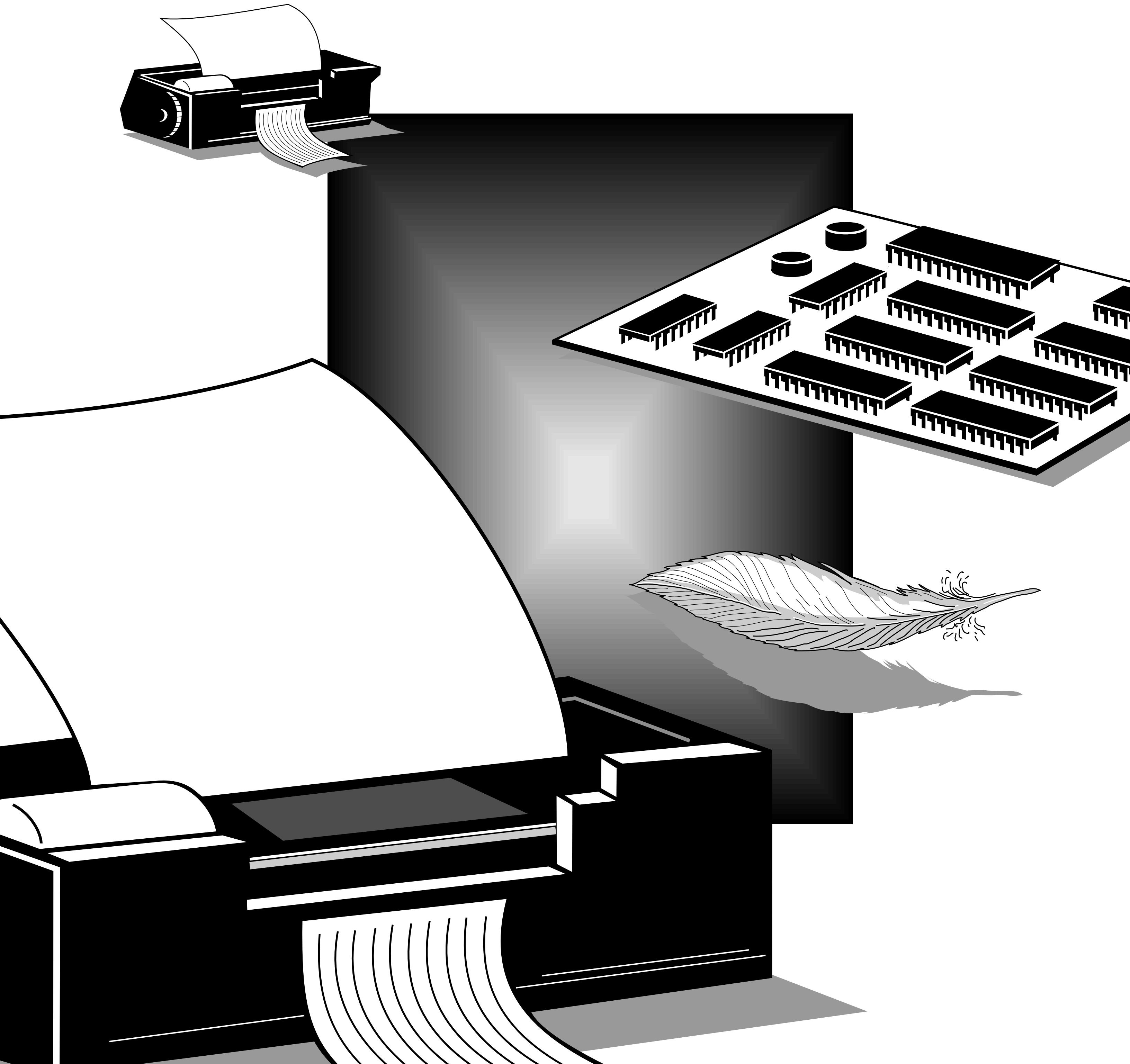
Seiko Instruments

STP411-F/G

Technical Reference



CONTENTS

1. GENERAL SPECIFICATIONS

Item		STP411F-256	STP411G-320	Remarks
Printing	Principle	Heat sensitive serial dot method		
	Printing direction	Character: Bidirectional logical seek		
		Graphic: Unidirectional logical seek		
	Printing timing	Step motor synchronization		
	Home position detection	Mechanical switch		
Mechanical specifications	Total no. of dots (vertical x horizontal per line)	8 x 256	9 x 320	
	No. of columns* (1 dot space)	42	40	
	Character size (H x W) [mm]	2.4 x 1.6	2.47 x 1.88	
	Dot size (H x W) [mm]	0.3 x 0.2	0.23 x 0.2	
	Printing width [mm]	89.6		
	Paper feed pitch [mm]	0.35	0.28	
	Printing speed [cps]	41	31	Motor f: 250 pps
	Tension of paper feed [g]	50 min.		Motor f: 250 pps
	Tension of paper hold [g]	100 min.		No paper feed motor excitation
	Service life	5×10^5 lines		5.0 V, rated energy, normal temperature, printing rate 50%
	Failure rate	1×10^{-6}/line max.		
	Dimensions (W x D x H) [mm]	153 x 44.5 x 20		
	Weight [g]	135		
Printer supply voltage [V]		5.0 VDC ± 0.5 VDC		
Environment	Operating temperature range [°C]	0 – 50		
	Storage temperature range [°C]	–20 – +60		
Heat-sensitive paper	Paper width [mm]	112^{+0}_{-1}		
	Paper thickness [μm]	66 ± 5		
	Recommended paper	SEIKO P/N TP411-25CL		

*STP411F-256 : 7 x 5 dot matrix
STP411G-320 : 9 x 7 dot matrix

2. APPEARANCE

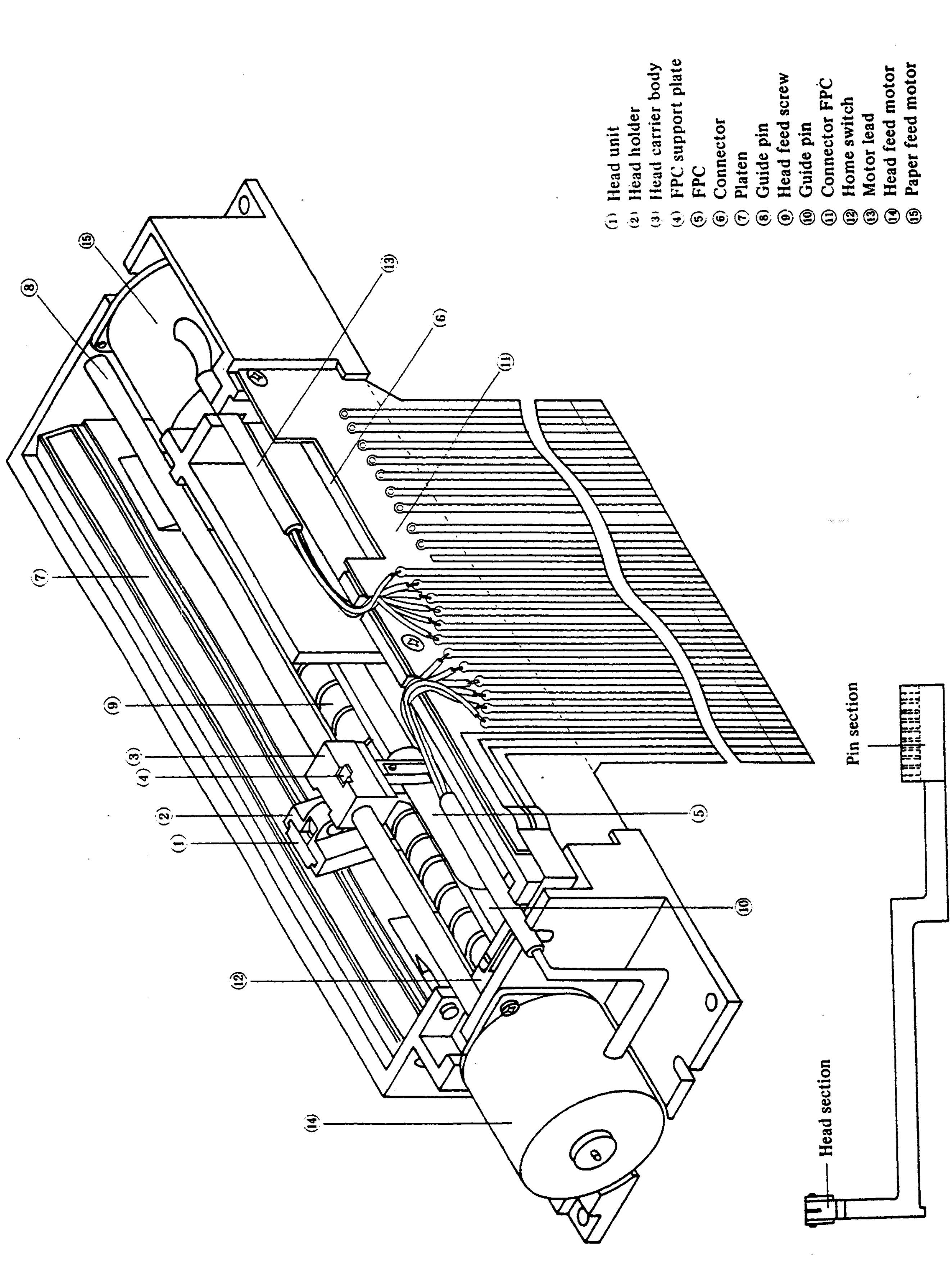
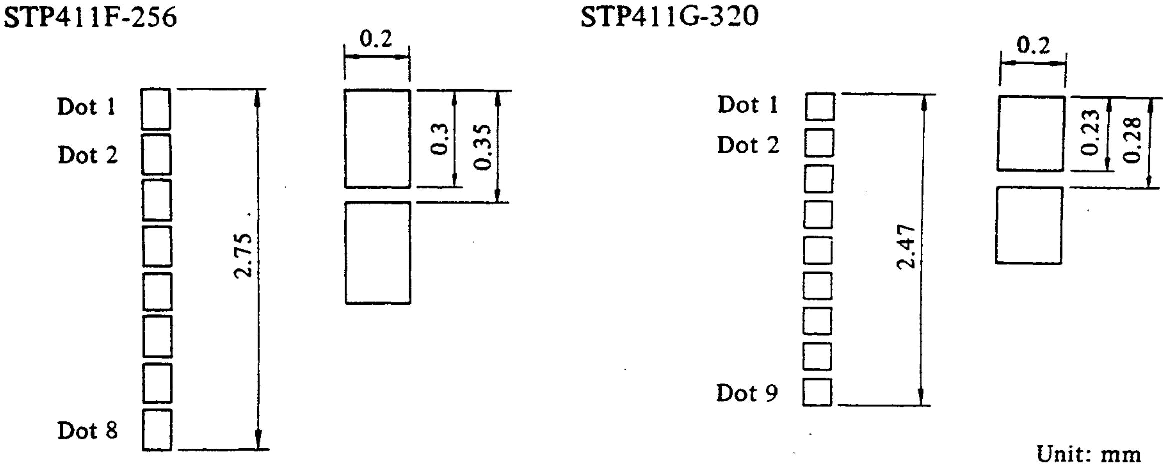


