SII

CAPM347
AUTOCUTTER INTEGRATED
THERMAL PRINTER MECHANISM
TECHNICAL REFERENCE

U00123639605

Seiko Instruments Inc.

CAPM347 AUTOCUTTER INTEGRATED THERMAL PRINTER MECHANISM TECHNICAL REFERENCE

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PREFACE

This technical reference describes the specifications and basic operating procedures for the CAPM347 autocutter integrated thermal printer mechanism (hereinafter referred to as “printer”).

The printer has the following models.

Model	Paper Loading Method	Remarks
CAPM347B-E	Easy Operation	Standard
CAPM347C-E	Auto-loading	Standard
CAPM347D-E	Easy Operation	Exclusive model for thick paper *1
CAPM347E-E	Auto Loading	Exclusive model for thick paper *1

*1: See "General Specification" in Chapter 3 for the specified thermal paper.

Hereinafter, the models are defined as below.

- Easy Operation Model : CAPM347B-E／CAPM347D-E
- Auto-loading Model : CAPM347C-E／CAPM347E-E
- Standard Model : CAPM347B-E／CAPM347C-E
- Exclusive Model for thick paper : CAPM347D-E／CAPM347E-E

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 (2011/65/EU)

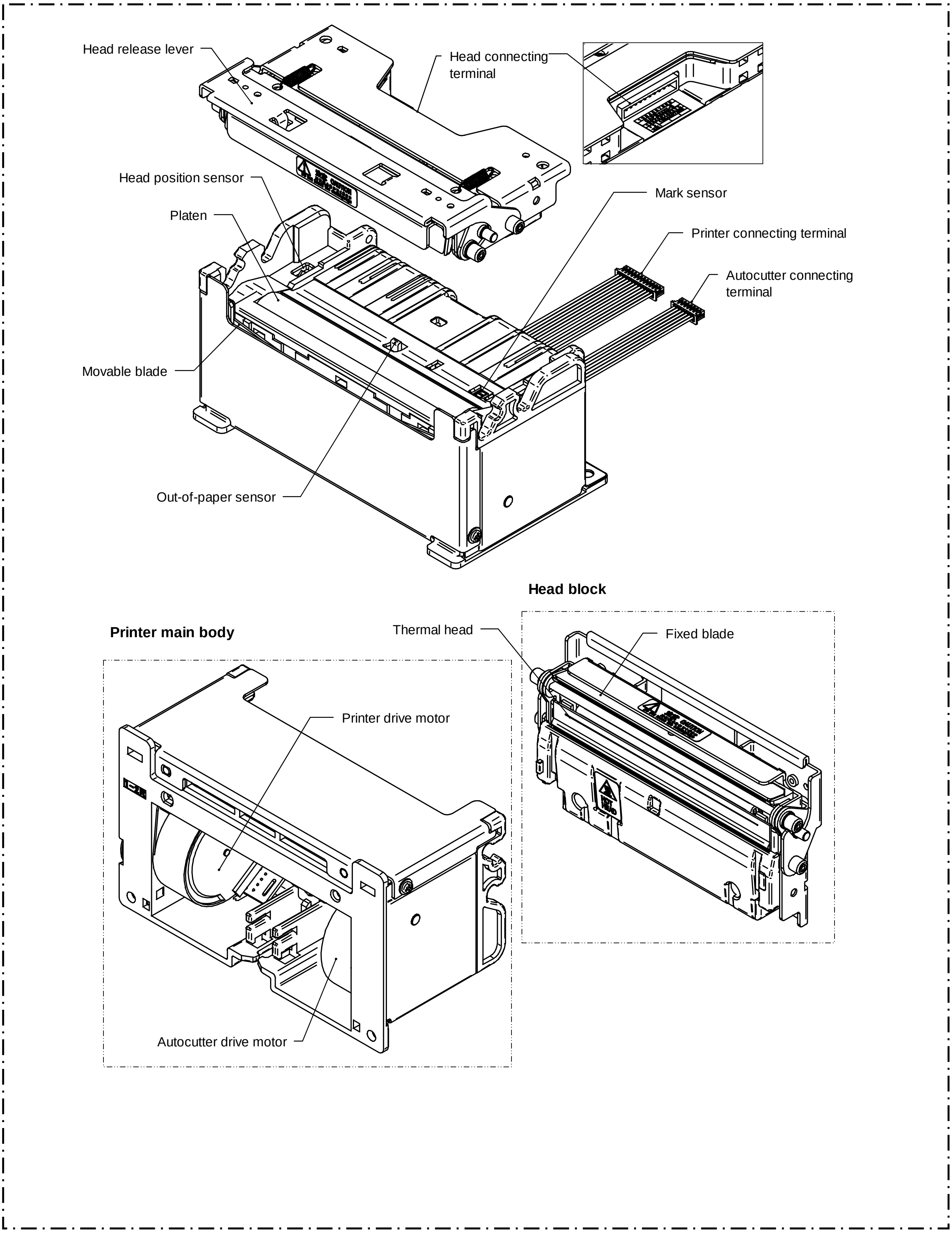
The printer contains “Pb”, the details are described below.

- a particular free-cutting steel parts, a particular component in glass of the electronic parts

  *Lead-containing items listed above are exempt from RoHS (2011/65/EU).

Identifying the parts of the printer as follows.

Printer mechanism (Easy operation model)



Printer mechanism (Auto-loading model)

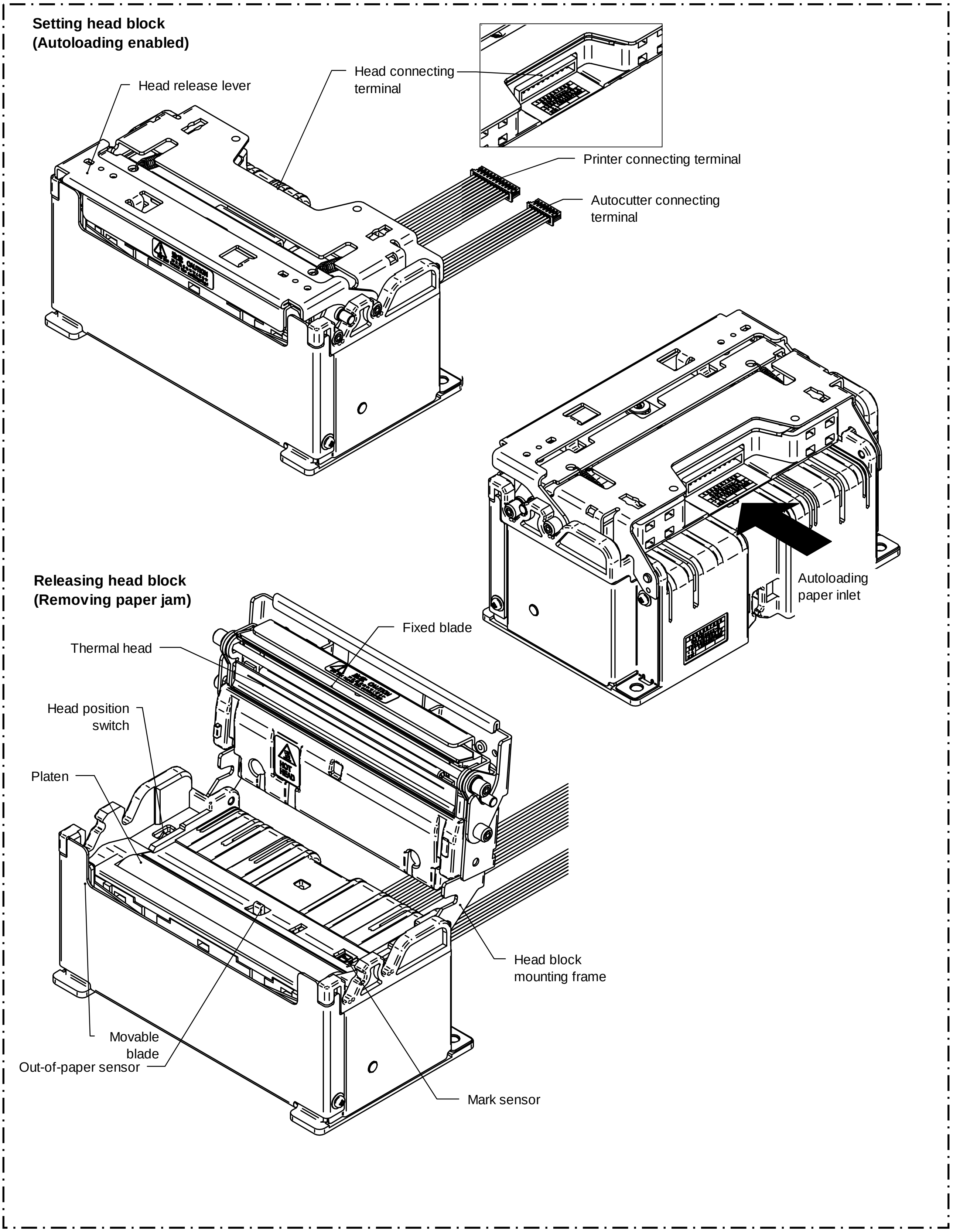


TABLE OF CONTENTS

CHAPTER 1
PRECAUTIONS

CHAPTER 2
FEATURES

CHAPTER 3
SPECIFICATIONS

CHAPTER 4
CONNECTING TERMIANLS

CHAPTER 5
DRIVE METHOD

CHAPTER 6
OUTER CASE DESIGN GUIDE

CHAPTER 7
EXTERNAL DIMENSIONS

CHAPTER 8
HANDLING METHOD

FIGURES

TABLES

CHAPTER 1
PRECAUTIONS

Read through this technical reference to design 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 for cutting the thermal paper**

  Make sure the thermal paper feed has been in a stop state when cutting the thermal paper. Paper powders can be caused while the autocutter is working. Be sure to design an outer case not to have the paper powders piled up on the control board and the power supply as this may cause short circuit failure.

- **Precautions for cutter blade**

  In this printer, the head block is removable from a printer main body so that the thermal paper can be set easily. Therefore, when the head block is in open state, the fixed cutter blade becomes exposed. To prevent users from injuring himself/herself by touching the cutter blades while the autocutter is in operation and replacing the thermal paper, design a structure such as a shutter in the outer case or place warning labels to warn users to ensure safe operation. Also, warn users not to touch the cutter blades directly during unpacking or assembling the printer into the outer case.

- **Precautions for the movable blade drive**

  Control the motor not to drive when the head block is in open state. Also, be sure to design the paper exit to prevent users from injuring himself/herself by touching the autocutter directly while the autocutter is operating.

- **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. Design the outer case and control the printer operation to prevent users from burn injuries by touching them. Place warning labels to warn users to ensure safe operation (e.g. do not apply current to thermal head in the cases that the head position sensor detects the releasing of head block). 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 surface 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. Control the motor drive (printer drive motor) not to drive when the outer case and the head 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.

- **Precautions for head block**

  In this printer, the head block is removable from a printer main body so that the thermal paper can be set easily. To prevent the users from getting their finger caught between head block and printer main body, 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 28 V.
- Make the wire resistance between the power supply (V_P and GND) and the printer (connecting terminals) as small as possible (below 50 mΩ). Keep distance from signal lines to reduce electrical interference.
- The switch and the sensor may generate instantaneous abnormal signal. Design the firmware in order to prevent malfunction due to the abnormal signal.
- Keep the V_P power off while not printing in order to prevent the thermal head from electrolytic corrosion. In addition, design the product so that the Signal Ground (GND) of the thermal head and the Frame Ground (FG) of the printer become the same electric potential.
- Use C-MOS IC chips for CLK, $\overline{LAT}$, DI and $\overline{DST}$ signals of the thermal head.
- When turning the power on or off, or during not printing, always disable the $\overline{DST}$ terminals.
- To prevent the thermal head from being damaged by static electricity, the printer main body and the head block are connected to the Frame Ground (FG) of the outer case.
  See Chapter 6 “OUTER CASE DESIGN GUIDE” for the connecting method.
  Verify the performance with your actual device.
- Always detect the outputs of the head position sensor, out-of-paper sensor and cutter position sensor. Never activate the thermal head or the cutter drive motor when the head block is in open state. Incorrect activation of the thermal head or the autocutter may reduce the life of the thermal head and the autocutter or may damage them. Never activate the thermal head when there is no paper. Incorrect activation of the thermal head may reduce the life of the thermal head and the platen or may damage them.
- A pause time between thermal head activations of the same heat element shall be secured more than 0.1ms. 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”.
- The number of the maximum thermal head division in 1 dot line should be 5 or lower. However, the print quality may degrade due to the type of thermal paper even if the number of thermal head division is 5 or lower. Verify the performance with your actual device.
- 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.
- Refer to Chapter 3 “Printer Drive Motor Drive Method” and “Autocutter Drive Motor Drive Method” to prevent the motor from overheating. Make sure the temperature of the motor outer case is 100°C or less. Install the drive circuit to prevent the overload current 1.6 A or more from flowing to the motor, refer to Chapter 3 "Sample Drive Circuit" for installing the drive circuit. Verify the performance with your actual device.
- 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 10 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 40 steps or more at the initialization, at a time after setting/releasing the head block, at a time after feeding the thermal paper backward, and a time after cutting with the autocutter.
- The printer has been left for long period of time after cutting the thermal paper, may occur the paper jam. To prevent this case, printing or feeding 7 mm or more after cutting.
- Do not feed the thermal paper backwards exceeding 5 mm. Feeding the thermal paper backward more than 5mm may cause paper skew and jams.
- Do not feed paper backwards after cutting with the partial cut. Backward feed may cause paper folding problem or paper jam. The part of the partial cut (tab left at the center) may be cut off.
- Surface of the thermal paper may get scratched by backward feed. The backward feed may cause paper skew and jams depending on the paper roll layout and designing of the 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 in the thermal head. Verify the performance with your actual device.
- When using the easy operation model, mount the head block on the outer case.
  When releasing/setting the head block, the outer case is subject to pressures. Because of this, design the paper cover and the mounting frame to have adequate strength. If they do not have adequate strength, it causes incorrect fitting. And as a result it leads to print defection, paper jam, cut failure, and/or damage of the cutter blade.
- When using the easy operation model, to ensure setting/releasing operation, design the mounting frame for the head block to maintain the allowable dimensions. Moreover, design to reduce the rattling of the rotating shaft for mounting frame as much as possible. See Chapter 6 “OUTER CASE DESIGN GUIDE” for details.
- When using the easy operation model, prevent the head block mounted on the mounting frame from being lifted in upward and twisted direction by overloaded pressure at the time of setting it. See Chapter 6 “OUTER CASE DESIGN GUIDE” for details.
- When using the easy operation model, do not apply pressure only on the center of the attachment plate for the head block. Pressure on the portion prevents smooth slide motion of the attachment plate, and it causes head block to be difficult to set. See Chapter 6 “OUTER CASE DESIGN GUIDE” for details.
- When using the easy operation model, if setting the paper cover by pushing its one end, it causes incorrect fitting (e.g. only one side of the head block is set). As a result, it leads to print defect, paper jam, cut failure and/or damage of cutter blade. Design the paper cover to be set by pushing its both ends. Verify the performance with your actual device. In order to let users to push designated portions, it is effective to put indications on the paper cover.
- Design the outer case to ensure enough space around the operating portion such as the head release lever. Otherwise the printer will be inoperable.

- If designing the outer case with a structure to bring the head block up automatically using a spring property after released, make sure not to apply more than enough force to bring the head 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 with the movable blade and the head block with the fixed blade will be improperly and will result in the print defect or the cut failure. Verify the performance with your actual device.

- When using the auto-loading model, if setting the head release lever by pushing its one end, it causes incorrect fitting (e.g. only one side of the head block is set). As a result, it leads to print defect, paper jam, cut failure and/or damage of cutter blade. Design the paper cover to be set by pushing its both ends. Verify the performance with your actual device. In order to let users to push designated portions, it is effective to put indications on the paper cover.

- 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 the thermal paper detection difficulty will be caused and the surface of thermal paper may get scratched. Verify the performance with your actual device.

- Warn users to clean the paper powder generated by cutting and feeding the thermal paper for long use of this product. The large amount of paper powder on sensor or switch may cause malfunction. Moreover, in the case that the fan is set on the outer case, paper powder, dust in the air and dirt may adhere to the thermal head, the sensor and the switch due to the flow of wind. This may cause malfunction and print defect. Pay special attention to the position of the fan.

- Do not use the paper except specified thermal paper. Do not use labeling paper, 2-ply thermal paper, and perforated thermal paper.

- Design the outer case so that a tension force is not applied to the head cables connected to the connecting terminal of the thermal head. The connecting terminal of the thermal head could be moved by setting/releasing the head block, so design the product that the head cables have enough play after connecting. The tension force may cause print problems, damage of the printer and/or the disconnection of the connecter.

- When fixing the head cables to the outer case, design the product so that the cables have enough slack on both sides of the fixed part. Especially on the side of the head block, let the cables have 1 cm to 2 cm of slack at a point 5cm away from the connector. Also, the slacks on the both sides of fixed part may shift to one side or the other by setting/releasing the head block. To ensure the adequate fixing of the head cables, it is recommended to bundle the head cables using banding band before fixing to the outer case.

- When using auto-loading model, fix the head cables on the top surface of the head block. Use the clamp (optional) or banding band to bundle the head cable and wire the head cable along the side of the printer so that it does not get in the way of releasing/setting the head block and inserting paper. Moreover, design the product so that the head cable does not block the way of the head block. Excessive force on the head block may cause damage on the connector. See Chapter 6 "OUTER CASE DESIGN GUIDE" for details.

- The head block of auto-loading model is movable without separating from the printer. Prevent excessive force on the head block. Otherwise, the hinge part of head block may become damaged. Set the stopper in the outer case so as not to exceed the maximum operation angle 95 degree of the head block at releasing.

- 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 the thermal 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
  (6) Cutter failure due to variety of the thermal paper thickness (and mechanical strength and paper density).

- 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 the 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 head 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 printer mechanism and the autocutter.

- Do not wipe oil that coating on the autocutter (movable blade and the fixed blade). It may reduce the efficiency of the autocutter.

- Do not release the head block during printing and cutting; otherwise this may reduce the efficiency of the printer and may cause damage.

- Do not apply stress to the head block while printing and cutting. The print defect and the cut failure may occur.

- Never pull out the thermal paper while the head block is set. The printer 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 mechanism and soil the thermal paper itself. Prevent the thermal head from a drop of water. It causes electrolytic corrosion of the thermal head. If condensed, do not activate electricity until dried.

- Connect or disconnect the connecting terminal (the thermal head connecting terminal, the printer connecting terminal, and the autocutter connecting terminal) after turn off the power of the printer.

- Do not apply stress to the lead wire while connecting and disconnecting the connecting terminal (the thermal head connecting terminal, the printer connecting terminal, and the autocutter connecting terminal). Otherwise the lead wire may become damaged.

- The lead wire is wired inside of the printer main body. Prevent excessive force on the lead wire. Otherwise, the lead wire may become damaged.

- Warn users not to pull the thermal paper and not to change the paper eject angle during printing and cutting. Otherwise, the print defect, the paper jam, and/or the cut failure may occur.
- Warn users to remove the thermal paper which cut with the full cut, then perform the next printing or cutting.
  If the thermal paper does not remove and perform the next printing or cutting, it may cause of the paper jam or cut failure depending on the mounting position.
- 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 papers, 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. If use the printer in a dusty place, it may damage the thermal head, paper drive system or reduce the efficiency of the autocutter.
- 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 printer, discard them according to the disposal regulations and rules of each respective district.

CHAPTER 2
FEATURES

The printer which has the thermal line dot printing method integrated the autocutter with the slide cutting 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.

- **High print speed** *

  Maximum 300 mm/s print is available.

- **Long life** *

  The printer has developed a long life of 200 million pulses of activation pulse, 200 km of abrasion resistance and 2 million cuts of paper cutting.

- **High reliability autocutter**

  The original head block positioning structure can assure the certain cutting performance constantly.

- **Easy operation**

  Head block open mechanism provides easy paper installation. (CAPM347B-E/CAPM347D-E)

- **Auto-loading function**

  Automatic insertion of thermal paper is enabled. (CAPM347C-E/CAPM347E-E)

- **Maintenance Free**

  No cleaning and no maintenance required.

*: Print speed and life span are different according to use conditions and thermal paper type. See Chapter 3 "SPECIFICATIONS" for details.

CHAPTER 3
SPECIFICATIONS

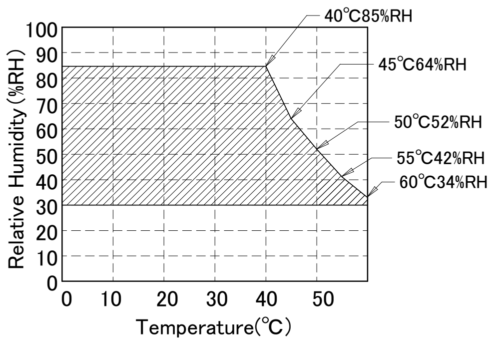
3.1 GENERAL SPECIFICATIONS

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

Table 3-1 General Specifications (Standard model CAPM347B-E/CAPM347C-E)

(1/3)

Items	Specifications			
	Paper width 83 mm	**Paper width 80 mm**	**Paper width 60 mm**	**Paper width 58 mm**
Printing method	Thermal dot line printing			
Total dots per line	640 dots			
Printable dots per line	640 dots	576 dots	448 dots	432 dots
Simultaneously activated dots	640 dots			
Resolution	W 8 dots/mm × H 8 dots/mm			
Paper feed pitch	0.0625 mm			
Maximum print speed	300 mm/s *1		300 mm/s *1 (0°C to 60°C) 250 mm/s (below 0°C)	
Print width	80 mm	72 mm	56 mm	54 mm
Paper width *2	$83^{\ 0}_{-1}$ mm	$80^{\ 0}_{-1}$ mm *3	$60^{\ 0}_{-1}$ mm *3	$58^{\ 0}_{-1}$ mm *3
Thermal head temperature detection	Thermistor			
Head position detection	Mechanical switch			
Out-of-paper detection	Transmission type photo interrupter			
Mark position detection	Reflection type photo interrupter *4			
Cutter home position detection	Transmission type photo interrupter			
Operating voltage range V_P line V_{dd} line	 21.6 V to 26.4 V 2.7 V to 3.6 V, 4.75 V to 5.25 V			
Paper set position	Center and One side (mark sensor side)			

Items		Specifications	
Printer current consumption V_P line Thermal head drive	Simultaneously activated dots	Maximum Voltage (26.4 V)	Rated Voltage (24.0 V)
	144 dots	5.6 A	4.9 A
	288 dots	11.2 A	9.9 A
	640 dots	24.9 A	21.9 A
Motor drive		1.2 A max.	
V_{dd} line Thermal head Logic		0.14 A max.	
Autocutter current consumption V_P line Motor driving		1.1 A max.	
Paper cutting method		Slide cutting	
Type of paper cutting		Full cut and Partial cut (1.5 ±0.5 mm tab left at the center)	
Paper curling tendency		Movable blade side	
Paper roll outside diameter [*5]		ϕ 60 mm to ϕ 100 mm ϕ 100 mm to ϕ 200 mm (Support paper roll by a center shaft)	
Minimum paper core diameter		ϕ 18 mm	
Minimum paper cutting length		20 mm	
Cutting processing time		Approx. 0.4 s/cycle	
Cutting frequency		1 cut/2 s max.	
Operating temperature range		-20°C to 60°C (Non condensing)	
Operating humidity range			
Storage temperature range		-30°C to 70°C (Non condensing)	
Life span (at 25ºC and rated energy)	Activation pulse resistance	200 million pulses or more [*6]	
	Abrasion resistance	200 km or more [*7]	
	Paper cutting resistance	2 million cuts or more [*8]	

Items	Specifications
Paper feed force	1.47 N (150 gf) or more [*9]
Paper hold force	0.98 N (100 gf) or more
Dimensions [*10]	Easy operation model W 110.0 mm × D 61.0 mm × H 53.4 mm Auto-loading model W 110.0 mm × D 61.0 mm × H 55.9 mm
Mass	Approx. 500 g
Specified thermal paper	Assured range temperature for printing: -20°C to 60°C Nippon Paper TP60KJ-R Mitsubishi Paper mills limited P220VBB-1 Mitsubishi Paper mills limited HP220AB-1
	Assured range temperature for printing: -20°C to 50°C Nippon Paper TF50KS-E2D Oji Paper PD160R Papierfabrik August Koehler AG KT55F20 Mitsubishi Hi-Tech Paper F5041 [*11] KSP P30023 [*12]
	Assured range temperature for printing: 0°C to 50°C Nippon Paper TL69KS-LH [*13] KSP KIP370 [*13]

*1 : Print speed changes according to the processing speed of the controller and print pulse width.
Maximum print speed is 280 mm/s when Vp voltage is over 21.6V and under 22.8V.

*2 : Only one of the specified paper widths can be used for a printer mechanism.
The specifications are applicable only when using the same paper width continuously.

*3 : Use thermal paper so that the center of its width comes to the center of printer mechanism.
See "PAPER WIDTH ADJUSTMENT" in Chapter 6 for details.

*4 : In the cases that the paper set position is at center alignment, mark position detection does not support 58mm and 60mm paper width..

*5 : Install the tension roller around the paper inlet slot.

*6 : Excluded when the same dots are printed continuously.
Life span of activation pulse resistance for specified thermal paper, TL69KS-LH (Nippon Paper) and KIP370 (KSP), is 150 million pulses or more.

*7 : Excluding damage caused by dust and foreign materials.
Life span of abrasion resistance for specified thermal paper, TL69KS-LH (Nippon Paper) and KIP370 (KSP), is 150 km or more.
In the cases that the paper set position is at one side alignment (paper width 58mm, 60mm), life span of abrasion resistance is 100 km or more. (All specified thermal paper)

*8 : In the cases that it operates at normal temperature and humidity, and paper eject shape is in accordance with structures described in Chapter 6.

*9 : Except for under the conditions of rapid load change. See "WHERE TO MOUNT THE PAPER HOLDER" in Chapter 6 for details.

*10 : Excluded convex part.

*11 : Life span of paper cutting resistance for specified thermal paper F5041 (Mitsubishi Hi-Tech Paper) is 1.5 million cuts or more.

*12 : Life span of paper cutting resistance for specified thermal paper P30023 (KSP) is 1.0 million cuts or more.

*13 : Life span of paper cutting resistance for specified thermal paper TL69KS-LH (Nippon Paper) and KIP370 (KSP) is 1.5 million cuts or more.

Table 3-2 lists the general specifications of the exclusive model for thick paper. The items other than the below is same specifications as a standard model.

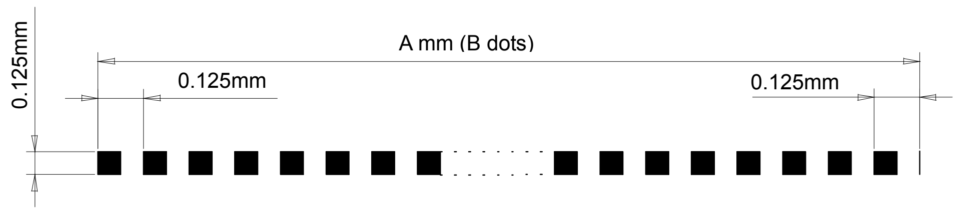
Table 3-2 General Specifications (Exclusive Model for Thick Paper, CAPM347D-E/CAPM347E-E)

Items		Specifications	
Maximum print speed		280 mm/s *1	
Life span (at 25ºC and rated energy)	Activation pulse resistance	100 million pulses or more *2	
	Abrasion resistance	100 km or more *3	
	Paper cutting resistance	1 million cuts or more *4	
Specified thermal paper (100 µm or more and 145 µm or less)		Assured range temperature for printing: 0°C to 50°C	
		Nippon Paper	TC11KS-LH
		Nippon Paper	TC98KS-LH
		Oji Paper	PDC110-100
		KSP	TO-381N

*1: Maximum print speed is 260 mm/s when Vp voltage is between 21.6V and 22.8V.
*2: Excluded when the same dots are printed continuously.
*3: Excluding damage caused by dust and foreign materials.
*4: In the cases that it operates at normal temperature and humidity, and paper eject shape is in accordance with structures described in Chapter 6.

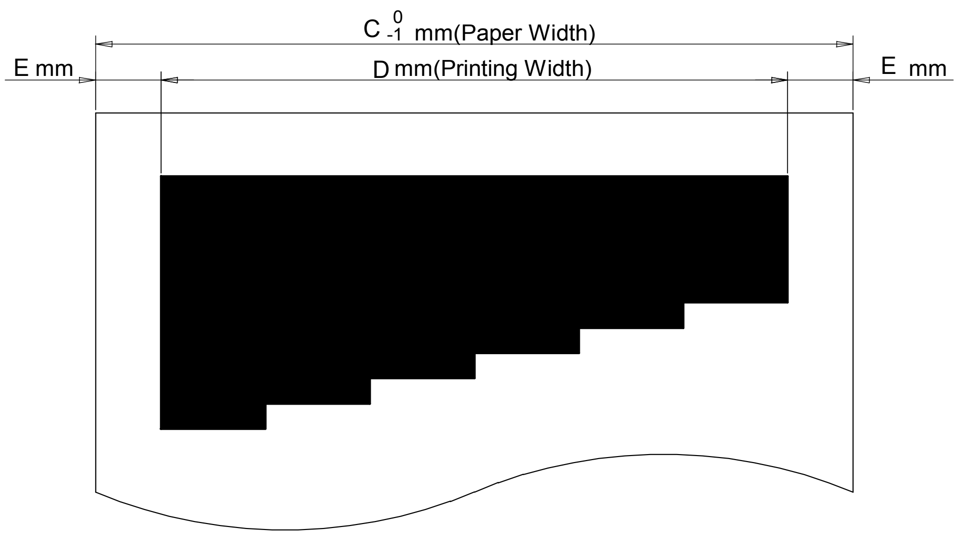
3.2 PRINT CONFIGURATION

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



Paper width 83 mm (A: 80, B: 640)
Paper width 80 mm (A: 72, B: 576)
Paper width 60 mm (A: 56, B: 448)
Paper width 58 mm (A: 54, B: 432)

Figure 3-1 Dot Pitch



Paper width 83 mm (C: 83, D: 80, E : 1.5)
Paper width 80 mm (C: 80, D: 72, E : 4)
Paper width 60 mm (C: 60, D: 56, E : 2)
Paper width 58 mm (C: 58, D: 54, E : 2)

Figure 3-2 Print Area

3.3 STEP MOTOR (PRINTER DRIVE MOTOR)

3.3.1 General Specifications

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

Table 3-3 General Specifications of the Step Motor

Item	Specifications
Type	PM type step motor
Drive method	Bi-polar chopper
Excitation	2-2 phase
Winding resistance per phase	3.7 Ω/phase ±10%
Motor drive voltage	V_P : 21.6 V to 26.4 V
Motor controlled current	600 mA/phase
Drive pulse rate	4800 pps max.

