Seiko Instruments Inc.

LTP3445

LINE THERMAL PRINTER MECHANISM

TECHNICAL REFERENCE

39019-2392-02

Seiko Instruments Inc.

Revision List for the LTP3445 Line Thermal Printer Mechanism Technical Reference

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Cover		Modification	39019-2392-01	39019-2392-02
Copyright		Addition		Third Edition March 1999
8-1	④	Addition		In addition, design the printer so that the signal GND of the thermal head and the frame GND of the printer mechanism become the same electric potential.

LTP3445 TECHNICAL REFERENCE

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PREFACE

This reference manual describes the specifications and basic operating procedures for the LTP3445 Line Thermal Printer Mechanism. Chapter 7 describes safety precautions. Read it thoroughly before designing so that you are able to use the LTP3445 properly.

SII has not investigated the intellectual property rights of the sample circuits included in this manual. Fully investigate the intellectual property rights of these circuits before using.

TABLE OF CONTENTS

Section Page

CHAPTER 1
FEATURES

CHAPTER 2
SPECIFICATIONS

Section Page

CHAPTER 3
CONNECTING EXTERNAL CIRCUITS

CHAPTER 4
DRIVE METHOD

CHAPTER 5
HOUSING DESIGN GUIDE

CHAPTER 6
APPEARANCE AND DIMENSIONS

CHAPTER 7
SAFETY PRECAUTIONS

CHAPTER 8
DESIGNING AND HANDLING PRECAUTIONS

TABLES

Table Page

FIGURES

Figure Page

Figure Page

CHAPTER 1

FEATURES

The LTP3445 Line Thermal Printer Mechanism is a compact, high-speed thermal line dot printing mechanism. It can be used with a measuring instrument and analyzer, a POS, a communication device, or a data terminal device.

Since the LTP3445 Line Thermal Printer Mechanism can be driven by battery, it can easily be mounted on a portable device such as a hand-held terminal.

The LTP3445 has the following features:

- Uses a 5 V power supply or battery power supply
  The voltage used to drive the thermal head is equal to the logic voltage, or is driven by a 5 V single power line.
  The range of operating voltage is wide, so you can use four through six Ni-Cd batteries or Ni-MH batteries. You can also use two Lithium-ion batteries.

- Compact and light
  The mechanism is compact and light: 130 mm in width, 51 mm in depth, 21 mm in height, and approximately 135 g in weight.

- High resolution printing
  A high-density print head of 8 dots/mm produces clear and precise printing.

- Long life
  The mechanism is maintenance-free device with a long life of 50 km print length or 50 million pulses.

- High speed printing [1]
  A maximum print speed of 160 dot lines per second (20 mm per second) at 5 V, and 400 dot lines per second (50 mm per second) at 7.2 V is attainable.

- High quality printing
  A history control IC produces high quality printing.

- Low current consumption
  The printer can be driven by lithium-ion batteries of low discharge current.

- Compatible with thick paper [2]
  There are two possible paper paths; with the straight path, printing on thick paper is possible.

- Low noise
  Thermal line dot printing is used to guarantee low-noise printing.

- Automatic paper load
  A paper detector enables the LTP3445 to load paper automatically.

- Thermal head cleaning
  Moving the head open lever to the open position enables one to clean the thermal head.

[1] Print speed differs depending on working conditions.

[2] Paper load path (curl or straight) is preset at the factory. To determine which path is used, contact a Seiko Instruments sales representative.

CHAPTER 2

SPECIFICATIONS

2.1 GENERAL SPECIFICATIONS

Table 2-1 General Specifications

Item	Specification
Print method	Thermal dot line printing
Dots per line	832 dots
Resolution	8 dots/mm
Print width	104 mm
Maximum print speed	160 dot lines/sec (20 mm/sec) (at 5 V) [1] 400 dot lines/sec (50 mm/sec) (at 7.2 V) [1]
Paper feed pitch	0.125 mm
Head temperature detection	Via a thermistor
Head-up detection	Via a mechanical switch
Out-of-paper detection	Via a photo interrupter
Operating voltage range V_P line (for head and motor drive) V_{dd} line (for head logic)	 4.2 V to 8.5 V (equivalent to four through six Ni-Cd or Ni-MH batteries, or two lithium-ion batteries) 4.5 V to 5.5 V

[1] Maximum print speed is attained in the conditions such as:

- When the driving voltage is 5 V, the temperature of the head is 50°C or more, and the number of simultaneously activated dots is 64 or less
- When the driving voltage is 7.2 V, the temperature of the head is 20°C or more, and the number of simultaneously activated dots is 64 or less

Table 2-1 General Specifications (Continued)

Item	Specification
Current consumption For driving the head (V_P) For driving the motor (V_P) For head logic (V_{dd})	 Average 1.7 A (at 5 V), 2.5 A (at 7.2 V) [2] Maximum 1.9 A (at 5 V), 2.8 A (at 7.2 V)[2] Maximum 0.6 A Maximum 0.026 A
Operating temperature range	0° to 50°C [3, 4]
Storage temperature range	-20° to 60°C
Life span (at 25°C and rated energy) Activation pulse resistance Abrasion resistance	 50 million pulses or more (print ratio=12.5%) [5] 50 km or more
Paper width	112^{+0}_{-1} mm
Paper feed force	50 g or more
Paper hold force	80 g or more
Dimensions (width × depth × height)	130.0 × 51.0 × 21.0 mm
Weight	Approximately 135 g

[2] When the number of simultaneously activated dots is specified as 64.
[3] Use TW80KK-S in the temperature range 5° to 4°C. Outside of this range, the print will bleed or be light.
[4] Use TCC in the temperture range 5° to 35°C. Outside of this range, the print will bleed or be light.
[5] In the case of using 2-ply thermal paper, the printing pulse is 2 pulse /1 dot, and so 50 million pulses means 25 million dot lines.

Table 2-1 General Specifications (Continued)

Item	Specification
Recommended thermal paper	TF50KS-E2C (65 μm paper) TF77KS-E2 (95 μm paper) TC98KS-T1 (125 μm paper) J & N tack HW74 (label paper) TW80KK-S (2-ply paper) from Nippon Paper Industries FH65BV-3 (65 μm paper) from Honshu Paper Co., Ltd. TCC (2-ply paper) from Fujicopian Co., Ltd.

2.2 HEAT ELEMENT DIMENSIONS

The LTP3445 contains a thermal head with 832 heat elements (dot-size).

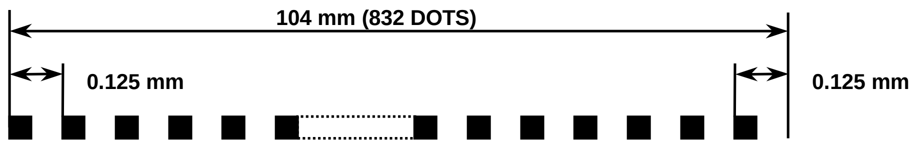


Figure 2-1 Heat Element Dimensions

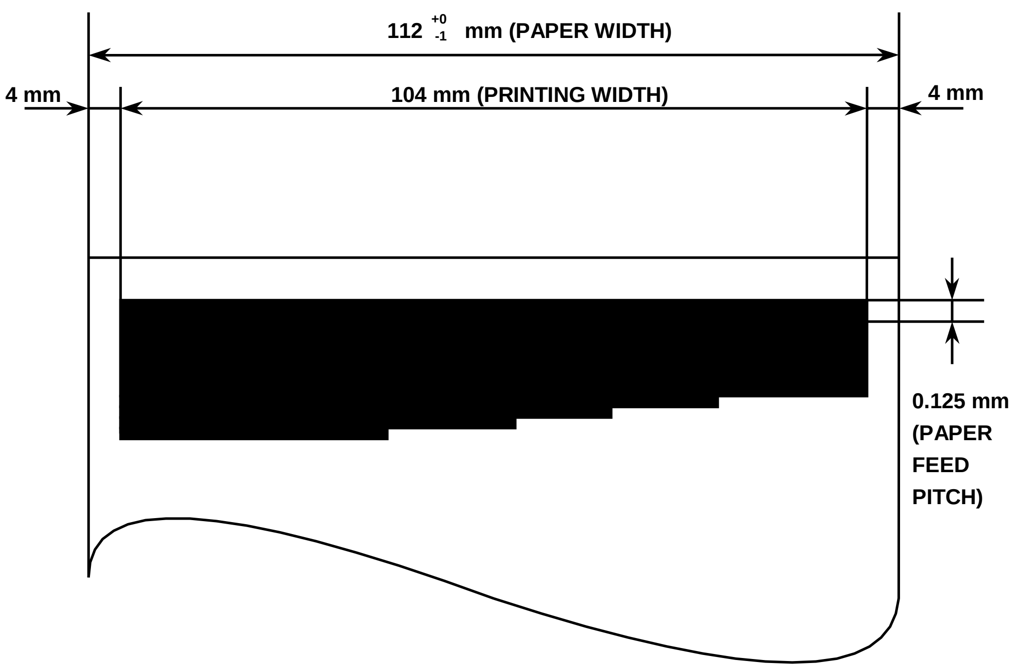


Figure 2-2 Print Area

2.3 PAPER FEED CHARACTERISTICS

- Paper is fed in the forward direction when the motor shaft is rotating in the normal direction (clockwise) as seen from the motor gear side.
- The motor is driven by a 2-2 phase excitation, constant current chopper method and feeds paper by 0.125 mm (equivalent to a single dot pitch) every two steps of the motor drive signal.
- To prevent deterioration in print quality due to backlash of the paper feed system, the motor should be driven 40 steps in the reverse direction then 40 steps in the normal direction during initialization or after backward feeding.
- During paper feed, the motor should be driven at lower than the value obtained by equation (1).

Equation 1:

7.2 V or more : $Vp \times 77 + 245.6$ (pps)
Less than 7.2 V : $Vp \times 160 - 352$ (pps)

- During printing, motor drive frequency should be adjusted according to the working conditions such as voltage, temperature, number of activated dots, etc. (For details, see Chapter 4.)
- To automatically load paper, the motor should be driven at lower than a quater of the value obtained by equation (1).
- It is not possible to print while the motor is rotating in the reverse direction.

Table 2-2 Sample Motor Drive Frequency

Operating Voltage	**Drive Frequency (Paper feed)**	**Drive Frequency (Automatically loading paper)**
4.2 V	320 pps	80 pps
5 V	448 pps	112 pps
6 V	608 pps	152 pps
7.2 V	800 pps	200 pps
8 V	862 pps	215 pps
8.5 V	900 pps	225 pps

2.4 STEP MOTOR CHARACTERISTICS

Table 2-3 General Motor Specifications

Item	Specification
Type	PM
Number of phases	4-phase
Drive method	Bipolar
Excitation	2-2 phase
Winding resistance per phase	11 Ω ± 7%
Rated voltage	4.2 - 8.5 V
Rated current	0.3 A / phase
Maximum current consumption	0.6 A
Drive frequency	50 - 900 pps (according to drive voltage)

2.4.1 Motor Drive Circuit

(1) Sample Drive Circuit

A sample drive circuit for the motor is shown in Figure 2-3.

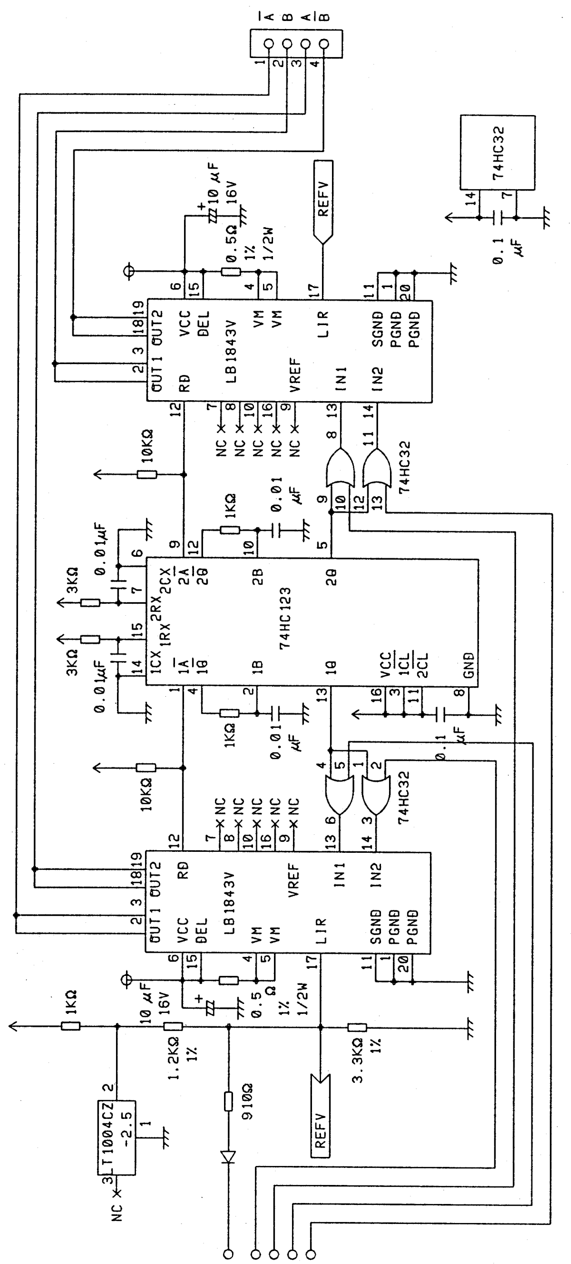


Figure 2-3 Sample Drive Circuit (Motor)

(2) Excitation Sequence

As shown in Table 2-4, the LTP3445 feeds the paper in the normal direction when the motor is excited in the order of step 1, step 2, step 3, step 4, step 1, step 2, ... On the other hand, to rotate the motor in the reverse direction, drive the motor in the reverse order: step 4, step 3, step 2, step 1, step 4, step 3, . .