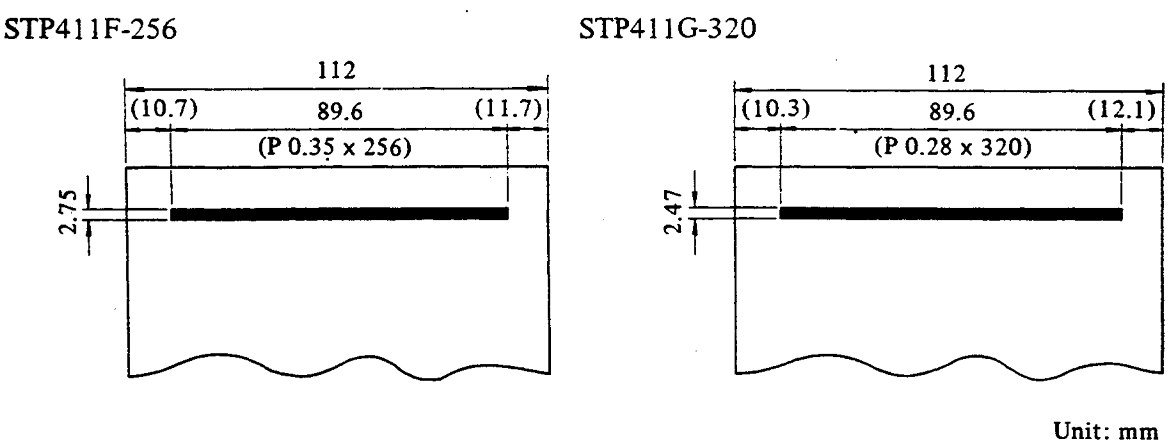
Figure 1 Appearance

3. PRINTING STRUCTURE

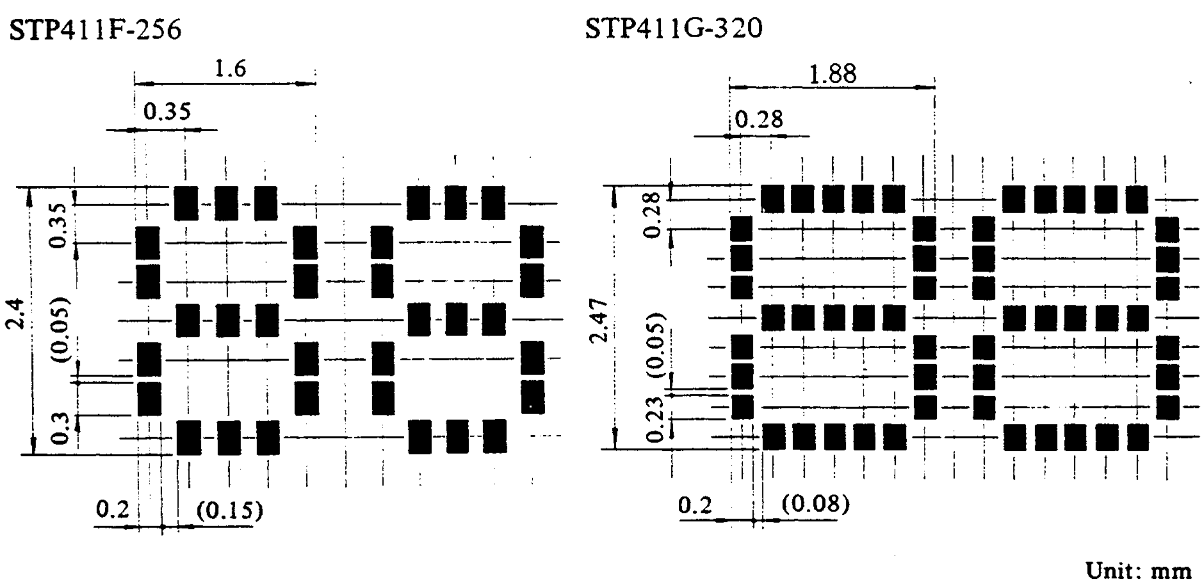
3.1 Heating Element Structure



3.2 Printing Range



3.3 Recommended Character Fonts



4. MOTOR CHARACTERISTICS

4.1 Head Feed Motor

- By rotating the head feed motor clockwise or counterclockwise, the head moves back and forth. Drive it at 250 pps.
- The head feed motor is driven at 2-2 phase excitation, one applied head pulse to one step of the motor drive signal. The head movement for one motor step is as follows.

STP411F-256: 0.35 mm
STP411G-320: 0.28 mm

4.2 Paper Feed Motor

- When the paper feed motor rotates counterclockwise, the paper is fed forwards. Intermittently feed the paper at 250 pps (40 ms/line minimum while resting).
- The paper feed motor is driven at 2-2 phase excitation, one pitch to four steps of the motor drive signal. The paper feed for four motor steps is as follows.

STP411F-256: 0.35 mm
STP411G-320: 0.28 mm

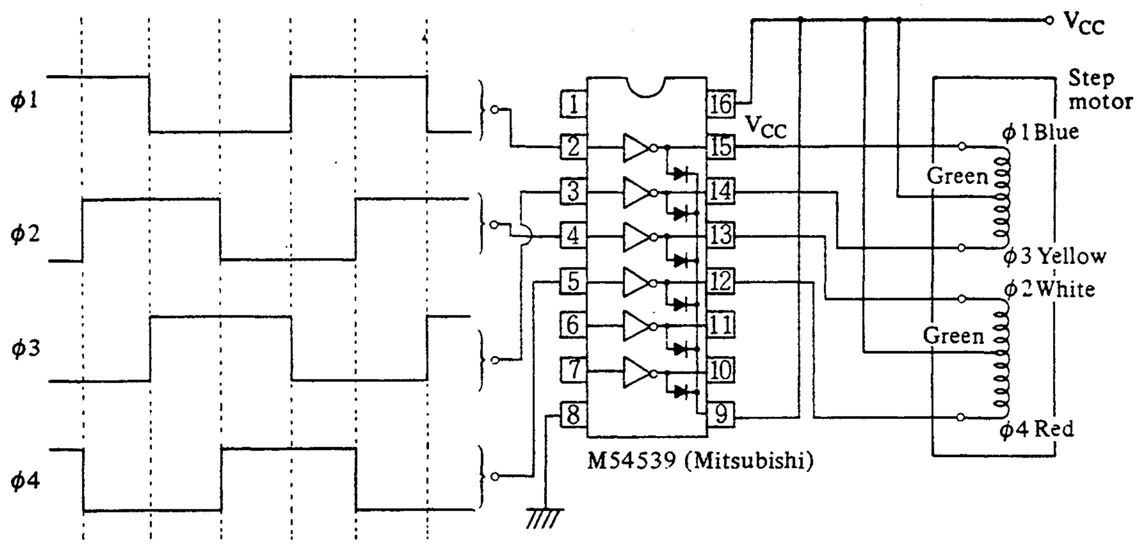
- Paper can be fed regardless of the position in which the head is stopped.
- Insert the paper after setting the head to the home position.

4.3 Step Motor

4.3.1 Head feed motor and paper feed motor characteristics

Item	Standard
Form	Permanent magnet
Phase	Four
Excitation method	2-2 phase
Coil resistance/phase	20 Ω ± 7%
Rated voltage	5.0 V ± 0.5 V
Current consumption	600 mA/2 phases max. (5.5 V)
Average current consumption	400 mA (5.0 V, 250 pps)

4.3.2 Drive circuit



4.3.3 Excitation

Clockwise rotation (head: left to right)

Step \ Excitation	Blue (ϕ1)	White (ϕ2)	Yellow (ϕ3)	Red (ϕ4)
1	ON	ON	OFF	OFF
2	OFF	ON	ON	OFF
3	OFF	OFF	ON	ON
4	ON	OFF	OFF	ON

Counterclockwise rotation (head: right to left, paper feed: forwards)

Step \ Excitation	Blue (ϕ1)	White (ϕ2)	Yellow (ϕ3)	Red (ϕ4)
1	OFF	OFF	ON	ON
2	OFF	ON	ON	OFF
3	ON	ON	OFF	OFF
4	ON	OFF	OFF	ON

5. HEAD CHARACTERISTICS

5.1 Heating Element Resistance

The average resistance of dot 8 or 9 on the flexible printed circuit (FPC) pins is divided into three as follows.

Rank	Resistance
A	17.9 Ω ± 1
B	16.3 Ω ± 1
C	14.7 Ω ± 1

Notes: 1. The resistance of the dots on the same head may vary by ±5%. The average resistance is ranked as shown.
2. The rank symbol is printed on the FPC.

5.2 Applied Head Voltage

5.0 VDC ± 0.5 VDC (in pins)

* Insert a 2,200 μF capacitor between the terminals of the power supply in the head drive circuit to flatten the ripple.

5.3 Peak Current

3.5 A max. (5.0 VDC, 9 dots driven simultaneously)

5.4 Average Current Consumption

420 mA (5 V, printing rate with B rank head 50%, 24°C)

5.5 Applied Head Energy

(Ta = 24°C)

Head applied voltage	STP411F-256			STP411G-320		
	4.5 V	5.0 V	5.5 V	4.5 V	5.0 V	5.5 V
Applied rated energy (mJ)	2.22	2.10	2.00	1.69	1.60	1.53
Maximum applied energy (mJ)	2.66	2.52	2.40	2.03	1.92	1.84

When the supplied voltage and the ambient temperature change during operation, use the applied energy accordingly with the applied energy correction equation below. (See the example of the pulse width control circuit.)

Applied energy correction equation

$$E = \frac{V_0 + V}{2V} E_0 \left(1 + \frac{T_0 - T}{100}\right)$$

Pulse width computation equation

$$t = \frac{R \cdot E}{V^2}$$

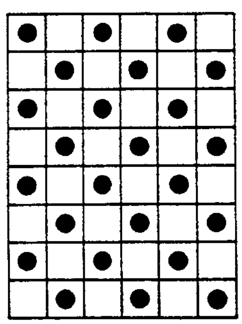
E: Applied energy (mJ)
V: FPC pin voltage (V)
T: Operating temperature (°C)
V_0: 5.0 V
E_0: STP411F-256: 2.10 mJ, STP411G-320: 1.60 mJ
T_0: 24°C
t: Pulse width for applying the rated energy (ms)
R: Head resistance

Rank	Head resistance
A	17.9 Ω
B	16.3 Ω
C	14.7 Ω

Adjust the pulse width according to the following steps.

1. Set the pulse width at the minimum value and apply energy to the thermal head. Use the grid pattern so that energization is always 100%.
2. Check the head terminal voltage using a synchroscope.
3. Obtain the pulse width value (t) from the applied energy correction equation and pulse width computation equation.
4. Increase the pulse width gradually and adjust it to the obtained value, while being careful not to apply excessive energy to the head.

