SII

LTPD245C, LTPD345C
THERMAL PRINTER MECHANISM
TECHNICAL REFERENCE

U00112636104

Seiko Instruments Inc.

LTPD245C, LTPD345C THERMAL PRINTER MECHANISM TECHNICAL REFERENCE

Document Number U00112636104

First Edition	July 2008
Second Edition	April 2009
Third Edition	October 2011
Fourth Edition	March 2012
Fifth Edition	May 2012

PREFACE

This technical reference describes the specifications and basic operating procedures for the LTPD245C and LTPD345C thermal printer mechanism (hereinafter referred to as “printer”).

The printers have the following models.

- LTPD245C-384-E
- LTPD345C-576-E

This technical reference usually describes information common to any printer unless otherwise specified. If the information is different depending on models, specific model names are mentioned clearly.

Chapter 1 “Precautions” describes safety, design, and handling precautions. Read it thoroughly before designing so that you are able to use the product properly.

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

The printer complies with EU RoHS Directive (2002/95/EC)

The printer contains “Pb”, the details are described below.

- Printer mechanism : a particular copper alloy parts, a particular component in glass of the electronic parts

＊Lead-containing items listed above are exempt from RoHS (2002/95/EC).

Identifying the parts of the printer as follows.

The following describes identifying the parts of the LTPD245C and LTPD345C as an example of the LTPD245C.

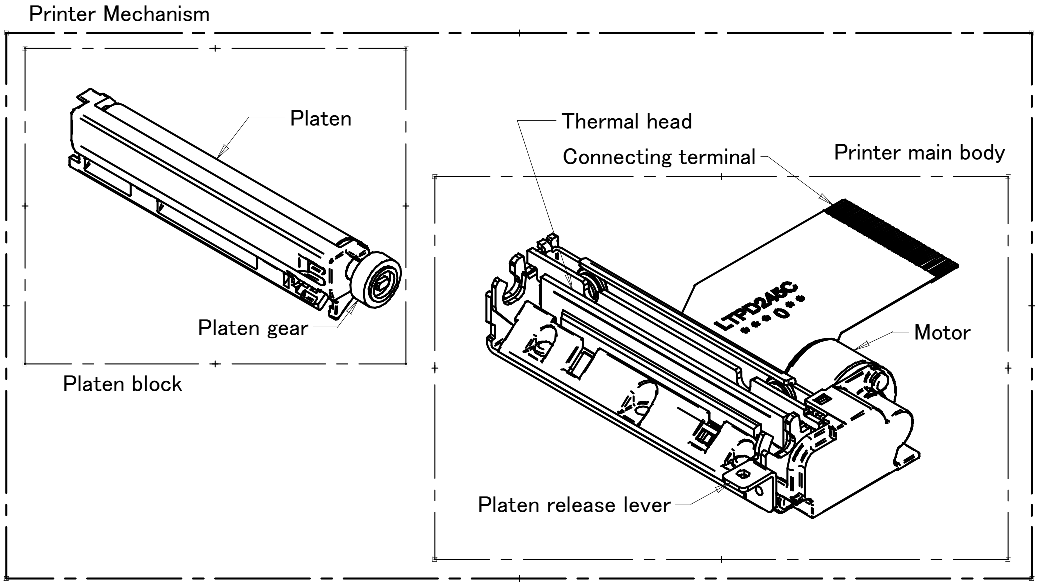


TABLE OF CONTENTS

Section Page

CHAPTER 1
PRECAUTIONS

CHAPTER 2
FEATURES

CHAPTER 3
SPECIFICATIONS

CHAPTER 4
CONNECTING TERMINALS

Section Page

CHAPTER 5
PRINT DRIVE METHOD

CHAPTER 6
OUTER CASE DESIGN GUIDE

CHAPTER 7
EXTERNAL DIMENSIONS

CHAPTER 8
HANDLING METHOD

TABLES

FIGURES

CHAPTER 1
PRECAUTIONS

Read through this technical reference to design a product and to operate the printer properly.　Pay special attention to the precautions noted in each section for details.　Information contained in this technical reference is subject to change without notice.
For the latest information, contact our sales representative.

Sufficient evaluation and confirmation should be performed with the designed outer case mounted, to ensure proper use of the printer.

SII shall not be liable for any and all claims, actions, lawsuits, demands, costs, liabilities, losses, damages and/or expenses that are caused by improper handling of the printer, any use not contained in this technical reference or that result from the outer case, unless such damages and/or loss originate from the printer itself.

SII makes no warrant that your products into which built the sample circuits included in this technical reference can work properly and safe. You shall evaluate and confirm sufficiently that such products can work properly and safe, and shall be liable for any and all claims, actions, lawsuits, demands, costs, liabilities, losses, damages and/or expenses arising out of or in relating to such products.

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

The printer is designed and manufactured to be mounted onto general electronic equipment.　If high reliability is required of the printer in respect to hazardous influences on the body or life and loss to property, redundant design of the entire system should be carried out and verify the performance with your actual device before commercialization.　And our sales representative should be informed as such in advance.

Follow the precautions listed below when designing your product for using safely.　Include any necessary precautions into your operation manual to ensure safe operation of your product by users.

1.1 SAFETY PRECAUTIONS

Follow the precautions listed below when designing your product for using safely. Include any necessary precautions into your operation manual and attach warning labels to your products to ensure safe operation.

- **Precautions to prevent the thermal head from overheating**

  When the thermal head heat elements are continuously activated by a CPU or other malfunction, the thermal head may overheat and may cause smoke and fire. Follow the method described in Chapter 3 “Detecting abnormal temperatures by hardware” to monitor the temperature of the thermal head to prevent overheating. Turn the printer off immediately if any abnormal conditions occur.

- **Precautions for rising temperatures of the thermal head**

  Temperature of the thermal head and its peripherals rises very high during and immediately after printing. Be sure to design the outer case to prevent users from burn injuries by touching them. Place warning labels to warn users to ensure safe operation. As for thermal head cleaning, warn users to allow the thermal head to cool before cleaning. In order to allow cooling, secure clearance between the thermal head and the outer case when designing the outer case.

- **Precautions for rising temperatures of the motor**

  Temperature of the motor and its peripherals rises very high during and immediately after printing. Be sure to design the outer case to prevent users from burn injuries by touching them. Place warning labels to warn users to ensure safe operation. In order to allow cooling, secure clearance between the motor and the outer case when designing the outer case.

- **Precautions for sharp edges of the printer**

  The printer may have some sharp edges and cutting surfaces of the metal parts. Be sure to design the outer case to prevent users from injuring himself/herself by touching the sharp edges and place warning labels to warn users to ensure safe operation.

- **Precautions for motor drive**

  The hair may get caught in the exposed platen and the gears. Control the motor not to drive when the outer case and the platen block are in open state. Also, make sure to design the outer case so as not to touch the platen and the gears and also prevent any objects from getting caught. Place warning labels to warn users to ensure safe operation.

1.2 DESIGN AND HANDLING PRECAUTIONS

To maintain the primary performance of the printer and to prevent future problems from occurring, follow the precautions below.

1.2.1 Design Precautions

- Apply power in the following manner:
  At power on : (1) V_{dd} → (2) V_P
  At shut down : (1) V_P → (2) V_{dd}

- A surge voltage between V_P and GND should not exceed 10V.

- For noise countermeasure, connect a 0.1μF capacitor between V_{dd} and GND pins near the connector.

- Make the wire resistance between the power supply (V_P and GND) and the printer (connecting terminals) as small as possible (below 50mΩ). Keep distance from signal lines to reduce electrical interference.

- Keep the V_P power off during not printing in order to prevent the thermal head from electrolytic corrosion. In addition, design the product so that the Signal Ground (SG) of the thermal head and the Frame Ground (FG) of the printer become the same electric potential.

- Use C-MOS IC chips for CLK, $\overline{\text{LAT}}$, DI and DST signals of the thermal head.

- When turning the power on or off, or during not printing, always disable the DST terminals.

- To prevent the thermal head from being damaged by static electricity:
  Connect on the printer main body to the Frame Ground (FG) of the outer case.
  See Chapter 6 "OUTER CASE DESIGN GUIDE" for details.
  Verify the performance with your actual device.

- Always detect the outputs of the platen position sensor and out-of-paper sensor. Never activate the thermal head when the platen block is in open state, and there is no thermal paper. Incorrect activation of the thermal head may reduce the life of the thermal head and the platen and may damage them.

- A pause time between thermal head activations of the same heat element shall be secured more than 0.5ms. Pay attention to when using one division printing or when a thermal head activation time becomes longer. If activating for a long time without the pause time, the thermal head may become damaged.

- If too much energy is applied to the thermal head, it may overheat and become damaged. Always use the printer with the specified amount of energy shown in Chapter 3 "CONTROLLING THE ACTIVATION PULSE WIDTH FOR THERMAL HEAD".

- Operation sound and vibration during printing vary depending on the motor pulse rate. Verify the performance with your actual device.

- Paper feed force can be decreased depending on the motor pulse rate. Verify the performance with your actual device.

- Do not perform continuous printing to prevent the motor from overheating. Refer to Chapter 3 "Motor Drive Method" to set a pause time.

- Paper feeding may be confused with several dot lines when printing is started from waiting status. When printing and paper feeding are interrupted and then started printing, as this may cause the paper feeding be confused. When printing bit images and so on, always feed the thermal paper for more than 48 steps at start up and do not interrupt printing.

- To prevent degradation in the print quality due to the backlash of the paper drive system, feed the thermal paper for 48 steps or more at the initialization, at a time after setting/releasing the platen block, at a time after feeding the thermal paper backward, and a time after cutting with a paper cutter.

- Surface of thermal paper may get scratched by backward feed. The backward feed may cause paper skew and jams depending on paper roll layout and designing of paper holder. Be sure to confirm performance with your product before using the backward feed.

- If printing at a high print ratio for longer length, non-printing area may be colored due to an accumulation of heat. Verify the performance with your actual device.

- If the printer main body and the platen block are not placed in proper position, the print defect and the paper jam may occur.

- Design the outer case to ensure enough space to allow users to handle the platen release lever easily with fingers. Otherwise the printer will be inoperable.

- If designing the outer case with a structure to bring the platen block up automatically using a spring property after released, make sure not to apply more than enough force to bring the platen block up. If designing a structure that the only one side of the outer case is brought up, the position relation between the printer main body and the platen block will be improperly and will result in the print defect. Verify the performance with your actual device.

- Design the thermal paper supply system in accordance with Chapter 6 “OUTER CASE DESIGN GUIDE”. When the thermal paper supply position is improper, print difficulty or paper detection difficulty will be caused and the surface of thermal paper may get scratched. Verify the performance with your actual device.

- Do not use 2-ply thermal paper, and thermal paper with thickness of 86μm or thicker.

- Design the outer case so that a tension force is not applied to the FPC. The FPC could be moved by setting/releasing the platen block, so design the product so that the FPC has enough play after connected it. The tension force may cause some print problems and may damage the FPC.

- Metal parts may become discolored and rusted due to the operational environment. Consider these factors regarding appearance.

1.2.2 Handling Precautions

Incorrect handling may reduce the efficiency of the printer and cause damage. Handle the printer with the following precautions.
Also, include any necessary precautions so that users handle the printer with care.

- Using anything other than the specified thermal paper does not guarantee print quality and life of the thermal head.
  The followings are examples of trouble:
  (1) Poor printing quality due to low thermal sensitivity
  (2) Abrasion of the thermal head due to paper surface roughness
  (3) Printing stuck and unusual noise due to sticking the thermal layer of the thermal paper
  to the thermal head
  (4) Printing fade due to low preservability of the thermal paper
  (5) Electrolytic corrosion of the thermal head due to inferior paper

- After the printer has been left not in use for long period of time, the platen could be deformed and resulted in print quality deteriorated. In this case, feed thermal paper for a while to recover deformation of the platen. If the thermal head is remained in contact with the platen without thermal paper for a long time, the platen and the thermal head may be stuck together and cause paper feed difficulty. If facing this problem, release the platen block and set it back again before starting printing.

- Never loosen the screws that fasten respective parts of the printer. Loosened screws may reduce the efficiency of the performance of the printer mechanism.
- Do not release the platen block during printing; otherwise this may reduce the efficiency of the printer and may cause damage.
- Do not apply stress to the platen block during printing. The print defect may occur.
- When setting the platen block, the reduction gear may interfere with the platen gear and may cause the platen block to not be set. In such a case, release the platen block and set it again.
- Never pull out the thermal paper while the platen block is set. The printer mechanism may become damaged.
- When handling the printer, make sure to use antistatic clothing and to ground yourself to prevent the thermal head from damaged by static electricity. Especially take care of the thermal head heat element and the connecting terminal.
- Do not hit or scratch the surface of the thermal head with any sharp or hard object. This could damage the thermal head.
- When printing at a high print ratio in a low temperature or high humidity environment, the vapor from the thermal paper during printing may cause condensation to form on the printer and soil the thermal paper itself. Prevent the thermal head from a drop of water. It may cause electrolytic corrosion of the thermal head. If condensed, do not activate electricity until dried.
- Connect or disconnect the connecting terminal after turn off the power.
- Do not apply stress to the FPC while connecting and disconnecting them. Otherwise the FPC may become damaged.
- Warn users not to pull the thermal paper and not to change the paper eject angle during printing. Otherwise, the print defect or the paper jam may occur.
- In order to prevent the thermal head from damage and to avoid the print defect, warn users not to touch the thermal head and the sensor directly when handling the printer like replacing thermal paper.
- Do not use the paper roll with glued end or folded end. In case of using such paper roll, replace to a new one before the end of the paper roll is shown up.
- The printer is not waterproof and drip proof. Prevent contact with water and do not operate with wet hands as it may damage the printer or may cause a short circuit or fire.
- The printer is not dust proof. Never use the printer in a dusty place, as it may damage the thermal head and paper drive system.
- Do not use the printer in corrosive gas and siloxane atmosphere as it may cause the contact failure.

1.2.3 Precautions on Discarding

When discarding used printers, discard them according to the disposal regulations and rules of each respective district.

CHAPTER 2
FEATURES

The printer is a compact printer that adopts a thermal line dot printing method. It can be used with measuring instruments and analyzer, a POS, a communication terminal device, or a data terminal device.

The printer has the following features:

- **High resolution printing**

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

- **Compact**

  LTPD245C realized reduction in size and mass.
  Dimensions : W69.0mm x D30.0mm x H15.0mm
  Mass : approx. 40 g

  LTPD345C realized reduction in size and mass.
  Dimensions : W91.0mm x D30.0mm x H15.0mm
  Mass : approx. 58 g

- **High print speed** *

  LTPD245C : Maximum 100mm/s print is available.
  LTPD345C : Maximum 80mm/s print is available.

- **Automatic paper loading**

  The automatic paper loading mechanism enables to load the thermal paper automatically.

- **Cleaning a paper jam**

  The jammed paper is easily removed by releasing the platen block.
  The platen block can be released with the platen release lever.

- **Maintenance Free**

  No cleaning and no maintenance required.

- **Low noise**

  Thermal printing technology realizes low-noise print.

∗: Print speed differs depending on working conditions.

CHAPTER 3
SPECIFICATIONS

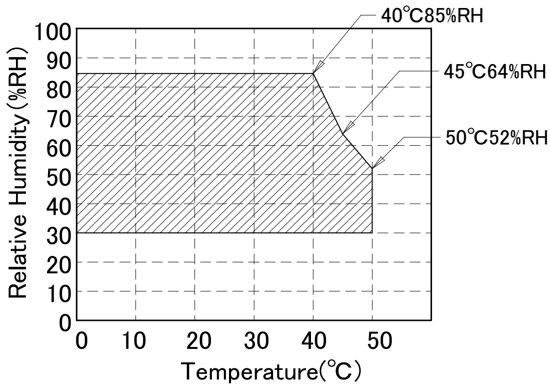
3.1 GENERAL SPECIFICATIONS

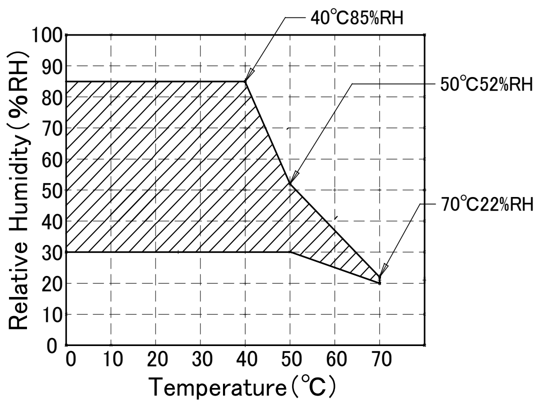
Table 3-1 lists the general specifications of the printer.

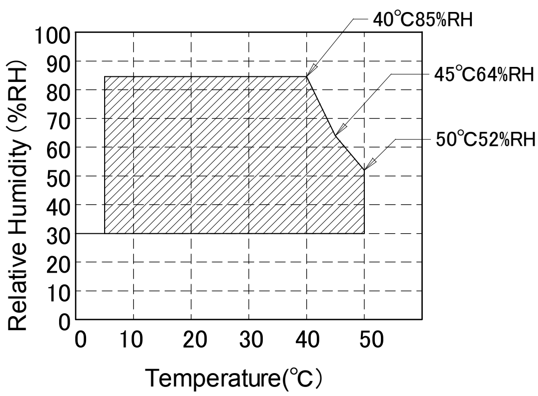
Table 3-1 General Specifications

(1/3)

Items	Specifications	
	LTPD245C	LTPD345C
Printing method	Thermal dot line printing	
Total dots per line	384 dots	576 dots
Printable dots per line	384 dots	576 dots
Simultaneously activated dots	96 dots	96 dots *1
Resolution	W 8 dots/mm × H 16 dots/mm *2	
Paper feed pitch	0.03125 mm	
Maximum print speed	100 mm/s *3	80 mm/s *3
Print width	48 mm	72 mm
Paper width	58^{0}_{-1} mm	80^{0}_{-1} mm
Thermal head temperature detection	Thermistor	
Platen position detection	Mechanical switch	
Out-of-paper detection	Reflection type photo interrupter	
Operating voltage range V_P line V_{dd} line	 4.75 V to 9.5 V *4 2.7 V to 3.6 V, 4.75 V to 5.25 V *5	
Current consumption V_P line Thermal head drive	5.49 A max. (at 9.5 V) *6	5.40 A max. (at 9.5 V) *6
Motor drive V_{dd} line Thermal head logic	0.60 A max. 0.10 A max.	

