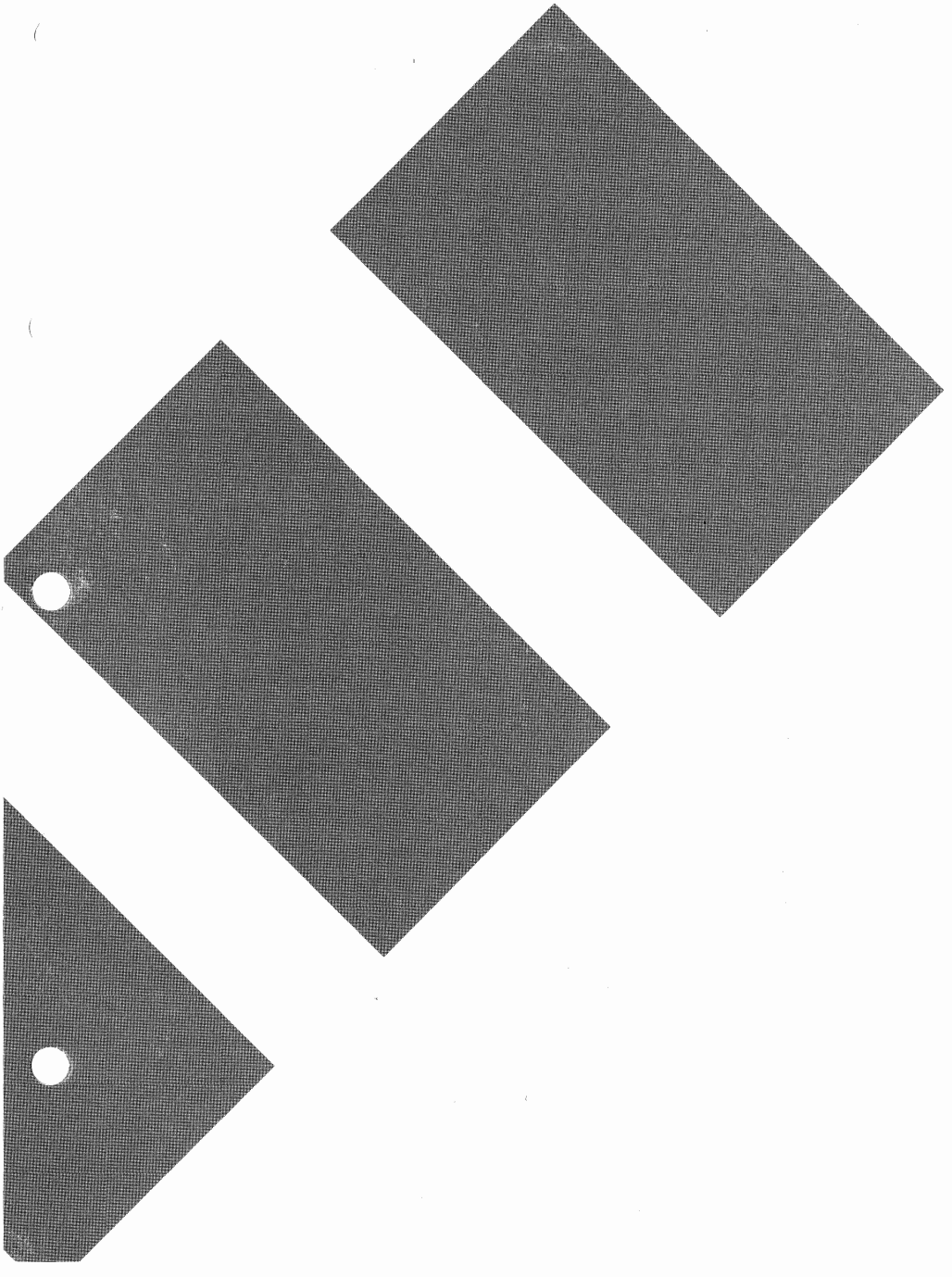
brother®

ELECTRONIC TYPEWRITER
SERVICE MANUAL

MODEL : EP-7/170



ELECTRONICS

SERVICE MANUAL

(Electronic Part)

Note:
This service manual covers the electronic components of model EP-7/170; EP7 series. For servicing the mechanical components, please refer to the service manual of EP-5/150; EP series.

EP-7 & EP-170 TYPEWRITER SERVICE MANUAL

Electronic Part

Contents

CHAPTER I. THEORY OF OPERATION

CHAPTER II. TROUBLESHOOTING

CHAPTER I. THEORY OF OPERATION

1. GENERAL

Fig. 1.1 shows the electric block diagram of the main PCB and the switch PCB.

1.1 Main PCB (B517031) (French verifier specification, B517039)

1.1.1 Main CPU (HD64180P)

This 8-bit CMOS microcomputer controls the entire EP-7/170 system.

1.1.2 ROM/RAM

The ROM consists of the main ROM and the SPROM. The main ROM stores the programs of the main CPU, and the SPROM stores the spell check dictionary. The main ROM capacity is 32 Kbytes for the English specification, and 64 Kbytes for the French specification. The SPROM capacity is 128 Kbytes for the English specification, and 256 Kbytes for the French specification.

The RAM (8-Kbyte) is used for the text memory, user's spell check dictionary, and correction memory.

1.1.3 Gate array (HG61H06)

The gate array consists of the address decoder and I/O ports (12 input ports and 34 output ports).

1.1.4 Key input detection circuit (membrane)

This circuit informs the main CPU which key is pressed. It takes the form of a matrix through which the key scanning signal is sent.

1.1.5 Thermal head rank setting circuit

This circuit informs the main CPU of the thermal head rank. To set the rank, one of the points B ~ G is soldered.

1.1.6 LED drive circuit

This circuit controls signals to the SHIFT LED and the POWER LED, causing them to light or to flash. (The POWER LED is located on the switch PCB.)

1.1.7 Thermal head driver circuit

Control signals from the main CPU pass through this circuit before energizing the thermal head.

This circuit incorporates two other circuits; a protective circuit which prevents damage to the thermal head when the CPU is unable to function properly due to software runaway, and a temperature control circuit which changes the energizing time in accordance with the ambient temperature.

1.1.8 Motor drive circuits

There are three motors in all: the carriage motor SM-25 (ø25), the paper feed motor SM-20 (ø20), and the thermal head motor SM-30 (ø20). They are driven through their respective drive circuits by signals from the main CPU.

1.1.9 Voltage regulator circuits

These circuits produces three stabilized voltages of Vcc (+5V), V_{BK} (+5V) and V_{CON} (+12V) from the fluctuating DC voltage supplied by the dry cell batteries or the AC adapter.

1.1.10 Buzzer drive circuit

The piezo-electric buzzer sounds when the buzzer drive circuit receives a clock signal sent from the clock generator in the main CPU.

1.1.11 Low voltage detection circuit

This circuit monitors whether or not the battery voltage (V_{BT}) has fallen below 5.5 V. The V_{BT} voltage level is detected by using the threshold voltage level of the CMOS IC (TC4050BP).

1.1.12 Leaf switch detection circuit

This circuit monitors whether the leaf switch is ON or OFF and sends this information to the main CPU.

1.1.13 Clock generator

The clock generator is incorporated into the main CPU but works in conjunction with an externally located ceramic oscillator (incorporating a 30 pF capacitor) to produce signals of 8 MHz ± 1%.

1.1.14 $\overline{NMI}$ and $\overline{RES}$ circuits

These circuits send $\overline{NMI}$ and $\overline{RES}$ (reset) signals to the main CPU when the power is switched ON or OFF.

1.2 Switch PCB (B517030)

1.2.1 Indication circuit (slide switches)

This circuit informs the main CPU which option has been selected for each of the following functions:

Calculator, typewriter, or word spell mode (TW, CAL, or W.SPELL), line feed pitch (1, 1 ½, or 2), density (LOW, MEDIUM, or HIGH), underline function (ON or OFF), style (BOLD, EXPANDED, or NORMAL)

