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EPSON

Thermal line printer

M-T530A/T540A

Specification

STANDARD	
Rev. No.	B
Notes	

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REVISION SHEET

The table below indicates which pages in this specification have been revised.
Before reading this specification, be sure you have the correct version of each page.

Revisions		Design Section			Sheet Rev. No.					
Rev.	Document	WRT	CHK	APL	Sheet	Rev.	Sheet	Rev.	Sheet	Rev.
A	Enactment	T.Takami	--	Takeuchi	I	B	18	B	App.1	B
B	Change				II	B	19	B	App.2	B
					III	B	20	B	App.3	B
					IV	B	21	B	App.4	B
					V	B	22	B		
							23	B		
							24	B		
					1	B	25	B		
					2	B	26	B		
					3	B	27	B		
					4	B	28	B		
					5	B	29	B		
					6	B	30	B		
					7	B	31	B		
					8	B	32	B		
					9	B	33	B		
					10	B	34	B		
					11	B	35	B		
					12	B	36	B		
					13	B	37	B		
					14	B	38	B		
					15	B	39	B		
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					17	B				

TITLE

M-T530A/T540A
Specification
(STANDARD)

Front Part					Contents	Appendix	Total
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1	2	--	3	2	39	4	51

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REVISION SHEET

REV.	SHEET	CHANGED CONTENTS
B	All	All pages are renumbered due to the page addition of Section 2.3.6, Back feed. In this specification, the term “curled path” is changed to “curved path”.
	3	1.10 Connectors ... (standard equipment) (addition)
	5	1.16 Reliability If the back feed is ..... (addition) 1.17 Paper Path Table 1.17.1 Impossible → Possible (change) * Please contact .... (deleted)
	6	1.18 Autocutter Table 1.17.1 Impossible → Possible (change) * Please contact .... (deleted)
	10	2.3.5 Drive Cycle and Drive Method In the Table 2.3.1 and Table 2.3.2, drive cycle at stop step is changed to 20.00 ms from 4.00ms. Notes) (addition)
	11	2.3.5 Drive Cycle and Drive Method In the Table 2.3.3 and Table 2.3.4, drive cycle at stop step is changed to 20.00 ms from 4.00ms.
	12	2.3.6 Back feed (addition)
	13	2.3.6 → 2.3.7 Motor drive sequence (2) 2-2 phase excitation (addition)
	20	4) Maximum impressed energy Emax (mJ) requirements → Maximum energizing pulse width (T.B.D.) → The descriptions are added.
	22	2.6.4 Cutting position 16.3 ± 0.5 mm → 16 ± 0.5 mm
	32	Table 2.9.1 ※ Please contact ... (deleted)
	38, 39	2.12.3 and 1.12.4 (addition)
	App.1	A.1.3 Warnings 9) (addition)
	App.2	A.1.4 How to load the paper Notes: 3. ... , because it may ... (addition)
	App.3	A.1.9 Maintenance Platen is added (4 parts)

TITLE

M-T530A/T540A

Specification

(STANDARD)

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Points You Must Observe To Assure Product Safety

In order to assure the safe operation of this product, carefully observe the specifications as well as the notes provided below.

Seiko Epson Corporation will not bear any responsibility for any damage or injuries arising from use of this product that is not in accordance with the specifications and the notes provided below.

Notes on Head Control

- The conditions setting forth the maximum time power can be applied (and the maximum voltage that can be applied) to electronic components such as the head, motor, and magnets must be observed.

  If the maximum time power can be applied (or the maximum voltage that can be applied) is exceeded, the components mentioned above could overheat and start a fire or begin to smoke.

- Always include protective circuitry governing the length of time power is applied and the amount of current that is applied when designing the drive and control circuits for the head, motor, magnets, etc.

  If protective circuitry is not included, misoperation of the printer control circuits could cause the components mentioned above to overheat and begin to smoke or burn.

Notes on Handling

- The case must be designed so that movable parts such as gears are not exposed.

  Touching moving parts could cause a laceration or other injury.

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GENERAL DESCRIPTION

1. Application

   This specification applies to the thermal line printer M-T530A/T540A.

2. Features

   1) High speed printer: 150 mm/s (5.9”/second) maximum
   2) High reliability: Life of 15 million lines and 37 million lines for MCBF.
   3) Platen open mechanism provides easy paper loading, easy removal of jammed paper, and easy head cleaning.
   4) Can use either 79.5 mm or 82.5 mm (3.13” or 3.25”) paper width.
   5) A scissors-type auto cutter.
   6) Can print paper thickness from 56 to 150 μm (0.0022” to 0.0059”)
   7) Black mark sensor (option).

3. Relationship between the model name and the specification

   Example:

   M - T 5 3 2 A F
   ① ② ③ ④ ⑤

   ① indicates the M-500 series.

   ② Indicates the paper width to be used.
   3: 79.5 ± 0.5 mm
   4: 82.5 ± 0.5 mm

   ③ indicates the type of the paper path.
   1: Curved path
   2: Straight path

   ④ indicates that the printer has an autocutter.

   ⑤ indicates the cutting type.
   F: Full cut (completely)
   P: Partial cut (one point left uncut)

   Contact Epson for the specification which the customer requires.

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Table of Contents

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1. GENERAL SPECIFICATIONS

1.1 Printing Method

Thermal line dot printing

1.2 Total Number of Dots

1.2.1 Total number of dots

640 dots/dot line

1.2.2 Available printing width

Maximum 80 mm

Paper width 79.5 ± 0.5 mm: 72 mm (2.8”) (recommended)

Paper width 82.5 ± 0.5 mm: 74 mm (2.9”) (recommended)

1.2.3 Example printing (reference)

Refer to Section 2.1.2, Example print format.

1) Dot pitch: Vertical direction: 0.125 mm (0.0049”) (8 dots/mm)
Horizontal direction: 0.125 mm (0.0049”) (8 dots/mm)

2) Example printing

Character structure:	12 (W) × 24 (H) font (including a horizontal 2-dot space)
Character size:	1.25 mm (W) × 3.0 mm (H) (.05" × .12")
Column pitch:	1.5 mm (.06")
Line pitch:	3.75 mm (.15") (including an 6-dot line spacing)
Number of columns:	53 maximum (for 80 mm printing width)

1.3 Printing Speed

1) High speed mode:	150 mm/s (5.9”) maximum (at 24 V)
2) Normal speed mode:	100 mm/s (3.9”/s)
3) Low speed mode:	50 mm/s (2”/s)

1.4 Paper Feeding

1) Feeding method:	Unidirectional with friction feed
2) Feeding pitch:	0.125 mm (0.0049”)
3) Feeding speed:	150 mm/s (5.9”/s) maximum

1.5 Paper

1) Paper type: Single-ply thermal paper roll

2) Specified thermal paper:

Original paper No. P350	KSP
Original paper No. TF50KS-E	NIPPON PAPER INDUSTRIES CO., LTD.
Original paper No. AF50KS-E	JUJO THERMAL
Original paper No. PD160R	OJI
Original paper No. TF11KS-ET	NIPPON PAPER INDUSTRIES CO., LTD.

A different paper type may give a different print quality.

As for the combination of paper path and paper thickness, refer to Table 1.17.1.

3) Size: Paper width: 79.5 ± 0.5 mm or 82.5 ± 0.5 mm
(3.13" ± 0.02" or 3.25" ± 0.02")

Outside diameter: ϕ254 mm (ϕ10") maximum
(Depending on the outside diameter, follow the conditions of paper roll supply shown in Section 2.11.)

1.6 Power Supply Voltage

1) Drive voltage: 24 VDC ± 10 %

NOTES: 1. The drive voltage above applies to the print head and the motor.
2. The same power source must be used for both the print head and the motor.

2) Circuit input voltage: 5 VDC ± 5 %

NOTE: The circuit input voltage above applies to the print head controller, head up sensor, paper-end sensor, and black mark sensor (optional).

1.7 Print Head Specifications

1) Heat element density: 8 dots/mm (0.125 mm/dot)
2) Total number of heat elements: 640 dots/dot line
3) Available printing width: 80 mm (3.15") maximum
4) Typical resistance value: 657 Ω ± 10%
(Default value)

1.8 Motor

1) Paper feed motor: 4-phase bi-polar stepping motor
2) Cutter motor: DC brush motor

1.9 Sensors

1) Paper-end sensor: Photosensor
2) Print head temperature sensor: Thermistor
3) Platen open sensor: Micro switch
4) Black mark sensor (optional): Reflecting photosensor

1.10 Connectors

1) Head and head temperature sensor: FFC connector (Standard equipment)

2) Paper feed motor, paper-end sensor, platen open sensor, autocutter, black mark sensor (optional): FFC connector (Standard equipment)

1.11 Overall Dimensions

126.9 mm (W) × 91.9 mm (D) × 57.5 mm (H) (5” (W) ×3.6” (D) × 2.3” (W))

(Refer to Section 2.12, Overall Dimensions.)

1.12 Weight

Approximately 550 g (19.4oz)

1.13 Environmental Conditions

1) Operating temperature: 0 to 55°C (32 to 131°F)
Reliable printing: 5 to 50°C (41 to 122°F)

2) Operating humidity: 10 to 80% (34°C (93.2°F) at 80%, non-condensing)

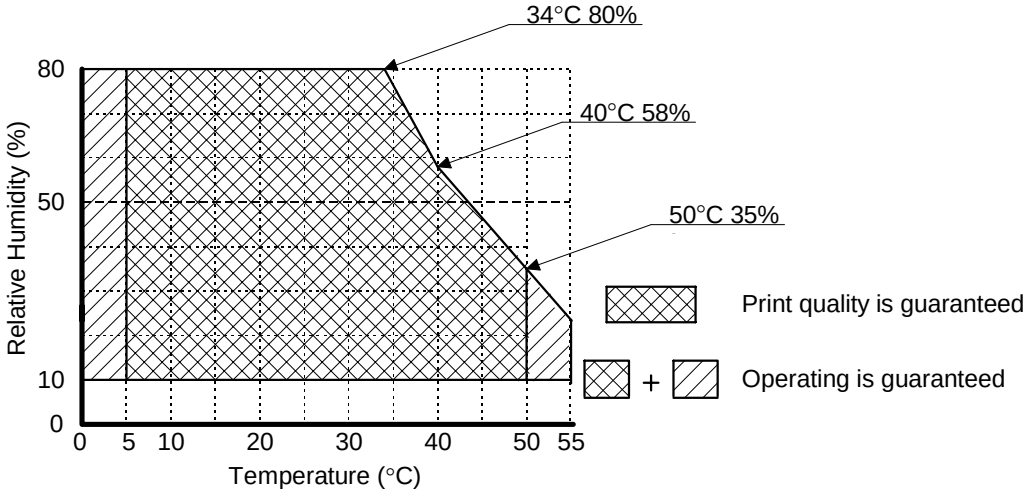


Figure 1.13.1 Environmental Conditions

1.14 Environmental Conditions for Storage

1) Storage at high temperatures and high humidity:
Temperature: 50°C (122°F)
Humidity: 90% RH
Total time: 240 hours

EPSON guarantees that no unexpected conditions will occur in operation of the mechanism at 25°C (77°F), 60% RH for two hours past storage in the above conditions.