Table 2-4 Excitation Sequence

Signal Name	**Sequence**			
	Step 1	Step 2	Step 3	Step 4
$\overline{A}$	Low	High	High	Low
B	High	High	Low	Low
A	High	Low	Low	High
$\overline{B}$	Low	Low	High	High

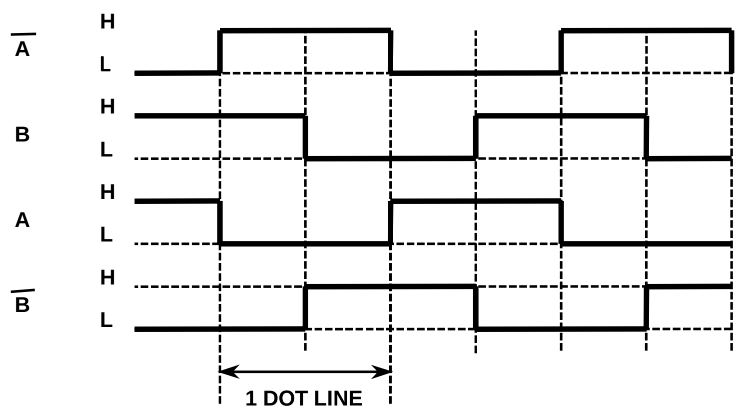


Figure 2-4 Input Voltage Signals for the Sample Drive Circuit (Motor)

2.4.2 Motor Timing

Refer to the time chart in Figure 2-5 when designing the control circuit or software for starting and stopping the motor. Also note the following precautions:

Precautions for Designing the Motor Control Circuit and Software

(1) Stop step

- To stop the motor, excite for a single step period with the same phase as the last one in the printing step.

(2) Pause state

- In the pause state, do not excite the step motor so as to prevent the motor from heating. Even when the step motor is not excited, it keeps holding force to prevent paper from sliding.

(3) Start step

- To restart the motor from the stop step, immediately shift the motor into the print sequence.

- To restart the motor from the pause (no excitation) state, shift the motor into the print sequence after outputting the same phase as that of the stop step for a single step.

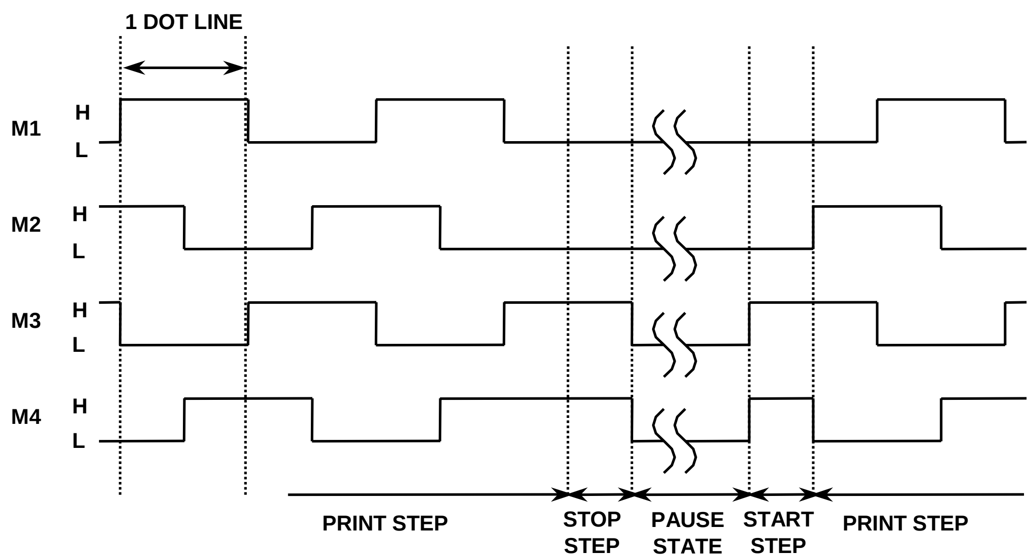


Figure 2-5 Motor Start/Stop Timing

(3) Other

- Do not print paper at the intermittent feed mode. Doing so may deteriorate the printing quality due to irregular paper feeding pitch.

- To print characters and bit images, always follow the start step and stop step.

2.4.3 Precautions for Driving the Motor

(1) Motor Current Consumption Control

The motor speed may slow down during printing depending upon the divided drive method, the printed contents and input data transmission speed during printing. At this time noises or over temperature of the motor may occur due to its over torque.

To prevent it, the amperage of the motor must be controlled as follows:

Startup Step : CTCTRL = "High"
1st Step : CTCTRL = "High"
2nd Step ON : Turn CTCTRL "High" for only time (T_{max}) of one step of the motor maximum drive speed at V_P, then set it to "Low".

Tmax (s) =1 / Motor Maximum Drive Frequency (pps)

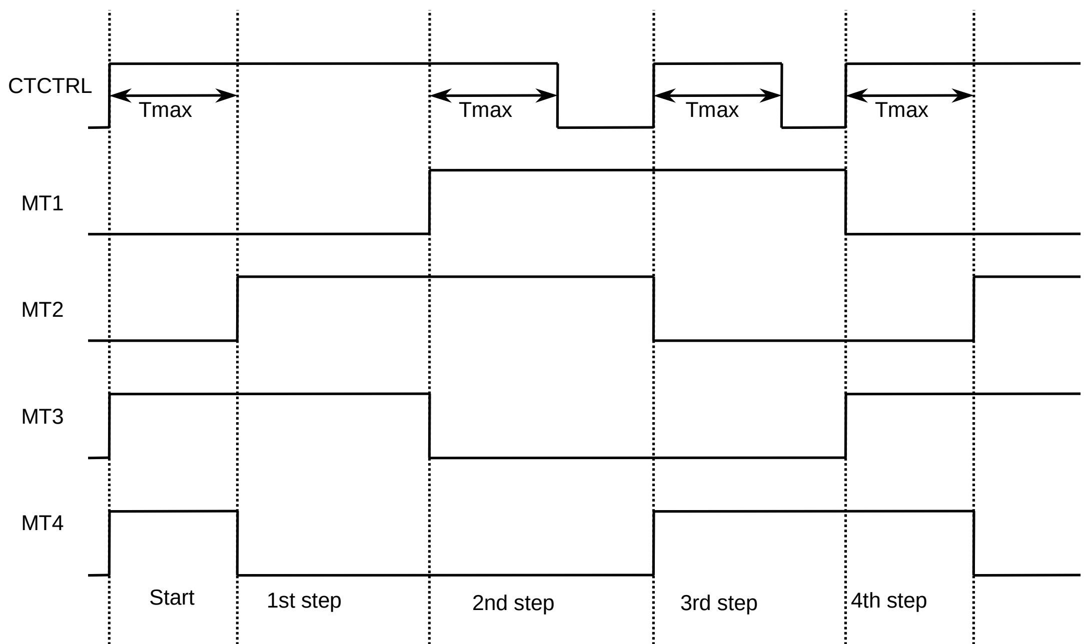


Figure 2-6 Motor Drive Timing Chart

(2) Acceleration Control

When driving the motor, acceleration control is needed to get paper feed started. In the case that the motor is to be driven at the maximum motor drive frequency that was calculated using equation (1), the motor must be driven slowly at first to avoid slipping of the motor under the heavy load, resulting in the motor being out of step.
Drive the motor to the maximum driving speed that was calculated using equation (1), according to acceleration steps in Table 2-5.

The method for accelerating the motor is as follows;

1. Output the start step for the time calculated using equation (1)
2. Output the first step for the first acceleration step time
3. Output the second step for the second acceleration step time
4. Output the nth step for the nth step acceleration time
5. After output for the time calculated using equation (1), the motor is driven at constant speed.

Can print during acceleration.

Table 2-5 Acceleration Steps

Number of Steps	Speed (pps)	Step Time (μs)
1	150	6666
2	265	3780
3	343	2913
4	408	2449
5	466	2147
6	518	1932
7	565	1770
8	609	1643
9	650	1538
10	689	1452
11	726	1378
12	761	1314
13	794	1259
14	827	1209
15	858	1165
16	888	1126
17	900	1111

2.5 THERMAL HEAD

2.5.1 Structure of the Thermal Head

As Figure 2-7 shows, the LTP3445 thermal head consists of 832 heat elements, heat element drivers and preline history controllers. The preline history controller allows the preheat pulse to be applied to nonactivated elements on the preceding dot line before the main heat pulse.

Serial print data input from the HDAT terminal is transferred to the shift register synchronously with the HCLK signal. When the print data is input at the High level of the CTRL terminal, only nonactivated dots on the preceding dot line are automatically transferred to the shift register as print data, then stored in the latch register at the timing of the LATCH signal. Next, when the print data is input at the Low level of the CTRL terminal, main heat pulse data is transferred to the shift register.

832 dots are divided into 13 blocks, namely -- 1 block consists of 64 dots, allowing for individually-divided printing. At the “High” level of the CTRL terminal, the block to be activated inputs 13-bit data which is selected synchronously with the HCLK signal to the BDAT terminal in serial. 13 bits correspond to the respective block. Only the block corresponding to ON bit is activated. Table 2-6 shows Blocks and Activated Heat Elements.

Turning ON the head activation signal (DST) activates heat elements in accordance with the print data stored in the latch register. Apply the preheat pulse. Next, by inputting the LATCH signal, the main heat data is stored in the latch register. Turn the DST ON and apply the main heat pulse.

As for remaining blocks, follow the same steps shown above. Select an appropriate block and apply the preheat pulse and main heat pulse.

Printing without preline history control is possible only by leaving the CTRL terminal “Low”.

For more detailed drive method, refer to Chapter 4, “DRIVE METHOD”.

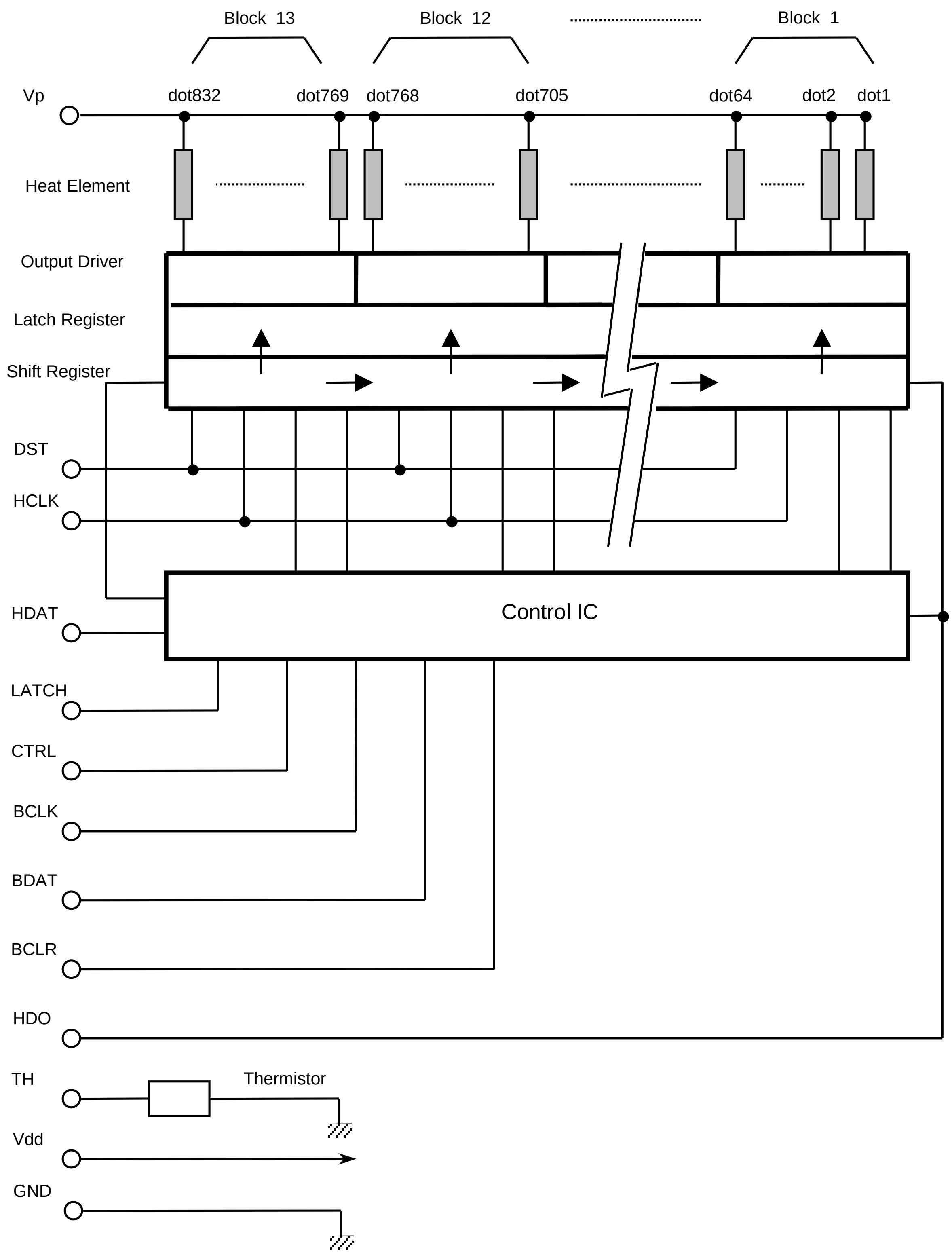


Figure 2-7 Thermal Head Block Diagram

Table 2-6 Blocks and Activated Heat Elements

Block Number	Heat Element Number	Dots / DST
1	1 - 64	64
2	65 - 128	64
3	129 - 192	64
4	193 - 256	64
5	257 - 320	64
6	321 - 384	64
7	385 - 448	64
8	449 - 512	64
9	513 - 576	64
10	577 - 640	64
11	641 - 704	64
12	705 - 768	64
13	769 - 832	64

2.5.2 Printed Position of the Data

Data dots from 1 to 832 which are transferred through HDAT are printed as shown in Figure 2-8.

