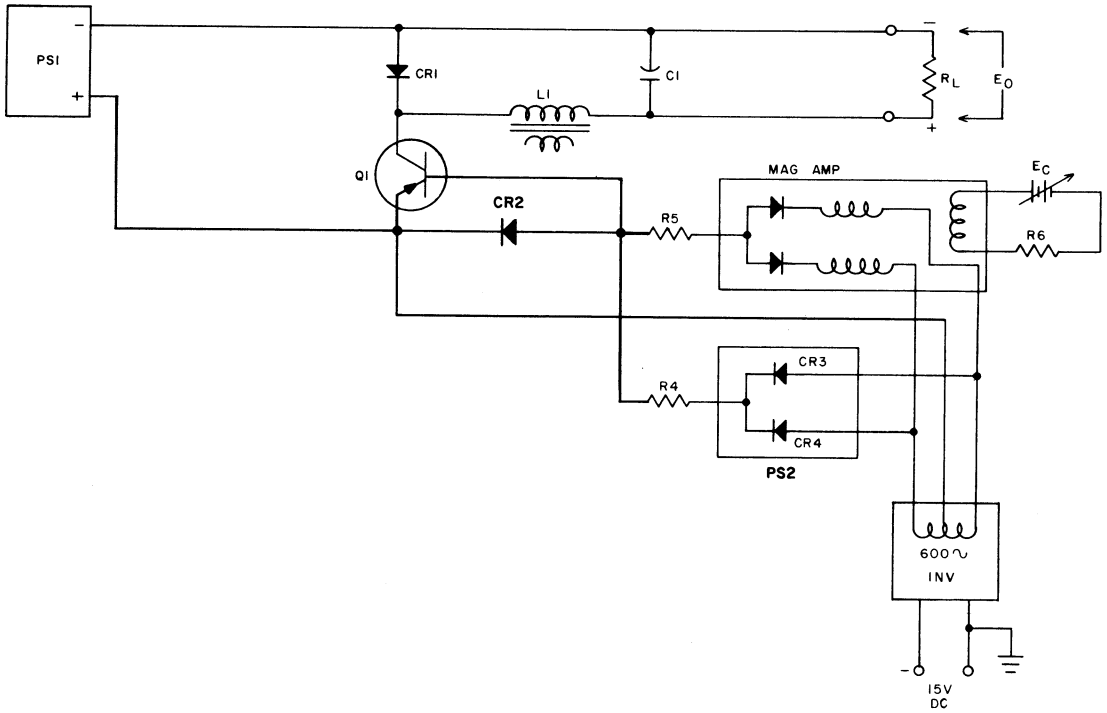


Figure 4-2. Magnetic Amplifier

-20v and +20v, provides an input to the -20v magnetic amplifier (T_4) in order to ensure that the magnitude of +20 output voltage follows that of the -20v section.

The overvoltage protection circuit, figure 4-4, prevents any prolonged overvoltage at the output terminals of the power supply unit in event of transistor failure. In most cases, a failure of this type will appear as a short between collector and emitters, resulting in a surge of approximately 25v above the normal 20v output. Relay RY1 energizes when the total output voltage rises to near 60 volts. Relay RY2 is energized by contact 1A and locked in by contact 2A which opens contact 2B, de-energizing the primary winding of the power transformer T1.

COOLING SYSTEM

A fan at the bottom of the cabinet circulates air-conditioned room air over cabinet components. The cool room air enters the bottom of the cabinet, is forced over the cabinet components and out through louvres on the rear door of the cabinet.

The exhaust temperature at the top of the cabinet is monitored by a 100°F (38°C) thermostat (figure 1-2). If the temperature reaches 100°F in the cabinet the thermostat opens to drop all power from the unit except for the convenience outlet. An actuated thermostat closes automatically when the temperature drops below 100°F; power to the unit is automatically reinstated. The fan, thermostat and fuses for the cooling system are shown on the power distribution diagram in chapter 6 of this volume.

CABLING

Cabling in the typewriter cabinet is detailed on the diagram of typewriter interconnections in chapter 6 of this volume.

TYPEWRITER UNIT TESTING

Certain tests have been written to check the operation of the typewriter unit. These tests may be found in "Test and Library Routines for the 160 Computer" a Control Data Corporation publication.

OUTPUT TEST

The Output Test program (T006) consists of several test routines on one tape; the first two test the typewriter.

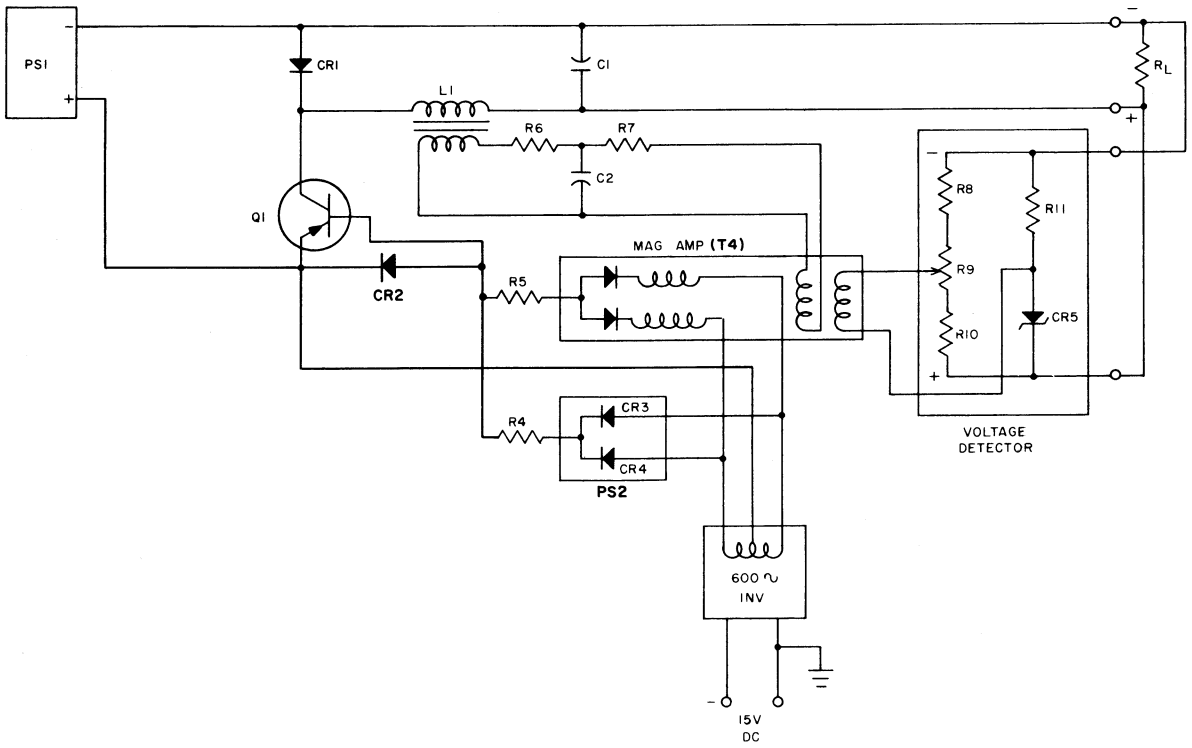


Figure 4-3. Voltage Detection and Stabilization Network

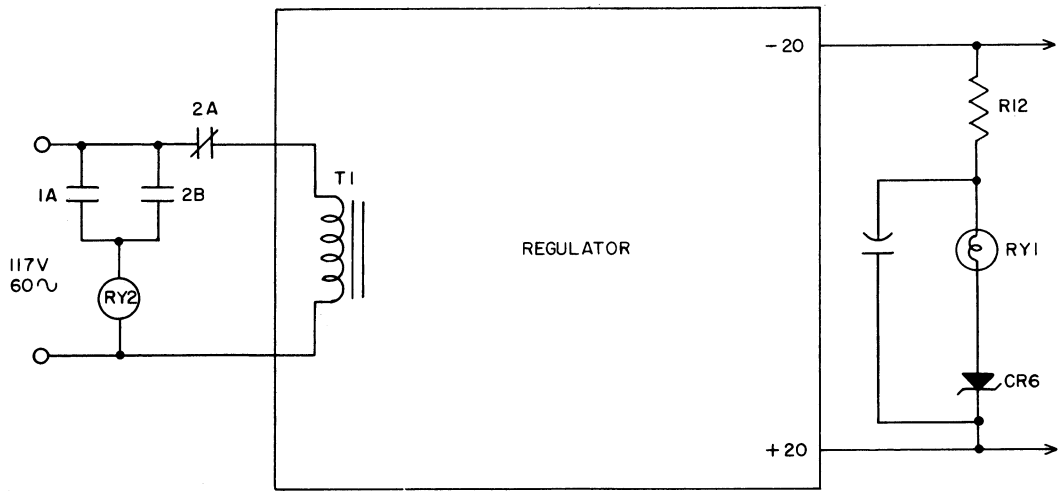


Figure 4-4. Over-Voltage Protection Circuit

The typewriter pattern test routine sends a repetitive pattern of binary 000000 to 111111 out to the typewriter. A visual check of the operation should be made. The typewriter alphabet test routine types out a pattern of all functions of the typewriter.