*Pattern for 100% carrying current

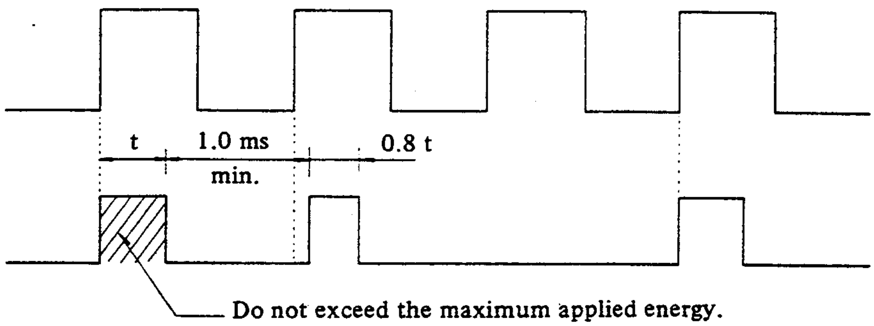


5.6 Carrying Current Pulse Width Control

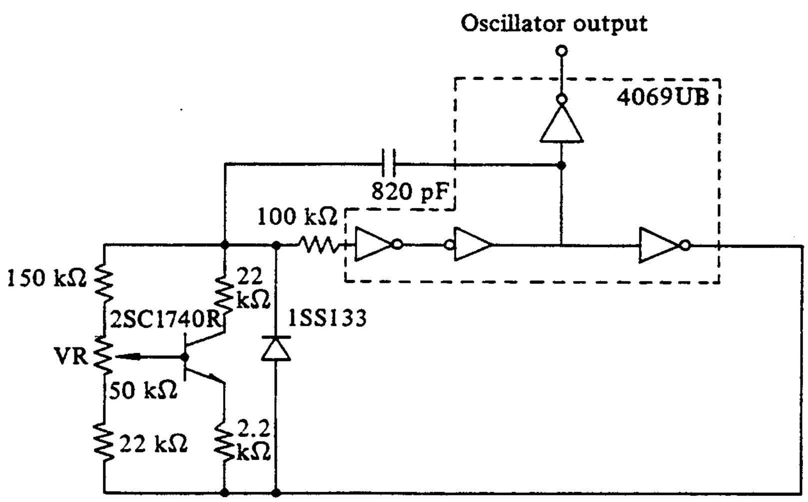
Synchronize the leading edge of the pulse with the timing signal.

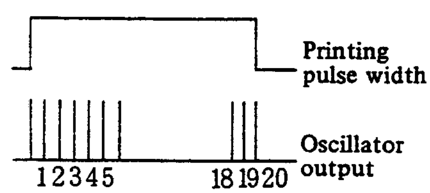
Using the pulse width control circuit, bring the applied rated energy to match the leading edge of the pulse.

* Avoid continuous carrying current. Make carrying current rests of 1.0 ms between pulses.
* When driving the same dot as the previous dot continuously, reduce the applied rated energy to 80%. (This delays the rise of the head drive signal.)



Example of pulse width control circuit





Head drive signal
(example: 20 pulse count)

* The temperature and voltage compensation circuits are included.
* Include VR to obtain the correct printing pulse width for 20 counts at normal temperature.
* The CPU counts the above oscillator output pulse, and the printing pulse width is obtained.

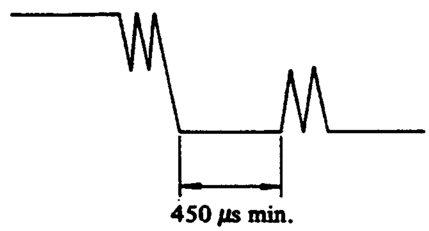
6. HOME SWITCH SIGNAL DETECTION

- The home switch detects when the head is at the home position. It is mechanical, and is off (open) at the home position. Use it under the following conditions.

  Contact resistance: 10 Ω max. (measured current: 50 μA)
  Current: 1 mA max. (5.0 VDC)

- When the off state continues for more than 450 μs to stop chattering malfunctions, consider the switch as off. From off detection to the next initialization, do not switch from on to off.

On to off detection



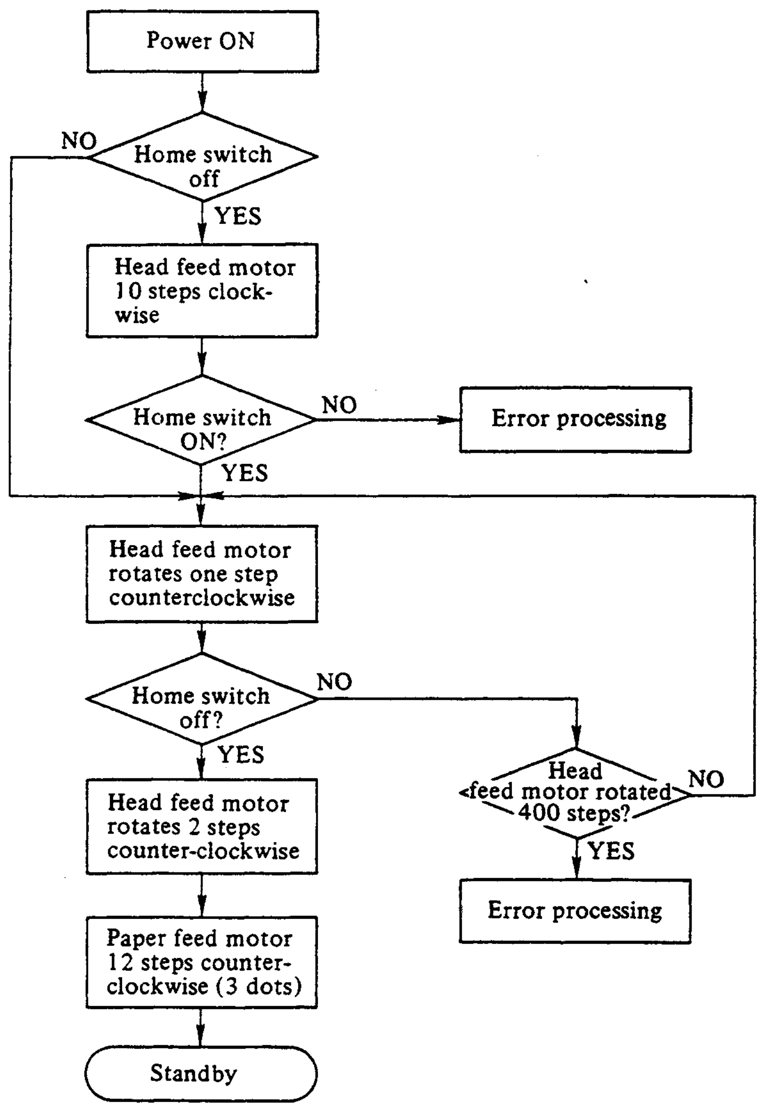
7. TIMING CHARTS

7.1 Timing Chart Examples

Examples of timing charts for printer operation are shown on the following pages.

7.2 Initialization

See the flowchart below.



7.3 Printing

The head is driven synchronously with the head feed motor drive signal. (See page 18.)

7.4 Paper Feed

Paper is fed one pitch (dot) for four steps of the paper feed motor drive signal.

7.5 Print End

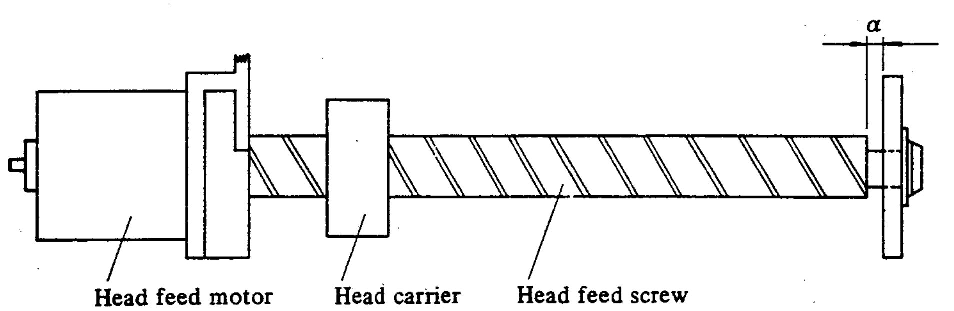
When printing has finished, the head returns to home position.

For example, when there is no data input for 500 ms or more after print end (determined by data input speed), the head returns to the home position.

7.6 Abnormality Detection

It is regarded as abnormal if home switch on-off is not detected even when the number of head feed motor drive steps (400 minimum) has been counted during home position search.

7.7 Number of Steps in Absorbing Rattle in Thrust Direction of Head Feed Screw



STP411F-256: $\alpha = 2$

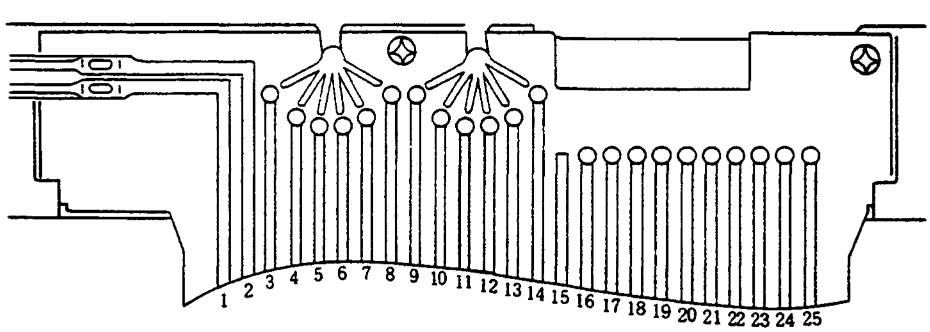
STP411G-320: $\alpha = 3$

7.8 Connections

Pin assignment

Pin no.		STP411F-256	STP411G-320
1		Home switch	
2			
3	Green	C	Head feed motor
4	Green	C	
5	Blue	$\phi 1$	
6	White	$\phi 2$	
7	Yellow	$\phi 3$	
8	Red	$\phi 4$	
9	Green	C	Paper feed motor
10	Green	C	
11	Blue	$\phi 1$	
12	White	$\phi 2$	
13	Yellow	$\phi 3$	
14	Red	$\phi 4$	
15		NC	NC
16		NC	Dot 1
17		Dot 1	Dot 2
18		Dot 2	Dot 3
19		Dot 3	Dot 4
20		Dot 4	Dot 5
21		Dot 5	Dot 6
22		Dot 6	Dot 7
23		Dot 7	Dot 8
24		Dot 8	Dot 9
25		Common	Common