3.3.2 Sample Drive Circuit

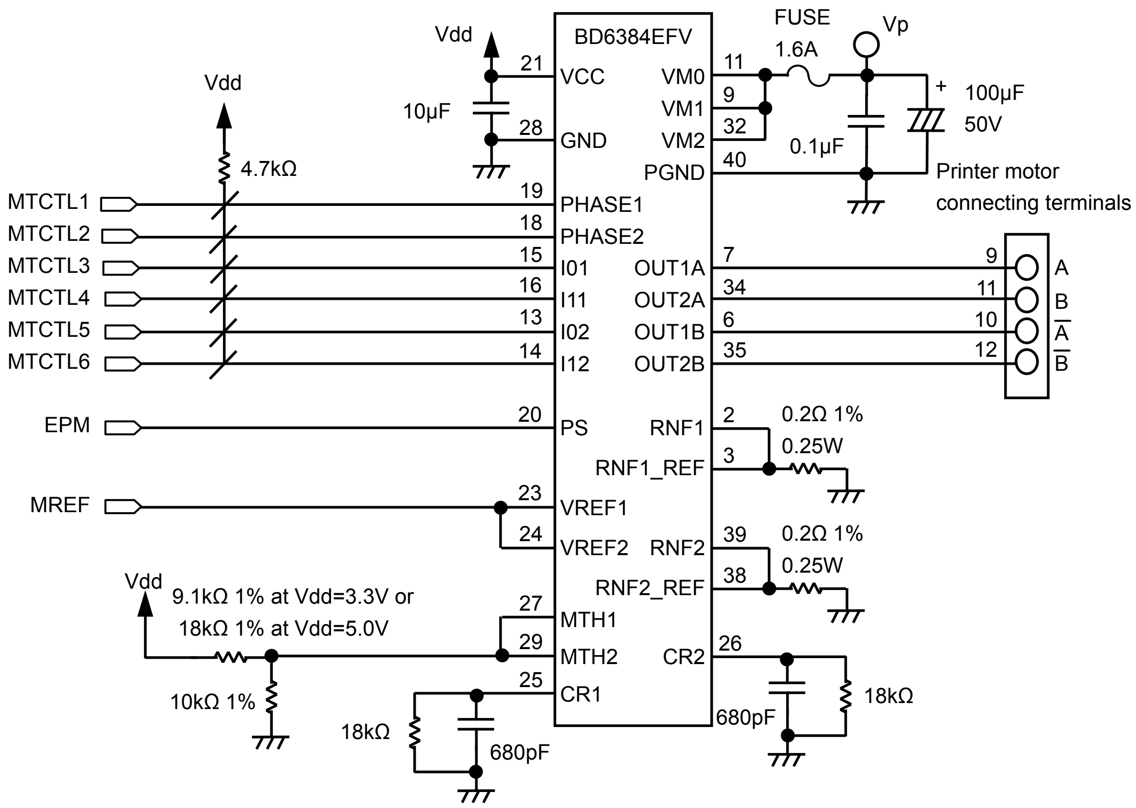
Figure 3-3 shows the sample drive circuit.

MREF signal

MREF signal is the reference signal for the motor current control. The motor drive setting current is set by the MREF signal setting voltage.
When operating paper feed and printing, set the motor drive setting current to 600 mA/phase.
When driving the motor drive setting current as 600 mA/phase, set MREF to 600 mV. In the case that constant steps more than 9 steps are continued at 797 pps and more, set 9th or higher constant step to 525 mA/phase (MREF=525mV).
In any case, if the motor step time exceeds 1 ms, set the motor drive setting current to 450 mA/phase (MREF = 450 mV) during that time.
Set 450 mA/phase (MREF=450 mV) consistently during auto-loading.

EPM signal

EPM signal is the output signal to control paper feed motor driver.
Normally, EPM signal should be High. Set EPM signal Low while the cutter motor is driving.



* Recommended motor driver : BD6384EFV (ROHM)
* Operating voltage range of Vcc for the recommended motor driver: 3.0 V to 5.5 V.

Figure 3-3 Sample Drive Circuit (Printer Drive Motor)

Note: Use printer mechanism with V_{dd} voltage range of 3.0V to 3.6V or 4.75V to 5.25V.

3.3.3 Excitation Sequence

Drive the motor with 2-2 phase excitation. One step of the motor drive signal feeds the thermal paper 0.0625 mm. One dot line is consisted of 2 steps. When the voltage signal shown in Figure 3-4 is input to the motor drive circuit shown in Figure 3-3, the motor is excited in order of step 1, step 2, step 3, step 4, step 1, step 2, ... , as shown in Table 3-4 and the printer feeds the thermal paper to the forward direction.

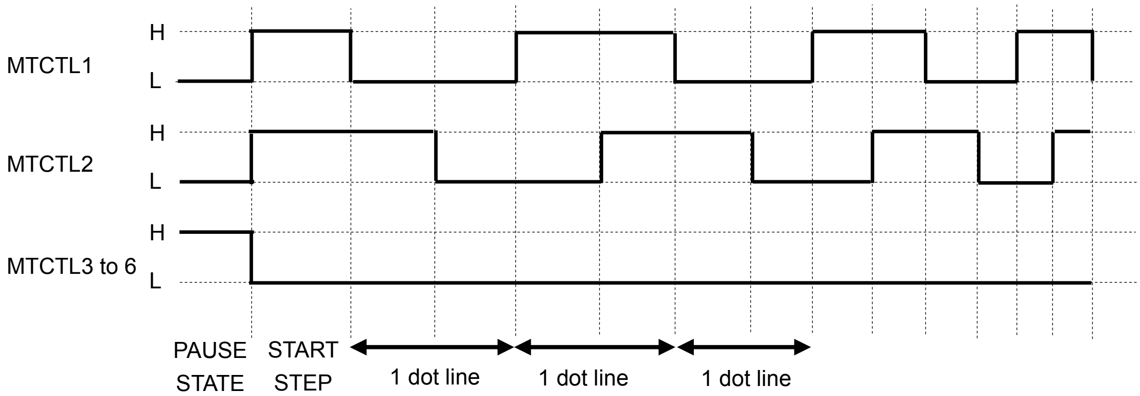


Figure 3-4 Input Voltage Waveforms for the Sample Drive Circuit

Table 3-4 Excitation Sequence

	Input Signal			Output Signal			
	MTCTL1	**MTCTL2**	**MTCTL 3 to 6**	**A**	**B**	**$\overline{A}$**	**$\overline{B}$**
Step 1	H	H	L	H	H	L	L
Step 2	L	H	L	L	H	H	L
Step 3	L	L	L	L	L	H	H
Step 4	H	L	L	H	L	L	H

3.3.4 Printer Drive 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 (10 ms) as that of the stop step for the first start step time.

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 print step for 40 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.

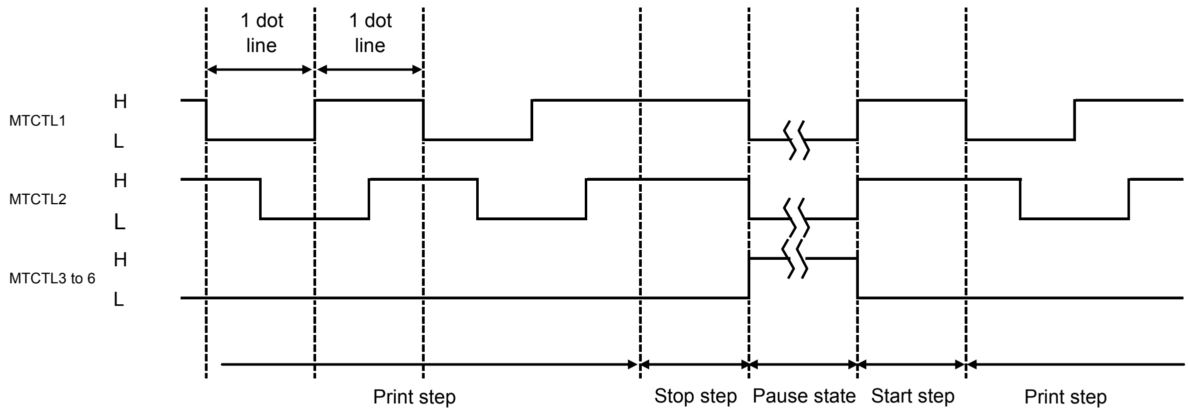


Figure 3-5 Printer Drive Motor Start/Stop Timing Chart

3.3.5 Printer Drive Motor Drive Method

Drive the printer drive motor by the following methods.

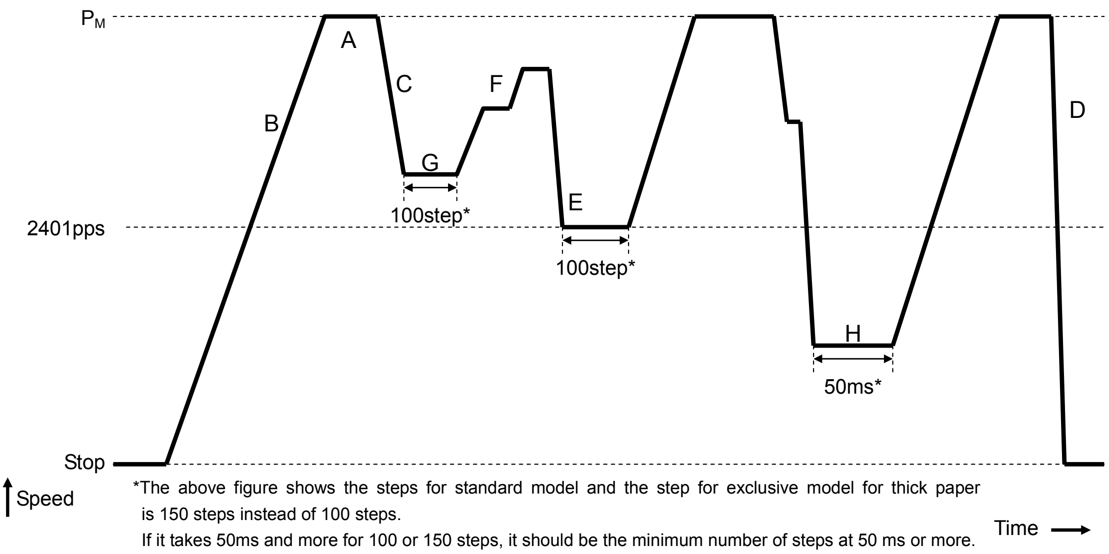


Figure 3-6 Printer Drive Motor Driving Chart

(1) Motor drive pulse rate

During paper feeding, the motor should be driven equal or lower the following maximum motor drive pulse rate as shown in Figure 3-6A and Table 3-5.

Table 3-5 Maximum motor drive pulse rate (P_M)

	V_P≧22.8V	V_P＜22.8V
Standard model	4800pps	4480pps
Exclusive model for thick paper	4480pps	4159pps

Drive the motor at 797 pps during auto-loading.

(2) Acceleration control

When driving the printer drive motor, the acceleration control is necessary to maintain the paper feed force of start up. If acceleration of the motor does not perform correctly, the motor may step out if it has a heavy workload. Accelerate the speed sequentially up to the maximum motor drive pulse rate P_M as shown in Figure 3-6B (refer to Table 3-6).

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

It is available to print during acceleration.

(3) Deceleration control

When reducing the motor speed or stopping the motor such as C and D in Figure 3-6, the deceleration control based on the estimated motor speed is necessary for preventing paper feed failure caused by the rapid change of the motor speed.

Decelerate the motor properly, otherwise the motor may not rotate properly due to the rapid change of the motor speed.

For appropriate deceleration of the motor speed, find the next acceleration step time according to following procedure:

Every dot line, predict the dot line that needs to decelerate after the next step. The predicted range is 20 dot lines (40 steps) ahead from the next step.
When the step that requiring deceleration of the motor is found by calculating "an" (the number of rows for deceleration at the next step), find the next step number according to the maximum value A of "an" (a1 to a40) and find the acceleration step time in Table 3-6 as below.

Find each "an" from the next acceleration step to the 40 steps ahead by following the procedure.

1. Find the thermal head activation time based on the equation shown in "3.5.1 Calculation of Activation Pulse Width". Calculate the Printing energy (E) and Adjusted voltage (V) using the temperature detected by thermistor and the thermal head drive voltage at that time.
   Calculate the Activation cycle (W) (the time from the start of the preceding activation to the start of the estimating activation) using "A" which is found at the immediately preceding step.
   Specify A = -1 during acceleration driving (if exceeding maximum motor drive pulse rate, A=0), A = 0 during at a constant speed drive.

2. Find the current acceleration step time in Table 3-6, and then find the nearest step number for the acceleration step time which is longer than a half of the calculated thermal head activation time.

3. Find the number of rows (an) of acceleration step to decelerate from current step number to next step by substituting the calculated step number into the following equation.
   When the paper feed steps or the number of print dot lines is less than 40 steps, fill in the gaps of the step number Yn as 1.

$$an = \frac{(Y - Y_n)}{n}$$

an: Number of rows to decelerate from current step number to next step
Y: Current step number
Yn: "n" step number ahead
n: Step to decelerate (n = 1, 2, 3…, 40)

(Example) When there is a dot line that the value of "an" is maximum at 20 steps ahead from the current acceleration step.

1. The calculated pulse width is assumed as t = 0.890 ms.
2. Find the step number from Table 3-6.
   Current acceleration step time of motor：313 μs -> Step number = 160
   Calculated acceleration step time of motor：447 μs -> Step number = 80
   (Necessary acceleration step time based on the calculated activation pulse width is 0.890/2 × 1000 ＝ 445 μs.
   The nearest acceleration step time which is longer than 445 μs and smallest is 447 μs.)
3. Find the number of rows (an) of acceleration step to decelerate from current step number to next step (an) using the following equation.

$$a20 = \frac{(160 - 80)}{20} = 4$$

According to the maximum value A = a20 = 4 by calculated value of "an" (a1 to a40), the acceleration step time of the next step should be 318 μs at the step number 156 which reduced the row by four rows from the step number 160.

Based on the above procedure and if the current acceleration step position is Y>92 (over 2401 pps) and deceleration of the motor speed is started when the paper feed steps or the number of print dot lines is less than 40 steps (if stop of the motor is predicted), decelerate the motor speed to at least 2401 pps (acceleration step number 92) shown in Figure 3-6E. In this case, find the first step of deceleration A based on the above procedure. For the second step or higher after the motor starts decelerating, use the larger of A found by the above procedure and A which is one step ahead as A for this time.

If the actual thermal head activation time exceeds the estimated acceleration step time, drive the printer drive motor as the acceleration step time that is the closest to and longer than a half of the head activation time.

(4) Reacceleration control

To reaccelerate the motor in case of driving the motor at constant speed drive lower than the maximum drive speed or after the motor drive decelerating, follow the procedure below.

(a) Reacceleration from constant speed drive lower than the maximum drive speed

When reaccelerate after constant speed drive, start the acceleration from the current acceleration step according to Table 3-6 in order (refer to Figure 3-6F).

(Example) When the step number for the current acceleration step is 21 (910 μs), the step number for the next acceleration step is 22 (887 μs) according to Table 3-6.

(b) Reacceleration after the motor drive decelerating

After decelerating the motor according to (3) Deceleration control, reaccelerate the motor at the acceleration step after driving the motor at constant speed drive,100 steps for standard model and 150 steps for exclusive model for thick paper as shown in Figure 3-6G. However, if constant speed drive time is 50 ms or more, specify the step number more than minimum number of step and 50 ms or higher shown in Figure 3-6H.

(Example) For a standard model, when decelerating the motor to the speed of the step number 92 (416 μs), after driving the motor at the constant speed drive for 100 steps (416μs × 100 steps = 41600 μs < 50 ms), the step number of the first step for the continuous reacceleration is 93 (414 μs).
Moreover, when decelerating the motor to the speed of the step number 52 (559 μs), after driving the motor at the constant speed drive for 90 steps (559 μs × 90 steps = 50310 μs ≧ 50 ms), the step number of the first step for the continuous reacceleration is 53 (554 μs).

(Example) For a exclusive model for thick paper, when decelerating the motor to the speed of the step number 146 (328 μs), after driving the motor at the constant speed drive for 150 steps (328 μs × 150 steps = 49200 μs < 50 ms), the step number of the first step for the continuous reacceleration is 147 (327 μs).
Moreover, when decelerating the motor to the speed of the step number 92 (416 μs), after driving the motor at the constant speed drive for 121 steps (416 μs × 121 steps = 50336 μs ≧ 50 ms), the step number of the first step for the continuous reacceleration is 93 (414 μs).

Hereinafter, accelerate the speed sequentially up to the maximum motor drive pulse rate P_M according to Table 3-6.

Table 3-6 Acceleration Steps of the Printer Drive Motor

(1/4)

Step Number	Drive Pulse Rate (pps)	Step Time (μs)	Step Number	Drive Pulse Rate (pps)	Step Time (μs)	Step Number	Drive Pulse Rate (pps)	Step Time (μs)
Start	-	10000	-	-	-	-	-	-
1	213	4696	31	1358	736	61	1942	515
2	213	4696	32	1382	723	62	1958	510
3	263	3800	33	1404	711	63	1974	506
4	345	2902	34	1427	700	64	1991	502
5	403	2480	35	1449	689	65	2007	498
6	446	2241	36	1471	679	66	2023	494
7	532	1881	37	1493	669	67	2038	490
8	606	1649	38	1514	660	68	2054	486
9	669	1495	39	1535	651	69	2070	483
10	714	1400	40	1556	642	70	2085	479
11	756	1321	41	1576	634	71	2101	476
12	797	1254	42	1597	626	72	2116	472
13	836	1196	43	1617	618	73	2131	469
14	873	1146	44	1636	611	74	2146	465
15	908	1101	45	1656	603	75	2161	462
16	942	1061	46	1675	596	76	2176	459
17	975	1025	47	1694	590	77	2191	456
18	1007	992	48	1713	583	78	2205	453
19	1039	962	49	1732	577	79	2220	450
20	1069	935	50	1750	571	80	2234	447
21	1098	910	51	1768	565	81	2249	444
22	1127	887	52	1786	559	82	2263	441
23	1155	866	53	1804	554	83	2277	439
24	1182	846	54	1822	548	84	2291	436
25	1209	827	55	1840	543	85	2305	433
26	1235	809	56	1857	538	86	2319	431
27	1260	793	57	1874	533	87	2333	428
28	1286	777	58	1891	528	88	2347	426
29	1310	763	59	1908	524	89	2360	423
30	1334	749	60	1925	519	90	2374	421

Step Number	Drive Pulse Rate (pps)	Step Time (μs)	Step Number	Drive Pulse Rate (pps)	Step Time (μs)	Step Number	Drive Pulse Rate (pps)	Step Time (μs)
91	2387	418	121	2762	361	151	3093	323
92	2401	416	122	2774	360	152	3103	322
93	2414	414	123	2786	358	153	3113	321
94	2427	411	124	2797	357	154	3124	320
95	2441	409	125	2809	356	155	3134	319
96	2454	407	126	2820	354	156	3144	318
97	2467	405	127	2832	353	157	3154	317
98	2480	403	128	2843	351	158	3165	315
99	2493	401	129	2854	350	159	3175	314
100	2506	399	130	2865	348	160	3185	313
101	2519	397	131	2877	347	161	3195	312
102	2531	395	132	2888	346	162	3205	312
103	2544	393	133	2899	344	163	3215	311
104	2557	391	134	2910	343	164	3225	310
105	2569	389	135	2921	342	165	3235	309
106	2582	387	136	2932	341	166	3245	308
107	2594	385	137	2943	339	167	3255	307
108	2606	383	138	2954	338	168	3265	306
109	2619	381	139	2965	337	169	3275	305
110	2631	380	140	2976	336	170	3285	304
111	2643	378	141	2987	334	171	3294	303
112	2655	376	142	2997	333	172	3304	302
113	2668	374	143	3008	332	173	3314	301
114	2680	373	144	3019	331	174	3324	300
115	2692	371	145	3029	330	175	3333	300
116	2704	369	146	3040	328	176	3343	299
117	2715	368	147	3051	327	177	3353	298
118	2727	366	148	3061	326	178	3362	297
119	2739	365	149	3072	325	179	3372	296
120	2751	363	150	3082	324	180	3381	295

Step Number	Drive Pulse Rate (pps)	Step Time (μs)	Step Number	Drive Pulse Rate (pps)	Step Time (μs)	Step Number	Drive Pulse Rate (pps)	Step Time (μs)
181	3391	294	211	3665	272	241	3920	255
182	3400	294	212	3674	272	242	3928	254
183	3410	293	213	3682	271	243	3936	254
184	3419	292	214	3691	270	244	3944	253
185	3429	291	215	3700	270	245	3953	252
186	3438	290	216	3709	269	246	3961	252
187	3447	290	217	3717	269	247	3969	251
188	3457	289	218	3726	268	248	3977	251
189	3466	288	219	3735	267	249	3985	250
190	3475	287	220	3743	267	250	3993	250
191	3485	286	221	3752	266	251	4001	249
192	3494	286	222	3760	265	252	4009	249
193	3503	285	223	3769	265	253	4017	248
194	3512	284	224	3777	264	254	4025	248
195	3521	283	225	3786	264	255	4033	247
196	3530	283	226	3795	263	256	4041	247
197	3540	282	227	3803	262	257	4049	246
198	3549	281	228	3811	262	258	4057	246
199	3558	281	229	3820	261	259	4065	245
200	3567	280	230	3828	261	260	4073	245
201	3576	279	231	3837	260	261	4081	245
202	3585	278	232	3845	260	262	4089	244
203	3594	278	233	3854	259	263	4097	244
204	3603	277	234	3862	258	264	4105	243
205	3612	276	235	3870	258	265	4113	243
206	3621	276	236	3879	257	266	4120	242
207	3630	275	237	3887	257	267	4128	242
208	3638	274	238	3895	256	268	4136	241
209	3647	274	239	3903	256	269	4144	241
210	3656	273	240	3912	255	270	4152	240

Step Number	Drive Pulse Rate (pps)	Step Time (μs)	Step Number	Drive Pulse Rate (pps)	Step Time (μs)	Step Number	Drive Pulse Rate (pps)	Step Time (μs)
271	4159	240	301	4386	228	331	4601	217
272	4167	239	302	4393	227	332	4608	217
273	4175	239	303	4400	227	333	4615	216
274	4183	239	304	4408	226	334	4622	216
275	4190	238	305	4415	226	335	4629	216
276	4198	238	306	4422	226	336	4636	215
277	4206	237	307	4430	225	337	4643	215
278	4213	237	308	4437	225	338	4650	215
279	4221	236	309	4444	225	339	4657	214
280	4229	236	310	4451	224	340	4664	214
281	4236	236	311	4459	224	341	4671	214
282	4244	235	312	4466	223	342	4677	213
283	4251	235	313	4473	223	343	4684	213
284	4259	234	314	4480	223	344	4691	213
285	4266	234	315	4487	222	345	4698	212
286	4274	233	316	4495	222	346	4705	212
287	4282	233	317	4502	222	347	4712	212
288	4289	233	318	4509	221	348	4719	211
289	4297	232	319	4516	221	349	4726	211
290	4304	232	320	4523	221	350	4732	211
291	4312	231	321	4530	220	351	4739	211
292	4319	231	322	4538	220	352	4746	210
293	4327	231	323	4545	220	353	4753	210
294	4334	230	324	4552	219	354	4760	210
295	4341	230	325	4559	219	355	4766	209
296	4349	229	326	4566	219	356	4773	209
297	4356	229	327	4573	218	357	4780	209
298	4364	229	328	4580	218	358	4787	208
299	4371	228	329	4587	218	359	4793	208
300	4378	228	330	4594	217	360	4800	208

* The value of step time in the table are rounded off. Calculated drive frequency value may differ from the listed value.

(5) Preventing overheat

To prevent the motor from overheating, the drive time and drive ratio are limited.
Follow the Table 3-7 shown below to set an operating time and a pause time of the motor.

Table 3-8 and Table 3-9 show the drive time and the paper length at temperature rise of 40ºC and 55ºC.

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

Table 3-7 Maximum Continuous Drive Time / Paper Length : Temperature Rise 40°C

Drive Pulse Rate (pps) (or more to less than)			Maximum Continuous Drive Time (s)	Drive Ratio
400	to	800	20.0	46.5%
800	to	1200	13.3	44.0%
1200	to	1600	10.0	38.5%
1600	to	2000	8.0	34.9%
2000	to	2400	6.6	30.9%
2400	to	2800	5.7	27.8%
2800	to	3200	4.9	26.5%
3200	to	3600	4.4	24.3%
3600	to	4000	3.9	22.5%
4000	to	4400	3.6	22.2%
4400	to	4800	3.3	22.1%

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

Table 3-8 Drive Time and Paper Length at Temperature Rise 40°C

Drive Pulse Rate (pps) (or more to less than)			Drive Time (min)	Paper Feed Length (m)
400	to	800	9.58	14.38 or longer
800	to	1200	8.25	24.75 or longer
1200	to	1600	6.92	31.13 or longer
1600	to	2000	5.58	33.50 or longer
2000	to	2400	5.00	37.50 or longer
2400	to	2800	4.58	41.25 or longer
2800	to	3200	4.08	42.88 or longer
3200	to	3600	3.83	46.00 or longer
3600	to	4000	3.67	49.50 or longer
4000	to	4400	3.33	50.00 or longer
4400	to	4800	3.17	52.25 or longer
4800			3.17	57.00 or longer

Table 3-9 Drive Time and Paper Length at Temperature Rise 55°C

Drive Pulse Rate (pps) (or more to less than)			Drive Time (min)	Paper Feed Length (m)
400	to	800	18.42	27.63 or longer
800	to	1200	15.00	45.00 or longer
1200	to	1600	12.17	54.75 or longer
1600	to	2000	9.75	58.50 or longer
2000	to	2400	8.42	63.13 or longer
2400	to	2800	7.67	69.00 or longer
2800	to	3200	6.67	70.00 or longer
3200	to	3600	6.25	75.00 or longer
3600	to	4000	6.00	81.00 or longer
4000	to	4400	5.50	82.50 or longer
4400	to	4800	5.17	85.25 or longer
4800			5.17	93.00 or longer

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 40 steps or more at the initialization, at a time after setting/releasing the head block, at a time after feeding the thermal paper backward, and a time after cutting with the autocutter. 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)

- The activation time of the thermal head can be longer than the motor step time depending on the type of the thermal paper, content of the printing and use conditions. In that case, drive the printer drive motor as the acceleration step time that is the closest to and longer than a half of the head activation time. (See Chapter 5 “PRINT DRIVE METHOD” for details).

- Do not feed the thermal paper backwards more than 5 mm. Feeding the thermal paper backward more than 5mm may cause paper skew and jams.

- The surface of thermal paper may get scratched by backward feed. The backward feed may cause paper skew and jams depending on the paper roll layout and designing of the paper holder. Verify the performance with your actual device.

- Do not print intermittently. (Do not repeat printing and stopping in a short interval.)
  If doing so, print quality may be decreased and operation sound may be louder due to unevenness of the paper feed pitch, and the paper-loosening may cause the step-out of the driver motor. Those malfunctions may result in adverse effect of the product durability.

- 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 necessary 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.

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

- Do not drive the printer drive motor while the autocutter drive motor is driving. It may cause the damage of the printer.

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 input from the DI terminal, print is "High" and non print is "Low". 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 $\overline{\text{DST}}$ signal "Low" in accordance with the stored print data.

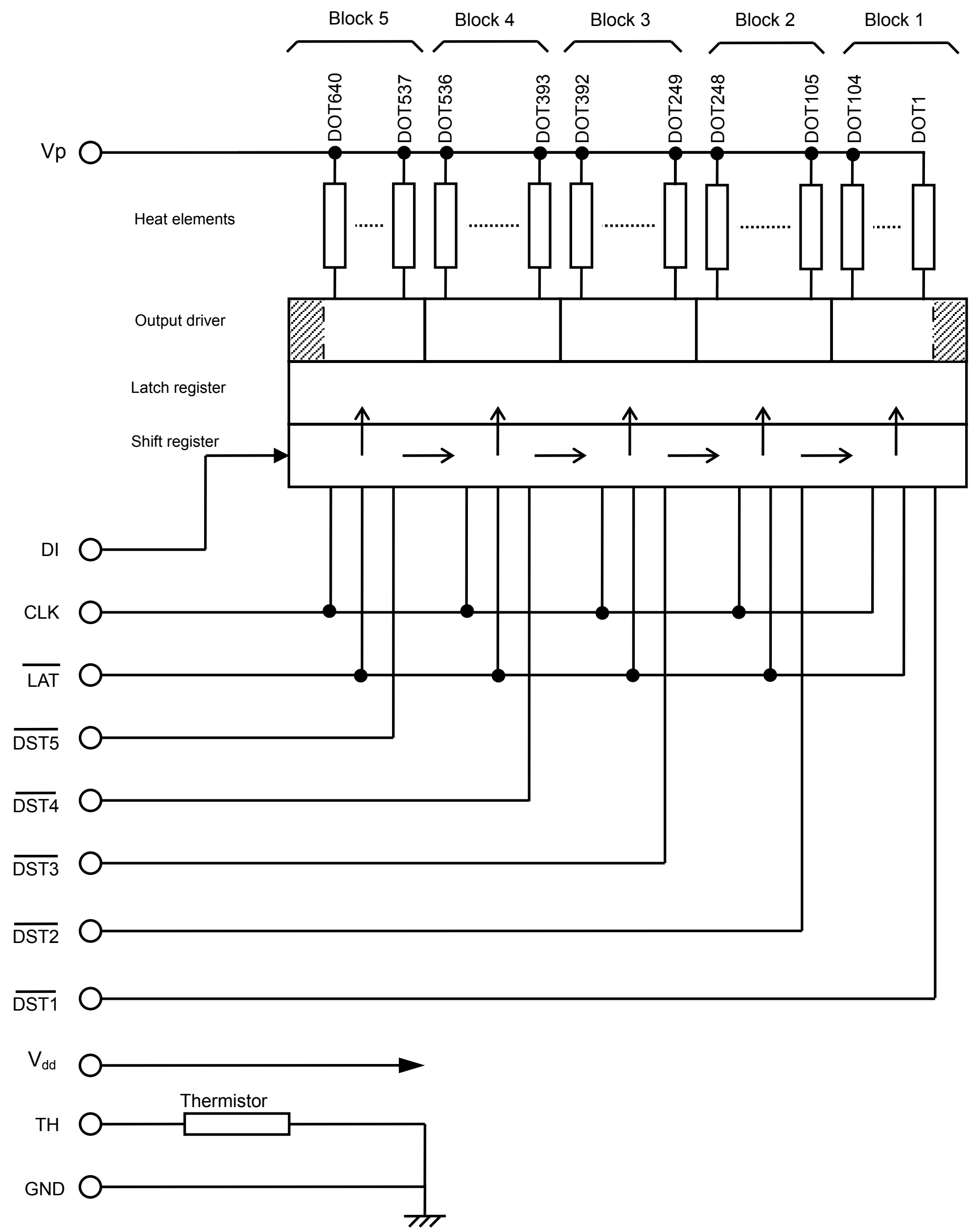
In the printer, a division printing by 5 blocks each is available. The divided printing is effective for a high print ratio printing because the peak current can be cut down with the reduction of the average print speed.