TYPEWRITER TEST

The typewriter input and output test (T009) consists of three routines. The first accepts ten characters typed in from the program and types out a carriage return followed by the ten characters. The second accepts information until an input disconnect occurs either automatically or manually. The program then types out a carriage return followed by the information up to the disconnect. The third routine accepts information until a carriage return is typed; it types out the same information.

PREVENTIVE MAINTENANCE

The section on Maintenance, Lubrication, and Adjustments in the Monitor Typewriter manual discusses preventive maintenance techniques applicable to the typewriter. The following preventive maintenance schedule is suggested for the typewriter unit.

Daily:	clean cabinet area	Weekly:	clean, oil and check typewriter
	run test programs	Monthly:	check fan

CHAPTER 5

FILE OF EQUATIONS

As in the computer, the logical interconnection of most printed circuit cards in the typewriter unit is described by Boolean algebraic equations. The file of these equations is the most important source of information about the logic of the typewriter unit.

EQUATION SYMBOL ASSIGNMENTS

J	-	Control Inverters
K	-	Flip-Flops
L	-	Output Conversions
M	-	Input Conversions
Y	-	Delays

The file of equations is preceded by card placement charts showing the physical location of the logic elements. The use of the file and card placement charts is explained in Volume 2 (Maintenance) of the computer instruction book series.

TYPEWRITER CHASSIS (30100)

VERTICAL COORDINATE A

17	J117	J216	22	
18			77	
19				
20	J107	J108	21	
21	K206	K207	32	
22	J413	J115	22	
23	K100	K101	31	
24	J102		15	
25	K102	K103	31	
26	J101		16	
27	K104	K105	31	
28	J204	J217	21	
29	J215	J205	23	
30	K200	K201	32	
31	J207		11	
32	K202	K203	32	

33	J208			13
34	K204	K205		32
35	Capacitor Card			73
36	K214	K215		33
37		J436		21
38	K414	K415		31
39	K412	K413		31
40	K400	K401		32
41	J431			16
42	K404	K405		31
43	K406	K407		31
44	K408	K409		31
45	K410	K411		31
46				
47				
48				

VERTICAL COORDINATE B

17	Cable Jumpers			
18	Cable Jumpers			
19	M420 M421	M422	61	
20	J111	J109	23	
21	K106	K107	32	
22	Capacitor Card		73	
23	K108	K109	31	
24	J202	J114	21	
25	K208	K209	32	
26	Capacitor Card		73	
27	K210	K211	32	
28	Capacitor Card		73	
29	K212	K213	32	
30	J201		16	
31	J209	J312	21	
32	J308	J310	21	

33	J309	J311		22
34	J411			16
35	J407	J435		24
36	J305	J307		22
37	J302	J304		21
38	J301	J303		22
39	J116	J106		21
40	K402	K403		32
41	J410	J412		21
42	J406	J408		21
43	J402	J404		21
44	J432	J306		21
45	J424			11
46	J405			15
47	J403	J409		23
48	J401			15

TYPEWRITER CHASSIS (30100)

VERTICAL COORDINATE C

17	P001	P002	P003	86	33	L301	L302	L303	62
18					34	M304	M305	M106	61
19	P004	P005	P006	86	35	M301	M302	M303	61
20					36		J210		11
21	P007			86	37	L307	L408		62
22					38	L404	L405	L406	67
23	L201	L101	L407	67	39	L401	L402	L403	67
24	J105		J110	22	40	J119		J434	21
25	M306	M107	M108	87	41	J211		J423	22
26	M109	M110	M111	61	42	J118		J420	22
27	M105	M112	M113	87	43		J414		11
28	M204	M101	M102	61	44	M413	M414	M415	61
29	M114	M115	M116	61	45	M410	M411	M412	61
30	M201	M202	M203	61	46	M407	M408	M409	87
31		J433		11	47	M404	M405	M406	61
32	L304	L305	L306	62	48	M401	M402	M403	61