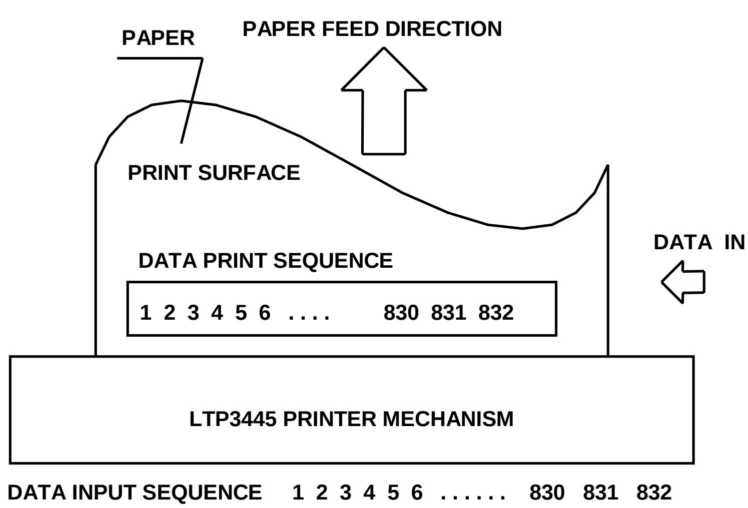


Figure 2-8 Printed Position of the Data

2.5.3 Head Resistance

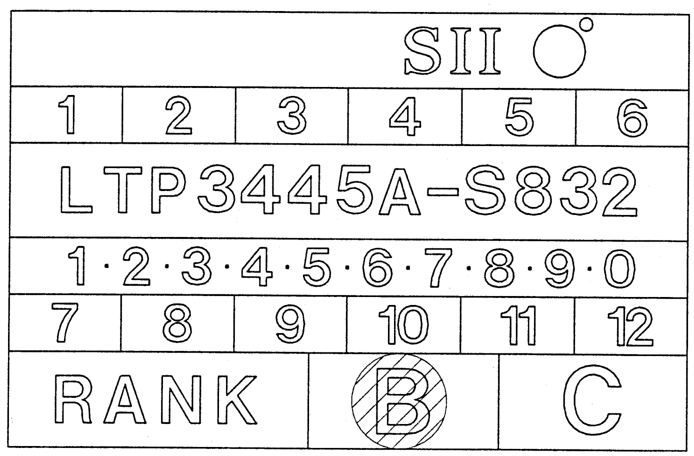
The LTP3445 head resistance is classified into two ranks as shown in Table 2-7. Head resistance ranks are also indicated on the label on the front of the LTP3445.

Table 2-7 Head Resistance Ranks

Rank	Head Resistance
B	162 to 178 Ω
C	145 to 161 Ω

Sample Label showing the Head Resistance Rank

In this example, the head resistance rank is B.



2.5.4 Head Voltage

The LTP3445 has a built-in head driver IC and control IC. Table 2-8 shows the head voltage.

Table 2-8 Head Voltage

Item		Voltage Range
Head drive voltage	V_P	4.2 to 8.5 V
Head logic voltage	V_{dd}	4.5 to 5.5 V

2.5.5 Peak Current

Since the peak current (maximum current) may reach the values calculated using equation (2) when the thermal head is driven, make sure that the allowable current for the cable material and the voltage drop on the cables are well within the specified range.

Equation 2:

$$I_P = \frac{N \times V_P}{RH}$$

I_P: Peak current (A)
N: Number of dots that are driven at the same time (Maximum 448 dots)
V_P: Head drive voltage (V)
RH: Head resistance (Ω)

2.5.6 Thermal Head Electrical Characteristics

Table 2-9 Thermal Head Electrical Characteristics (at Vdd=5V, 25°C)

Item	Symbol	Conditions	Minimum			Unit
			MIN	TYP	MAX	
Head resistance	RH		145	—	178	Ω
Head drive voltage	Vp		4.2	—	8.5	V
Logic block voltage	Vdd		4.5	5.0	5.5	V
Logic block current	Idd	Waiting for activation	—	—	1.5	mA
		fclk=4MHz , HDAT=Fixed	—	—	13	mA
		fclk=4MHz , HDAT=HLHLHL--	—	—	26	mA
"High" input voltage	Vih	HCLK,HDAT,LATCH,DST BCLK,BDAT,BCLR,CTRL	0.8×Vdd	—	Vdd	V
"Low" input voltage	Vil	HCLK,HDAT,LATCH,DST BCLK,BDAT,BCLR,CTRL	0	—	0.2×Vdd	V
"High" input current	Iih	HCLK term	—	—	6.5	μA
		HDAT,LATCH,BCLK,BDAT	—	—	10	μA
		DST	—	—	455	μA
		BCLR,CTRL	—	—	320	μA
"Low" input current	Iil	HCLK term	—	—	-6.5	μA
		HDAT,LATCH,BCLK,BDAT	—	—	-10	μA
		DST	—	—	-6.5	μA
		BCLR,CTRL	—	—	-10	μA
"High" output voltage	Voh	HDO, Vdd=4.5(V) at no load	4.45	—	—	V
"Low" output voltage	Vol		—	—	0.05	V
"High" output current	Ioh	HDO, Voh=Vdd-0.4(V)	-0.5	—	—	mA
"Low" output current	Iol	HDO, Vol=0.4(V)	0.5	—	—	mA
HCLK,BCLK frequency	fclk		—	—	4	MHz
HCLK pulse width	t1	See the timing chart.	100	—	—	ns
CTRL setup time	t2	See the timing chart.	20	—	—	ns
HDAT setup time	t3	See the timing chart.	70	—	—	ns
HDAT hold time	t4	See the timing chart.	20	—	—	ns
HDO output delay time	t5	See the timing chart.	—	—	200	ns
LATCH setup time	t6	See the timing chart.	100	—	—	ns
LATCH pulse width	t7	See the timing chart.	120	—	—	ns
DST setup time 1	t8	See the timing chart.	100	—	—	ns
BCLK pulse width	t9	See the timing chart.	100	—	—	ns
BDAT setup time	t10	See the timing chart.	20	—	—	ns
BDAT hold time	t11	See the timing chart.	20	—	—	ns
DST setup time 2	t12	See the timing chart.	20	—	—	ns
BCLR pulse width	t13	See the timing chart.	20	—	—	ns

2.5.7 Timing Chart

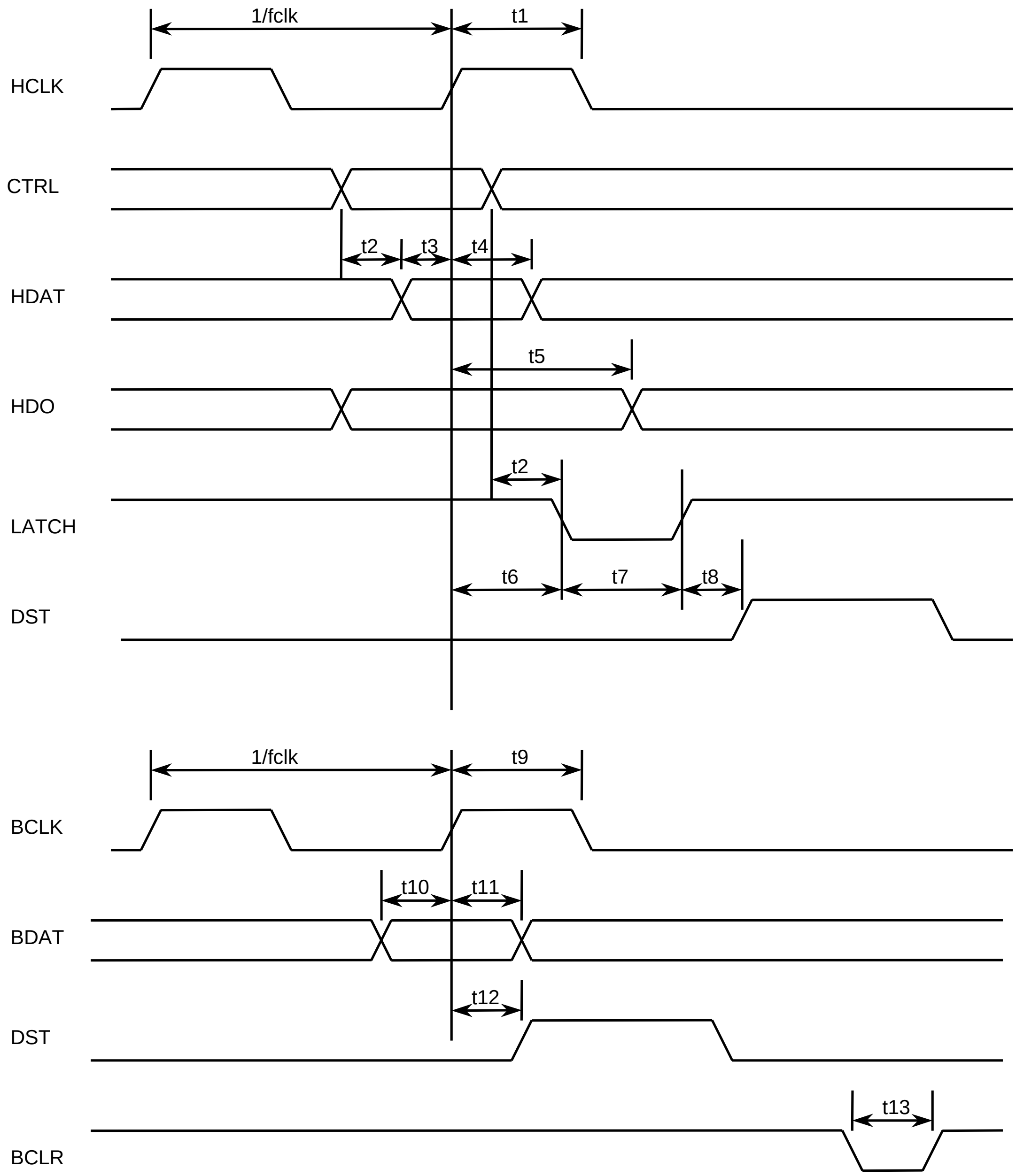


Figure 2-9 Timing Chart

2.6 CONTROLLING THE HEAD ACTIVATION (DST) PULSE WIDTH

2.6.1 Calculation of the Head Activation Pulse Width

The LTP3445 is provided with a preline history control function, allowing the preheat pulse to be applied to the nonactivated element on the preceding dot line before the main heat pulse. For actual drive method, refer to Section 4, “DRIVE METHOD”.
The head activation pulse width is calculated using the following equation (3).
To execute high quality printing using the LTP3445, the value that is calculated using the following equation (3) must be adjusted according to the printer installation environment. Calculate each value used according to the steps in Sections 2.6.2 to 2.6.6 and control so that the pulse width with the tm (ts) value obtained by substituting each value into the equation (3).
Printing using too high of voltage or too long of pulse width may shorten the life of the thermal head.

Equation 3:

$$t_X = \frac{E \times R}{V^2} \times Cm\ (Cs)$$

t_m:	Main heat pulse width (ms)	
t_s:	Preheat pulse width (ms)	
$_E$:	Standard applied energy (mj)	Refer to section 2.6.2.
V :	Applied voltage (V)	Refer to section 2.6.3.
R :	Head resistance (Ω)	Refer to section 2.6.4.
C_m :	Main heat pulse term coefficient	Refer to section 2.6.6.
C_s :	Preheat pulse term coefficient	Refer to section 2.6.6.

2.6.2 Calculation of the Applied Energy

The applied energy should be according to the temperature of the thermal head and the printer installation environment
The thermal head has a built-in thermistor. Measure the temperature using the thermistor resistance. The standard applied energy is based on using the recommended thermal paper (65μm) and a temperature of 25°C. Calculate the printing energy using equation (6) and the paper coefficient and temperature coefficient.

Equation 6:

$$E = (0.32 - T_C\ (T_X - 25)\ ) \times P$$

T_X: Detected temperature using the thermistor (°C) [1]
P : Thermal paper coefficient

TF50KS-E2C (65 μm paper)	1.0
FH65BV-3 (65 μm paper)	1.0
TF77KS-E2 (95 μm paper)	1.0

TC98KS-T1 (125 µm paper)	1.3	
J & N tack HW74	1.3	
TW80KK-S (2-ply paper)	2.6	[2]
TCC (2-ply paper)	2.6	[2]

T_C : Temperature coefficient

2-ply thermal paper 0.00448

Recommended thermal paper (except for 2-ply thermal paper) 0.00352

[1] The thermistor resistance value at T_X (°C). Refer to Section 2.6.7.

[2] For driving for 2-ply thermal paper, refer to Section 2.6.8.

2.6.3 Adjustment of the Head Activation Voltage

Adjustment of the head activation pulse width because of changing the head activation voltage is according to equation (5). The adjustment method is different if the head drive voltage (V_P) is over 6 V or under 6 V.

Equation 5:

$V=V_P - 0.9$ (over 5 V)

$V=V_P \times 1.26 - 2.46$ (under 5 V)

V_P: Head activation voltage (V)

2.6.4 Adjustment of the Head Resistance

Adjustment of the head resistance is according to equation (6). Due to wiring resistance there is a drop in voltage.

Equation 6:

$$R = \frac{(RH + 60 + (R_C + rc) \times N)^2}{RH}$$

RH: Head resistance

rank B (162 - 178Ω) 178 (Ω)

rank C (145 - 161Ω) 161 (Ω)

60: Wiring resistance in the thermal head (Ω)

R_C: Common terminal wiring resistance in the thermal head 0.1 (Ω)

rc: Wiring resistance between V_P and GND (Ω) [1]

N: Number of dots driven at the same time

[1] This resistance is the resistance of the wire used between the FPW terminal of thermal head, the power supply, the resistance of switching circuit of relay, etc.