<table>
<tr><th rowspan="2">Items</th><th colspan="2">Specifications</th></tr>
<tr><th>LTPD245C</th><th>LTPD345C</th></tr>
<tr><td colspan="2">Operating temperature and humidity range
(Non condensing) *7</td><td colspan="2">-10°C to 50°C　Standard ambient temperature


-30°C to 70°C　Wide ambient temperature *8


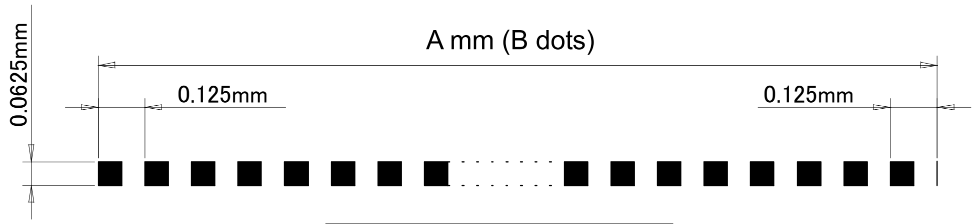
5°C to 50°C　Labeling paper ambient temperature

</td></tr>
<tr><td colspan="2">Storage temperature range</td><td colspan="2">-35°C to75°C (Non condensing)</td></tr>
<tr><td rowspan="2">Life span
(at 25°C and rated energy)</td><td>Activation pulse resistance</td><td colspan="2">100 million pulses or more *9</td></tr>
<tr><td>Abrasion resistance</td><td colspan="2">50 km or more *10</td></tr>
<tr><td colspan="2">Paper feed force</td><td colspan="2">0.49 N (50 gf) or more</td></tr>
<tr><td colspan="2">Paper hold force</td><td colspan="2">0.78 N (80 gf) or more</td></tr>
</table>

Items	Specifications	
	LTPD245C	LTPD345C
Dimensions (excluding convex part)	W 69.0 mm × D 30.0 mm × H 15.0 mm	W 91.0 mm × D 30.0 mm × H 15.0 mm
Mass	Approx. 40 g	Approx. 58 g
Specified thermal paper *11	Nippon Paper Oji Paper Mitsubishi Paper mills limited Jujo Thermal Mitsubishi Hi-Tech Paper Papierfabrik August Koehler AG KSP KANZAN Appleton	TF50KS-E2D TP50KJ-R TL69KS-LH PD160R-63 PD160R-N P220VBB-1 AP50KS-D AF50KS-E F5041 P5045 KT55F20 P300 P350 P350-2.0 KIP370 KIP470 KF50 KPR440 Alpha900-3.4
Specified thermal paper *12	Jujo Thermal	AP50KS-FZ
Specified thermal paper *13 (Labeling paper)	LINTEC HW54E TL69KS-HW76B MACtac DTM9502 (KL370/ST95)	LINTEC HW54E

*1 : Up to 128 dots are available if the V_P is 7.9V or lower.
*2 : See Chapter 5 "DRIVE METHOD" for the drive method.
*3 : Print speed changes according to the processing speed of the controller and print pulse width.
Maximum print speed using the labeling paper is; 80 mm/s for LTPD245C and 60mm/s for LTPD345C.
When temperature is out of the standard ambient temperature range (-10°C to 50°C), maximum print speed is 32.5mm/s.
*4 : Operating voltage is 5.5V to 9.5V when temperature is out of the standard ambient temperature range (-10°C to 50°C).
*5 : Operating voltage is 3.0V to 3.6V, or 4.75V to 5.25V when temperature is out of the standard ambient temperature range (-10°C to 50°C). When using the labeling paper, operating voltage is 3.0V to 3.6V, or 4.75V to 5.25V as well.
*6 : The value when the number of simultaneously activated dots is 96 dots.
*7 : Ambient temperature differs according to the specified thermal paper.
*8 : When the printer mechanism is used in out of the standard ambient temperature range (-10°C to 50°C), ambient temperature should be detected by other than the thermistor of thermal head.
Due to the heating of thermal head, a large gap between the thermistor detection temperature as mentioned above and ambient temperature causes beyond the reasonable control.
Available printing in out of the standard ambient temperature range (-10°C to 50°C) is 24 dots font only.
When ambient temperature is less than -10°C, using LTPD345C that print ratio of one dot line is lower than 75%.
*9 : Excluded when the same dots are printed continuously.
*10 : Excluding damage caused by dust and foreign materials.
*11 : The specified thermal paper can be used when temperature of the printer mechanism is in the standard ambient temperature range (-10°C to 50°C).
*12 : The specified thermal paper can be used when temperature of the printer mechanism is in the wide ambient temperature range (-30°C to 70°C).
*13 : The specified thermal paper can be used when temperature of the printer mechanism is in the labeling paper ambient temperature range (5°C to 50°C).

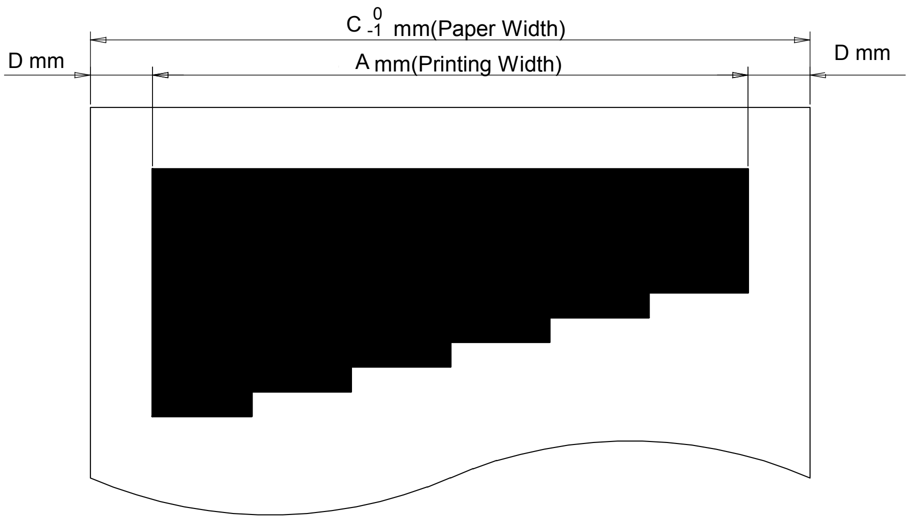
3.2 PRINT CONFIGURATION

Figure 3-1 shows print dot pitch.　Figure 3-2 shows print area.



LTPD245C (A: 48, B: 384)
LTPD345C (A: 72, B: 576)

Figure 3-1　Print Dot Pitch



LTPD245C (A:48, C:58, D:5)
LTPD345C (A:72, C:80, D:4)

Figure 3-2　Print Area

3.3 STEP MOTOR

3.3.1 General Specifications

Table 3-2 shows general specifications of the step motor.

Table 3-2 General Specifications of the Step Motor

Item	Specifications	
	LTPD245C	LTPD345C
Type	PM type step motor	
Drive method	Bi-polar chopper	
Excitation	1-2 phase	
Winding resistance per phase	12 Ω/ phase ±10%	
Motor drive voltage	V_P : 4.75 V to 9.5 V *1	
Motor controlled current	300 mA/phase *2	300 mA/phase *2 (500 mA/phase) *3
Drive pulse rate	3200 pps max. *4	2560 pps max. *4

*1 : Motor drive voltage is 5.5 V to 9.5 V, when temperature is out of the standard ambient temperature range (-10°C to 50°C).
*2 : In the condition of paper feed or print.
*3 : In the condition of auto-loading of the thermal paper.
*4 : Drive pulse rate is 1040pps max., when temperature is out of the standard ambient temperature range (-10°C to 50°C).

Refer to “3.3.2 Sample Drive Circuit” for setting of Motor controlled current.

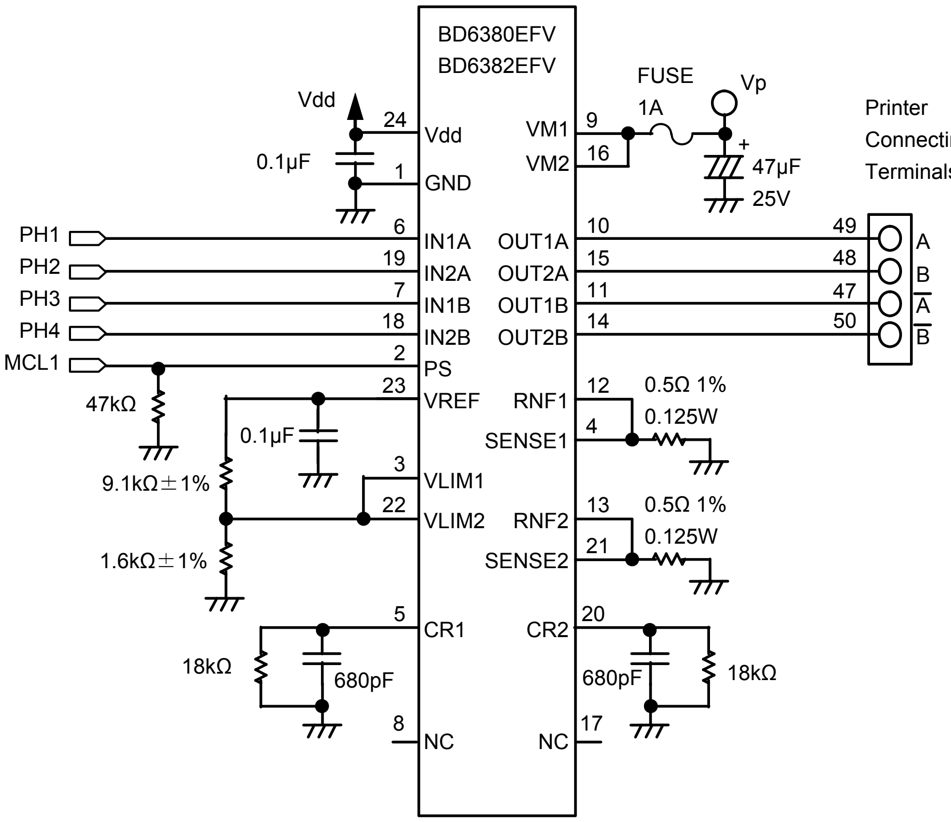
3.3.2 Sample Drive Circuit

Figure 3-3 shows a sample drive circuit.

- MREF signal

  MREF signal is reference signal for controlling the motor current. Motor controlled current is based on the setting voltage by the MREF signal.

  In the condition of paper feed or print (300 mA): 150 mV ± 5%
  In the condition of auto-loading of the thermal paper: (LTPD345C, 500 mA): 250 mV ± 5%

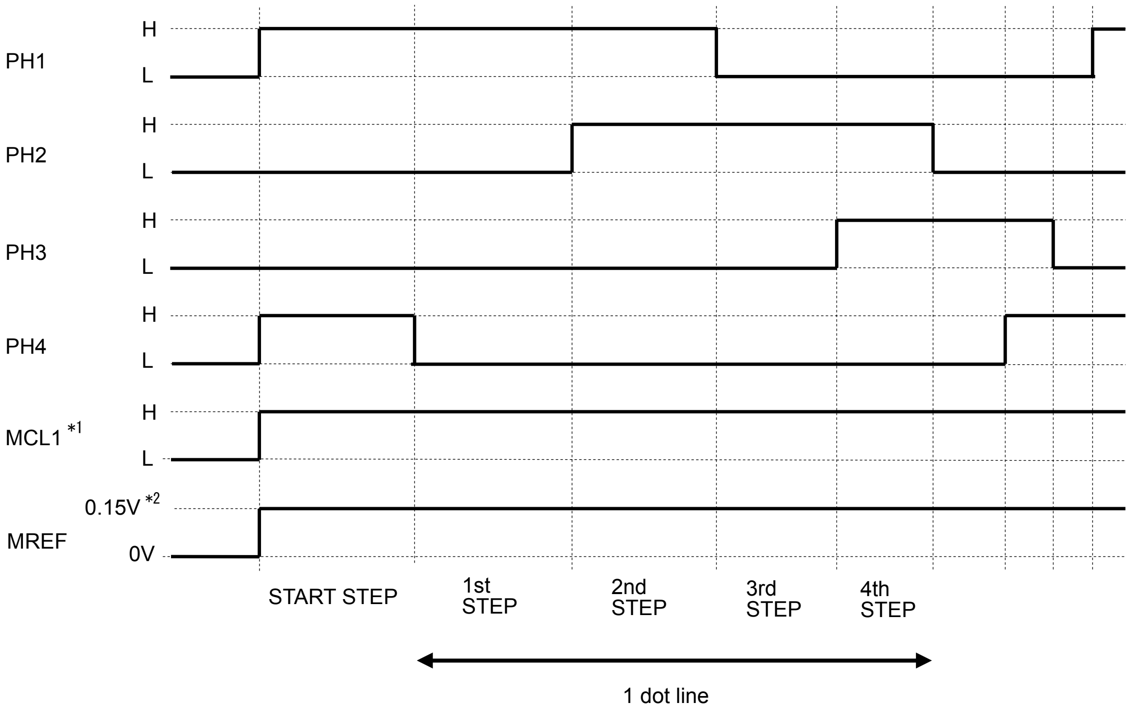


*: Recommended motor driver : BD6380EFV (ROHM, Correspond to within standard ambient temperature range only. Vdd acceptable range: 2.7V to 3.6V and 4.75V to 5.25V)
BD6382EFV (ROHM, Correspond to wide ambient temperature range. Vdd acceptable range: 3.0V to 3.6V and 4.75V to 5.25V)

Figure 3-3 Sample Drive Circuit

3.3.3 Excitation Sequence

Drive the motor with 1-2 phase excitation. One step of the motor drive signal feeds the paper 0.03125 mm. One dot line is consisted of 4 steps. When the voltage signal shown in Figure 3-4 is input to the motor drive circuit shown in Figure 3-3, the printer feeds the paper in the normal direction when the motor is excited in order of step 1, step 2, step 3, step 4, step 5, step 6, step7, step 8, step 1, step 2, ... , as shown in Table 3-3.



*1: Set MCL1 to "High" while the motor is driven.
*2: Paper feed or print: 0.15 V, auto-loading of the thermal paper for LTPD345C: 0.25 V

Figure 3-4 Input Voltage Waveforms for the Sample Drive Circuit

Table 3-3 Excitation Sequence

	Input signal				Output signal			
	PH1	**PH2**	**PH3**	**PH4**	**A**	**B**	$\overline{\mathbf{A}}$	$\overline{\mathbf{B}}$
Step1	H	L	L	L	H	OPEN	L	OPEN
Step2	H	H	L	L	H	H	L	L
Step3	L	H	L	L	OPEN	H	OPEN	L
Step4	L	H	H	L	L	H	H	L
Step5	L	L	H	L	L	OPEN	H	OPEN
Step6	L	L	H	H	L	L	H	H
Step7	L	L	L	H	OPEN	L	OPEN	H
Step8	H	L	L	H	H	L	L	H

3.3.4 Motor Start/Stop Method

Refer to the timing chart in Figure 3-5 when designing the control circuit or software for starting and stopping the motor. Also note the following precautions:

(1) Start step

To start the motor from the pause (no excitation) state, shift the motor to the sequence of print step after exciting the same phase as that of the stop step for the first acceleration step time of the acceleration step.

To restart the motor from the stop step, immediately shift the motor to the sequence of print step.

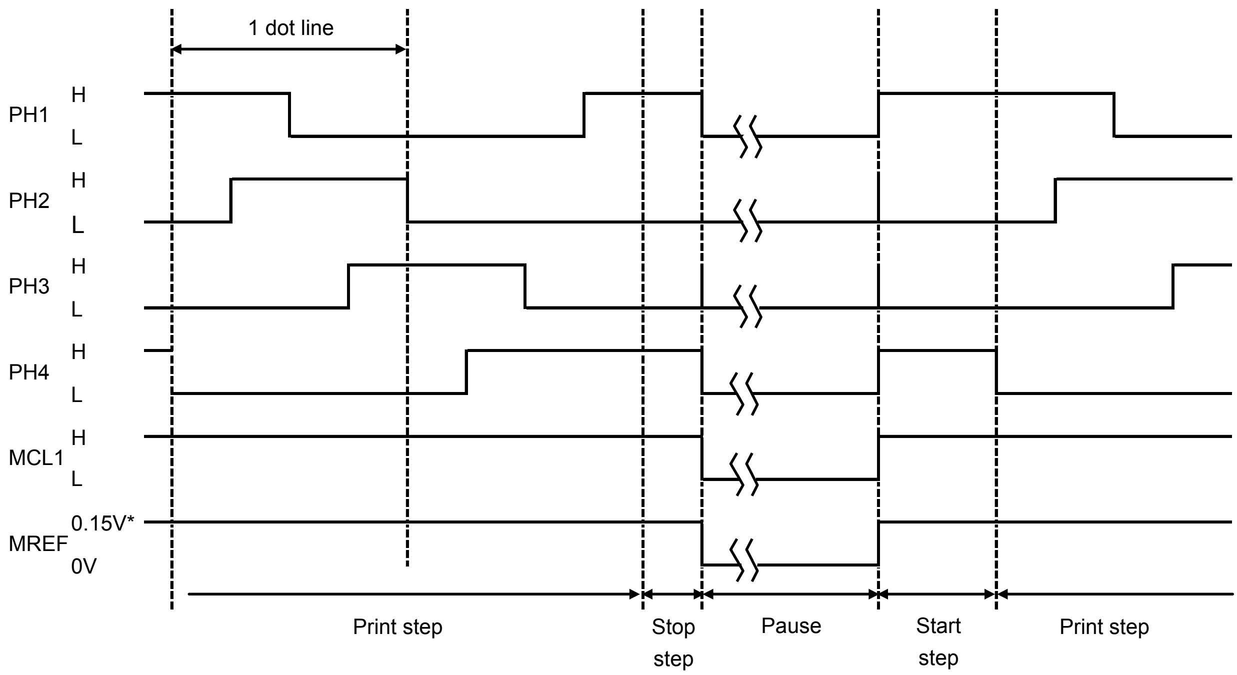
(2) Stop step

To stop the motor, excite the same phase as the last one in the printing step for 20 ms.

(3) Pause state

In the pause state, do not excite the motor to prevent to the motor from overheating. Even when the motor is not excited, holding torque of the motor prevents the thermal paper from moving.

Input signals for a sample drive circuit are shown in Figure 3-5.



*: Paper feed or print: 0.15 V, auto-loading of the thermal paper for LTPD345C: 0.25 V

Figure 3-5 Motor Start/Stop Timing Chart

3.3.5 Motor Drive Method

Drive the motor by the following methods.

(1) Motor drive pulse rate

During paper feeding, the motor should be driven lower than the value obtained by equation (1).

Equation (1):

LTPD245C: $P_M = V_P \times 534 - 1339$ (pps) (except labeling paper)
$P_M = V_P \times 363 - 526$ (pps) (labeling paper)
LTPD345C: $P_M = V_P \times 400 - 840$ (pps) (except labeling paper)
$P_M = V_P \times 229 - 27$ (pps) (labeling paper)

P_M : Maximum motor drive pulse rate at V_P (pps)
However, when temperature is out of the standard ambient temperature range (-10°C to 50°C), maximum motor drive pulse rates for LTPD245C and LTPD345C are 1040pps max.
LTPD245C:
Except labeling paper : 3200 pps max., Labeling paper : 2560 pps max.
LTPD345C
Except labeling paper : 2560 pps max., Labeling paper : 1920 pps max.

V_P : Motor drive voltage (V)

Table 3-4 Maximum Motor Drive Pulse Rate

Vp	Maximum Motor Drive Pulse Rate			
	LTPD245C		LTPD345C	
	Except Labeling Paper	Labeling Paper	Except Labeling Paper	Labeling Paper
4.75 V	1198 pps	1198 pps	1060 pps	1060 pps
5.5 V	1598 pps	1471 pps	1360 pps	1233 pps
6.0 V	1865 pps	1652 pps	1560 pps	1347 pps
7.2 V	2506 pps	2088 pps	2040 pps	1622 pps
8.0 V	2933 pps	2378 pps	2360 pps	1805 pps
8.5 V	3200 pps	2560 pps	2560 pps	1920 pps
9.5 V	3200 pps	2560 pps	2560 pps	1920 pps

When inserting the thermal paper with auto-loading, always drive the motor pulse rate at 320 pps.