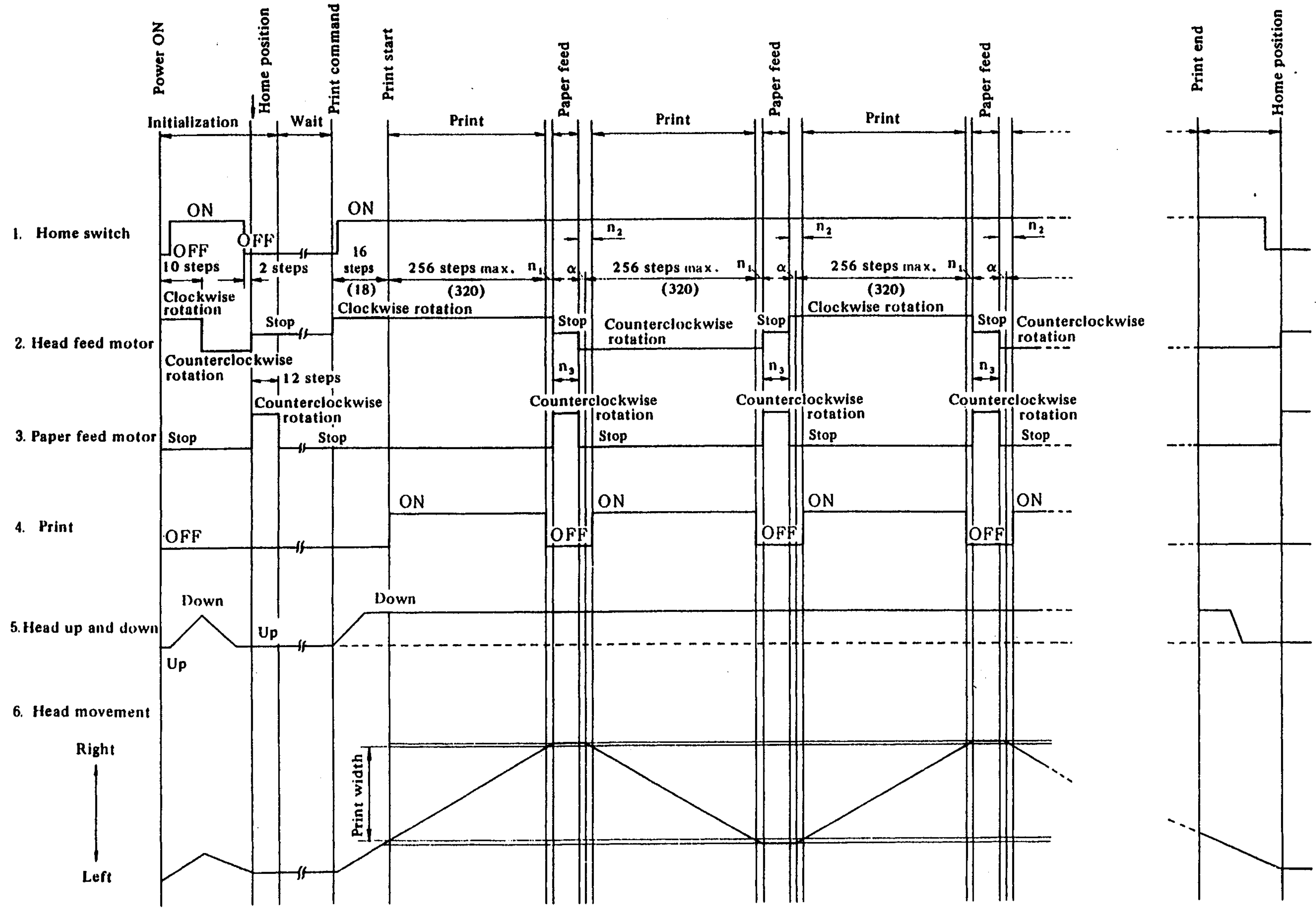
Pin configuration



Timing chart 1

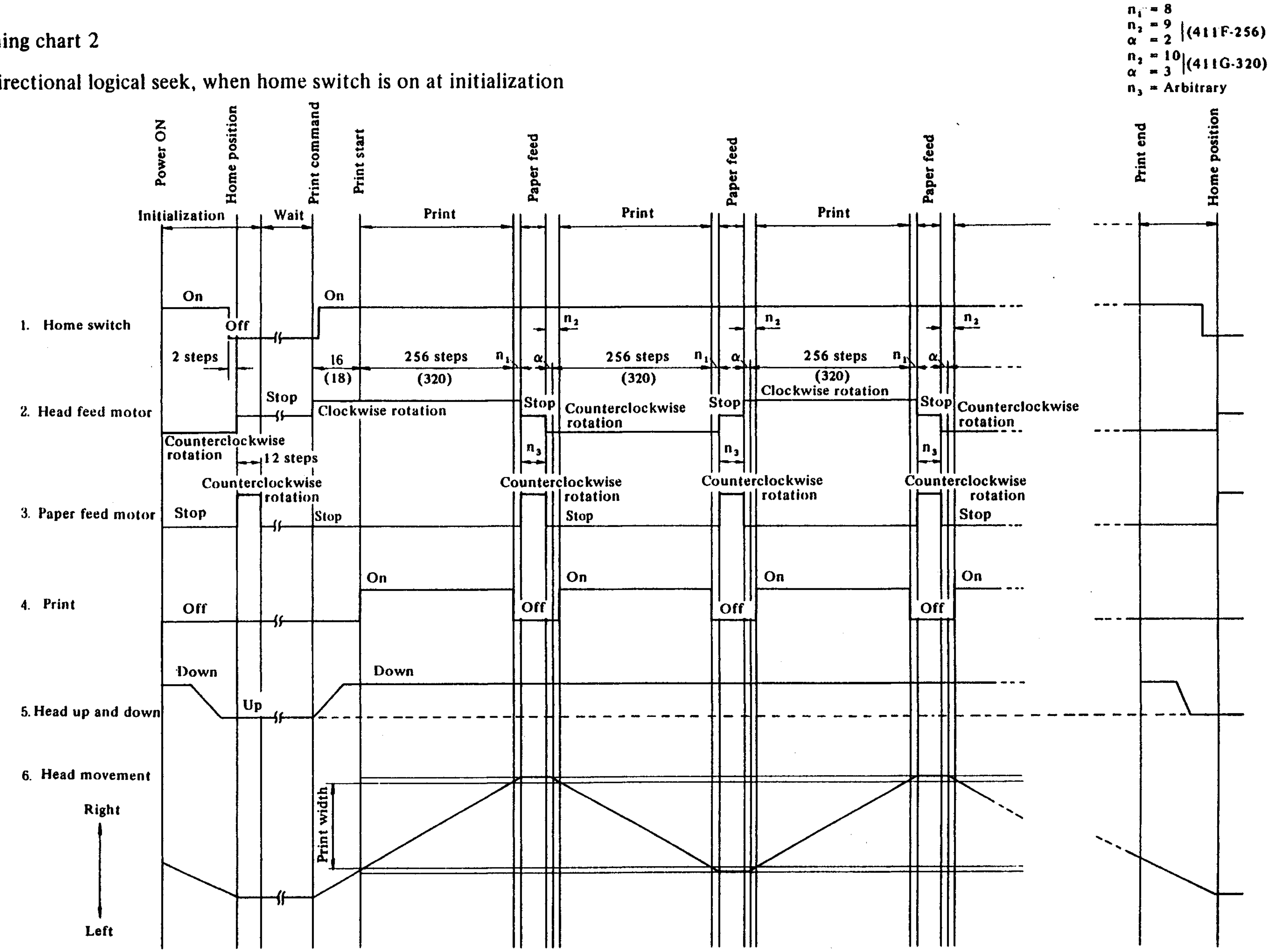
Bidirectional logical seek, when home switch is off at initialization

$n_1 = 8$
$n_2 = 9$, $\alpha = 2$ (411F-256)
$n_2 = 10$, $\alpha = 3$ (411G-320)
n_3 = Arbitrary



Timing chart 2

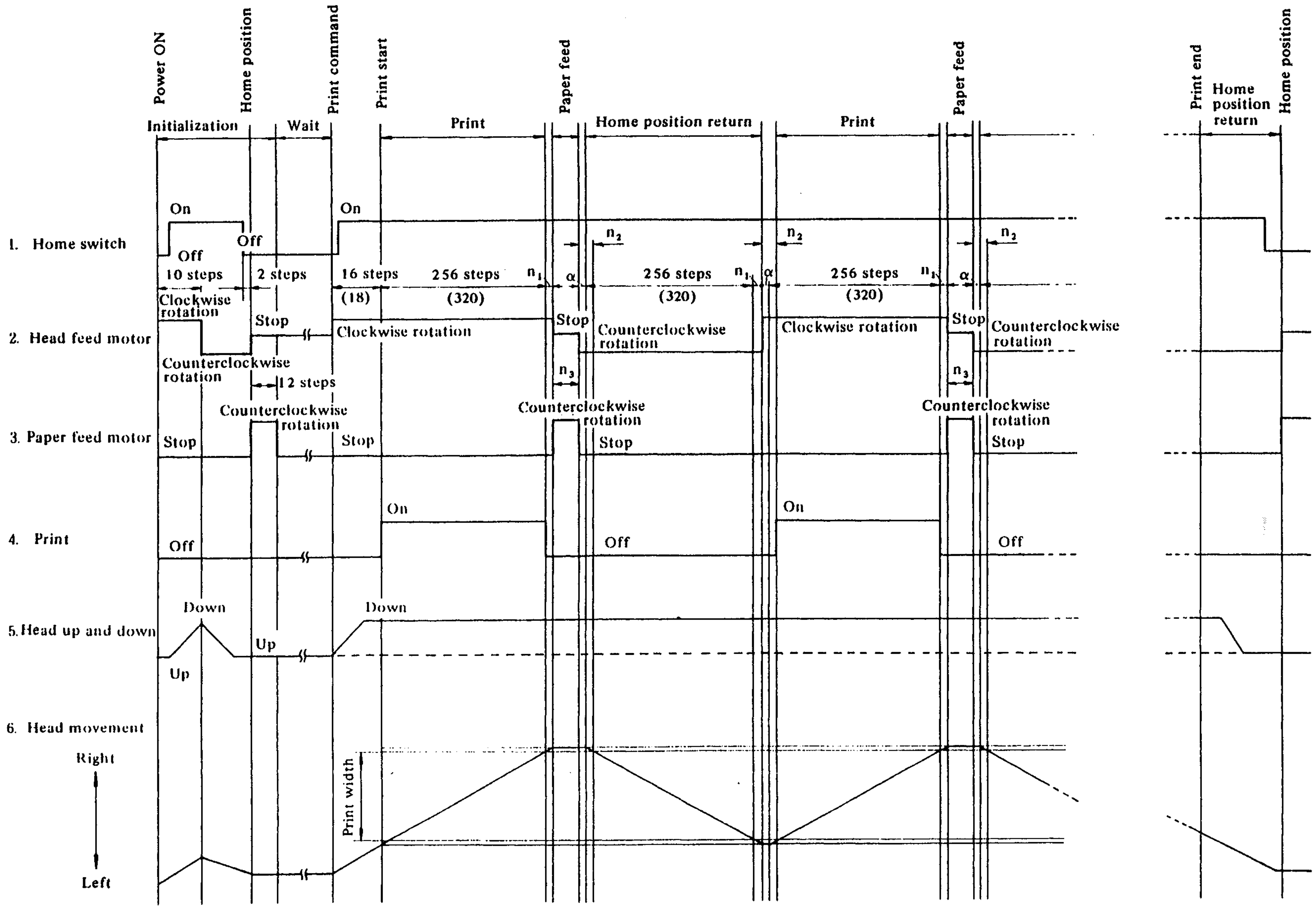
Bidirectional logical seek, when home switch is on at initialization