2) Storage at high temperatures:
Temperature: 70°C (158°F)
Total time: 240 hours

EPSON guarantees that no unexpected conditions will occur in operation of the mechanism at 25°C (77°F) for two hours past storage in the above conditions.

3) Storage at low temperatures:
Temperature: –25°C (-13°F)
Total time: 240 hours

EPSON guarantees that no unexpected conditions will occur in operation of the mechanism at 25°C (77°F) for two hours past storage in the above conditions.

4) Vibration resistance:

Frequency:	10 – 150 – 10 Hz
Sweep:	20 minutes for coming and returning (One hour for each direction)
Acceleration:	2G (X, Y, and Z directions)
Center of vibration:	Any mechanism installed part

EPSON guarantees that no unexpected conditions will occur in operation of the mechanism after vibration under the above conditions.

5) Impact resistance:

Impact acceleration:	50G
Total operation time:	11 ms
Direction:	Once each for X, Y, and Z direction
Impact operation point:	Any mechanism installed part

EPSON guarantees that no unexpected conditions will occur in operation of the mechanism after impact under the above conditions.

6) Long-term storage:

Temperature:	5 – 30°C (41 – 86°F)
Humidity:	40 – 70 %RH
Period:	Within 12 months (Within 18 months after the production)

1.15 Insulation Resistance

10 MΩ or more at initial (500 VDC, between the motor terminal and the printer frame.)

1.16 Reliability

Mechanism (except thermal head and autocutter)

Life: 15,000,000 lines paper feeding
MCBF: 37,000,000 lines paper feeding

If the back feed is executed, the life and MCBF values must be considered for the running period with the back feed.

Thermal head

Life: 100 Km, 100 million pulses

Autocutter

Paper thickness	Life
56 – 90 μm	1,000,000 cuts (when 30°C or above and 60%RH or above, 750,000 cuts)
90 – 150 μm	1,000,000 cuts

NOTES:
1. Reliability statistics assume that the printer repeats printing in which one dot line consists of an average of 160 dots or less, and the average number of printing dots per dot line per element is 30 dots.
2. Life end is defined as the point at which two or more adjacent heat elements are damaged (when two or more adjacent dots are omitted), except when damaged by foreign objects or external causes.

1.17 Paper Path

1) Combination of paper path and paper width

Any of the combinations of paper path and paper width can be selected.

Table 1.17.1 Combination with Paper Path, Paper Width and Paper Thickness

Paper path / Paper width	Straight Pass	Curved Pass
79.5 ± 0.5 mm	Possible	Possible
82.5 ± 0.5 mm	Possible	Possible
Paper thickness	56 – 150 μm	56 – 90 μm

1.18 Autocutter

1) Combination of autocutter and paper width

Any of the combinations of paper path and paper width can be selected.

Table 1.18.1 Combination with Autocutter and Paper Width

Paper width \ Autocutter	Full Cut	Partial Cut
79.5 ± 0.5 mm	Possible	Possible
82.5 ± 0.5 mm	Possible	Impossible

1.19 Option

1) Black mark sensor

Note that the black mark sensor is installed to any one of both sides of paper or one of right and left sides of paper.
Refer to section 2.9 Black Mark Sensor, for details.

2. DETAILED SPECIFICATIONS

2.1 Printing Specifications

2.1.1 Total number of printing dots and printable area

The print head consists of 640 heat elements.

1) Printable area

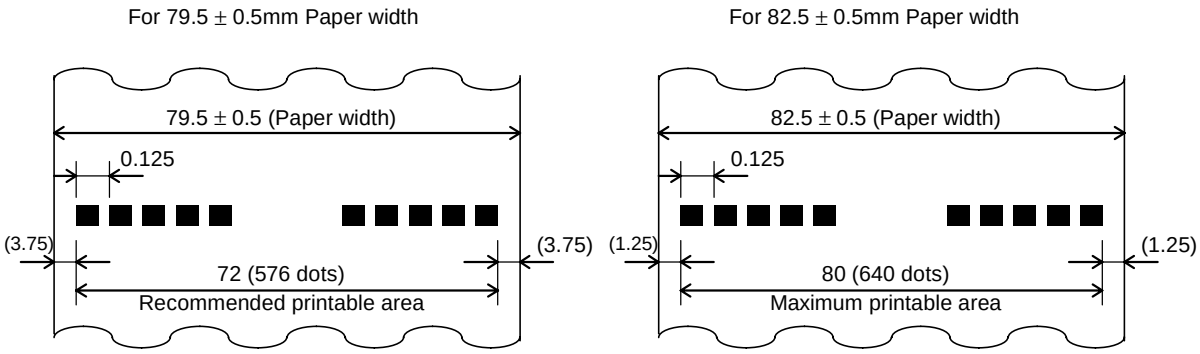


Figure 2.1.1 Total Number of Printing Dots and Printable Area

NOTES: 1. The center position of the paper and the print head is conformed. By this reason, each 32 dots of both sides of the total 640 head elements are not energized when the 79.5 ± 0.5 mm paper (the recommended printable area is 72 mm) is used.

2. When the print head elements are separately energized, the spacing between printed dots shifts approximately 0.0625 mm in the paper feed direction, as shown below. Note that the print head elements are divided into three banks. Consider this before using such print patterns.

Figure 2.1.2 Shifting Print Position

3. When the print head elements are separately energized, the print dot shape may be changed by some of the motor operation timings and the head energizing pulse. Consider this when printing graphics.

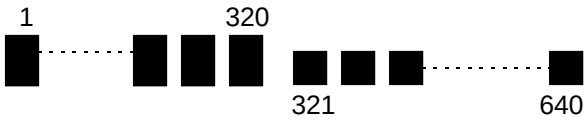
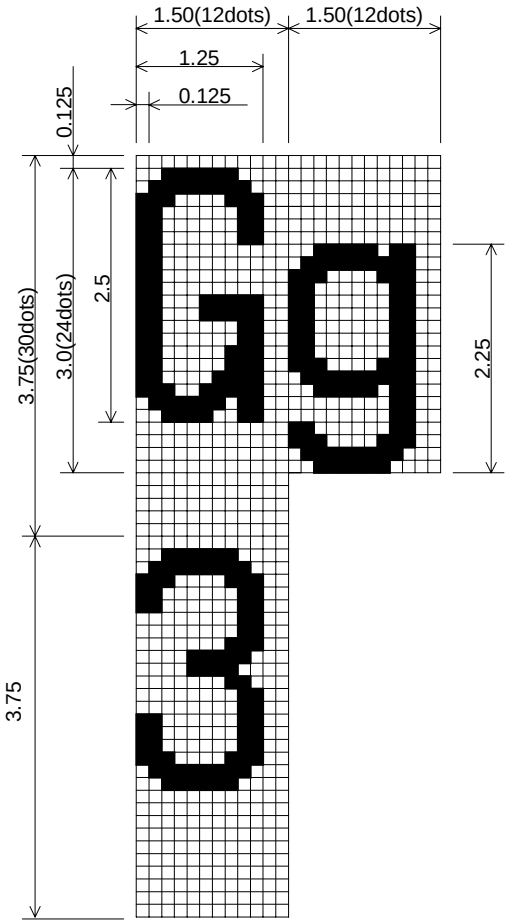


Figure 2.1.3 Print Dot Shape

4. When the paper width 82.5 ± 0.5 mm is used with 80 mm of printable area, make sure to align the paper at the paper insertion or exit so that the paper is not out of the printable area.

2.1.2 Example print format

1) 12 x 24 font



2) Example receipt design (continuous issuing)

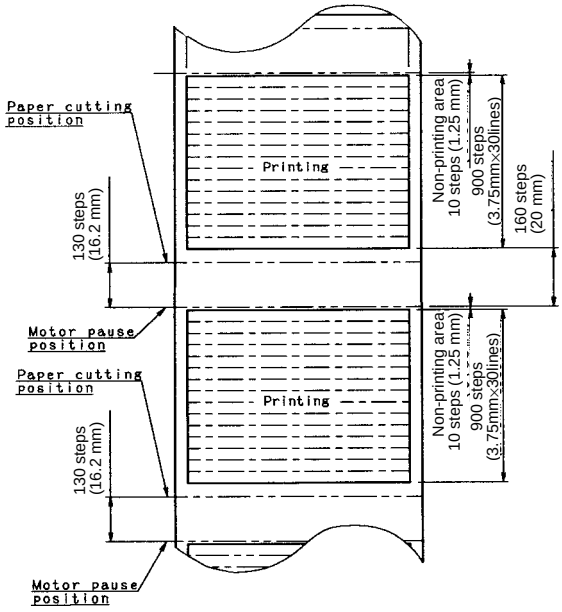


Figure 2.1.5 Example Print Design

Figure 2.1.4 12 × 24 Font Example Print Format

NOTES:
1. Characters should be printed using two horizontally consecutive dots.
2. Black / white reverse print should be printed using at least three vertically consecutive dots.
3. To prevent dot position misalignment due to gear backlash or sticking thermal paper on heat elements, do not print for a minimum of 10 dots after restarting the paper feed motor.
4. At the end of printing, to prevent thermal paper from sticking to the thermal elements, it is recommended to feed the paper for approximately 10 dots after energizing the head, then stop to terminate printing.
5. Especially in low temperature, thermal paper may be sticking on heat element. Give an consideration described on items 3 or 4 above.

2.2 Paper Feeding

2.2.1 Paper feed method
Friction feed

2.2.2 Paper feed pitch
0.125 mm (0.0049”) (using 2-2 phase excitation of the motor)

2.2.3 Feeding speed

High speed mode:	150 mm/s (5.9”/s) maximum
Normal speed mode:	100 mm/s (3.9”/s)
Low speed mode:	50 mm/s (2”/s)

2.2.4 Paper feed direction
Forward.

2.2.5 Paper roll supply load
2N (204 gf) or more (at paper entrance)

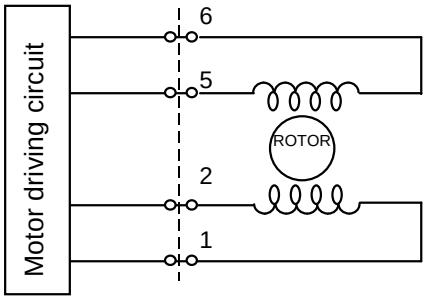
2.3 Paper Feed Motor

2.3.1 Type
4-phase 48-step PM bi-polar stepping motor

2.3.2 Power supply terminal voltage
24 VDC ± 10%

2.3.3 Coil resistance
11.5 Ω ± 7% (25°C(77°F)/phase)

2.3.4 Connection Diagram



2.3.5 Drive Cycle and Drive Method

Constant-current control 480 mA ± 7% / phase

1) Paper semi-automatic loading

Table 2.3.1 Paper Feed Drive in Semi-automatic Loading

Step	Drive Cycle	Drive Method
Rush	4.00 ms	2-2 phase excitation
1st to 10th	10.00 ms	2-2 phase excitation
After 11th step	5.00 ms	2-2 phase excitation
Stop (rush)	20.00 ms	2-2 phase excitation

Note: If the printer is driven when the paper is not set, the semi-automatic loading must be performed.