(2) Motor speed control

When driving the motor, the acceleration control is required to maintain the paper feed force of start up. If acceleration of the motor does not perform correctly, the motor may not be able to rotate normally if it has a heavy workload. Accelerate the speed sequentially up to the maximum motor drive pulse rate P_M according to the Table 3-5, Table 3-6, Table 3-7, Table 3-8, Table 3-9 and Table 3-10 Acceleration Steps.

Acceleration should be performed by the acceleration step time below, that is output the phase.

1. Drive the start step as same as acceleration step time at Start acceleration step.
2. Drive the first step as same as acceleration step time at 1st acceleration step.
3. Drive the second step as same as acceleration step time at 2nd acceleration step.
4. Hereinafter, drive the "n"th step as same as acceleration step time at "n"th acceleration step.
5. After accelerating up to the maximum motor drive pulse rate P_M, drive the motor at a constant speed.

Available to print during acceleration.

The activation time of the thermal head may be longer than the motor step time depending on the type of the thermal paper, content of the printing and use conditions. In this case, drive the printer drive motor so that the motor driving composition of 1st and 2nd step of the half dot line divides the thermal head activation time equally.

Follow the procedures below if :
Unable to accelerate the speed for the reasons above even if following the Table 3-5, Table 3-6, Table 3-7, Table 3-8, Table 3-9 and Table 3-10.
The speed has been reduced at a certain speed and then accelerates the speed again.

The next step time after reducing the speed is the nearest acceleration step time, which should be shorter than the previous acceleration step time and longest.

(ex) In the case of Figure 3-5, if the previous step time is 900 μs, the next step should be the 10th acceleration step (880 μs).

Hereinafter, accelerate the speed sequentially up to the maximum motor drive pulse rate P_M according to Table 3-5, Table 3-6, Table 3-7, Table 3-8, Table 3-9 and Table 3-10. The recommended acceleration table of the LTPD245C depends on the thermal paper in use. The recommended acceleration table is different when temperature is out of the standard ambient temperature range (-10°C to 50°C).

Recommended acceleration tables are shown below;

Table 3-5 Acceleration Steps (LTPD245C) (1)
Table 3-6 Acceleration Steps (LTPD245C) (2)
Table 3-7 Acceleration Steps (LTPD245C) (3)
Table 3-8 Acceleration Steps (LTPD345C) (1)
Table 3-9 Acceleration Steps (LTPD345C) (2)
Table 3-10 Acceleration Steps (When temperature is out of the standard ambient temperature range (-10 to 50°C) : LTPD245C and/or LTPD345C)

Table 3-5 Acceleration Steps (LTPD245C) (1)

Number of Steps	Drive Pulse Rate (pps)	Step Time (μs)	Number of Steps	Drive Pulse Rate (pps)	Step Time (μs)
Start	-	5000	37	2274	440
1	270	3707	38	2305	434
2	436	2291	39	2337	428
3	565	1769	40	2367	422
4	673	1485	41	2398	417
5	768	1302	42	2428	412
6	853	1172	43	2457	407
7	931	1074	44	2487	402
8	1004	996	45	2515	398
9	1072	933	46	2544	393
10	1136	880	47	2572	389
11	1197	836	48	2600	385
12	1255	797	49	2628	381
13	1310	763	50	2655	377
14	1364	733	51	2683	373
15	1415	707	52	2709	369
16	1465	683	53	2736	365
17	1513	661	54	2762	362
18	1560	641	55	2788	359
19	1605	623	56	2814	355
20	1649	606	57	2840	352
21	1692	591	58	2865	349
22	1734	577	59	2891	346
23	1775	563	60	2916	343
24	1815	551	61	2940	340
25	1854	539	62	2965	337
26	1893	528	63	2989	335
27	1930	518	64	3013	332
28	1967	508	65	3037	329
29	2004	499	66	3061	327
30	2039	490	67	3085	324
31	2075	482	68	3108	322
32	2109	474	69	3131	319
33	2143	467	70	3154	317
34	2176	459	71	3177	315
35	2209	453	72	3200	313
36	2242	446	—	—	—

Table 3-6 Acceleration Steps (LTPD245C) (2)

Object thermal paper :
The paper with thickness of 80μm or thicker (TL69KS-LH, KIP370, KIP470, Alpha900-3.4)

(1/2)

Number of Steps	Drive Pulse Rate (pps)	Step Time (μs)	Number of Steps	Drive Pulse Rate (pps)	Step Time (μs)
Start	—	5000	31	1600	625
1	208	4805	32	1627	615
2	337	2970	33	1653	605
3	436	2293	34	1679	596
4	519	1925	35	1704	587
5	593	1688	36	1729	578
6	658	1519	37	1754	570
7	719	1392	38	1778	562
8	774	1291	39	1802	555
9	827	1209	40	1826	548
10	876	1141	41	1850	541
11	923	1083	42	1873	534
12	968	1033	43	1896	528
13	1011	989	44	1918	521
14	1052	951	45	1940	515
15	1092	916	46	1963	510
16	1130	885	47	1984	504
17	1167	857	48	2006	499
18	1203	831	49	2027	493
19	1238	808	50	2048	488
20	1272	786	51	2069	483
21	1305	766	52	2090	478
22	1338	748	53	2111	474
23	1369	730	54	2131	469
24	1400	714	55	2151	465
25	1430	699	56	2171	461
26	1460	685	57	2191	456
27	1489	671	58	2210	452
28	1518	659	59	2230	448
29	1546	647	60	2249	445
30	1573	636	—	—	—

(2/2)

Number of Steps	Drive Pulse Rate (pps)	Step Time (μs)	Number of Steps	Drive Pulse Rate (pps)	Step Time (μs)
61	2268	441	91	2781	360
62	2287	437	92	2797	358
63	2306	434	93	2812	356
64	2325	430	94	2827	354
65	2343	427	95	2842	352
66	2361	423	96	2858	350
67	2380	420	97	2873	348
68	2398	417	98	2888	346
69	2416	414	99	2903	345
70	2433	411	100	2917	343
71	2451	408	101	2932	341
72	2469	405	102	2947	339
73	2486	402	103	2962	338
74	2503	399	104	2976	336
75	2520	397	105	2991	334
76	2538	394	106	3005	333
77	2554	391	107	3019	331
78	2571	389	108	3034	330
79	2588	386	109	3048	328
80	2605	384	110	3062	327
81	2621	382	111	3076	325
82	2638	379	112	3090	324
83	2654	377	113	3104	322
84	2670	375	114	3118	321
85	2686	372	115	3132	319
86	2702	370	116	3146	318
87	2718	368	117	3159	317
88	2734	366	118	3173	315
89	2750	364	119	3186	314
90	2765	362	120	3200	313

Table 3-7 Acceleration Steps (LTPD245C) (3)

Object thermal paper :
Labeling paper (HW54E, TL69KS-HW76B, DTM9502)

(1/3)

Number of Steps	Drive Pulse Rate (pps)	Step Time (μs)	Number of Steps	Drive Pulse Rate (pps)	Step Time (μs)
Start	-	6494	31	1184	844
1	154	6494	32	1204	831
2	249	4013	33	1223	817
3	323	3099	34	1242	805
4	384	2602	35	1261	793
5	438	2281	36	1280	781
6	487	2053	37	1298	770
7	532	1881	38	1316	760
8	573	1745	39	1334	750
9	612	1634	40	1351	740
10	648	1542	41	1369	731
11	683	1464	42	1386	722
12	716	1396	43	1403	713
13	748	1337	44	1419	705
14	778	1285	45	1436	696
15	808	1238	46	1452	689
16	836	1196	47	1468	681
17	864	1158	48	1484	674
18	890	1123	49	1500	667
19	916	1092	50	1516	660
20	941	1062	51	1531	653
21	966	1035	52	1547	647
22	990	1010	53	1562	640
23	1013	987	54	1577	634
24	1036	965	55	1592	628
25	1059	945	56	1606	622
26	1080	926	57	1621	617
27	1102	907	58	1636	611
28	1123	890	59	1650	606
29	1144	874	60	1664	601
30	1164	859	-	-	-

Number of Steps	Drive Pulse Rate (pps)	Step Time (μs)	Number of Steps	Drive Pulse Rate (pps)	Step Time (μs)
61	1678	596	91	2058	486
62	1692	591	92	2069	483
63	1706	586	93	2081	481
64	1720	581	94	2092	478
65	1734	577	95	2103	475
66	1747	572	96	2115	473
67	1761	568	97	2126	470
68	1774	564	98	2137	468
69	1787	559	99	2148	466
70	1801	555	100	2159	463
71	1814	551	101	2170	461
72	1827	547	102	2181	459
73	1840	544	103	2191	456
74	1852	540	104	2202	454
75	1865	536	105	2213	452
76	1878	533	106	2224	450
77	1890	529	107	2234	448
78	1903	526	108	2245	445
79	1915	522	109	2255	443
80	1927	519	110	2266	441
81	1940	516	111	2276	439
82	1952	512	112	2287	437
83	1964	509	113	2297	435
84	1976	506	114	2307	433
85	1988	503	115	2317	432
86	2000	500	116	2328	430
87	2011	497	117	2338	428
88	2023	494	118	2348	426
89	2035	491	119	2358	424
90	2046	489	120	2368	422

Number of Steps	Drive Pulse Rate (pps)	Step Time (μs)
121	2378	421
122	2388	419
123	2398	417
124	2408	415
125	2417	414
126	2427	412
127	2437	410
128	2447	409
129	2456	407
130	2466	406
131	2475	404
132	2485	402
133	2494	401
134	2504	399
135	2513	398
136	2523	396
137	2532	395
138	2541	393
139	2551	392
140	2560	391

Table 3-8 Acceleration Steps (LTPD345C) (1)

Number of Steps	Drive Pulse Rate (pps)	Step Time (μs)	Number of Steps	Drive Pulse Rate (pps)	Step Time (μs)
Start	-	5000	37	1819	550
1	216	4634	38	1844	542
2	349	2864	39	1869	535
3	452	2211	40	1894	528
4	539	1856	41	1918	521
5	614	1627	42	1942	515
6	683	1465	43	1966	509
7	745	1342	44	1989	503
8	803	1245	45	2012	497
9	857	1166	46	2035	491
10	909	1100	47	2058	486
11	957	1044	48	2080	481
12	1004	996	49	2102	476
13	1048	954	50	2124	471
14	1091	917	51	2146	466
15	1132	883	52	2168	461
16	1172	853	53	2189	457
17	1210	826	54	2210	453
18	1248	802	55	2231	448
19	1284	779	56	2251	444
20	1319	758	57	2272	440
21	1354	739	58	2292	436
22	1387	721	59	2312	432
23	1420	704	60	2332	429
24	1452	689	61	2352	425
25	1483	674	62	2372	422
26	1514	660	63	2391	418
27	1544	648	64	2411	415
28	1574	635	65	2430	412
29	1603	624	66	2449	408
30	1632	613	67	2468	405
31	1660	603	68	2486	402
32	1687	593	69	2505	399
33	1714	583	70	2523	396
34	1741	574	71	2542	393
35	1768	566	72	2560	391
36	1793	558	—	—	—

Table 3-9 Acceleration Steps (LTPD345C) (2)

Object thermal paper :
Labeling paper (HW54E)

(1/3)

Number of Steps	Drive Pulse Rate (pps)	Step Time (μs)	Number of Steps	Drive Pulse Rate (pps)	Step Time (μs)
Start	-	9263	31	830	1205
1	108	9263	32	844	1185
2	175	5725	33	858	1166
3	226	4421	34	871	1148
4	269	3711	35	884	1131
5	307	3253	36	897	1115
6	341	2928	37	910	1099
7	373	2683	38	923	1084
8	402	2489	39	935	1069
9	429	2331	40	947	1056
10	455	2200	41	960	1042
11	479	2088	42	972	1029
12	502	1992	43	983	1017
13	524	1907	44	995	1005
14	546	1832	45	1007	993
15	566	1766	46	1018	982
16	586	1706	47	1029	971
17	605	1652	48	1041	961
18	624	1602	49	1052	951
19	642	1557	50	1063	941
20	660	1515	51	1074	932
21	677	1477	52	1084	922
22	694	1441	53	1095	913
23	710	1408	54	1105	905
24	726	1377	55	1116	896
25	742	1348	56	1126	888
26	757	1320	57	1137	880
27	773	1294	58	1147	872
28	787	1270	59	1157	864
29	802	1247	60	1167	857
30	816	1225	-	-	-

Number of Steps	Drive Pulse Rate (pps)	Step Time (μs)	Number of Steps	Drive Pulse Rate (pps)	Step Time (μs)
61	1177	850	91	1443	693
62	1186	843	92	1451	689
63	1196	836	93	1459	686
64	1206	829	94	1467	682
65	1215	823	95	1475	678
66	1225	816	96	1482	675
67	1234	810	97	1490	671
68	1244	804	98	1498	668
69	1253	798	99	1506	664
70	1262	792	100	1513	661
71	1271	786	101	1521	657
72	1281	781	102	1529	654
73	1290	775	103	1536	651
74	1299	770	104	1544	648
75	1308	765	105	1551	645
76	1316	760	106	1559	641
77	1325	755	107	1566	638
78	1334	750	108	1574	635
79	1343	745	109	1581	632
80	1351	740	110	1588	630
81	1360	735	111	1596	627
82	1368	731	112	1603	624
83	1377	726	113	1610	621
84	1385	722	114	1617	618
85	1394	718	115	1625	616
86	1402	713	116	1632	613
87	1410	709	117	1639	610
88	1418	705	118	1646	608
89	1426	701	119	1653	605
90	1435	697	120	1660	602

Number of Steps	Drive Pulse Rate (pps)	Step Time (μs)	Number of Steps	Drive Pulse Rate (pps)	Step Time (μs)
121	1667	600	141	1801	555
122	1674	597	142	1808	553
123	1681	595	143	1814	551
124	1688	592	144	1820	549
125	1695	590	145	1827	547
126	1702	588	146	1833	545
127	1708	585	147	1840	544
128	1715	583	148	1846	542
129	1722	581	149	1852	540
130	1729	578	150	1858	538
131	1735	576	151	1865	536
132	1742	574	152	1871	535
133	1749	572	153	1877	533
134	1755	570	154	1883	531
135	1762	568	155	1889	529
136	1769	565	156	1896	528
137	1775	563	157	1902	526
138	1782	561	158	1908	524
139	1788	559	159	1914	522
140	1795	557	160	1920	521

Table 3-10 Acceleration Steps
(When temperature is out of the standard ambient temperature range (-10 to 50°C) :
LTPD245C and/or LTPD345C)

Number of Steps	Drive Pulse Rate (pps)	Step Time (μs)	Number of Steps	Drive Pulse Rate (pps)	Step Time (μs)
Start	-	11406	37	739	1353
1	88	11406	38	749	1335
2	142	7049	39	759	1317
3	184	5444	40	769	1300
4	219	4570	41	779	1283
5	250	4006	42	789	1267
6	277	3606	43	799	1252
7	303	3303	44	808	1237
8	326	3065	45	818	1223
9	348	2871	46	827	1209
10	369	2709	47	836	1196
11	389	2571	48	845	1183
12	408	2452	49	854	1171
13	426	2348	50	863	1159
14	443	2256	51	872	1147
15	460	2174	52	881	1136
16	476	2101	53	889	1125
17	492	2034	54	898	1114
18	507	1973	55	906	1103
19	522	1917	56	915	1093
20	536	1866	57	923	1083
21	550	1818	58	931	1074
22	564	1774	59	939	1064
23	577	1733	60	948	1055
24	590	1695	61	956	1046
25	603	1659	62	964	1038
26	615	1626	63	971	1029
27	627	1594	64	979	1021
28	639	1564	65	987	1013
29	651	1536	66	995	1005
30	663	1509	67	1003	998
31	674	1483	68	1010	990
32	685	1459	69	1018	983
33	696	1436	70	1025	975
34	707	1414	71	1033	968
35	718	1393	72	1040	962
36	729	1372	-	-	-

(3) Preventing Overheat

To prevent the motor from overheating, the maximum continuous drive time and drive ratio are limited. Table 3-11 shows the maximum continuous drive time and drive ratio of the motor. And Table 3-12 shows the maximum continuous drive time and drive ratio when ambient temperature is 50°C or higher.

Follow Table 3-11 or Table 3-12 shown below to set drive time and a pause time of the motor.

Temperature rise of the motor is different according to the use conditions. (ambient temperature, designing the outer case etc.) Keep the temperature of the motor outer case, 100°C or lower. Verify the performance with your actual device.

Table 3-11 Maximum Drive Time and Drive Ratio

Drive pulse rate (pps)	Maximum continuous drive time (s)	Motor drive voltage Vp (V)				
		$9.5V \geq V_P > 8.5V$	$8.5V \geq V_P > 7.5V$	$7.5V \geq V_P > 6.5V$	$6.5V \geq V_P > 5.5V$	$5.5V \geq V_P \geq 4.75V$
		Drive ratio	Drive ratio	Drive ratio	Drive ratio	Drive ratio
320 to 560	450	85%	85%	85%	85%	90%
560 to 800	450	85%	85%	85%	90%	90%
800 to 1040	450	85%	85%	85%	90%	95%
1040 to 1280	450	85%	85%	90%	95%	100%
1280 to 1520	450	85%	90%	90%	100%	100%
1520 to 1760	450	85%	90%	95%	100%	100%
1760 to 2000	455	85%	90%	100%	100%	×
2000 to 2240	465	85%	95%	100%	100%	×
2240 to 2480	485	90%	100%	100%	×	×
2480 to 2720	515	90%	100%	100%	×	×
2720 to 2960	575	95%	100%	×	×	×
2960 to 3200	665	95%	100%	×	×	×
3200	1445	95%	100%	×	×	×
× : Unusable						

Table 3-12 Maximum Drive Time and Drive Ratio (Ambient Temperature 50°C or Higher)

Drive pulse rate (pps)	Maximum continuous drive time (s)	Motor drive voltage V_P(V)				
		$9.5 \geq V_P > 8.5V$	$8.5 \geq V_P > 7.5V$	$7.5 \geq V_P > 6.5V$	$6.5 \geq V_P > 5.5V$	$5.5 \geq V_P \geq 4.75V$
		Drive ratio	Drive ratio	Drive ratio	Drive ratio	Drive ratio
320 to 560	100	20%	20%	20%	20%	20%
560 to 800	57	20%	20%	25%	25%	25%
800 to 1040	40	25%	25%	25%	25%	25%

$$\text{Drive Ratio}(\%) = \frac{\text{Drive Time}}{\text{Drive Time} + \text{Pause Time}} \times 100\,(\%)$$

3.3.6 Motor Drive Precautions

- Using the motor drive circuit other than the circuit shown in "3.3.2 Sample Drive Circuit" may not ensure the specified efficiency.

- To prevent degradation in the print quality due to the backlash of the paper drive system, feed the paper for 48 steps or more at the initialization, at a time after setting/releasing the platen block, at a time after feeding the thermal paper backward, and a time after cutting with a paper cutter. During this time, drive the motor with constant speed at the 1st acceleration step.