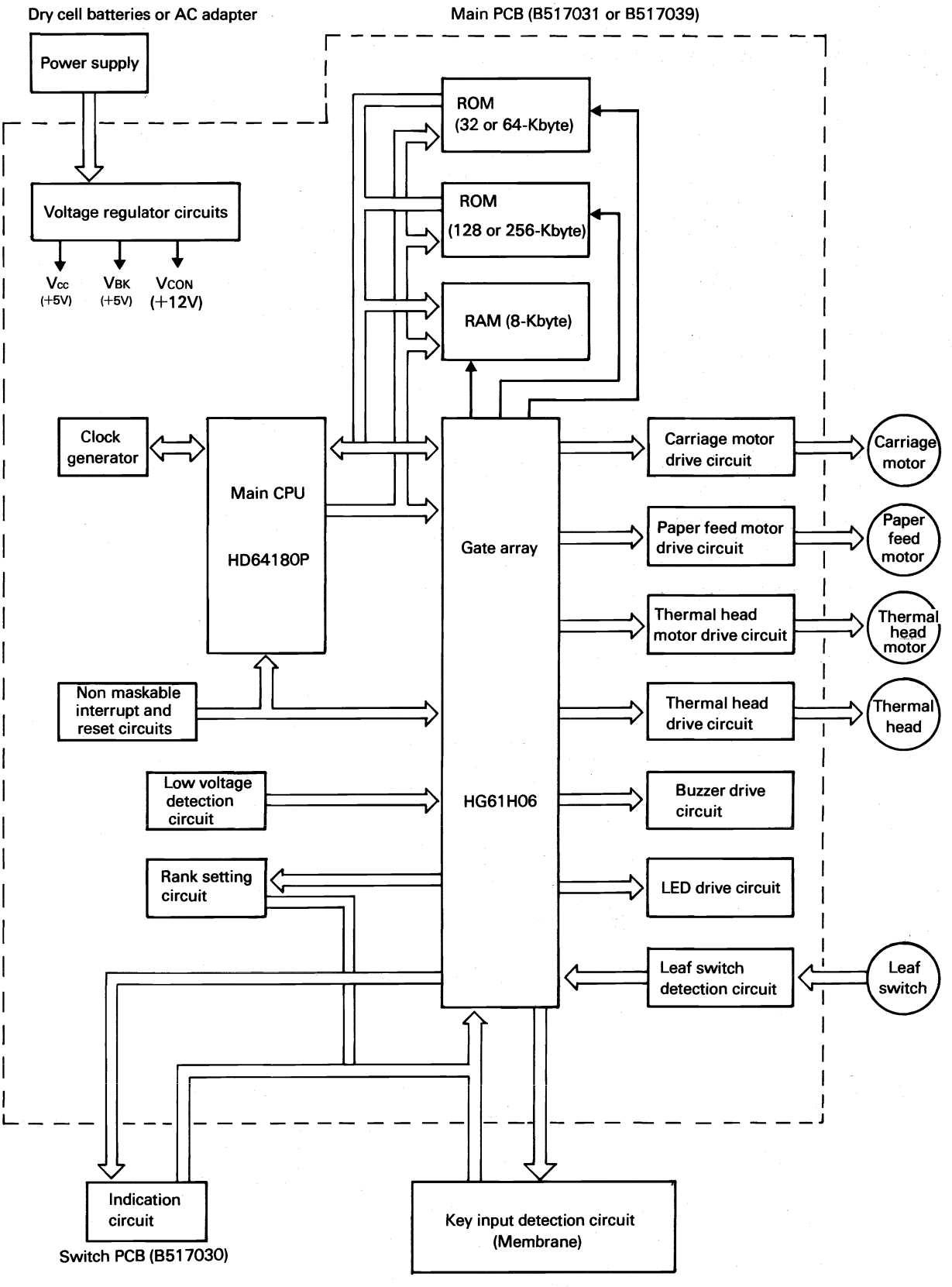


Fig. 1.1 Electronic Block Diagram of Main PCB and Switch PCB

2. KEYBOARD

2.1 Construction of the Keyboard

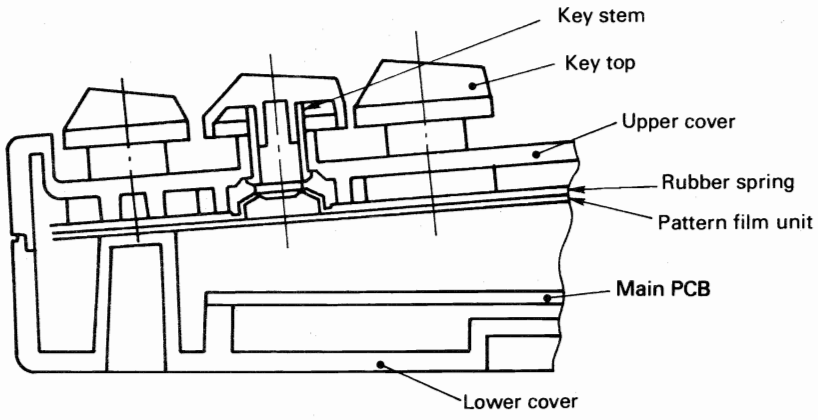


Fig. 2.1 Sectional View of the Keyboard

Fig. 2.1 shows a sectional view of the keyboard. The key top is fitted onto the key stem, whose movement is guided by the upper cover. Beneath the upper cover lie the rubber spring and pattern film unit.

2.2 Operation of the Keyboard

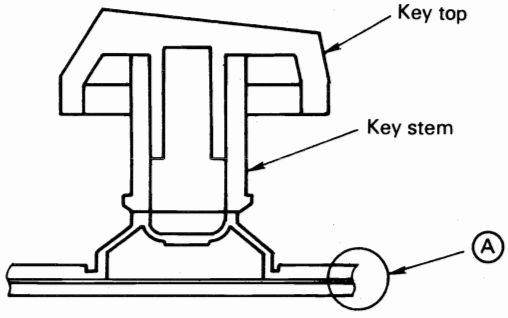


Fig. 2.2 Detailed Structure of the Keyboard

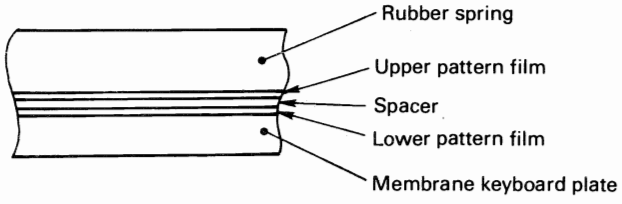


Fig. 2.3 Detail of Part Ⓐ

The detailed construction of the keyboard is shown in Figs. 2.2 and 2.3. The rubber spring is composed of highly insulating silicone rubber. Beneath it lie the upper pattern film, the spacer, the lower pattern film, and the membrane keyboard plate.

There is a pair of electrodes, one each on the upper and lower pattern films; when the key is pressed, the electrodes contact each other through a hole in the spacer and close the circuit.

3. OUTLINE OF PROGRAM EXECUTION

Control of the EP-7 and EP-170 is done by the 8-bit CPU HD64180P. It controls the scanning of the keyboard and slide switches, paper feed motor drive, carriage motor drive, thermal head motor drive, thermal head drive, etc.

A time sharing method is adopted for the execution of control programs. Keyboard and slide switch scanning, processing of keyed-in data, etc., are dealt with in the main program, which is interrupted by subroutines such as that for control of the printing mechanism.

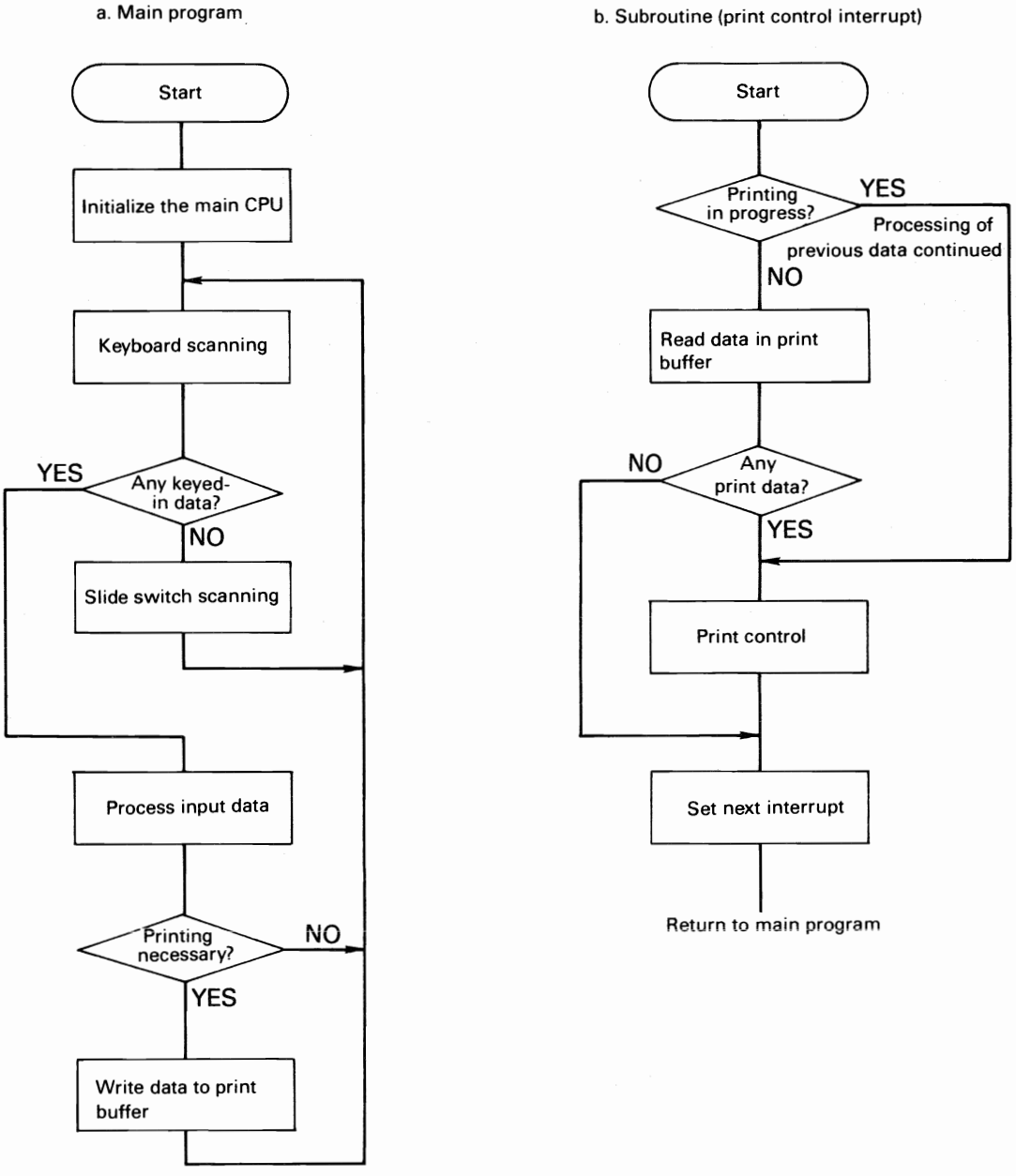


Fig. 3.1 Program Outline

As shown in Fig. 3.1, when there is no key data input, the main CPU normally scans the keyboard and is on standby waiting for data input. At this time, the control subroutine for operation of the printing mechanism interrupts the main program every 8 ms for execution of print control.