2.6.5 Determination of Activation Pause Time and Activation Pulse Period

Dot lines may be activated in succession to the same thermal dot in order to protect thermal head elements. Determine the activation period (the time from preceding activation start to current activation start) which conforms to equation (7) to reserve the pause time.

Equation 7:

$W > ts + tm + 0.5(ms)$

W : Activation period of 1-dot line (ms)

2.6.6 Head Activation Pulse Term Coefficient

Adjust using the head activation pulse term coefficient (equal motor drive frequency) because the printing density changes by printing speed.

According to equations (8) and (9), calculate compensation coefficient Cm of the main heat pulse and compensation coefficient Cs of the preheat pulse. When the preline history control function is not needed, use Cm + Cs of equations (8) and (9) as the respective compensation coefficient.

Equation 8:

$Cm = 1 - 3.5/(3.5 + W)$

$Cs = 1 - Cm$ (When Cm is 0.75 or more)

$Cs = 0.25$ (When Cm is less than 0.75)

Equation 9:

$W = 2000$ / motor drive frequency

2.6.7 Calculation Sample for the Head Activation Pulse Width

Table 2-10 displays the calculation sample of the head activation pulse width that was calculated using equation (3) and the values obtained using equations (4) to (9).

Table 2-10 Activation Pulse Width

Head drive Voltage (V)	Thermistor Temperature(°C)	Motor Drive Frequency (PPS)									
		80	160	240	320	400	480	560	640	720	800
4.8	0	10.69	10.69								
	10	9.77	9.77								
	20	8.85	8.85								
	30	7.92	7.92	7.56							
	40	7.00	7.00	6.68							
	50	6.08	6.08	5.80	5.42						
	60	5.16	5.16	4.92	4.59	4.32					
	70	4.23	4.23	4.04	3.77	3.55					
	80	3.31	3.31	3.16	2.95	2.78					
5.0	0	9.33	9.33								
	10	8.53	8.53								
	20	7.72	7.72	7.37							
	30	6.92	6.92	6.60							
	40	6.11	6.11	5.83	5.45						
	50	5.31	5.31	5.06	4.73	4.45					
	60	4.50	4.50	4.30	4.01	3.77					
	70	3.70	3.70	3.53	3.29	2.10					
	80	2.89	2.89	2.76	2.58	2.42					
6.0	0	5.29	5.29	5.05	4.71	4.44					
	10	4.83	4.83	4.61	4.31	4.05					
	20	4.38	4.38	4.18	3.90	3.67	3.47				
	30	3.92	3.92	3.74	3.49	3.29	3.11	2.96			
	40	3.47	3.47	3.31	3.09	2.90	2.75	2.62			
	50	3.01	3.01	2.87	2.68	2.52	2.39	2.27			
	60	2.55	2.55	2.44	2.27	2.14	2.03	1.93			
	70	2.10	2.10	2.00	1.87	1.76	1.66	1.58			
	80	1.64	1.64	1.56	1.46	1.37	1.30	1.24			
7.2	0	3.47	3.47	3.31	3.09	2.91	2.75	2.62	2.50		
	10	3.17	3.17	3.02	2.82	2.66	2.51	2.39	2.29	2.19	
	20	2.87	2.87	2.74	2.56	2.41	2.28	2.17	2.07	1.99	1.91
	30	2.57	2.57	2.45	2.29	2.15	2.04	1.94	1.85	1.78	1.71
	40	2.27	2.27	2.17	2.02	1.90	1.80	1.71	1.64	1.57	1.51
	50	1.97	1.97	1.88	1.76	1.65	1.56	1.49	1.42	1.37	1.31
	60	1.67	1.67	1.60	1.49	1.40	1.33	1.26	1.21	1.16	1.12
	70	1.37	1.37	1.31	1.22	1.15	1.09	1.04	0.99	0.95	0.92
	80	1.07	1.07	1.03	0.96	0.90	0.85	0.81	0.78	0.74	0.72
8.4	0	2.45	2.45	2.33	2.18	2.05	1.94	1.85	1.77	1.69	1.63
	10	2.24	2.24	2.13	1.99	1.87	1.77	1.69	1.61	1.55	1.49
	20	2.02	2.02	1.93	1.80	1.70	1.61	1.53	1.46	1.40	1.35
	30	1.81	1.81	1.73	1.62	1.52	1.44	1.37	1.31	1.26	1.21
	40	1.60	1.60	1.53	1.43	1.34	1.27	1.21	1.16	1.11	1.07
	50	1.39	1.39	1.33	1.24	1.17	1.10	1.05	1.00	0.96	0.93
	60	1.18	1.18	1.13	1.05	0.99	0.94	0.89	0.85	0.82	0.79
	70	0.97	0.97	0.92	0.86	0.81	0.77	0.73	0.70	0.67	0.65
	80	0.76	0.76	0.72	0.68	0.64	0.60	0.57	0.55	0.52	0.51

(Note in table area for 4.8 V, 480–720 PPS:) Do not use this area because paper feed error may occur because of motor torque

1) Upper table is the value of ts+tm at 65µ recommended thermal paper, resistance rank B, RC+rc=0.05, and N=64.
2) In the shaded area, the drive pulse width is greater than the period of the motor drive. Therefore, use a lower frequency than that in the shaded area.

2.6.8 Thermistor Resistance

The resistance of the thermistor at the operating temperature (T_X°C) is determined using the following equation (10).

Equation 10:

$$R_X = R_{25} \times EXP \left\{ B \times \left(\frac{1}{273 + T_X} - \frac{1}{298} \right) \right\}$$

R_X:	Resistance at operating temperature Tx (°C)
R_{25}:	15 kΩ ± 10% (25°C)
B:	3750 K ± 200 K
T_X:	Operating temperature (°C)
EXP (A):	The Ath power of natural logarithm e (2.71828)

[Rating]

Operating temperature range: -40°C to +125°C

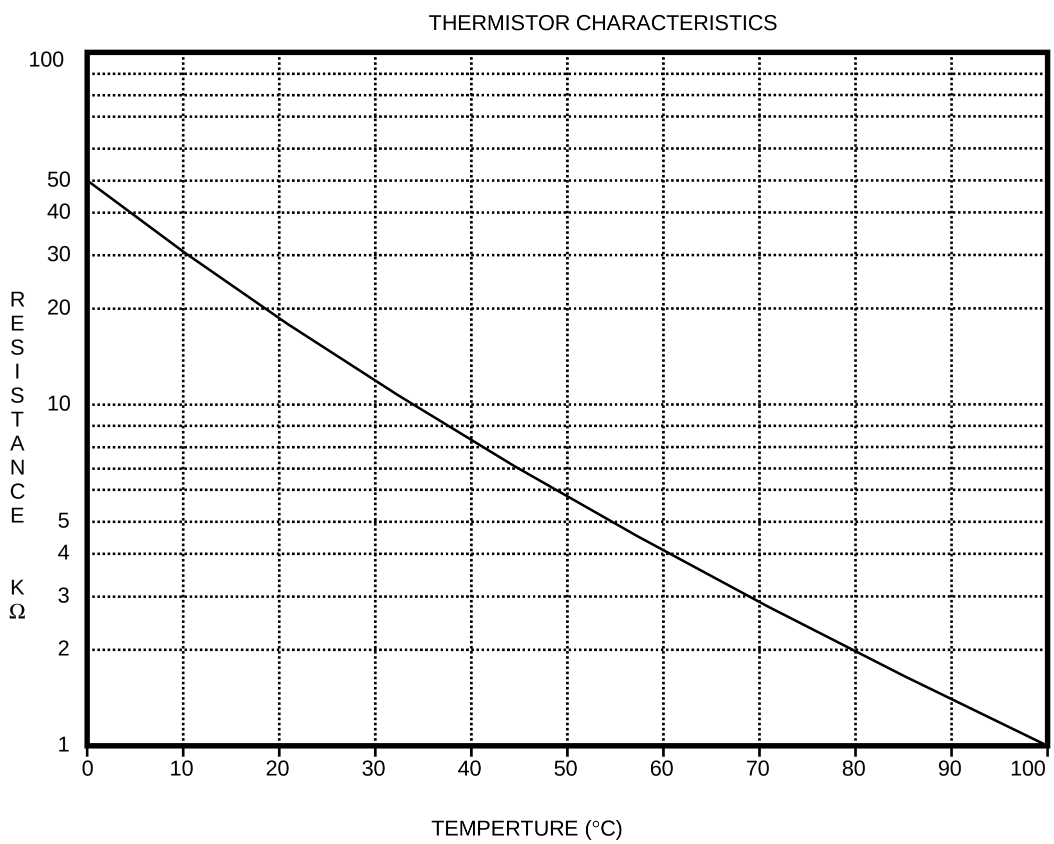


Figure 2-10 Thermistor Resistance vs. Temperature

Table 2-11 Temperature and Corresponding Thermistor Resistance

Temperature (°C)	Thermistor Resistance (kΩ)
0	47.49
5	37.09
10	29.23
15	23.22
20	18.59
25	15.00
30	12.19
35	9.97
40	8.21
45	6.80
50	5.66
55	4.74
60	4.00
65	3.38
70	2.88
75	2.46
80	2.11
85	1.82
90	1.58
95	1.37
100	1.19

2.6.9 How to Print Using 2-ply Thermal Paper

For fine printing, drive the thermal elements two times at half of the drive pulse that was calculated using equation (5) in Section 2.6.1.

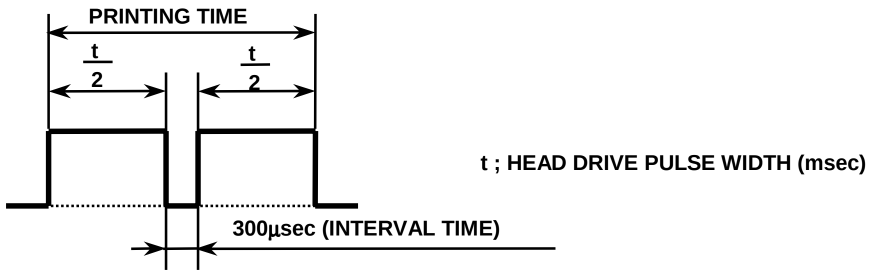


Figure 2-11 How to Drive 2-ply Thermal Paper

2.6.10 Detecting Abnormal Temperatures of the Thermal Head

To protect the thermal head and to ensure personal safety, abnormal thermal head temperatures must be detected by both hardware and software as follows:

- Detecting abnormal temperatures by software

  Design software that will deactivate the heat elements if the thermal head thermistor (TH) detects a temperature higher than 80°C (thermistor resistance RTH ≤ 2.11 kΩ), and reactivate the heat elements when a temperature lower than 60°C (RTH ≥ 4.00 kΩ) is detected. If the thermal head continues to be activated at a higher temperature than 80°C, the life of the thermal head may be shortened significantly.

- Detecting abnormal temperatures by hardware

  If the control unit (CPU) malfunctions, the software for detecting abnormal temperatures may not function properly, resulting in overheating of the thermal head. The overheating of the thermal head may cause damage to the thermal head or cause skin burns.
  Always use hardware in conjunction with software for detecting abnormal temperatures to ensure personal safety (this may not prevent damage to the thermal head).

  Using a window comparator circuit or similar detector, design hardware that detects the following abnormal conditions:

(a) Overheating of the thermal head (approximately 100°C or higher (RTH ≤ 1.19 kΩ))

(b) Faulty thermistor connection (the thermistor may be open or short-circuited).

If (a) and (b) detected, immediately deactivate the heat elements. Reactivate the heat elements after they have returned to normal.

2.7 HEAD-UP DETECTOR

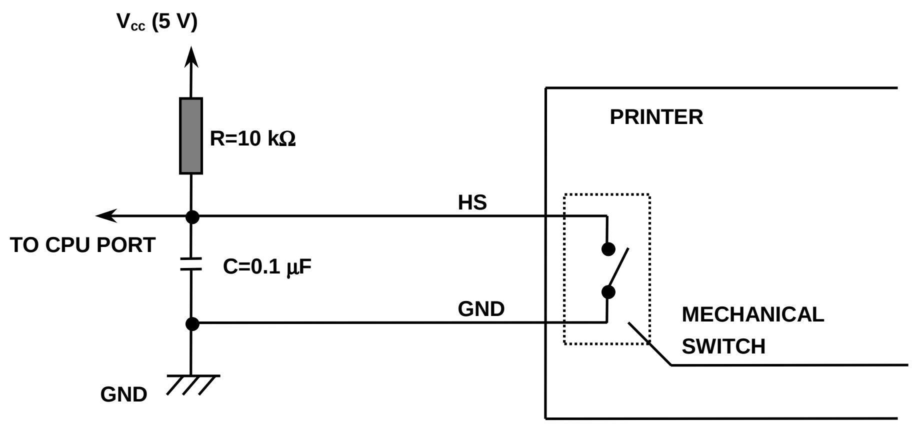
LTP3445 has a built-in head-up detector to detect whether the head is up or down. This detector is a mechanical switch which is designed to close when the head is in the down position (printing state) and to open when in the up position.

The external circuit should be designed so that it detects the output from the head-up detector and does not activate the thermal head when the head is in the up position. Otherwise, the thermal head may be damaged or the life of the head may be shortened significantly.

2.7.1 General Specifications

Maximum rating: 5 V DC, 1 mA
Contact resistance: 70 m Ω maximum

2.7.2 Sample External Circuit



The mechanical switch is closed when the head is in the down position.

Figure 2-12 Sample External Circuit for the Head-Up Detector

Note that there is a time lag between the time when the thermal head stays completely up or down and when the head-up detector starts to operate.