- When printing, change the motor drive pulse rate depending on the operational conditions such as voltage, temperature, and the number of activated dots. (See Chapter 5 “PRINT DRIVE METHOD” for details)

- When printing, change the motor drive pulse rate so that the activation pulse width of the thermal head does not exceed the sum of the two-step times of the motor. (See Chapter 5 “PRINT DRIVE METHOD” for details).

- Surface of thermal paper may get scratched by backward feed. The backward feed may cause paper skew and jams depending on paper roll layout and designing of paper holder. Be sure to confirm performance with your product before using the backward feed.

- Do not print intermittently (Do not repeat printing and stopping in a short interval.)
  If doing so, print quality may be decreased due to unevenness of the paper feed pitch.

- Always perform the start and the stop steps for both character print and bit image print.

- For the motor stop, a minimum one dot line of motor feed is required from the step that thermal head was activated. If the motor is stopped at the step that the thermal head has been activated, paper feed difficulty may be caused due to sticking of the thermal paper to the thermal head.

- Sound and vibration during printing vary depending on the motor drive pulse rate. Verify the performance with your actual device.

3.4 THERMAL HEAD

The thermal head consists of heat elements and a thermal head driver that drives and controls the heat elements.
The data from the DI terminal is transferred to the shift register at the rising edge of the CLK signal.
The data is stored into the latch register by making $\overline{\text{LAT}}$ signal "Low" after one line data is transferred. The heat elements are activated by making DST signal "High" in accordance with the stored print data.

In the LTPD245C, a division printing by 6 blocks is available. Each block has 64 dots heat elements.
In the LTPD345C at 7.9V or lower, a division printing by 64 dots in 1 block and 128 dots in 4 blocks each are available (when operating voltage exceeds 7.9V, a division printing is available at dynamic division method.) The divided printing is effective for a high print ratio printing because the peak current can be cut down with the reduction of the average print speed.

3.4.1 Structure of the Thermal Head

Figure 3-6 shows the thermal head block diagram when driving the LTPD245C.

Table 3-13 and Table 3-14 show the relationship between DST terminals and activated heating elements.

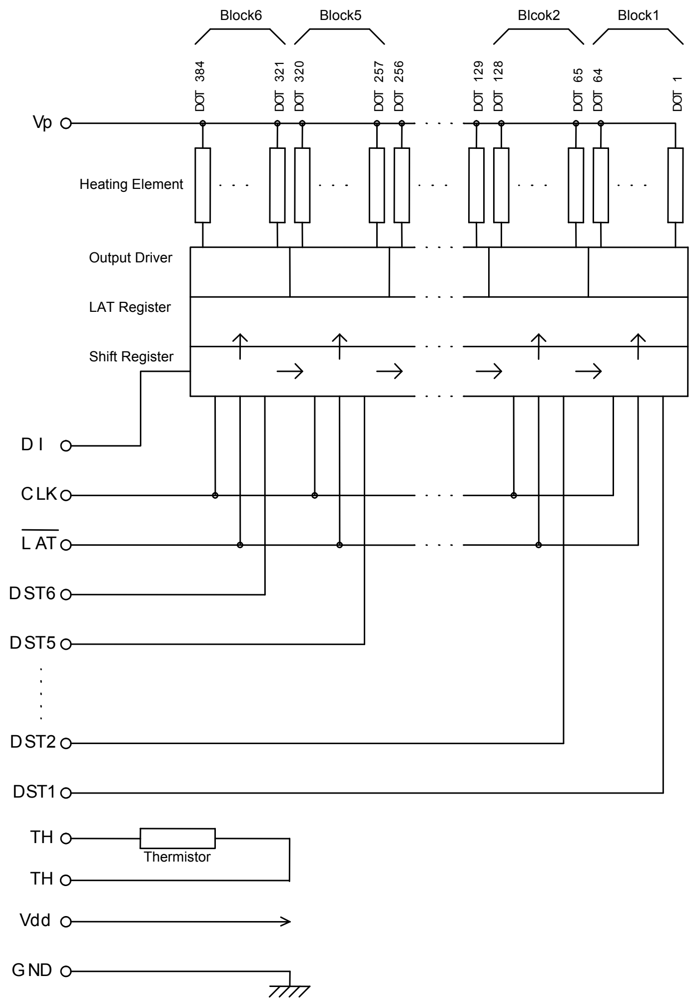


Figure 3-6 Thermal Head Block Diagram (LTPD245C)

Table 3-13 DST Terminals and Heating Elements (LTPD245C)

Block	DST Number	Heating Element Number	Dots/DST
1	DST1	1 to 64	64
2	DST2	65 to 128	64
3	DST3	129 to 192	64
4	DST4	193 to 256	64
5	DST5	257 to 320	64
6	DST6	321 to 384	64

Table 3-14 DST Terminals and Heating Elements (LTPD345C)

Block	DST Number	Heating Element Number	Dots/DST
1	DST1	1 to 128	128
2	DST2	129 to 256	128
3	DST3	257 to 320	64
4	DST4	321 to 448	128
5	DST5	449 to 576	128

3.4.2 Print Position of the Data

384-bit data (#1 to #384) transferred through DI terminals are printed when driving the LTPD245C as shown in Figure 3-7.

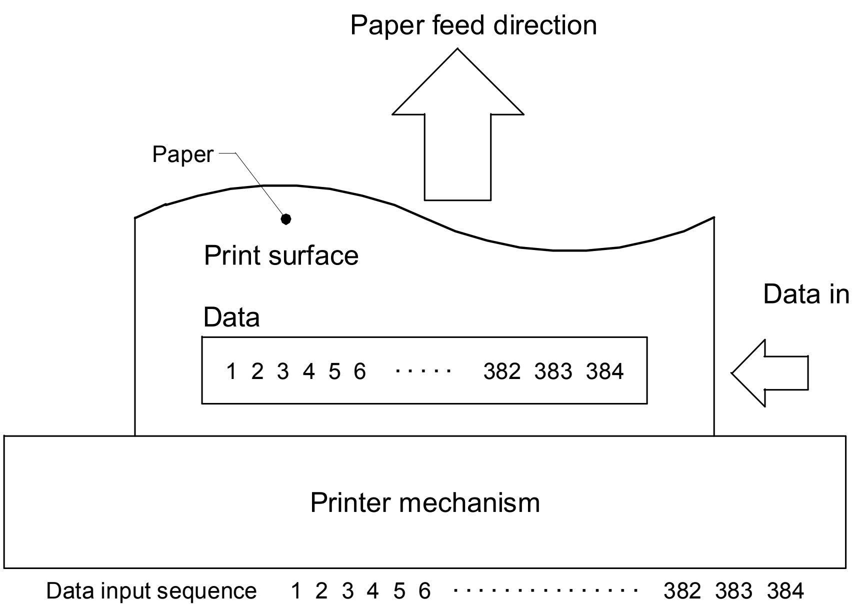


Figure 3-7 Print Position of the Data (LTPD245C)

3.4.3 Electrical Characteristics of Thermal Head

Table 3-15 and Table 3-16 show electrical characteristics of thermal head.

Table 3-15 Electrical Characteristics of Thermal Head (LTPD245C)

(at 25°C)

Item		Symbol	Conditions		Rated value Min.	Rated value Typ.	Rated value Max.	Unit
Thermal head heat element resistance		R_H			166.0	173.0	180.0	Ω
Thermal head drive voltage		V_P			4.75	-	9.5	V
Thermal head drive current		I_P	The number of simultaneously activated dots = 96		-	-	5.49	A
Logic voltage		V_{dd}			2.7	3.3	3.6	V
					4.75	5.00	5.25	
Logic current		I_{dd}	$f_{DI} = 1/2f_{CLK}$		-	-	36.0	mA
Input voltage	High	V_{IH}	CLK, DI, $\overline{LAT}$, DST		$0.8V_{dd}$	-	V_{dd}	V
	Low	V_{IL}	CLK, DI, $\overline{LAT}$, DST		0	-	$0.2V_{dd}$	V
DI input current	High	I_{IH} DI	$V_{IH} = V_{dd}$		-	-	0.5	μA
	Low	I_{IL} DI	$V_{IL} = 0$ V		-	-	-0.5	μA
DST input current	High	I_{IH} DST	$V_{dd} = 5.0$ V, $V_{IH} = V_{dd}$		-	-	55.0	μA
	Low	I_{IL} DST	$V_{IL} = 0$ V		-	-	-0.5	μA
CLK input current	High	I_{IH} CLK	$V_{IH} = V_{dd}$		-	-	1.0	μA
	Low	I_{IL} CLK	$V_{IL} = 0$ V		-	-	-1.0	μA
$\overline{LAT}$ input current	High	I_{IH} $\overline{LAT}$	$V_{IH} = V_{dd}$		-	-	1.0	μA
	Low	I_{IL} $\overline{LAT}$	$V_{IL} = 0$ V		-	-	-1.0	μA
CLK frequency		f_{CLK}	$2.7 V \le V_{dd} < 3.0 V$		-	-	5.0	MHz
			$3.0 V \le V_{dd} \le 3.6 V$		-	-	8.0	MHz
			$4.75 V \le V_{dd} \le 5.25 V$		-	-	8.0	MHz
CLK pulse width		t1	See the timing chart.	$2.7 V \le V_{dd} < 3.0 V$	50	-	-	ns
				$3.0 V \le V_{dd} \le 3.6 V$	30	-	-	ns
				$4.75 V \le V_{dd} \le 5.25 V$	30	-	-	ns
DI setup-time		t2	See the timing chart.	$2.7 V \le V_{dd} < 3.0 V$	70	-	-	ns
				$3.0 V \le V_{dd} \le 3.6 V$	30	-	-	ns
				$4.75 V \le V_{dd} \le 5.25 V$	30	-	-	ns
DI hold time		t3	See the timing chart.	$2.7 V \le V_{dd} < 3.0 V$	40	-	-	ns
				$3.0 V \le V_{dd} \le 3.6 V$	30	-	-	ns
				$4.75 V \le V_{dd} \le 5.25 V$	30	-	-	ns
$\overline{LAT}$ setup time		t4	See the timing chart.		100	-	-	ns
$\overline{LAT}$ pulse width		t5	See the timing chart.		100	-	-	ns
$\overline{LAT}$ hold time		t6	See the timing chart.		50	-	-	ns
DST setup time		t7	See the timing chart.		300	-	-	ns
$\overline{LAT}$ wait time		t8 *	See the timing chart.	$2.7 V \le V_{dd} < 3.0 V$	36	-	-	μs
				$3.0 V \le V_{dd} \le 3.6 V$	30	-	-	μs
				$4.75 V \le V_{dd} \le 5.25 V$	30	-	-	μs

*: If Min at "$\overline{LAT}$ wait time" in the table cannot be secured, it may cause V_p voltage fluctuations.

Table 3-16 Electrical Characteristics of Thermal Head (LTPD345C)

(at 25°C)

Item		Symbol	Conditions		Rated value Mim.	Typ.	Max.	Unit
Thermal head heat element resistance		R_H			168.9	176.0	183.1	Ω
Thermal head drive voltage		V_P			4.75	-	9.5	V
Thermal head drive current		I_P	The number of simultaneously activated dots = 96		-	-	5.4	A
Logic voltage		V_{dd}			2.7	3.3	3.6	V
					4.75	5.00	5.25	
Logic current		I_{dd}	f_{DI} = 1/2f_{CLK}		-	-	54.0	mA
Input voltage	High	V_{IH}	CLK, DI, $\overline{LAT}$, DST		$0.8V_{dd}$	-	V_{dd}	V
	Low	V_{IL}	CLK, DI, $\overline{LAT}$, DST		0	-	$0.2V_{dd}$	V
DI input current	High	I_{IH} DI	$V_{IH} = V_{dd}$		-	-	0.5	μA
	Low	I_{IL} DI	V_{IL} = 0 V		-	-	-0.5	μA
DST input current	High	I_{IH} DST	V_{dd} = 5.0 V, $V_{IH} = V_{dd}$		-	-	110.0	μA
	Low	I_{IL} DST	V_{IL} = 0 V		-	-	-1.0	μA
CLK input current	High	I_{IH} CLK	$V_{IH} = V_{dd}$		-	-	1.5	μA
	Low	I_{IL} CLK	V_{IL} = 0 V		-	-	-1.5	μA
$\overline{LAT}$ input current	High	I_{IH} $\overline{LAT}$	$V_{IH} = V_{dd}$		-	-	1.5	μA
	Low	I_{IL} $\overline{LAT}$	V_{IL} = 0 V		-	-	-1.5	μA
CLK frequency		f_{CLK}	2.7 V ≤ V_{dd} < 3.0 V		-	-	5.0	MHz
			3.0 V ≤ V_{dd} ≤ 3.6 V		-	-	8.0	MHz
			4.75 V ≤ V_{dd} ≤ 5.25 V		-	-	8.0	MHz
CLK pulse width		t1	See the timing chart.	2.7 V ≤ V_{dd} < 3.0 V	50	-	-	ns
				3.0 V ≤ V_{dd} ≤ 3.6 V	30	-	-	ns
				4.75 V ≤ V_{dd} ≤ 5.25 V	30	-	-	ns
DI setup-time		t2	See the timing chart.	2.7 V ≤ V_{dd} < 3.0 V	70	-	-	ns
				3.0 V ≤ V_{dd} ≤ 3.6 V	30	-	-	ns
				4.75 V ≤ V_{dd} ≤ 5.25 V	30	-	-	ns
DI hold time		t3	See the timing chart.	2.7 V ≤ V_{dd} < 3.0 V	40	-	-	ns
				3.0 V ≤ V_{dd} ≤ 3.6 V	30	-	-	ns
				4.75 V ≤ V_{dd} ≤ 5.25 V	30	-	-	ns
$\overline{LAT}$ setup time		t4	See the timing chart.		100	-	-	ns
$\overline{LAT}$ pulse width		t5	See the timing chart.		100	-	-	ns
$\overline{LAT}$ hold time		t6	See the timing chart.		50	-	-	ns
DST setup time		t7	See the timing chart.		300	-	-	ns
$\overline{LAT}$ wait time		t8 *	See the timing chart.	2.7 V ≤ V_{dd} < 3.0 V	36	-	-	μs
				3.0 V ≤ V_{dd} ≤ 3.6 V	30	-	-	μs
				4.75 V ≤ V_{dd} ≤ 5.25 V	30	-	-	μs

*: If Min. at "$\overline{LAT}$ wait time" in the table cannot be secured, it may cause V_p voltage fluctuations.

3.4.4 Timing Chart

Figure 3-8 shows a thermal head drive timing chart.

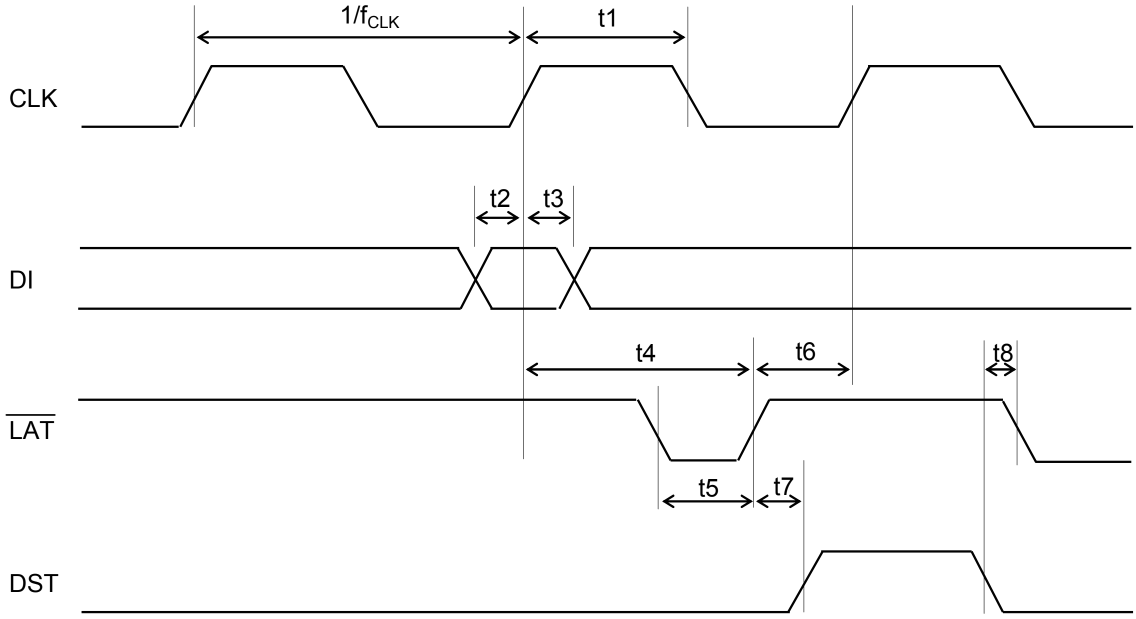


Figure 3-8 Thermal Head Drive Timing Chart

3.4.5 Thermal Head Heat Element Resistance

Table 3-17 shows resistance of the thermal head heat element of the printer.

Table 3-17 Thermal Head Heat Element Resistance

Thermal Head Heat Element Resistance	
LTPD245C	LTPD345C
166.0Ω to 180.0Ω	168.9Ω to 183.1Ω

3.4.6 Maximum Current Consumption

Since the maximum current consumption may reach the values calculated using equation (2) when the thermal head is driven, the number of simultaneously activated dots should be determined not to exceed power supply capacity. Also, allowable current for the cable material and the voltage drop on the cable should be cared well.

Equation (2):

$$I_P = \frac{N_{SA} \times V_P}{R_{H\,min}}$$

I_P	:	Maximum current consumption (A)
N_{SA}	:	Number of simultaneously activated dots
V_P	:	Thermal head drive voltage (V)
$R_{H\,min}$	:	Minimum thermal head heat element resistance 166.0 (Ω) (LTPD245C) 168.9 (Ω) (LTPD345C)

3.5 CONTROLLING THE ACTIVATION PULSE WIDTH FOR THERMAL HEAD

To execute high quality printing using the printer, the activation pulse width according to printer use condition must be used. Control printing with the activation pulse width calculated by the following sequence. Printing at too high voltage or too long activation pulse width may shorten the life of the thermal head.

3.5.1 Calculation of Activation Pulse Width

Each value can be calculated according to the steps in Section 3.5.2 to 3.5.6 and the activation pulse width “t” can be calculated by substituting each value into the equation (3).

Equation (3):

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

t	:	Thermal head activation pulse width (ms)	
E	:	Printing energy (mJ)	See section 3.5.2
R	:	Adjusted resistance (Ω)	See section 3.5.3
V	:	Adjusted voltage (V)	See section 3.5.4
C	:	Thermal head activation pulse cycle coefficient	See section 3.5.6

3.5.2 Calculation of Printing Energy

The printing energy “E” can be calculated using equation (4) as the appropriate printing energy is different depending on each specified thermal paper and the temperature of the thermal head.

Equation (4):

$$E = E_{25} - T_C \times (T_X - 25)$$

E_{25}	:	Standard printing energy (mJ)	See Table 3-18
T_C	:	Temperature coefficient	See Table 3-18
T_X	:	Temperature detected by thermistor (°C) *	

*: Measure the temperature using the resistance of the built-in thermistor on the thermal head.
For the thermistor resistance value at T_X (°C), see Section 3.5.8.