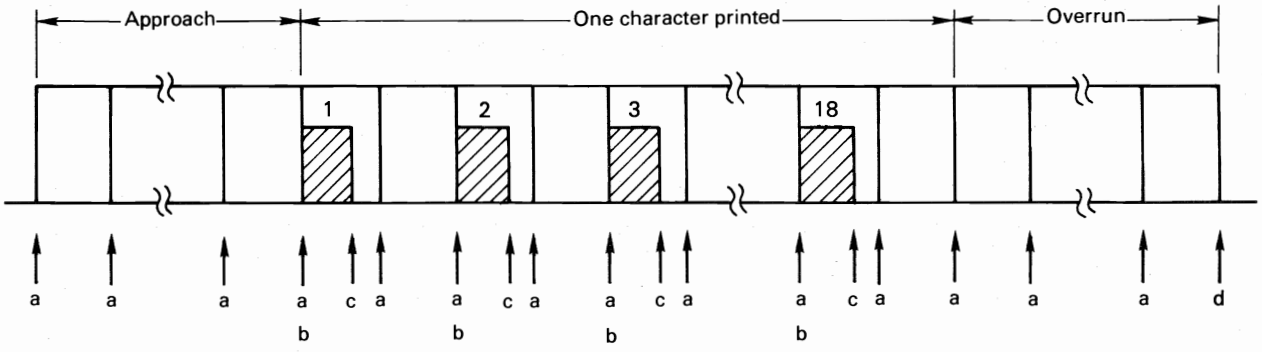
If there is no print data in the print buffer at the time of interruption, control is returned to the main program after preparation for the next interrupt (since there is no print data, this will come 8 ms later).

When data is input, the main CPU processes the data and writes it to the print buffer when printing is necessary. It then returns to the keyboard scanning program and goes on standby waiting for data input. The data written to the print buffer is read at the time of the next interrupt and the subroutine directs the printing mechanism to print in accordance with this data.

The subroutine controls the motor operation and thermal head drive during printing (i.e., interrupt). It sets the time required for this interrupt and directs printing only during the set time period. It then prepares for the next interrupt before returning control to the main program.

When the next interrupt comes, unfinished processing of data from the previous interrupt is executed until the printing operation is completed. The main CPU then checks for data in the print buffer again. (See Figs. 3.2 and 3.3).

Example of program execution during printing



*a, b, c, and d indicate points where the subroutine interrupts or drive to mechanical parts goes ON or OFF.

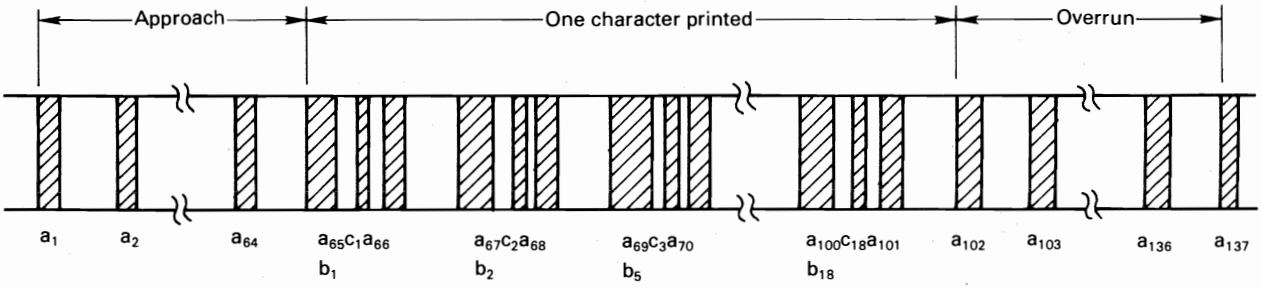
a...Carriage motor drive goes ON or motor phase changed

b...Thermal head drive ON

c...Thermal head drive OFF

d...Thermal head motor drive OFF

Fig. 3.2 Example of Print Subroutine Execution



*The shaded bands represent the time taken for the execution of print control during subroutine interruption. The unshaded bands indicate processing by the main program.

a_1	Carriage motor turned ON
$a_2 \sim a_{136}$	Carriage motor phase changed
a_{137}	Carriage motor turned OFF
$b_1 \sim b_{18}$	Thermal head turned ON
$c_1 \sim c_{18}$	Thermal head turned OFF

Fig. 3.3 Example of Program Execution Sequence

4. OPERATION OF THE MAIN CPU AND PERIPHERAL CIRCUITS

4.1 Main CPU, $\overline{\text{NMI}}$ and $\overline{\text{RES}}$ Circuits

The main CPU is an 8-bit CPU of the 80 series, which does not have ROM nor RAM in it. The clock generator works in conjunction with an externally located ceramic oscillator to produce signals of 8 MHz.

Fig. 4.1 shows the non-maskable interrupt ($\overline{\text{NMI}}$) and reset ($\overline{\text{RES}}$) circuits. These circuits generate $\overline{\text{NMI}}$ and $\overline{\text{RES}}$ signals using the capacitor and the time constant of the resistors, shown in Fig. 4.2.

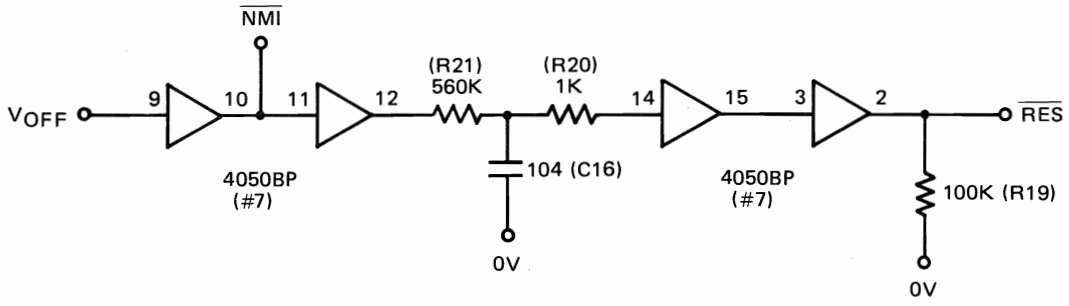


Fig. 4.1 $\overline{\text{NMI}}$ and $\overline{\text{RES}}$ circuits

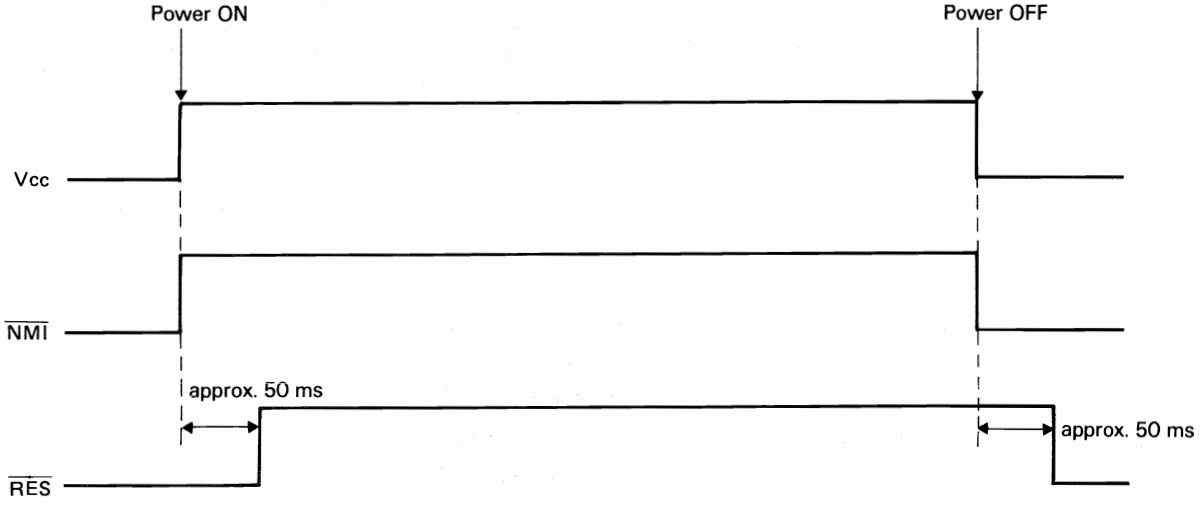


Fig. 4.2 $\overline{\text{NMI}}$ and $\overline{\text{RES}}$ signal generation sequence