2) High-speed printing mode (150 mm/s(5.9”/s))

Table 2.3.2 Paper Feed Drive in High-Speed Printing Mode

Step	Drive Cycle	Drive Method
Rush	4.000 ms	2–2 phase excitation
1	3.898 ms	2–2 phase excitation
2	3.016 ms	2–2 phase excitation
3	2.518 ms	2–2 phase excitation
4	2.218 ms	2–2 phase excitation
5	2.004 ms	2–2 phase excitation
6	1.844 ms	2–2 phase excitation
7	1.477 ms	2–2 phase excitation
8	1.250 ms	2–2 phase excitation
9	1.100 ms	2–2 phase excitation
10	1.020 ms	2–2 phase excitation
11	0.945 ms	2–2 phase excitation
12	0.884 ms	2–2 phase excitation
After 13th step	0.833 ms	2–2 phase excitation
Stop (rush)	20.000 ms	2–2 phase excitation

3) Middle-speed printing mode (100 mm/s(3.9”/s))

Table 2.3.3 Paper Feed Drive in Middle-Speed Printing Mode

Step	Drive Cycle	Drive Method
Rush	4.000 ms	2–2 phase excitation
1	3.898 ms	2–2 phase excitation
2	3.016 ms	2–2 phase excitation
3	2.518 ms	2–2 phase excitation
4	2.218 ms	2–2 phase excitation
5	2.004 ms	2–2 phase excitation
6	1.844 ms	2–2 phase excitation
7	1.477 ms	2–2 phase excitation
After 8th step	1.250 ms	2–2 phase excitation
Stop (rush)	20.000 ms	2–2 phase excitation

4) Low-speed print mode (50 mm/s(2”/s))

Table 2.3.4 Paper Feed Drive in Low-Speed Printing Mode

Step	Drive Cycle	Drive Method
Rush	4.000 ms	2–2 phase excitation
1	3.898 ms	2–2 phase excitation
2	3.016 ms	2–2 phase excitation
After 3rd step	2.500 ms	2–2 phase excitation
Stop (rush)	20.000 ms	2–2 phase excitation

NOTES: 1. The drive frequency tolerance should be set within ±4%.

2. To prevent damage of the motor coil from heating, continuous energizing to the same phase should be set to be less than 1 second, the power supply terminal voltage is 24V (except for hold current).

2.3.6 Back feed

Back feed can be done by rotating the paper feed motor in the reverse direction to change the print starting position. The back feed must be executed under the following conditions:

- Execute the back feed only for the change of the print starting position after cutting the paper.
- If the autocutter cuts the paper partially, do not execute the back feed.
- The amount of the back feed for one time must be less than 118 steps of the paper feed motor.
- After the back feed is executed, be sure to rotate the paper feed motor for 10 steps at least in the forward direction.

Table 2.3.5 Back Feed Drive Method

Step	Drive Cycle	Drive Method	Motor Rotation Direction
Rush	4.000 ms	2–2 phase excitation	Reverse (clockwise)
1	3.898 ms	2–2 phase excitation	Reverse (clockwise)
2	3.016 ms	2–2 phase excitation	Reverse (clockwise)
3	2.518 ms	2–2 phase excitation	Reverse (clockwise)
4	2.218 ms	2–2 phase excitation	Reverse (clockwise)
5	2.004 ms	2–2 phase excitation	Reverse (clockwise)
After 6th step	2.000 ms	2–2 phase excitation	Reverse (clockwise)
Stop (rush)	20.000 ms	2–2 phase excitation	Reverse (clockwise)
Rush	4.000 ms	2–2 phase excitation	Forward (counterclockwise)
1	3.898 ms	2–2 phase excitation	Forward (counterclockwise)
2	3.016 ms	2–2 phase excitation	Forward (counterclockwise)
3	2.518 ms	2–2 phase excitation	Forward (counterclockwise)
4	2.218 ms	2–2 phase excitation	Forward (counterclockwise)
5	2.004 ms	2–2 phase excitation	Forward (counterclockwise)
After 6th step	2.000 ms	2–2 phase excitation	Forward (counterclockwise)
Stop (rush)	20.000 ms	2–2 phase excitation	Forward (counterclockwise)

2.3.7 Motor drive sequence

1) 2-2 phase excitation

Rotation direction: Counterclockwise rotation as seen from the motor output shaft side.

Step / Pin No.	1	2	3	4
6 (Red / phase A)	H	H		
2 (Blue / phase B)	H			H
5 (White / phase $\overline{A}$)			H	H
1 (Orange / phase $\overline{B}$)		H	H	

NOTES: 1. H means 100% excitation in the current ratio, and blank means no excitation.
2. Paper is fed 0.125 mm (0.0049") by 1-step driving.

2) 2-2 phase excitation

Rotation direction: Clockwise rotation as seen from the motor output shaft side.

Step / Pin No.	1	2	3	4
6 (Red / phase A)			H	H
2 (Blue / phase B)	H			H
5 (White / phase $\overline{A}$)	H	H		
1 (Orange / phase $\overline{B}$)		H	H	

2.4 Paper (supplied by the user)

2.4.1 Paper type

Thermal paper roll (single sheet)

Specified thermal paper:

Original paper No. P350	KSP
Original paper No. TF50KS-E	NIPPON PAPER INDUSTRIES CO., LTD.
Original paper No. AF50KS-E	JUJO THERMAL
Original paper No. PD160R	OJI
Original paper No. TF11KS-ET	NIPPON PAPER INDUSTRIES CO., LTD.

A different paper type may give a different print quality.

As for the combination of paper path and paper thickness, refer to Table 1.17.1.

2.4.2 Size

Paper width: 79.5 ± 0.5 mm or 82.5 ± 0.5 mm
(3.13" ± 0.02" or 3.25" ± 0.02")

Outside diameter: ϕ254 mm (ϕ10") maximum
(Depending on the outside diameter, follow the condition of paper roll supply shown in Section 2.11.)

2.4.3 Thickness

56 - 150 μm

2.5 Print Head

2.5.1 Structure

1) Total number of heat elements: 640

2) Density of heat elements: 0.125 mm /dot (0.0049”/dot) (8 dots/mm)

3) Typical resistance: 657 Ω ± 10%
(Default value)

4) Power supply voltage: Driving print head V_H: 24 VDC ± 10%
Driver IC V_{DD}: 5 VDC ± 5%

5) Energizing pulse width: Refer to Section 2.5.5, Energizing pulse width formula.

6) Current consumption (reference)

Print head current consumption at a printing ratio of 25%:

(Printing ratio is defined as the number of print dots/dot line (640 dots).)

① Peak current: Approximately 6.7 A (the moment all 160 dots are energized)

NOTE: The peak current is measured at the minimum resistive value and at the maximum voltage.

Conditions:

V_H max: Head connector terminal voltage max. 26.4 V
R min: Head resistance value minimum 626.8 Ω

② Mean current: Approximately 1.75 A
(Head terminal voltage V_H = 24 V, head resistive value R=657Ω, print duty of 25%, mean energizing pulse width of 248 μs (assumed that 50% of printed dots are energized just before), synchronizing with 833 μs)

The following formula is used to obtain the head drive current.

$$Imean = \frac{V\ (V)}{R\ (\Omega)} \times 640\ dots \times printing\ ratio \times \frac{energizing\ pulse\ width}{cycle}$$

NOTES:
1. If the number of dots that are energized at the same time is increased, a higher current will flow; therefore, the user should use power supplies with a current capacity adequate for the corresponding print duty.
2. When designing lines and bit images, take the printing ratio and print duty into account.
3. Printing quality may be poor if the printing ratio or print duty is high.
4. Definitions of printing ratio and print duty:
   - Printing ratio: the number of printing dots (energizing pulses)/dot line
   - Print duty: the number of printing dots (energizing pulses)/ elements/paper feed amount (two steps, including non-printing area)
5. Average energizing pulse width is defined as 107 of 160 dots per dot line that are continuously energized.

2.5.2 Thermal head electrical characteristics

1) Absolute maximum ratings

Table 2.5.1 Absolute Maximum Ratings

Item	Symbol	Terms	Rated value	Units
Circuit power supply	V_{DD}		6.5	V
Input voltage	V_{IN}		-0.5 to V_{DD} + 0.5	V
Surge breakdown voltage	V_{HOFF}	when driver transistor is off	32 Max.	V

2) Allowable operating range (T= 25°C (77°F), V_{DD} = 5.0 V)

Table 2.5.2 Allowable Operating Range

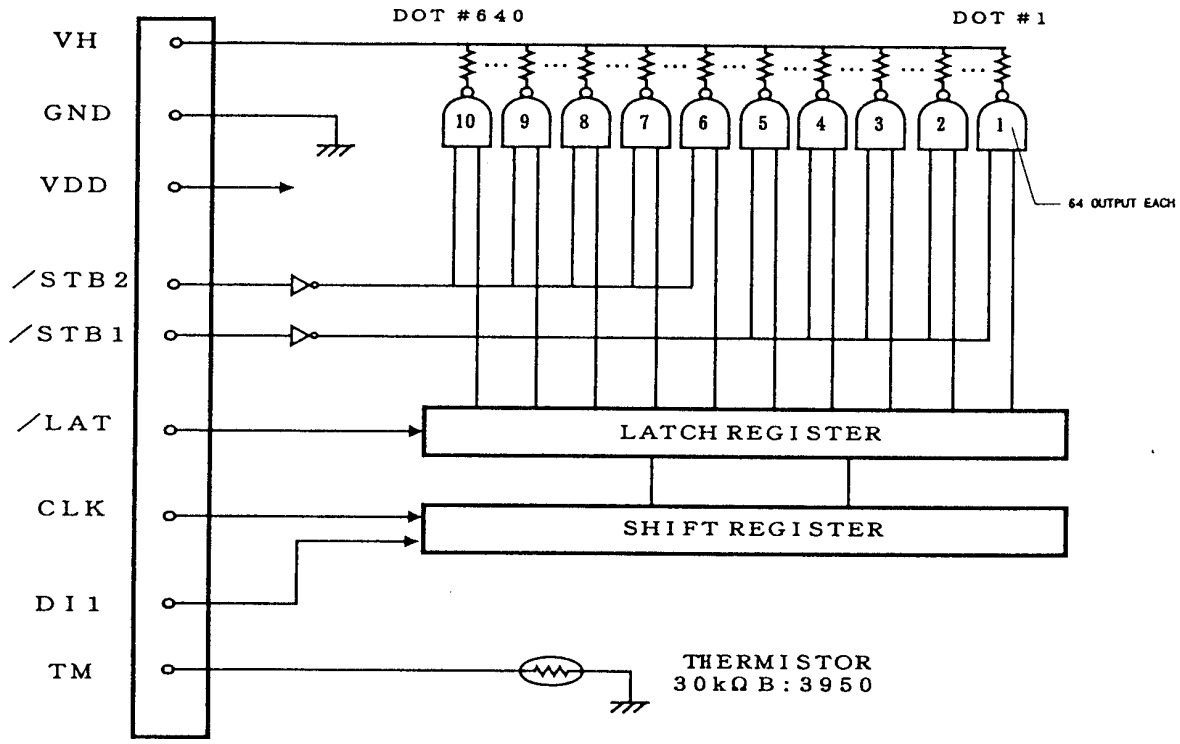
Item	Symbol	Terms	Rated value			Units
			MIN	TYP	MAX	
Circuit power supply	V_{DD}		4.75	5.00	5.25	V
High input voltage	V_{IH}		0.8V_{DD}		V_{DD}	V
Low input voltage	V_{IL}		0		0.2V_{DD}	V
Clock frequency	F_{CLK}	DUTY 50% (±5%)			6	MHz
Setup time	t1	DATA IN → CLOCK	70			ns
Hold time	t2	CLOCK → DATA IN	30			ns
Setup time	t3	CLOCK → $\overline{\text{LATCH}}$	300			ns
$\overline{\text{Latch}}$ pulse width	t4		200			ns
Setup time	t5	$\overline{\text{LATCH}}$ → $\overline{\text{STROBE}}$	1500			ns