$J^{101} = K^{108} + J^{210} + K^{203} + K^{205} + K^{215} + K^{409}$

A26B : K^{106} : : K^{103} : K^{105}

$J^{102} = J^{107} + M^{116} + M^{113} + M^{114} + M^{115}$

A24B : K^{100} : K^{102} : K^{104} : L^{201} : K^{106}

$J^{105} = M^{106} + M^{107}$

C24A : J^{116} : J^{106}

$J^{106} = J^{105}$

B39C : K^{203} : K^{205} : K^{215} : K^{401} : K^{403}

$J^{107} = M^{101} M^{102} M^{105}$

A20A : J^{102}

$J^{108} = M^{108}$

A20C : L^{404}

$J^{109} = M^{109} + J^{110} J^{111} + M^{111} J^{420} K^{400} J^{115} K^{402}$

B20C : J^{110}

$J^{110} = J^{109} + K^{102}$

C24C : L^{101} : J^{114} : J^{109}

$J^{111} = M^{110} + Y^{999} + Y^{999}$

B20A : J^{109}

$J^{114} = J^{110} Y^{102}$

B24C : L^{101}

$J^{115} = K^{407} + K^{406} Y^{101}$

A22C : J^{109}

$J^{116} = J^{105}$

B39A : K^{201} : K^{207} : K^{209} : K^{211} : K^{213}

$J^{117} = K^{106} + Y^{999}$

A17A : K^{100} : K^{102} : K^{104} : L^{201}

$J^{118} = M^{112} + Y^{999}$

C42A : L^{403}

$J^{119} = M^{105}$

C40A : K^{107}

$J^{201} = J^{302} + J^{304} + J^{306} + J^{308} + J^{310} + J^{312}$

B30B : J^{202}

$J^{202} = J^{201}$

B24A : K^{208} : K^{202}

$J^{204} = M^{201}\ K^{206}\ K^{105}\ K^{214}\ Y^{212}\ K^{108}$

A28A : J^{205} : J^{208} : K^{204} : K^{201}

$J^{205} = J^{204} + J^{210} + K^{205}$

A29C : K^{200}

$J^{207} = K^{202}$

A31B : J^{301} : J^{303} : J^{305} : J^{307} : J^{309} : J^{311}

$J^{208} = J^{210} + J^{204} + K^{205}$

A33B : J^{301} : J^{303} : J^{305} : J^{307} : J^{309} : J^{311}

$J^{209} = M^{203}$

B31A : J^{211} : K^{414}

$J^{210} = K^{410}\ K^{406}\ K^{404}\ J^{211}$

C36B : J^{101} : J^{205} : J^{208} : J^{211} : K^{215} : J^{413}

$J^{211} = J^{209}\ J^{210} + M^{204}$

C41A : J^{210}

$J^{215} = J^{301} + J^{304} + J^{311}$

A29A : K^{214} : K^{214} : K^{214}

$J^{216} = K^{209}\ Y^{204} + K^{208}$

A17C : K^{206}

$J^{217} = K^{100}\ K^{102}\ K^{104}$

A28C : L^{201} : K^{107} : L^{201}

$J^{301} = M^{301}\ J^{208} + J^{302}\ J^{207}$

B38A : J^{302} : L^{301} : J^{215}

$J^{302} = J^{301}$

B37A : J^{301} : : J^{201}

$J^{303} = M^{302}\ J^{208} + J^{304}\ J^{207}$

B38C : J^{304} : L^{302}

$J^{304} = J^{303}$

B37C : J^{303} : J^{215} : J^{201}

$J^{305} = M^{303}\ J^{208} + J^{306}\ J^{207}$

B36A : J^{306} : K^{214} : L^{303} : K^{214}

$J^{306} = J^{305}$

B44C : J^{305} : K^{214} : J^{201}

$J^{307} = M^{304}\ J^{208} + J^{308}\ J^{207}$

B36C : J^{308} : K^{214} : L^{304} : K^{214}

$J^{308} = J^{307}$

B32A : J^{307} : K^{214} : J^{201}

$J^{309} = M^{305}\ J^{208} + J^{310}\ J^{207}$

B33A : J^{310} : K^{214} : L^{305} : K^{214}

$J^{310} = J^{309}$

B32C : J^{309} : K^{214} : J^{201}

$J^{311} = M^{306}\ J^{208} + J^{312}\ J^{207}$

B33C : J^{312} : L^{306} : J^{215}

$J^{312} = J^{311}$

B31C : J^{311} : : J^{201}

$J^{401} = K^{407} + J^{424}\ M^{401} + J^{414}\ J^{402} + K^{405} + K^{413} + K^{415}$

B48B : J^{402}

$J^{402} = J^{401}$

B43A : L^{401} : J^{401}

$J^{403} = J^{424}\ M^{402} + J^{414}\ J^{404} + K^{413}$

B47A : J^{404}

$J^{404} = J^{403}$

B43C : L^{402} : J^{403}

$J^{405} = K^{407} + K^{411} + J^{424}\ M^{403} + J^{414}\ J^{406} + K^{413}$

B46B : J^{406}

$J^{406} = J^{405}$

B42A : L^{403} : J^{405}

$J^{407} = K^{405} + J^{424}\ M^{404} + J^{414}\ J^{408} + K^{413}\ M^{422}$

B35A : J^{408}

$J^{408} = J^{407}$

B42C : L^{404} : J^{407}

$J^{409} = J^{424}\ M^{405} + J^{414}\ J^{410} + K^{415}$

B47C : J^{410}

$J^{410} = J^{409}$

B41A : L^{405} : J^{409}

$J^{411} = K^{405} + K^{407} + J^{424}\ M^{406} + J^{414}\ J^{412} + K^{413} + K^{415}$

B34B : J^{412}

$J^{412} = J^{411}$

B41C : L^{406} : J^{411}

$J^{413} = J^{210} + Y^{999}$

A22A : J^{434}

$J^{414} = K^{400}\ K^{402}$

C43B : J^{411} : J^{409} : J^{407} : J^{405} : J^{403} : J^{401}

$J^{420} = J^{423} + K^{109}$

C42C : L^{408} : J^{109} : K^{401}

$J^{423} = M^{407} + Y^{999}$

C41C : J^{420} : : K^{403}

$J^{424} = K^{408}$

B45B : J^{411} : J^{409} : J^{407} : J^{405} : J^{403} : J^{401}

$J^{431} = K^{411} + K^{409} + K^{405} + K^{407} + K^{400} + J^{436}$

A41B : K^{402} : K^{401} : L^{405}

$J^{432} = J^{435}\ K^{412}\ K^{414}$

B44A : K^{400}

$J^{433} = K^{102}$

C31B : L^{403} : L^{402} : L^{401} : L^{406} : L^{405} : L^{404}

$J^{434} = K^{214}\ K^{202}\ K^{204}\ J^{413}$

C40C : L^{406}

$J^{435} = K^{411} + K^{409} + K^{407} + K^{405}$

B35C : J^{432}

$J^{436} = K^{414}\ K^{412}$

A37C : J^{431}

$K^{100} = K^{101} + J^{102}\ M^{306}\ J^{117}$

A23A : K^{101} : L^{408} : K^{106} : : J^{217}

$K^{101} = K^{100} + K^{109}$

A23C : K^{100} : L^{406} : L^{405} : L^{404} : L^{403} : L^{407}

$K^{102} = K^{103} + J^{102}\ M^{305}\ M^{108}\ J^{117}$

A25A : K^{103} : : J^{110} : J^{433} : J^{217}

$K^{103} = K^{102} + J^{101}$

A25C : K^{102} : L^{408} : K^{402} : K^{401}

$K^{104} = K^{105} + J^{102}\ M^{304}\ M^{108}\ J^{117}$

A27A : K^{105} : J^{217} : K^{400}

$K^{105} = K^{104} + J^{101}$

A27C : K^{104} : J^{204} : : K^{208} : K^{200}

$K^{106} = K^{107} + J^{101}\ K^{100}\ Y^{103} + K^{109}\ M^{306}\ Y^{107}\ J^{102}$

B21A : K^{107} : K^{108} : J^{117}

$K^{107} = K^{106} + K^{108}\ J^{119}\ J^{217} + Y^{999}$

B21C : K^{106} : K^{109}

$K^{108} = K^{109} + K^{106}\ M^{105}$

B23A : K^{109} : K^{107} : J^{101} : L^{201} : J^{204}

$K^{109} = K^{108} + K^{107}\ Y^{105}$

B23C : K^{108} : J^{420} : K^{106} : K^{101}

$K^{200} = K^{201} + J^{205}\ K^{105}\ Y^{213} + K^{201}$

A30A : K^{201}

$K^{201} = K^{200} + J^{204} + J^{116}$

A30C : K^{200} : L^{201} : K^{202} : K^{200}

$K^{202} = K^{203} + K^{201}\ J^{202} + K^{203}$

A32A : K^{203} : K^{205} : J^{207} : J^{434}

$K^{203} = K^{202} + K^{211} + J^{106}$

A32C : K^{202} : K^{204} : K^{202} : J^{101}

$K^{204} = K^{205} + K^{203}\ J^{204} + K^{205}$

A34A : K^{205} : J^{434}

$K^{205} = K^{204} + K^{202}\ K^{210}\ K^{212}\ K^{208} + J^{106}$

A34C : K^{204} : J^{205} : J^{208} : K^{204} : J^{101}

$K^{206} = K^{207} + J^{216} + K^{207}$

A21A : K^{207} : J^{204} : L^{307}

$K^{207} = K^{206} + M^{202} + J^{116}$

A21C : K^{206} : : K^{206}

$K^{208} = K^{209} + J^{202}\ K^{210}\ K^{105}\ Y^{201} + K^{209}$

B25A : K^{209} : K^{205} : J^{216}

$K^{209} = K^{208} + K^{211}\ Y^{202} + J^{116}$

B25C : K^{208} : J^{216} : K^{210} : K^{208}

$K^{210} = K^{211} + K^{209}\ K^{212}\ Y^{203} + K^{211}$

B27A : K^{211} : K^{208} : K^{213} : K^{205}

$K^{211} = K^{210} + K^{213}\ Y^{205} + J^{116}$

B27C : K^{210} : K^{209} : K^{212} : K^{203} : K^{210}

$K^{212} = K^{213} + K^{211}\ Y^{206} + K^{213}$

B29A : K^{213} : K^{205} : K^{210}

$K^{213} = K^{212} + K^{210}\ Y^{207}$: J^{116}

B29C : K^{212} : K^{211} : K^{212}

$K^{214} = K^{215} + J^{215}\ J^{305}\ J^{308}\ J^{309}\ Y^{209} + J^{215}\ J^{306}\ J^{307}\ J^{309}\ Y^{210} + J^{215}\ J^{305}\ J^{307}\ J^{310}\ Y^{211}$