4.2 Key Input Detection Circuit and Indication Circuit

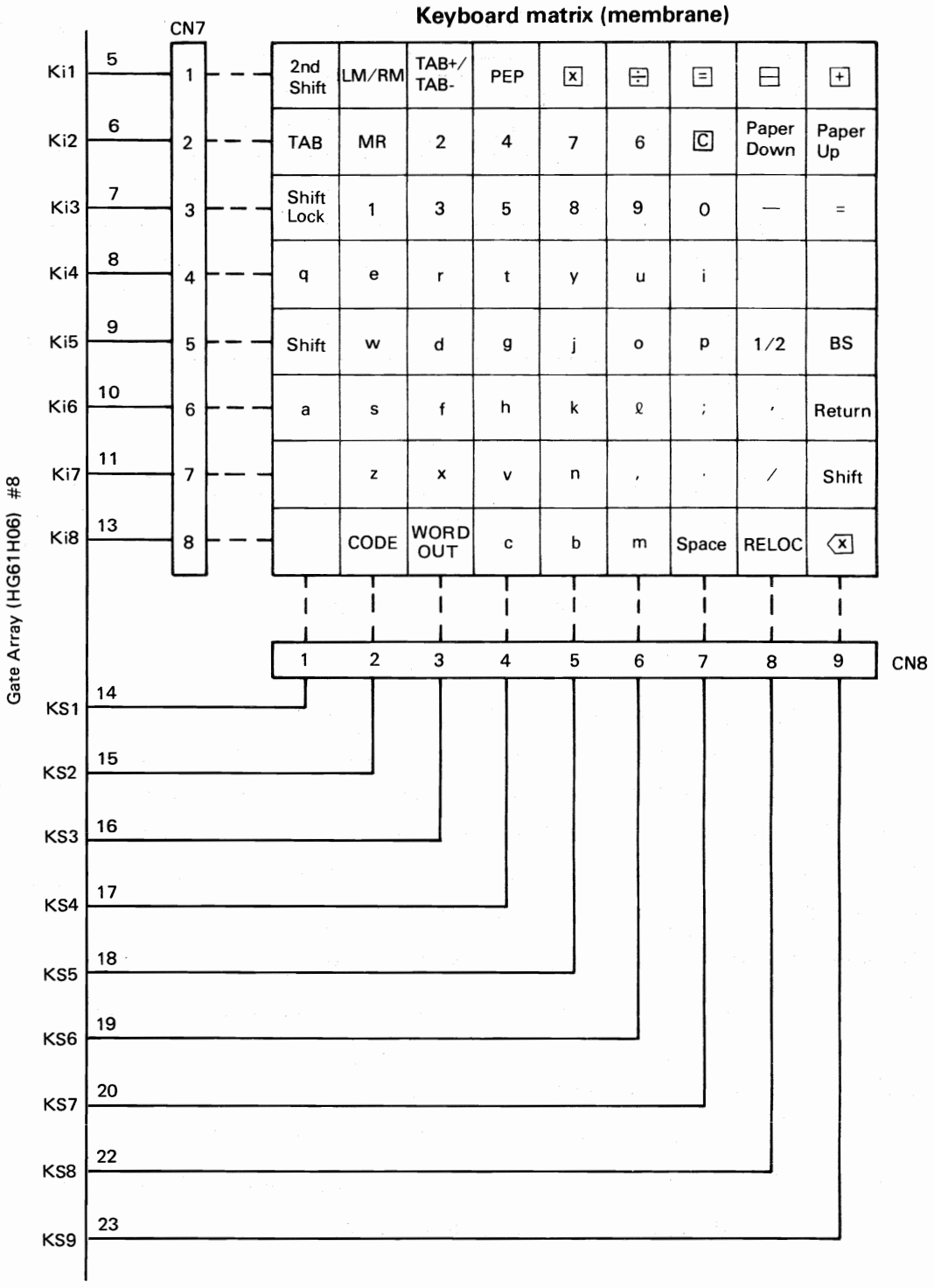


Fig. 4.3 Key Input Detection Circuit

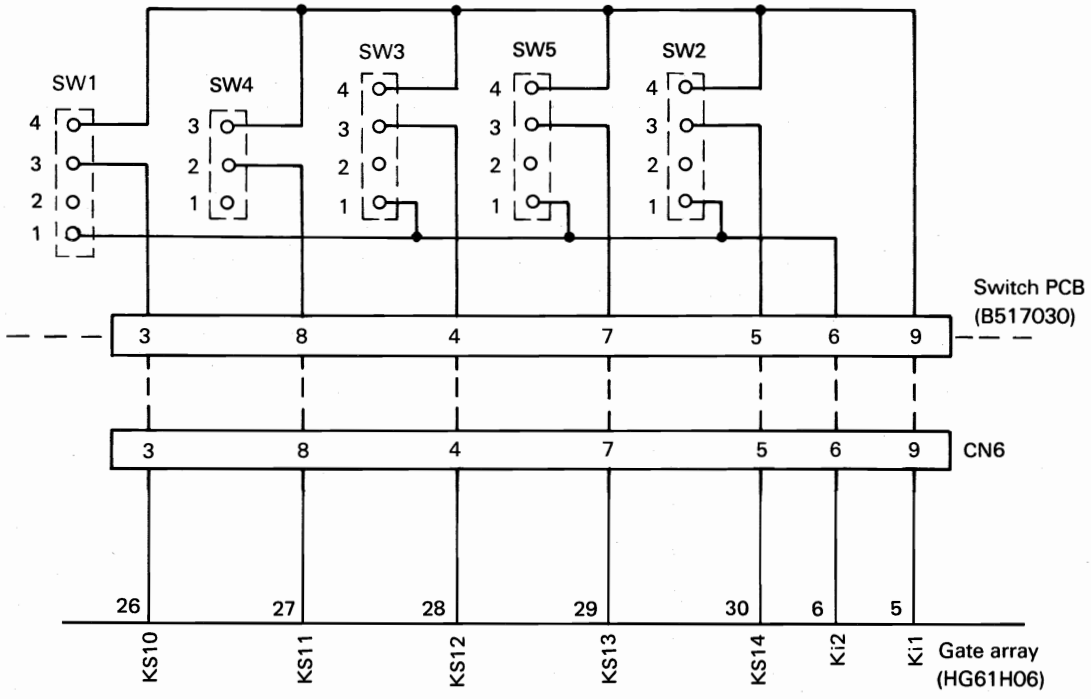


Fig. 4.4 Indication Circuit

Fig. 4.3 shows the key input detection circuit. The main CPU monitors which keys are being pressed by outputting the keyboard scanning signals through the gate array, shown in Fig. 4.5, and by receiving the scanning results from the eight signal lines of connector CN7. The main CPU determines which keys are being pressed from the signal input timing.

The indication circuit is shown in Fig. 4.4. The main CPU monitors the current setting of the slide switches by outputting scanning signals like those shown in Fig. 4.5 to this circuit.

The slide switches illustrated in Fig. 4.4 have the following functions.

SW1: Switches among calculator, typewriter, and word spell modes (CAL/TWR/W.SPELL).

SW2: Sets the paper feed pitch (1, 1 ½, 2).

SW3: Sets the print density to low, medium or high (L/M/H).

SW4: Switches the automatic underlining function ON or OFF (UNDL ON/OFF).

SW5: Sets the print style (BOLD/EXP/NORMAL).