3) Electrical characteristics (T = 25°C (77°F), V_{DD} = 5.0 V)

Table 2.5.3 Electrical Characteristics

Item	Symbol	Terms	Rated value			Units
			MIN	TYP	MAX	
Current consumption	I_{DD}	V_{DD} = 5.0V, F_{CLK} = 4 MHz			81	mA
$\overline{STROBE}$, $\overline{LAT}$, CLK/DI High input current	I_{IH1} $\overline{STROBE}$	V_{DD} = 5.0V $V_I = V_{DD}$			16	µA
	I_{IH2} $\overline{LAT}$, CLK	V_{DD} = 5.0V $V_I = V_{DD}$			5.0	µA
	I_{IH3} DI	V_{DD} = 5.0V $V_I = V_{DD}$			1.0	µA
$\overline{STROBE}$, $\overline{LAT}$, CLK/DI Low input current	I_{IL1} $\overline{STROBE}$	V_{DD} = 5.0V $V_I = V_{DD}$ (Low active)			150	µA
	I_{IL2} $\overline{LAT}$, CLK	V_{DD} = 5.0V $V_I = V_{DD}$			-5.0	µA
	I_{IL3} DI	V_{DD} = 5.0V $V_I = V_{DD}$			-1.0	µA
Dr L output voltage	V_{OL}	V_{DD} = 5.0V, I_{OL} = 15mA		(1.0)		V
Output delay time	t6	$\overline{STB}$ → ELEMENT ON			10	µs
Output delay time	t7	$\overline{STB}$ → ELEMENT OFF			10	µs

2.5.3 Block diagram of the thermal head



STROBE No.	Dot No.	dots / STROBE
1	1 ~ 320	320
2	321 ~ 640	320

Figure 2.5.1 Thermal Head Block Diagram

NOTES:
- A slash before a signal name indicates active LOW.
- The STB terminal is pulled down in the control IC.

2.5.4 Timing chart

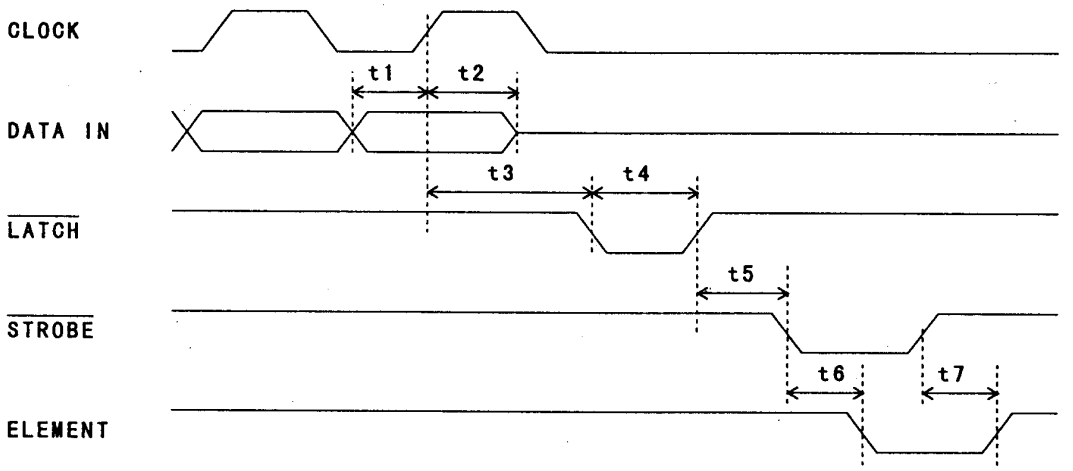


Figure 2.5.2

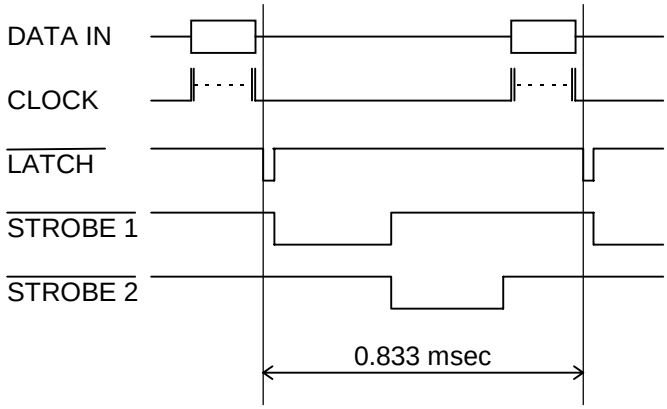


Figure 2.5.3

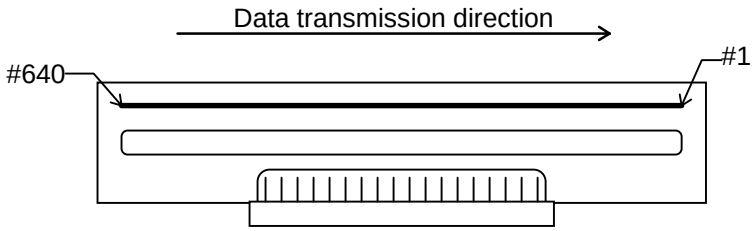


Figure 2.5.4 Data Transmission Direction (as Viewed from the Thermal Elements)

2.5.5 Energizing pulse width formula

Set the standard energizing pulse width based on the remarks below. This setting, however, is valid only for 144 dots or less for energizing simultaneously, one-partition printing, and use of the specified thermal paper.

1) Standard energizing pulse width PLS (μs)

$$PLS = Pt \times Qv \times Qs \times Qd \overset{*}{\pm} 40$$

- Pt is defined as follows, depending on the temperature detected by the thermistor:

  $Pt = -4.35K + 1650$

  K: Absolute temperature detected by the thermistor K=T + 273.16

  T: temperature detected by the thermistor (°C)

- Qv is defined as follows, depending on the head terminal voltage V_H:

  $Qv = (24 / V_H)^2$

  V_H: Head terminal voltage (V)

- Qs is defined as follows, depending on the energizing cycle SLT:

  $Qs = +0.83 \log_{10}(SLT) + 1.07$

  SLT: Energizing cycle (ms)

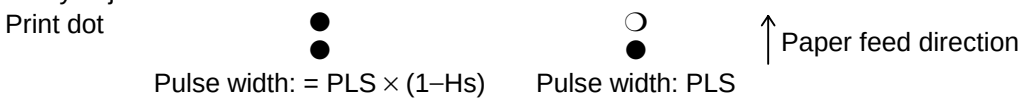
  When a 2-2 phase excitation: SLT = Motor energizing cycle

- Qd is defined as follows, depending on the thermal paper type.

Original Paper No.	Manufacturer	Qd
P350	KSP	0.85
TF50KS-E	NIPPON PAPER INDUSTRIES CO., LTD.	1.00
AF50KS-E	JUJO THERMAL	1.00
TF11KS-ET	NIPPON PAPER INDUSTRIES CO., LTD.	1.15
PD160R	OJI	1.00

2) History control

Apply the energy reducing rate (Hs) to the basic energizing pulse width (PLS) when printed dots are vertically adjacent.



Hs is defined as follows, depending on the energizing cycle SLT:

$Hs = +0.58 - 0.145 \times SLT$

$Hs = +0.55 - 0.145 \times SLT$ (when printing the ladder bar code)

3) Notes on setting the energizing pulse width PLS

① The larger the tolerance of ∗, the worse the print quality becomes. Use a value as close to the calculated value as possible.

② If low resolution is set in the pulse width table, the print density becomes irregular.

③ When printing at a temperature of -5°C (21°F) or less, the output becomes faint. Do not print if the thermistor is damaged, because the R_T (thermistor resistance) becomes ∞ (always low temperature).

④ The print head temperature must be detected by the thermistor at least once in 30 dot lines to set the head energizing pulse width. (Detection of the temperature for every dot line is recommended.)

⑤ Voltage fluctuation can cause printing to be shaded, unwanted print patterns, or paper discoloration. In this case, the basic energizing pulse width PLS can be corrected when the maximum energizing pulse width is less than the values shown in Section 2.5.5 part 4). Give print quality consideration, too.

⑥ When the printer prints ladder barcode or 1-dot configured font, the print result may not be cleared. To improve the print quality for this case, it is recommended to set the printing speed slower than 70 mm/sec.

⑦ If the history control is not applied, the thermal head may be energized continuously. Set off time for 250 μs or more. Otherwise, continuous energizing may occur the print head.

4) Maximum energizing pulse width PLSmax (μs)

The maximum energizing pulse width PLSmax is defined as follows, depending on the energizing cycle SLT(ms), the head terminal voltage V_H (V), and the energy reducing rate Hs:

$$PLSmax = \frac{257 \times SLT + 123}{1 - Hs} \times \left[\frac{24}{V_H}\right]^2 \quad (\mu s)$$

2.5.6 Thermistor (head temperature sensor) specifications

1) Electrical characteristics

Constant B: 3950 K ± 2%

Resistance value: 30 KΩ ± 5% (T= 25°C (77°F))

2) Temperature characteristics

$R_T = R(25) \times \exp [B \times \{1/(T+273)-1/(25 + 273)\}]$

T: Temperature (°C)
R_T: Resistance value (Ω) at T°C
R(25): Resistance (30 KΩ ± 5%) at 25°C (77°F)

3) Ratings

Operating temperature: -20° to 80°C (-4° to 176°F)

2.5.7 Notes on using the thermal print head

1) Do not input $\overline{\text{LATCH}}$ signal while the $\overline{\text{STROBE}}$ is on or for 20 µs after the $\overline{\text{STROBE}}$ goes off.
2) To avoid damage to the heat elements, follow the sequence shown below:

Power supply on: Turn on the circuit power voltage (V_{DD}); then turn on the head terminal voltage (V_H).