Timing chart 3

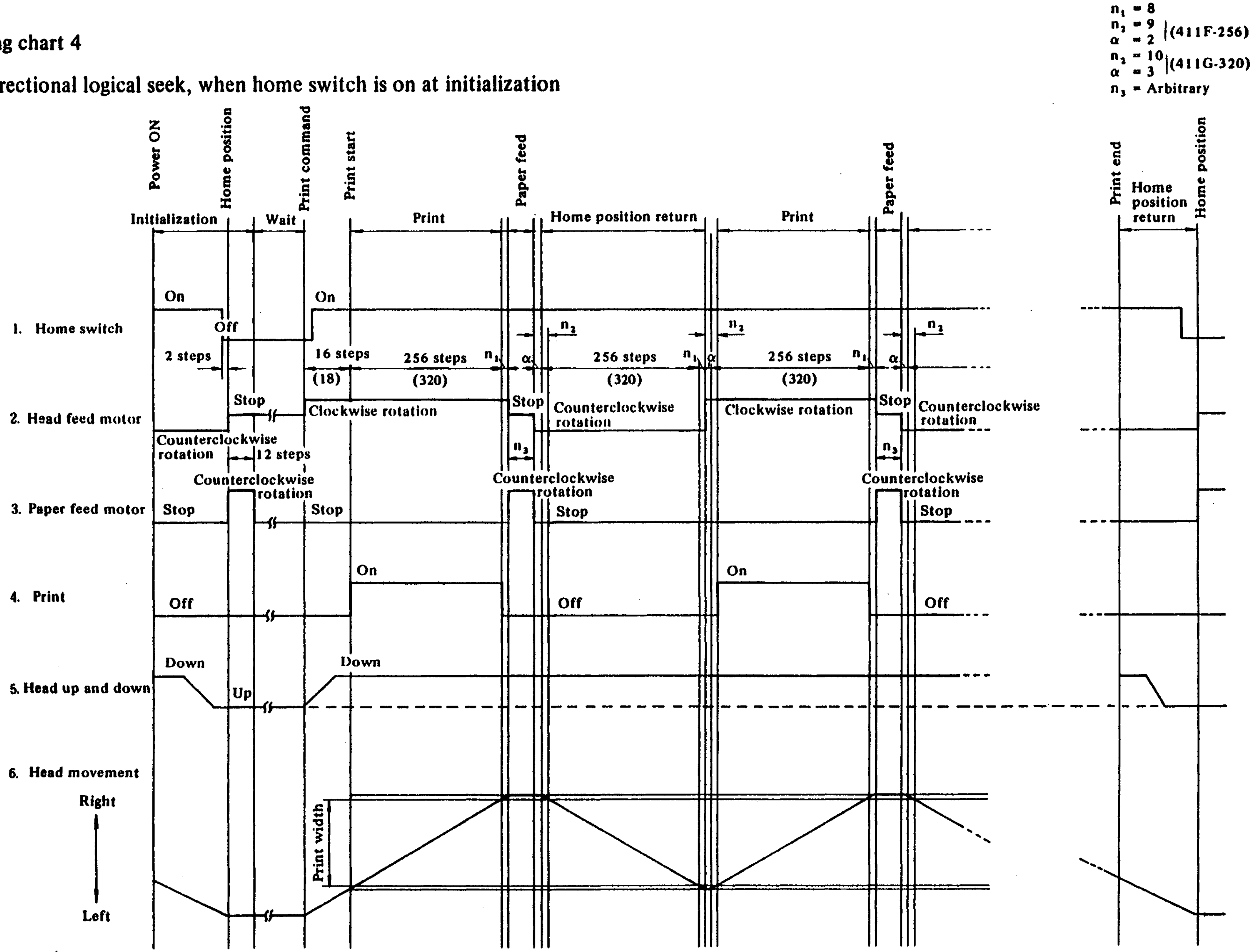
Unidirectional logical seek, when home switch is off at initialization

$n_1 = 8$
$n_2 = 9$, $\alpha = 2$ (411F-256)
$n_2 = 10$, $\alpha = 3$ (411G-320)
n_3 = Arbitrary



Timing chart 4

Unidirectional logical seek, when home switch is on at initialization

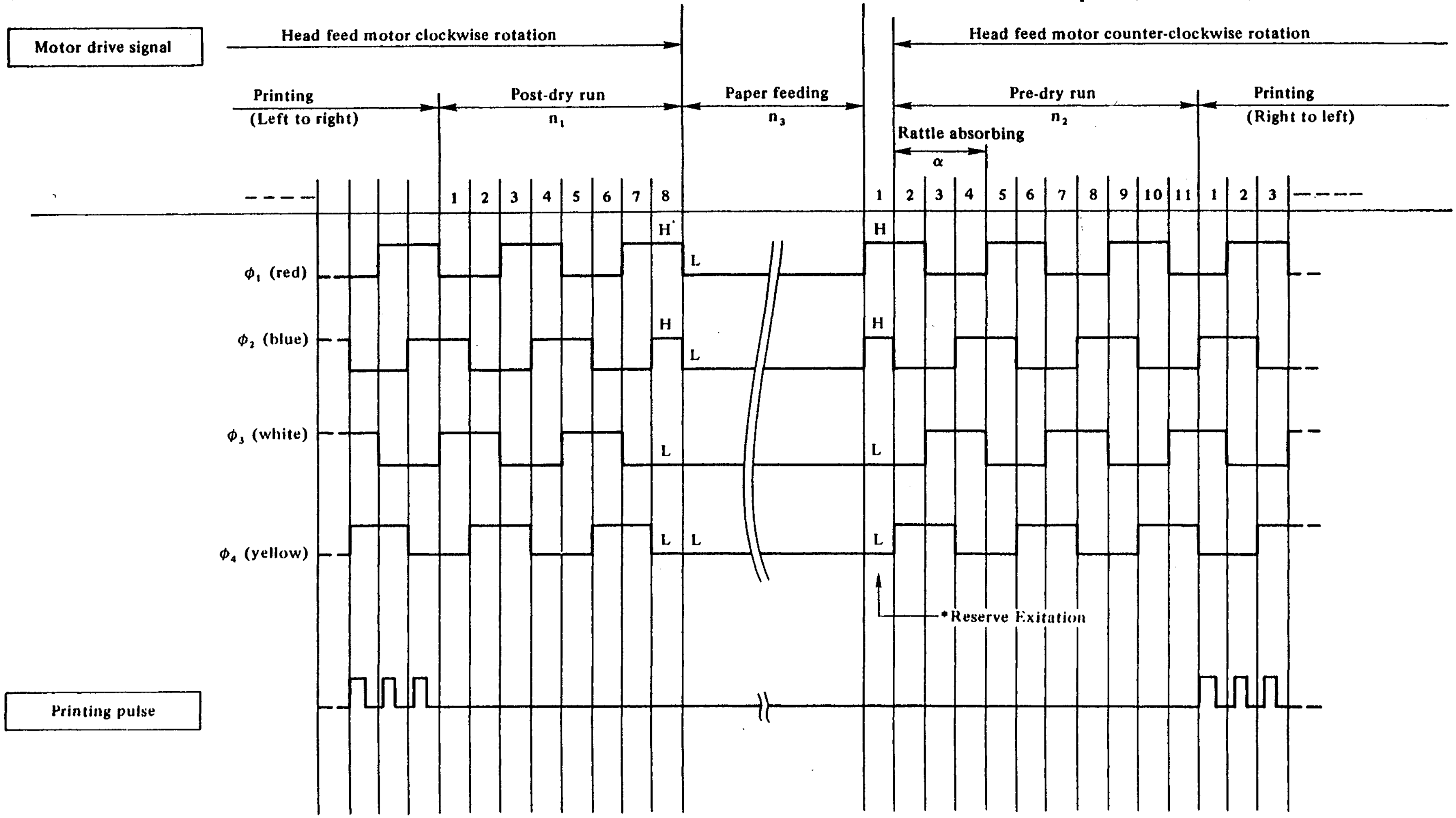


Detailed Timing Chart (STP411G-320)

(Head feed motor clockwise rotation → counterclockwise rotation)

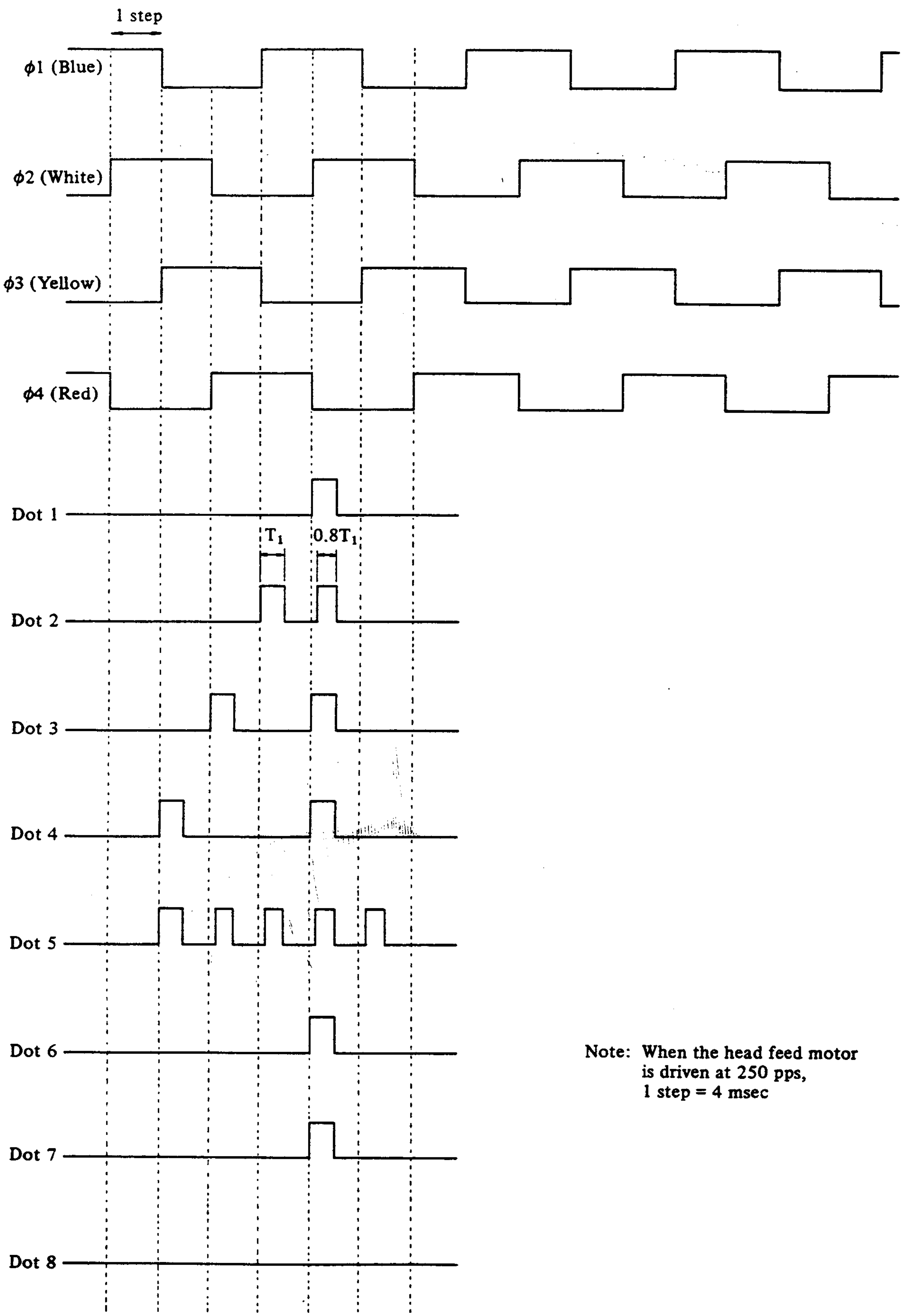
$n_1 = 8$
$n_2 = 9$ (STP411F-250)
$n_2 = 10$ (STP411G-320)

n_3 = Arbitrary
$\alpha = 2$ (STP411F-250)
$\alpha = 3$ (STP411G-320)



* When actuating the motor after a pause or when changing the rotation direction, excite the phase immediately before the pause as reserve exitation to restart. This reserve exitation is needed for the paper feed motor as well as for the head feed motor.