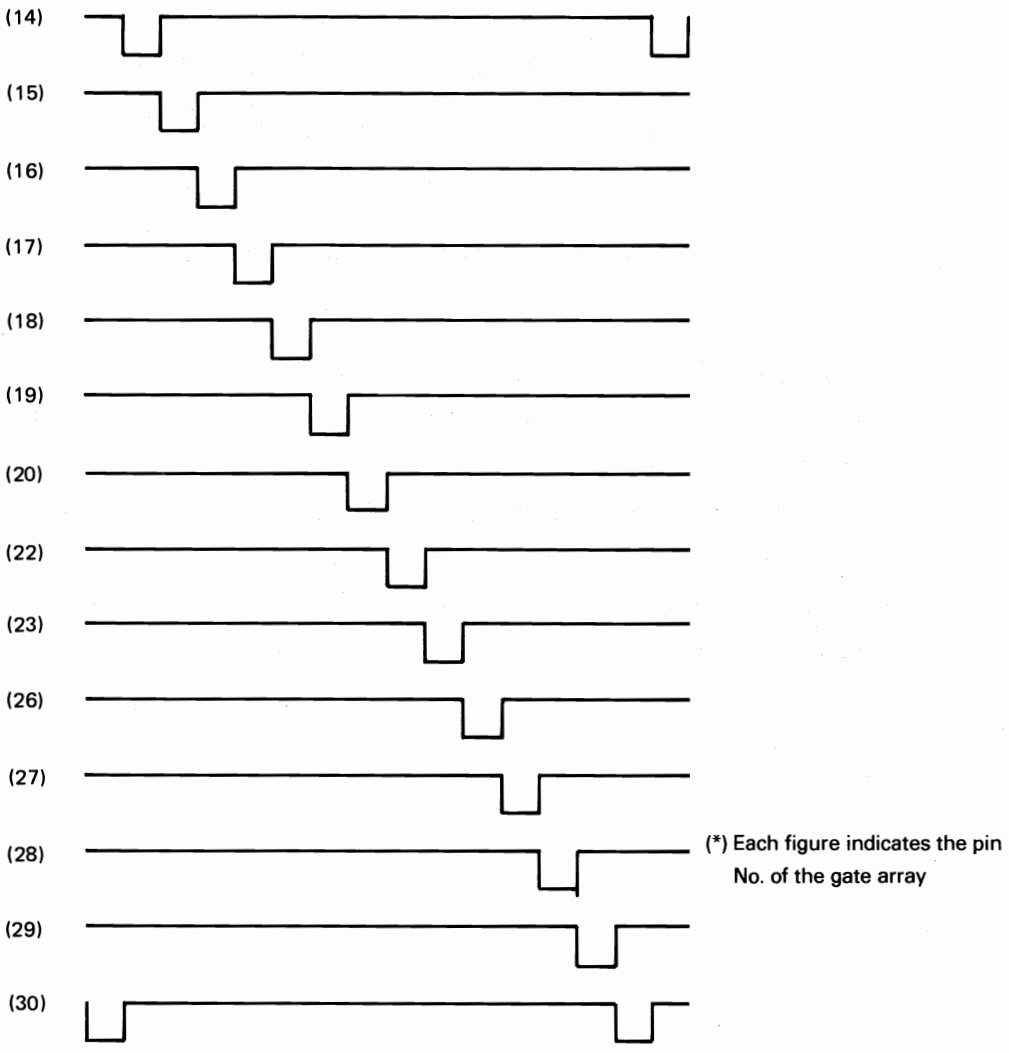


Fig. 4.5 Scanning Signals

4.3 Thermal Head Rank Setting Circuit

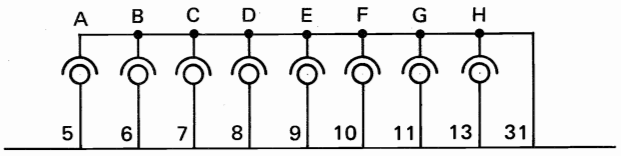


Fig. 4.6 Thermal Head Rank Setting Circuit

Fig. 4.6 shows the thermal head rank setting circuit. The thermal head rank is set by closing the appropriate soldering point among B through G according to Table 4.1. (solder points A and H are not used.)

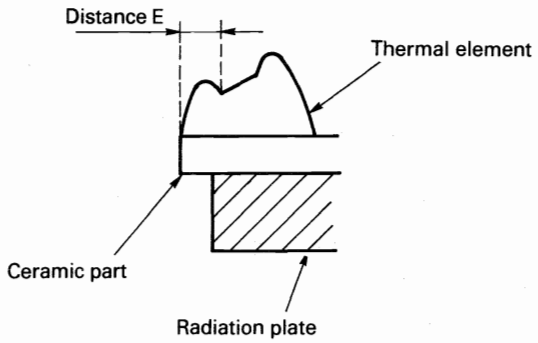
The thermal head rank is read once only (immediately after the power is switched ON) by a scanning signal output from pin 31 on the gate array. If none of the thermal head rank solder points has been closed, or two or more have been closed, the typewriter will not operate.

Solder point settings for thermal head rank are shown in Table 4.1.

E (μm) / (ohms) Resistance	125 ~ 100	100 ~ 80
225 ~ 240	B	C
212 ~ 225	C	D
200 ~ 212	D	E
190 ~ 200	E	F
180 ~ 190	F	G

Table 4.1 Solder Point Settings for Thermal Head Rank

*** E is the distance from the edge of the ceramic plate in the thermal head to the closest edge of the thermal elements.**



4.4 LED Drive Circuit

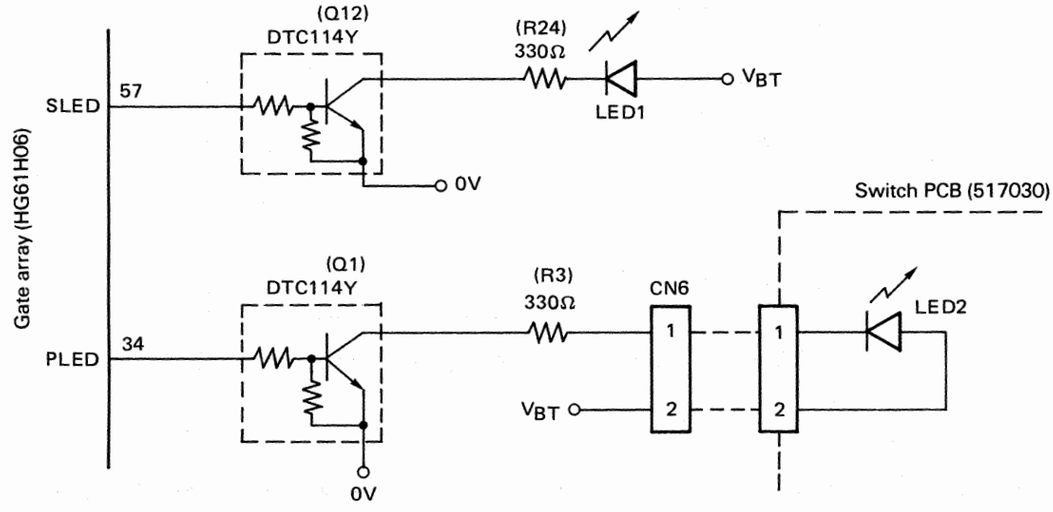


Fig. 4.7 LED Drive Circuit

Fig. 4.7 shows the LED drive circuit.

While the power is ON, the main CPU causes LED 2 to light. When the main CPU detects low voltage, it causes LED 2 to flash, informing the user that the batteries are weak.
When the SHIFT key is held down, or the SHIFT LOCK key is pressed, the main CPU causes LED 1 to light.

LED 1 alerts the user to various information in the store mode by flashing three times. Lighting or flashing of the LED's is controlled by the main CPU through the gate array.

4.5 Thermal Head Drive Circuit

Fig. 4.8 shows the thermal head drive circuit. It is composed of three circuits; the driver IC (M54970P), the temperature control circuit which reacts to the ambient temperature, and the protective circuit which protects the thermal head if the main CPU becomes unable to operate properly due to software runaway.
Data is serially transferred from pin 51 (TXS) of the main CPU to the driver IC in synchronization with the clock signals output from pin 53 (CKS) of the main CPU.

The serial data is converted to parallel data by the latch signal from pin 47 (LAT) on the gate array. EN signal output from pin 48 on the gate array determines the timing of the output of the parallel data from the driver IC to the thermal head, which it energizes.

Two sets of serial data are output for the thermal head to print one line. The first set is "record data" which indicates those thermal elements which were energized last and therefore retain some residual heat. The second is the "main data" which indicates which thermal elements are to be energized.

The temperature control circuit uses a thermistor to adjust control of the printing and correction mechanisms in accordance with the ambient temperature so as to avoid any temperature-related variations in the performance of these mechanisms.

It adjusts the pulse width of the signal received from pin 51 (ENA) on the gate array to produce the EN signal. The new pulse width is determined by the thermistor and the time constant of the resistor and capacitor in the circuit.

If there is a software runaway, and the ENA signal fails to go LOW, parallel data output to the thermal head is forcibly stopped after a constant time interval fixed by the time constant of the resistor and capacitor, thus protecting the thermal head.

The power cut signal output from pin 46 on the gate array controls the power supply circuit in the driver IC. When the thermal head drive circuit is idle, it goes LOW to reduce the consumption of current in the driver IC.

The EN signal sometimes exceeds the rated thermal head wattage due to printing or temperature conditions.
When this happens, the PC signal forces it to go LOW.

Fig. 4.9 shows a time chart for the thermal head drive.