Power supply off: Turn off the power supply voltage (V_H); then turn off the circuit power voltage (V_{DD}).

If V_H cannot be discharged to GND level when turning VDD on or off, VDD should be turned on or off only when V_H is 1.5 V or less.

3) To prevent damage of the thermal head by electrolytic corrosion, after printing is finished and the motor stops, turn off the head terminal voltage V_H. If a capacitor retains charge voltage, it must be discharged to GND level. The device that turns the power supply for the print head on/off should have a low voltage loss.
4) When the power is turned on or off, the $\overline{\text{STROBE}}$ signal must be high.
5) When the print head temperature detected by the thermistor reaches 70°C (158°F), printing must be stopped within 30 dots. Restart printing only after the print head temperature falls below 60°C (140°F).
6) To prevent malfunction of the print head due to noise and to prevent damage to the print head IC due to surge voltage, install capacitors in the power line (near the print head FPC connector) to stabilize the power line voltage.
7) Each CLOCK, $\overline{\text{LATCH}}$, $\overline{\text{STROBE}}$, and DATA IN signal must be input by the CMOS IC level interface.
8) Each cable length and each line resistance for V_H and GND line to the thermal print head should be less than 30 cm (11.8") and less than 15 mΩ respectively. To prevent interference to signal lines. Consider that the power line must be separated from the signal lines as far as possible.

2.6 Autocutter

Autocutter performs full or a partial (one point left uncut) cutting paper with the cutter motor (forward rotation), detecting the cutter reset sensor signal.
If the cutter motor locks by jamming paper, rotate the motor in reverse direction to recover the problem.

2.6.1 Cutting method

Scissors with separated blades

2.6.2 Cutting type

Full cut or one point (left side) left uncut

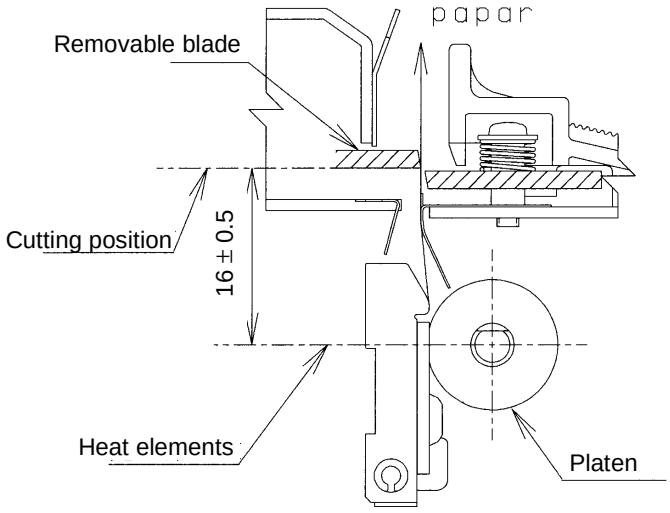
NOTE: • Cutting position (full or one point left uncut) cannot be changed by autocutter control.

2.6.3 Operating duration

Approximately 350 ms (at 24 VDC, 25°C (77°F))

2.6.4 Cutting Position

The distance between the thermal head elements and the cutting position is 16 ± 0.5 mm.



2.6.5 Cutter reset detector

The cutter reset detector detects the position of the cutter blade.

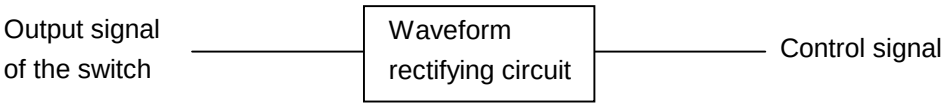
1) Method — Micro switch

2) On position — On when cutting (closed)
Off when in standby position

3) Nominal value for contact — Rated voltage 5 VDC ± 5%
Recommended current 0.1 mA (Rated current 0.04 - 100 mA)

4) Treatment method of output signal

To absorb chattering of the output signal, the user is required to rectify the output signal with a time constant of 50 μs or less.



2.6.6 Cutter motor

1) Supply voltage — 24 VDC ± 10%

2) Current

① Peak current — Approximately 0.9 A
(Supply voltage 24 VDC, at 25°C(77°F), start-up)
1.2 A maximum
(Supply voltage 26.4 VDC, at 0°C(32°F), start-up)

② Mean current — Approximately 110 mA
(Supply voltage 24 VDC, at 25°C(77°F), except start-up, reverse rotation holding)

3) Driving method

① Speed control — None

② Forward rotation — To execute a cutting operation, supply (+) voltage to the (+) terminal of the autocutter and supply (-) voltage to the (-) terminal of the autocutter.

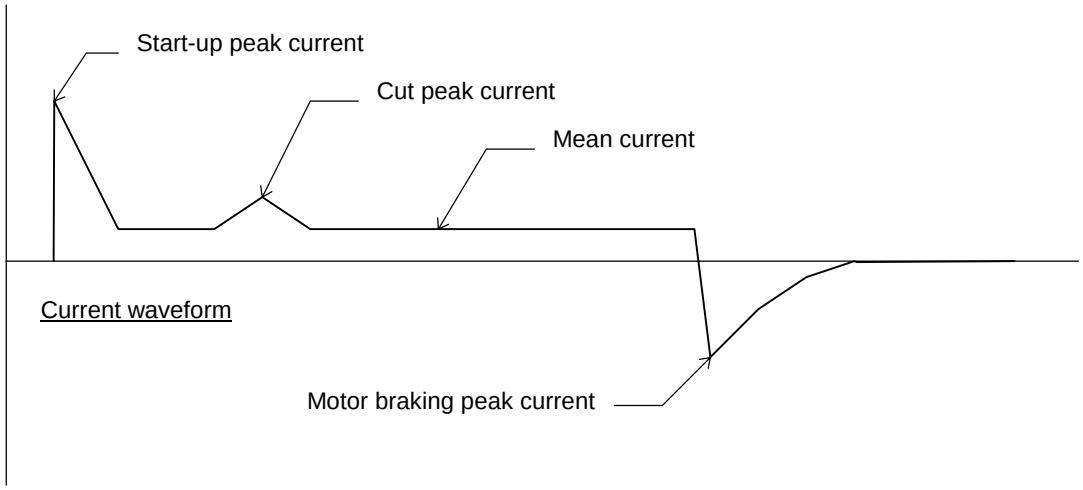
③ Reverse rotation (when initializing or locking)

To move the autocutter to the standby position from the any position except the initial standby position, or from the locking position, supply (-) voltage to the (+) terminal of the autocutter supply and supply (+) voltage to the (-) terminal of the autocutter.

NOTE: Never energize the forward driving circuit and the reverse driving circuit simultaneously.

④ Braking

To move the cutter blade to the standby position, cut the cutter motor driver off. Then, after 20 – 120 μs pass, short the cutter motor braking transistor for 100 ± 5 ms.



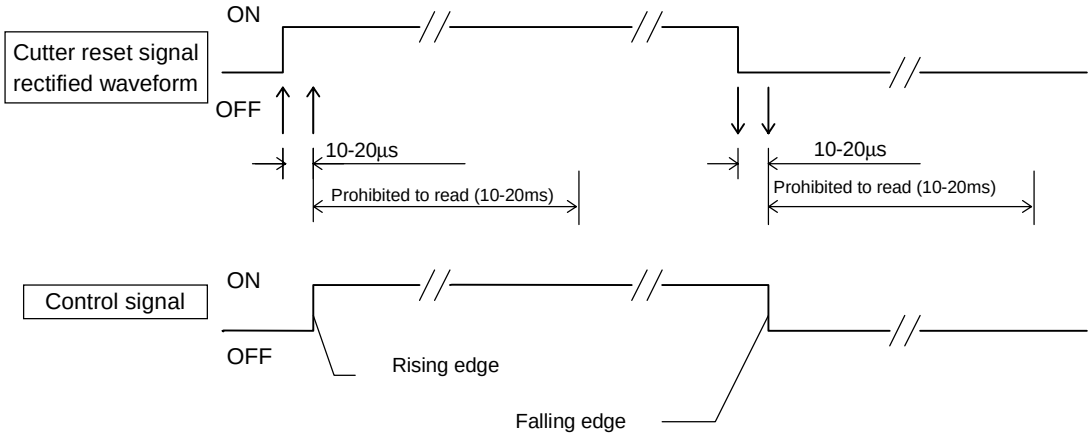
2.6.7 Timing chart

1) Signal processing method

The cutter reset signal is generated by recognizing both edges for rising and falling signal of the rectified reset signal from the autocutter as follows:

① To eliminate noise, the autocutter reset signal (rectified waveform) is sampled twice when the rising (or falling) edge is detected and when 10-20μs has passed after the rising (or falling) edge is detected. If the reading result of both signal levels is the same, the signal is regarded to be read correctly. If not, it is regarded to be noise.

② After the second sampling edge, the signal should not be read for 10-20ms.

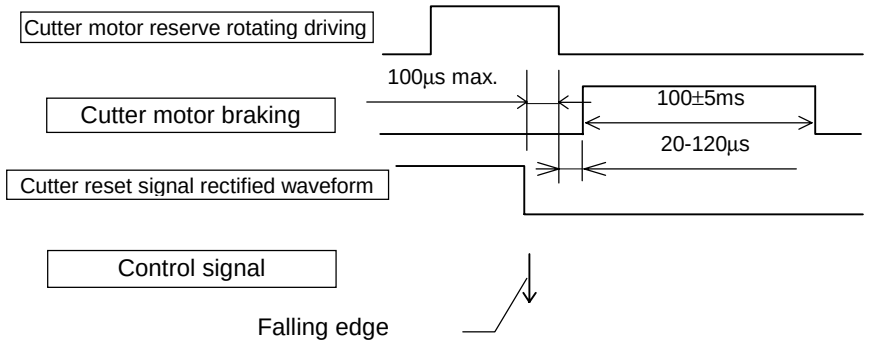


2) Initialization

① When the control signal is on:

1) Rotate the cutter motor in reverse.

2) Within 100µs after the falling edge of the control signal is recognized, turn the cutter motor driver off so that the cutter motor is on hold.