Always use the capacitor shown in Figure 2-12 to prevent the switch from malfunctioning as a result of chattering.

2.8 PAPER DETECTOR

The LTP3445 has a built-in paper detector (reflection type photo-interrupter) to check for the presence or absence of paper.

The external circuit should be designed so that it detects the output from the paper detector and does not activate the thermal head when paper runs out. Otherwise, the thermal head or platen roller may be damaged or the life of the thermal head may be significantly shortened.

2.8.1 General Specifications

Table 2-12 Absolute Maximum Ratings of the Paper Detector (at 25°C)

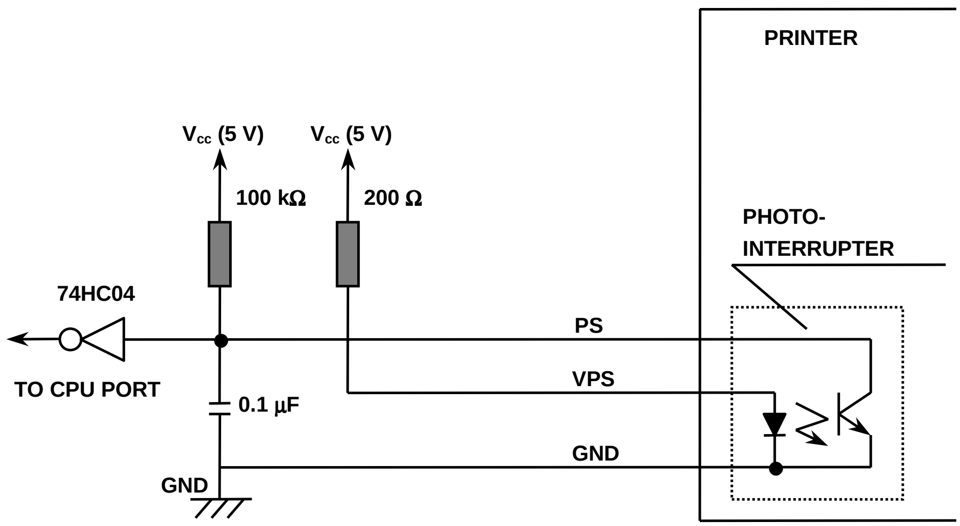
Item		Symbol	Rating
LED (input)	Forward current	I_F	50 mA
	Peak forward current	I_{FM}	1A
	Reverse voltage	V_R	6 V
	Allowable current	P	75 mW
Phototransistor (output)	Collector-to-emitter voltage	V_{CEO}	35 V
	Emitter-to-collector voltage	V_{ECO}	6 V
	Collector current	I_C	20 mA
	Collector loss	P_C	75 mW
Total allowable loss		P_{tot}	100 mW
Operating temperature		T_{opr}	-25° to +85°C
Storage temperature		T_{stg}	-40° to +100°C

Table 2-13 Paper Detector Input/Output Conditions

Item		Symbol	Conditions	Std.	Max.
LED (input)	Forward voltage	V_F	I_F=20 mA	1.2 V	1.4 V
	Peak forward voltage	V_{FM}	I_{FM}=0.5A	3.0 V	4.0 V
	Reverse current	I_R	V_R=6 V	—	10 µA
	Capacity between terminals	Ct	V_R=0 V, f=1 kHz	50 pF	100 pF
Phototransistor (output)	Dark current	I_{CEO}	V_{CE}=20 V	10^{-9}A	10^{-7}A
Transfer char.	Photoelectric current	I_C	I_F=4 mA, V_{CE}=2 V	45 µA	120 µA
	Response time (at rise)	t_r	I_C=100 µA, V_{CE}=2 V R_L=1 kΩ, d=1 mm [1]	20 µs	100 µs
	Response time (at fall)	t_f		20 µs	100 µs
	Leak current	I_{LEAK}	I_F=4 mA, V_{CE}=2 V	—	0.1 µA

[1] d = Sensing distance

2.8.2 Sample External Circuit



The PS signal is high when paper is exhausted.

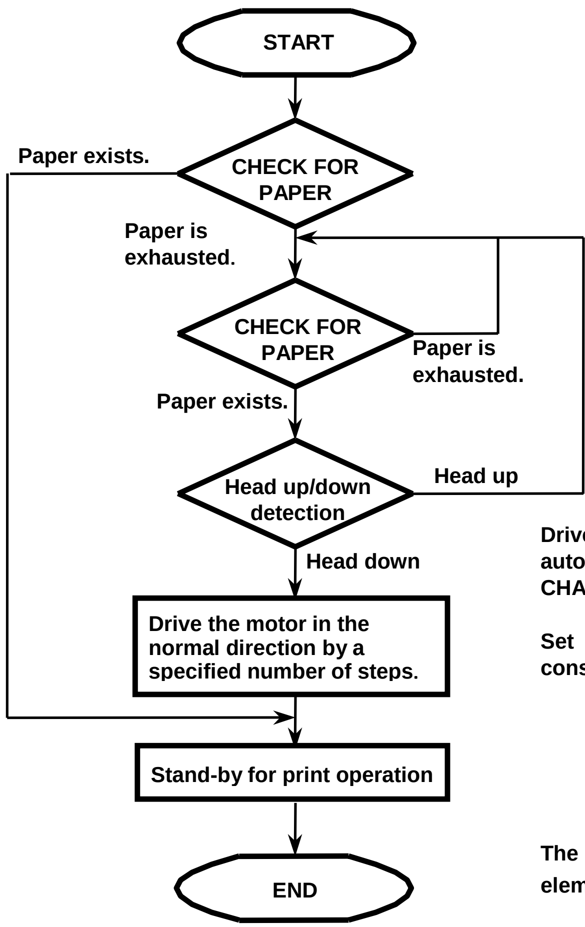
Figure 2-13 Sample External Circuit of the Paper Detector

2.8.3 Automatic Paper Load

Paper can be automatically loaded when used in conjunction with the paper detector. To prevent paper from skewing, cut the edges at right angles with respect to the paper feed direction before loading it.

If skewed, feed the paper until it is straight, or place the head in the up position and adjust the paper so that it is fed straight.

Figure 2-14 shows a flowchart for automatically loading paper.



Drive the motor at lower than the frequency during automatic paper loading described in ”2.3 PAPER FEED CHARACTERISTICS”.

Set the number of motor drive steps taking into consideration:

- **Deviation in the force of the rubber roller to catch the paper**
- **Distance to the paper eject**

The distance between the paper detector and the heat elements is:

approximately 10.5 mm (curl path)
approximately 13 mm (straight path)

Figure 2-14 Flowchart for Automatic Paper Load

CHAPTER 3

CONNECTING EXTERNAL CIRCUITS

The LTP3445 has a flexible printed wiring board (FPW) and a connector (510-21-09900 from Molex Co., Ltd.) used for connecting it to external circuits.

Use the recommended connectors for connecting the external circuits as shown in Table 3-1.

Table 3-1 Recommended Connectors

Terminal Block	External Circuit Functions	Number of Pins	Recommended Connectors (External Circuit)
Thermal head control FPW	Thermal head control	25	Molex Co., Ltd. 520-44-2510 (horizontal type) 520-45-2510 (vertical type) 5597-25APB (horizontal type) 5597-25CPB (vertical type)
Motor/detector connector	Motor control, out-of-paper detection, and head-up detection	9	Molex Co., Ltd. 530-47-0910 (vertical type) 530-48-0910 (horizontal type)

3.1 THERMAL HEAD CONTROL FPW

Figure 3-1 shows the terminal configuration of the thermal head control FPW.

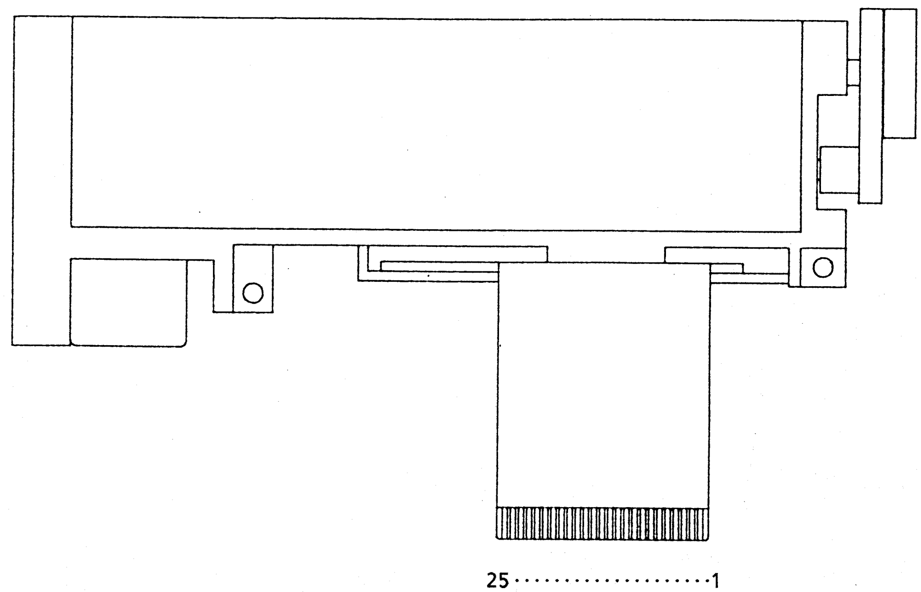


Figure 3-1 Thermal Head Control Terminals (FPW)

Table 3-2 Thermal Head Control Terminal Assignments

Terminal Number	Signal Name	Input/ Output	Function
1	V_P	Input	Thermal head drive voltage
2	V_P	Input	Thermal head drive voltage
3	V_P	Input	Thermal head drive voltage
4	GND	—	GND
5	GND	—	GND
6	GND	—	GND
7	TH	—	Thermistor
8	DST	Input	Thermal head print activation instruction signal
9	HDO	Output	Print data output
10	BCLR	Input	Block select all clear
11	BDAT	Input	Block select data input (serial input)
12	BCLK	Input	Block select data transfer synchronization signal
13	CTRL	Input	History control signal
14	HDAT	Input	Print data input (serial input)
15	Vdd	Input	Logic power supply (5V)
16	GND	—	GND
17	LATCH	Input	Print data latch (memory storage)
18	HCLK	Input	Synchronizing signal for data transfer
19	GND	—	GND
20	GND	—	GND
21	GND	—	GND
22	GND	—	GND
23	Vp	Input	Thermal head drive voltage
24	Vp	Input	Thermal head drive voltage
25	Vp	Input	Thermal head drive voltage

3.2 MOTOR/DETECTOR CONNECTOR

Figure 3-2 shows the motor control terminals, paper detector terminals, and head-up detector terminals on the motor/detector connector.

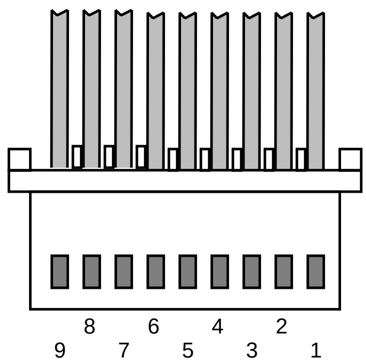


Figure 3-2 Terminals on the Motor/Detector Connector

Table 3-3 Terminal Assignments of the Motor/Detector Connector

Terminal Number	Signal Name	Function
1	$\overline{A}$	Motor drive signal
2	B	Motor drive signal
3	A	Motor drive signal
4	$\overline{B}$	Motor drive signal
5	V_{PS}	LED anode (Power supply)
6	PS	Photo Tr Collector (Output)
7	GND	Paper detector GND
8	GND	Paper detector GND
9	HS	Head up detector output

Terminal numbers 8 and 9 can be reversed because the head up detector is a mechanical switch.

CHAPTER 4

DRIVE METHOD

4.1 THERMAL HEAD DRIVE TIMING

4.1.1 In case of executing previous line history control

- Preface
  Input signals to the CTRL pin controls the driving of the previous line history control called pre-heat and main heat.
  BCLR should be normally “High”. “Low” forcifully clears the selected block.

- Input of pre-heat pulse
  Input of HDAT and HCLK transfer the print data to the shift register in serial input. “High” means printing and “Low” means no-printing in HDAT. HDAT data is read in at the rising edge of the HCLK inputs. Let CTRL go to “High” when inputting pre-heat pulse data. When inputting print data, only “Low” data of dot in previous line turns to “High”, and is transferred to the shift register. The transferred line of data is stored in the latch register by turning LATCH to “Low” after turning CTRL to “Low”.

- Input of main heat pulse
  Let CTRL go to “Low” for input of main heat pulse data. Input the print data in the same way as pre-heat pulse data.