Table 3-18 Standard Printing Energy and Temperature Coefficient

Thermal Paper			Standard Printing Energy (mJ)	Temperature Coefficient
Nippon Paper	TF50KS-E2D		0.2489	0.002885
	TP50KJ-R		0.2745	0.002950
	TL69KS-LH		0.3286	0.002341
Oji Paper	PD160R-63		0.2393	0.001678
	PD160R-N		0.3068	0.003668
Mitsubishi Paper mills limited	P220VBB-1		0.2864	0.003028
Jujo Thermal	AP50KS-D	25°C or higher	0.2796	0.003093
		Less than 25°C	0.2798	0.002085
	AF50KS-E		0.2651	0.002981
	AP50KS-FZ		0.2934	0.002707
Mitsubishi Hi-Tech Paper	F5041		0.2576	0.002847
	P5045		0.3262	0.003601
Papierfabrik August Koehler AG	KT55F20		0.3068	0.003668
KSP	P300		0.2703	0.002797
	P350		0.2462	0.002723
	P350-2.0		0.2347	0.002778
	KIP370		0.3206	0.002328
	KIP470		0.2759	0.003447
KANZAN	KF50		0.2774	0.002183
	KPR440		0.2966	0.001951
Appleton	Alpha900-3.4		0.2476	0.003539
LINTEC	HW54E		0.2471	0.003460
	TL69KS-HW76B		0.2823	0.002865
MACtac	DTM9502（KL370/ST95）		0.3740	0.003263

3.5.3 Adjustment of Thermal Head Resistance

The adjusted resistance “R” can be calculated using equation (5) to adjust the thermal head resistance as a voltage drop is caused by wiring resistance.

Equation (5):

$$R = \frac{(R_H + R_i + (R_C + r_c) \times N_{SA})^2}{R_H}$$

R_H	:	Thermal head heat element resistance	173.0 (Ω)(LTPD245C) 176.0 (Ω)(LTPD345C)
R_i	:	Wiring resistance in the thermal head	9 (Ω) *1
R_C	:	Common terminal wiring resistance in the thermal head	0.20 (Ω)
r_C	:	Wiring resistance between V_p and GND (Ω) *2	

*1 : V_{dd} is 5.0 V. Ri is 13 (Ω) if V_{dd} is 3.0 V or 3.3 V
*2 : The resistance is a serial resistance of the wire and switching circuit of relay between control terminal and power supply.

3.5.4 Adjustment of Thermal Head drive Voltage

The adjusted voltage “V” can be calculated using equation (6) as the printing density changes by the difference of the thermal head drive voltage.

Equation (6):

$$V = 1.368 \times V_P - 2.800$$

$$V = 1.055 \times V_P - 1.076 \text{ (KIP470, Alpha900 - 3.4)}$$

V_P : Thermal head drive voltage (V)

3.5.5 Setting of Activation Pause Time

In order to protect the thermal head heat elements, when the same heat element dots are activated continuously on the successive dot line, determine the activation pulse cycle (the time from the start of the preceding activation to the start of the current activation) which meets equation (7) to secure the pause time.

Equation (7):

$$W > t + 500 \left(\mu s \right)$$

W : The activation cycle (μs)*

*: The activation cycle W is the driving time of the printer drive motor for 2 steps (one-half dot line).

3.5.6 Adjustment by Thermal Head Activation Pulse Cycle

The thermal head activation pulse cycle coefficient “C” can be calculated using equations (8) as the printing density varies by the thermal head activation pulse cycle (equivalent for motor drive pulse rate).

Equation (8):

$$C = 1 - \frac{1020 \times V_p - 1650}{(V_p - 3.55) \times (W + 1350) + 1920}$$

3.5.7 Calculation Sample for the Activation Pulse Width

Table 3-19 lists the calculation samples of the activation pulse width calculated using equation (3) and the values obtained using equations (4) to (8).

Table 3-19 Activation Pulse Width

(1/2)
Unit : ms

Vp [V]	Tx [°C]	Motor drive pulse rate [pps]														
		400	600	800	1000	1200	1400	1600	1800	2000	2200	2400	2600	2800	3000	3200
4.75	−10	3.977	3.446	3.059	2.764	2.531	×	×	×	×	×	×	×	×	×	×
	0	3.649	3.162	2.806	2.536	2.323	×	×	×	×	×	×	×	×	×	×
	10	3.321	2.878	2.554	2.308	2.114	×	×	×	×	×	×	×	×	×	×
	20	2.994	2.594	2.302	2.080	1.905	×	×	×	×	×	×	×	×	×	×
	30	2.666	2.310	2.050	1.852	1.696	×	×	×	×	×	×	×	×	×	×
	40	2.338	2.025	1.798	1.624	1.488	×	×	×	×	×	×	×	×	×	×
	50	2.010	1.741	1.545	1.396	1.279	×	×	×	×	×	×	×	×	×	×
	60	1.682	1.457	1.293	1.168	1.070	×	×	×	×	×	×	×	×	×	×
	70	1.354	1.173	1.041	0.941	0.862	×	×	×	×	×	×	×	×	×	×
	80	1.026	0.889	0.789	0.713	0.653	×	×	×	×	×	×	×	×	×	×
5.5	-10	2.650	2.352	2.126	1.948	1.805	1.687	1.589	×	×	×	×	×	×	×	×
	0	2.432	2.158	1.950	1.787	1.656	1.548	1.458	×	×	×	×	×	×	×	×
	10	2.213	1.964	1.775	1.627	1.507	1.409	1.327	×	×	×	×	×	×	×	×
	20	1.995	1.770	1.600	1.466	1.358	1.270	1.196	×	×	×	×	×	×	×	×
	30	1.776	1.576	1.424	1.305	1.210	1.131	1.065	×	×	×	×	×	×	×	×
	40	1.558	1.382	1.249	1.145	1.061	0.992	0.934	×	×	×	×	×	×	×	×
	50	1.339	1.188	1.074	0.984	0.912	0.852	0.803	×	×	×	×	×	×	×	×
	60	1.121	0.994	0.899	0.824	0.763	0.713	0.672	×	×	×	×	×	×	×	×
	70	0.902	0.800	0.723	0.663	0.614	0.574	0.541	×	×	×	×	×	×	×	×
	80	0.683	0.606	0.548	0.502	0.465	0.435	0.410	×	×	×	×	×	×	×	×
6.0	-10	2.081	1.863	1.696	1.562	1.454	1.364	1.289	1.224	×	×	×	×	×	×	×
	0	1.910	1.710	1.556	1.433	1.334	1.252	1.182	1.123	×	×	×	×	×	×	×
	10	1.738	1.556	1.416	1.305	1.214	1.139	1.076	1.022	×	×	×	×	×	×	×
	20	1.567	1.402	1.276	1.176	1.094	1.027	0.970	0.921	×	×	×	×	×	×	×
	30	1.395	1.249	1.136	1.047	0.974	0.914	0.864	0.820	×	×	×	×	×	×	×
	40	1.223	1.095	0.996	0.918	0.855	0.802	0.757	0.719	×	×	×	×	×	×	×
	50	1.052	0.941	0.857	0.789	0.735	0.689	0.651	0.619	×	×	×	×	×	×	×
	60	0.880	0.788	0.717	0.661	0.615	0.577	0.545	0.518	×	×	×	×	×	×	×
	70	0.708	0.634	0.577	0.532	0.495	0.464	0.439	0.417	×	×	×	×	×	×	×
	80	0.537	0.481	0.437	0.403	0.375	0.352	0.332	0.316	×	×	×	×	×	×	×
7.2	-10	1.273	1.153	1.059	0.984	0.921	0.869	0.825	0.786	0.753	0.724	0.698	×	×	×	×
	0	1.168	1.058	0.972	0.902	0.845	0.797	0.757	0.722	0.691	0.664	0.641	×	×	×	×
	10	1.063	0.963	0.885	0.821	0.769	0.726	0.689	0.657	0.629	0.605	0.583	×	×	×	×
	20	0.958	0.868	0.797	0.740	0.693	0.654	0.621	0.592	0.567	0.545	0.526	×	×	×	×
	30	0.853	0.773	0.710	0.659	0.617	0.582	0.553	0.527	0.505	0.485	0.468	×	×	×	×
	40	0.748	0.678	0.623	0.578	0.541	0.511	0.485	0.462	0.443	0.426	0.410	×	×	×	×
	50	0.643	0.583	0.535	0.497	0.465	0.439	0.417	0.397	0.381	0.366	0.353	×	×	×	×
	60	0.538	0.488	0.448	0.416	0.389	0.367	0.349	0.332	0.318	0.306	0.295	×	×	×	×
	70	0.433	0.392	0.360	0.335	0.314	0.296	0.281	0.268	0.256	0.246	0.238	×	×	×	×
	80	0.328	0.297	0.273	0.254	0.238	0.224	0.213	0.203	0.194	0.187	0.180	×	×	×	×
8.0	-10	0.967	0.881	0.812	0.756	0.710	0.671	0.638	0.610	0.585	0.563	0.543	0.526	0.510	×	×
	0	0.888	0.808	0.745	0.694	0.652	0.616	0.586	0.559	0.536	0.516	0.499	0.483	0.468	×	×
	10	0.808	0.735	0.678	0.631	0.593	0.561	0.533	0.509	0.488	0.470	0.454	0.439	0.426	×	×
	20	0.728	0.663	0.611	0.569	0.534	0.505	0.480	0.459	0.440	0.424	0.409	0.396	0.384	×	×
	30	0.648	0.590	0.544	0.507	0.476	0.450	0.428	0.409	0.392	0.377	0.364	0.352	0.342	×	×
	40	0.568	0.518	0.477	0.444	0.417	0.395	0.375	0.358	0.344	0.331	0.319	0.309	0.300	×	×
	50	0.489	0.445	0.410	0.382	0.359	0.339	0.322	0.308	0.295	0.284	0.275	0.266	0.258	×	×
	60	0.409	0.372	0.343	0.320	0.300	0.284	0.270	0.258	0.247	0.238	0.230	0.222	0.216	×	×
	70	0.329	0.300	0.276	0.257	0.242	0.228	0.217	0.207	0.199	0.192	0.185	0.179	0.174	×	×
	80	0.249	0.227	0.209	0.195	0.183	0.173	0.165	0.157	0.151	0.145	0.140	0.136	0.132	×	×

(2/2)

Unit : ms

Vp [V]	Tx [°C]	Motor drive pulse rate [pps]														
		400	600	800	1000	1200	1400	1600	1800	2000	2200	2400	2600	2800	3000	3200
8.5	-10	0.829	0.756	0.698	0.651	0.612	0.580	0.551	0.527	0.506	0.487	0.471	0.456	0.443	0.431	0.420
	0	0.760	0.694	0.641	0.598	0.562	0.532	0.506	0.484	0.464	0.447	0.432	0.418	0.406	0.395	0.385
	10	0.692	0.631	0.583	0.544	0.511	0.484	0.460	0.440	0.423	0.407	0.393	0.381	0.370	0.360	0.350
	20	0.624	0.569	0.526	0.490	0.461	0.436	0.415	0.397	0.381	0.367	0.354	0.343	0.333	0.324	0.316
	30	0.555	0.507	0.468	0.437	0.410	0.388	0.370	0.353	0.339	0.327	0.315	0.306	0.297	0.289	0.281
	40	0.487	0.444	0.410	0.383	0.360	0.341	0.324	0.310	0.297	0.286	0.277	0.268	0.260	0.253	0.247
	50	0.419	0.382	0.353	0.329	0.309	0.293	0.279	0.266	0.256	0.246	0.238	0.230	0.224	0.218	0.212
	60	0.350	0.320	0.295	0.275	0.259	0.245	0.233	0.223	0.214	0.206	0.199	0.193	0.187	0.182	0.177
	70	0.282	0.257	0.238	0.222	0.208	0.197	0.188	0.179	0.172	0.166	0.160	0.155	0.151	0.147	0.143
	80	0.214	0.195	0.180	0.168	0.158	0.149	0.142	0.136	0.130	0.126	0.121	0.118	0.114	0.111	0.108
9.5	-10	0.628	0.574	0.532	0.497	0.468	0.444	0.423	0.405	0.389	0.375	0.363	0.351	0.341	0.332	0.324
	0	0.576	0.527	0.488	0.456	0.430	0.407	0.388	0.372	0.357	0.344	0.333	0.322	0.313	0.305	0.297
	10	0.524	0.480	0.444	0.415	0.391	0.371	0.353	0.338	0.325	0.313	0.303	0.294	0.285	0.278	0.271
	20	0.472	0.432	0.400	0.374	0.353	0.334	0.318	0.305	0.293	0.282	0.273	0.265	0.257	0.250	0.244
	30	0.421	0.385	0.357	0.333	0.314	0.298	0.284	0.271	0.261	0.251	0.243	0.236	0.229	0.223	0.217
	40	0.369	0.338	0.313	0.292	0.275	0.261	0.249	0.238	0.229	0.220	0.213	0.207	0.201	0.195	0.190
	50	0.317	0.290	0.269	0.251	0.237	0.224	0.214	0.205	0.197	0.189	0.183	0.178	0.173	0.168	0.164
	60	0.265	0.243	0.225	0.210	0.198	0.188	0.179	0.171	0.164	0.159	0.153	0.149	0.144	0.141	0.137
	70	0.214	0.196	0.181	0.169	0.159	0.151	0.144	0.138	0.132	0.128	0.123	0.120	0.116	0.113	0.110
	80	0.162	0.148	0.137	0.128	0.121	0.115	0.109	0.104	0.100	0.097	0.094	0.091	0.088	0.086	0.084

X : Unusable

(Note) The table above is applicable under the following condition:

- Use of thermal paper “TF50KS-E2D”
- V_p and GND wiring resistance : $r_c = 0$
- The number of simultaneously activated dots : $N_{SA} = 96$

3.5.8 Temperature Characteristics of Thermistor

Calculate the resistance of the thermistor (R_X) at the operating temperature T_X (°C) using the following equation (9). Variation of resistance by temperature is shown in Figure 3-9 and Table 3-20.

Equation (9):

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

R_X	:	Resistance at T_X °C (Ω)	
R_{25}	:	Resistance at 25 °C	30 kΩ ±5%
B	:	B value	3950 K ±2%
T_X	:	Temperature detected by thermistor (°C)	
EXP (A)	:	The "A" th power of natural logarithm e (2.71828)	

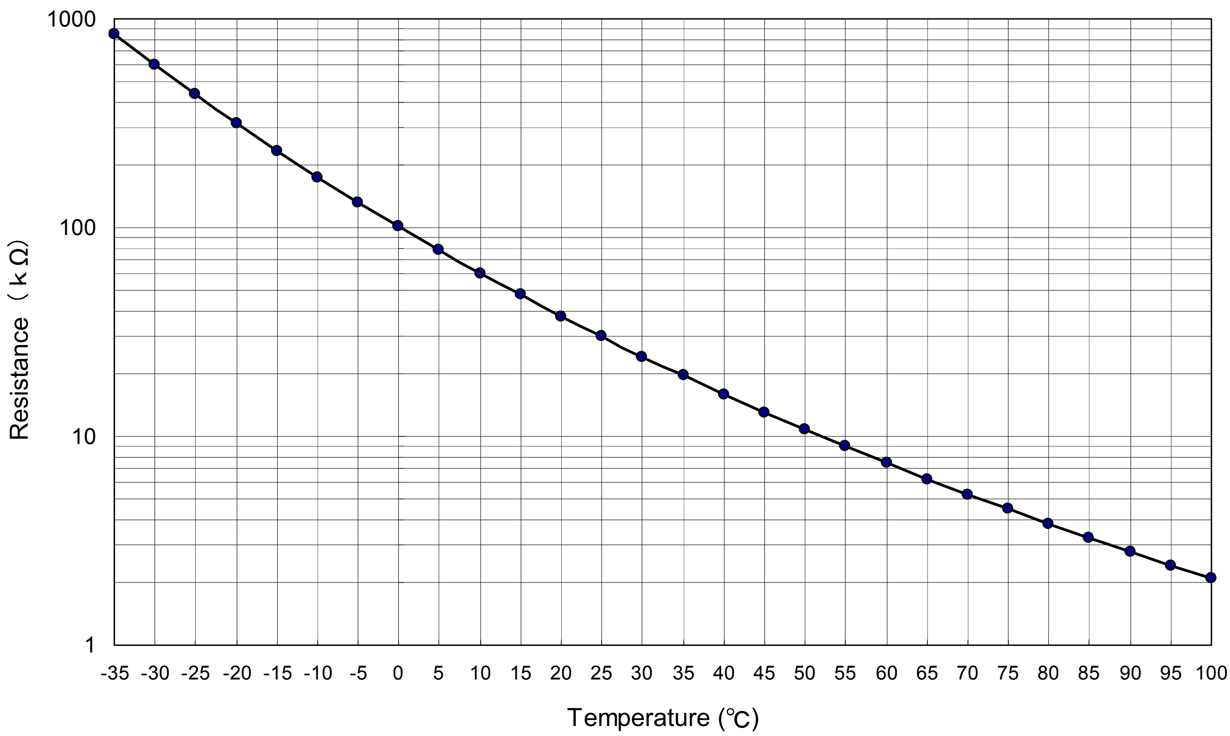


Figure 3-9 Temperature Characteristics of the Thermistor

Table 3-20 Temperature Characteristics of the Thermistor

Temperature (°C)	Thermistor Resistance (kΩ)
-35	847.93
-30	602.63
-25	434.23
-20	316.97
-15	234.22
-10	175.07
-5	132.29
0	100.99
5	77.85
10	60.57
15	47.53
20	37.61
25	30.00
30	24.11
35	19.51
40	15.89
45	13.03
50	10.75
55	8.92
60	7.45
65	6.25
70	5.27
75	4.47
80	3.80
85	3.25
90	2.79
95	2.41
100	2.09

3.5.9 Detecting Abnormal Temperature of the Thermal Head

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

(1) Detecting abnormal temperatures by software

Design software that will deactivate the heat elements if the thermal head thermistor (TH) detects a temperature higher than 85°C (thermistor resistance $R_{TH} \leq 3.25\ k\Omega$), and reactivate the heat elements when a temperature lower than 60°C ($R_{TH} \geq 7.45\ k\Omega$) is detected. If the thermal head continues to be activated at a temperature higher than 85°C, the life of the thermal head may be shortened significantly.

(2) Detecting abnormal temperatures by hardware

If the thermal head continues to be activated by malfunction of the control unit (CPU), the software for detecting abnormal temperatures may not function properly, resulting in overheating of the thermal head. Overheating of the thermal head not only may damage the thermal head but also may cause smoke, fire and burn injuries. Always use hardware together with software for detecting abnormal temperatures to ensure personal safety. (If the control unit malfunctions, it may be impossible to prevent damage on the thermal head even if an abnormal temperature is detected by hardware.).

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

(a) Overheating of the thermal head
(approximately 100°C or higher ($R_{TH} \leq 2.09\ k\Omega$))

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

If abnormal condition is detected, immediately turn off the power supply. Reactivate the heat elements after they have returned to normal.