3.4.1 Structure of the Thermal Head

The following describes the thermal head block diagram as the printer.

Figure 3-7 shows the thermal head block diagram.

Table 3-10 shows the relationship between $\overline{\text{DST}}$ terminals and activated heat elements.



*: Shaded area: NULL data specified area (40 bits)

Figure 3-7 Thermal Head Block Diagram

Table 3-10 $\overline{DST}$ Terminals and Activated Heat Elements

Block	$\overline{DST}$ Number	Heat Element No.	Number of Heat Element	Dots/$\overline{DST}$
1	$\overline{DST1}$	1 to 104	104	144
2	$\overline{DST2}$	105 to 248	144	144
3	$\overline{DST3}$	249 to 392	144	144
4	$\overline{DST4}$	393 to 536	144	144
5	$\overline{DST5}$	537 to 640	104	144

3.4.2 Connection of Transfer Data and Print Position

The following describes the print position of the data.

720-bit data (#1 to #720) transferred through DI terminals are printed as shown in Figure 3-8.
In transferred data of 720-bit, input NULL data between #1 and #40, #681 and #720.

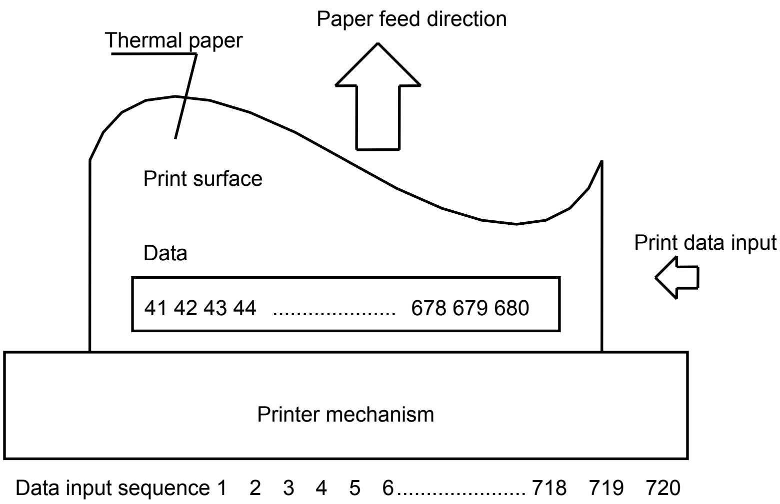


Figure 3-8 Transfer Data and Print Position

3.4.3 Electrical Characteristics of Thermal Head

Table 3-11 shows electrical characteristics of thermal head.

Table 3-11 Electrical Characteristics of Thermal Head

(at 25 °C)

Item		Symbol	Conditions	Rated value Min.	Rated value Typ.	Rated value Max.	Unit
Thermal head heat elements resistance		R_H		679.0	700.0	721.0	Ω
Thermal head drive voltage		V_P		21.6	24.0	26.4	V
Thermal head drive current		I_P	at the number of simultaneously activated dots = 640	—	—	24.9	A
Logic voltage		V_{dd}		2.7	3.3	3.6	V
				4.75	5.0	5.25	V
Logic current		I_{dd}	V_{dd} = 5.0 V, f_{CLK} =12 MHz	—	—	144.0	mA
			All signals stop state	—	—	0.1	mA
Input voltage	High	V_{IH}	CLK, DI, $\overline{LAT}$, $\overline{DST}$	0.8V_{dd}	—	V_{dd}	V
	Low	V_{IL}	CLK, DI, $\overline{LAT}$, $\overline{DST}$	0	—	0.2V_{dd}	V
DI input current	High	I_{IH} DI	V_{dd} = 3.3 V, V_{IH} = V_{dd}	—	—	1.0	μA
	Low	I_{IL} DI	V_{dd} = 3.3 V, V_{IL} = 0 V	—	—	-1.0	μA
$\overline{DST}$ input current	High	I_{IH} $\overline{DST}$	V_{dd} = 3.3 V, V_{IH} = V_{dd}	—	—	5.0	μA
	Low	I_{IL} $\overline{DST}$	V_{dd} = 3.3 V, V_{IL} = 0 V	—	—	-200.0	μA
CLK input current	High	I_{IH} CLK	V_{dd} = 3.3 V, V_{IH} = V_{dd}	—	—	5.0	μA
	Low	I_{IL} CLK	V_{dd} = 3.3 V, V_{IL} = 0 V	—	—	-5.0	μA
$\overline{LAT}$ input current	High	I_{IH} $\overline{LAT}$	V_{dd} = 3.3 V, V_{IH} = V_{dd}	—	—	5.0	μA
	Low	I_{IL} $\overline{LAT}$	V_{dd} = 3.3 V, V_{IL} = 0 V	—	—	-5.0	μA
CLK frequency		f_{CLK}	DUTY 50% (±5%)	—	—	12.0	MHz
DI setup time		t1	See the Timing Chart.	50	—	—	ns
DI hold time		t2	See the Timing Chart.	20	—	—	ns
$\overline{LAT}$ setup time		t3	See the Timing Chart.	150	—	—	ns
$\overline{LAT}$ pulse width		t4	See the Timing Chart.	100	—	—	ns
$\overline{DST}$ setup time		t5	See the Timing Chart.	150	—	—	ns
$\overline{LAT}$ wait time		t6*	See the Timing Chart.	5	—	—	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 3-9 shows a thermal head drive timing chart.

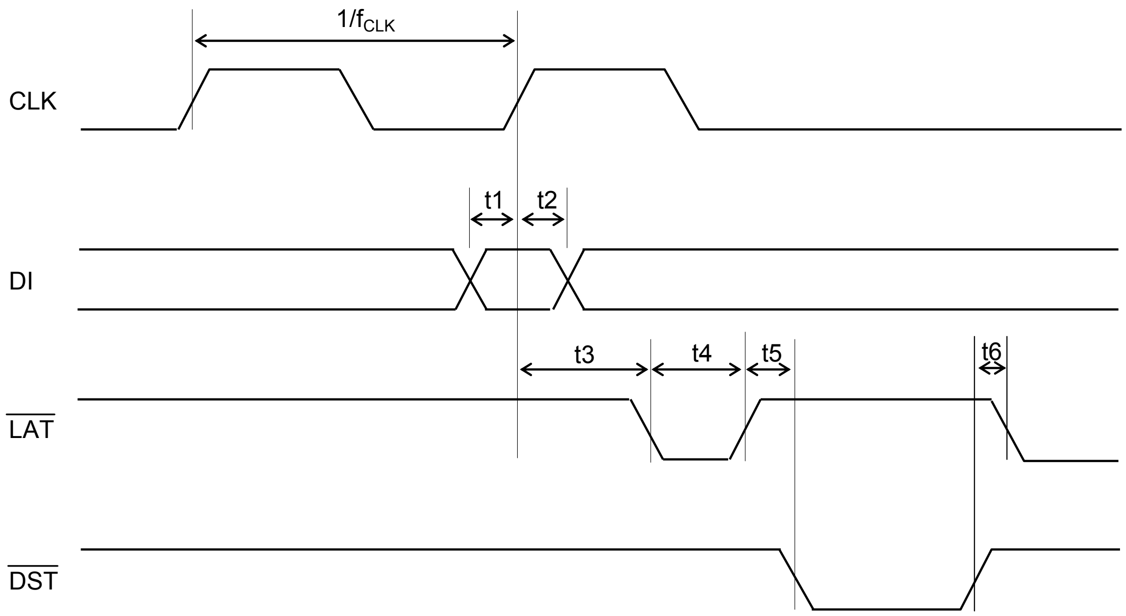


Figure 3-9 Thermal Head Drive Timing Chart

3.4.5 Thermal Head Heat Elements Resistance

Table 3-12 shows resistance of the thermal head heat elements of the printer.

Table 3-12 Thermal Head Heat Elements Resistance

Thermal Head Heat Elements Resistance
679.0 Ω to 721.0 Ω

3.4.6 Maximum Current Consumption

Since the maximum current consumption may reach the values calculated using equation (1) 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 (1):

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

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 elements resistance 679 (Ω)

3.5 CONTROLLING THE ACTIVATION PULSE WIDTH FOR THERMAL HEAD

To execute high quality printing using the printer, the activation pulse width is controlled according to use conditions. 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 (2).

Equation (2):

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

t:	Thermal head 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)	
C:	Motor step activation cycle coefficient	See section 3.5.5
D:	Heat storage coefficient	See section 3.5.6

3.5.2 Calculation of Printing Energy

The printing energy "E" can be calculated using equation (3) as the appropriate printing energy is different depending on each specified thermal paper and the temperature of the thermal head.

Equation (3):

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

E_{25}:	Standard printing energy (mJ)	See Table 3-13 and Table 3-14
T_C:	Temperature coefficient	See Table 3-13 and Table 3-14
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), refer to "3.5.9 Temperature Characteristics of the Thermistor".

Table 3-13 Standard Printing Energy and Temperature Coefficient (Standard Model)

Thermal paper		Standard printing energy (mJ)	Temperature coefficient	
			Below 25°C	25°C or higher
TF50KS-E2D	Nippon Paper	0.374	0.003614	0.005184
TP60KJ-R	Nippon Paper	0.420	0.004603	
TL69KS-LH	Nippon Paper	0.503	0.002183	0.002976
PD160R	Oji Paper	0.391	0.003522	0.004172
P220VBB-1	Mitsubishi Paper mills limited	0.373	0.004106	
HP220AB-1	Mitsubishi Paper mills limited	0.355	0.003901	
KT55F20	Papierfabrik August Koehler AG	0.386	0.002656	0.005099
F5041	Mitsubishi Hi-Tech Paper	0.431	0.003930	0.005922
P30023	KSP	0.396	0.003003	0.003648
KIP-370	KSP	0.484	0.002470	0.003730

Table 3-14 Standard Printing Energy and Temperature Coefficient (Exclusive Model for Thick Paper)

Thermal paper		Standard printing energy (mJ)	Temperature coefficient	
			Below 25°C	25°C or higher
TC11KS-LH	Nippon Paper	0.403	0.002501	
TC98KS-LH	Nippon Paper	0.418	0.002997	
PDC110-100	Oji Paper	0.424	0.003516	
TO-381N	KSP	0.312	0.003063	0.003879

3.5.3 Adjustment of Thermal Head Resistance

The adjusted resistance “R” can be calculated using equation (4) to adjust the thermal head resistance as a voltage drop is caused by wiring resistance.

Equation (4):

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

R_H:	Thermal head heat elements resistance	700 (Ω)
Ri:	Wiring resistance in the thermal head	17.6 (Ω) V_{dd} = 3.0 V 11.6 (Ω) V_{dd} = 5.0 V
R_C:	Common terminal wiring resistance in the thermal head	0.194 (Ω)
r_C:	Wiring resistance between V_p and GND (Ω) *1	

*1 : The resistance is a serial resistance of the wire and switching circuit of relay between control terminal and power supply.

3.5.4 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 cycle (the time from the start of the preceding activation to the start of the current activation) which meets equation (5) to secure the pause time.

Equation (5):

$$W > t + 100(\mu s)$$

W: The activation cycle (μs)*

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

3.5.5 Adjustment by Motor Step Activation Cycle

The Motor step activation cycle coefficient “C” can be calculated using equations (6) as the printing density varies by the Motor step activation cycle “W”.

Equation (6):

$$C = 1 - \frac{730}{w + 820}$$

w: The dot line cycle (μs)*

*: The dot line cycle w is the dot line cycle at previous one dot line (the printer drive motor for 2 steps).

3.5.6 Adjustment by Heat Storage Simulation

In high speed printing, there is a difference between the temperature raised by the thermal head activation and the temperature detected by the thermistor. Therefore, the activation pulse width must be adjusted by simulating the temperature of the thermal head.
When the print ratio is low, no adjustment is needed, but set "1" as the heat storage coefficient.

The heat storage coefficient is calculated as follows:

(1) Prepare the heat storage counters to simulate heat storage.

(a) Heat storage due to thermal head activation
The heat storage counter counts up in each print period as follows.

$$T' = T + \frac{N \times 64 \times C}{640}$$

T: Heat storage counter value
N: The number of activated dots (dot line)
C: Motor step activation cycle coefficient

(b) Radiation
The heat storage counter value is multiplied by the radiation coefficient in each 2ms.

$$T' = T \times K$$

K: Radiation coefficient 0.996

(2) Calculate the heat storage coefficient "D" with the following equation (7).

Equation (7)

$$D = 1 - \frac{T}{60000}$$

3.5.7 Calculation Sample for the Activation Pulse Width

Table 3-15 lists the calculation samples of the activation pulse width calculated using equation (2) and the values obtained using equations (3), (4), (6) and (7).

Table 3-15 Activation Pulse Width

Unit : ms

V_P [V]	T_X [°C]	Motor drive frequency [pps]											
		400	800	1200	1600	2000	2400	2800	3200	3600	4000	4400	4800
21.6	-10	0.732	0.653	0.592	0.542	0.502	0.468	0.439	0.414	0.393	0.374	0.358	0.343
	0	0.680	0.606	0.549	0.503	0.465	0.434	0.407	0.384	0.365	0.347	0.332	0.318
	10	0.627	0.559	0.506	0.464	0.429	0.400	0.376	0.355	0.336	0.320	0.306	0.294
	20	0.574	0.512	0.463	0.425	0.393	0.366	0.344	0.325	0.308	0.293	0.280	0.269
	30	0.509	0.454	0.411	0.377	0.348	0.325	0.305	0.288	0.273	0.260	0.249	0.238
	40	0.433	0.386	0.350	0.320	0.297	0.276	0.260	0.245	0.232	0.221	0.212	0.203
	50	0.357	0.318	0.288	0.264	0.245	0.228	0.214	0.202	0.192	0.182	0.174	0.167
	60	0.281	0.251	0.227	0.208	0.193	0.180	0.169	0.159	0.151	0.144	0.137	0.132
	70	0.205	0.183	0.166	0.152	0.141	0.131	0.123	0.116	0.110	0.105	0.100	0.096
	80	0.129	0.115	0.104	0.096	0.089	0.083	0.077	0.073	0.069	0.066	0.063	0.061
24.0	-10	0.593	0.529	0.479	0.439	0.406	0.379	0.356	0.336	0.318	0.303	0.290	0.278
	0	0.550	0.491	0.445	0.407	0.377	0.351	0.330	0.311	0.295	0.281	0.269	0.258
	10	0.508	0.453	0.410	0.376	0.348	0.324	0.304	0.287	0.272	0.259	0.248	0.238
	20	0.465	0.415	0.375	0.344	0.318	0.297	0.279	0.263	0.249	0.237	0.227	0.218
	30	0.412	0.368	0.333	0.305	0.282	0.263	0.247	0.233	0.221	0.211	0.201	0.193
	40	0.351	0.313	0.283	0.260	0.240	0.224	0.210	0.198	0.188	0.179	0.171	0.164
	50	0.289	0.258	0.234	0.214	0.198	0.185	0.173	0.164	0.155	0.148	0.141	0.135
	60	0.228	0.203	0.184	0.169	0.156	0.145	0.136	0.129	0.122	0.116	0.111	0.107
	70	0.166	0.148	0.134	0.123	0.114	0.106	0.100	0.094	0.089	0.085	0.081	0.078
	80	0.105	0.093	0.085	0.078	0.072	0.067	0.063	0.059	0.056	0.054	0.051	0.049
26.4	-10	0.490	0.437	0.396	0.363	0.336	0.313	0.294	0.277	0.263	0.251	0.240	0.230
	0	0.455	0.406	0.367	0.337	0.312	0.290	0.273	0.257	0.244	0.232	0.222	0.213
	10	0.419	0.374	0.339	0.310	0.287	0.268	0.251	0.237	0.225	0.214	0.205	0.197
	20	0.384	0.343	0.310	0.284	0.263	0.245	0.230	0.217	0.206	0.196	0.188	0.180
	30	0.341	0.304	0.275	0.252	0.233	0.218	0.204	0.193	0.183	0.174	0.166	0.160
	40	0.290	0.259	0.234	0.215	0.198	0.185	0.174	0.164	0.156	0.148	0.142	0.136
	50	0.239	0.213	0.193	0.177	0.164	0.153	0.143	0.135	0.128	0.122	0.117	0.112
	60	0.188	0.168	0.152	0.139	0.129	0.120	0.113	0.106	0.101	0.096	0.092	0.088
	70	0.137	0.123	0.111	0.102	0.094	0.088	0.082	0.078	0.074	0.070	0.067	0.064
	80	0.087	0.077	0.070	0.064	0.059	0.055	0.052	0.049	0.046	0.044	0.042	0.041

* : Use of thermal paper "TF50KS-E2D", Vp and GND wiring resistance : rc = 0 and Ri = 11.6 Ω, the number of simultaneously activated dots: N=144 and the heat storage coefficient D=1.

3.5.8 Heat History Control

Follow the following procedure to control the heat history control properly.

(1) Prepare an activation data for additional pulse

Prepare an activation data for additional pulse against each dot.

$$d_H = d \times \overline{d_1} \times \overline{d_2}$$

d_H: Activation data for an additional pulse
d: Activation data of a current dot
d_1: Activation data of previous dot
d_2: Activation data of dot before previous dot

dH, d, d1 and d2 are activation data 0 or 1 (white or black). Even if the dot line without activation dot that does not output the activation pulse, the activation data for an additional pulse should be calculated with the value of d1 and d2. Specify d1 and d2 as 0 immediately after the motor start-up.

(2) Calculate an additional pulse time

Find an additional pulse time using the pulse (hereinafter called a main pulse) calculated by "3.5.1 Calculation of Activation Pulse Width" and "3.5.6 Adjustment by Heat Storage Simulation". Calculate the additional pulse time “tS” with the following equation.

$$t_S = t \times \frac{350}{w + 80}$$

t_S: Additional pulse time (μs)
t: Main pulse time (μs)
w: The dot line cycle at previous one dot line
(the printer drive motor for 2 steps) (μs)

(3) Pulse activation

Apply the main pulse for the target dot line, and then apply the additional pulse prepared by (1) after taking 10μs pause. If there is the limitation of the simultaneously activated dots to divide the dot line, apply the additional pulse for each division. Therefore, the pulse is applied in order of 1st division main pulse activation, 1st division additional pulse activation, 2nd division main pulse activation, 2nd division additional pulse activation･･･.

3.5.9 Temperature Characteristics of the Thermistor

Calculate the resistance of the thermistor (R_X) at the operating temperature T_X (°C) using the following equation (8). Variation of resistance by temperature is shown in Figure 3-10 and Table 3-16.

Equation (8):

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

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

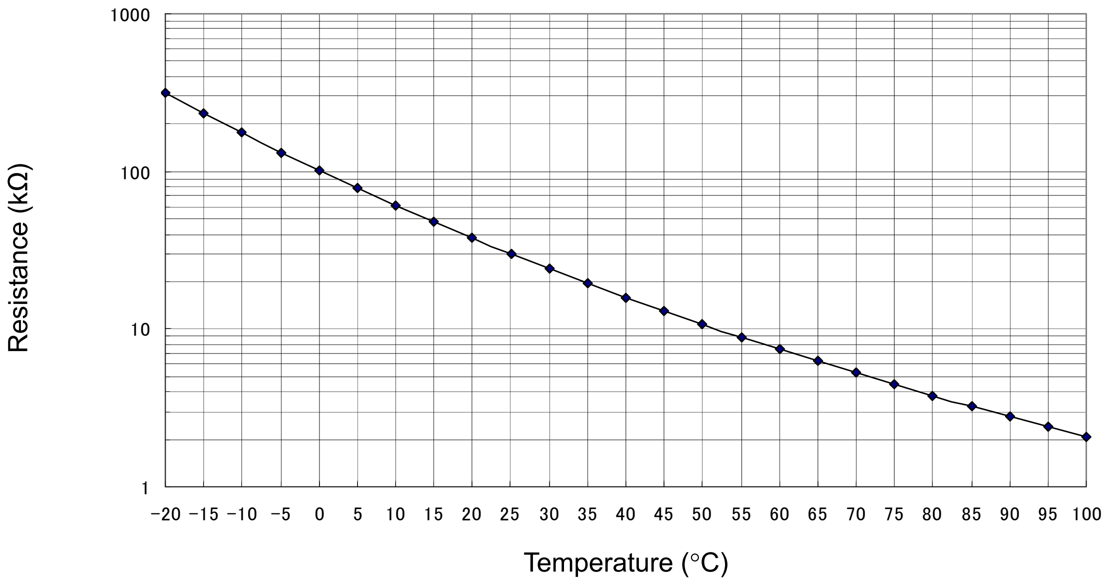


Figure 3-10 Temperature Characteristics of the Thermistor

Table 3-16 Temperature Characteristics of the Thermistor

Temperature (°C)	Thermistor Resistance (kΩ)
-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

3.5.10 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 80°C (thermistor resistance $R_{TH} \leq 3.80$ kΩ), and reactivate the heat elements when a temperature lower than 60°C ($R_{TH} \geq 7.45$ kΩ) is detected. If the thermal head continues to be activated at a temperature higher than 80°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 ($R_{TH} \leq 2.09$ kΩ))

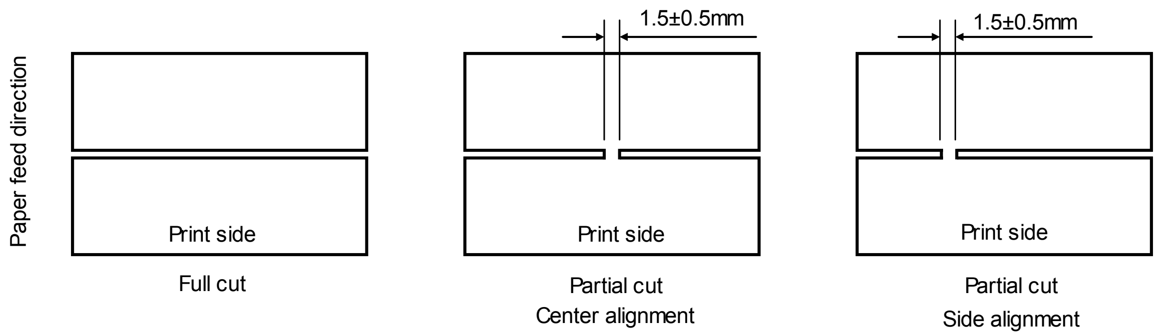
(b) Faulty thermistor connection (the thermistor may be open or short-circuited).

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

3.6 THERMAL PAPER CUTTING CONDITIONS

The autocutter of this printer can select the method to cut the thermal paper in full cut or partial cut (tab left at the center) by changing the number of driving steps for autocutter drive motor.
See 5.2 AUTOCUTTER DRIVE METHOD in Chapter 5 for details.

Figure 3-11 shows the full cutting method and the partial cutting method for the thermal paper.



*: When side alignment is selected, partial cut portion is shifted to left.

Figure 3-11 Thermal Paper Cut Condition

3.7 STEP MOTOR (AUTOCUTTER DRIVE MOTOR)

3.7.1 General Specifications

Table 3-17 shows general specifications of the step motor.

Table 3-17 General Specifications of the Step Motor

Item	Specifications
Type	PM type step motor
Drive method	Bi-polar chopper
Excitation method	1-2 phase
Winding resistance per phase	8.5 Ω/phase ±10%
Motor drive voltage	V_P: 21.6 V to 26.4 V
Motor controlled current	550 mA/ phase (at 2-phase) 820 mA/ phase (at 1-phase)
Drive pulse rate	2400 pps max.(Outward) 2600 pps max.(Homeward)

3.7.2 Sample Drive Circuit

* Operating voltage range of Vcc for the recommended motor driver: 3.0 V to 5.5 V.

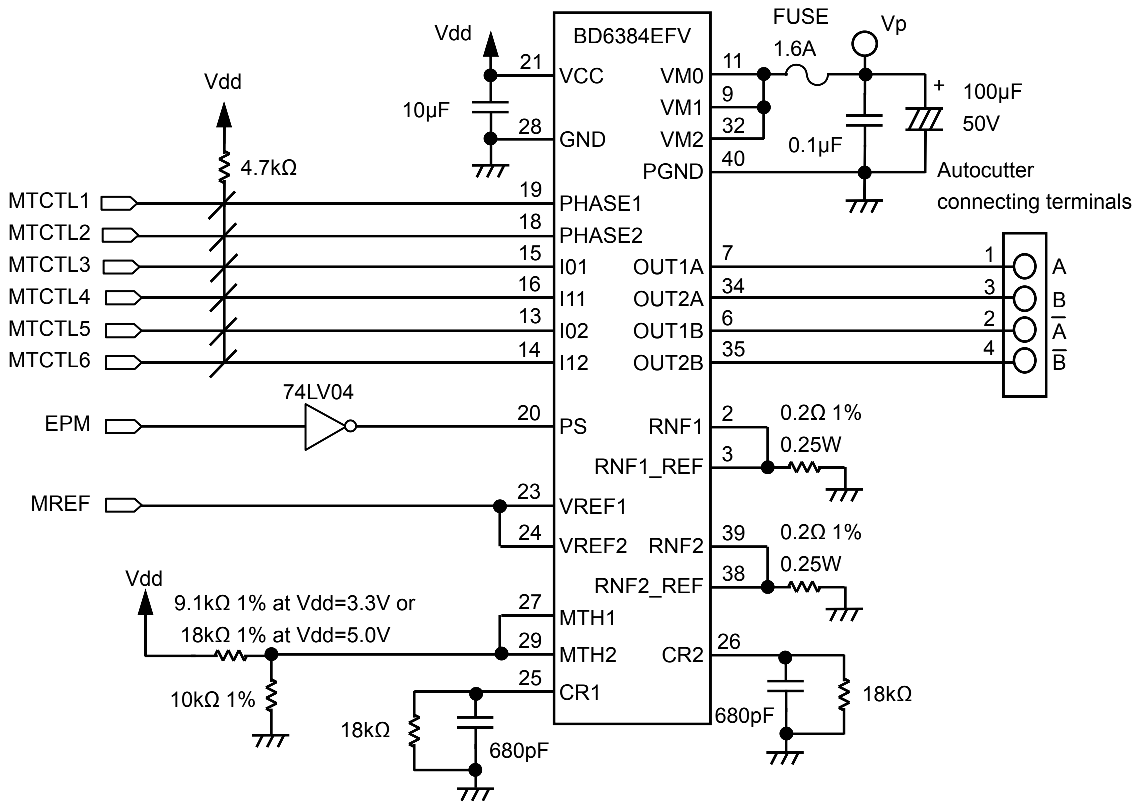
Figure 3-12 shows the sample drive circuit.

MREF signal

MREF signal is the reference signal for the motor current control. The motor drive setting current is set by the MREF signal setting voltage.
When driving the autocutter motor drive, set MREF to 820 mV.

EPM signal

EPM signal is the output signal to control autocutter motor driver.
Normally, EPM signal should be "High". Set EPM signal "Low" while the cutter motor is driving.



* Recommended motor driver : BD6384EFV(ROHM)
* Operating voltage range of Vcc for the recommended motor driver: 3.0 V to 5.5 V.

Figure 3-12 Sample Drive Circuit (Autocutter Drive Motor)

Note: Use printer mechanism with V_{dd} voltage range of 3.0V to 3.6V or 4.75V to 5.25V.

3.7.3 Excitation Sequence

Drive the motor with 1-2 phase excitation. The voltage wave forms shown in Figure 3-13 put to the motor drive circuit shown in Figure 3-12, the motor drives in the normal rotation, the movable blade is moved to the fixed blade direction (Outward) and cut the thermal paper when the motor is excited in order of step 1, step 2, step 3, step 4, step 5, step 6, step 7, step 8, step 1, step 2, ... , as shown in Table 3-18.

The voltage wave forms shown in Figure 3-14 put to the motor drive circuit shown in Figure 3-12 the motor is rotated in the reverse direction, the movable blade is moved to the home position direction (Homeward) when the motor is excited in order of step 1, step 8, step 7, step 6, step 5, step 4, step 3, step 2, step 1, step 8, ... , as shown in Table 3-18.