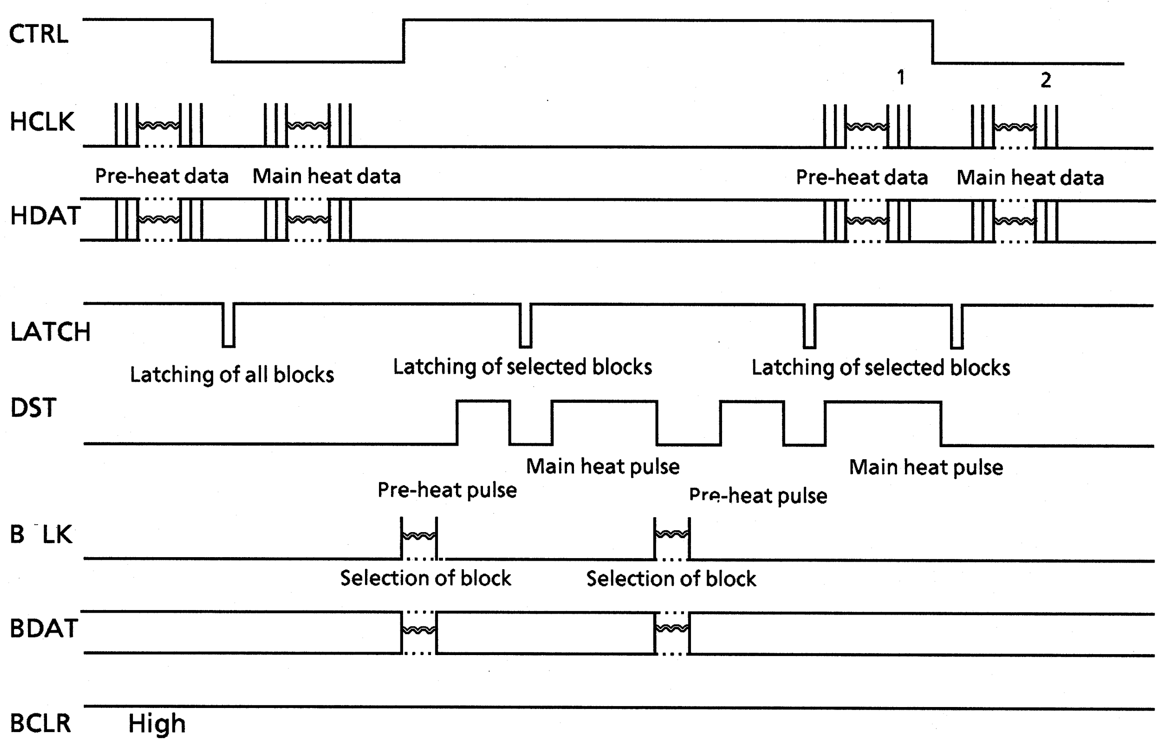
- Selection of the heat block
  BDAT and BCLK input transfer the selected block data in serial input. “High” means selected and “Low” means unselected in BDAT. BDAT data is read in at the rising edge of BCLK input. CTRL should be kept “High”. 13 bits selected data input corresponding to the 13 blocks are transferred in serial and the corresponded blocks are selected. The 1st input bit corresponds to the 1st block and the last input bit corresponds to the 13th block .

- Input of pre-heat pulse
  Keep CTRL in “High”. “High” of DST drives heat elements of the thermal head in the blocks selected by BDAT. Then, let DST go to “Low” after driving for the period calculated using the formula shown in “2.6 CONTROLLING THE HEAD ACTIVATION (DST) PULSE WIDTH”.

- Input of main heat pulse
  Keep CTRL in “High”. “Low” of Latch stores main heat pulse data in the selected block by BDAT in the latch register. “High” of DST drives the heat elements of the thermal head. Then let DST go to “Low” after driving for the period calculated using the formula shown in “2.6 CONTROLLING THE HEAD ACTIVATION (DST) PULSE WIDTH”.

Repeat the selection of the driving block, input of the pre-heat pulse and input of the main heat pulse to all blocks.

Figure 4-1 shows the example of timing chart in case of executing previous line history control.



1: When executing previous line history control, the pre-heat pulse data for the next line should not be transferred until the start of the last main heat driving of the previous line.

2: When executing previous line history control, the main heat pulse data should not be transferred until the completion of the last main heat driving of the previous line.

Figure 4-1 Example of timing chart when executing previous line history control

4.1.2 When previous line history control is not executed

- Preface
  CTRL is always set to “Low”.
  BCLR should be normally “High”. “Low” forcifully clears the selected block.

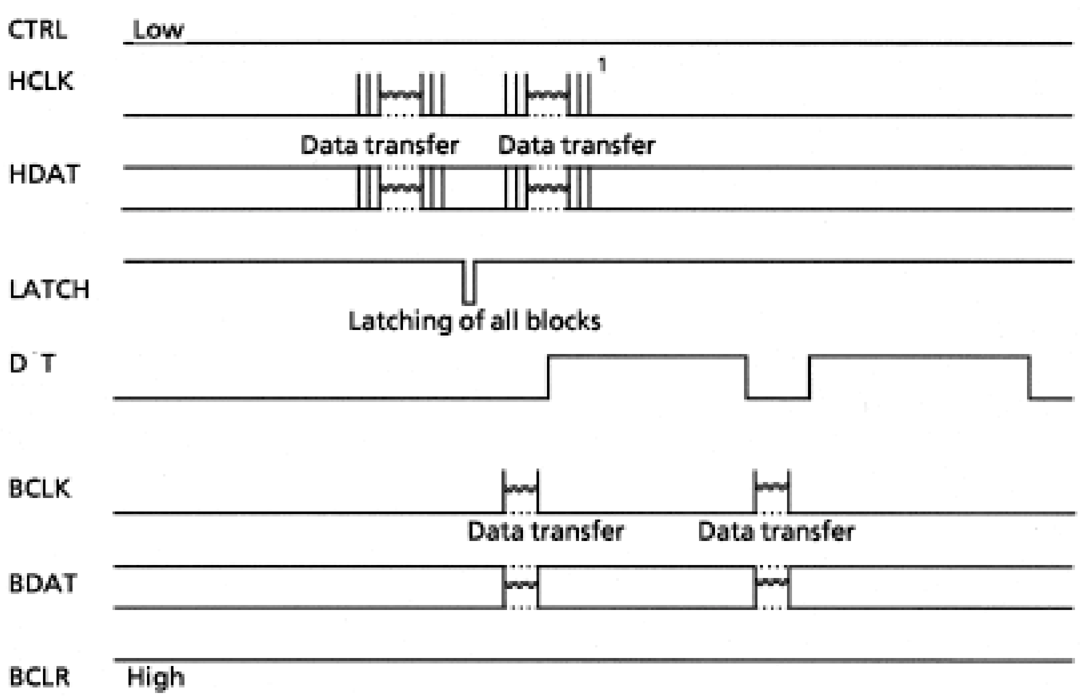
- Input of print data
  Input of HDAT and HCLK transfer the print data to the shift register in serial input.
  “High” means printing and “Low” means no-printing in HDAT.
  HDAT data is read in at the rising edge of the HCLK inputs.
  The transferred line of data is stored in the latch register by turning LATCH to “Low”.

- Selection of the heat block
  BDAT and BCLK input transfer the selected block data in serial input.
  “High” means selected and “Low” means unselected in BDAT.
  BDAT data is read in at the rising edge of BCLK input.
  13 bits selected data input corresponding to the 13 blocks are transferred in serial and the corresponded blocks are selected.
  The 1st input bit corresponds to the 1st block and the last input bit corresponds to the 13th block.

- Input of heat pulse
  “High” of DST drivers heat elements of the thermal head. Then, let DST go to “Low after driving for the period calculated using the formula shown in “2.6 CONTROLLING THE HEAD ACTIVATION (DST) PULSE WIDTH”.

  Repeat the selection of the driving block and input of the pulse to all blocks.

Figure 4-2 shows an example of the timing chart when not executing previous line history control.



1: When not executing previous line history control, the print data of the next line can be transferred immediately after storing it in the latch register.

Figure 4-2 Example of timing chart when not executing previous line history control

4.2 MOTOR DRIVE TIMING

The phase of motors and the thermal head need to be synchronized to print.
There are two driving modes, high speed print mode for high speed printing and standard print mode for high print quality.
Select either of the two modes according to the application.
Basic pulse width of the motor drive pulse, Tm, is a value (unit: msec) obtained by multiplying by 1000 the reciprocal number of the driving frequency calculated using formula 1 of “2.3 Paper Feed Characteristics”.

[High speed print mode]

In high speed print mode, the head drive and the motor drive are executed independently of each other by separating 13 blocks constituting one line into arbitrary groups each time one line is printed. This independent drive of the thermal head and the motor makes print speed highest when one line (corresponding to two phases of the motor) is printed in one group. When one line is printed in more than one group, however, because two phases of the motor constitutes one line, dots of the same block may be printed either in the 1st step or in the 2nd step, or printed in the 1st and 2nd steps, causing poor print quality.

- Pause State
  Transfer the print data to the thermal head according to “4.1 THERMAL HEAD DRIVE TIMING”.

- Start up phase
  Excite the previous phase of pausing motors. The step time should be Tm.

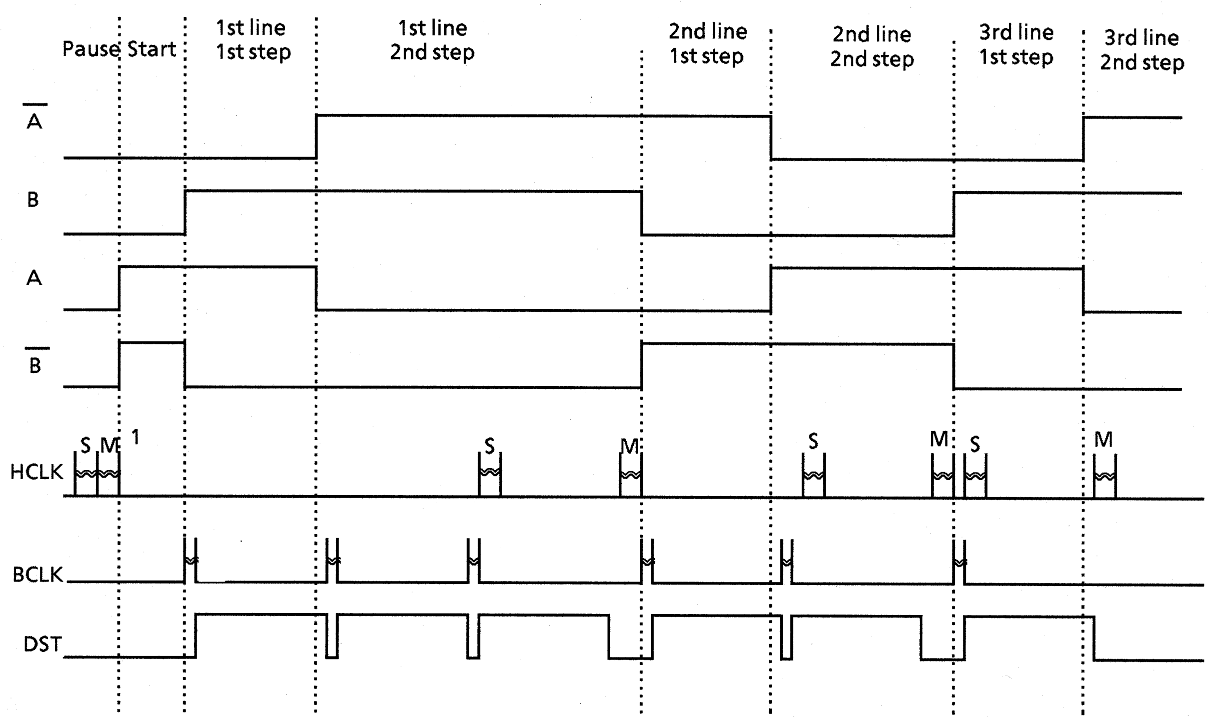
- 1st line
  Drive the motor by one step (1st step). The step time should be the accelerating 1st step time or Tm, whichever is longer.
  Input the selected block data to the thermal head and set DST to high in synchronization with the motor drive.
  After setting DST to high, set DST to low when the driving time calculated in “2.6 CONTROLLING THE HEAD ACTIVATION (DST) PULSE WIDTH” has passed.
  When there are blocks for which driving is not completed, print 1 line by repeating the input of the selected block, setting DST to high and setting DST to low after driving is completed.
  Transfer the print data of the next line to the thermal head after completing 1 line of print. Drive the motor by one step (2nd step) regardless of whether DST is high or low (during thermal head driving or not) after completion of the motor's 1st step. The step time should be the accelerating 2nd step or Tm, whichever is longest.
  Move to the 2nd line after driving all blocks, the transfer of print data for the next line and the 2nd step time of the motor.

- 2nd line
  Drive the motor by one step (3rd step). Since the 2nd step time of the 1st line changes depending on the contents of the print, the 3rd step time should be the next acceleration step time nearest to the time of the previous step or Tm, whichever is longer.

Print the 1 line of data and transfer the next line of data in the same manner as the 1st line.
Drive the motor by one step (4th step) regardless of whether DST is high or low after completing the 3rd step of the motor. The step time should be the next acceleration time of the 3rd step or Tm, whichever is longest.
Move to the next line after driving all blocks, the transfer of the print data for the next line and 4th step time of the motor.

Print each line in the same manner continuously.

Figure 4-3 shows an example of the motor drive timing chart in “High speed print mode”.



1: S: Transfer of pre-heat data, M: Transfer of main heat data

Figure 4-3 Example of motor drive timing chart in “High speed print mode”

[Standard print mode]

This driving method fixes the blocks printed in the 1st step and the 2nd step of each line.
To give an example, the method will be described in which 1 line is divided into four groups, blocks 1 to 3, blocks 4 to 6, blocks 7 to 9 and block 10 to 13 and two groups are printed every one step of the motor.
High print quality is provided by fixing the blocks printed in the 1st and the 2nd steps.

- Pause State
  Transfer the print data to the thermal head according to “4.1 Thermal Head Drive Timing”.

- Start up phase
  Excite the previous phase of pausing motors. The step time should be Tm.

- 1st line, 1st step
  Drive the motor by one step (1st step). The step time should be the acceleration time of the 1st step or Tm, whichever is longer.
  Input the data of the selected block 1 to 3 to the thermal head and turn DST high in synchronization with the motor drive. After turning DST high, turn DST low when the driving time calculated in “2.6 Print Drive Pulse Width Control for the Thermal Head” has passed.
  Next, input the data of the selected block 4 to 6 and turn DST high. Turn DST low when the driving time has passed.
  Move to the next step after driving blocks 4 to 6 and the 1st step time of the motor.