②When the control signal is off:

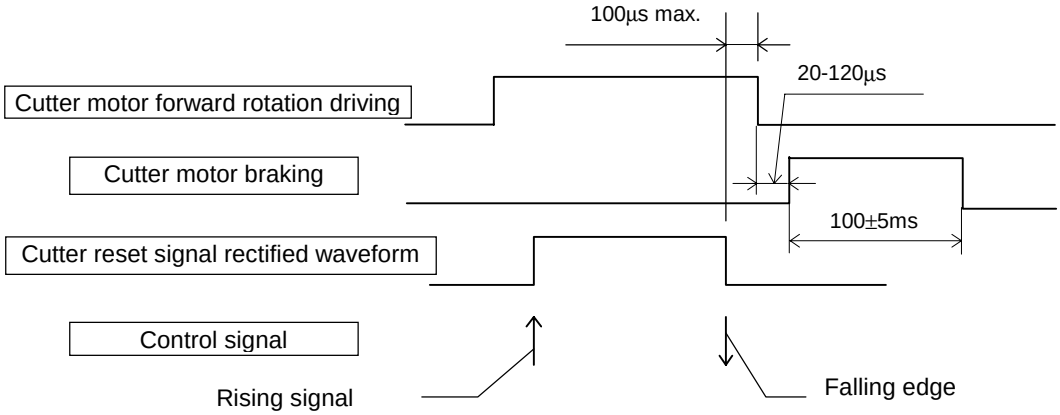
1) Standby.

3) Cutting

1) Rotate the cutter motor forward.

2) Even though the rising edge of the rectified waveform is recognized, continue to rotate the cutter motor more.

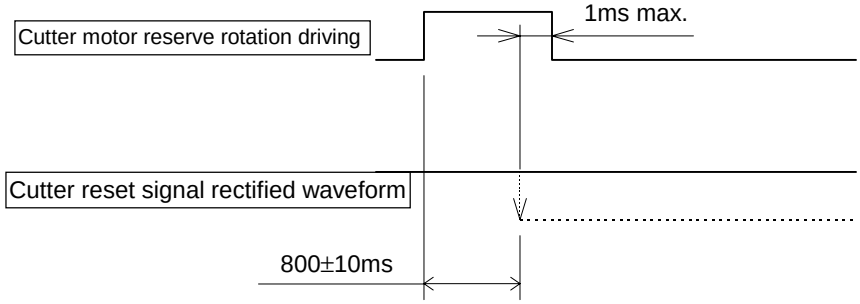
3) Within 100µs after the falling edge of the control signal is recognized, turn the cutter motor driver off so that the cutter motor is on hold. (Refer to Section 2.6.6 3) ④)



2.6.8 Cutter motor locking protection

1) At initialization (when the cutter reset signal rectified waveform is on)

If the rising edge of the cutter reset signal rectified waveform is not recognized even it is passed for 800±10ms after the motor rotation of the cutter motor is started in reverse, it is regarded that an error has occurred. To initialize the cutter motor again, within 1ms after the cutter reset signal rectified waveform is not recognized, turn the cutter motor off, let an operator inform that the error has occurred and remove the error cause.

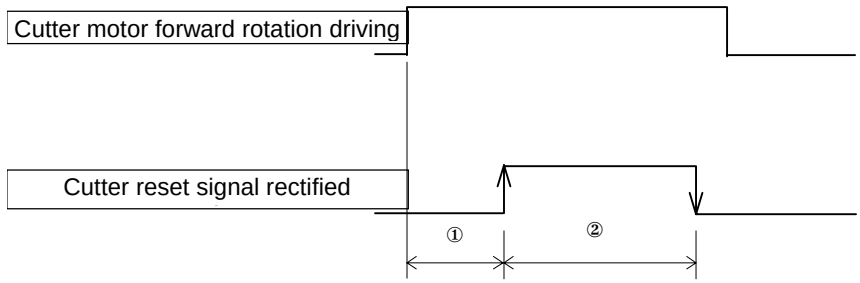


2) In autocutting

① If the rising edge of the cutter reset signal rectified waveform is not recognized even it is passed for 200±10ms after the motor rotation of the cutter motor is started in the forward direction, it is regarded that an error has occurred. To initialize the cutter motor again, within 1ms after the cutter reset signal rectified waveform is not recognized, turn the cutter motor off, let an operator inform that the error has occurred and remove the error cause.

② If the falling edge of the cutter reset signal rectified waveform is not recognized even it is passed for 800±10ms even after the rising edge of the cutter reset signal rectified waveform is recognized, it is regarded that an error has occurred. To initialize the cutter motor again, within 1ms after the cutter reset signal rectified waveform is not recognized, stop the cutter motor forward rotation, and rotate the cutter motor after it is passed for 20-120µs. Then follow the same control sequence as the initialization (Refer to Section 2.3.1. 1) and 2) ①) to stop the cutter motor, and let an operator inform that the error has occurred and remove the error cause.

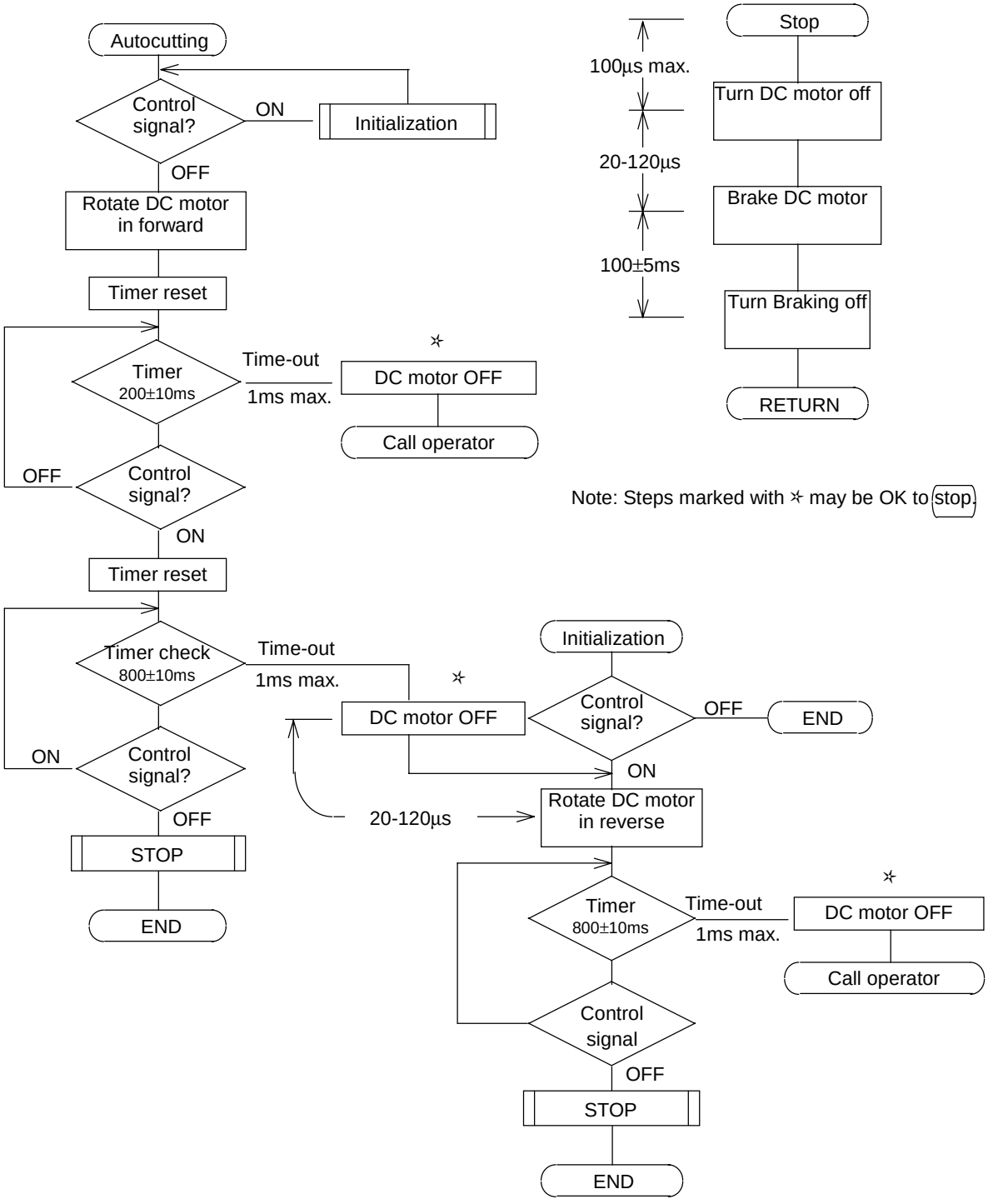
③ If the falling edge of the cutter reset signal rectified waveform is not recognized even it is passed for 800±10ms after the motor rotation of the cutter motor is started in reverse in above operation mentioning in ②, within 1ms after the cutter reset signal rectified waveform is not recognized, turn the cutter motor off, let an operator inform that the error has occurred and remove the error cause.



3) How to determine if an error has occurred

If the cutter motor operation does not recover to normal even though the same error occurs at least 10 times, an error has occurred.

2.6.9 Flowchart



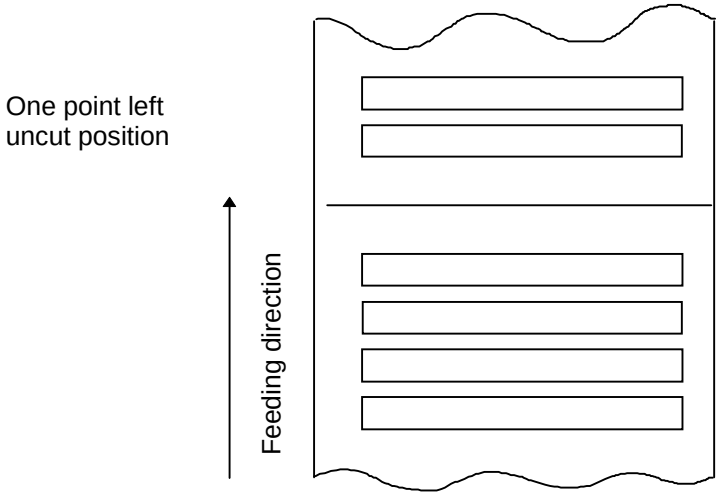
Note: Steps marked with ✲ may be OK to stop.

2.6.10 Autocutter operation to be prohibited

Do not drive the cutter motor while paper is fed or the platens is opened.

2.6.11 Cutting pattern (for one point left uncut)

To prevent the paper from dropping down after cutting, one point left uncut is performed as shown in figure below.



NOTE: If the paper is pulled straight up by grasping the uncut portion, the paper may be loosened.