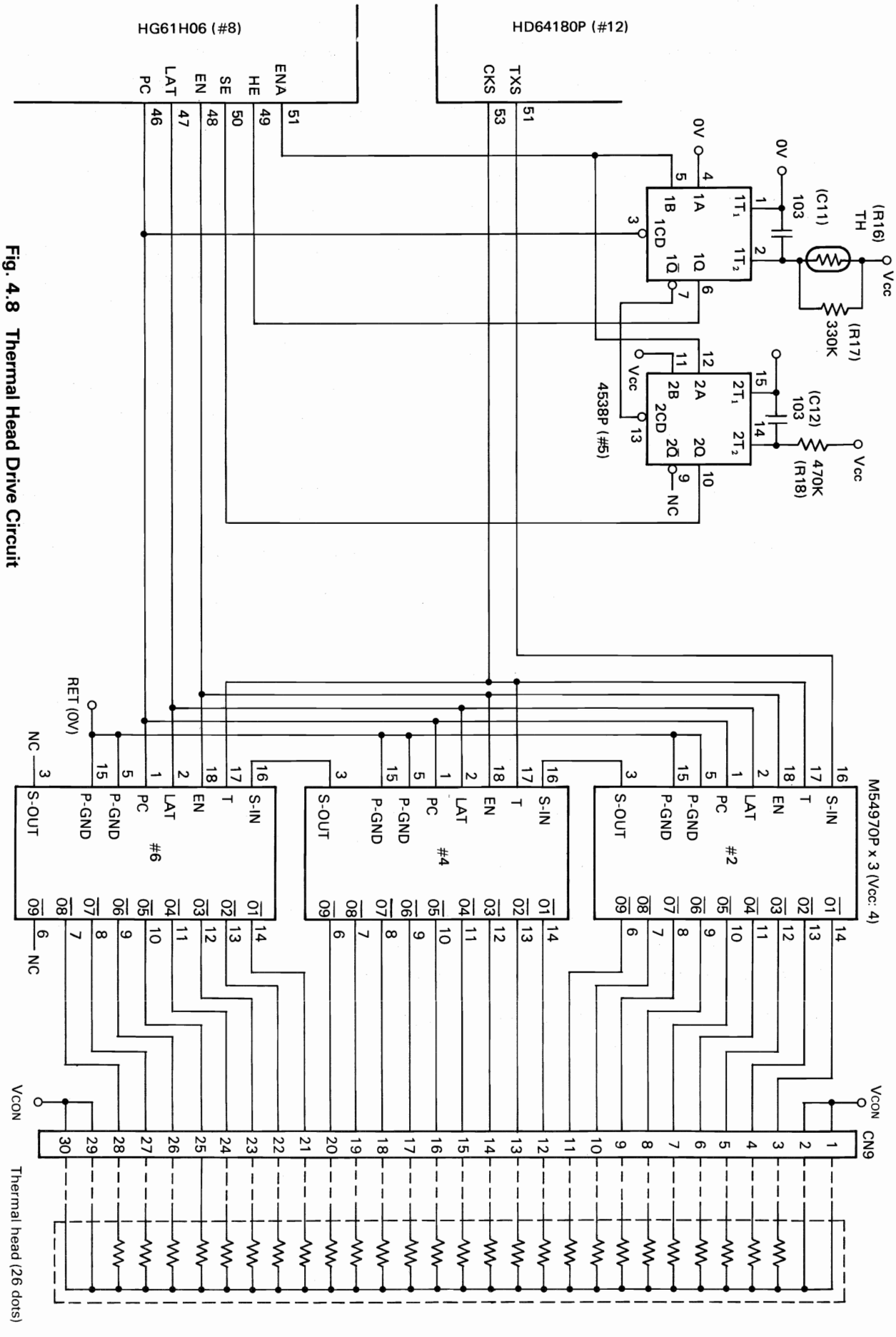


Fig. 4.8 Thermal Head Drive Circuit

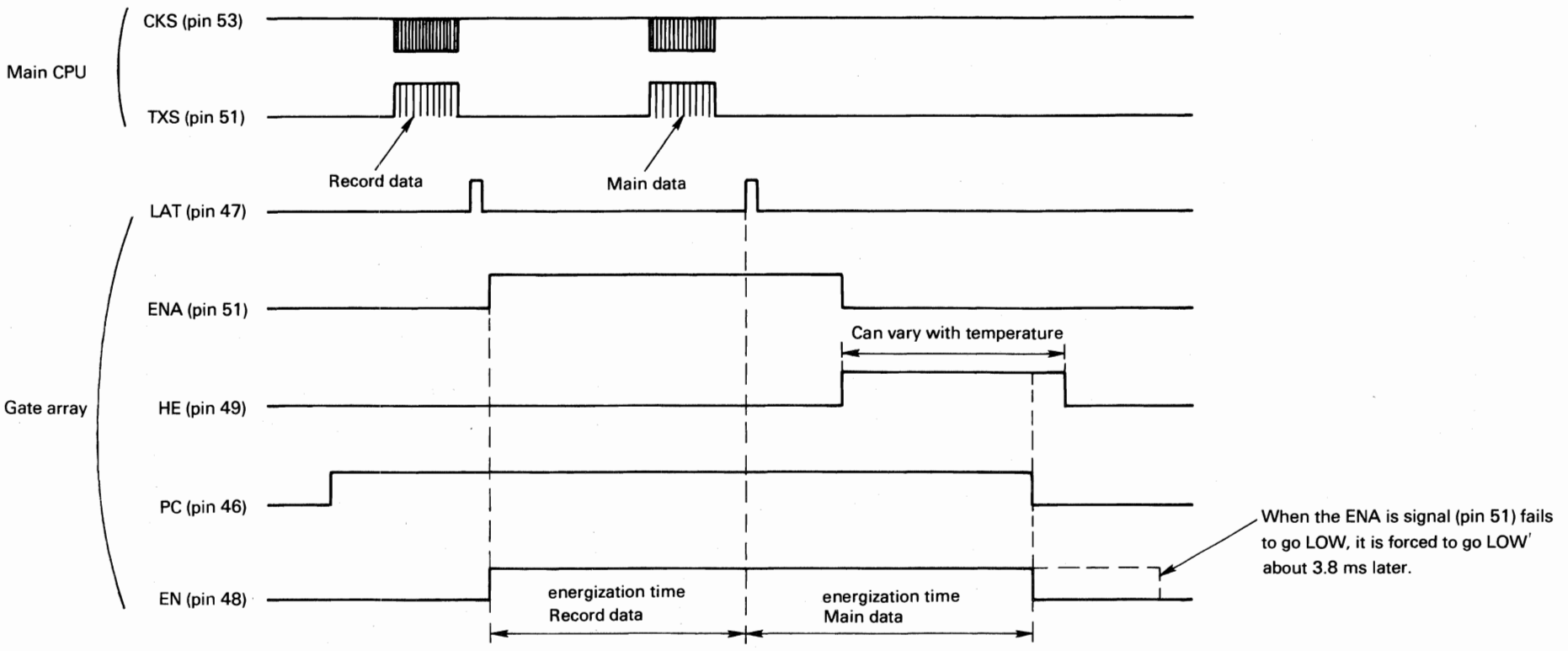


Fig. 4.9 Thermal Head Drive Timing Chart

4.6 Motor Drive Circuits

Fig. 4.11 shows the motor drive circuit. Three motors (carriage motor, paper feed motor, and thermal head motor) are controlled by the main CPU through the gate array. M54539P is the motor drive circuit. All motors are driven in one-two phase excitation (see Fig. 4.10). The drive cycles for the motors are detailed below.

4.6.1 Carriage motor

(1) Printing
Four speed-up pulses (to gradually bring the motor up to operating speed) and four slow-down pulses (to gradually bring the motor to a stop).
2.14 ms/pulse (468 pps during operation)

(2) Correction
Four speed-up pulses and four slow-down pulses.
2.53 ms/pulse (396 pps)

(3) Medium speed drive (space repeat and back space repeat)
18 speed-up pulses and 18 slow-down pulses.
1.25 ms/pulse (800 pps)

(4) High speed drive (tabulation and carriage return)
36 speed-up pulses and 36 slow-down pulses.
1 ms/pulse (1000 pps)

4.6.2 Paper feed motor

30 speed-up pulses.
1.92 ms/pulse (520 pps)

4.6.3 Thermal head motor

Three speed-up pulses and three slow-down pulses.
1.67 ms/pulse (600 pps)

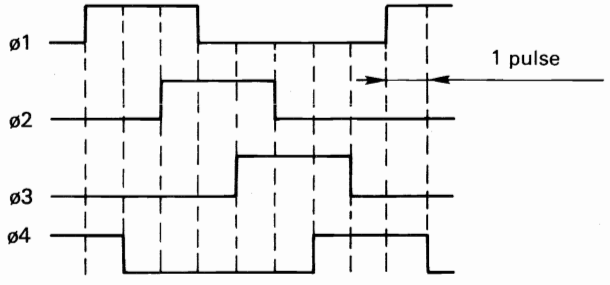


Fig. 4.10 Motor Drive Signal Waveforms

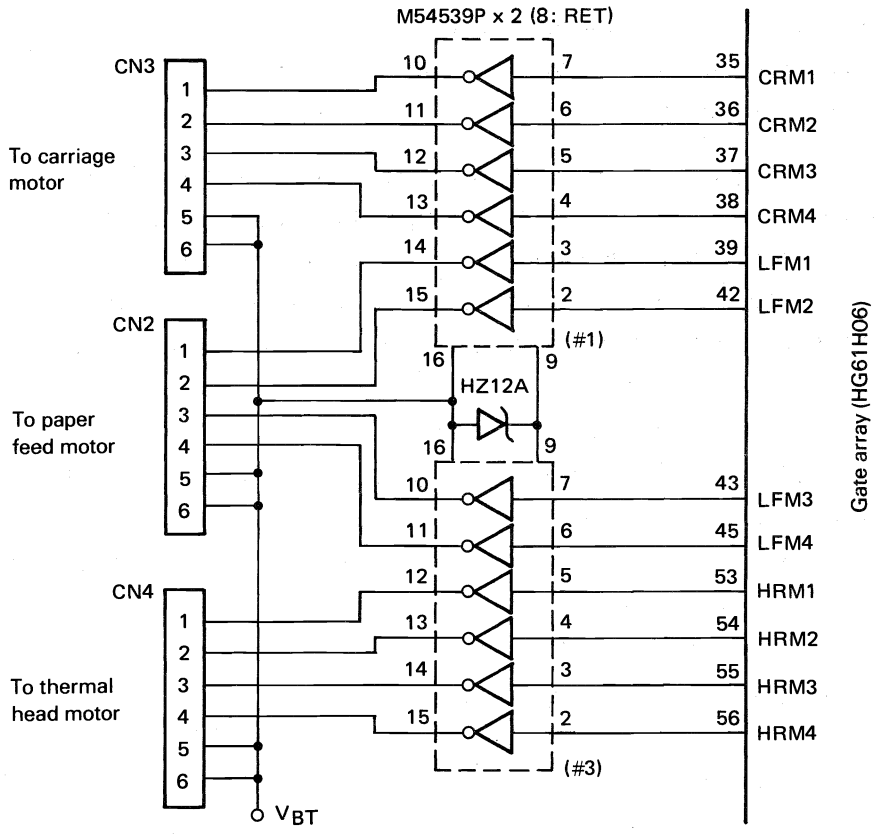


Fig. 4.11 Motor Drive Circuit

4.7 Voltage Regulator Circuits

Fig. 4.12 shows the voltage regulator circuits.