3.6 OUT-OF-PAPER SENSOR

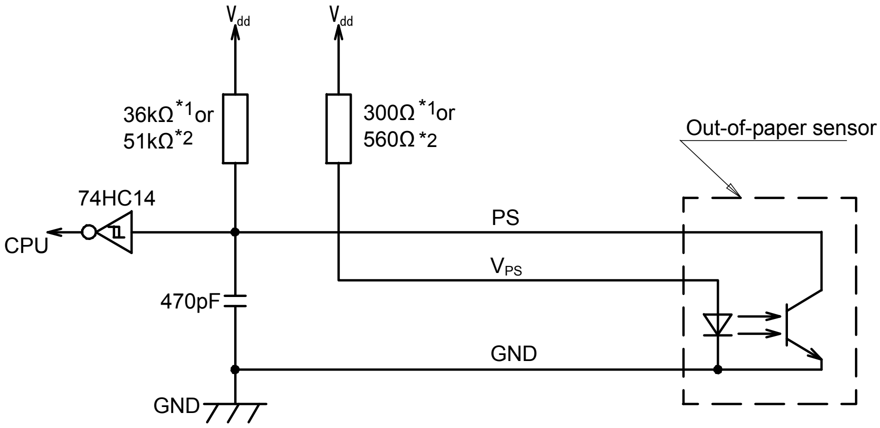
The printer has a built-in out-of-paper sensor (reflection type photo interrupter) to detect whether paper is present or not. An external circuit should be designed so that it detects output from the out-of-paper sensor and does not activate the thermal head and motor when there is no paper. Doing not so may cause damage to the thermal head or platen roller or shorten the life of the thermal head significantly. If the motor is driven for a long period of time when there is no paper, a load is put on the paper drive system and the life of the printer may be shortened significantly.

Table 3-21 shows about the out-of-paper sensor used for this printer.

Table 3-21 Out-of-paper Sensor

Item	Specification
Type	NJL5902R (Rank B)
Manufacturer	New Japan Radio Co.,Ltd.

Figure 3-10 shows sample external circuit of the out-of-paper sensor. Use the resistances *1 and *2 within the operating voltage range in the table below.



*: The PS signal is “High” when there is no paper.

Resistances	Other than Labeling Paper	Labeling Paper
*1	2.7 V to 3.6 V	3.0 V to 3.6 V
*2	4.75 V to 5.25 V	4.75 V to 5.25 V

Figure 3-10 Sample External Circuit of the Out-of-paper Sensor

3.7 PLATEN POSITION SENSOR

The printer has a built-in platen position sensor for detecting the platen block is set. This sensor is a mechanical switch which is designed to be ON when the platen block is set and to be OFF when it is released.

The external circuit should be designed to detect output from the platen position sensor and output from the out-of-paper sensor described in 3.6. If the platen block is released and no paper are detected, the external circuit should not activate the thermal head. Otherwise, the thermal head may become damaged or its life may be shortened significantly.

Activate the thermal head when the platen is set by detecting the output from the platen position sensor, and in the paper presence state by detecting the output from the out-of-paper sensor.

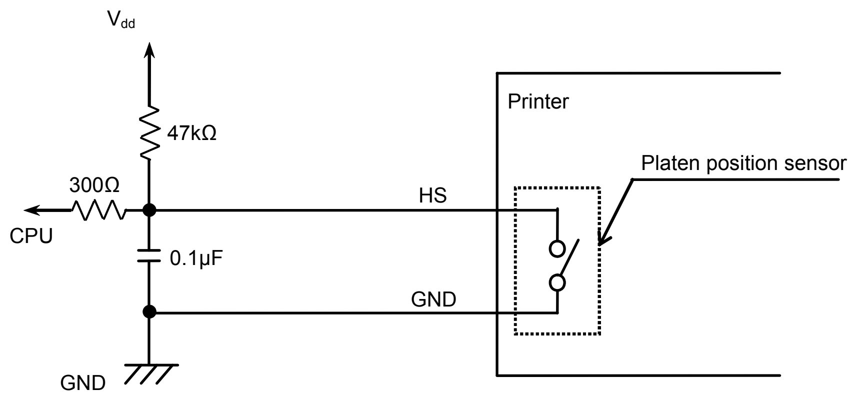
3.7.1 General Specifications

Table 3-22 shows about the general specification

Table 3-22 General Specifications of Platen Position Sensor

Item	Specification
Rated voltage	DC5.0 V
Rated current	1 mA
Contact resistance	3 Ω max.

Figure 3-11 shows sample external circuit of the platen position sensor.



*: The HS signal is “High” when the platen is in OPENED state.

Figure 3-11 Sample External Circuit of the Platen Position Sensor

3.7.2 Precautions for the Platen Position Sensor

- Be sure that there is a time lag between the time when the thermal head is set and the time when the platen position sensor actually starts detecting.
- Always use the capacitor shown in Figure 3-11 to prevent the switch from malfunctioning due to chattering.

CHAPTER 4
CONNECTING TERMINALS

4.1 RECOMMENDED CONNECTOR FOR EXTERNAL CIRCUITS

Use the recommended connectors listed in Table 4-1 to connect the printer connecting terminals firmly to the external circuits.

Table 4-1 Recommended Connectors

Number of Terminals	Recommended Connectors
50	MOLEX INC: 0541045031 (Right angle type : Top contact, Gold plated)

4.2 CONNECTING TERMINALS

Figure 4-1 shows the terminal configuration of the connecting terminals and Table 4-2 and Table 4-3 show terminal assignments of the connecting terminals.

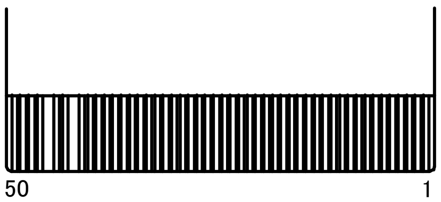


Figure 4-1 Connecting Terminals

Table 4-2 Terminal Assignments of the Connecting Terminal (LTPD245C)

(1/2)

Terminal No.	Signal Name	Function
1	V_P	Thermal head drive power supply
2	V_P	Thermal head drive power supply
3	V_P	Thermal head drive power supply
4	V_P	Thermal head drive power supply
5	V_P	Thermal head drive power supply
6	V_P	Thermal head drive power supply
7	DI	Print data input (serial input)
8	CLK	Synchronizing signal for print data transfer
9	GND	GND
10	GND	GND
11	GND	GND
12	GND	GND
13	GND	GND
14	GND	GND
15	DST6	Thermal head print activation instruction signal (#6 block)
16	DST5	Thermal head print activation instruction signal (#5 block)
17	DST4	Thermal head print activation instruction signal (#4 block)
18	V_{dd}	Logic power supply
19	TH2	Thermistor (the one is used for GND)
20	TH1	Thermistor (same as connecting terminal #21)
21	TH1	Thermistor (same as connecting terminal #20)
22	DST3	Thermal head print activation instruction signal (#3 block)
23	DST2	Thermal head print activation instruction signal (#2 block)
24	DST1	Thermal head print activation instruction signal (#1 block)
25	GND	GND
26	GND	GND
27	GND	GND
28	GND	GND
29	GND	GND
30	GND	GND

(2/2)

Terminal No.	Signal Name	Function
31	$\overline{LAT}$	Print data latch (memory storage) signal
32	V_P	Thermal head drive power supply
33	V_P	Thermal head drive power supply
34	V_P	Thermal head drive power supply
35	V_P	Thermal head drive power supply
36	V_P	Thermal head drive power supply
37	V_P	Thermal head drive power supply
38	N.C.	No connection
39	PS	Output signal of the out-of-paper sensor (Photo-transistor collector)
40	V_{PS}	Power supply of the out-of-paper sensor (LED anode)
41	GND	GND of the out-of-paper sensor (LED cathode, photo-transistor emitter) Platen position sensor GND
42	HS	Platen position sensor output
43	N.C.	No connection
44	FG	Frame Ground
45	FG	Frame Ground
46	N.C.	No connection
47	$\overline{A}$	Motor drive signal
48	B	Motor drive signal
49	A	Motor drive signal
50	$\overline{B}$	Motor drive signal

Table 4-3 Terminal Assignments of the Connecting Terminal (LTPD345C)

(1/2)

Terminal No.	Signal Name	Function
1	V_P	Thermal head drive power supply
2	V_P	Thermal head drive power supply
3	V_P	Thermal head drive power supply
4	V_P	Thermal head drive power supply
5	V_P	Thermal head drive power supply
6	V_P	Thermal head drive power supply
7	DI	Print data input (serial input)
8	CLK	Synchronizing signal for print data transfer
9	GND	GND
10	GND	GND
11	GND	GND
12	GND	GND
13	GND	GND
14	GND	GND
15	N.C.	No connection
16	DST5	Thermal head print activation instruction signal (#5 block)
17	DST4	Thermal head print activation instruction signal (#4 block)
18	V_{dd}	Logic power supply
19	TH2	Thermistor (the one is used for GND)
20	TH1	Thermistor (same as connecting terminal #21)
21	TH1	Thermistor (same as connecting terminal #20)
22	DST3	Thermal head print activation instruction signal (#3 block)
23	DST2	Thermal head print activation instruction signal (#2 block)
24	DST1	Thermal head print activation instruction signal (#1 block)
25	GND	GND
26	GND	GND
27	GND	GND
28	GND	GND
29	GND	GND
30	GND	GND

Terminal No.	Signal Name	Function
31	$\overline{\text{LAT}}$	Print data latch (memory storage) signal
32	V_P	Thermal head drive power supply
33	V_P	Thermal head drive power supply
34	V_P	Thermal head drive power supply
35	V_P	Thermal head drive power supply
36	V_P	Thermal head drive power supply
37	V_P	Thermal head drive power supply
38	N.C.	No connection
39	PS	Output signal of the out-of-paper sensor (Photo-transistor collector)
40	V_{PS}	Power supply of the out-of-paper sensor (LED anode)
41	GND	GND of the out-of-paper sensor (LED cathode, photo-transistor emitter) Platen position sensor GND
42	HS	Platen position sensor output
43	N.C.	No connection
44	FG	Frame Ground
45	FG	Frame Ground
46	N.C.	No connection
47	$\overline{\text{A}}$	Motor drive signal
48	B	Motor drive signal
49	A	Motor drive signal
50	$\overline{\text{B}}$	Motor drive signal

CHAPTER 5
PRINT DRIVE METHOD

5.1 MOTOR AND THERMAL HEAD DRIVE METHOD

The motor and the thermal head must be driven at the same time for printing.

The printer uses the thermal head with heat elements which size is a half-dot size of the feed direction. One dot is, therefore, composed of two of the half dots. The motor feeds the thermal paper for one dot line with four steps. In order to print one dot line, feed the thermal paper for four steps and activate the thermal head in every two step.

The following describes the drive method as an example of the LTPD245C.
Figure 5-1 shows a timing chart for driving using six division printing.
Figure 5-2 shows a timing chart for driving using one division printing.

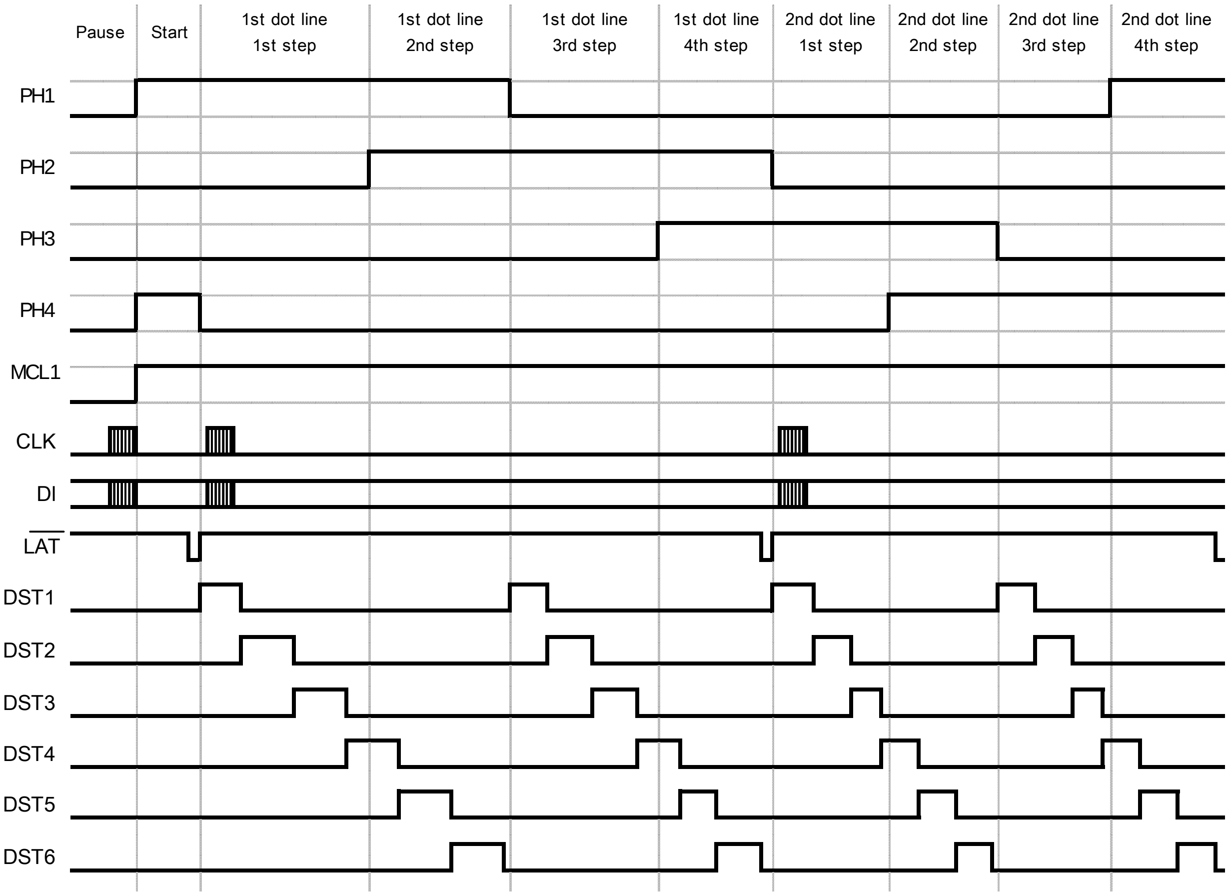


Figure 5-1 Timing Chart for Driving Using Six Divisions (LTPD245C)

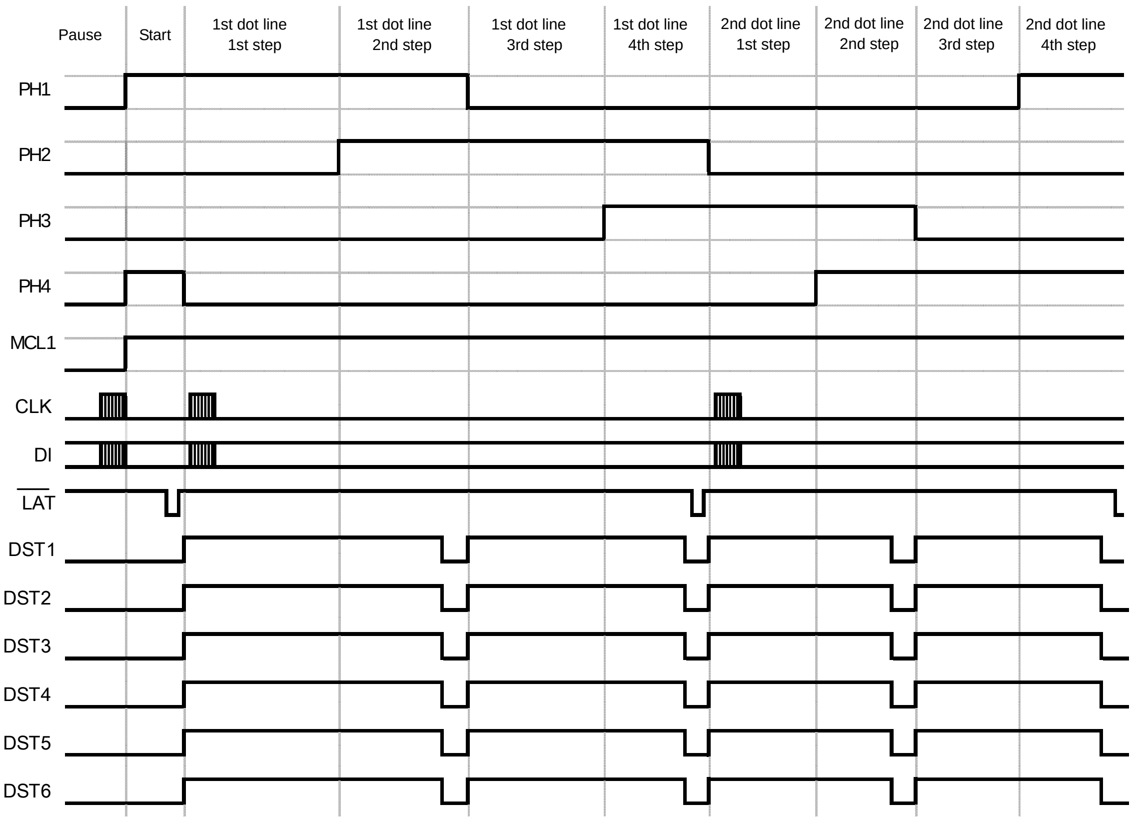


Figure 5-2 Timing Chart for Driving Using One Division (LTPD245C)

The drive method using six divisions is described below (See Figure 5-1):

(1) Pause state

Inactivate the motor and always make DST signal of the thermal head "Low".

(2) Start step

Excite the motor by the same phase which is output just before the motor stops.

(3) 1st dot line

Activate the thermal head once every 2 steps of the motor drive signal. Configure 1 dot line by 4 steps of the motor drive signal.

At the 1st step of the motor drive signal, start activation of the thermal head by synchronized the DST1 signal and printing the 1st half dot line at the 1st dot line by DST1 to DST6.

After 1 step of the motor drive signal is completed, input the 2nd step of the motor drive signal. (It is not necessary to synchronize the activation of the thermal head.)

After printing the 1st half dot line at the 1st dot line, the 3rd step of the motor drive signal, start activation of the thermal head by synchronized the DST1 signal and printing the 2nd half dot line at the 1st dot line by DST1 to DST6.

After 3 step of the motor drive signal is completed, input the 4th step of the motor drive signal. (It is not necessary to synchronize the activation of the thermal head.)

Input the DST signal previously, transfer the data which is printed into the “SHIFT REGISTER” in the thermal head. And latch to “LATCH REGISTER” of the thermal head by inputting the $\overline{\text{LAT}}$ signal.

(4) Procedures that follows the 2nd dot line

Drive the motor in the same way as the way for the 1st dot line. Repeat the motor driving and thermal head activation.

5.2 THERMAL HEAD DIVISION DRIVE METHOD

In the thermal head of the printer, there are 6 blocks (every 64 dots) in 1 dot line for LTPD245C. There are 5 blocks (4 blocks are divided every 128 dots and 1 block is divided 64dots) in 1 dot line for LTPD345C. These blocks are called physical blocks. DST signal is allocated to each physical block to activate it. To drive the thermal head, physical blocks are activated in groups. The group of physical blocks is called a logical block.

The following two methods are available as thermal head division drive methods. Select one you desire.