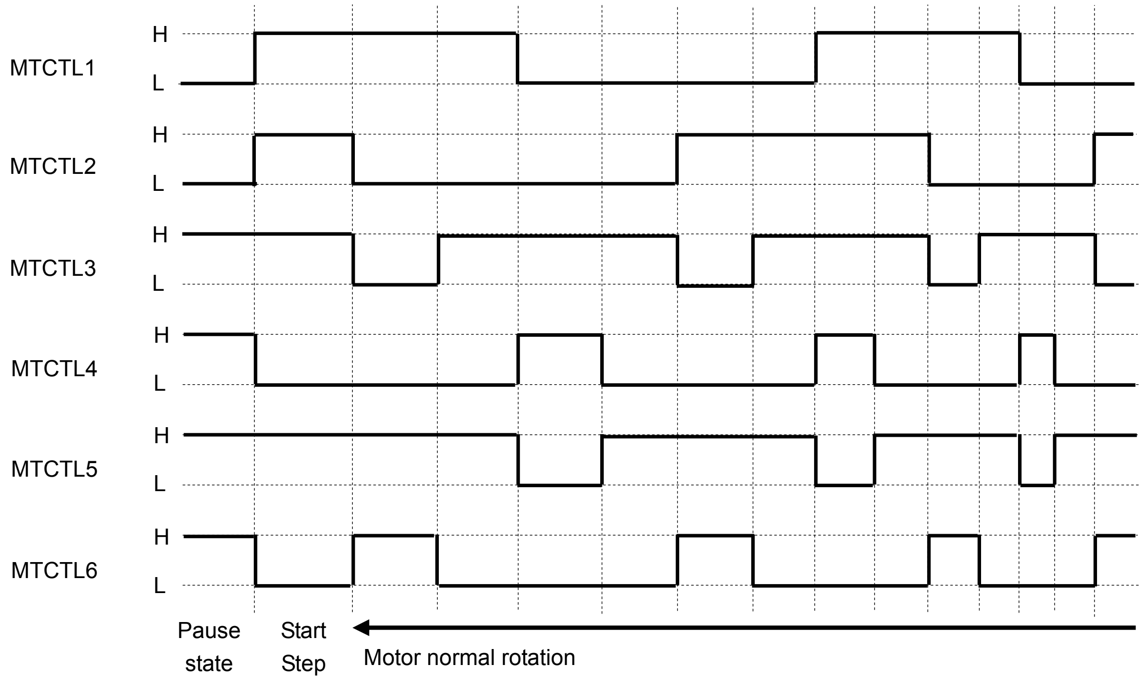


Figure 3-13 Input Voltage Waveforms for the Sample Drive Circuit (Outward)

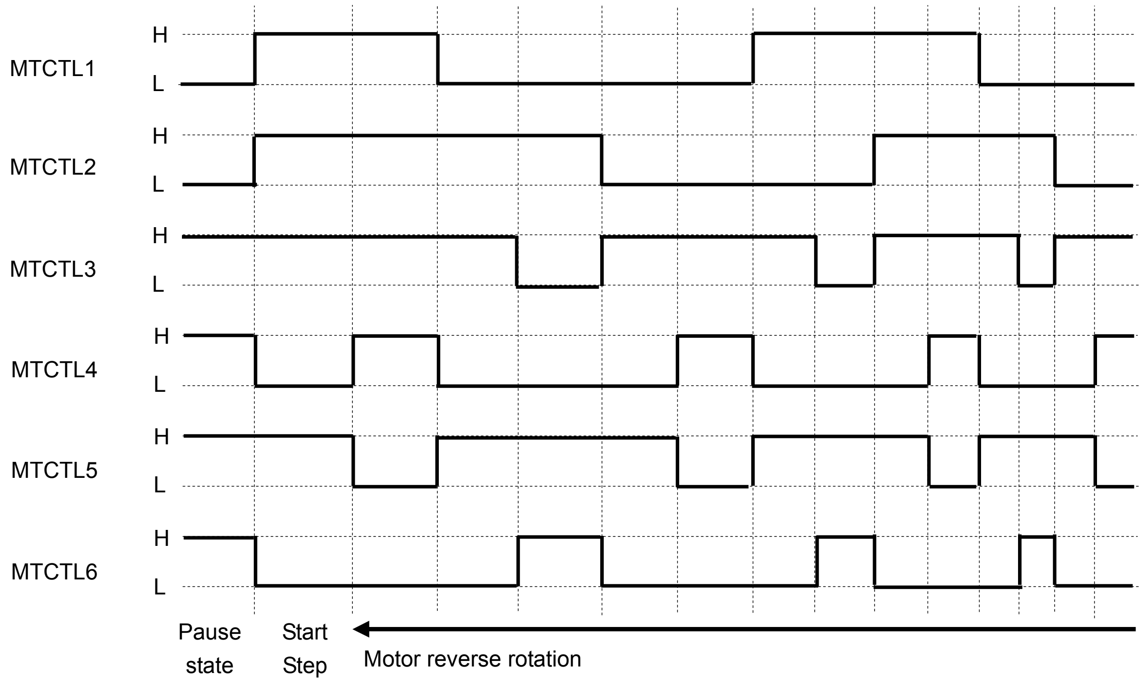


Figure 3-14 Input Voltage Waveforms for the Sample Drive Circuit (Homeward)

Table 3-18 Excitation Sequence

	Input signal						Output signal			
	MTCTL1	MTCTL2	MTCTL3	MTCTL4	MTCTL5	MTCTL6	A	B	$\overline{A}$	$\overline{B}$
Step 1	H	H	H	L	H	L	H	H	L	L
Step 2	H	L	L	L	H	H	H	OFF	L	OFF
Step 3	H	L	H	L	H	L	H	L	L	H
Step 4	L	L	H	H	L	L	OFF	L	OFF	H
Step 5	L	L	H	L	H	L	L	L	H	H
Step 6	L	H	L	L	H	H	L	OFF	H	OFF
Step 7	L	H	H	L	H	L	L	H	H	L
Step 8	H	H	H	H	L	L	OFF	H	OFF	L

3.7.4 Autocutter Drive Motor Start/Stop Method

Design the control circuit and software to stop/start for autocutter drive motor, refer Figure 3-15 Timing Chart.

(1) Start step

To start the motor from the pause (no excitation) state, shift the motor to the sequence of cut step after exciting the same phase as that of the stop step for the first acceleration step time of the acceleration step.
Perform the start step by the 2 phase excitation condition.

(2) Stop step

To stop the motor, excite the same phase as the last one in the cut step for 30 ms including the time of the last one step.

(3) Pause state

In the pause state, do not excite the motor to prevent to the motor from overheating.

The voltage wave forms of the sample drive circuit is shown in Figure 3-15.

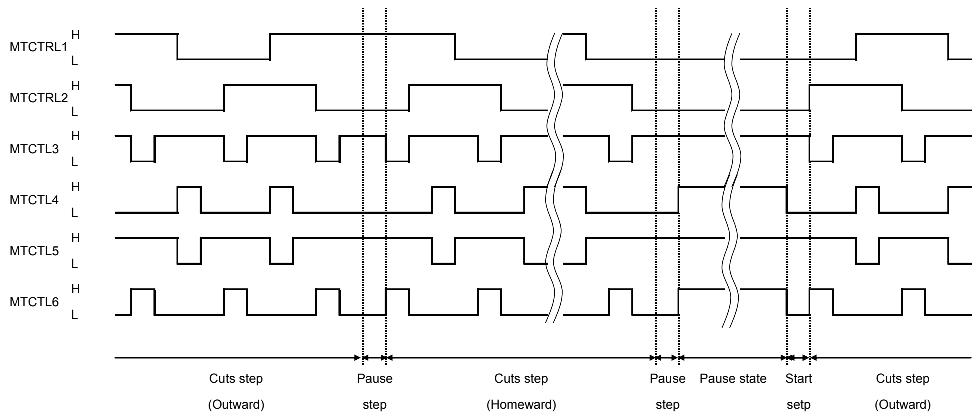


Figure 3-15 Autocutter Drive Motor Start/Stop Timing Chart

3.7.5 Autocutter Drive Motor Drive Method

To drive the autocutter drive motor, follow the method below.

(1) Drive frequency

The motor is normal rotation (Outward) : 2400pps max.
The motor is reverse rotation (Homeward) : 2600pps max.

(2) Speed control

When driving the motor, the acceleration control is necessary. If acceleration of the motor does not perform correctly, the motor may step out. Accelerate the speed sequentially up to the maximum motor drive pulse rate P_M according to the Table 3-19 Acceleration Steps of the Autocutter Drive Motor.

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.

(3) Preventing overheat

It is possible to drive the autocutter drive motor continuously, within the specifications.

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 3-19 Acceleration Steps of the Autocutter Drive Motor

Step Number	Drive Pulse Rate (pps)	Step Time (μs)	Step Number	Drive Pulse Rate (pps)	Step Time (μs)
Start	-	50000	35	1835	545
1	224	4464	36	1861	537
2	362	2759	37	1888	530
3	469	2131	38	1914	522
4	559	1789	39	1940	515
5	638	1568	40	1966	509
6	709	1411	41	1991	502
7	773	1293	42	2016	496
8	834	1200	43	2040	490
9	890	1124	44	2065	484
10	943	1060	45	2089	479
11	994	1006	46	2112	473
12	1042	960	47	2136	468
13	1088	919	48	2159	463
14	1132	883	49	2182	458
15	1175	851	50	2205	454
16	1216	822	51	2227	449
17	1256	796	52	2250	444
18	1295	772	53	2272	440
19	1333	750	54	2294	436
20	1369	730	55	2315	432
21	1405	712	56	2337	428
22	1440	695	57	2358	424
23	1474	679	58	2379	420
24	1507	664	59	2400	417
25	1540	649	60	2421	413
26	1572	636	61	2441	410
27	1603	624	62	2462	406
28	1634	612	63	2482	403
29	1664	601	64	2502	400
30	1693	591	65	2522	397
31	1723	581	66	2542	393
32	1751	571	67	2561	390
33	1779	562	68	2581	387
34	1807	553	69	2600	385

3.7.6 Precaution of the Autocutter Drive Motor

- It cannot give the specified performance, if using except 3.7.2 Sample Drive Circuit.
- Do not drive the autocutter drive motor while the printer drive motor is driving. It may cause of damage.

3.8 OUT-OF-PAPER SENSOR

The printer has a built-in out-of-paper sensor (photo interrupter based sensor) to detect whether the thermal paper is present or not. The external circuit should be designed to detect the output from the out-of-paper sensor for preventing the activation of the thermal head, the printer drive motor or the autocutter drive motor when the thermal paper is not inserted. Otherwise it may cause damages on the thermal head or the platen, or shortening the life of the thermal head significantly.

The printer drive motor is driven when there is no paper, a load is put on the paper drive system and the life of the printer may be shortened significantly.

The autocutter drive motor is driven when there is no paper, the life of the autocutter may be shortened significantly.

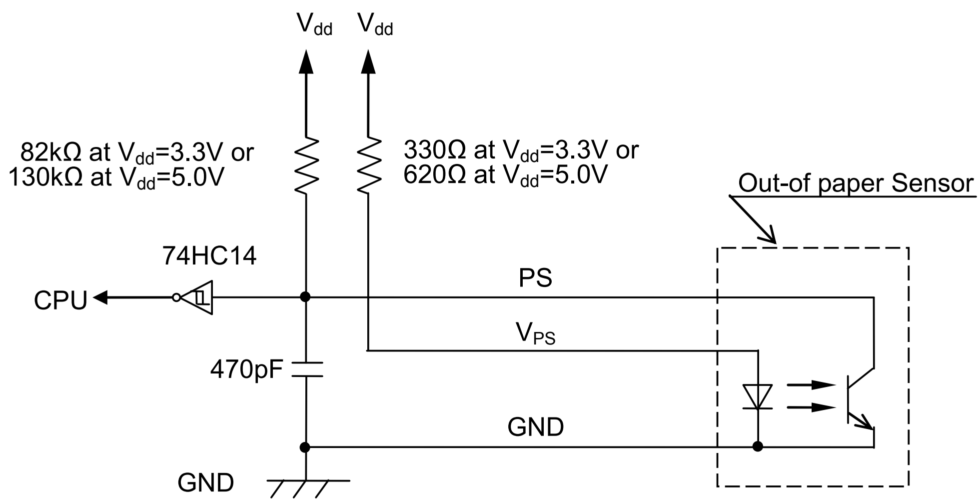
3.8.1 General Specifications

Table 3-20 shows about the out-of-paper sensor used for this printer.

Table 3-20 Out-of-paper Sensor

Item	Specification
Model	RPI-5100
Manufacturer	ROHM

Figure 3-16 shows sample external circuit of the out-of-paper sensor.



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

Figure 3-16 Sample External Circuit of the Out-of-paper Sensor

3.8.2 Precautions for the Out-of-Paper Sensor

- The out-of-paper sensor may generate instantaneous abnormal signal. Design the firmware in order to prevent malfunction due to the abnormal signal. (Recommended frequency: detecting twice every 10 ms)

3.9 HEAD POSITION SENSOR

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

The external circuit should be designed so that it detects output from the head position sensor and does not activate the thermal head, the printer drive motor and the autocutter drive motor when the head block is in open state. Otherwise, the thermal head may become damaged or its life may be shortened significantly.

The autocutter drive motor is driven when the head block is in open state, it is dangerous users can touch the movable blade directly.

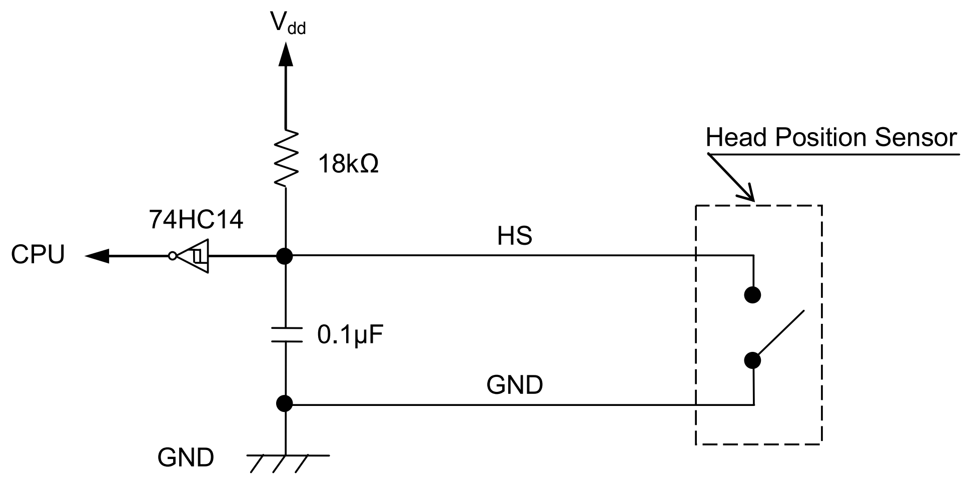
3.9.1 General Specifications

Table 3-21 shows about the general specification

Table 3-21 General Specifications of the Head Position Sensor

Item	Specification
Rated voltage	DC5.0 V
Rated current	0.1 mA to 100 mA
Contact resistance	1 Ω max.

Figure 3-17 shows sample external circuit of the head position sensor.



*: The HS signal is “High” when the head block is released.

Figure 3-17 Sample External Circuit of the Head Position Sensor

3.9.2 Head Position Sensor Precautions

- Be sure that there is a time lag between the time when the thermal head is set and the head position sensor actually starts detecting.
- Always use the capacitor shown in Figure 3-17 to prevent the switch from malfunctioning due to chattering.
- The head position sensor may generate instantaneous abnormal signal. Design the firmware in order to prevent malfunction due to the abnormal signal. (Recommended frequency: detecting twice every 10 ms)

3.10 CUTTER HOME POSITION SENSOR

The printer has a built-in cutter home position sensor (transmission type photo interrupter) for detecting the position of the movable blade. The external circuit should be designed so that the cutter home position sensor detects where the movable blade is and it will not drive the motor unless the movable blade is in its home position.

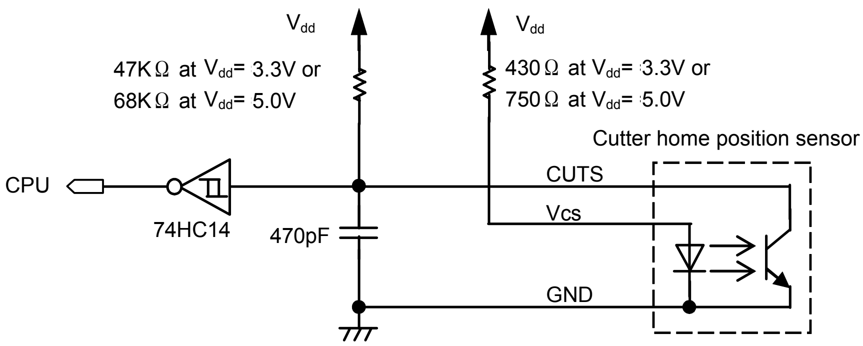
If the movable blade is driven out of the home position, it occurs the paper jam or damaged for the movable blade.

Table 3-22 shows the specifications of the cutter home position sensor.

Table 3-22 Cutter Home Position Sensor

Item	Specification
Model	GP1S092HCPIF
Manufacturer	Sharp Corporation

Figure 3-18 shows the sample external circuit of the cutter home position sensor.



*: The CUTS signal is “High” when the movable blade is in its home position.

Figure 3-18 Sample External Circuit of the Mark Sensor

3.11 MARK SENSOR

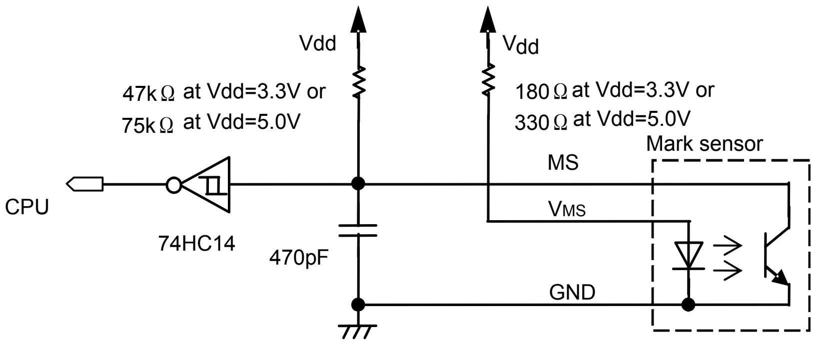
The printer has a built-in mark sensor for detecting the position of mark on the thermal paper.

Table 3-23 shows the specifications of the mark sensor.

Table 3-23 Mark Sensor

Item	Specification
Model	CNB1001 (SII Custom Rank)
Manufacturer	Panasonic Corporation

Figure 3-19 shows the sample external circuit of the mark sensor.



*: The MS signal is "High" when detecting the mark on the thermal paper.

Figure 3-19 Sample External Circuit of the Mark Sensor

Figure 3-20 shows timing mark sample, the distance between sensor and heat elements, and the distance between heat elements and cut position.

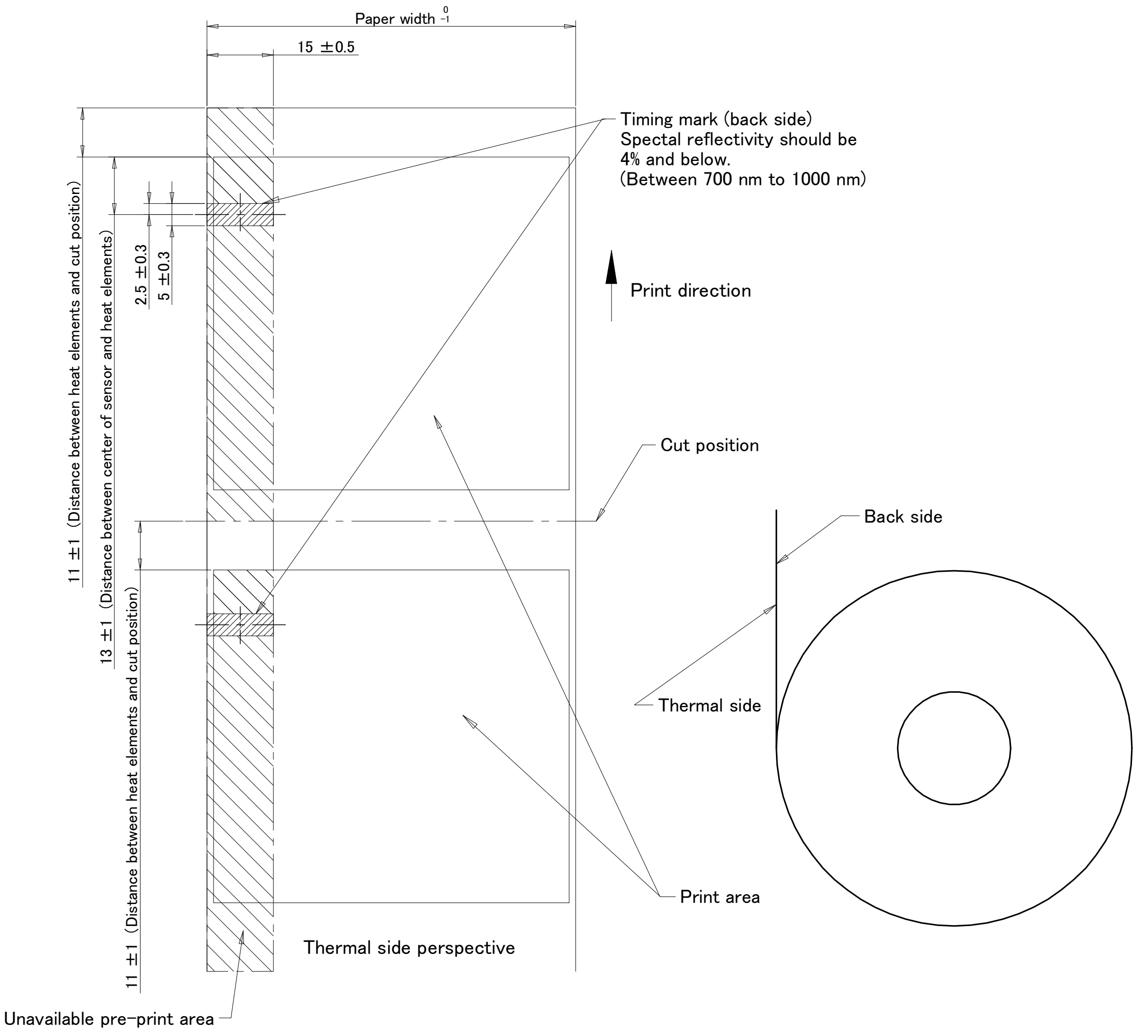


Figure 3-20 Example of Timing Mark

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

No.	Connector for External Circuits	Number of Terminals	Connectors	Recommended Connectors
1	Thermal head connecting terminals	22	B22B-PHDSS(LF)(SN)	JST PHDR-22VS(LF)(SN) *Contact: JST SPHD-001T-P0.5
2	Printer connecting terminals	12	MOLEX INC : 0510211200	MOLEX INC: 0533981271
3	Autocutter connecting terminals	7	MOLEX INC : 0510210700	MOLEX INC: 0533980771

4.2 THERMAL HEAD CONNECTING TERMINALS

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

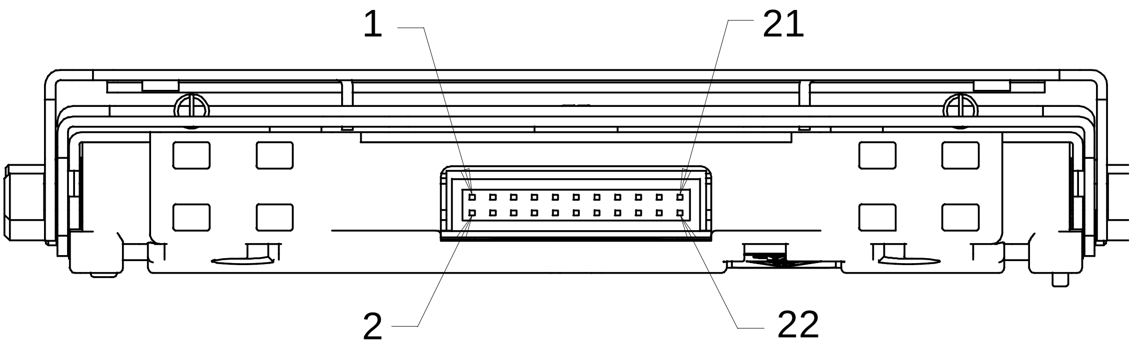


Figure 4-1 Thermal Head Connecting Terminals

Table 4-2 Terminal Assignments of the Thermal Head Connecting Terminal

Terminal No.	Signal Name	Function
1	GND	GND
2	V_P	Thermal head drive power supply
3	$\overline{DST1}$	Thermal head print activation instruction signal (#1 block)
4	V_P	Thermal head drive power supply
5	$\overline{DST2}$	Thermal head print activation instruction signal (#2 block)
6	V_P	Thermal head drive power supply
7	$\overline{DST3}$	Thermal head print activation instruction signal (#3 block)
8	TH	Thermistor
9	$\overline{DST5}$	Thermal head print activation instruction signal (#5 block)
10	$\overline{DST4}$	Thermal head print activation instruction signal (#4 block)
11	DI	Print data input (serial input)
12	GND	GND
13	$\overline{LAT}$	Print data latch (memory storage) signal
14	GND	GND
15	CLK	Synchronizing signal for print data transfer
16	GND	GND
17	GND	GND
18	V_P	Thermal head drive power supply
19	GND	GND
20	V_P	Thermal head drive power supply
21	V_{dd}	Logic power supply
22	V_P	Thermal head drive power supply

4.3 PRINTER CONNECTING TERMINALS

Figure 4-2 shows the terminal configuration of the printer connecting terminals and Figure 4-3 shows terminal assignments of the printer connecting terminals.

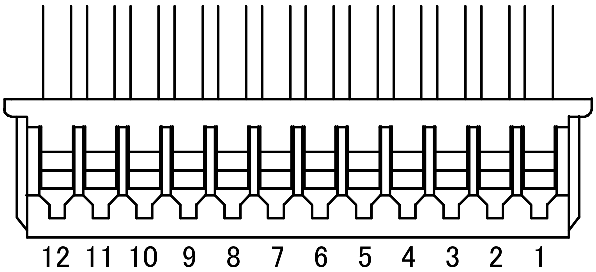


Figure 4-2 Printer Connecting Terminals

Table 4-3 Terminal Assignments of the Printer Connecting Terminal

Terminal No.	Signal Name	Function
1	V_{PS}	Power supply of the out-of-paper sensor (LED anode)
2	PS	Output signal of the out-of-paper sensor (Photo-transistor collector)
3	GND	GND of the out-of-paper sensor (LED cathode, photo-transistor emitter)
4	V_{MS}	Power supply of the mark sensor (LED anode)
5	MS	Output signal of the mark sensor (Photo-transistor collector)
6	GND	GND of the mark sensor (LED cathode, photo-transistor emitter)
7	HS	Head position sensor output
8	GND	GND
9	A	Printer drive motor drive signal
10	$\overline{A}$	Printer drive motor drive signal
11	B	Printer drive motor drive signal
12	$\overline{B}$	Printer drive motor drive signal

4.4 AUTOCUTTER CONNECTING TERMINALS

Figure 4-3 shows the terminal configuration of the autocutter connecting terminals and Table 4-4 shows terminal assignments of the autocutter connecting terminals.

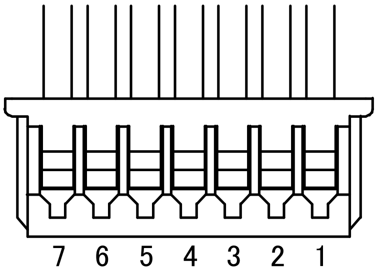


Figure 4-3 Autocutter Connecting Terminals

Table 4-4 Terminal Assignments of the Autocutter Connecting Terminal

Terminal No.	Signal Name	Function
1	A	Autocutter drive motor drive signal
2	$\overline{A}$	Autocutter drive motor drive signal
3	B	Autocutter drive motor drive signal
4	$\overline{B}$	Autocutter drive motor drive signal
5	V_{CS}	Power supply of the cutter home position sensor (LED anode)
6	CUTS	Output signal of the cutter home position sensor (Photo-transistor collector)
7	GND	GND of the cutter home position sensor (LED cathode, photo-transistor emitter)

CHAPTER 5
DRIVE METHOD

5.1 PRINT DRIVE METHOD

5.1.1 Printer Drive Motor and Thermal Head Drive Method

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

Figure 5-1 shows a timing chart for using fixed two division printing.
Figure 5-2 shows a timing chart for using batch printing.

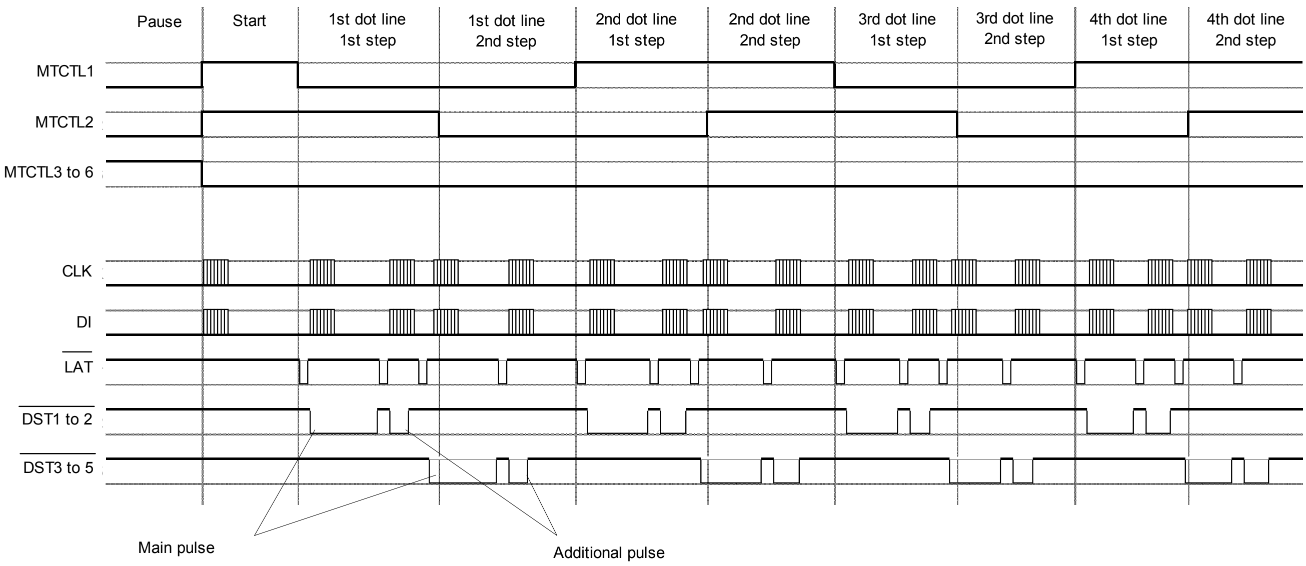


Figure 5-1 Timing Chart for Using Fixed Two Divisions

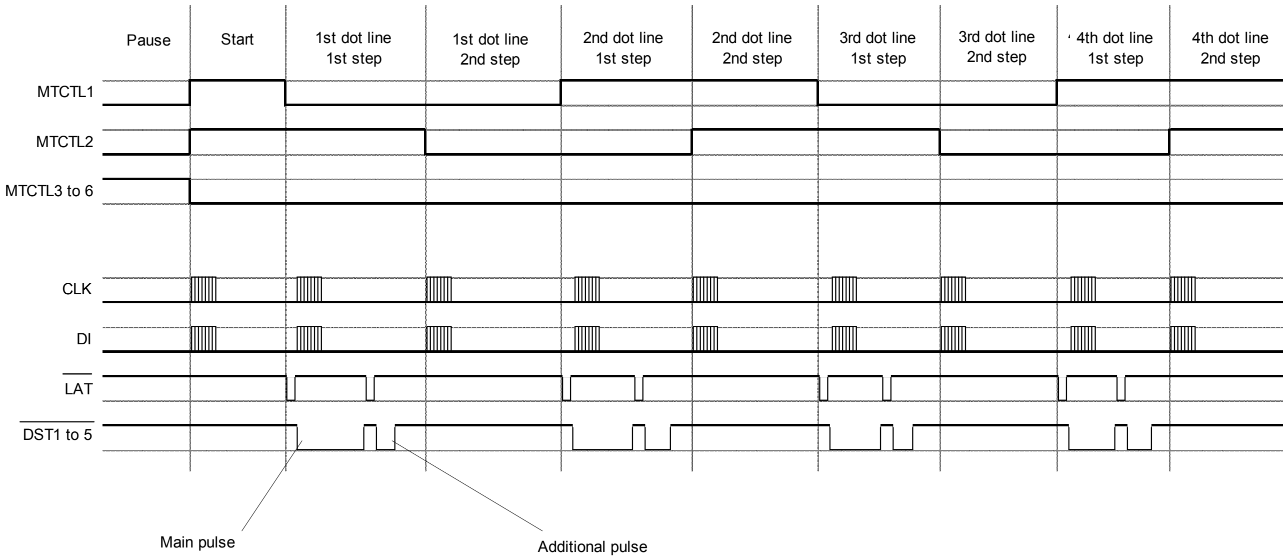


Figure 5-2 Timing Chart for Using Batch Printing

The drive method using fixed two divisions is explained below (See Figure 5-1):

(1) Pause state

Inactivate the motor and always make $\overline{\text{DST}}$ signal of the thermal head "High".