A36A : K^{215} : J^{204} : K^{215} : J^{434}

$K^{215} = K^{214} + J^{210}\ Y^{208} + J^{106} + K^{214}$

A36C : K^{214} : J^{101}

$K^{400} = K^{401} + J^{432}\ K^{104} + Y^{999}$

A40A : K^{401} : J^{431} : J^{109} : J^{414} : K^{403}

$K^{401} = K^{400} + J^{420}\ J^{431}\ K^{103}\ Y^{401} + J^{106}$

A40C : K^{400}

$K^{402} = K^{403} + J^{431}\ K^{103} + Y^{999}$

B40A : K^{403} : J^{414} : J^{109}

$K^{403} = K^{402} + K^{400}\ J^{423} + J^{106}$

B40C : K^{402} : : : L^{407}

$K^{404} = K^{405} + M^{414}$

A42A : K^{405} : : J^{210}

$K^{405} = K^{404} + M^{415}$

A42C : K^{404} : J^{401} : J^{407} : J^{411} : J^{431} : J^{435}

$K^{406} = K^{407} + M^{412}$

A43A : K^{407} : : J^{210} : J^{115}

$K^{407} = K^{406} + M^{413}$

A43C : K^{406} : J^{115} : J^{401} : J^{405} : J^{411} : J^{431} : J^{435}

$K^{408} = K^{409} + M^{410}$

A44A : K^{409} : : J^{424}

$K^{409} = K^{408} + M^{411}$

A44C : K^{408} : J^{101} : J^{431} : J^{435}

$K^{410} = K^{411} + M^{408}$

A45A : K^{411} : : J^{210}

$K^{411} = K^{410} + M^{409}$

A45C : K^{410} : J^{405} : J^{431} : J^{435}

$K^{412} = K^{413} + M^{203}\ M^{420}$

A39A : K^{413} : J^{432} : J^{436}

$K^{413} = K^{412} + M^{421}$

A39C : K^{412} : J^{411} : J^{407} : J^{405} : J^{403} : J^{401}

$K^{414} = K^{415} + J^{209}\ M^{204}$

A38A : K^{415} : J^{432} : J^{436}

$K^{415} = K^{414} + M^{203}$

A38C : K^{414} : J^{411} : J^{409} : J^{401}

$L^{101} = J^{110}\ J^{114} + Y^{999}$

C23B : 1J06-V 1J07-V

$L^{201} = K^{201}\ J^{217} + K^{108}\ J^{102}\ J^{217}\ J^{117}$

C23A : 1J04-S 1J05-S

$L^{301} = J^{301}$

C33A : P^{001}

$L^{302} = J^{303}$

C33B : P^{002}

$L^{303} = J^{305}$

C33C : P^{003}

$L^{304} = J^{307}$

C32A : P^{004}

$L^{305} = J^{309}$

C32B : P^{005}

$L^{306} = J^{311}$

C32C : P^{006}

$L^{307} = K^{206}$

C37A : P^{007}

$L^{401} = J^{402}\ J^{433} + Y^{999}$

C39A : 1J06-A 1J07-A