- 1st line, 2nd step
  Drive the motor by one step (2nd step). The step time should be the acceleration time of the next step nearest to the previous step taking time, or Tm, whichever is longer.
  Input the data of blocks 7 to 9 to the thermal head and turn DST high in synchronization with the motor drive. Then turn DST low after completing the driving time.
  Input the data of blocks 10 to 13 to the thermal head and turn DST high and then turn DST low after completing the driving time.
  Transfer the print data of the next line to the thermal head after printing block 7 to 13.
  Move to the next line after the transfer of the print data for the next line and 2nd step time of the motor.

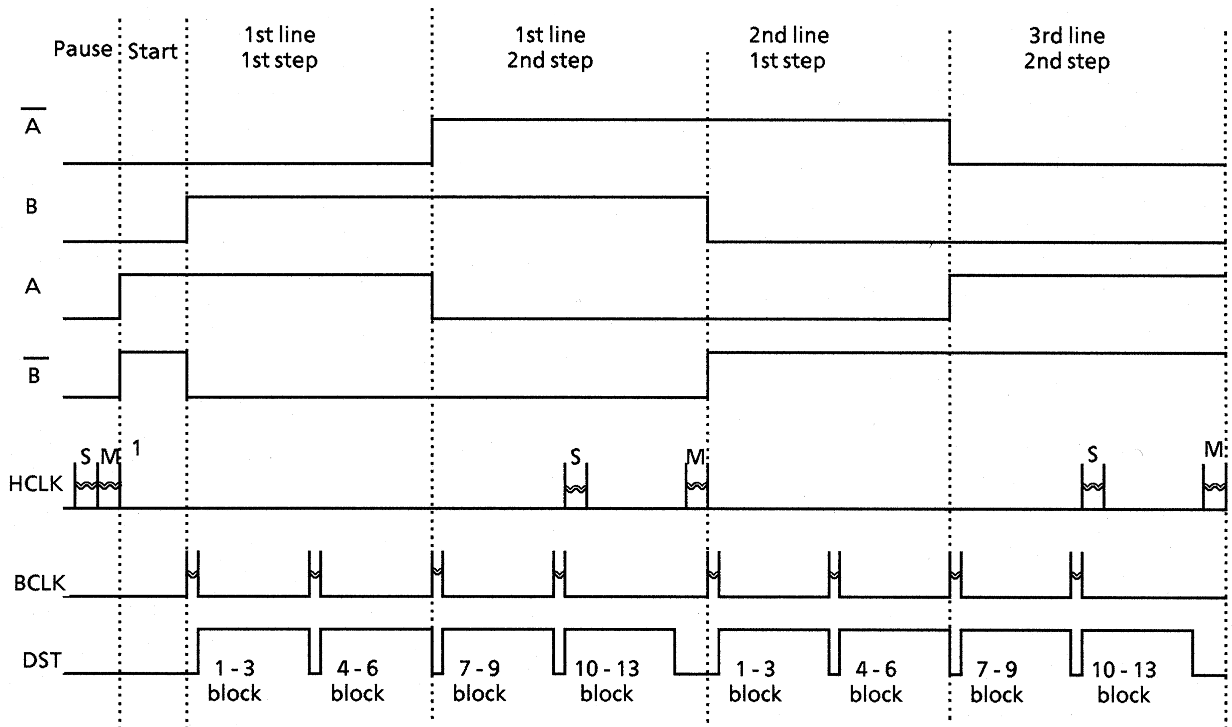
- 2nd line, 1st step
  Drive the motor by one step (3rd step). The step time should be the acceleration time of the next step nearest to the previous step taking time or Tm, whichever is longer.
  Drive blocks 1 to 3 and blocks 4 to 6 in the same manner as the 1st line.

- 2nd line, 2nd step
  Drive the motor by one step (3rd step). The step time should be the acceleration time of next step nearest to the previous step taking time or Tm, whichever is longer.

  Drive blocks 7 to 9 and blocks 10 to 13 in the same manner as the 1st line, and transfer the next line data.

  Print each line in the same manner, printing the same blocks in the 1st step and the 2nd step respectively.

  Figure 4-4 shows an example of the motor drive timing chart in “Standard print mode”.



1: S: Transfer of pre-heat data, M: Transfer of main heat data

Figure 4-4 Example of motor drive timing chart in “Standard print mode”

CHAPTER 5

HOUSING DESIGN GUIDE

5.1 SECURING THE PRINTER

The LTP3445 can be secured to the outer casing with screws.

5.1.1 Printer Mounting Method

Secure the printer with 2 mounting holes (ϕ2.8) and 2 shaped indents.
Refer to “Figure 6-1 LTP3445 Appearance” of “CHAPTER 6 APPEARANCE AND EXTERNAL DIMENSION” for the locations and dimensions.

Recommended Screws and Washers

Recommended mounting screws and washers are as follows:

① A combination of:
M2.5 or M2.6 pan head Phillips screw and
2.5 or 2.6 small round flat washer

② A combination of:
Pan head tapping screw 2.5 for resin and
2.5 small round flat washer

③ Screws and washers with 6 mm or less outer diameter and 15 mm or less height in accordance with ① and ②.

5.1.2 Precautions for Securing the Printer

Secure the printer with the following attentions.
Securing the printer incorrectly may cause a deterioration of print quality, a paper skew, a paper jam and/or excessive noise.

- Prevent excessive force, deformation or torsion acts on the printer when securing it.
- Secure the FPW connected to the thermal head by snapping the attaching part of it to the printer.

5.2 LAYOUT OF PRINTER AND PAPER

The LTP3445 can be laid out as shown in Figure 5-2 or 5-3 according to the loading direction of the paper. When ordering, make your selection between the two models based on the desired use.

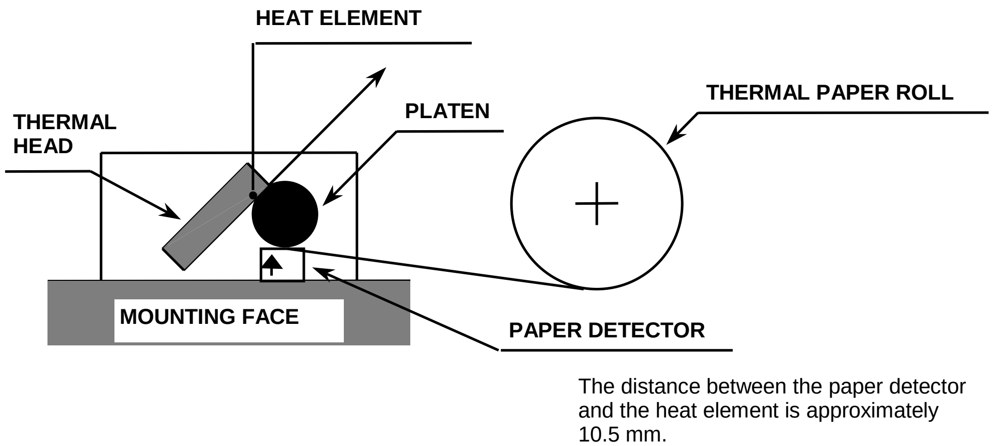


Figure 5-2 Curled Path

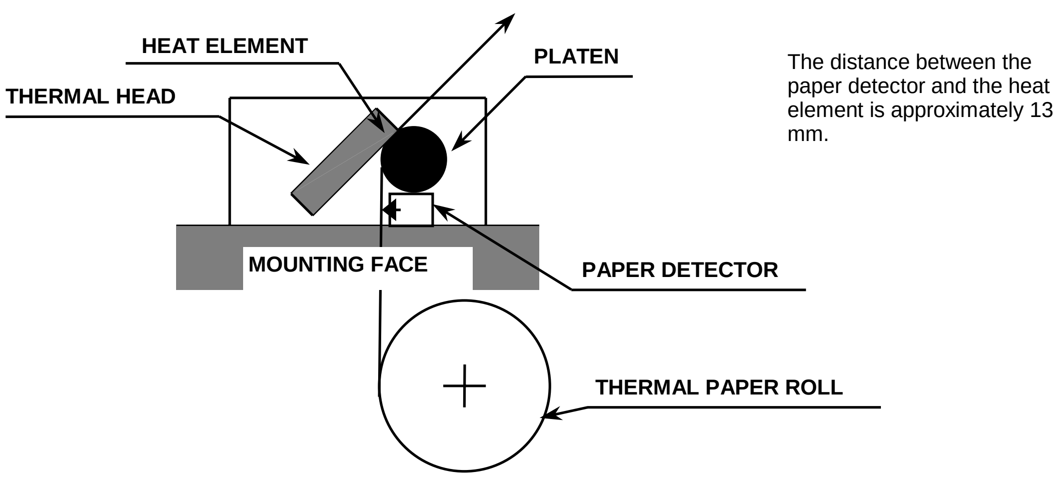


Figure 5-3 Straight Path

5.3 WHERE TO MOUNT THE PAPER HOLDER

When determining the layout of paper holder, note the following:

- When you use a paper roll, set the holder so that the paper is in alignment with the paper intake with no horizontal offset, and that the center axis of the paper roll is parallel with the printer.

- Keep the paper feed force 50 g or less.

5.4 WHERE TO MOUNT THE PAPER CUTTER

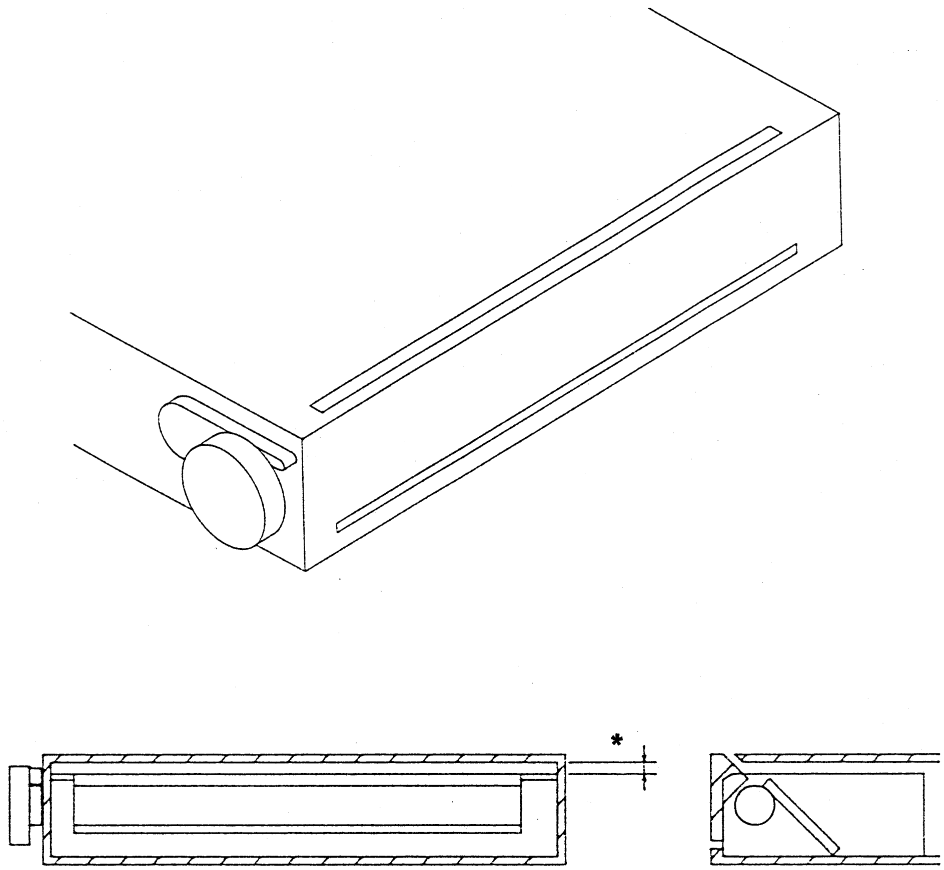
Install the paper cutter so that it does not interfere with the paper feed. The angles and positions for feeding paper are shown in Figure 6-1.

- If the distance between the edge of the thermal head and the edge of the fed paper is too small, the paper may be caught by the platen. Please take this into account when designing.

- Use a cutter with a sharp edge so that paper is cut with the paper hold force or less.

5.5 OUTER CASING STRUCTURE

Figure 5-4 shows a sample structure for the outer casing.



* Provide a gap of a few mm between the printer and the outer casing since the area over the thermal head becomes very hot.

Figure 5-4 Sample Outer Casing Structure

CHAPTER 6

APPEARANCE AND DIMENSIONS

Figure 6-1 shows the appearance and external dimensions of the LTP3445.