(2) Start step

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

(3) 1st dot line

Configure the 1 dot line by 2 steps of the motor drive signal.

At the 1st step of the motor drive signal, start activation of the thermal head by synchronized $\overline{\text{DST1}}$ and $\overline{\text{DST2}}$, print 1st dot line by $\overline{\text{DST3}}$ to $\overline{\text{DST5}}$ after the activation of $\overline{\text{DST1}}$ and $\overline{\text{DST2}}$ is completed.

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.)

Input the $\overline{\text{DST}}$ 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.

To active an addition pulse for heat history control, which should be activated after completing a main pulse activation and taking 10 μs pause. If the time between the main pulse and the additional pulse exceeds 10 μs, active the additional pulse after the data transmitting to the thermal head and then the latch of those data are completed.

(4) Procedures that follows the 2nd dot line

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

5.1.2 Thermal Head Division Drive Method

In the thermal head of the printer, there are 5 blocks in 1 dot line. These blocks are called physical blocks.
$\overline{\text{DST}}$ 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.

5.1.3 Precautions for Print Drive

- The activation time of the thermal head can be longer than the motor step time depending on the type of the thermal paper, content of the printing and use conditions. In that case, the 1st step time and the 2nd step time divide equally of the thermal head activation time.
- When using batch printing for physical blocks, a pause time between thermal head activations of the same heat element shall be secured more than 0.1 ms. However, a time between an addition pulse and a main pulse is exempt from a pause time (10 μs).
- The number of the maximum thermal head division in 1 dot line should be 5 or lower. However, the print quality may degrade due to the type of thermal paper even if the number of thermal head division is 5 or lower. Verify the performance with your actual device.
- 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 10 steps at start up and do not interrupt printing.

5.2 AUTOCUTTER DRIIVE METHOD

5.2.1 Timing Chart for Autocutter Drive

Change the speed according to the timing chart shown in Figure 5-3. Follow the acceleration steps of autocutter drive motor which is shown in Table 3-14 of Chapter 3, and accelerate to the maximum motor drive frequency in order.

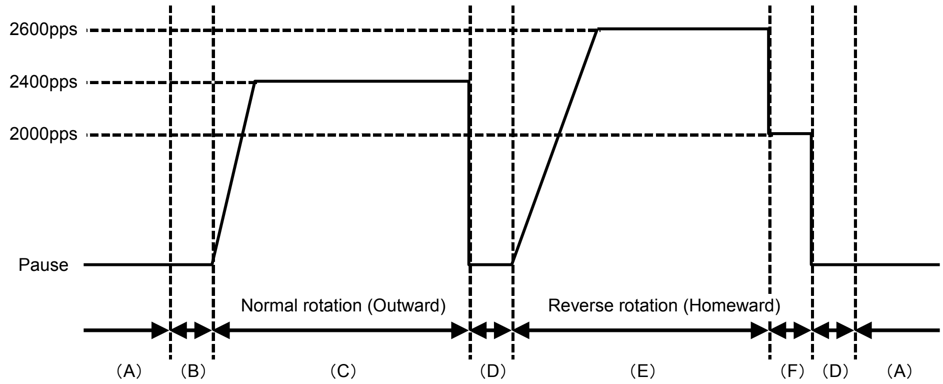


Figure 5-3 Timing Chart for Autocutter Drive

(A) Pause state

Inactivate the motor.

(B) Start step

Excite the motor by the same phase which is output just before the motor stops.
Perform the start step by the 2 phase excitation condition.

(C) Cut performance step (Outward)

Perform the acceleration control till maximum motor drive frequency of the outward, and drive the motor (normal rotation) according to the cut condition (Full cut/Partial cut). See Figure 5-5 for the number of cut step.

(D) Stop step

Perform the stop step by the 2 phase excitation condition.
Excite the stop step for 30 ms.

(E) Cut performance step (Homeward)

Perform the acceleration control till maximum motor drive frequency of the homeward, and drive (reverse rotation) for the motor. See Figure 5-5 for the number of cut step.

(F) Cutter home position detecting step

Detects CUTS = ”High”, and drive (reverse rotation) 10 steps by 2000 pps of the motor drive frequency.

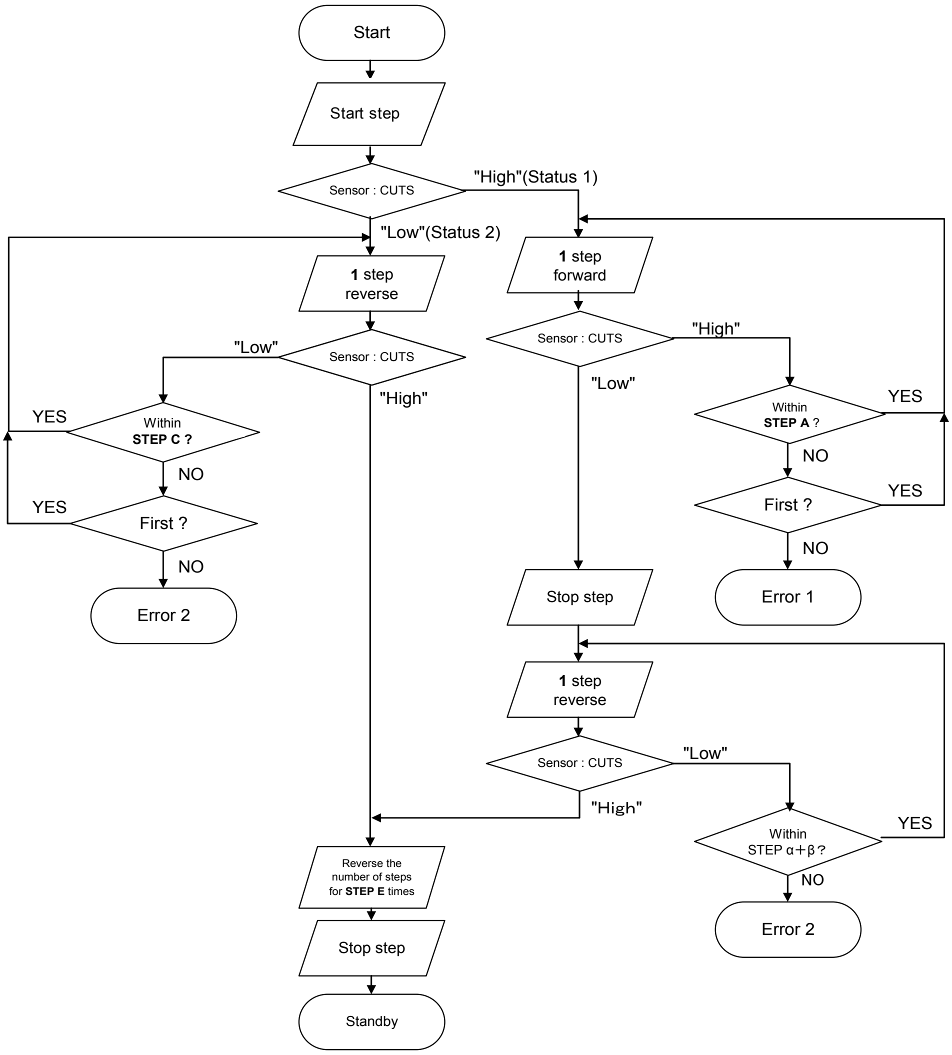
(D) Stop step

Excite the stop step for 30 ms.

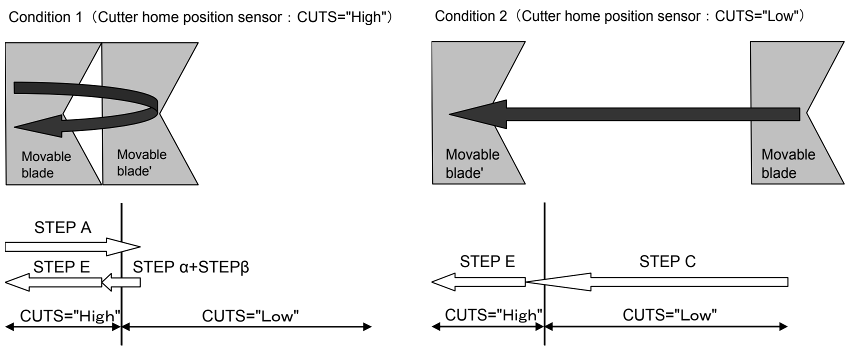
5.2.2 Flow Chart for Autocutter Drive

(1) Initializing performance

When turn the power on or the resetting, perform the initializing performance to return the movable blade to the home position. The flow chart of initializing performance is shown in Figure 5-4.



Error 1 : The printer mechanism failure or the poor connection may occur.
Error 2 : The cutter error may occur. Refer to Chapter 8 “INSTALLING/UNINSTALLING THE THERMAL PAPER” for releasing method when the cutter error is occurred.

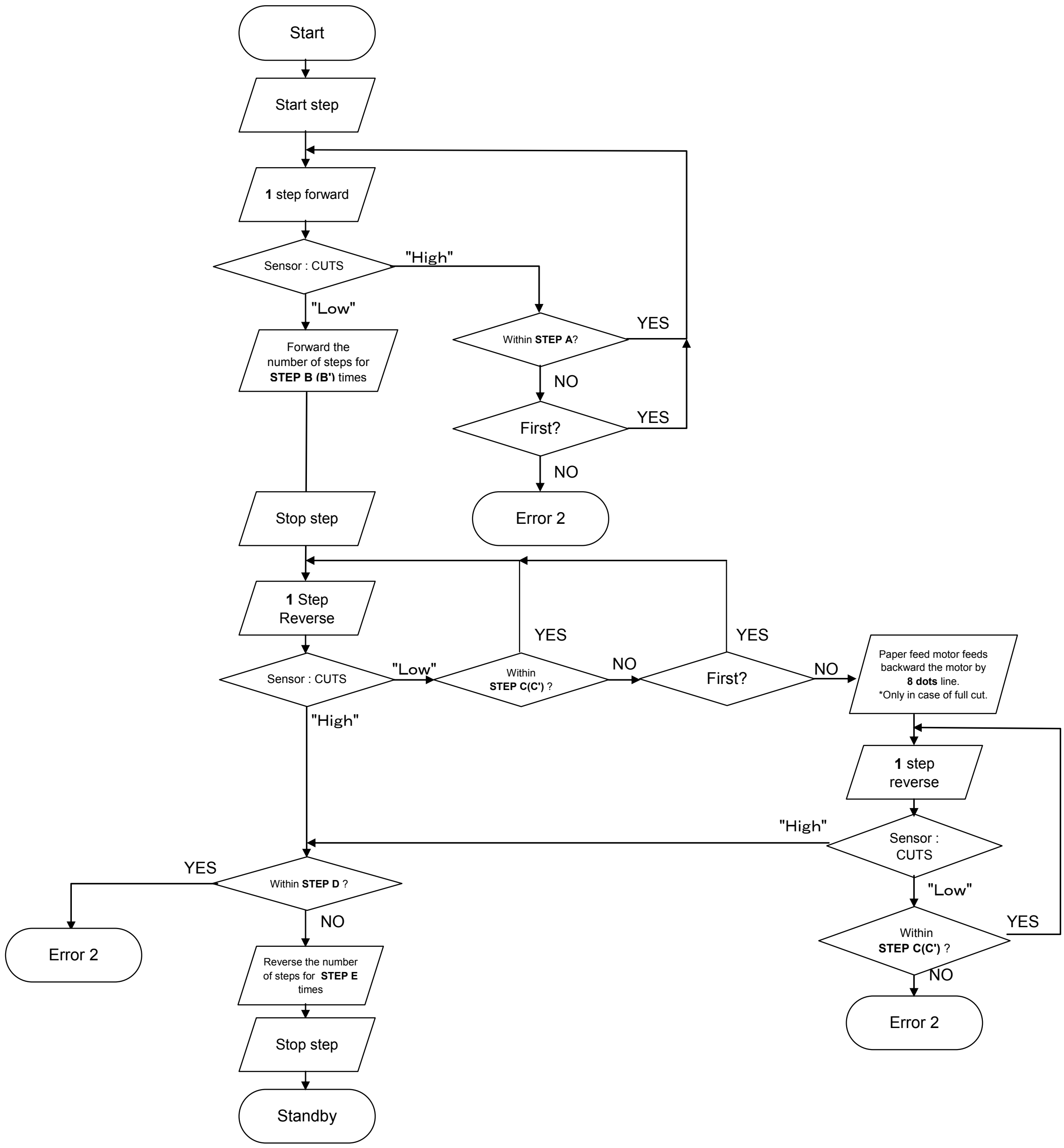


Item	Number of steps	
	Standard	Thick Paper
STEP A	60	60
STEP C (Full cut)	310	318
STEP C'(Partial cut)	278	282
STEP E	10	10
STEP α	20	20
STEP β	16	16

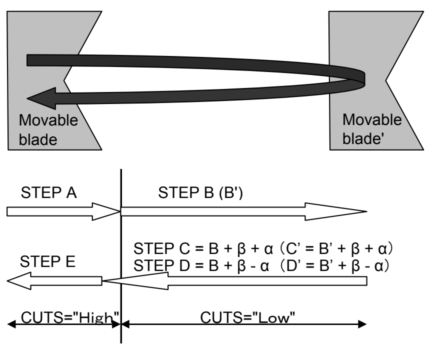
Figure 5-4 Autocutter Flow Chart: Initializing

(2) Cut performance

The flow chart of cut performance is shown in Figure 5-5.



Error 2 : The cutter error may occur. Refer to Chapter 8 “INSTALLING/UNINSTALLING THE THERMAL PAPER” for releasing method when the cutter error is occurred.



Item	Number of steps	
	Standard	Thick paper
STEP A	60	60
STEP B (Full cut)	274	282
STEP B' (Partial cut)	242	246
STEP C (Full cut)	310	318
STEP C'(Partial cut)	278	282
STEP D (Full cut)	270	278
STEP D'(Partial cut)	238	242
STEP E	10	10
STEP α	20	20
STEP β	16	16

Figure 5-5 Autocutter Flow Chart: Cut Performance

5.2.3 Precautions for Using the Autocutter

- Figure 5-6 shows how to make the most efficient use of the thermal paper that margin from print area to cut area, printing “Print B” after next “Print A” is printed and cut.
  The distance of the cut position and the heat elements at the thermal head is 11 ±1 mm approx. Do not print over the cut position.
  If “Print A” and “Print B” are printed as continuous pattern, its cutting operation which pauses printing during cutting the thermal paper causes a little gap between “Print A” and “Print B”.

- Remove the thermal paper which is cut with the full cut, then perform the next printing or cutting.
  If the printer performs the next printing or cutting without removing the thermal paper, it may cause of the paper jam or cut failure depending on the mounting position. Verify the performance with your actual device.

- The printer has been left for long period of time after cutting the thermal paper, may occur the paper jam. To prevent this case, printing or feeding 7 mm or longer after cutting.

- Do not feed paper backwards after cutting with the partial cut. The part of the partial cut (tab left at the center) may be cut off.

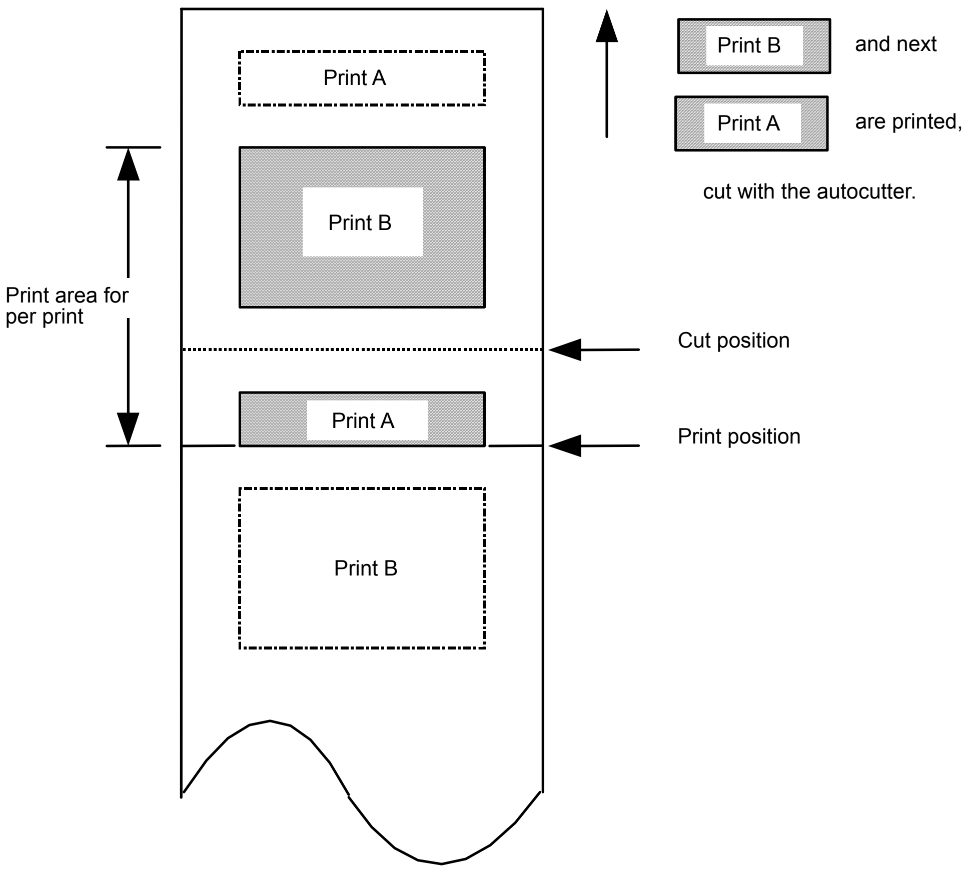
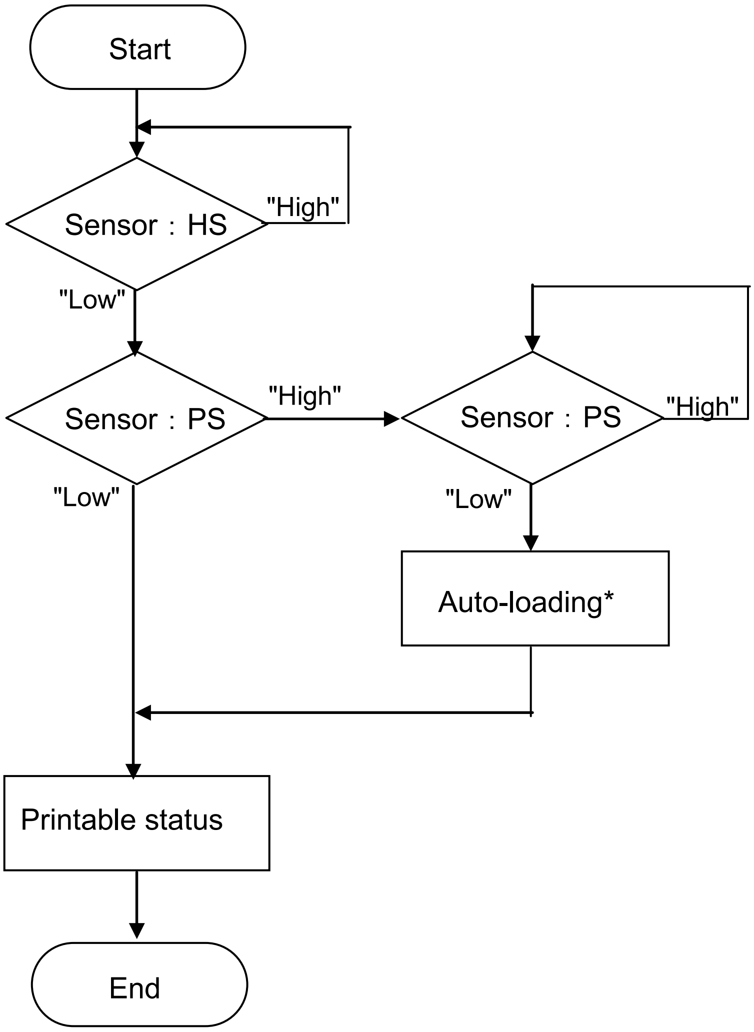


Figure 5-6 Effective Use of the Cutting Thermal Paper

5.3 AUTO-LOADING METHOD OF THERMAL PAPER

For auto-loading model, auto-loading of thermal paper (automatic insertion) is available with out-of-paper sensor shown in Chapter 3. Control auto-loading according to Figure 5-7.

See 8.1.1 " Procedure for Installing the Thermal Paper" in Chapter 8 for the procedure of paper installation by auto-loading.



*: ·Drive the printer drive motor at normal rotation.
·Specify the auto-loading length arbitrarily.
It takes approximately 1 or 2 seconds to load the thermal paper into platen roller after passing the out-of-paper sensor.
The distance between out-of-paper sensor and heat elements is approximately 13 mm.
The distance between heat elements and auto cutter cutting position is approximately 11mm.
·Drive the motor at 797 pps during auto-loading.

Figure 5-7 Flow Chart of Thermal Paper Auto-loading

CHAPTER 6
OUTER CASE DESIGN GUIDE

6.1 MOUNTING POSITION

Figure 6-1 shows the possible mounting position (θ). This printer is able to be mounted at an angle of 0° to 360°.

6.1.1 Precaution for Mounting Position

Remove the thermal paper which cut with the full cut, then perform the next printing or cutting.
If the printer performs the next printing or cutting without removing the thermal paper, it may cause the paper jam or cut failure depending on the mounting position. Verify the performance with your actual device.

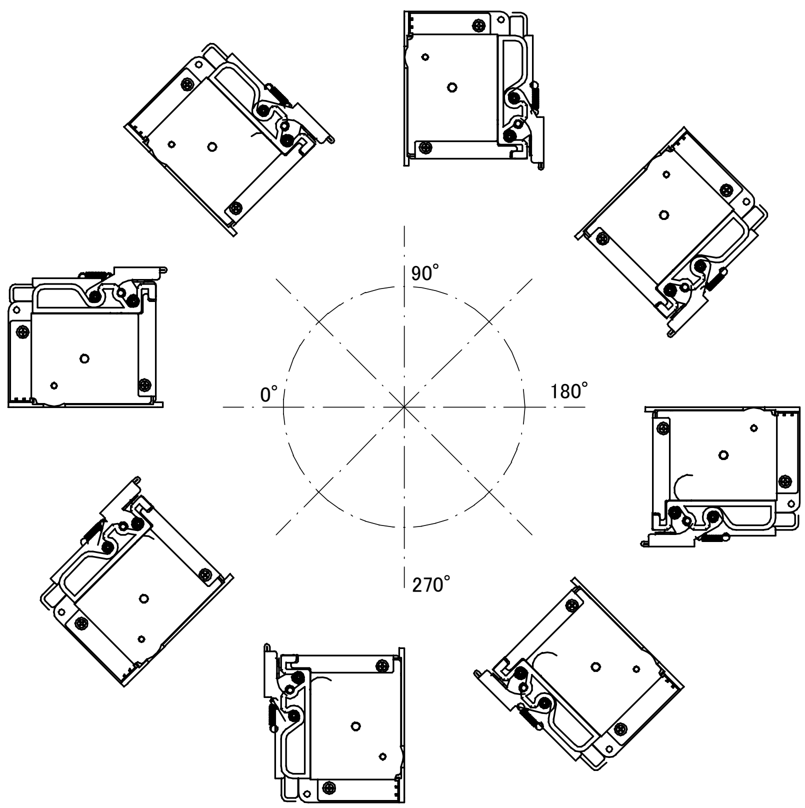


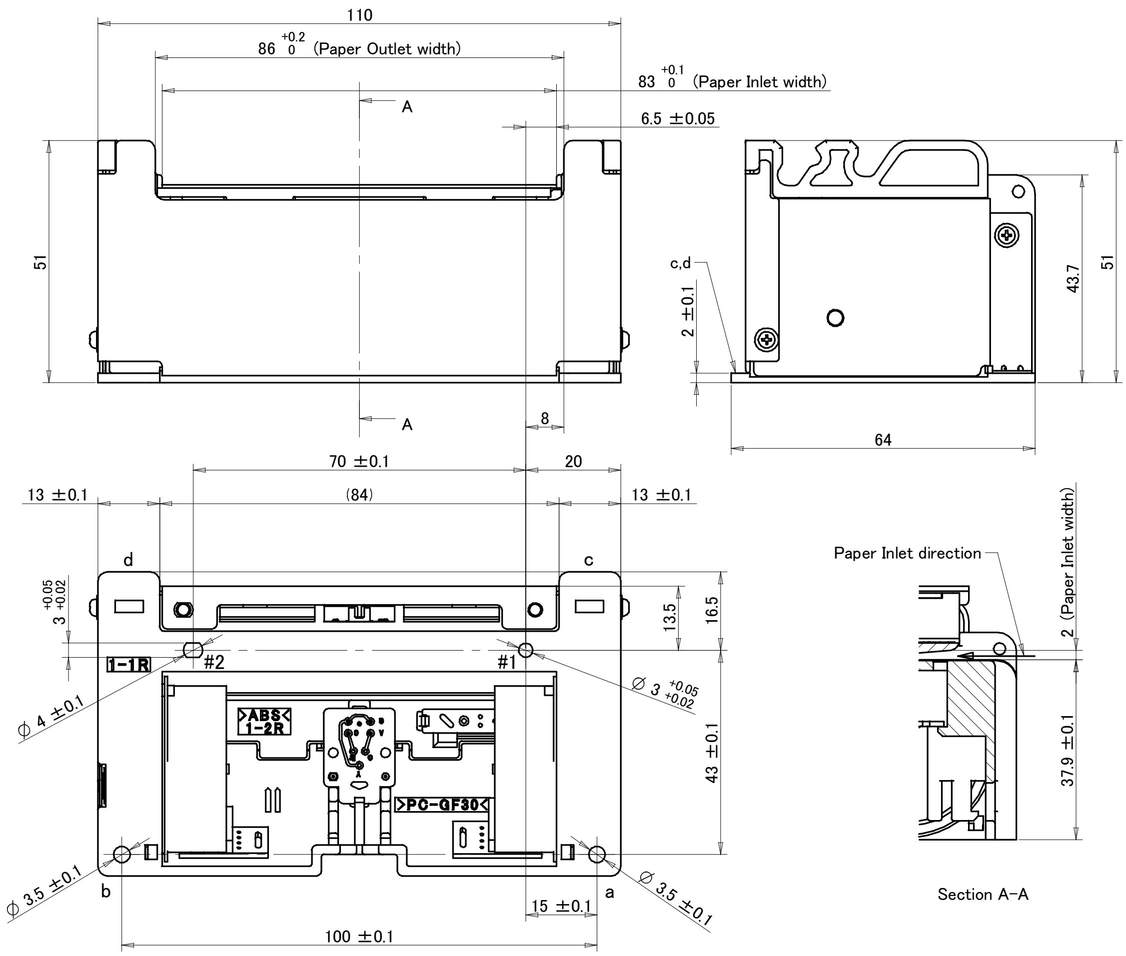
Figure 6-1 Mounting Position

6.2 SECURING THE PRINTER MAIN BODY

6.2.1 How to Mount the Printer Main Body

Figure 6-2 shows 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 1.5 mm or less.
- Secure the printer main body using the holes “a” and "b" by the screw.
- Design the fixing hook to the part of "c" and "d".



Unit : mm
General tolerance for dimensions : ±0.3
General tolerance for angle : ±1°

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

Figure 6-3 and Figure 6-4 show samples for positioning and securing the printer main body.

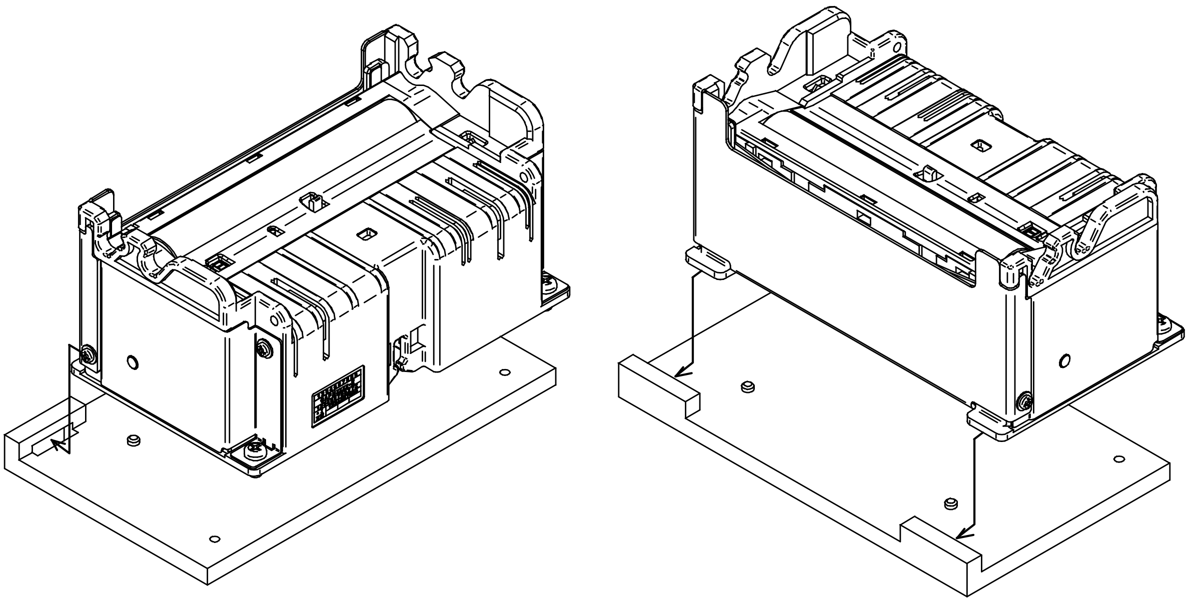


Figure 6-3 Sample for Positioning and Securing the Printer Main Body (Perspective View)

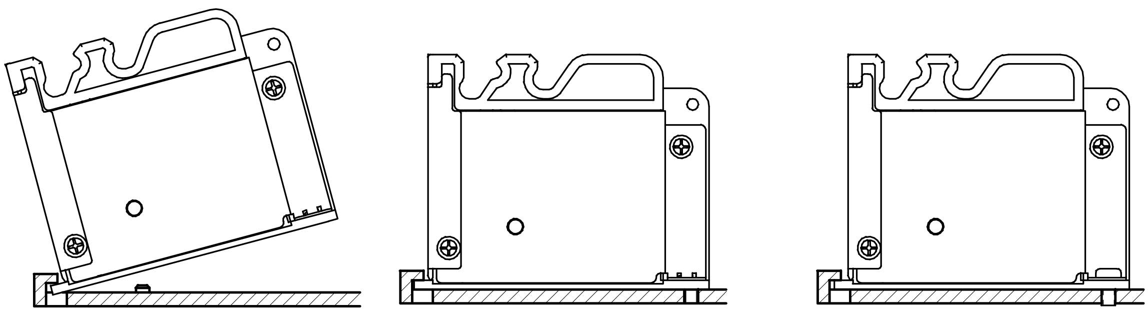


Figure 6-4 Sample for Positioning and Securing the Printer Main Body (Side View)

6.2.2 Recommended Screws

The recommended mounting screw is as follows:

(1) JIS B1111: M2.6 or M3.0 cross-recessed pan head machine nickel coating screws

(2) Tapping screws for resin: 2.6 or 3.0 cross-recessed pan head machine nickel coating tapping screws

6.2.3 Precautions for Securing the Printer Main Body

- Mount the printer main body on a flat surface and avoid places subject to vibrations.
- Verify the strength of the fixing hooks with your actual device.
- When securing the printer main body, be sure to prevent overload pressure, deformation, and twisting. The deformed or twisted printer main body causes print defect, paper skew, paper jam, noise, cut failure and damage of cutter blade.
- Pay attention not to damage the lead wire when securing the printer main body.