(1) Fixed division method

Logical blocks (physical blocks to be driven at the same time) are predetermined for the fixed division method.

In this method, high quality printing is available because the physical blocks are always driven in the same order.

(2) Dynamic division method

Logical blocks are predetermined so that number of dots of the physical block does not exceed the specified maximum number of the activating dots for every 1 dot line printing. Logical blocks are predetermined for every 1 dot line printing.
The maximum current consumption can be controlled within a constant value.

Since the order of the printing block and print speed are changed in each dot line according to the content of the print data, print quality in this method may be lower than that in fixed division method. If print quality is regarded as important, printing in fixed division method is recommended.

5.3 PRECAUTIONS FOR PRINT DRIVE

- When using one division printing, a pause time between thermal head activations of the same heat element shall be secured more than 0.5ms.

- The number of the maximum thermal head division in a half dot line should be 6 or lower for LTPD245C and 9 or lower for LTPD345C to maintain print quality. The number of the simultaneously activated dots should be 96 dots or less. (Up to 128 dots are available if the V_P is 7.9 or lower for LTPD345C.)

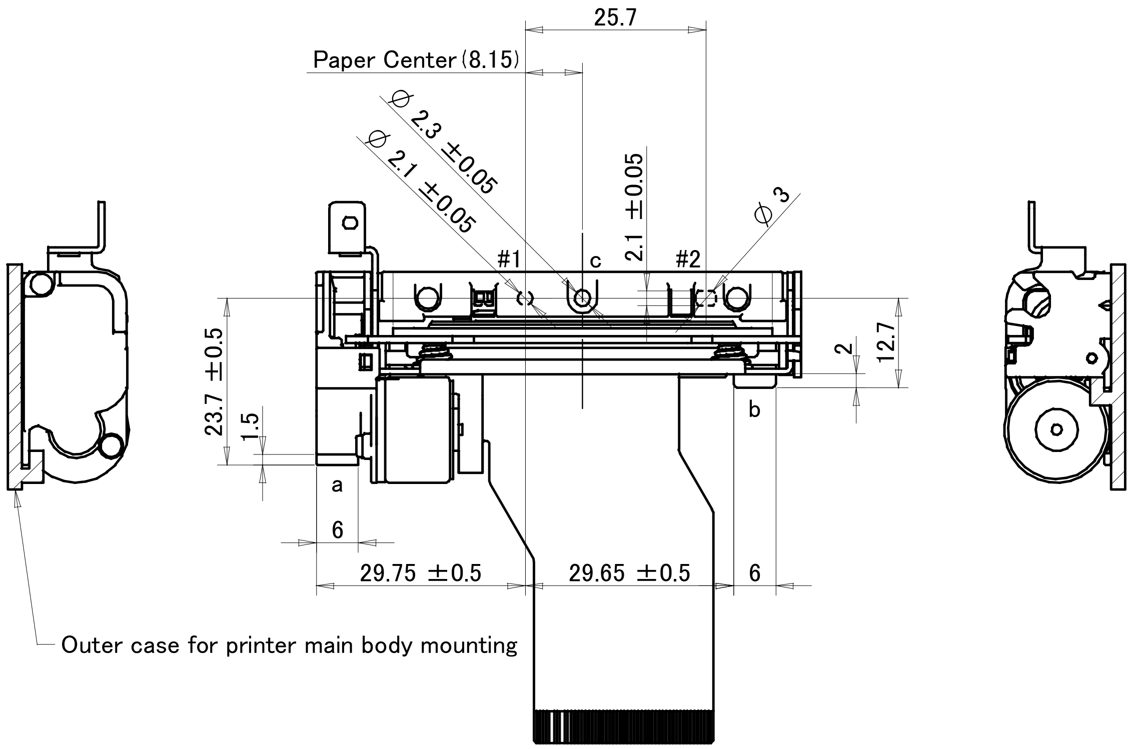
CHAPTER 6
OUTER CASE DESIGN GUIDE

6.1 SECURING THE PRINTER MAIN BODY

6.1.1 How to Mount the Printer Main Body

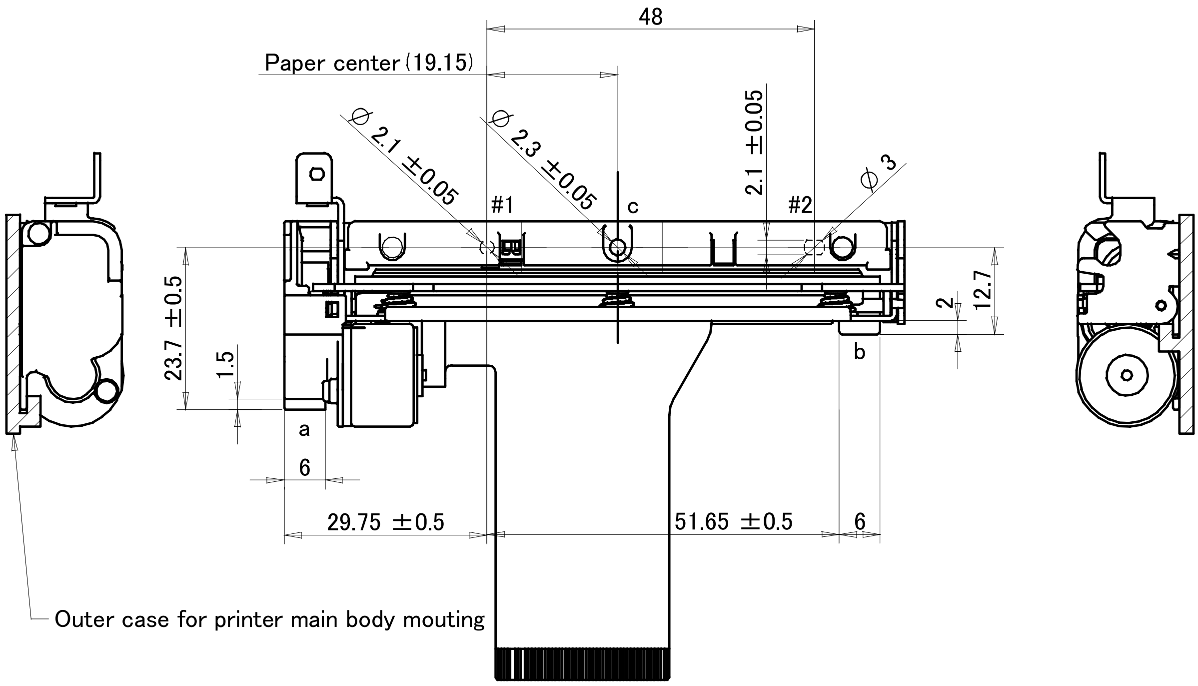
Figure 6-1 and Figure 6-2 show dimensions for positioning and securing the printer main body.

- Holes #1 and #2 must be used for positioning the printer main body. Design bosses on the outer case to position the printer main body for the positioning holes #1 and #2. The height of the bosses on the outer case must be 1.5mm (Max.)
- Secure by screw at the U shaped screwing position c.
- Design the fixing hook to the part of a and b.



Unit : mm
General tolerance for dimensions : ±0.1

Figure 6-1 Dimensions for Positioning and Securing the Printer Main Body (LTPD245C)



Unit : mm
General tolerance for dimensions : ±0.1

Figure 6-2 Dimensions for Positioning and Securing the Printer Main Body (LTPD345C)

6.1.2 Recommended Screws

M2 cross-recessed pan head screw

6.1.3 Precautions for Securing the Printer Main Body

- Prevent from excessive stress, deformation, and torsion for securing the printer, otherwise poor printing quality, paper skewing, paper jamming, and noise during printing may be caused.
- The printer main body to be mounted on a flat surface and prevent from vibration.
- Verify the intensity of the fixing hook with your actual device.
- Pay attention not to damage on the FPC when securing the printer main body.

6.2 CONNECT THE PRINTER TO FRAME GROUND (FG)

To prevent the thermal head from being damaged by static electricity, it is recommended that the printer is connected to frame ground (FG).

6.2.1 How to Connect the Printer to Frame Ground (FG)

- Connect the printer main body to the frame ground (FG) of the outer case with the printer connecting terminals No.44 and 45 shown in Chapter 4, through the frame ground (FG) of the circuit board. When the printer main body is connected, make the shortest possible position of the printer connecting terminals and the frame ground (FG) of the outer case. And those are not effect to the control signal.

- If using a sheet metal material for the door, the door should also be connected to the frame ground (FG) of the interface board.

- The electric potential of all the frame ground (FG) of the printer are equal.

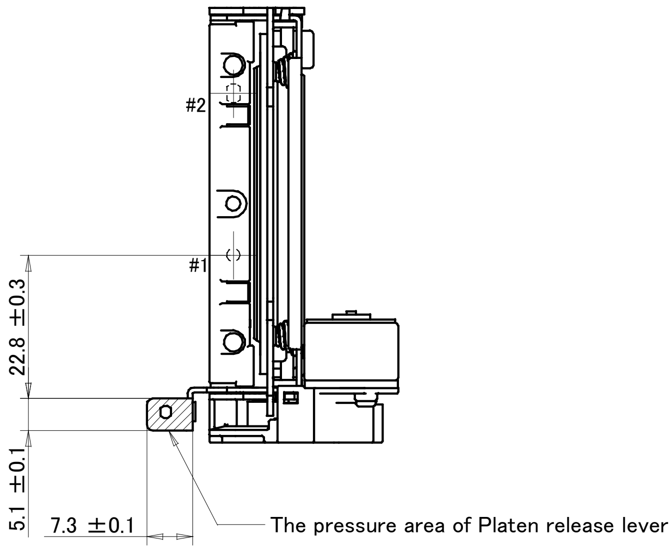
- Connect the signal ground (SG) to the frame ground (FG) using a 1MΩ resistor so that the electric potential of the signal ground (SG) of the thermal head and that of the frame ground (FG) of the printer are equal.

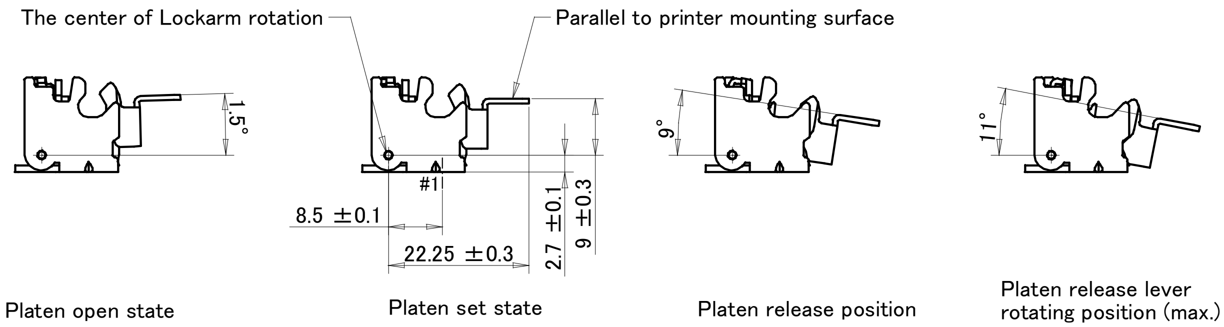
6.3 DESIGN THE PLATEN RELEASE LEVER

Figure 6-3 shows dimensions, the pressure area and its movement of the platen release lever when the platen release lever is released.

When designing the button or the lever that will operate simultaneously with the platen release lever, follow the precautions below.

- Design a stopper in the outer case to prevent to exceed a 11 degree range of the platen release lever's motion and to be applied excessive force (29.4N (3kg)).
- Design the button or the lever and its motion so that the platen release lever is pushed to an angle of 9 degrees of the released position.
- Design the button or the lever so that no load is constantly applied to it while the platen block is set.





Unit : mm

Figure 6-3 External Dimensions and Motion of the Platen Release Lever

6.4 LAYOUT OF THE PRINTER MECHANISM AND THE THERMAL PAPER

The printer mechanism can be laid out as shown below.

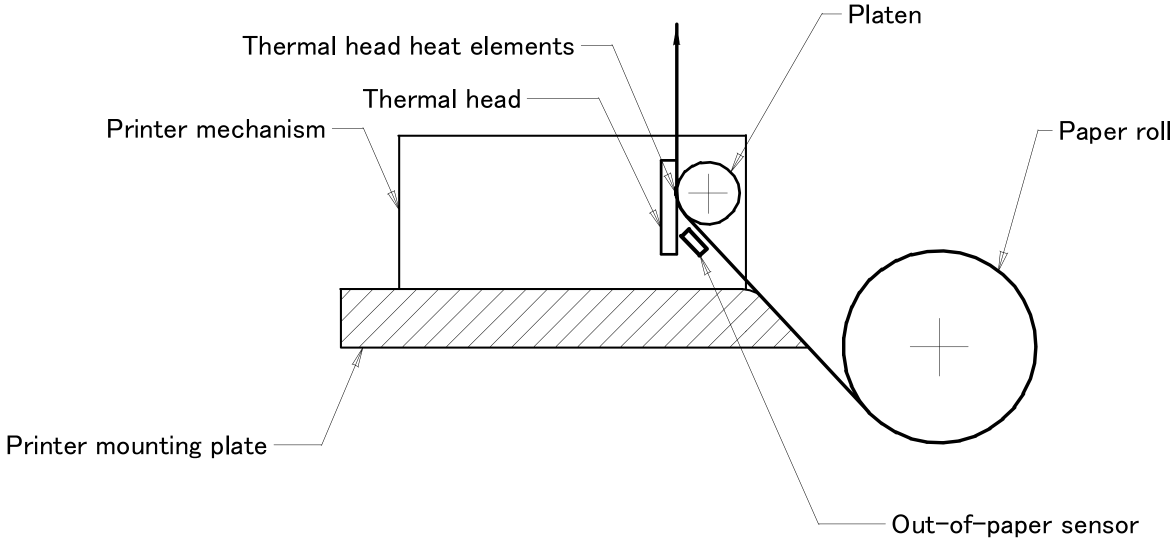


Figure 6-4 Layout of the Printer Mechanism and the Thermal Paper

* The thermal paper feeding distance between the out-of-paper sensor and the heat element is approximately 8.3mm

6.5 WHERE TO MOUNT THE PAPER HOLDER

When designing the layout of the paper holder, note the followings. The recommended configuration of the paper holder is shown in Figure 6-5.

- Design the paper holder and the paper guide so that the thermal paper will be straight to the paper inlet port without any horizontal shifting and so that the center axis of the paper roll will be parallel to the printer when using paper roll.

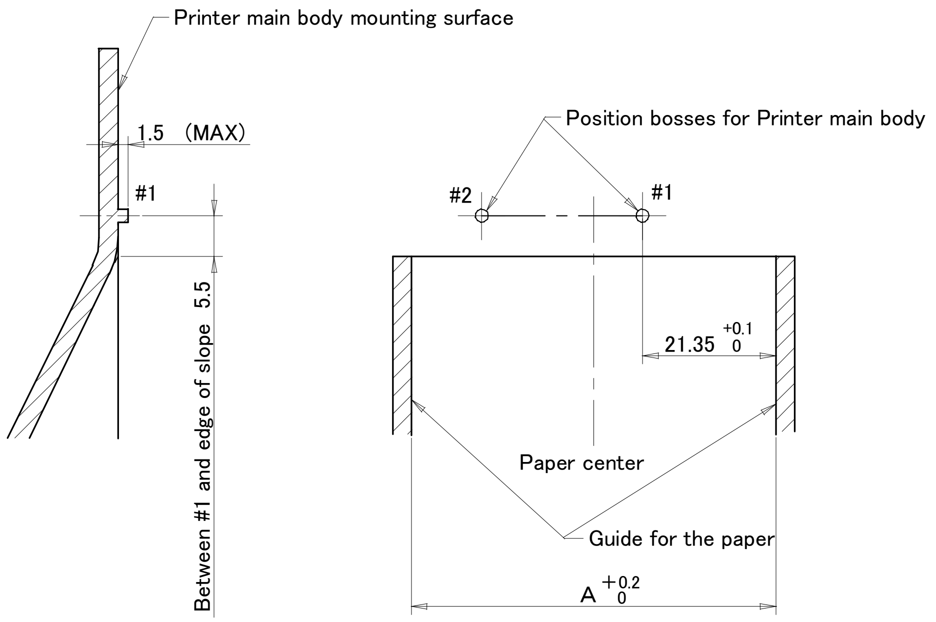
- Design the paper holder so that the paper feed load should be 0.49N (50gf) or less. Be aware that the printing problem and paper feed problem may occur in the following case even if it is below 0.49N. Design the paper holder so as not to make these conditions and verify the performance with your actual device.

  ex)
  In case that the paper roll wobbles in the paper holder.
  In case that tension of the thermal paper between the paper roll and the printer changes rapidly.

  In addition, do not use following types of the paper roll:

  Expanded paper roll
  Deformed paper roll
  Roll core is sticking out.
  Width of the paper roll is out of spec

- When feeding the thermal paper backwards, secure enough space in the paper holder so that the thermal paper can return to the paper holder smoothly.



Unit : mm
General tolerance for dimensions : ±0.1

LTPD245C (A:59)
LTPD345C (A:81)

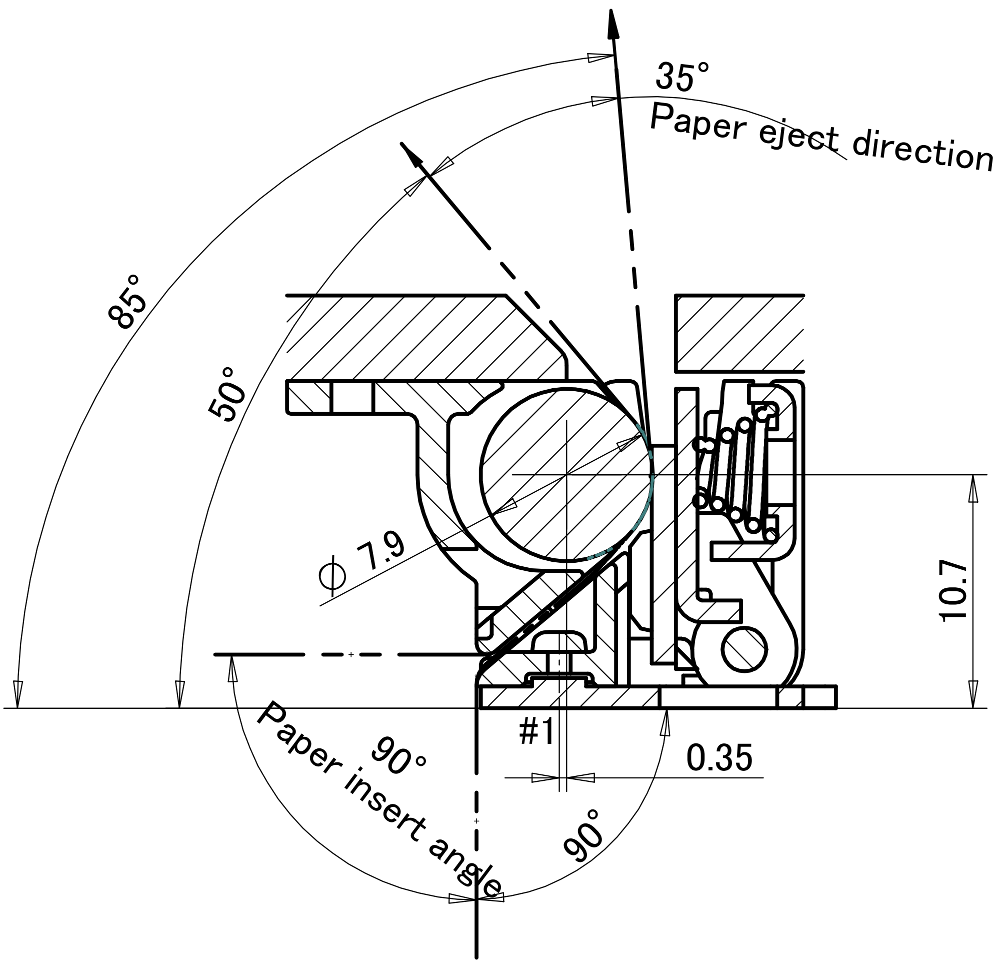
Figure 6-5 Recommended Paper Holder Dimensions

6.6 DESIGN PAPER EXIT

6.6.1 Design the Shape of the Paper Exit

When designing the shape of the paper exit, note the followings.