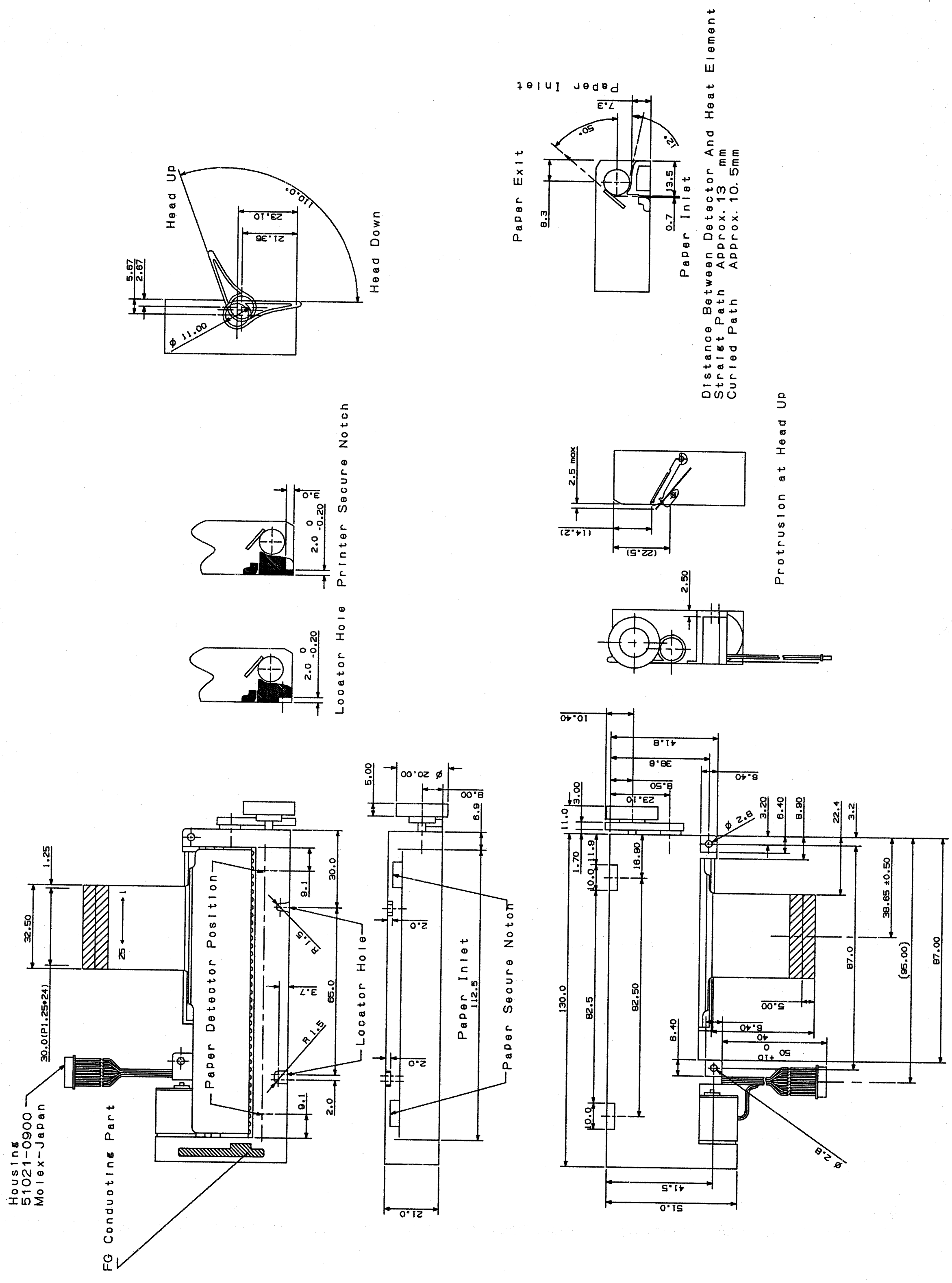


Figure 6-1 LTP3445 Appearance and Dimensions

CHAPTER 7

SAFETY PRECAUTIONS

To use the printer safely, design the product with observing the following precautions.
Additionally, caution users by describing some directions in the instruction manual or paste the caution labels on the product, if necessary.

7.1 DESIGN PRECAUTIONS

- Precautions to prevent the thermal head from over heating
  If the thermal head heat element, which is always supplied electricity by the CPU, malfunctions, the thermal head may over heat. To prevent personal injury, design to perform detection of abnormal temperatures of the thermal head as described in Section 2.6.9.

7.2 DESIGNING THE OUTER CASE

- Precautions to rising the temperatures of the thermal head
  Be sure to design the outer case to prevent user from burning by touching the thermal head directly since the thermal head is hot during and immediately after printing. Regarding paper insertion and head cleaning, prepare caution descriptions in the manual to perform these operations after the head temperature drops. To allow cooling, place clearance between the head and the outer case in designing.

- Precautions to the rising temperatures of the motor
  Be sure to design the outer case to prevent user from burning himself/herself by touching the thermal head directly since the motor is hot during and immediately after driving. To allow cooling, place clearance between the head and the outer case in designing.

- Precautions for driving gears
  Be sure to design the outer case to prevent the user or other materials from touching or getting caught in the high-speed gears.

- Precautions for sharp edges of the printer body
  The printer body or some parts may have some sharp edges. Be sure to design the outer case to prevent the user from injuring himself/herself by touching the sharp edges.

7.2 BATTERY DRIVING

- Precautions for battery drive
  As with any battery, there is always a danger of some mishap occurring from an overheating or bursting of the battery through over-discharge. Observe the precautions of the battery to be used.

CHAPTER 8

DESIGNING AND HANDLING PRECAUTIONS

To maintain the initial level of performance of the LTP3445 and to prevent future problems from occurring, observe the following precautions.

8.1 DESIGN PRECAUTIONS

① Do not apply an energy source that is too high.

If too much energy is applied to the thermal head, it may overheat and become damaged. Always use the printer with the specified energy.

② When turning the power on or off, always disable (put in low state) the DST terminals.

③ To prevent the thermal head from being damaged by static electricity:

- Connect the FG connector (see Figure 6-1) to the FG
- Connect the GND terminal of the thermal head control FPW to FG through an approximately 1 MΩ resistor.

④ Keep the V_P power off while not printing in order to prevent the thermal head from being electrolytically corroded.
In addition, design the printer so that the signal GND of the thermal head and the frame GND of the printer mechanism become the same electric potential.

⑤ Make the wire resistance between the power supply and the V_P and GND terminals on the FPW as small as possible (below 50 mΩ) .

⑥ For noise detection, connect a capacitor near the FPW connector.

V_P-GND	approximately 10 μF capacitor
V_{dd}-GND	approximately 1 μF capacitor

8.2 HANDLING PRECAUTIONS

① If any paper other than that specified is used, high print quality and long life of the thermal head cannot be guaranteed.

Possible problems that may occur:

- Poor print quality due to low-sensitivity paper
- Abrasion of the thermal head due to paper surface which is too rough
- Sticking between the thermal layer of the paper and the thermal head resulting in excessive noise during printing
- Print fading due to low print preservation
- Corroded thermal head

② Do not print without paper; otherwise, the platen or thermal head may become damaged.

③ Do not hit or scratch the surface of the thermal head with any sharp or hard object.

④ When the printer is not in use, place the thermal head in the up position. If the thermal head is left in contact with the platen, the platen may become deformed.

⑤ To prevent the heat elements, ICs, etc. from being damaged due to static electricity, take both antistatic and grounding measures before handling the printer.

⑥ Do not apply any stress to the FPW terminal.

⑦ If high print ratio printing (black solid or small check pattern) is executed at an extremely low temperature or in a high humidity environment, the paper may become stained or moisture from the vapor emitted from the paper may condense on the printer.

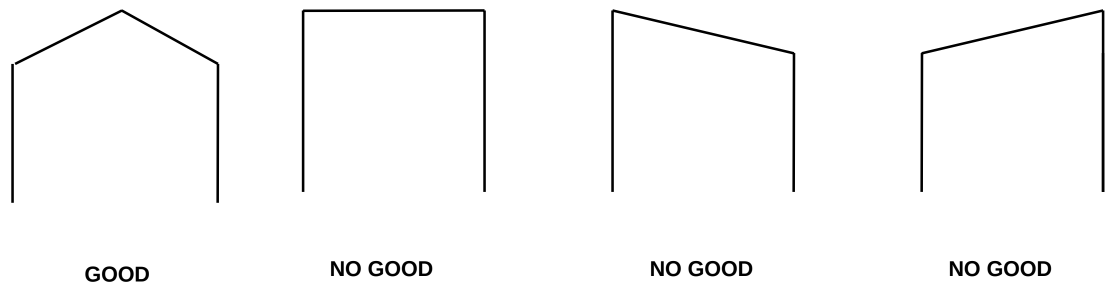
8.3 LOADING/UNLOADING PAPER PRECAUTIONS

① Loading paper

- Load paper with the thermal head in the up position.
  (See Figure 8-1 Head Cleaning Procedure (b) in Section 8.4 “HEAD CLEANING PROCEDURES AND PRECAUTIONS”).

- Cut the edge of the paper so that the center of the paper will be inserted first

.



- Insert the paper straight into the paper inlet.

- When the edge of the paper comes up from between the thermal head and the platen, pull the edge of the paper, check whether the paper is aligned correctly, and place the thermal head into the down position.

② Unloading paper

- Unload paper with the thermal head in the up position.

- Pull the paper straight up by hand in the direction in which the paper is normally fed.

- If the paper is bonded on the core of the paper roll, separate the paper from the core and then pull the paper out.

③ Automatic paper load

- Assemble the guide in a position that contacts the side edge and back side of the paper so the paper can be inserted smoothly. The guide should be assembled away from the printer for 1 mm or less.

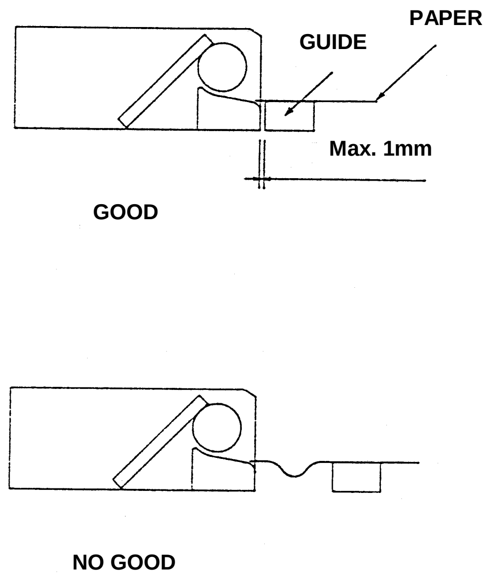
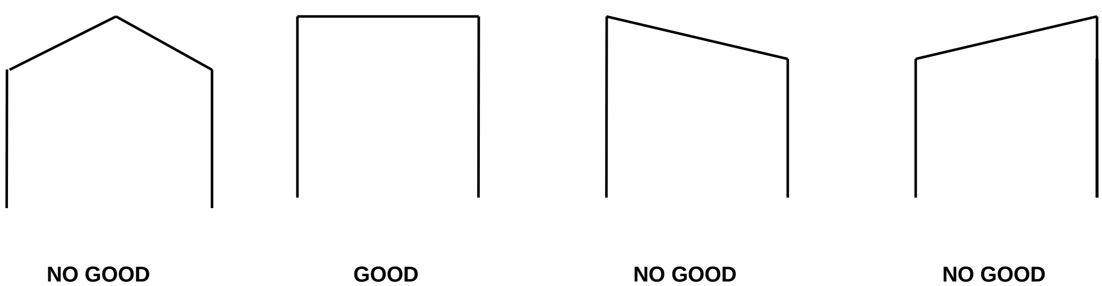


Figure 8-1 Guide Design Example

- If the paper skews, place the thermal head into the up position and reset the paper.



- Cut the edge of the paper so it is vertical to the direction of the paper feed.

- If the thermal head has been in the down position for a long time, the paper will be unable to be inserted because the head is in contact with the platen. In this case, place the head into the up position once and insert the paper again.

8.4 HEAD CLEANING PROCEDURE AND PRECAUTIONS

PROCEDURE :

① Lift the head open lever (a) so it stands upright (b).

② Push the head open lever into the opening in the back of the frame, rolling the head up (c), and latch it.

③ Clean the heat elements using alcohol and a cotton swab.

④ After cleaning, set the head open lever to its original position by reversing the steps.

PRECAUTIONS :

① Cleaning fluid :
ethyl alcohol, isopropyl alcohol.

② Do not use sandpaper, cutter, etc. when cleaning. They will damage the heat elements.

③ Don’t start the printing operation until after the alcohol is dry.

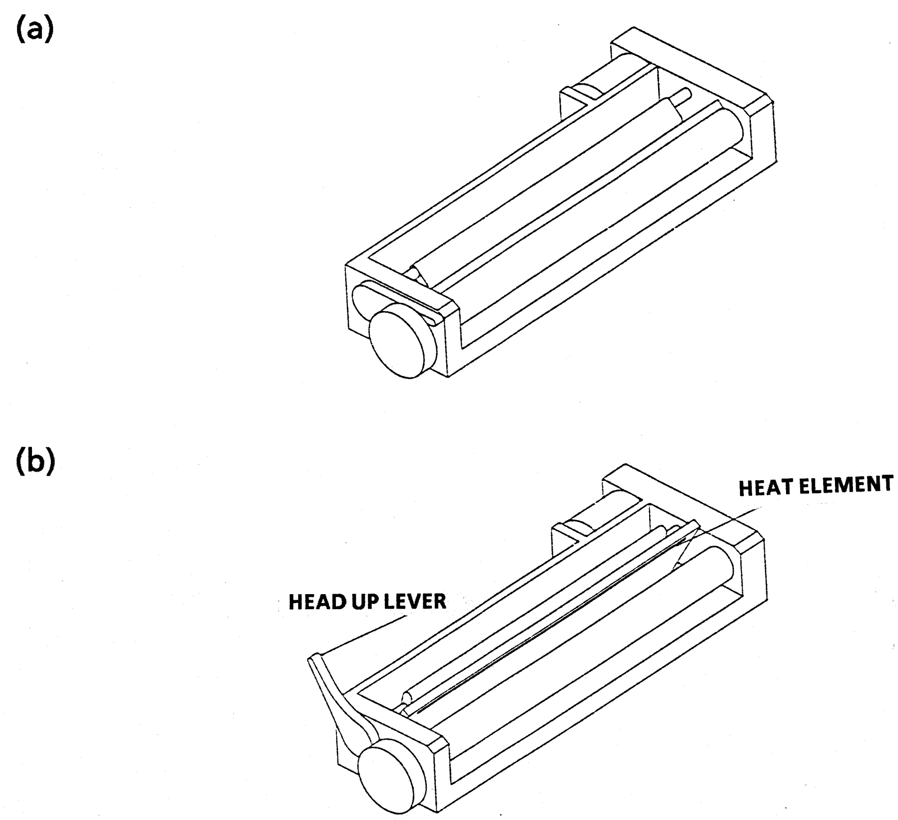


Figure 8-2 Head Cleaning Procedure