6.3 SECURING THE HEAD BLOCK

6.3.1 How to Mount the Head block (Easy operation model)

For an easy operation model, Figure 6-5 shows an engagement position of the printer main body and the head block when setting or releasing the head block mounted on the mounting frame, and the rotation center area for the mounting frame (shaded area).

- The holes #3 and #4 must be used for positioning the head block. Design the bosses for the positioning holes #3 and #4 on the outer case. The height of the bosses must be 1 mm or less.
- Secure the head block using the "e" and "f".

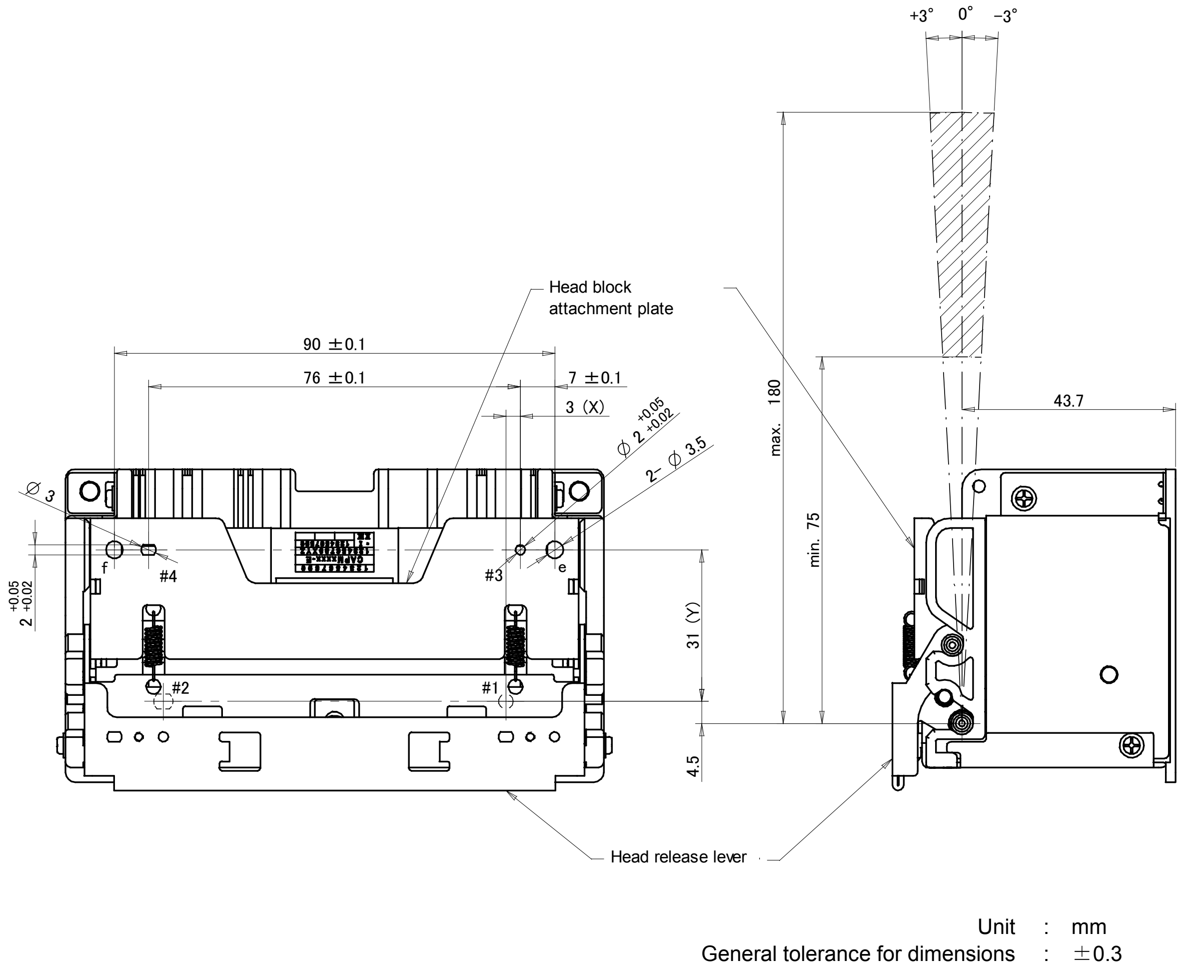


Figure 6-5 Dimensions for Positioning and Securing the Head Block (Easy Operation Model)

Table 6-1 Allowable Dimensions

Unit: mm

Allowable X dimension	Allowable Y dimension
3 ± 0.1	$31^{+0.4}_{-0}$

6.3.2 Recommended Screws

The recommended mounting screws for easy operation model are as follows:

(1) JIS B1111: M2.6 or M3.0 cross-recessed pan head machine nickel coating screws

(2) Tapping screws for resin: 2.6 or 3.0 cross-recessed pan head machine nickel coating tapping screws

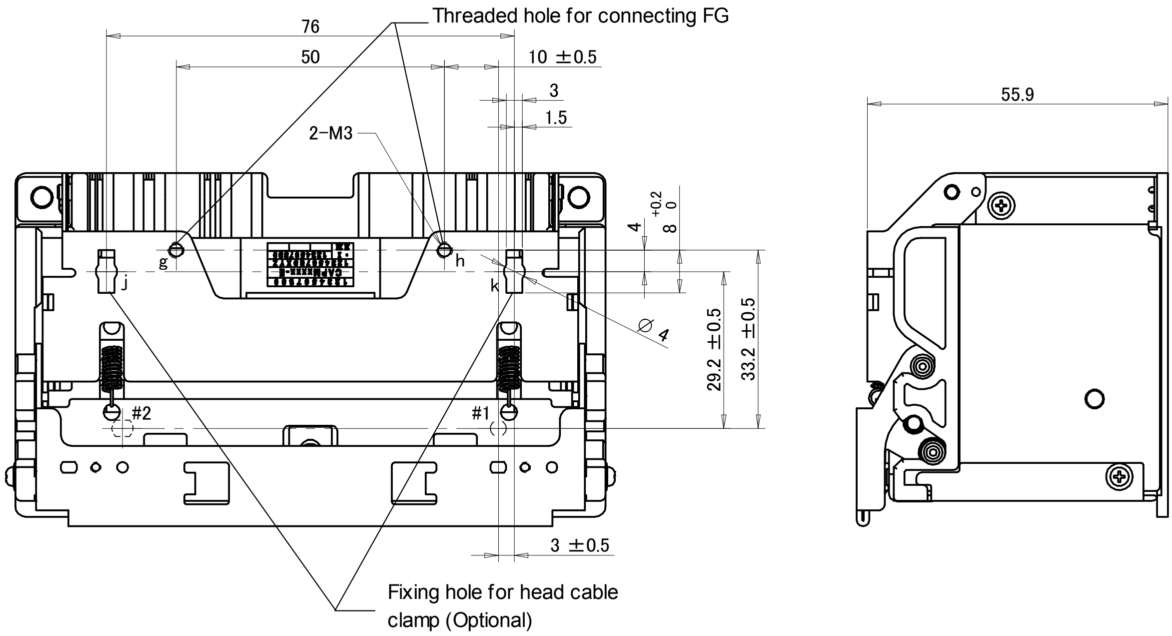
Note: Do not use the screw head more than 5.5 mm in diameter.

6.3.3 How to mount the head block (Auto-loading model)

The head block of auto-loading model is movable without separating from the printer and it is unnecessary to secure on the outer case.

Figure 6-6 shows the positioning dimensions of the clamp for fixing the head cable (optional) and the cable for connecting the frame ground (FG) regards to auto-loading model.

- Holes g and h are threaded holes for connecting the frame ground (FG) of the head block. Use them connecting to the frame ground.
- Holes j and k are mounting hole for the clamp for fixing the head cable (optional). Use them securing the head cable.



Unit : mm
General tolerance for dimensions : ±0.3

Figure 6-6 Dimensions for Positioning and Securing the Head block (Auto-loading Model)

6.3.4 Recommended Pressure Position for Head Block

Figure 6-7 shows the recommended pressure position for setting the head block.

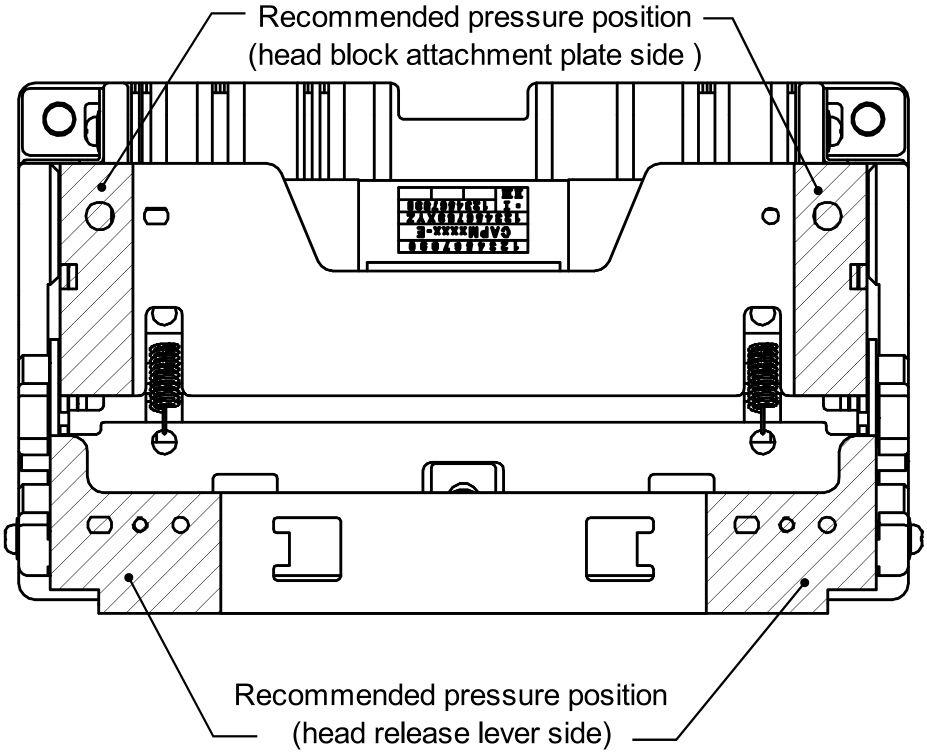


Figure 6-7 Recommended Pressure Position for Head Block

6.3.5 How to secure the head cable

Figure 6-8 shows recommended sample of securing head cables for easy operation model.

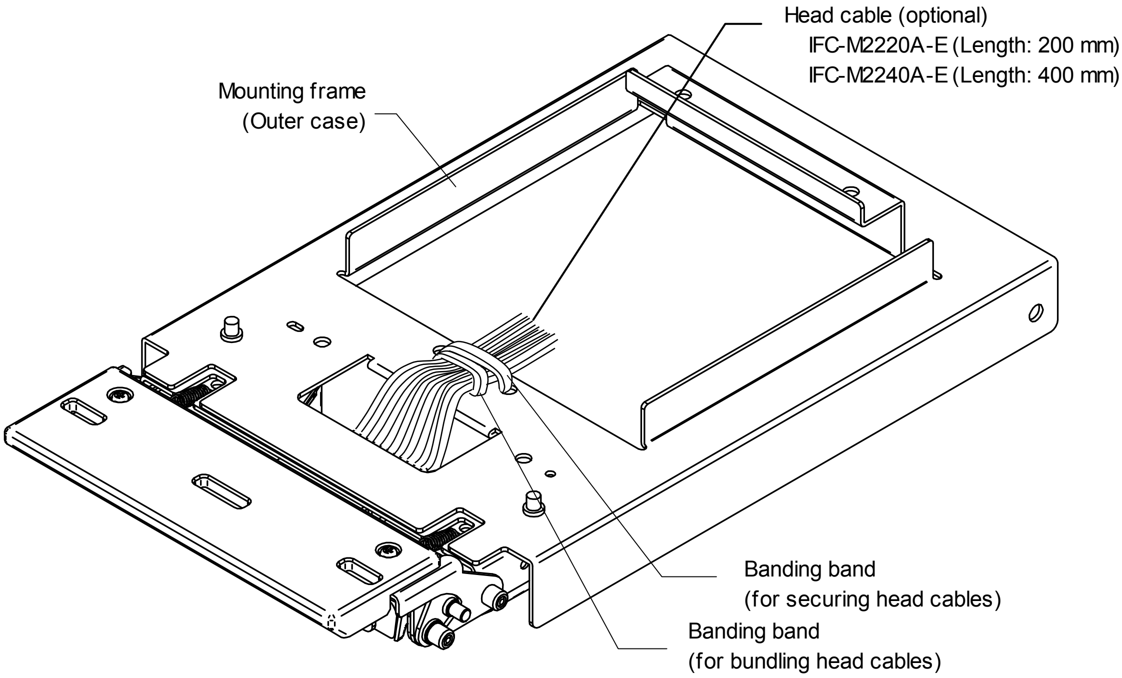


Figure 6-8 Recommended Example for Securing Head Cables (Easy Operation Model)

Figure 6-9 shows recommended sample of securing head cables for auto-loading model.

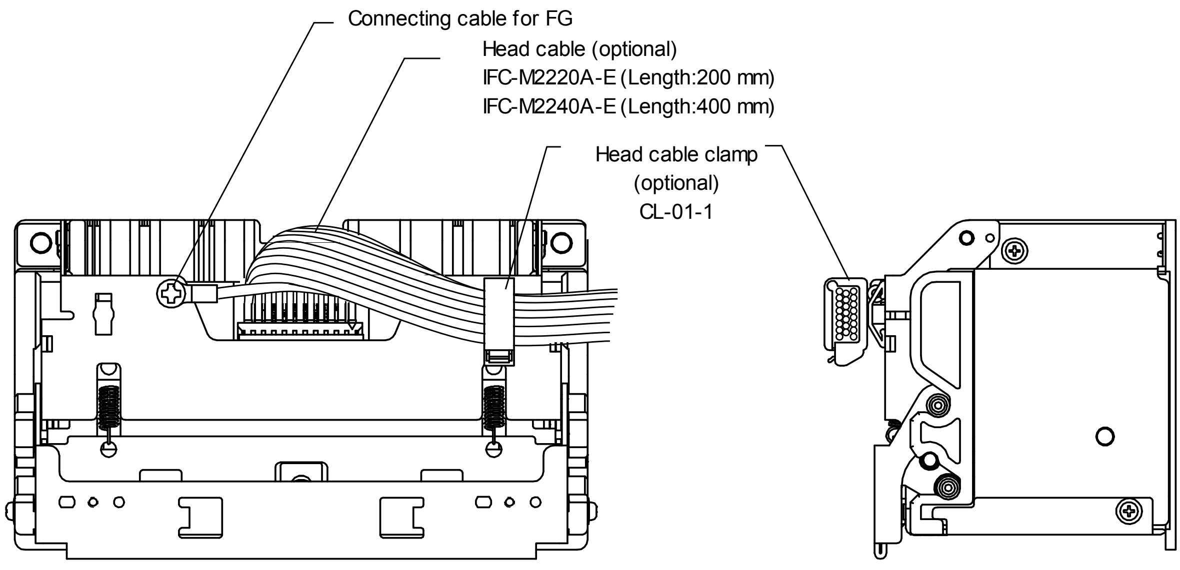


Figure 6-9 Recommended Example for Securing Head Cables (Auto-loading Model)

It is recommended the paper guide (hereinafter called bazel) is mounted on the paper inlet side as shown in Figure 6-10. The shape of the bazel should cover the flection of the head cables in order to protect the head cables when releasing the head block. In addition to the bazel, installing the guiding table on the printer main body side allows the paper insertion straight and smoothly.

It is available to mount the bazel using the rectangle hole on the rear of the head block. Figure 6-11 shows the dimensions for positioning and securing the bazel regarding auto-loading model.

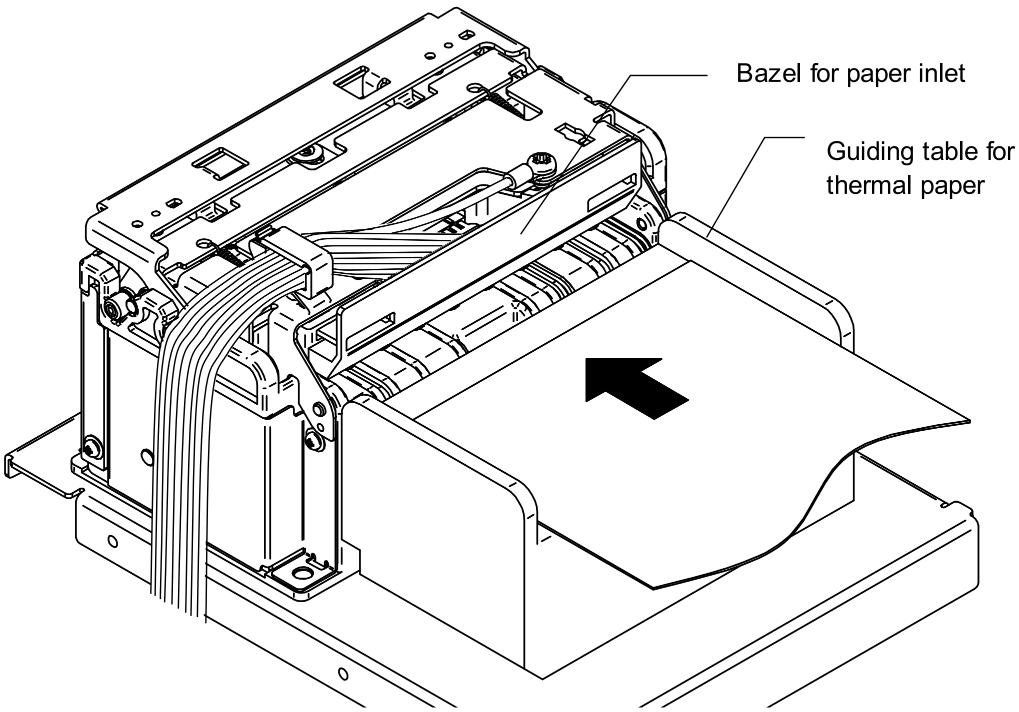
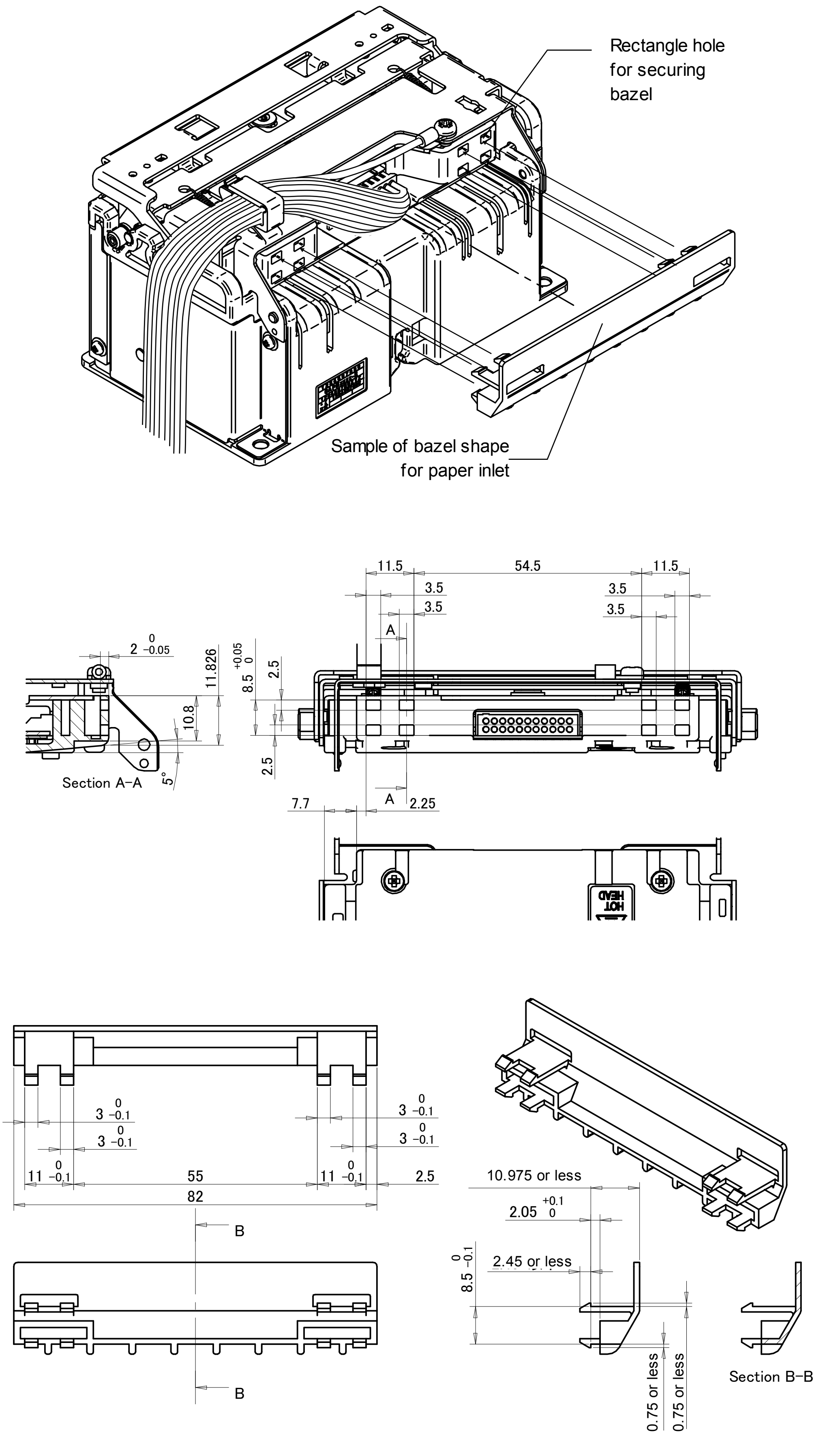


Figure 6-10 Recommended Form of Paper Inlet (Auto-loading Model)



Unit : mm
General tolerance for dimensions : ±0.1

Figure 6-11 Dimensions for Positioning and Securing the Bazel (Auto-loading Model)

6.3.6 Precautions for Securing the Head block

When using the easy operation model, follow the precautions below.

- Design the mounting position of the head block that X and Y dimensions as shown in Figure 6-5 is within the allowable dimensions as shown in Table 6-1. Otherwise the head block set defect may occur.
- Design the positioning hole #3 - #4 of the head block and the positioning hole #1 - #2 of the printer main body that the parallelism are 0.2 mm or less.
- Design the head block mounting surface to be parallel to the printer main body mounting surface:
  The parallelism of the cross direction is 0.2 mm or less.
  The parallelism of the width direction is 0° ± 2° or less.
- Design the mounting frame so that the center of the rotation is in the shaded area as shown in Figure 6-5.
- Design the rotation axis for the mounting frame, the positioning hole #1 - #2 and the mounting surface of the printer main body that the parallelism are 0.2 mm or less.
- It is recommended to adapt the structure that the part of outer case guides the paper cover and the mounting frame when setting the head block into the printer main body. For high precision design, it is also recommended to incorporate the rotation fulcrum to the mounting component of the printer main body.
- When securing the head block, be sure to prevent overload pressure, deformation, and twisting. The deformed or twisted head block causes print defect, paper skew, paper jam, noise, cut failure and damage of cutter blade.
- When releasing/setting the head block, the outer case is subject to pressures. Because of this, design the paper cover and the mounting frame to have adequate strength. If they do not have adequate strength, it causes incorrect fitting. And as a result it leads to print defection, paper jam, cut failure, and/or damage of the cutter blade.
- To ensure setting/releasing operation, design the mounting frame for head block to maintain the allowable dimensions. Moreover, design to reduce the rattling of the rotating shaft for mounting frame as much as possible. See Chapter 6.3.1 “How to Mount the Head block” for details.
- Prevent the head block mounted on the mounting frame from being lifted in upward and twisted direction by overloaded pressure at the time of setting it. Refer to Figure 6-12 “Example of Recommended Head Block Position” for the details.
- When setting the head block, push its both ends which is the recommended pressure position simultaneously shown in Figure 6-7 (head block attachment plate side). If setting the head release lever by pushing its one end, it causes incorrect fitting (e.g. only one side of the head block is set). As a result, it leads to print defect, paper jam, cut failure and/or damage of cutter blade. In order to let users to push designated portions, it is effective to put indications on the paper cover.
- Do not apply pressure only on the center of the attachment plate for head block. Pressure on the portion prevents smooth slide motion of the attachment plate, and it causes the head block to be difficult to set. If the mounting position of the head block and the mounting frame is not adequate, it causes difficult to the set head block into the printer main body. As a result, it causes print defect, paper skew, paper jam, noise, and/or cut failure.
- If designing the outer case with a structure to bring the head block up automatically using a spring property after released, make sure not to apply more than enough force to bring the head 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 with the movable blade unit and the head block with the fixed blade unit will be improperly and will result in the print defect or the cut failure. Verify the performance with your actual device.

- Design the product so that a tension force is not applied to the head cables connected to the connecting terminal of the thermal head. The connecting terminal of the thermal head could be moved by setting/releasing the head block, so design the product that the head cables have enough play after connecting. The tension force may cause print problems, damage of the printer and/or the disconnection of the connecter.

- When fixing the head cables to the outer case, design the product so that the cables have enough slack on both sides of the fixed part. Especially on the side of the head block, let the cables have 1 cm to 2 cm of slack at a point 5cm away from the connector. Also, the slacks on the both sides of fixed part may shift to one side or the other by setting/releasing the head block. To ensure the adequate fixing of the head cables, it is recommended to bundle the head cables using banding band before fixing to the outer case.

When using the auto-loading model, follow the precautions below.

- Fix the head cables on the top surface of the head block. Use the clamp (optional) or banding band to bundle the head cable and wire the head cable along the side of the printer so that it does not get in the way of releasing/setting the head block and inserting paper.
  Moreover, design the product so that the head cable does not block the way of the head block. Excessive force on the head block may cause damage on the connector.

- When setting the head block, push its both ends which is the recommended pressure position simultaneously shown in Figure 6-7 (head release lever side). If setting the head release lever by pushing its one end, it causes incorrect fitting (e.g. only one side of the head block is set). As a result, it leads to print defect, paper jam, cut failure and/or damage of cutter blade. In order to let users to push designated portions, it is effective to put indications on the paper cover.

Figure 6-12 shows a recommended example of securing the head block.

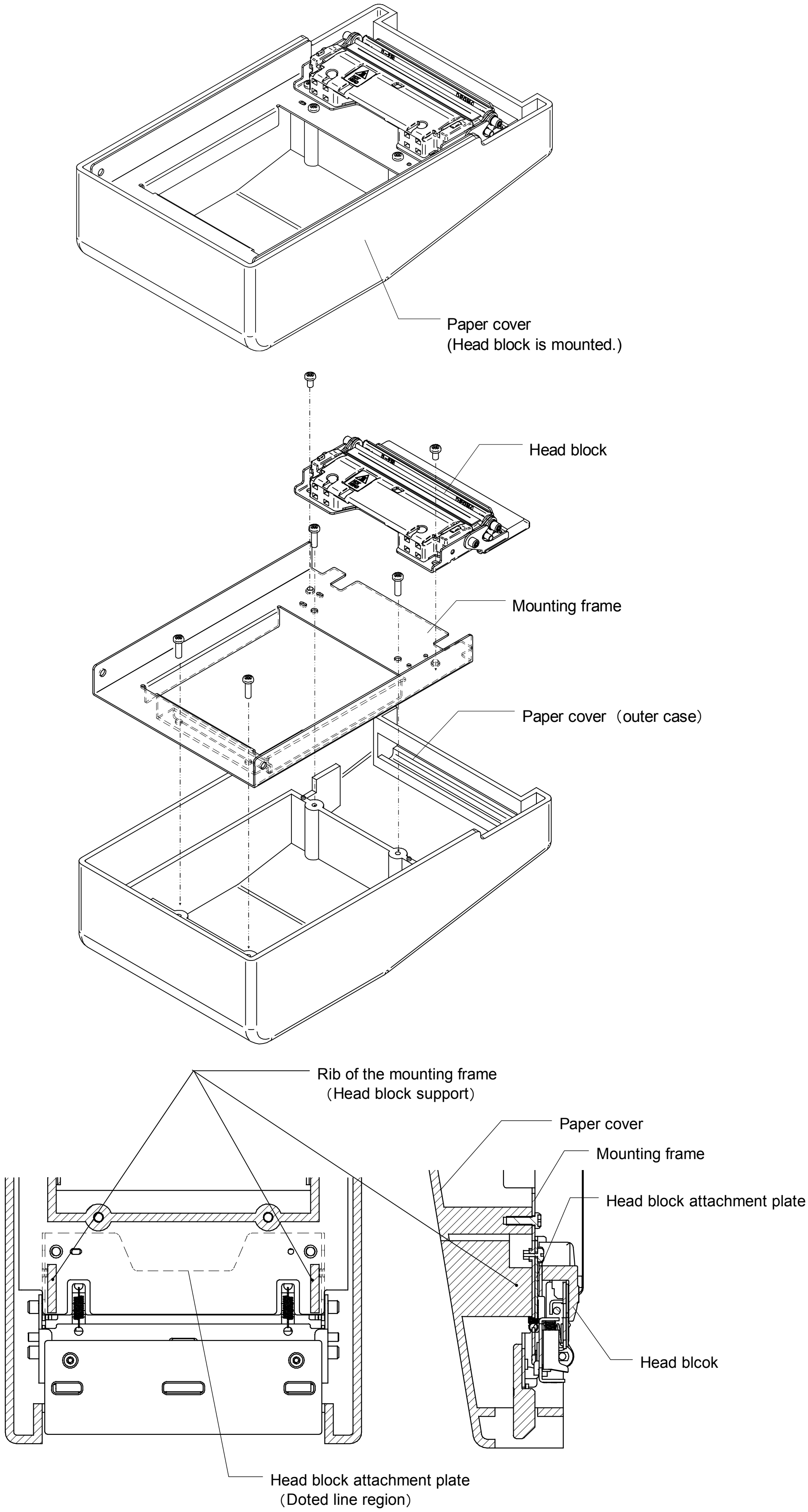


Figure 6-12　Example of Recommended Head Block Position (Easy Operation Model)

6.4 CONNECT TO THE FRAME GROUND (FG)

To prevent the thermal head from being damaged by static electricity, connect the printer main body and the head block to frame ground (FG) of the outer case. Verify the performance with your actual device.