Motor drive signal (head feed motor)

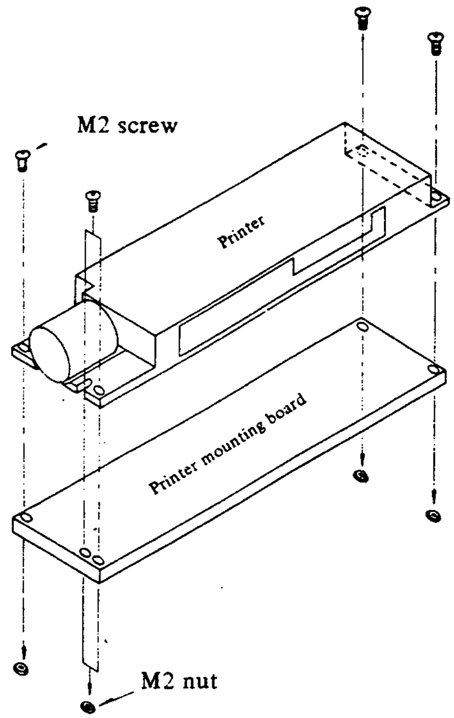


Note: When the head feed motor is driven at 250 pps, 1 step = 4 msec

8. OUTER DESIGN MANUAL

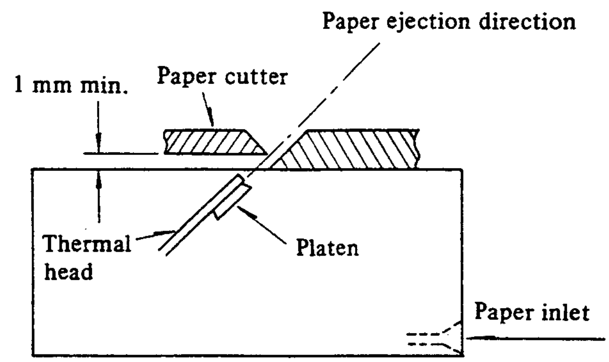
8.1 Fixing the Printer

- Insert an L-shaped dowel or pin into the two U-shaped holes in the printer (2.2 mm) and tighten the screws in the holes.
- It is recommended to insert a damper, such as rubber, into the space between the printer and cabinet to prevent resonance.



8.2 Mounting the Paper Cutter

- Design the cutter so that its tip comes to the extrapolated line from where the paper comes out.
- Design the printer so that the paper does not roll up again. (See the external dimensions diagram for details of dimension.)
- Design the cutter to cut paper at 80 g or less force.



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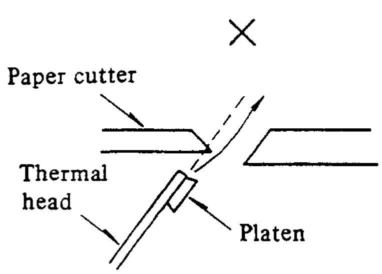
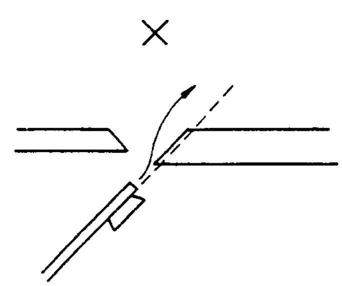


This is not a good design for the platen and thermal head. It will affect the printing quality.

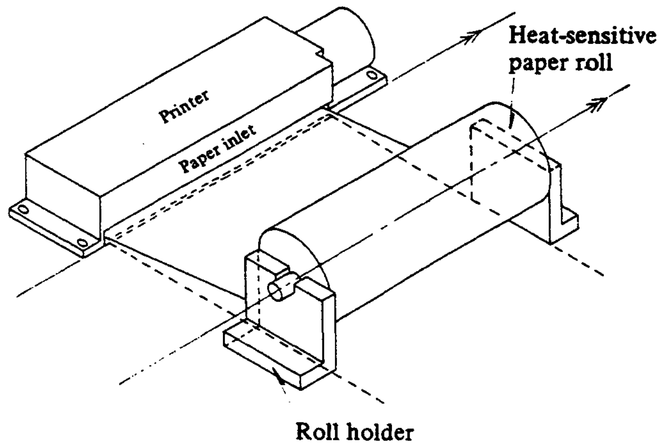


This design will damage the paper. Cutting the paper will exert unnecessary force on the thermal head.

8.3 Mounting Position for the Heat-sensitive Paper Roll Holder

Note the following points when designing the heat-sensitive paper roll holder.

- Do not let the heat-sensitive paper move to the left or right in relation to the printer paper inlet; keep the looseness in the holder and heat-sensitive paper roll thrust direction to 2 mm.
- Design the holder rod so that it is parallel to the printer paper inlet.
- Deep the load of the paper roll on the printer to 50 g or less.
- The paper guide in the paper inlet should be 58.3 mm wide and 3 mm long minimum.



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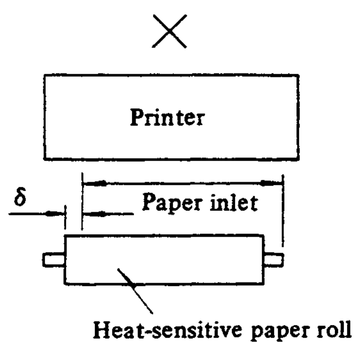
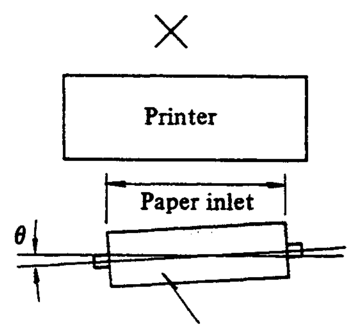




8.4 Designing the Paper Winding Mechanism

The paper winding mechanism must not pull the printed paper. The paper should always sag as shown in Figure 2.

If the printed paper is pulled, the printing head may not make proper contact with the thermal paper and the printing quality may affected, even when paper guides are installed as shown in Figure 1.

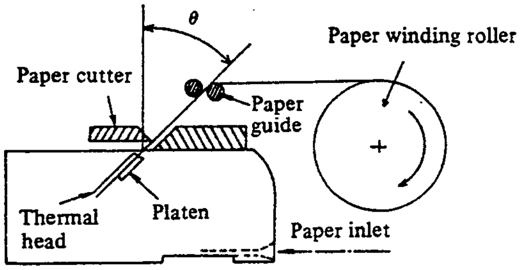


Figure 1 Bad design

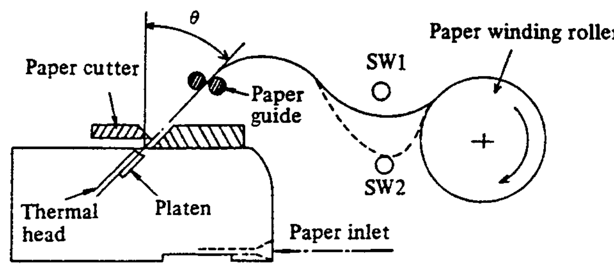


Figure 2 Good design

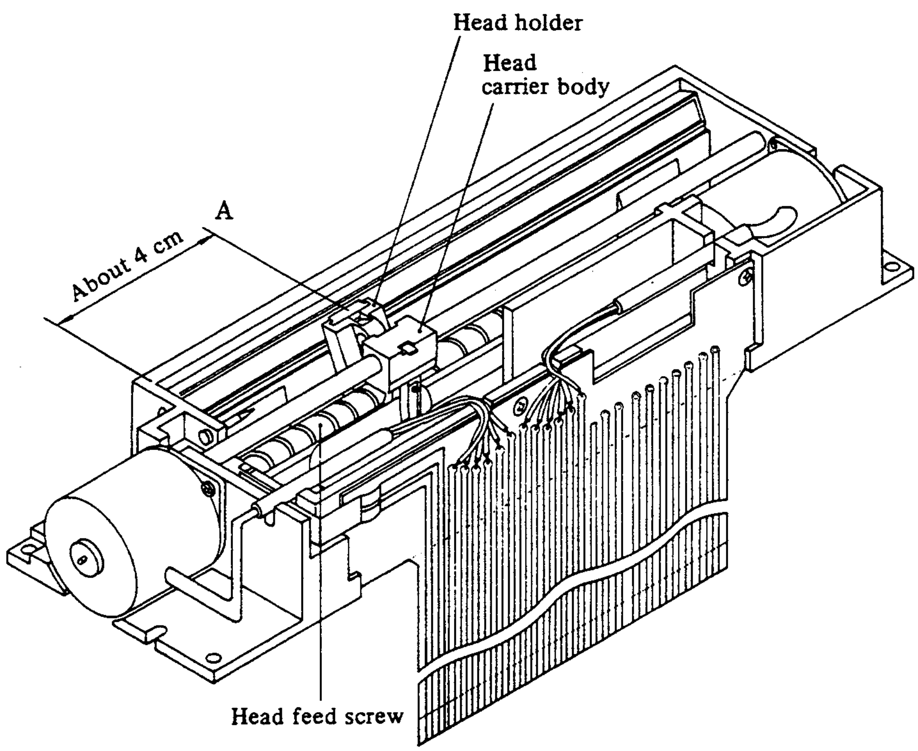
This design uses two switches so that the paper always sags : when SW2 is ON, the winding roller rotates. When SW1 is ON, the winding roller stops rotating.

9. REPLACING THE HEAD UNIT

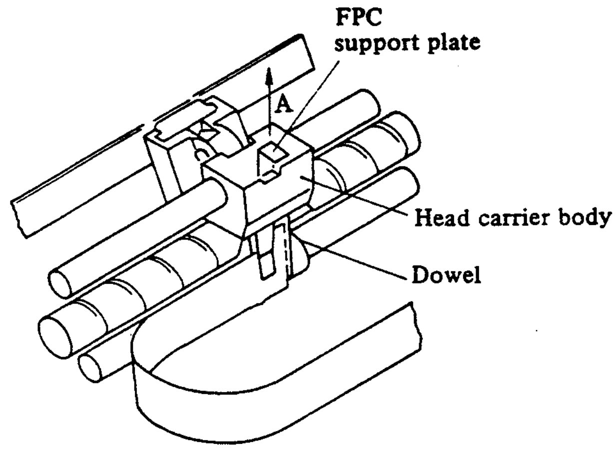
9.1 Removing the Head Unit

(1) Move the head holder to position A, where it is easy to take off the head unit.