4.7.1 V_{CC} supply voltage regulator circuit

This circuit keeps V_{CC} supply voltage within $+5^{\pm 0.3}$ V despite V_{BT} (battery) input voltage fluctuations.

In normal operation, the coil across pins 1 and 2 and the coil across pins 3 and 4 of transformer T1 generate an oscillating voltage which is output from pin 6, rectified and smoothed to produce the Vcc supply. It goes through Zener diode ZD2, and the current output from ZD2 is then controlled as the base current by transistor Q4. In effect, the voltage is regulated by altering the oscillation frequency produced by Q2 and Q3.

4.7.2 V_{CON} supply voltage regulator circuit

V_{CON} is the $12^{\pm 0.3}$ V supply to the thermal head. An oscillating voltage is generated by transistors Q5 and Q6, coil L1, a capacitor, and a resistor.

Transistor Q8 regulates the voltage by reference to the current level output from Zener diode ZD3.

Transistor Q7 controls oscillation.

4.7.3 V_{BK} supply voltage regulator circuit

This circuit supplies voltage to the RAM. When the power is ON, the V_{BK} voltage is almost the same as the V_{CC} voltage. However, when the power is OFF, the AC adapter or dry cell batteries supply approximately 4 V backup voltage to the RAM. C2 is a backup capacitor providing power backup to the RAM when the dry cell batteries are being replaced.

4.7.4 Power switch peripheral circuits

Power may be supplied by five size-D dry cell batteries or by an AC adapter (7.5 V, 1A). When the AC adapter is plugged in, the ⊕ (positive contact for batteries) and ⊕′ (positive contact for AC adapter) in the power jack open and the positive contact of the AC adapter connects with the positive contact inside the power jack, thus disconnecting the battery circuit.

Whichever power source is used, power is supplied to V_{BT} when the power switch is set to the ON position.

When the power is switched OFF, V_{BT} is connected to 0V pin, and the accumulated current is quickly discharged.

Fig. 4.13 shows the polarity of the AC adapter plug.

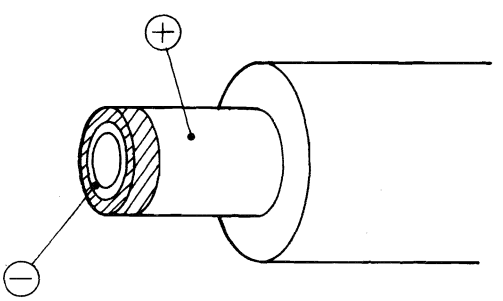


Fig. 4.13 Polarity of the AC Adapter Plug

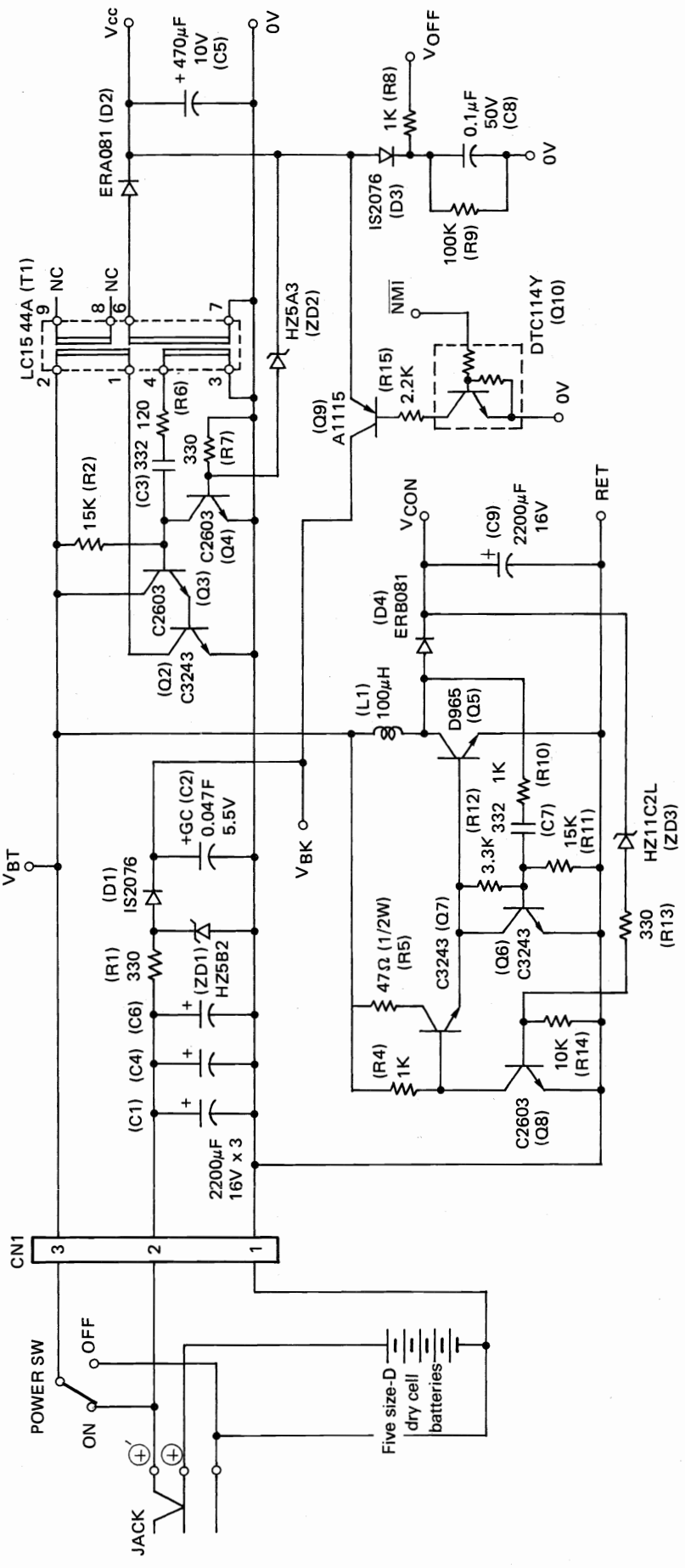


Fig. 4.12 Voltage Regulator Circuits

4.8 Buzzer Drive Circuit

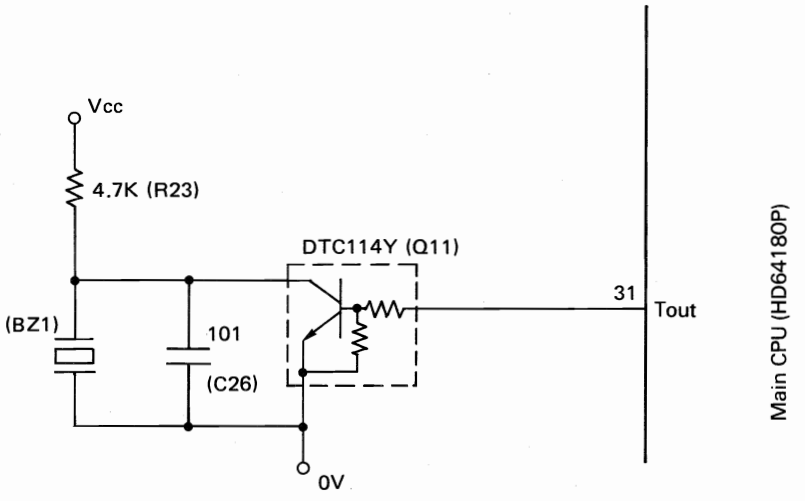


Fig. 4.14 Buzzer Drive Circuit

As shown in Fig. 4.14, the piezo-electric buzzer is controlled by the main CPU. When the main CPU detects a condition which calls for the buzzer to be driven, a pulse train (the buzzer drive signal) is output from pin 31 and pulled up to about the Vcc voltage level by transistor Q11 before being applied across the terminals of the piezo-electric buzzer. The buzzer then sounds.