6.4.1 How to Connect to the Frame Ground (FG)

- Connect the mounting holes "a" or "b" of the printer main body to the Frame Ground (FG) of the outer case with the metal screw (screw with cross-recessed pan head machine nickel coating).
- For easy operation model, connect the mounting holes "e" or "f" of the head block to the Frame Ground (FG) of the outer case with the metal screw (screw with cross-recessed pan head machine nickel coating).
- For auto-loading model, connect the mounting thread holes "g" or "h" of the head block to the Frame Ground (FG) of the outer case with the metal screw (screw with cross-recessed pan head machine nickel coating and length 4 mm or less). See the Figure 6-9 Recommended Example for Securing Head Cables (Auto-loading Model) for the detail structure.
- All Frame Ground (FG) must be same electrical potentials.
- Connect the Signal Ground (GND) to the Frame Ground (FG) through approximately 1 MΩ resistance.

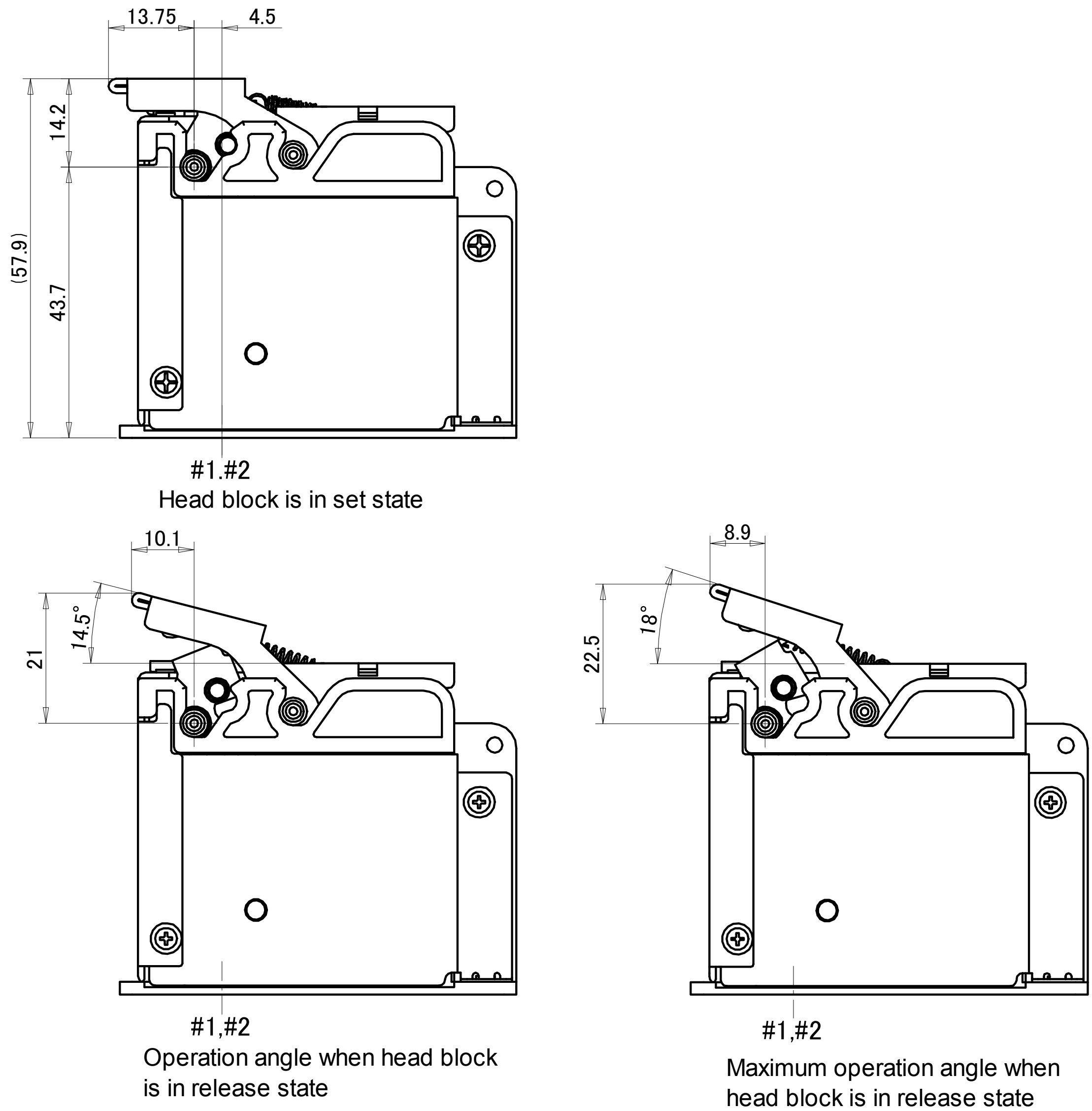
6.5 DESIGN AROUND THE HEAD RELEASE LEVER

6.5.1 Design around the Head Release Lever (Easy Operation Model)

Figure 6-13 shows working area of the head release lever and Figure 6-14 shows external dimensions of the head release lever.

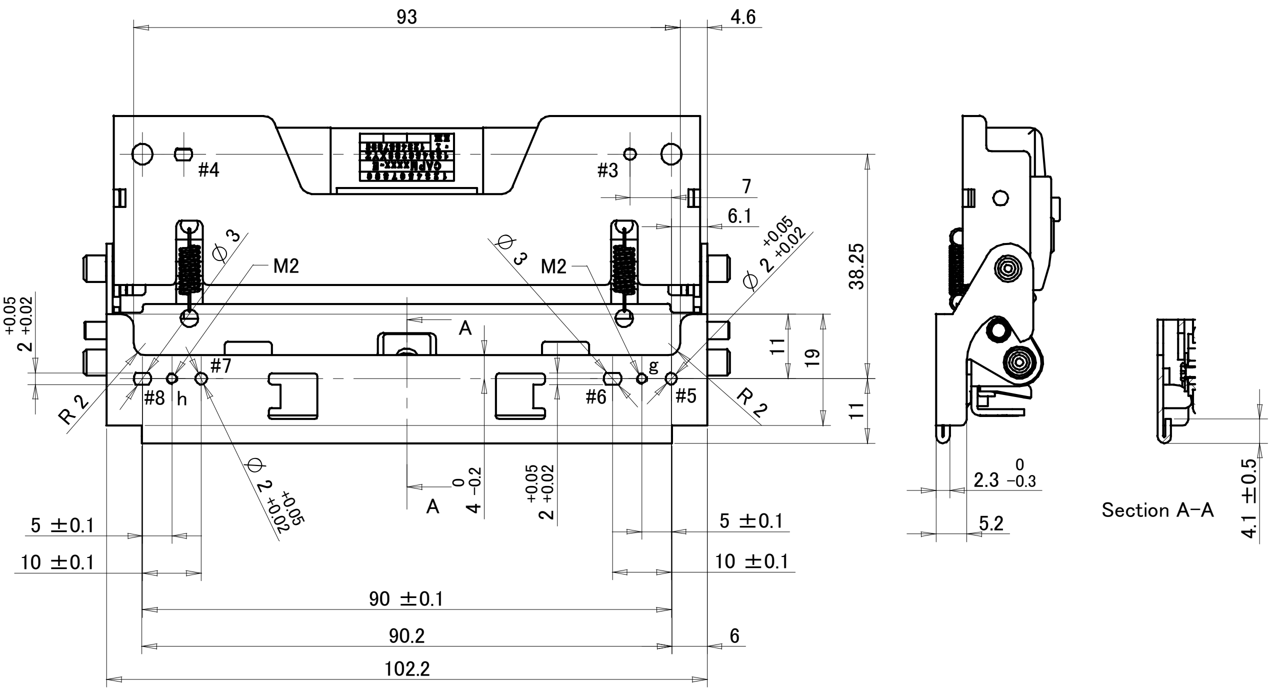
When designing the button or the lever that will operate simultaneously with the head release lever, follow the precautions below.

- Design the button or the lever and its motion so that the head release lever is pulled up to an angle of 14.5 degrees of the released position. Set the stopper in the outer case so as not to exceed the maximum operation angle 18 degree of the head release lever to prevent the lever being damaged when exceeding force is applied to the head release lever.
- Design the button or the lever so that no load is constantly applied to it while the head block is set.



Unit : mm
General tolerance for dimensions : ±0.5

Figure 6-13 Working Area of the Head Release Lever



Unit : mm
General tolerance for dimensions : ±0.2

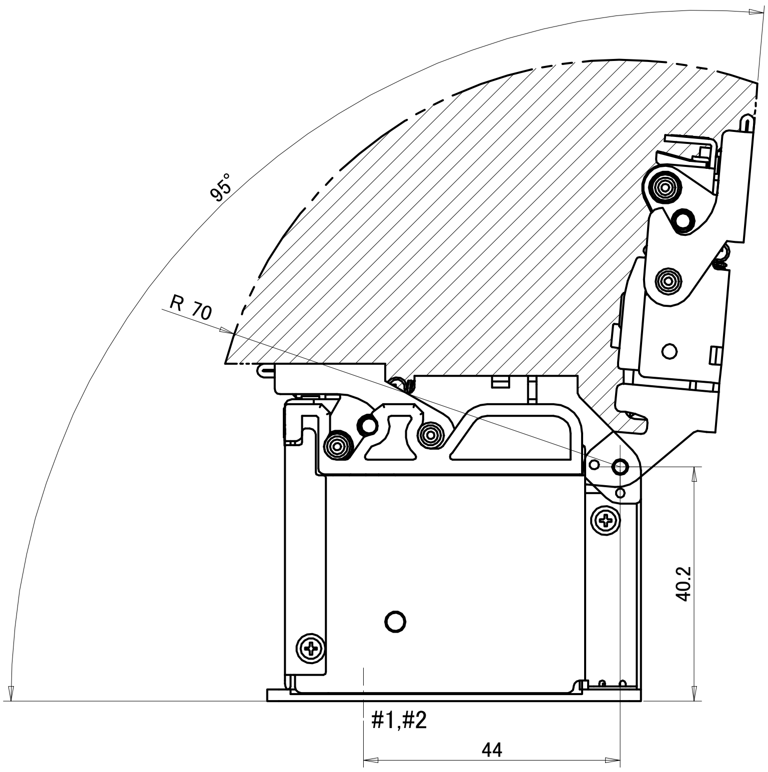
Figure 6-14 External Dimensions of the Head Release Lever

6.5.2 Design around the Head Release Lever (Auto-loading Model)

Figure 6-15 shows the working area for auto-loading model when releasing and setting head block.

Design the head release lever paying attention to the following points.

- Set the stopper in the outer case so as not to exceed the maximum operation angle 95 degree of the head block in order to prevent the hinge parts of head block from being damaged due to the excessive force on the head block.
- Secure enough space in the shaded area so that the head block does not get in the way of the release lever.
  When mounting the external lever on the release lever, secure enough space for the lever considering the shape of the lever.
- When the head block is set, prevent constant force on the head release lever.



Unit : mm
General tolerance for dimensions : ±0.3
General tolerance for angle : ±1°

Figure 6-15 Working Area for Releasing and Setting Head Block (Auto-loading Model)

Figure 6-16 shows design example of the external lever for the head release lever.

- Fix the hole g and h with screws.
- Design the fixing fook on the front side of head release lever.
- The circular hole (#5, #7) and the elongate hole (#6, #8) are positioning hole. Use them as needed.

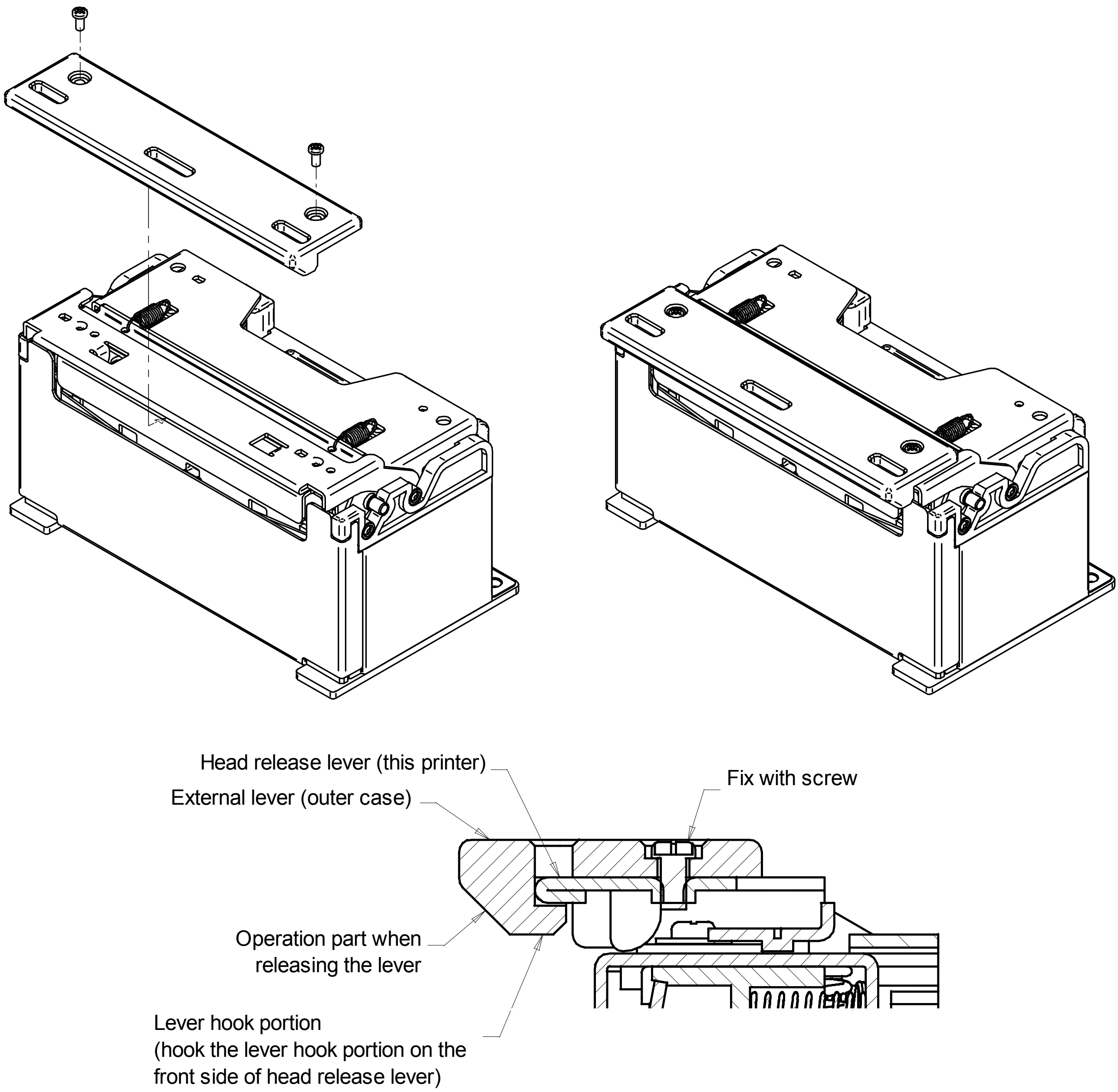


Figure 6-16 Design Example of the External Lever

6.6 LAYOUT OF THE PRINTER MECHANISM AND THE THERMAL PAPER

The printer can be laid out as follows.

Figure 6-17 shows the example of the design for easy operation model.

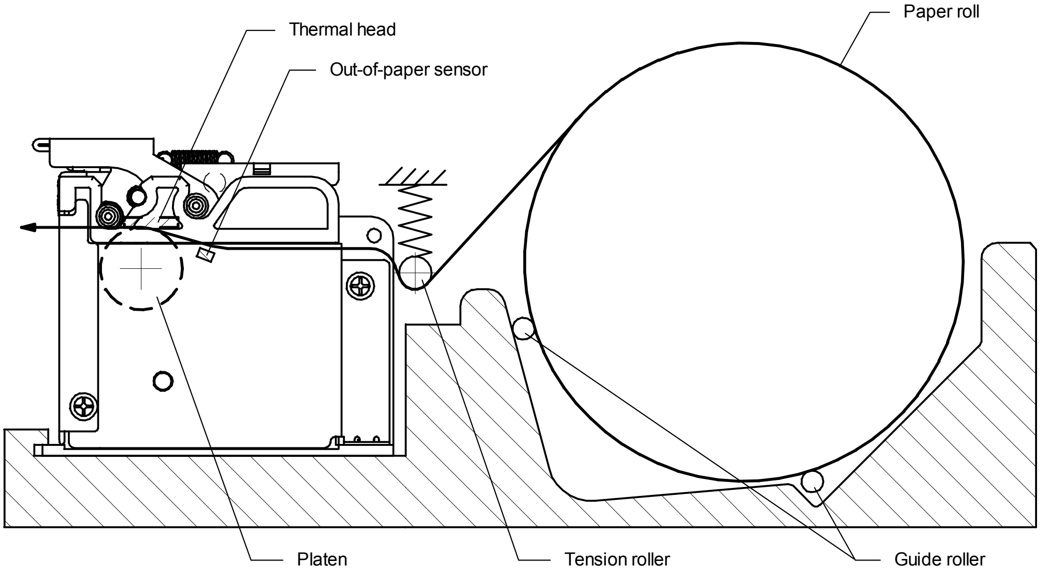
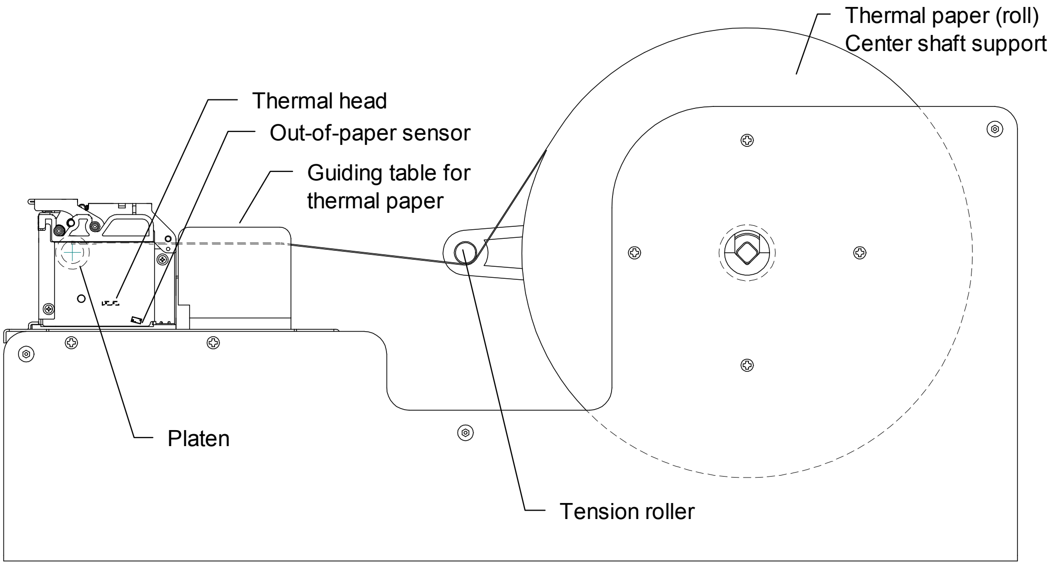


Figure 6-17 Recommended Layout between the Printer Mechanism and the Thermal Paper (Easy Operation Model)

*: The thermal paper feeding distance between the out-of-paper sensor and the heat elements is approximately 13 mm ±1 mm.

Figure 6-18 shows the example of the design for auto-loading model.



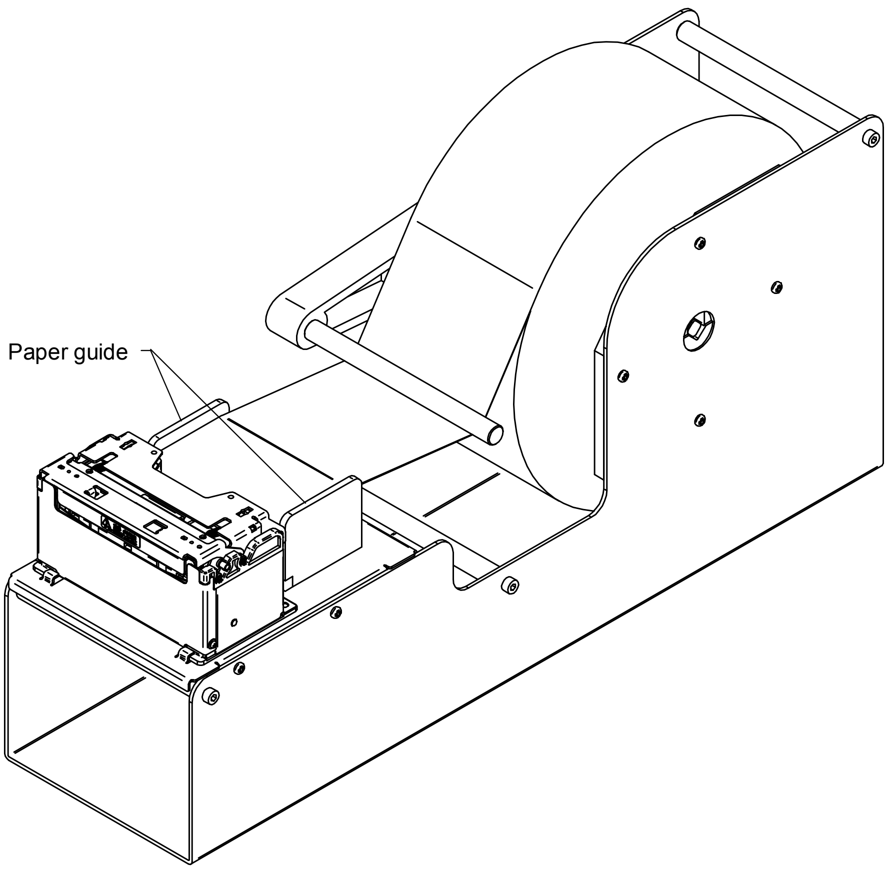


Figure 6-18 Recommended Layout between the Printer Mechanism and the Thermal Paper (Auto-loading Model)

6.7 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 6-19.

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

- In the case that the paper path between the paper roll and the printer is long, design the guide to prevent the thermal paper from moving to the width direction on the paper insertion side of the printer, as a guiding table shown in Figure 6-18.
  If the thermal paper slants to the width direction, the large amount of paper powder is generated by rubbing the edge of thermal paper against the paper guide. The large amount of paper powder on sensor or switch may cause malfunction.

- The printer is available in high-speed printing. Be aware that the printing problem may occur in the following case during high-speed printing. Design the paper holder so as not to make these conditions and the paper feed load should be 0.98 N (100 gf) or less. Design the structure such as a tension roller in the paper inlet part to reduce the paper load change. A load of the tension roller and the best specification of the stroke depend on the outer case design so verify the performance with your actual device.

  (Example)

  - In case that the paper roll wobbles in the paper holder.
  - In case that the paper load changes rapidly due to the paper-loosening or the paper tension affected by the acceleration/deceleration.

  In addition, do not use following types of thermal paper:

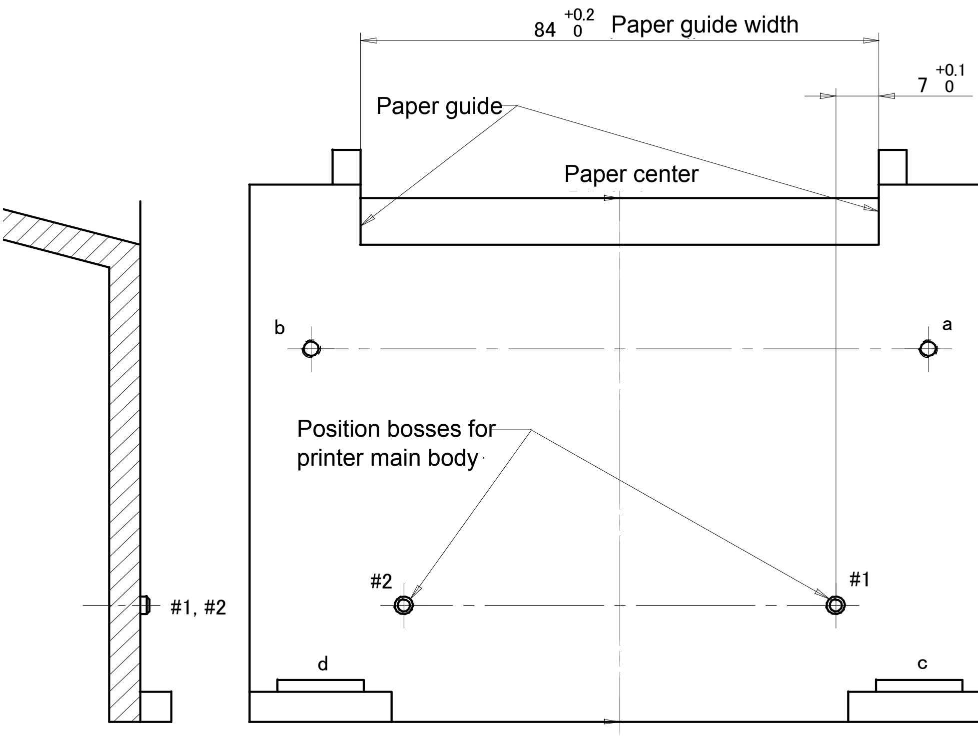
  - Expanded paper roll
  - Deformed paper roll
  - Roll core is sticking out
  - Width of the paper roll is out of spec

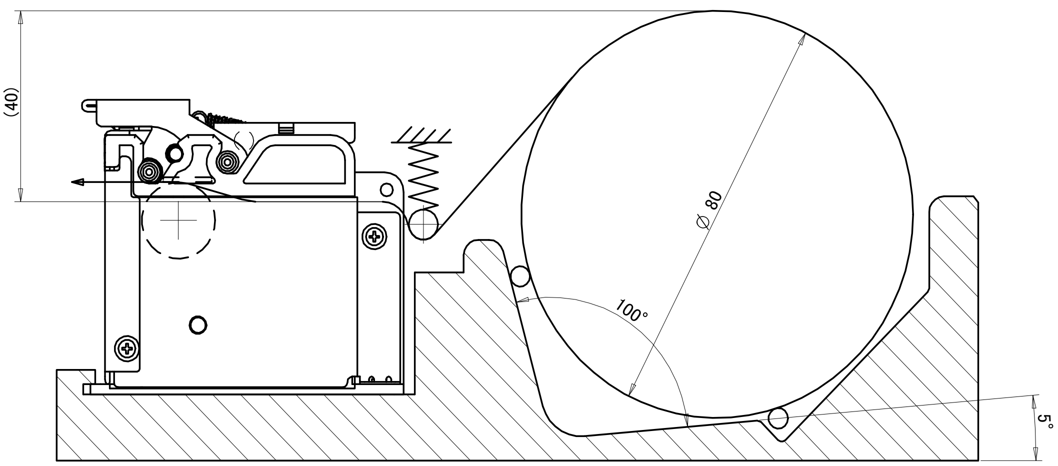
- When the thermal paper feeds backwards, design the space for the thermal paper returns to the paper holder side smoothly. Otherwise the backward feed may cause paper skew and jam. Allowable amount of paper feed in backwards is 5 mm or less. Longer backward feed may cause paper folding problem or paper jam.

- To prevent paper rattle, design the paper holder so that the paper roll is always located alongside the printer mechanism. (e.g. design the slope at the angle of 5 degree on the paper holder bottom surface.)

- Support the paper roll with the guide roller to reduce the rotational load between the paper roll and the paper holder as shown in Figure 6-17. When using large paper roll of more than 100 mm in diameter, design the outer case to reduce the paper roll load by using the paper shaft.

- When using auto-loading model, set the tension roller so as not to get in the way of paper insertion as shown in Figure 6-18.





Unit : mm

Figure 6-19 Recommended Paper Holder Dimensions

6.8 PAPER WIDTH ADJUSTMENT

6.8.1 Recommended Configuration of Paper Width Separation

The printer has some slits on the paper outlet to fix the paper width separation used according to the paper width.

Figure 6-20 shows a slit location for the paper position at one side alignment.

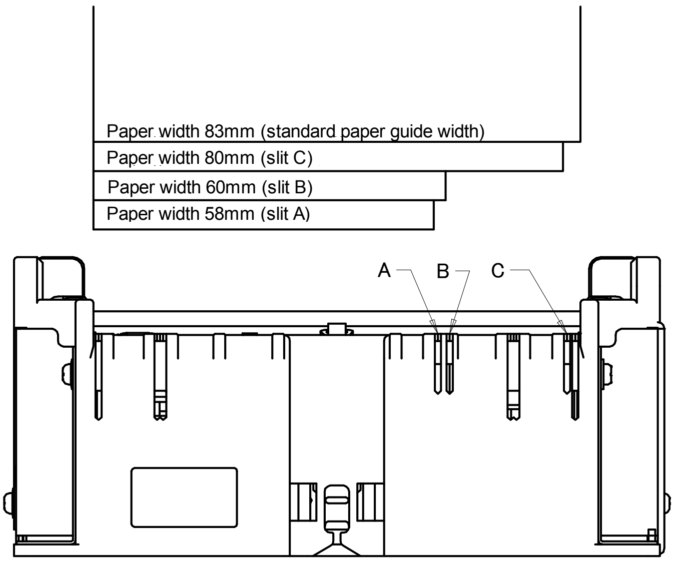


Figure 6-20 Slit Location (One Side Alignment)

Figure 6-21 shows a slit location for the paper position at center alignment.