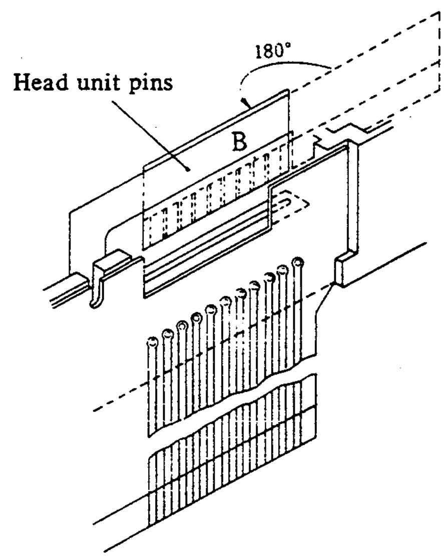
* Press the side of the head holder with your fingers, or move it by turning the head feed screw by hand.



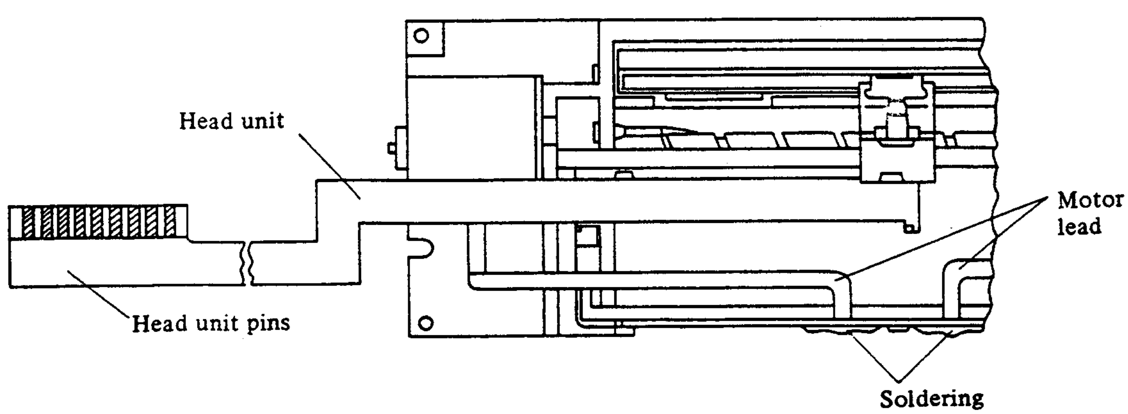
(2) Remove the FPC support plate from the head carrier in direction A, using the tip of a screwdriver.



(3) Remove the head unit pins from the connector, taking care not to damage the FPC.

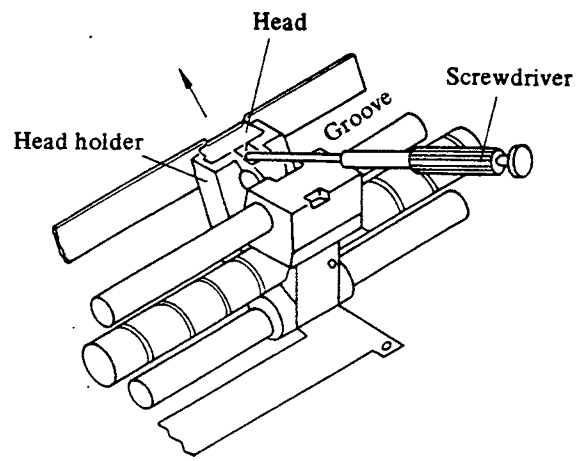


(4) Set the head unit as shown below, taking care not to break the soldered part of motor lead.



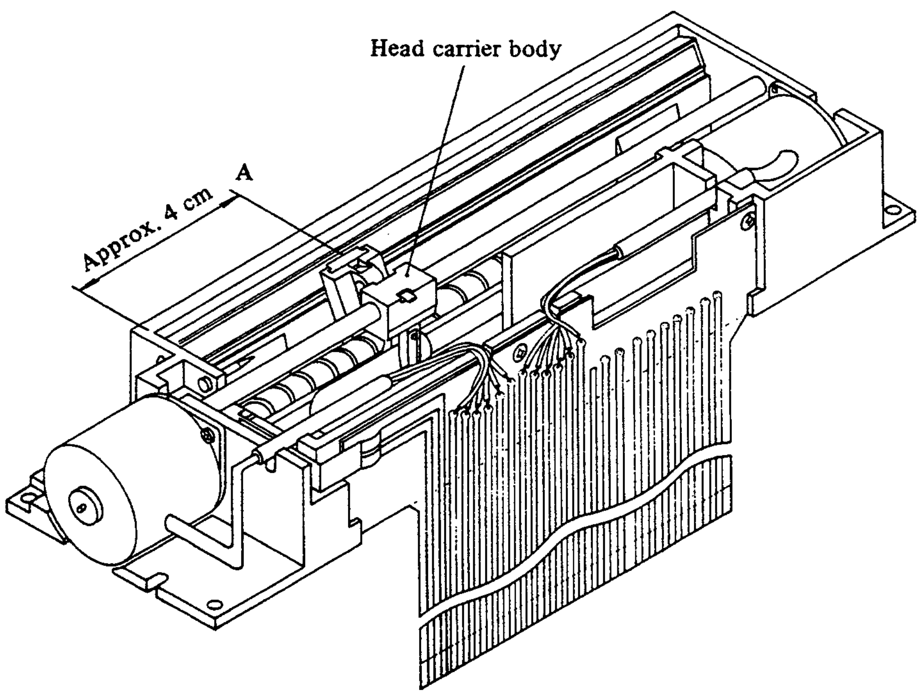
(5) Insert the tip of a screwdriver in the groove of the head holder, and pull until the head comes out of the head holder.

Hold the head with your fingers, and pull it up out of the printer.

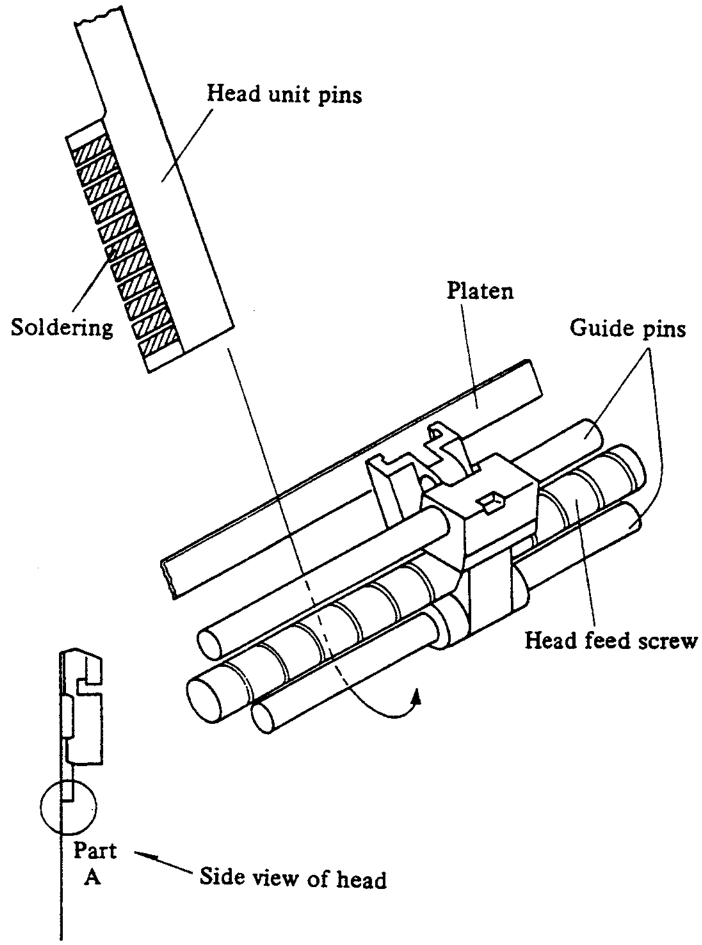


9.2 Mounting the Head Unit

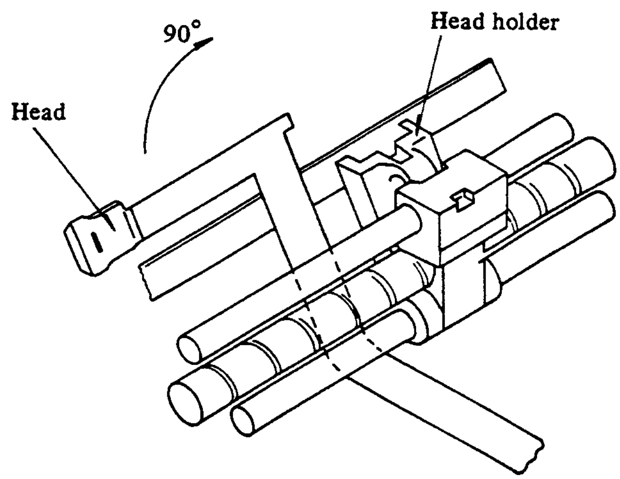
(1) Move the head carrier to position A, where it is easy to mount the head unit.



(2) With the soldered part of the head unit pin section facing up, push it under the guide pins and out. Use pliers to pull it up. Be careful not to bend part A when mounting the head unit.



(3) After pulling up the head unit pins, set the unit.
Turn the head 90°C to set it.

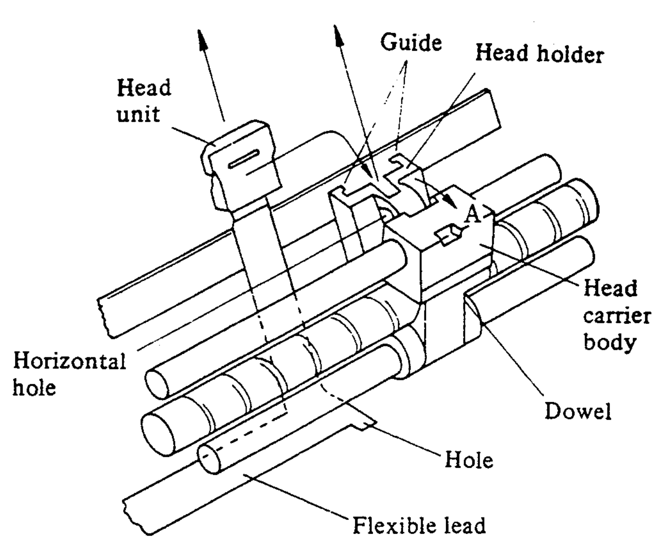


(4) Set the head unit and holder parallel.