4.9 Low Voltage Detection Circuit

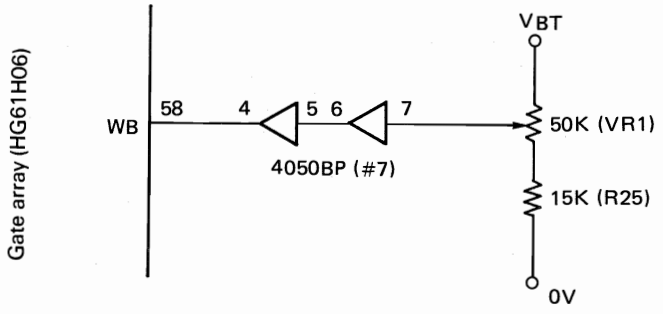


Fig. 4.15 Low Voltage Detection Circuit

Fig. 4.15 shows the low voltage detection circuit.

This circuit informs the main CPU when the voltage has dropped. If V_{BT} drops below 5.5 V when the carriage motor is in high speed drive, pin 4 on IC#7 (4050BP) goes LOW. The main CPU detects this and causes LED2 (POWER LED) to flash.

Whether the V_{BT} voltage is low or not is determined by detecting the potential between voltage regulator VR1 and resistor R25, using the threshold element of IC #7.

4.10 Leaf Switch Detection Circuit

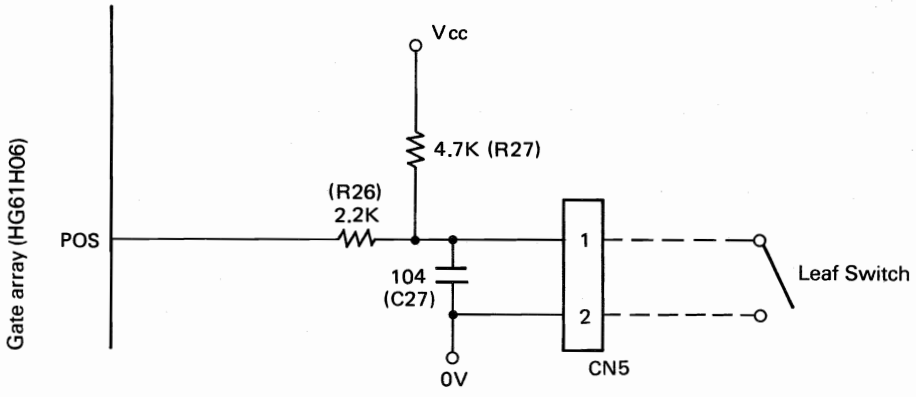


Fig. 4.16 Leaf Switch Detection Circuit

Fig. 4.16 shows the leaf switch detection circuit.

This circuit detects when the carriage is at the home position (it informs the main CPU through the gate array whether the leaf switch is ON or OFF).

CHAPTER II. TROUBLESHOOTING

GENERAL

This section will help in determining the cause of typewriter malfunctions. However, since it is impossible to predict what problems will occur with a particular typewriter or when they will occur, establishing a failsafe troubleshooting procedure is extremely difficult. This section therefore does no more than guide by reference to example problems. It is recommended that you develop a thorough understanding of the functions of each block so that you can determine approximately where problems have occurred by analyzing and examining them.

1.1 Precautions on Repair

(1) To supply power from an AC source, use the specified AC adapter.
(2) When an automatic voltage regulator is used, it should have a rating of 5-9 V and 2 A or more.
(3) The power must be switched OFF before testing for continuity with a multimeter.
(4) If a problem occurs with the thermal head or printing mechanism, the thermal head's flexible cable should be kept disconnected until the thermal head drive circuit is working normally.
(5) In the Probable Cause column, pay particular attention to items associated with "IC #12 (HD64180P) defective," since the failure of this IC may be caused by a defective ROM or RAM.

Note: As to the question in the troubleshooting charts, when the answer is yes, the condition is normal. If not, it is abnormal.

Problem	Points to check		Probable cause	Remedy	Repair	Manual reference section
Nothing happens when the power is switched ON.	Switch ON the power pressing the CLEAR [C] key.		Software runaway			
	Inspect to make sure that only one head rank (B ~ G) is soldered.		Rank setting defective	Solder the correct rank solder point.		4.3 Thermal Head Rank Setting Circuit
	Are V_{BT} and 0V voltages supplied to the main PCB?		Power switch unit defective	Replace the power switch unit.	Replace the defective parts or resolder.	4.7 Voltage Regulator Circuit
	Are Vcc and V_{BK} 5V when the power is switched ON?		Vcc and V_{BK} voltage regulator circuits defective	Replace the main PCB assembly.	Check each part on the main PCB.	
	Are any of the keys stuck in the "down" position?		Rubber spring defective	Replace the rubber spring.		2.2 Operation of the Keyboard
	Are $\overline{NMI}$ and $\overline{RES}$ signals output at the correct time?		$\overline{NMI}$ and $\overline{RES}$ circuits defective	Replace the main PCB assembly.	Replace IC #7 (4050BP).	4.1 Main CPU, $\overline{NMI}$ and $\overline{RES}$ circuits
The carriage does not return to its home position when the power is switched ON.	Is the leaf switch operation normal?		Leaf switch defective	Replace the leaf switch unit.		4.10 Leaf Switch Detection Circuit
		Normal	IC #8 (gate array) defective	Replace the main PCB assembly.	Replace IC #8 (gate array).	
			IC #12 (HD64180P) defective		Replace IC #12 (HD64180P).	
The carriage motor, paper feed motor, or thermal head motor does not operate properly.	Is the motor waveform output at the gate array normal?		IC #8 (gate array) defective		Replace IC #8 (gate array).	4.6 Motor Drive Circuits
			IC #12 (HD64180P) defective		Replace IC #12 (HD64180P).	
	Is the waveform output at the motor drive circuit (M54539P) normal?		M54539P defective		Replace M54539P.	
		Normal	Motor connector defective		Replace the motor connector.	
			Motor unit defective	Replace the motor unit.		

Problem	Points to check	Probable cause	Remedy	Repair	Manual reference section
Key input is impossible.	Is the membrane key input detection circuit properly connected to the connector?	Connection defective	Reconnect the membrane circuit.		4.2 Key Input Detection Circuit and Indication Circuit
	Are any of the keys stuck in the "down" position?	Rubber spring defective	Replace the rubber spring.		
	Are the key scanning signals at pins 14 to 23 and key input signals (pins 5 to 13) on the gate array normal?	IC #8 (gate array) defective	Replace the main PCB assembly.	Replace IC #8 (gate array)	
		IC #12 (HD64180P) defective		Replace IC #12 (HD64180P).	
		CN7 or CN8 defective		Replace CN7 or CN8.	
		Membrane circuit defective	Replace the membrane circuit.		
LED's do not light or flash.	Are the waveforms at the output pins on the gate array normal?	IC #8 (gate array) defective	Replace the main PCB assembly.	Replace IC #8 (gate array)	4.4 LED Drive Circuit
		IC #12 (HD64180P) defective		Replace IC #12 (HD64180P).	
	Normal	Driver (DTC114Y) defective		Replace DTC114Y.	
	Normal	LED 1 defective		Replace LED 1.	
	Normal	LED 2 defective	Replace the switch PCB assembly.	Replace LED 2.	
The buzzer does not sound.	Are the waveforms at the output pins on the main CPU (HD64180P) normal?	IC #12 (HD64180P) defective	Replace the main PCB assembly.	Replace IC #12 (HD64180P).	4.8 Buzzer Drive Circuit
	Normal	Buzzer defective		Replace the buzzer.	
The slide switches do not work.	Are the scanning signals at pins 26 to 30 and input signals at pins 5 and 6 on the gate array normal?	IC #8 (gate array) defective		Replace IC #8 (gate array)	4.2 Key Input Detection Circuit and Indication Circuit
		IC #12 (HD64180P) defective		Replace IC #12 (HD64180P).	
		Slide switch harness defective	Replace the switch PCB assembly.	Replace the slide switch harness.	
		Slide switches defective		Replace the slide switches.	

Problem	Points to check		Probable cause	Remedy	Repair	Manual reference section
LED 2 (battery) is abnormal.	Is the variable resistor VR1 voltage properly set?		VR1 setting defective	Adjust the VR1 setting.		4.9 Low Voltage Detection Circuit
	Is the output at pin 4 on IC #7 (4050BP) normal?		IC #7 (4050BP) defective	Replace the main PCB assembly.	Replace IC #7 (4050BP).	
		Normal	IC #8 (gate array) defective		Replace IC #8 (gate array)	
Printing is impossible. Print is too faint. One particular dot does not print.	Is the waveform output at driver M54970 normal?		M54970 defective.	Replace the main PCB.	Replace M54970.	4.5 Thermal Head Drive Circuit
			IC #5 (4538P) defective		Replace IC #5 (4538P).	
			IC #8 (gate array) defective		Replace IC #8 (gate array).	
			IC #12 (HD64180P) defective		Replace IC #12 (HD64180P).	
		Normal	CN9 defective		Replace CN9.	
			Thermal head assembly defective	Replace the thermal head assembly.		
	Is V_{CON} voltage 12 $\pm$0.3 V?		V_{CON} voltage regulator circuit defective	Replace the main PCB.	Check each part on the main PCB.	4.7 Voltage Regulator Circuit

brother®

Sep. '87
575008BE0