$L^{402} = J^{404}\ J^{433} + Y^{999}$

C39B : 1J06-B 1J07-B

$L^{403} = J^{406}\ J^{433} + K^{101}\ J^{118}$

C39C : 1J06-C 1J07-C

$L^{404} = J^{408}\ J^{433} + K^{101}\ J^{108}$

C38A : 1J06-D 1J07-D

$L^{405} = J^{410}\ J^{433} + K^{101}\ J^{431}$

C38B : 1J06-E 1J07-E

$L^{406} = J^{412}\ J^{433} + K^{101}\ J^{434}$

C38C : 1J06-F 1J07-F

$L^{407} = K^{403}\ M^{407} + K^{101}\ M^{407}$

C23C : 1J06-R 1J07-R

$L^{408} = J^{420}\ K^{103}\ K^{100}$

C37B : 1J02-N

M^{101} = 1J04-J 1J05-J

C28B : : J^{107}

M^{102} = 1J04-N 1J05-N

C28C : : J^{107}

M^{105} = 1J04-T 1J05-T

C27A : J^{107} : K^{108} : J^{119}

M^{106} = 1J04-U 1J05-U

C34C : J^{105}

M^{107} = 1J02-P

C25B : : J^{105}

M^{108} = 1J02-R

C25C : K^{102} : J^{108} : K^{104}

M^{109} = 1J02-S

C26A : J^{109}

M^{110} = 1J02-T

C26B : : J^{111}

M^{111} = 1J02-U

C26C : : J^{109}

M^{112} = 1J01-V 1J02-Y

C27B : J^{118}

M^{113} = 1J04-M 1J05-M

C27C : J^{102}

M^{114} = 1J04-L 1J05-L

C29A : J^{102}

M^{115} = 1J04-K 1J05-K

C29B : J^{102}

M^{116} = 1J04-H 1J05-H

C29C : J^{102}

M^{201} = 1J04-R 1J05-R

C30A : : J^{204}

M^{202} = 1J01-L

C30B : K^{207}

M^{203} = 1J01-S

C30C : J^{209} : K^{412}
: K^{415}

M^{204} = 1J01-H

C28A : K^{414} : J^{211}

M^{301} = 1J04-A 1J05-A

C35A : : J^{301}

M^{302} = 1J04-B 1J05-B

C35B : : J^{303}

M^{303} = 1J04-C 1J05-C

C35C : : J^{305}

M^{304} = 1J04-D 1J05-D

C34A : K^{104} : J^{307}

M^{305} = 1J04-E 1J05-E

C34B : K^{102} : J^{309}

M^{306} = 1J04-F 1J05-F

C25A : J^{311} : K^{100} : K^{106}

M^{401} = 1J02-A

C48A : J^{401}

M^{402} = 1J02-B

C48B : : J^{403}

M^{403} = 1J02-C

C48C : J^{405}

M^{404} = 1J02-D

C47A : J^{407}

M^{405} = 1J02-E

C47B : J^{409}

M^{406} = 1J02-F

C47C : J^{411}

M^{407} = 1J06-S 1J07-S

C46A : J^{423} : L^{407} : L^{407}

M^{408} = 1J01-M

C46B : K^{410}

M^{409} = 1J01-N

C46C : K^{411}

M^{410} = 1J02-H

C45A : K^{408}

M^{411} = 1J02-J

C45B : K^{409}