- Design the shape of the paper exit of outer case so that stress is not applied to the thermal paper to be rejected.
- Design the paper exit of the outer case and the door so that the paper eject angle must be within of 50° to 85° as shown in Figure 6-6. However, design the paper exit of outer case so that the thermal paper can be ejected without changing its eject direction. Do not change the paper eject direction around the paper exit of printer mechanism. If changing the paper eject direction, verify the performance with your actual device.



Unit : mm
General tolerance for dimensions : ±0.1

Figure 6-6 Paper Path

6.6.2 Mount the Paper Cutter

- Design paper cutter mounting position so the edge of the cutter blade does not touch with a platen block when the platen block is set and released.
- Use a well-cut cutter so that the thermal paper can be cut with less force than paper holding force.
- Design the blade edge of the cutter as shown in the right figure of Figure 6-7 so that the blade edge can guide the thermal paper edge after cutting. If designing the blade edge as shown in the left figure, the paper edge may be caught by the blade edge and result in the thermal paper edge to be caught inside of the cutter.
- Set the paper cutter to a position that allows to feed the paper backwards up to 9mm.

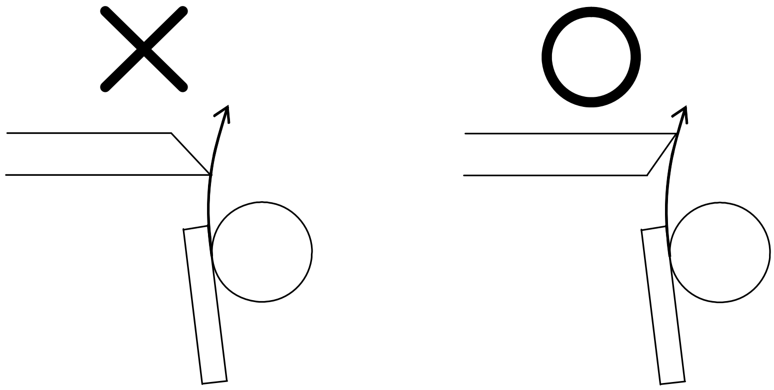


Figure 6-7 Blade Edge

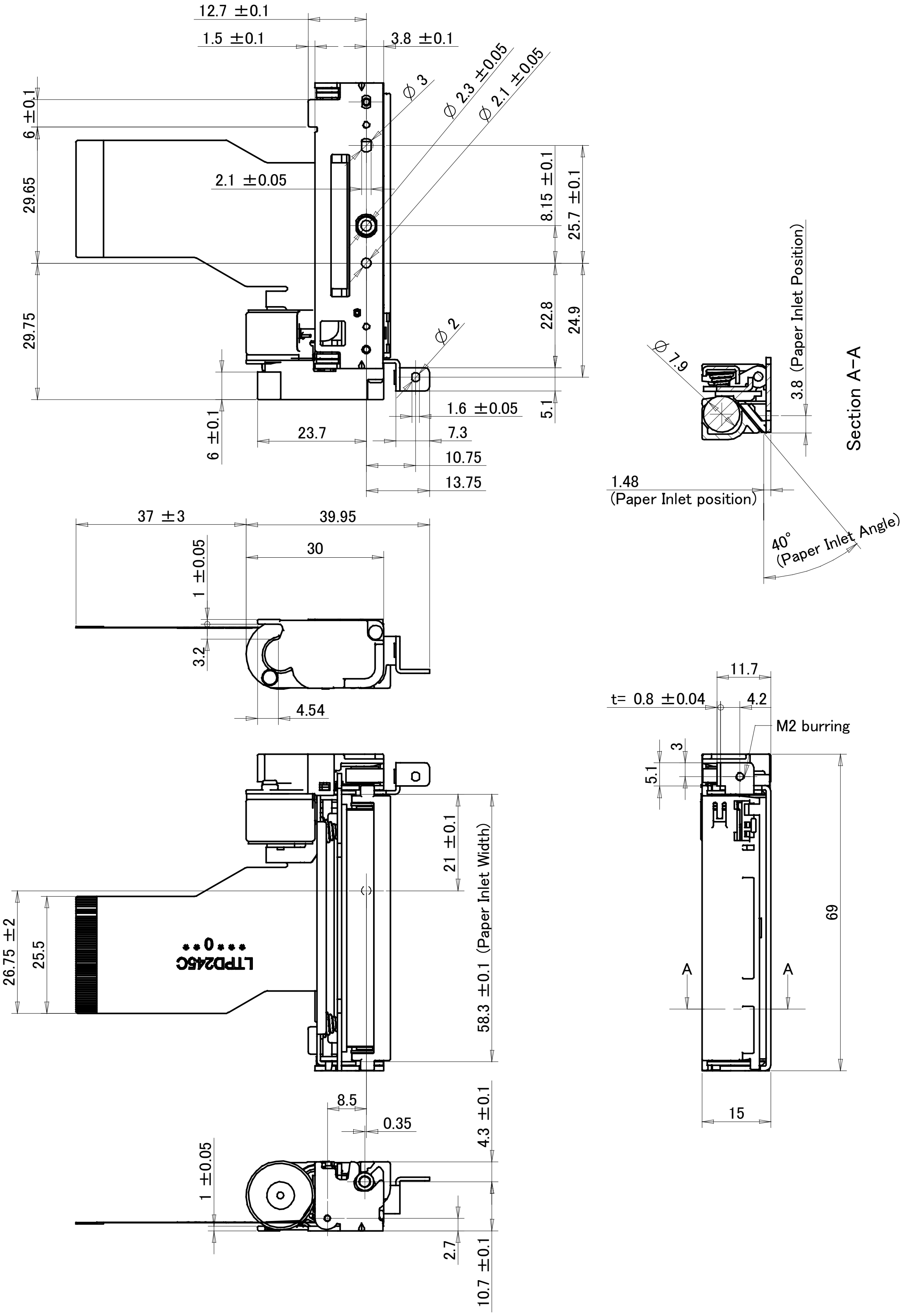
6.7 PRECAUTIONS FOR DESIGNING THE OUTER CASE

- The thermal paper with a small winding diameter may cause the paper jam in the printer main body and a gap between the printer and the outer case. If using such a thermal paper with the small diameter, verify the performance with your actual device.
- Design the outer case to ensure enough space to allow users to handle the platen release lever easily with fingers.
  See Chapter 8 “PROCEDURES for INSTALLING/UNINSTALLING THERMAL PAPER” for specific procedures. Also, see 6.3 “DESIGN THE PLATEN RELEASE LEVER” for its motion.
- Design the outer case so that it and parts for the outer case will not apply any load to the printer main body and the platen block. The load may affect printing, and also may damage the printer mechanism. Secure 1.0mm (min.) space between the printer main body and platen block and the outer case.
- Temperature of the thermal head and its peripherals rises very high during and immediately after printing. Be sure to design the outer case to prevent users from burn injuries by touching them. Place warning labels to warn users to ensure safe operation. As for thermal head cleaning, warn users to allow the thermal head to cool before cleaning. In order to allow cooling, secure clearance between the thermal head and the outer case when designing the outer case.
- Temperature of the motor and its peripherals rises very high during and immediately after printing. Be sure to design the outer case to prevent users from burn injuries by touching them. Place warning labels to warn users to ensure safe operation. In order to allow cooling, secure clearance between the motor and the outer case when designing the outer case.

CHAPTER 7
EXTERNAL DIMENSIONS

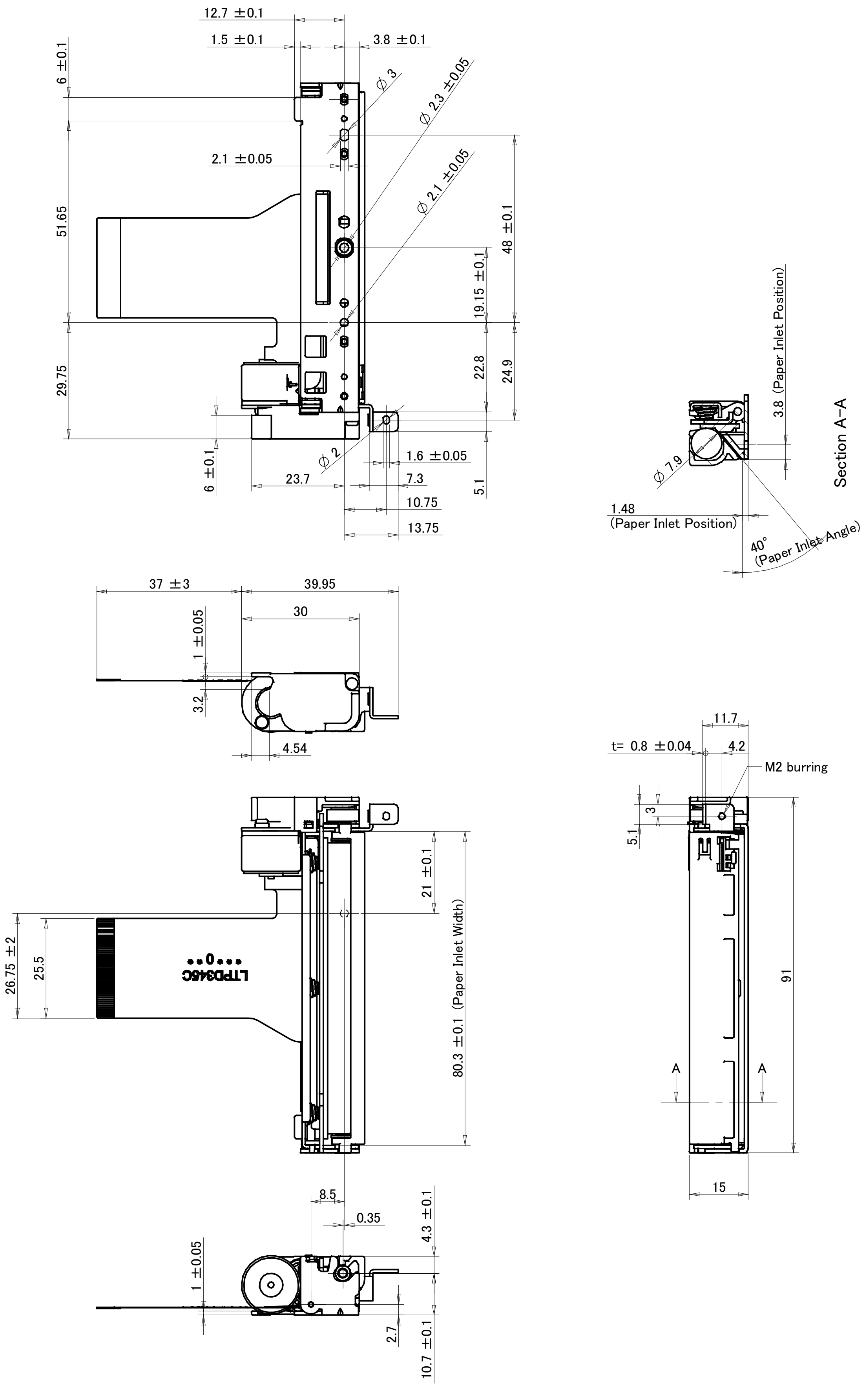
Figure 7-1 shows external dimensions of the printer mechanism LTPD245C.

Figure 7-2 shows external dimensions of the printer mechanism LTPD345C.



Unit : mm
General tolerance for dimensions : ±0.5

Figure 7-1 External Dimensions of the Printer Mechanism (LTPD245C)



Unit : mm
General tolerance for dimensions : ±0.5

Figure 7-2 External Dimensions of the Printer Mechanism (LTPD345C)

CHAPTER 8
HANDLING METHOD

8.1 PROCEDURES FOR INSTALLING/UNINSTALLING THE THERMAL PAPER

8.1.1 Procedures for Installing/Uninstalling the Thermal Paper

(a) Installing the thermal paper

- Cut the edge of the paper finely with scissors, a cutter knife, etc. It is recommended that the edge of the thermal paper be cut in the shape shown in Figure 8-1.

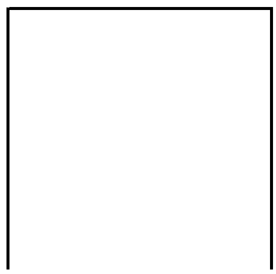


Figure 8-1 Thermal Paper Edge

- Insert the thermal paper from the paper inlet until it meets resistance.
- Feed the thermal paper while inserting the thermal paper. See Chapter 3 “Motor Drive Method” for motor drive pulse rate.

(b) Uninstalling the thermal paper

- Cut the thermal paper near the paper inlet.
- Feed the paper until the paper is totally discharged.

(c) Clearing a paper jam

- Uninstall the paper according to the method of uninstalling the thermal paper.
- If a paper jam is not solved, operate the platen release lever as shown in Figure 8-2 and remove the thermal paper.

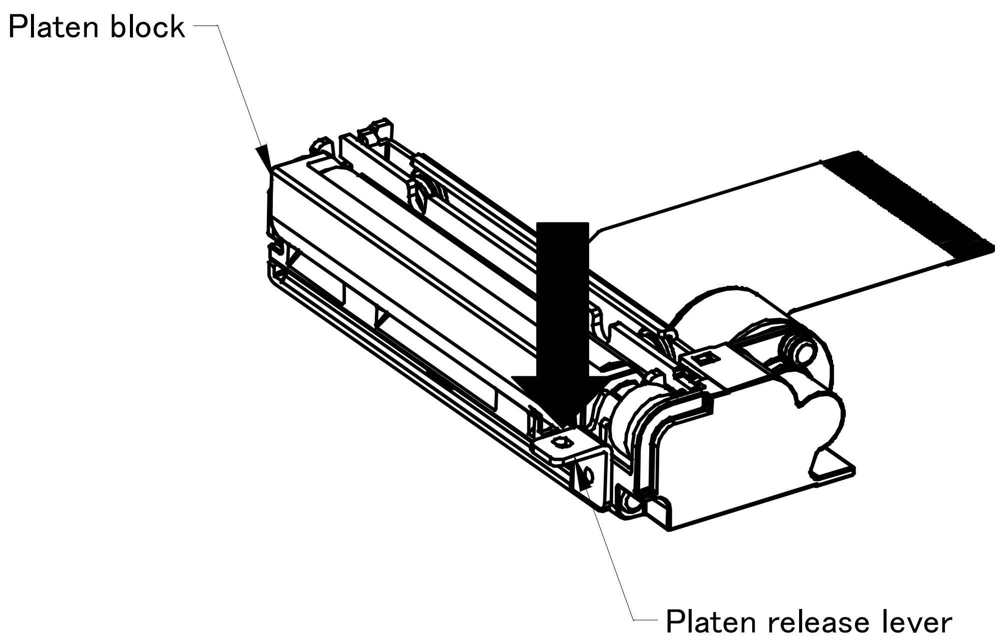


Figure 8-2 Releasing the Platen Block

8.1.2 Precaution for Installing/Uninstalling the Thermal Paper

- After the printer has been left not in use with the platen block set without the thermal paper for long period of time, the platen and the thermal head may be stuck together and cause difficulty in automatic loading of the thermal paper.
  If facing this problem, release the platen block and set it back again before starting printing.

- When setting the platen block, the reduction gear may interfere with the platen gear and may cause the platen block to not be set. In such a case, release the platen block and set it again.

- If the thermal paper is skewed, feed the thermal paper until the thermal paper becomes straight or install the thermal paper again.

- Remove the jamming paper with the platen block released. Do not pull the thermal paper by force because severe damages may occur.

8.2 CLEANING THE THERMAL HEAD

If the surface of the thermal head exposed to dirt, ensure to clean the thermal head to avoid a print defect.

8.2.1 Procedures for Cleaning the Thermal Head

- Turn off the power before cleaning.
- Push the platen release lever to the direction of the arrow in the Figure 8-3. Pull up the platen block after making sure that the platen block is released from the printer main body.
- Clean the heat element shown in Figure 8-3 using a cotton swab dipped in ethyl alcohol or isopropyl alcohol.
- Set the platen block after the alcohol has dried completely.

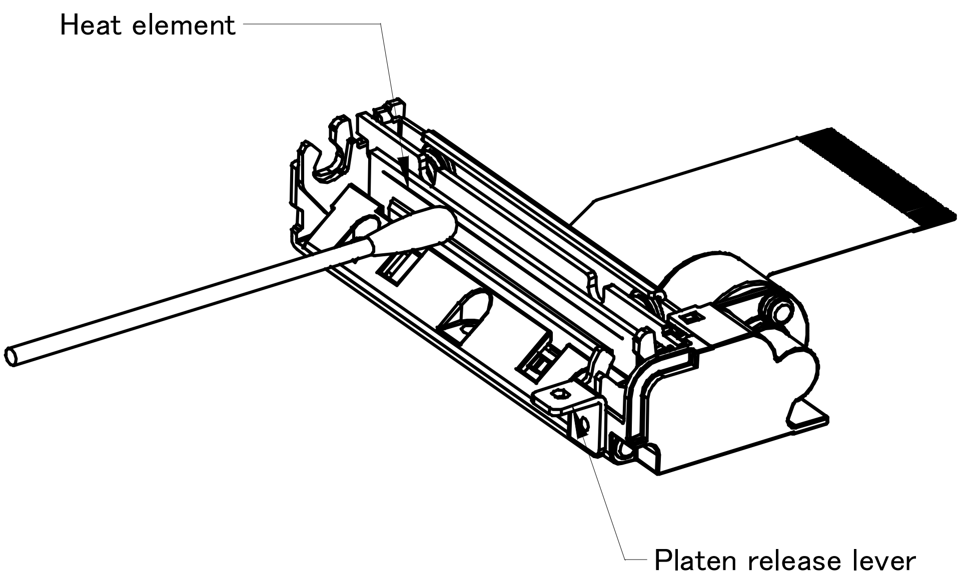


Figure 8-3 Cleaning Position of the Thermal Head

8.2.2 Precautions for Cleaning the Thermal Head

- Do not clean the thermal head immediately after printing because the temperature of the thermal head and its peripherals rises very high during and immediately after printing.
- Clean the thermal head with the platen block released.
- Do not use sandpaper, a cutter knife, or anything which may damage the heat element for cleaning.