2.7 Paper-end Sensor

1) Type Photo interrupter

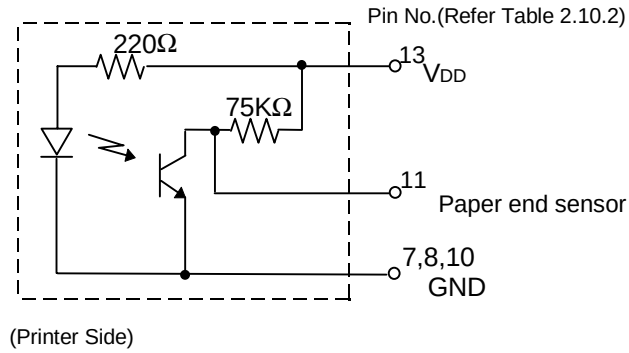


Figure 2.7.1 Paper-end Sensor

2) Absolute Maximum Rating

Table 2.7.1

Item		Symbol	Rated value	Unit
Input characteristics	Forward current	I_F	50	mA
	Reverse voltage	V_R	6	V
	Allowable loss	P_D	75	mW
Output characteristics	Collector-emitter voltage	V_{CEO}	35	V
	Emitter-collector voltage	V_{ECO}	6	V
	Collector current	I_C	20	mA
	Collector loss	P_C	75	mW
Total allowable loss		P_{TOT}	100	mW

3) Ratings

Table 2.7.2

Item			Symbol	Condition	Specifications			Unit
					Min	Typ	Max	
LED input characteristics	Forward voltage		V_F	I_F=20mA		1.2	1.4	V
	Reverse current		I_R	V_R=3V		–	10	μA
Photo transistor output characteristics	Dark current		I_{CE0}	V_{CE}=20V	–	–	0.1	μA
Transfer characteristics	Light current		I_C	V_{CE}=5V, I_F=5mA	100	–	400	μA
	Saturation voltage		$V_{CE(sat)}$	I_F=10mA, I_C=40μA	–	–	0.4	V
	Response time	Rising	tr	V_{CE}=5V, I_C=0.1mA	–	50	150	μs
		Falling	tf	R_L=1KΩ	–	50	150	μs

4) Detection method

Sample the paper-end signal in each dot line. If the signal is low in two or more consecutive samples, the paper has run out.

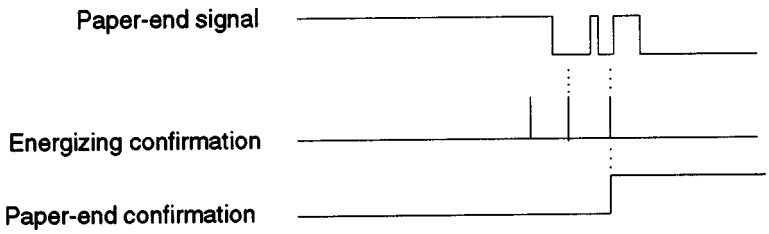


Figure 2.7.2

5) Notes

- To prevent thermal head and printer mechanism failure, never energize the thermal head when no paper is installed.
- When the paper-end is not necessary to be detected, the power supply to the paper-end sensor should be shut down. The paper-end detection should be done after 1 msec or more from when the power is supplied again.

2.8 Platen open sensor

A sensor is used to detect whether the platen is loaded or unloaded.

Platen open means that the platen is apart from the thermal head and platen down means that the platen contacts the thermal head.

1) Sensor type: Micro switch

2) Supply voltage: 5 VDC ± 5%

3) Current rating: 1 to 50 mA

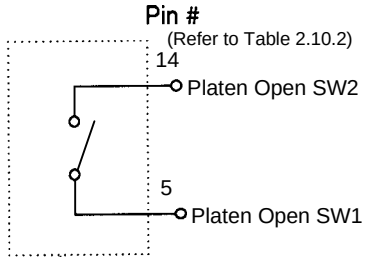
4) Micro switch maximum rating: 30 VDC, 0.1 A (resistance load)

5) Detection method: Off when the platen is up.

NOTES: 1. Sample the signal in a cycle of 1 ms or less. If the micro switch is off, the platen is up.

2. Energizing the thermal head may shorten its life.

3. Never drive the paper feed motor or the cutter motor when the platen is up (micro switch is off).



Pins 14 and 15 can be reversed.

Figure 2.8.1 Platen Open Sensor

2.9 Black Mark Sensor

A photosensor is used to detect a black mark in the path near the thermal head. Refer to section 2.12 Overall Dimensions for the installation position of the photo sensor, in detail.
Contact Epson for the black mark sensor when you use it.

1) Type Reflecting photo interruptor

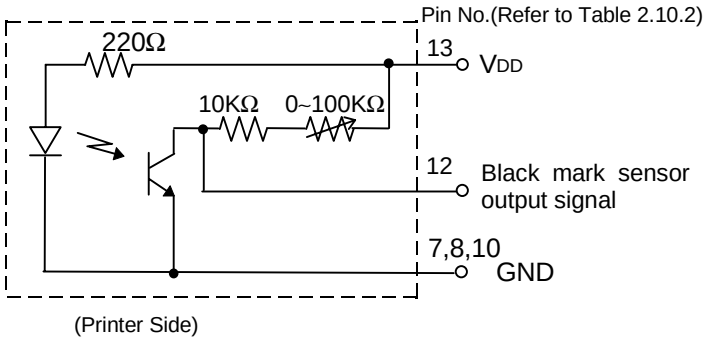


Figure 2.9.1 Black Mark Sensor

2) Absolute Maximum Rating

Table 2.9.1

Item		Symbol	Rated value	Unit
Input characteristics	Forward current	I_F	50	mA
	Reverse voltage	V_R	6	V
	Allowable loss	P_D	75	mW
Output characteristics	Collector-emitter voltage	V_{CEO}	35	V
	Emitter-collector voltage	V_{ECO}	6	V
	Collector current	I_C	20	mA
	Collector loss	P_C	75	mW
Total allowable loss		P_{TOT}	100	mW

3) Ratings

Table 2.9.2

Item			Symbol	Condition	Specifications			Unit
					Min	Typ	Max	
LED input characteristics	Forward voltage		V_F	I_F=20mA		1.2	1.4	V
	Reverse current		I_R	V_R=6V	-	-	10	μA
Photo transistor output characteristics	Dark current		I_{CEO}	V_{CE}=20V	-	1	100	nA
Transfer characteristics	Light current		I_C	Vcc=2V, I_F=4mA	20	45	120	μA
	Leak current		I_{LEAR}	Vcc=2V, I_F=4mA	-	-	100	nA
	Response time	Rising	tr	Vcc=2V, I_C=100μA	-	20	100	μs
		Falling	tf	R_L=1000Ω, d=1mm	-	20	100	μs

4) Detection method

Sample the detection signal in each dot line. If two consecutive samples are the same (they change from high to low), the paper has run out. (During printing)

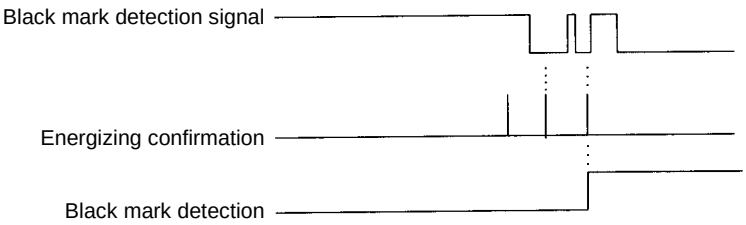


Figure 2.9.2 Example Detection Method for Black Mark

5) Size and specifications for black mark sensor

The standard position of the black mark is on the right side on back of the paper.

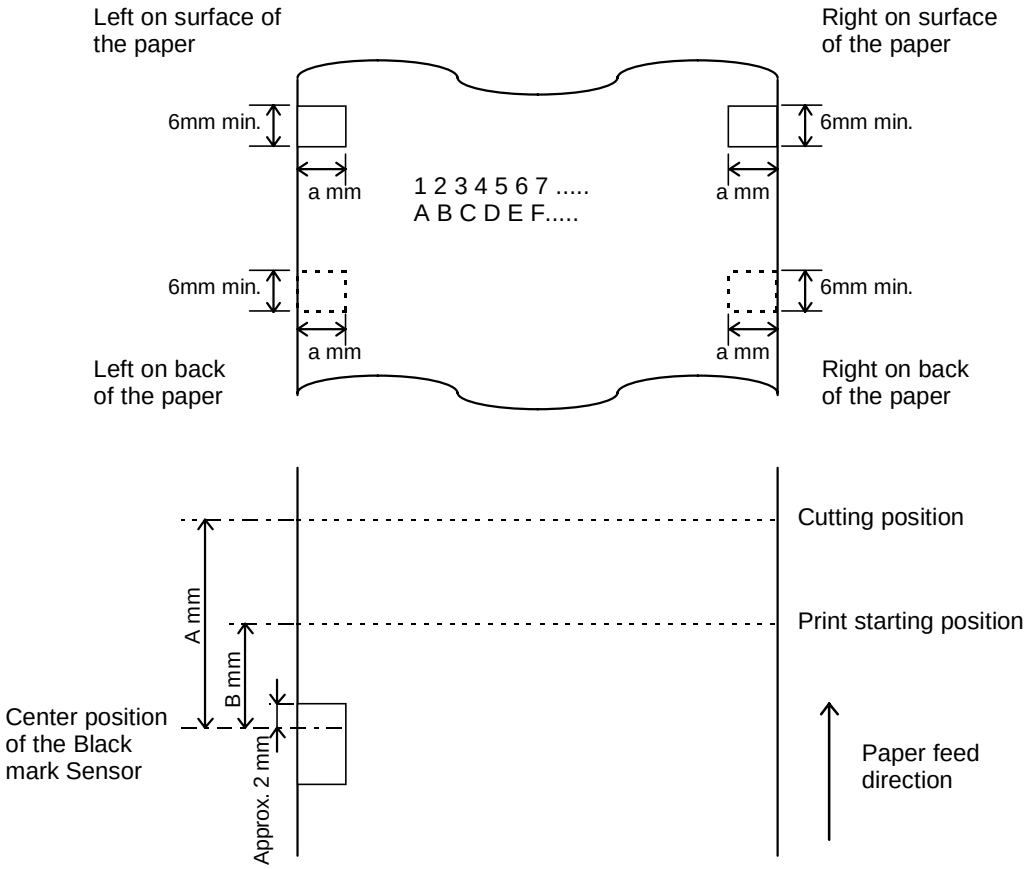


Figure 2.9.3 Size and Position for Black mark

Table 2.9.1 Combination of Black Mark Specifications

	a				A	B
	Surface		Back side			
	Left	Right	Left	Right		
M-T531: Paper width 79.5 mm Curved path	7 or more	7 or more	8 or more	8 or more	37.2	21.2
M-T532: Paper width 79.5 mm Straight path	7 or more	7 or more	7 or more	7 or more	33.6	17.6
M-T541: Paper width 82.5 mm Curved path	7 or more	7 or more	9.5 or more	9.5 or more	37.2	21.2
M-T542: Paper width 82.5 mm Straight path	7 or more	7 or more	7 or more	7 or more	33.6	17.6

NOTES:
- The size and position of the black mark sensor must be as shown in Figure 2.9.3 and in Table 2.9.1.
- The reflecting rate of the black mark must be 10% or less, and the reflecting rate of the white be 75% or less. The reflecting rate means the value which is measured with Macbeth density meter (PCMII) D filter.
- When the black mark is not necessary to be detected, the power supply to the black mark sensor should be shut down. The black mark detection should be done after 1 msec or more from when the power is supplied again.