M^{412} = 1J01-T

C45C : K^{406}

M^{413} = 1J01-U

C44A : K^{407}

M^{414} = 1J01-P

C44B : K^{404}

M^{415} = 1J01-R

C44C : K^{405}

M^{420} = 1J01-H

B19A : K^{412}

M^{421} = 1J01-W

B19B : K^{413}

M^{422} = 1J01-Y

B19C : J^{407}

P^{001} = L^{301}

C17A : 1J01-A TM1

P^{002} = L^{302}

C17B : 1J01-B TM2

P^{003} = L^{303}

C17C : 1J01-C TM3

P^{004} = L^{304}

C19A : 1J01-D TM4

P^{005} = L^{305}

C19B : 1J01-E TM5

P^{006} = L^{306}

C19C : 1J01-F TM6

P^{007} = L^{307}

C21A : 1J01-J TCM

Y^{101} = 40 us

B26-7 : J^{115}

Y^{102} = 20 us

B26-8 : J^{114}

Y^{103} = 20 us

B28-8 : K^{106}

Y^{105} = 5 us

B22-6 : K^{109}

Y^{107} = 7.5 us

B22-5 B22-4 B26-4 B28-4 B26-5 : K^{106}

Y^{201} = 30 ms

A18-10 B22-11 B22-12 : K^{208}

Y^{202} = 400 us

B26-10 : K^{209}

Y^{203} = 60 ms

A18-7 A18-8 : K^{210}

Y^{204} = 400 us

A35-10 : J^{216}

Y^{205} = 400 us

B28-10 : K^{211}

Y^{206} = 30 ms

A18-9 : K^{212}

Y^{207} = 5 ms

B28-11 : K^{213}

Y^{208} = 200 us

A35-9 : K^{215}

Y^{209} = 5 us

B26-6 : K^{214}

Y^{210} = 5 us

B28-6 : K^{214}

Y^{211} = 5 us

A35-6 : K^{214}

Y^{212} = 1.5 us

B28-5 : J^{204}

Y^{213} = 1.5 us

A35-5 : K^{200}

Y^{401} = 1.5 us

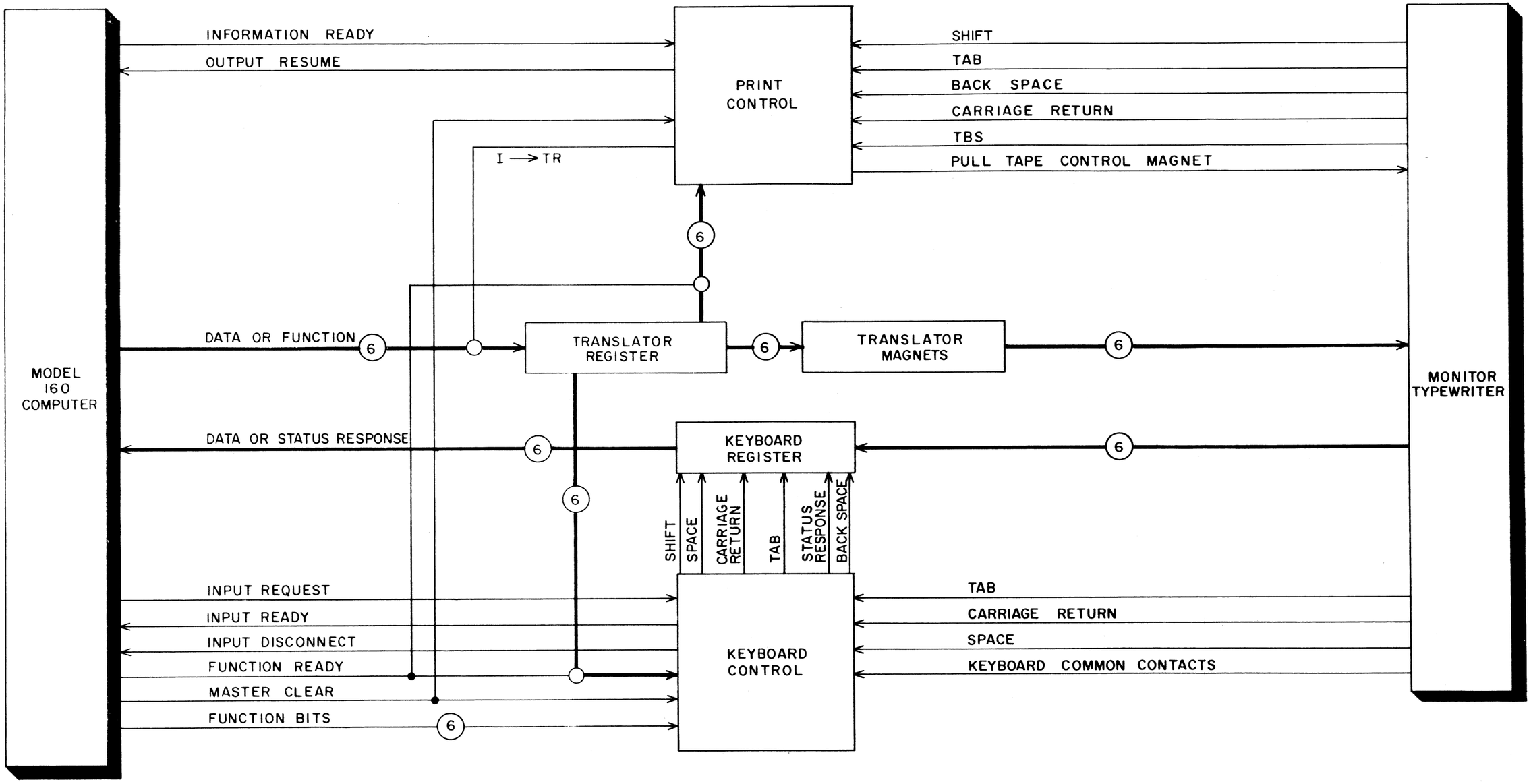
A35-4 : K^{401}

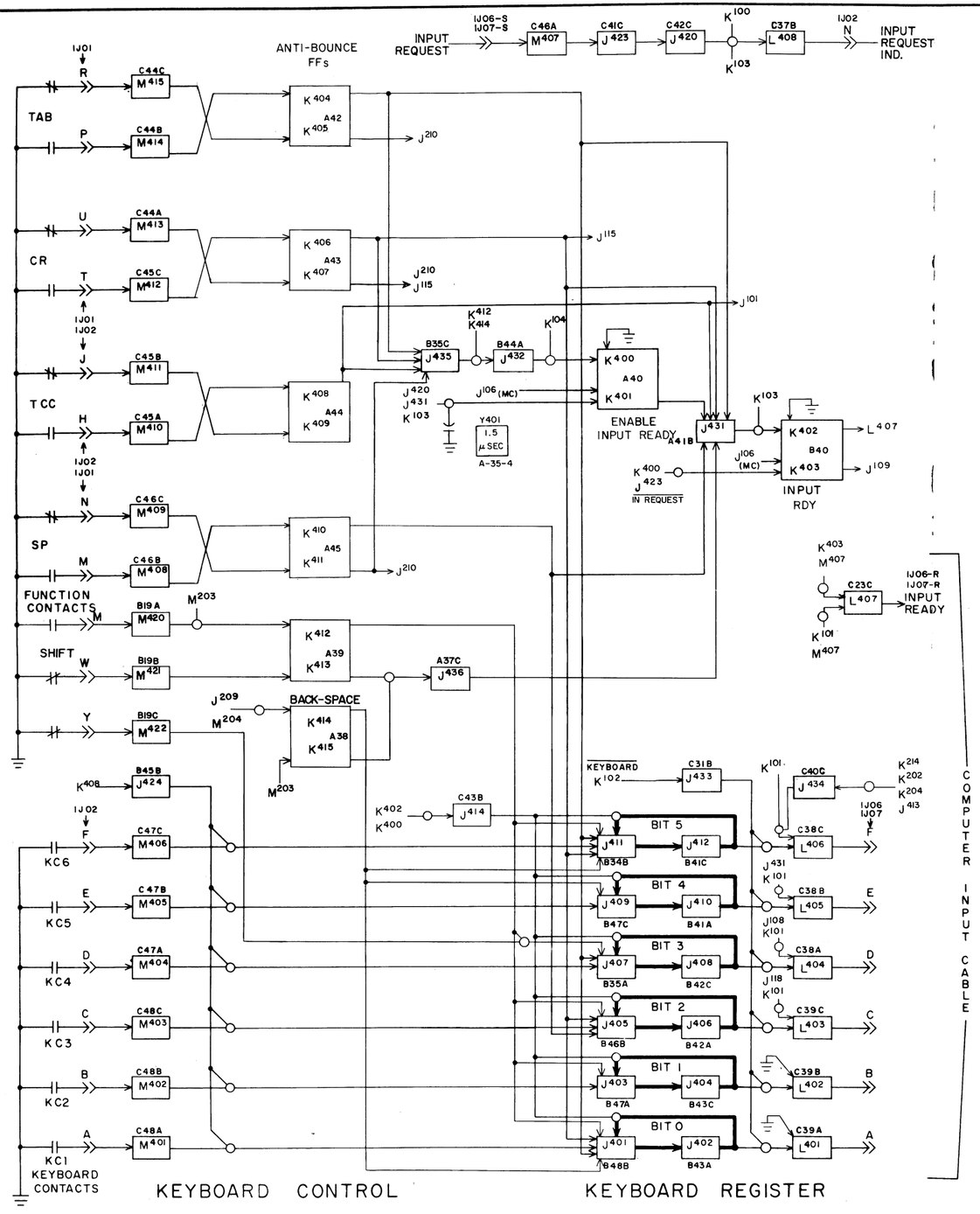
Y^{999} = Ground

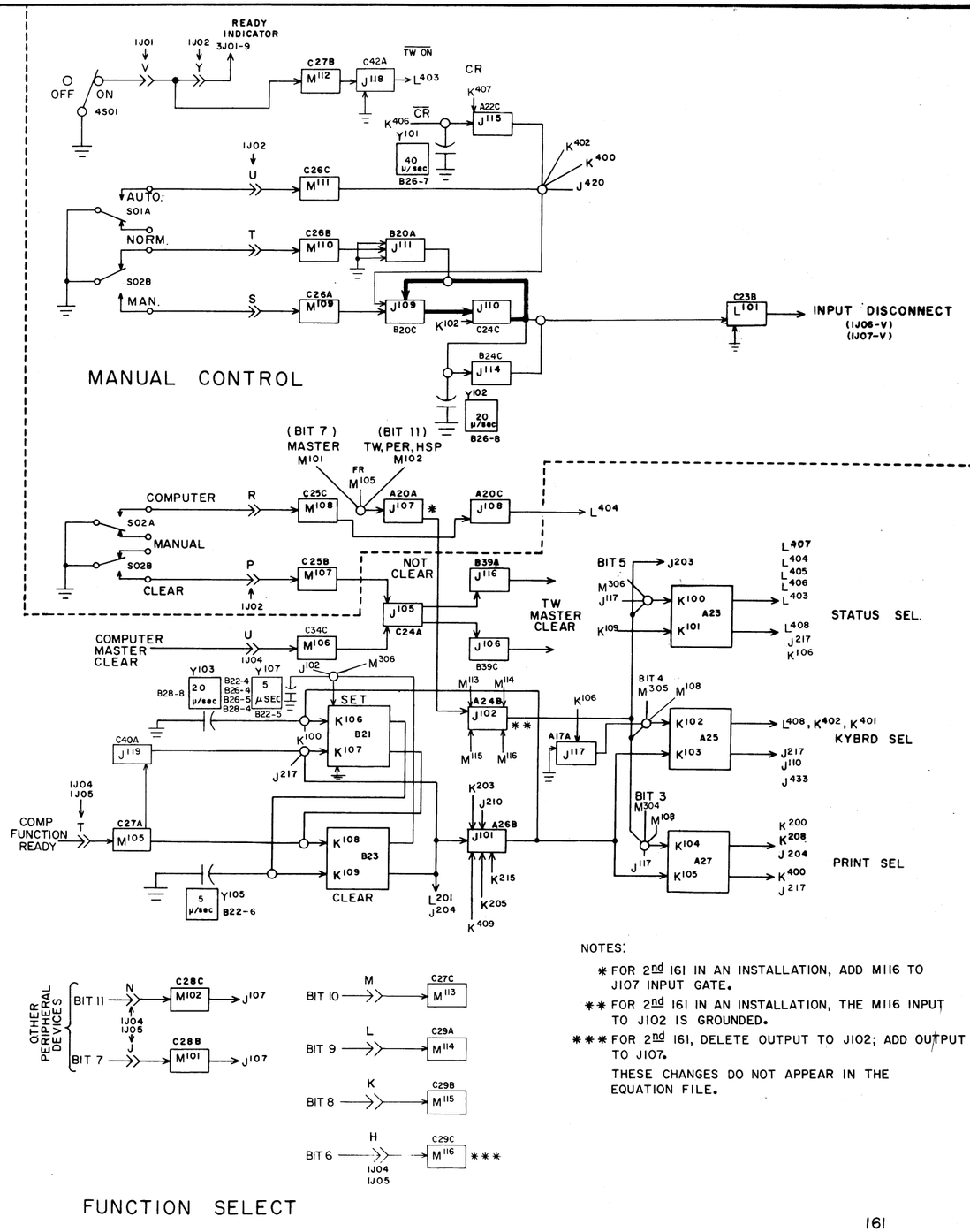
..

CHAPTER 6

EQUIPMENT DRAWINGS


INFORMATION READY
OUTPUT RESUME
PRINT CONTROL
SHIFT
TAB
BACK SPACE
CARRIAGE RETURN
TBS
PULL TAPE CONTROL MAGNET
I → TR
6
DATA OR FUNCTION
TRANSLATOR REGISTER
TRANSLATOR MAGNETS
MODEL 160 COMPUTER
MONITOR TYPEWRITER
DATA OR STATUS RESPONSE
KEYBOARD REGISTER
SHIFT
SPACE
CARRIAGE RETURN
TAB
STATUS RESPONSE
BACK SPACE
INPUT REQUEST
INPUT READY
INPUT DISCONNECT
FUNCTION READY
MASTER CLEAR
FUNCTION BITS
KEYBOARD CONTROL
TAB
CARRIAGE RETURN
SPACE
KEYBOARD COMMON CONTACTS





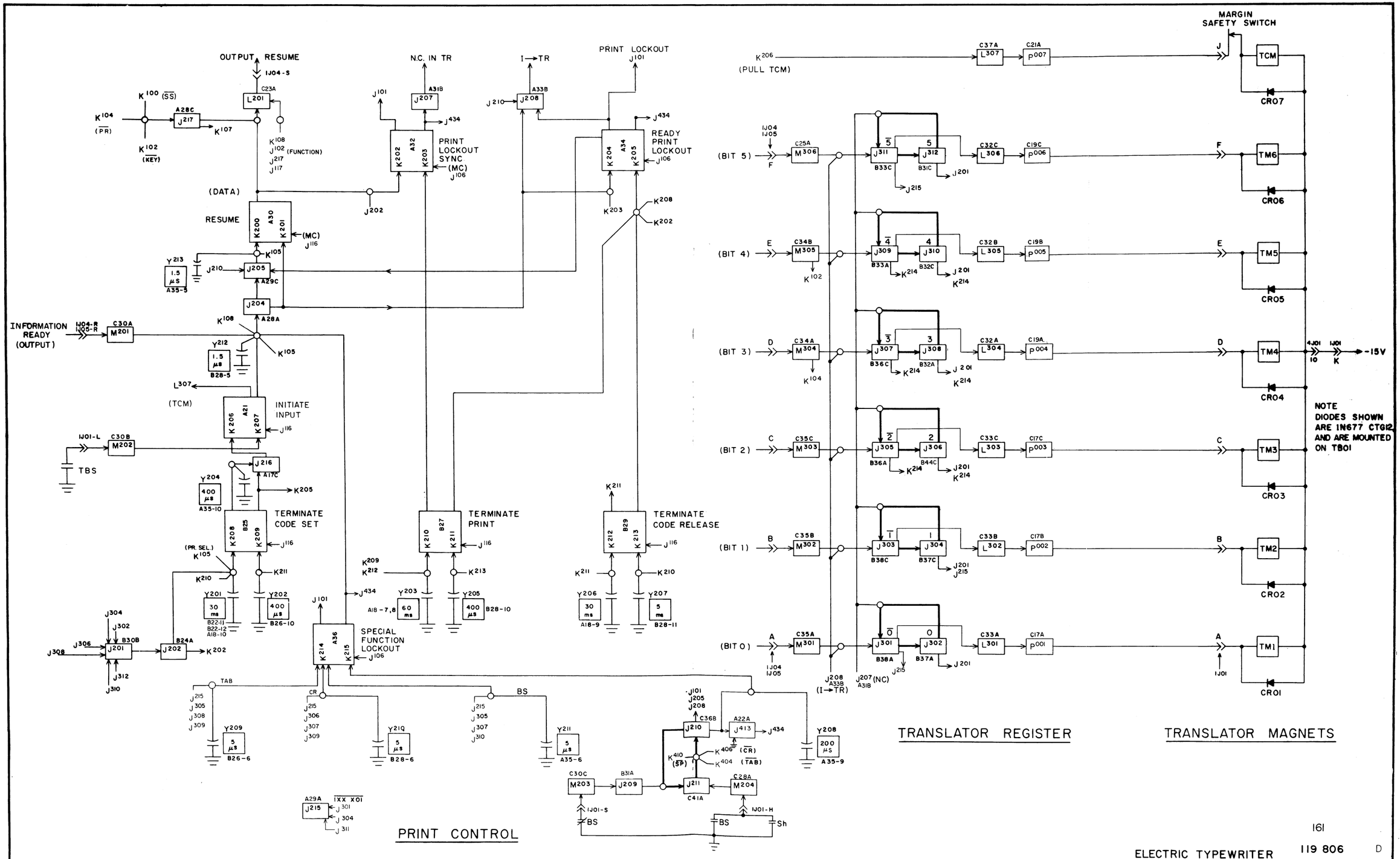
NOTES:

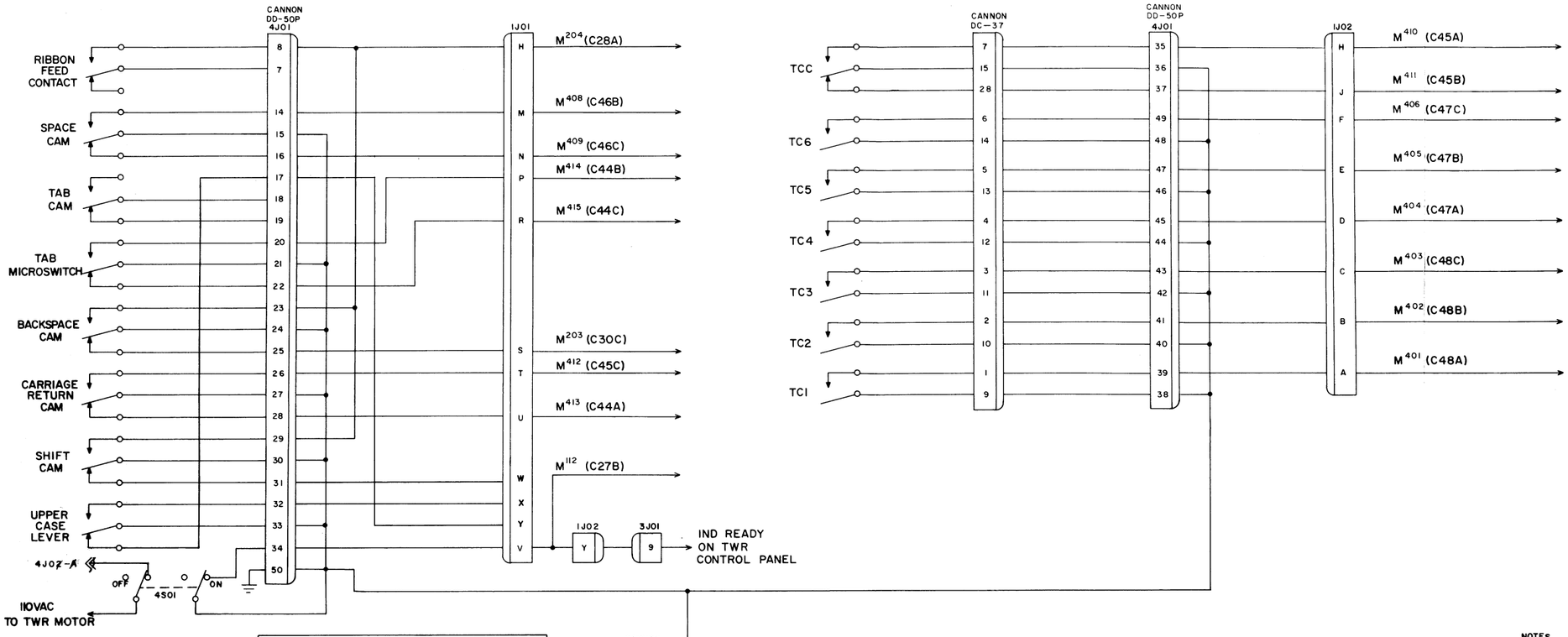
* FOR 2nd 161 IN AN INSTALLATION, ADD M116 TO J107 INPUT GATE.

** FOR 2nd 161 IN AN INSTALLATION, THE M116 INPUT TO J102 IS GROUNDED.

*** FOR 2nd 161, DELETE OUTPUT TO J102; ADD OUTPUT TO J107.

THESE CHANGES DO NOT APPEAR IN THE EQUATION FILE.


OUTPUT RESUME
1J04-S
C23A
L201
K100 (SS)
K104 (PR)
K102 (KEY)
A28C
J217
K107
K108
J102 (FUNCTION)
J217
J117
N.C. IN TR
J101
A31B
J207
J434
PRINT LOCKOUT SYNC
K202 A32 K203
(MC) J106
I→TR
J210
A33B
J208
PRINT LOCKOUT
J101
J434
READY PRINT LOCKOUT
K204 A34 K205
J106
(DATA)
J202
K203
K208
K202
RESUME
K200 A30 K201
(MC) J116
K105
Y213
1.5 μs
A35-5
J210
J205
A29C
J204
A28A
K108
INFORMATION READY (OUTPUT)
1J04-R
1J05-R
C30A
M201
Y212
1.5 μs
B28-5
K105
L307
(TCM)
INITIATE INPUT
K206 A21 K207
J116
1J01-L
C30B
M202
TBS
J216
A17C
Y204
400 μs
A35-10
K205
TERMINATE CODE SET
K208 B25 K209
J116
(PR. SEL.) K105
K210
K211
Y201
30 ms
B22-11
B22-12
A18-10
Y202
400 μs
B26-10
J304
J302
J306
J308
B30B
J201
J312
J310
B24A
J202
K202
J101
J434
K214 A36 K215
J116
SPECIAL FUNCTION LOCKOUT
TERMINATE PRINT
K210 B27 K211
J116
K209
K212
K213
Y203
60 ms
A18-7,8
Y205
400 μs
B28-10
TERMINATE CODE RELEASE
K212 B29 K213
J116
K211
K210
Y206
30 ms
A18-9
Y207
5 ms
B28-11
TAB
J215
J305
J308
J309
Y209
5 μs
B26-6
CR
J215
J306
J307
J309
Y210
5 μs
B28-6
BS
J215
J305
J307
J310
Y211
5 μs
A35-6
J101
J205
J208
C36B
J210
A22A
J413
J434
Y208
200 μs
A35-9
K410 (SP)
K406 (CR)
K404 (TAB)
C30C
M203
B31A
J209
J211
C41A
C28A
M204
1J01-S
BS
1J01-H
BS
Sh
A29A
J215
1XX X01
J301
J304
J311
PRINT CONTROL
K206 (PULL TCM)
C37A
L307
C21A
P007
MARGIN SAFETY SWITCH
J
TCM
CR07
(BIT 5)
1J04
1J05
F
C25A
M306
J311
B33C
J215
5
J312
B31C
J201
C32C
L306
C19C
P006
F
TM6
CR06
(BIT 4)
E
C34B
M305
K102
J309
B33A
K214
4
J310
B32C
J201
K214
C32B
L305
C19B
P005
E
TM5
CR05
(BIT 3)
D
C34A
M304
K104
J307
B36C
K214
3
J308
B32A
J201
K214
C32A
L304
C19A
P004
D
TM4
CR04
4J01
10
1J01
K
-15V
NOTE
DIODES SHOWN
ARE IN677 CTG12
AND ARE MOUNTED
ON TB01
(BIT 2)
C
C35C
M303
J305
B36A
K214
2
J306
B44C
J201
K214
C33C
L303
C17C
P003
C
TM3
CR03
(BIT 1)
B
C35B
M302
J303
B38C
1
J304
B37C
J201
J215
C33B
L302
C17B
P002
B
TM2
CR02
(BIT 0)
A
C35A
M301
1J04
1J05
J303
B38A
0
J302
B37A
J215
J201
C33A
L301
C17A
P001
A
1J01
TM1
CR01
J208
A33B
(I→TR)
J207 (NC)
A31B
TRANSLATOR REGISTER
TRANSLATOR MAGNETS