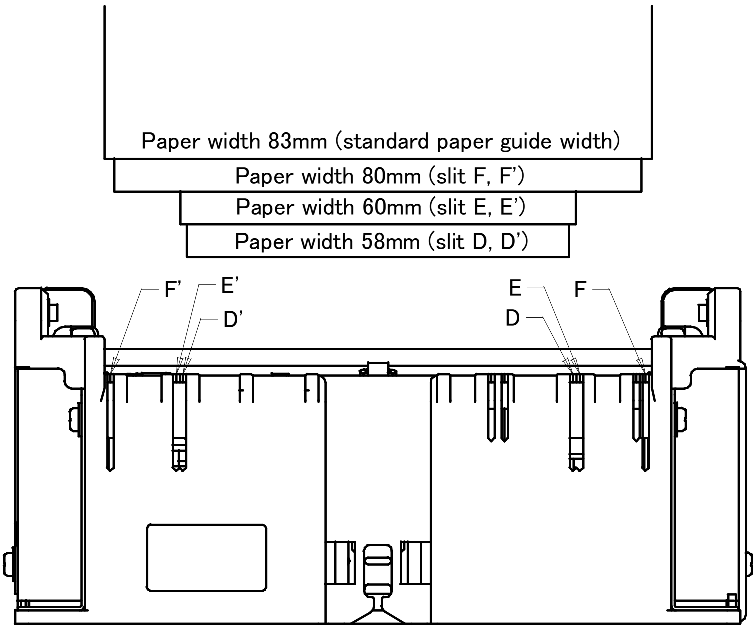
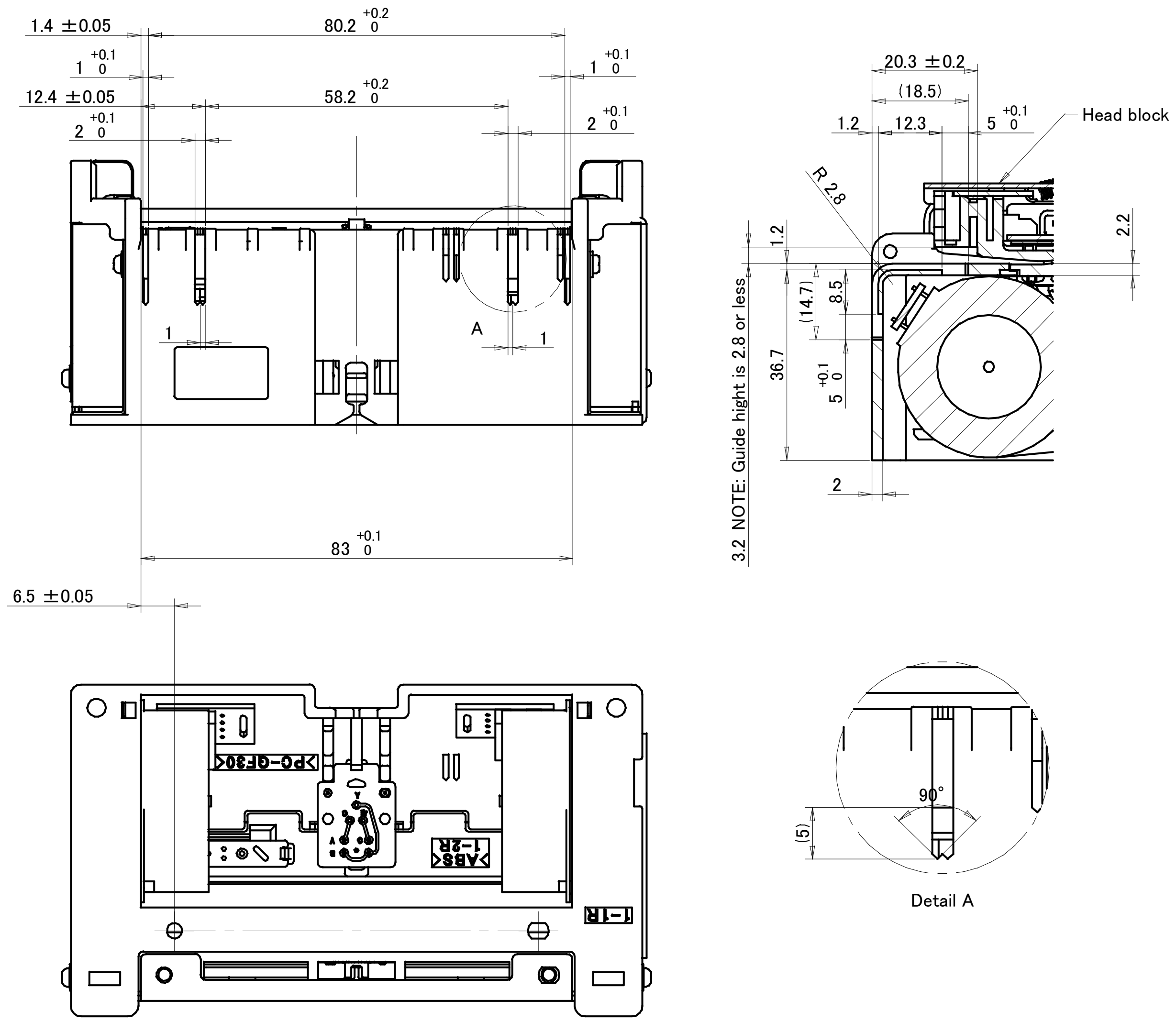


Figure 6-21 Slit Location (Center Alignment)

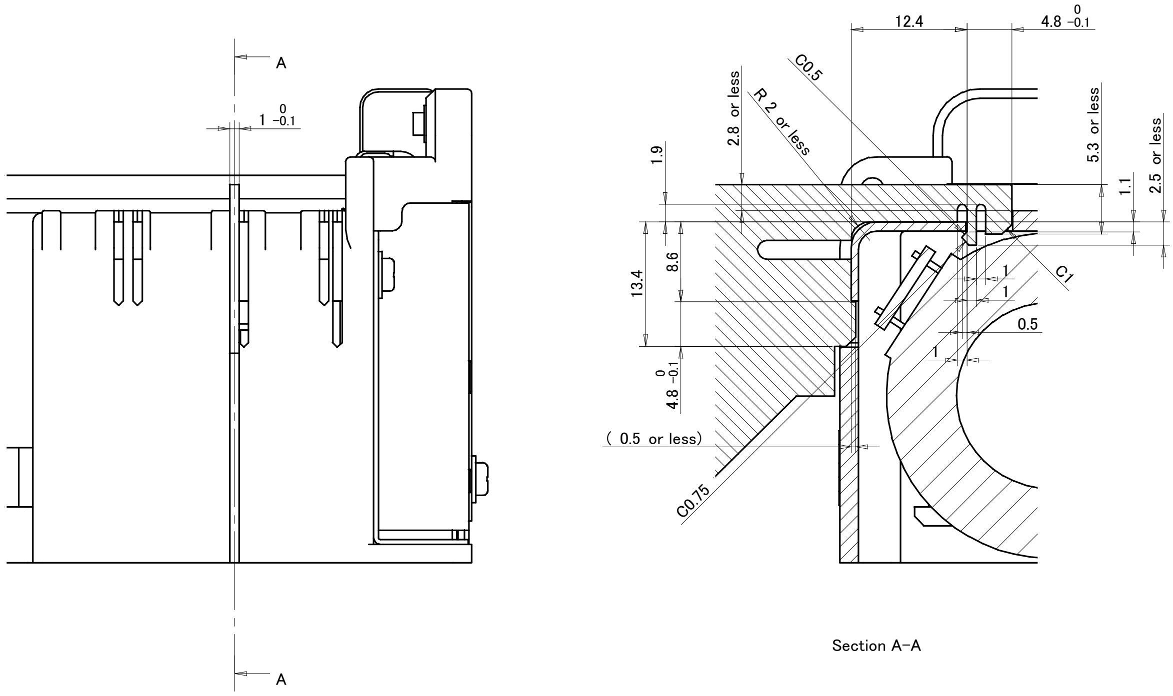
Figure 6-22 shows slit configuration of paper width separation.



Unit : mm
General tolerance for dimensions : ±0.1
General tolerance for angle : ±1°

Figure 6-22 Slit Configuration for Paper Width Separation

Figure 6-23 shows a sample of recommended outer case design for paper width separation.



Unit : mm
General tolerance for dimensions : ±0.1
General tolerance for angle : ±1°

Figure 6-23 Sample of Recommended Design for Paper Width Separation

When designing paper width separation, note the followings.

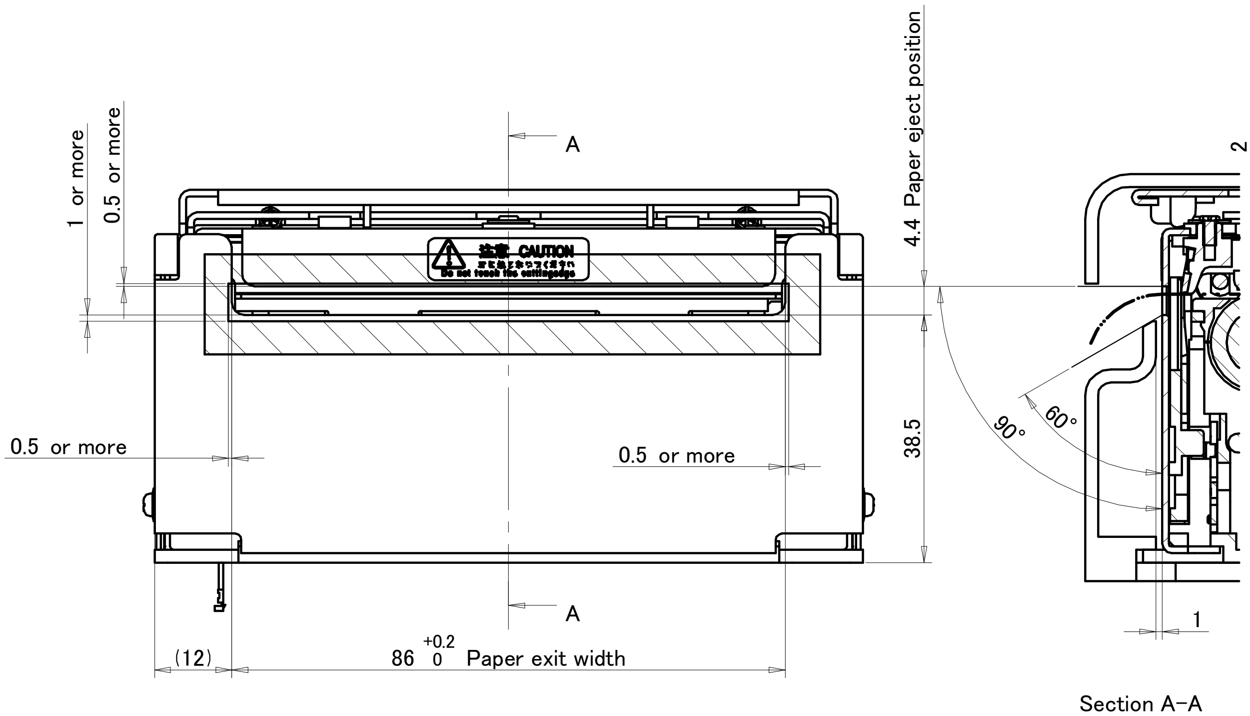
- The through holes of the slit parts (slit C, D, D', E, E', F, F') are located near the motor terminals and the motor outer case. Design the paper width separation with insulating materials. If using electrical conducting material, it causes short-circuit between motor terminal and paper width separation, and/or the motor to be out of control due to static electricity transferred to its outer case.

6.9 DESIGN THE PAPER EXIT

6.9.1 Design the Shape of the Paper Exit

When designing 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 ejected.
- Design the paper exit of the outer case and the paper cover so that the paper outlet angle shall be 60° to 90° as shown in Figure 6-24. The paper exit design should not interfere with the thermal paper ejecting. Design the paper exit not to change the paper eject direction and not to interfere with paper feeding. Verify the performance with your actual device when the thermal paper direction is changed.
- Design the front surface of the printer main body, to keep the specified space shown in the Figure 6-24. Otherwise the cut failure may occur.
- Design the paper exit to prevent from inserting a finger.
- Design the paper path side of the outer case so that the thermal paper should not contact a projection, a scratch, or a burr. It may cause a paper jam or gives a scratch to the thermal paper.
- Design the outer case larger than the paper outlet of the printer main body as shown in Figure 6-24. Otherwise the paper jam error may occur due to the difference in size between the printer and the outer case.
- Design the outer case to ensure enough space between the paper eject position of printer and the paper outlet of outer case as shown in the side view of Figure 6-24. If the thermal paper is caught by users during paper ejecting, the paper is caught in the printer and the paper jam error may occur.



Unit : mm
General tolerance for dimensions : ±0.1
General tolerance for angle : ±1°

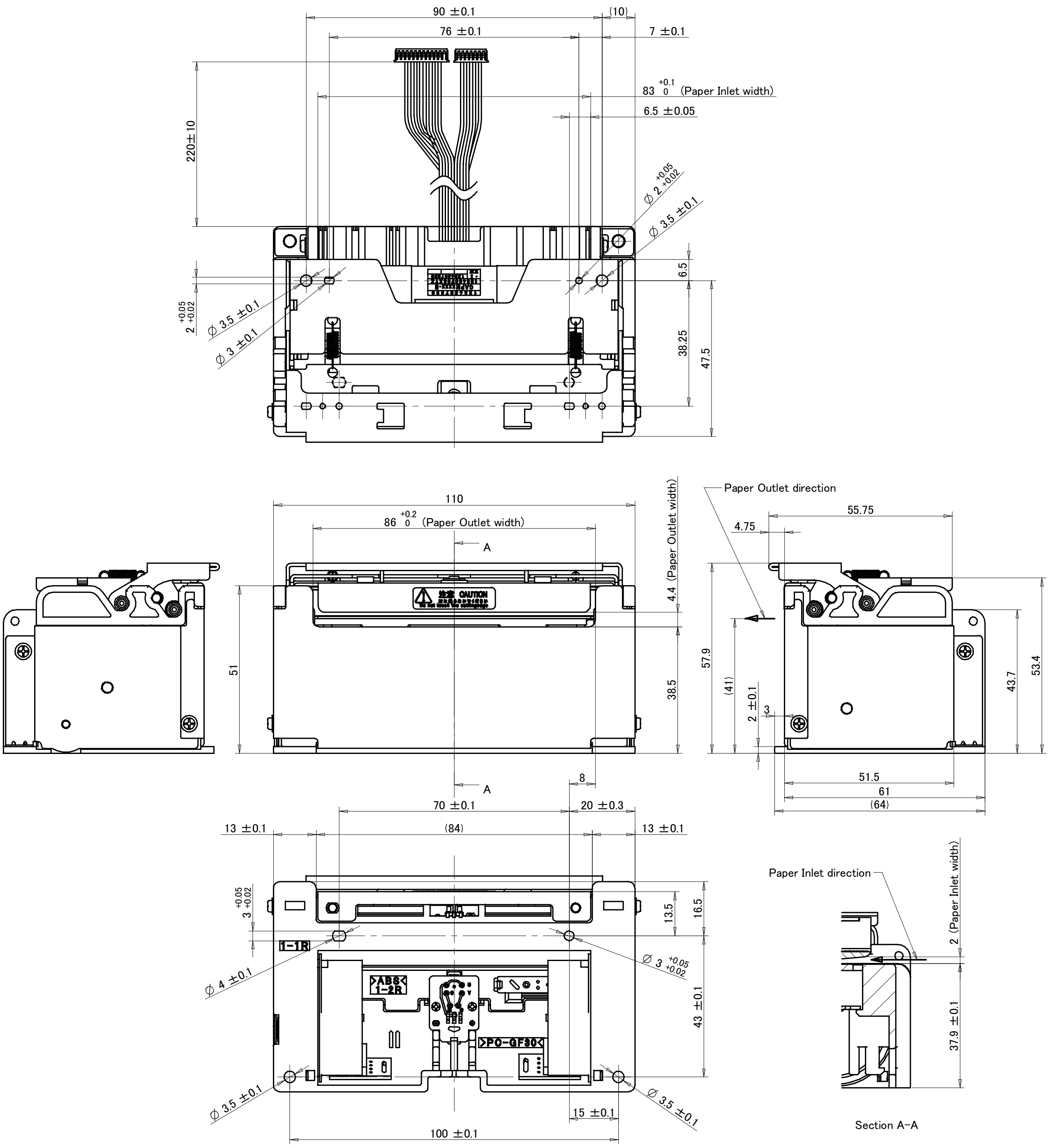
Figure 6-24 Recommended Sample of the Paper Outlet

6.10 PRECAUTIONS FOR DESIGNING THE OUTER CASE

- In this printer, the head block is removable from a printer main body so that the thermal paper can be set easily. Therefore, when the head block is in open state, the fixed cutter blade becomes exposed. To prevent users from injuring himself/herself by touching the cutter blades while the autocutter is in operation and replacing the thermal paper, design a structure such as a shutter in the outer case or place warning labels to warn users to ensure safe operation.
- In this printer, the head block is removable from a printer main body. To prevent the users from getting their finger caught between head block and printer main body, place warning labels to warn users to ensure safe operation.
- 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 head release lever easily with fingers.
  See Chapter 8 “PROCEDURES for INSTALLING/UNINSTALLING THERMAL PAPER” for specific procedures. Also, see 6.5 “DESIGN THE HEAD RELEASE LEVER” for its motion.
- Except for the operation parts, design the printer main body and the head block not to be subject to load from outside. If they are subject to load, it causes print defect, paper jam, cut failure, and damage of the printer. To avoid this, leave at least 1.0 mm space between the outer case and the printer main body or the head block.
- Paper powders can be caused while the autocutter is working. Be sure to design an outer case not to have the paper powders piled up on the control board and the power supply as this may cause short circuit failure.
- Temperature of the thermal head and its peripherals rise very high during and immediately after printing. Design the outer case and control the printer operation to prevent users from burn injuries by touching them. Place warning labels to warn users to ensure safe operation. As an example for printer operation: Control not to apply the electrical current to the thermal head while the head block is released. 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.

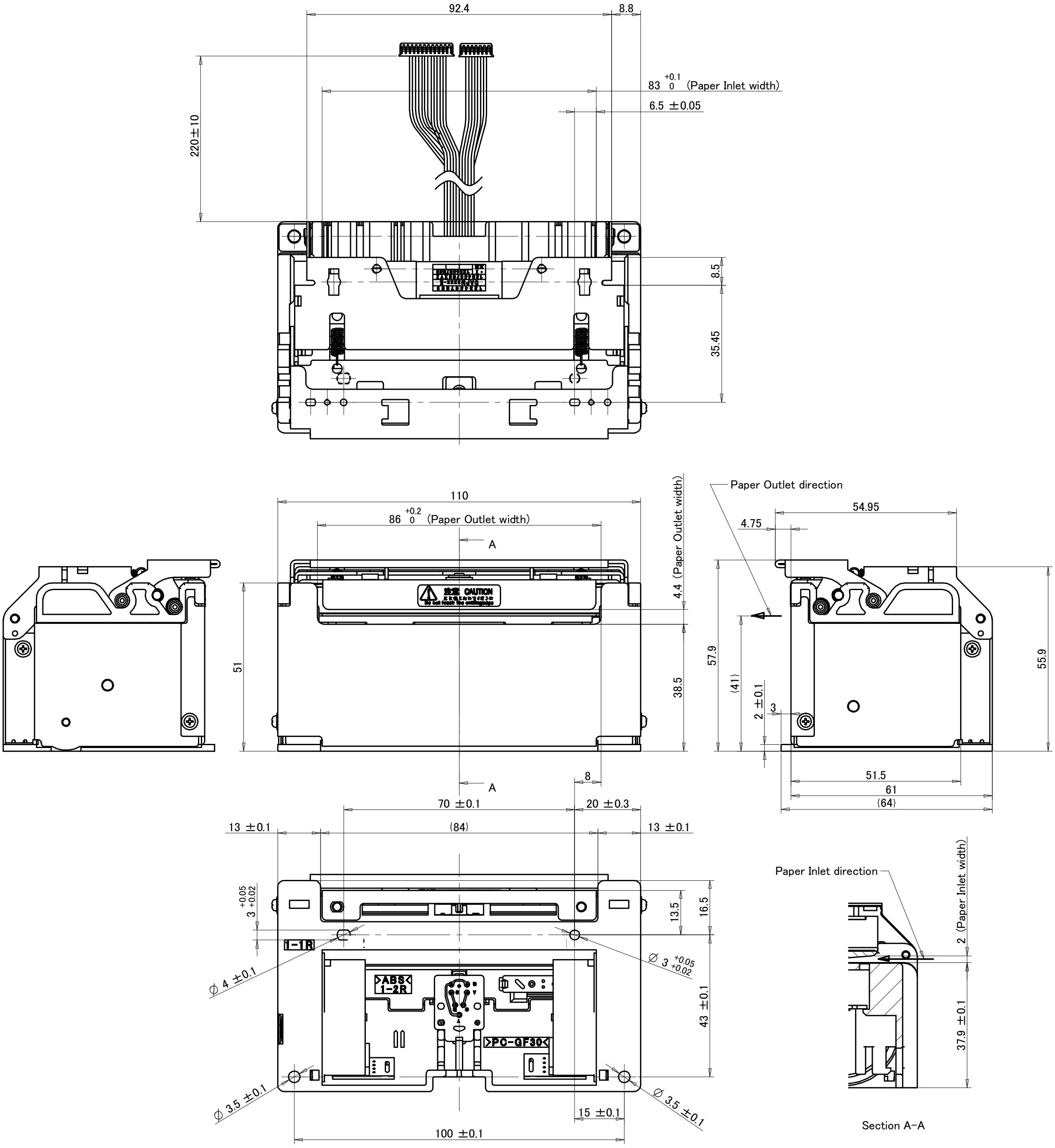
CHAPTER 7
EXTERNAL DIMENSIONS

Figure 7-1 and Figure 7-2 show external dimensions of the printer for easy operation model and auto-loading model.



Unit : mm
General tolerance for dimensions : ±0.5

Figure 7-1 External Dimensions (Easy Operation Model)



Unit : mm
General tolerance for dimensions : ±0.5

Figure 7-2 External Dimensions (Auto-loading Model)

CHAPTER 8
HANDLING METHOD

8.1 INSTALLING/UNINSTALLING THE THERMAL PAPER

8.1.1 Procedures for Installing the Thermal Paper

(1) Procedures for installing the thermal paper by the easy operation
(setting and releasing the head block)

(a) Push the head release lever in the direction of the arrow in the Figure 8-1a.

(b) Pull up the head block after making sure that the head block is released from the printer main body. (Open state)

(c) Set the thermal paper straight to the printer and set the thermal paper until its edge is ejected for 5cm and more from the top surface of the printer mechanism as shown in the Figure 8-1b.

(d) Set the head block in the Figure 8-1c after making sure that the thermal paper is set straight. (Close state)

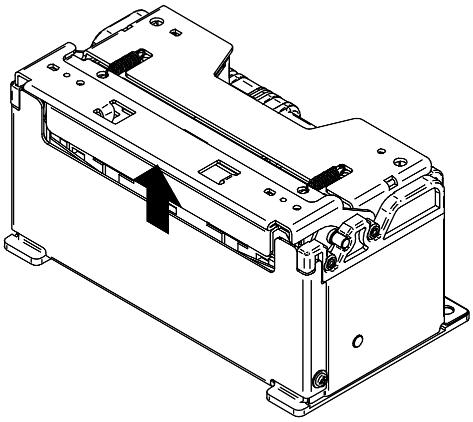


Figure 8-1a Installing the Thermal Paper by the Easy Operation

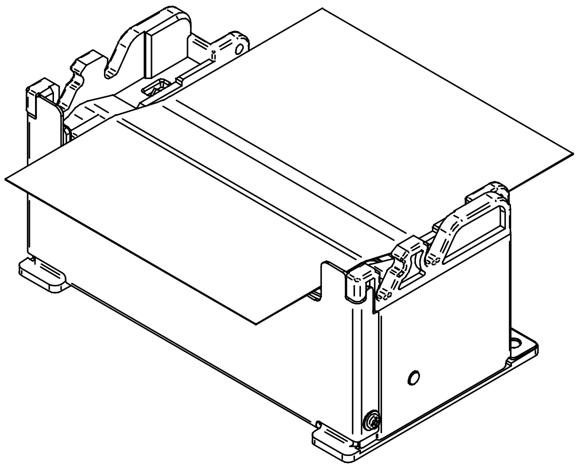


Figure 8-1b Installing the Thermal Paper by the Easy Operation

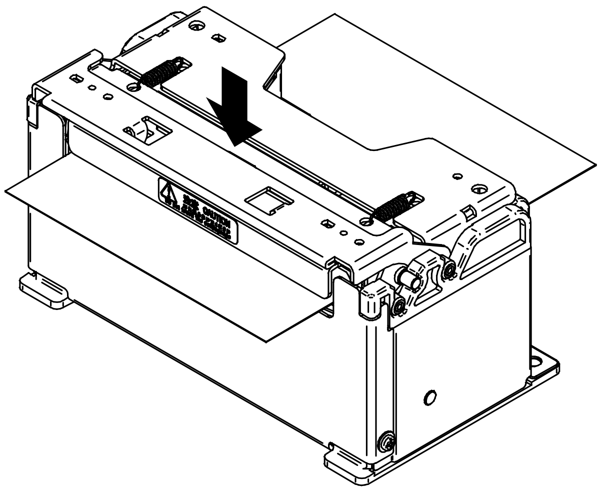


Figure 8-1c Installing the Thermal Paper by the Easy Operation

(2) Procedures for installing the thermal paper by auto-loading function (automatic insertion at setting head block in the close state)

(a) Set the head block in the close state.

(b) Cut the thermal paper edge straight with scissors or a cutter. The thermal paper edge must be cut at right angle to the paper feed direction as shown in Figure 8-2.

(c) Insert the thermal paper straight all the way in as shown in Figure 8-3.

(d) Feed the thermal paper pushing it. See "5.3 AUTO-LOADING METHOD OF THERMAL PAPER" in Chapter 5 for details.

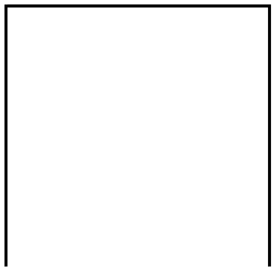


Figure 8-2 Shape of the Thermal Paper Edge

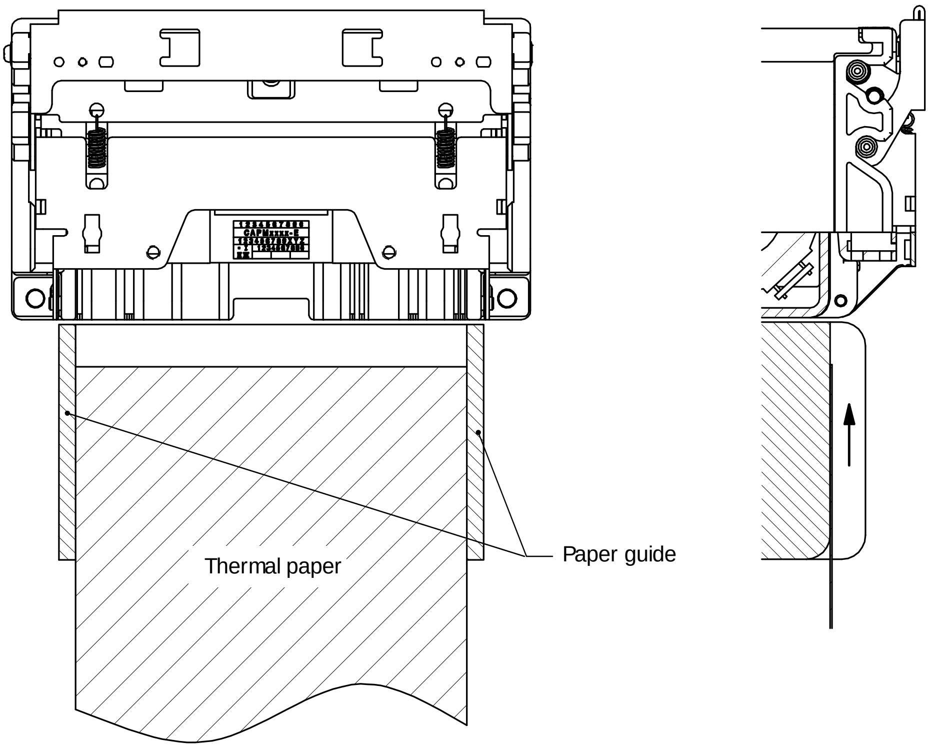


Figure 8-3 Installing the Thermal Paper by the Auto-loading Function

8.1.2 Procedures for Uninstalling the Thermal Paper

(1) Pull up the head release lever in the direction of the arrow in the Figure 8-1a.

(2) Pull up the head block after making sure that the head block is released from the printer main body.

(3) Remove the thermal paper.

8.1.3 Procedures for Removing the Paper Jam

(1) Pull up the head release lever in the direction of the arrow in the Figure 8-1a.

(2) Pull up the head block after making sure that the head block is released from the printer main body.

(3) Remove the thermal paper.

8.1.4 Procedures for Releasing when the Movable Blade is Stopped

When the movable blade is stopped during cutting performance, release the movable blade the following procedures and back to the home position.

(1) Pull up the head release lever in the direction of the arrow in the Figure 8-1a.

(2) If the movable blade cannot release at once, repeat the motion of the above to return the movable blade its home position.

(3) Release the head block in the same way as “Procedures for Removing the Paper Jam” to remove the cause of stopping the movable blade.

8.1.5 Precautions for Installing/Uninstalling the Thermal Paper

- If the thermal paper is skewed, feed the thermal paper until the thermal paper becomes straight, or release the head block and install the thermal paper again.
- Release the head block to remove jamming paper. 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

(1) Turn the power off.

(2) Pull up the head release lever to the direction of the arrow in the Figure 8-1a.

(3) Pull up the head block after making sure that the head block is released from the printer main body.

(4) Clean the heat elements shown in Figure 8-4 using a cotton swab dipped in ethyl alcohol or isopropyl alcohol.

(5) Set the head block after the alcohol has dried completely.

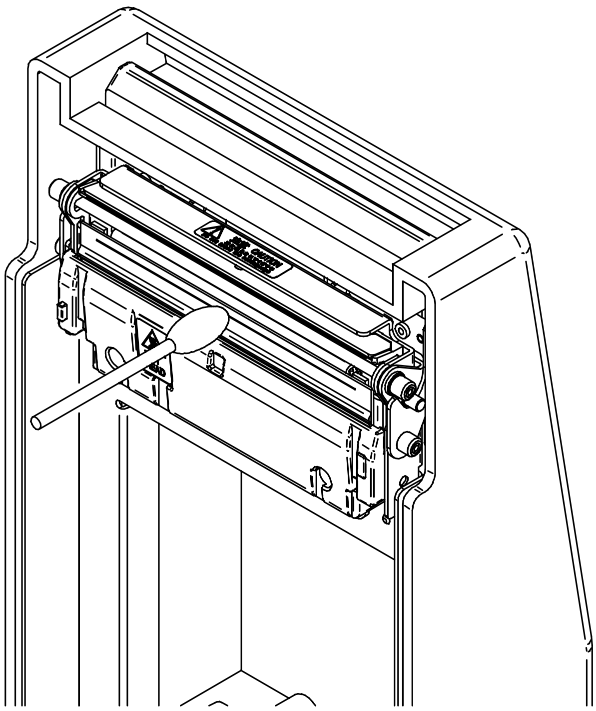


Figure 8-4 Cleaning Position of the Thermal Head

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 head block released.
- Do not use sandpaper, a cutter knife, or anything which may damage the heat elements for cleaning.