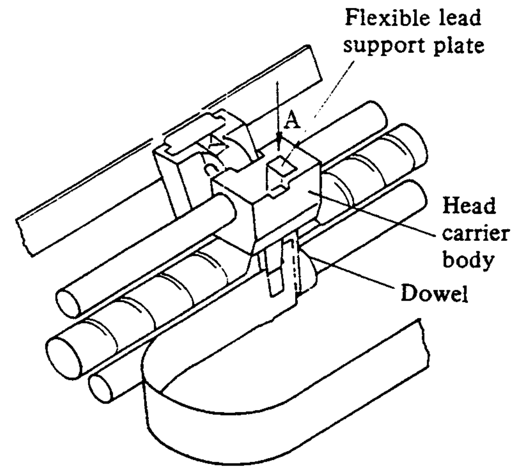
Pull the head holder towards you in the direction of A, and move the head unit parallel at the right.

Following the head holder guide, insert it until it clicks.

Insert the tip of a screwdriver into the horizontal head holder hole, and pull towards you.



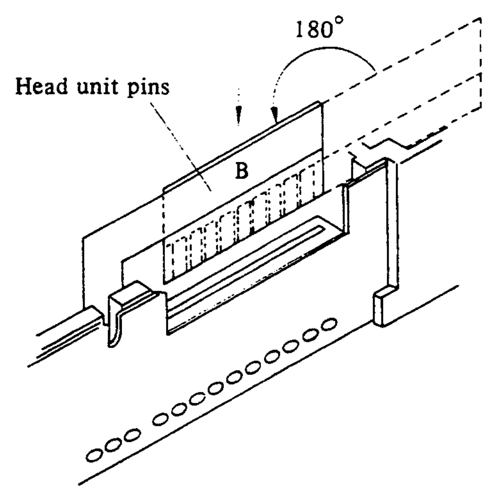
(5) Align the dowel with the FPC hole and press the FPC support plate into the head carrier body in the direction of A.



(6) Bend the head unit pins 180°, and insert the connector.

Notes:

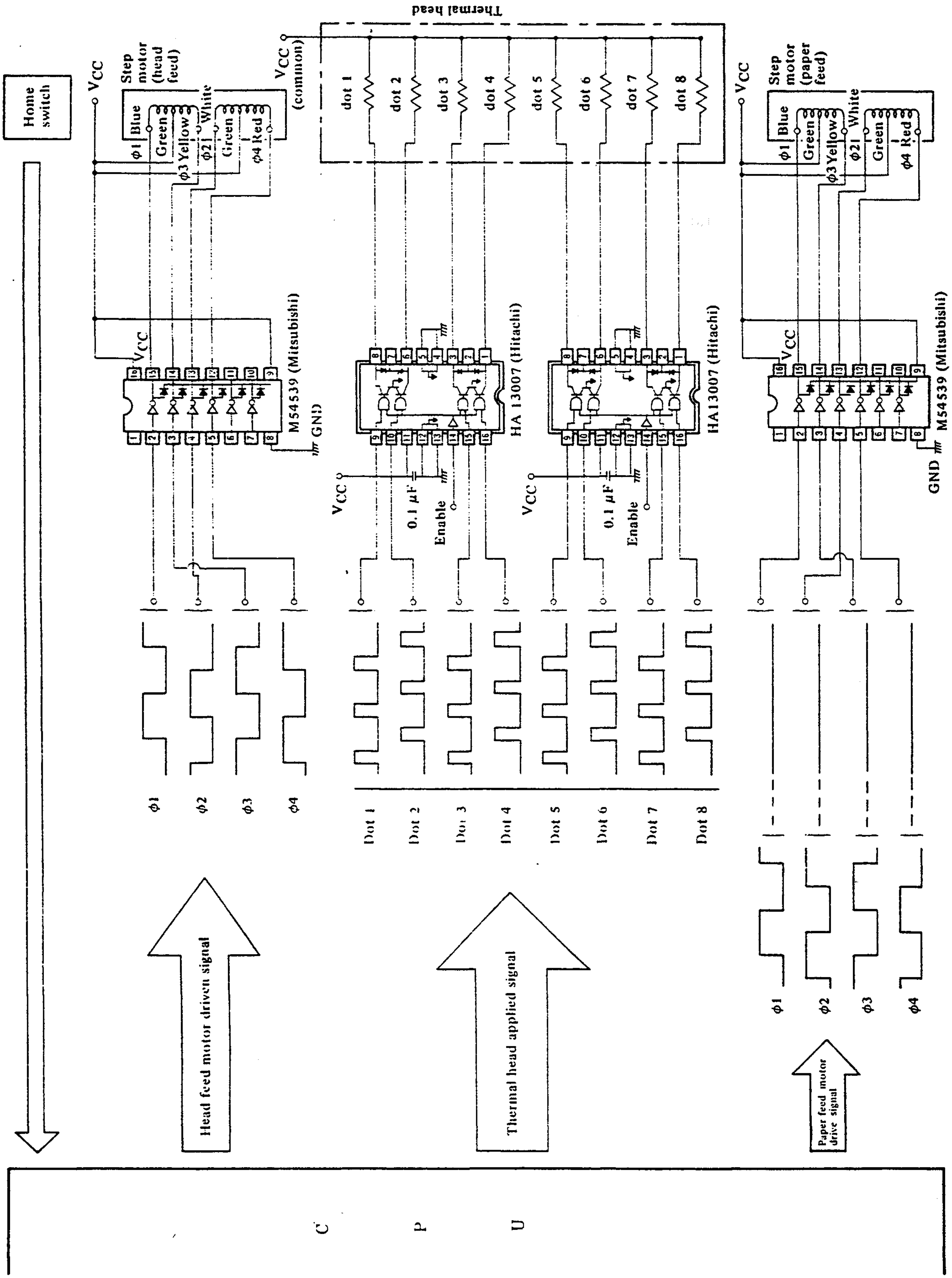
1. When inserting the connector, wipe any oil or dirt off the pins.
2. When mounting an eight-dot head, insert the connector as far to the right as possible.



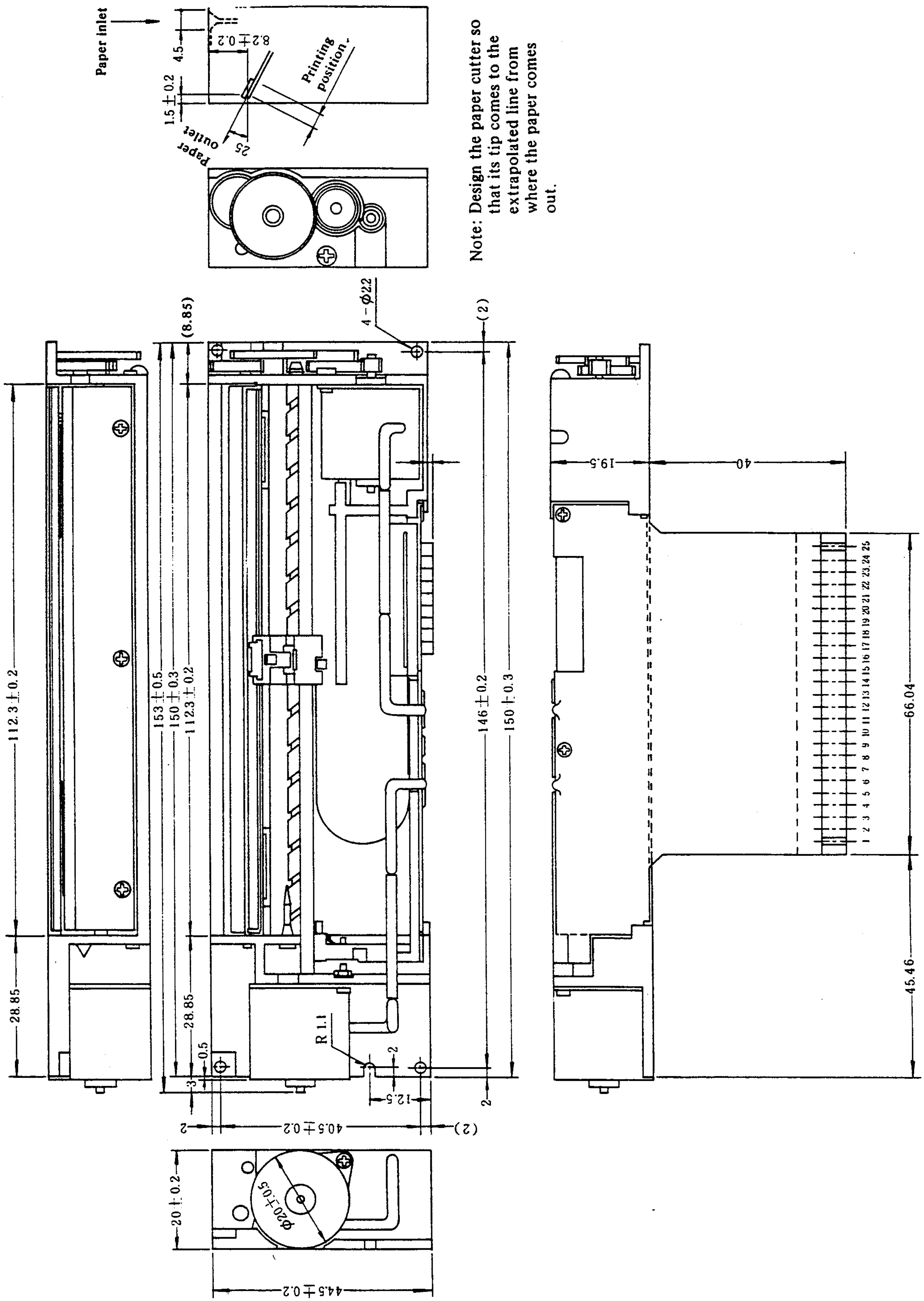
(7) Return the motor lead to its original position.

(8) Return the head carrier body to the home position (home switch side).

10. BLOCK DIAGRAM



11. DIMENSIONS



12. NOTES ON HANDLING

- Do not apply excessive energy.

  Since excessive energy in the thermal head will cause heat damage, use the specified applied pulse width.

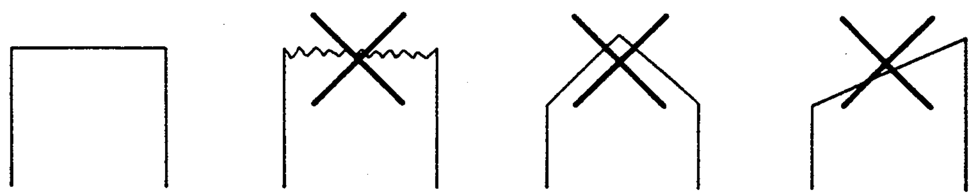
  When setting the applied pulse width, set it from the lowest energy value.

- If the recommended heat-sensitive paper is not used, clear printing and normal head service life cannot be guaranteed.

- Do not print without paper.

- Cut the heat-sensitive paper as shown below, insert it straight into the paper inlet until it touches the wall behind.

  If paper is bent during feed, it will come out skewed. Keep feeding paper until it comes out straight. Sometimes there is a noise when the paper wraps around the feed roller, but this is normal.



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(Specifications subject to change without notice.)