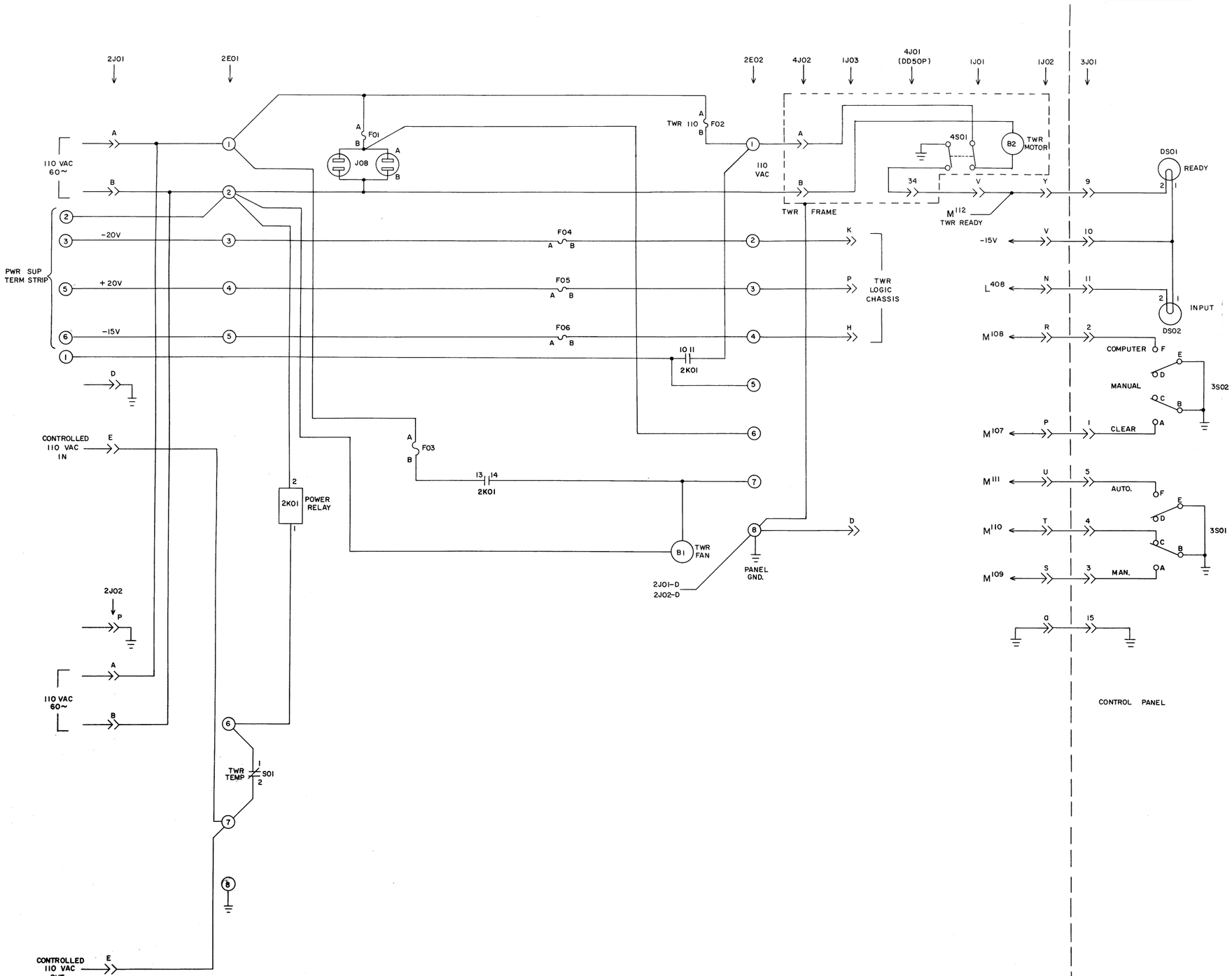
NOTES

1. ALL DIODES ARE TG-12 (IN677) POLARIZED + ▷| −
2. PORTIONS OF THIS DRAWING ARE TAKEN FROM SOROBAN ENGINEERING INC. DRAWING NO. C-1556.
3. NUMBERS IN PARENTHESES INDICATE JACK ASSIGNMENTS LOCATED ON 30100 CHASSIS.

WIRING DIAGRAM TYPEWRITER INTERCONNECTIONS

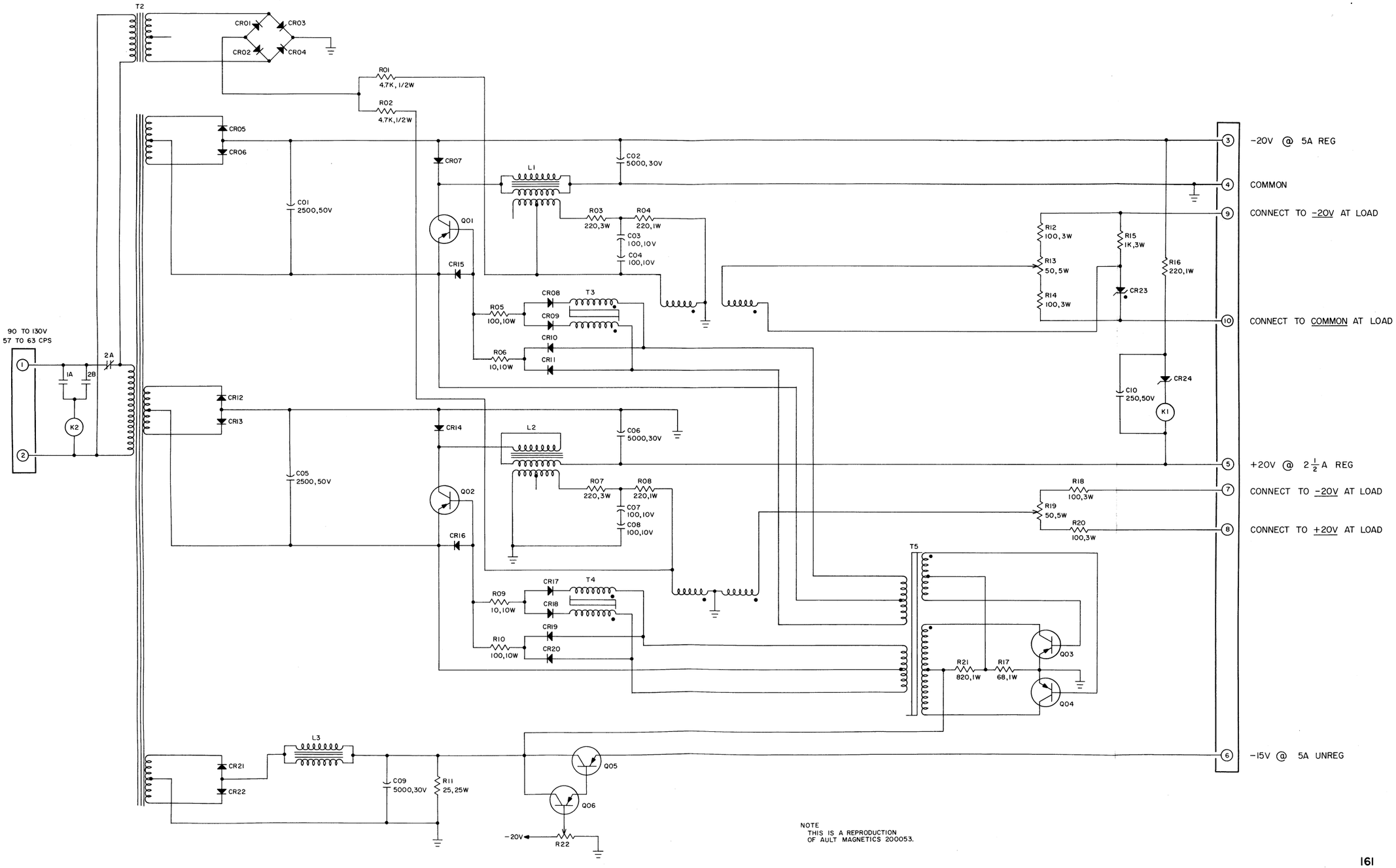
103052 A

ECO 9 6-9



CONNECTOR KEY

1J01	LOGIC	TWR LOGIC CHASSIS
1J02	LOGIC	
1J03	POWER	
1J04	OUTPUT	
2J01, 2J02		JUNCTION BOX POWER
2E01, 2E02		JUNCTION BOX TERMINAL STRIPS
3J01		CONTROL PANEL CONNECTOR
4J01, 4J02		TWR CHASSIS



NOTE
THIS IS A REPRODUCTION
OF AULT MAGNETICS 200053.

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SCHEMATIC - TYPEWRITER
POWER SUPPLY

102390 A

6-13

CONTROL DATA
CORPORATION

COMPUTER DIVISION

501 PARK AVENUE, MINNEAPOLIS 15, MINNESOTA