2.10 Connectors

The printer has the following connectors:

2.10.1 Head connector

Printer side: IL-FPC-21CLIP (JAE) or equivalent

User side: FFC 21pin 1.25 mm pitch, Pin thickness 0.1 mm or more

Table 2.10.1 Head Connector Pin Assignment

No.	Signal Name	No.	Signal Name	No.	Signal Name
1	COM	8	GND	15	GND
2	COM	9	GND	16	GND
3	COM	10	TM	17	CLOCK
4	NC	11	$\overline{\text{STR1}}$	18	SI
5	$\overline{\text{LAT}}$	12	VDD	19	COM
6	NC	13	$\overline{\text{STR2}}$	20	COM
7	GND	14	GND	21	COM

2.10.2 Paper feed motor, paper-end sensor, platen open sensor, autocutter, and black mark sensor connector

Printer side: 15FE–BT–VK–N (JST) or equivalent

User side: FFC 15pin 1.25 mm pitch

Table 2.10.2 Paper feed motor, Paper-end sensor, platen open sensor, Autocutter, and Black mark sensor Connector Pin Assignments

No.	Signal Name	No.	Signal Name
1	Paper feed motor phase $\overline{\text{A}}$	9	Autocutter reset
2	Paper feed motor phase B	10	GND
3	Paper feed motor phase A	11	Paper-end sensor output
4	Paper feed motor phase $\overline{\text{B}}$	12	Black mark sensor output
5	Autocutter motor (+)	13	V_{DD} (+5V)
6	Autocutter motor (–)	14	Platen open SW2
7	GND	15	Platen open SW1
8	GND		

2.11 Condition for Paper Roll Supply

To feed the paper smoothly, satisfy the following conditions for the paper roll supply.
Epson guarantees the quality for the paper pitch specification in the following conditions:

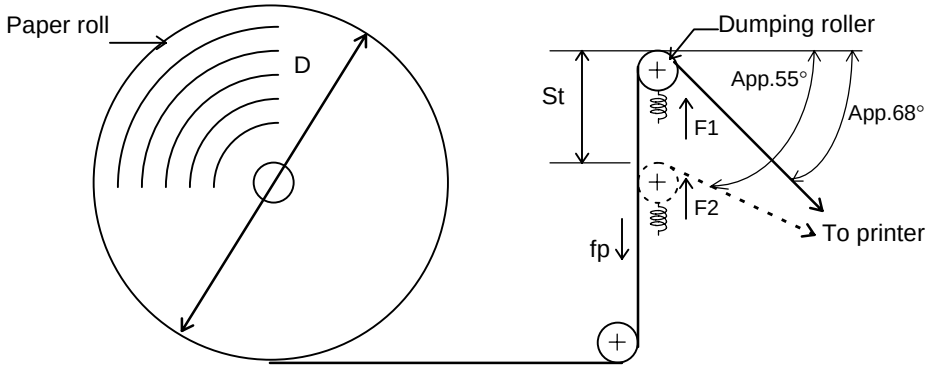
1) Necessity of damper mechanism (provided by users)

D / Paper path	ϕ83mm	ϕ152.4mm (ϕ6")	ϕ203.2mm (ϕ8")	ϕ254mm (ϕ10")
Curved	Not necessary	Necessary	Necessary	Necessary
Straight	for 150mm/s .....Necessary for 100,50mm/s .Not necessary	Necessary	Necessary	Necessary

D: Diameter of paper roll

"Necessary" means that a damper mechanism is required.

2) Structure of the damper mechanism



St: Stroke of the damper mechanism: 30mm
F1: Spring force at the top of the damping roller: 50g or less
F2: Spring force at the bottom of the damping roller: Refer to 3)
fp: Static Friction force of the paper roll: Refer to 3)

Figure 2.11.1 Structure of the Damper Mechanism

3) Conditions for the damper mechanism, and static friction load

a) For 83 mm diameter or roll

	Straight path			Curved path		
Paper feed speed	F1	F_2	fp	F_1	F_2	fp
50mm/s	–	–	150g max.	–	–	150g max.
100 mm/s	–	–	35g max.	–	–	150g max.
150mm/s	50g max.	80g	35g max.	–	–	150g max.

b) For 127 mm diameter roll

	Straight path			Curved path		
Paper feed speed	F1	F_2	fp	F_1	F_2	fp
50mm/s	50g max.	120g	70g max.	50g max.	120g	70g max.
100 mm/s	50g max.	120g	70g max.	50g max.	120g	70g max.
150mm/s	50g max.	150g	70g max.	50g max.	120g	70g max.

c) For 152.4 mm diameter roll

	Straight path			Curved path		
Paper feed speed	F1	F_2	fp	F_1	F_2	fp
50mm/s	50g max.	120g	70g max.	50g max.	120g	70g max.
100 mm/s	50g max.	180g	70g max.	50g max.	180g	70g max.
150mm/s	50g max.	270g	70g max.	50g max.	270g	70g max.

d) For 203 mm diameter roll

	Straight path			Curved path		
Paper feed speed	F1	F_2	fp	F_1	F_2	fp
50mm/s	50g max.	120g	70g max.	50g max.	120g	70g max.
100mm/s	50g max.	180g	70g max.	50g max.	180g	70g max.
150mm/s	50g max.	270g	70g max.	50g max.	270g	70g max.

e) For 254mm diameter roll

	Straight path			Curved path		
Paper feed speed	F1	F_2	fp	F_1	F_2	fp
50mm/s	50g max.	170g	90g max.	50g max.	170g	90g max.
100 mm/s	50g max.	270g	90g max.	50g max.	270g	90g max.
150mm/s	50g max.	500g	90g max.	50g max.	500g	90g max.

2.12 Overall Dimensions

2.12.1 M-T531A

2.12.2 M-T532A

2.12.3 M-T541A

2.12.4 M-T542A

APPENDIX

A.1 Notes on Handling the Printer

A.1.1 Initial installation

1) To prevent electrostatic damage to the ICs and heat elements of the print head, handle the printer only after taking proper countermeasures against static electricity in the environment and on your body.

A.1.2 Printer handling

1) Because the printer uses a line thermal print head, avoid operating it in dusty environments so as not to shorten the life of the print head.
2) Avoid condensation, because the printer uses a thermal print head. If it does occur, do not turn on the power until condensation has disappeared.

A.1.3 Warnings

1) Never apply power to the print head without paper or with the platen open, because the life of the print head may be shortened. (When using the head open lever, be aware that the head load/unload state cannot be detected.)
2) Do not touch heat elements of the print head, the driver IC, or the IC terminals with a screwdriver or tweezers, or directly with your fingers.
3) Avoid applying mechanical stress or shocks, including friction generated from microparticles, to the print head surface.
4) Do not touch the print head area and the motor surface, because they become very hot during and just after printing.
5) Avoid leaving the printer unused for a long period without paper, because the platen and the print head may stick together temporarily.
6) Make sure no foreign objects are attached to the thermal paper and the platen.
7) Never pull out the paper in any direction with the print head loaded.
8) Do not force the thermal head excessively. The maximum times of removing and inserting the FFC should be 10.
9) Do not overlap the FFCs for the thermal print head and the printer mechanism and other cables to prevent the printer from malfunctions.

A.1.4 How to load the paper

1) For a straight path model
    a) The leading edge of the thermal paper should be cut straight, as shown in Figure A.1.1.
    b) Insert the thermal paper straight into the paper entrance, and feed it manually. Use your hand to guide the paper.
    c) After the paper-end sensor detects the paper existence, drive the paper feed motor, following the paper feed drive method in the semi-automatic loading shown in Table 2.3.5.
    d) Then, insert the paper into the paper entrance manually.

2) When the platen is opened for a curved path model
   a) The leading edge of the thermal paper should be cut straight, as shown in Figure A.1.1.
   b) Rotate the platen open lever in the clockwise direction to open the platen.
   c) Insert the thermal paper straight into the paper entrance, and feed it manually. Use your hand to guide the paper.
   d) When the leading edge of the paper roll comes out from the paper exit, pull it out by hand.
   e) Push the platen cover down to close the platen unit (called “platen close”). Make sure that the platen is closed securely.
3) When the platen is not opened for a curved path model
   a) The leading edge of the thermal paper should be cut straight, as shown in Figure A.1.1.
   b) Insert the thermal paper straight into the paper entrance, and feed it manually. Use your hand to guide the paper to feed it.
   c) After the paper-end sensor detects the paper existence, drive the paper feed motor, following the paper feed drive method in the semi-automatic loading shown in Table 2.3.4.
   d) Then insert the paper into the paper entrance manually.

Notes:
1. Paper may jam if the paper is not inserted straight even though one of these loading methods described in 1) through 3) is performed. If this occurs, remove the jammed paper after raising the platen open lever; then insert the paper again.
2. The leading edge of the thermal paper should be cut straight, without tears or wrinkle, as shown in Figure A.1.1.
3. Paper that curls in reverse should not be inserted, because it may cause a paper jam.
4. For a straight path model, the paper may be inserted even with the platen open.

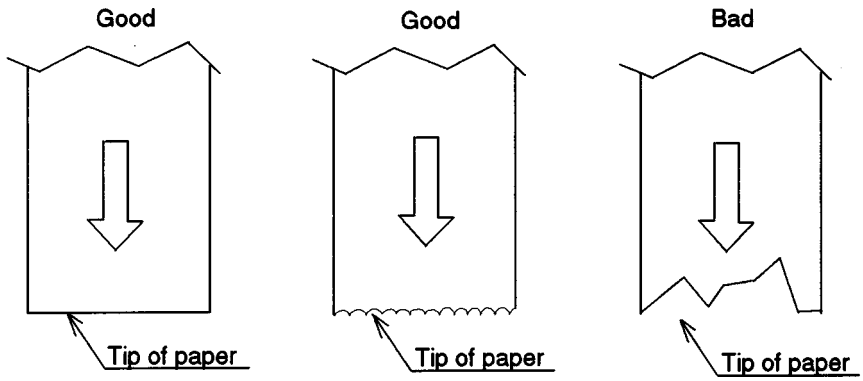


Figure A.1.1

A.1.5 Notes on paper removal

1) After the printer stops, raise the platen open lever to open the platen.
2) Pull the paper out straight in the proper paper feeding direction.

A.1.6 When not using the printer for a long period

1) If the printer is left unused for a long period with the print head loaded on the platen, discoloration of the thermal paper, loss of heat sensitivity, or sticking of the paper to the platen may occur. In these cases, replace the thermal paper with a new roll. In addition, some printed characters may be faint due to deformation of the platen rubber.
2) If the printer is left unused for a long period with the paper loaded, discoloration of the thermal paper, loss of heat sensitivity, or sticking of the paper to the platen may occur. In these cases, replace the thermal paper with a new roll.

A.1.7 Using the printer at low temperature

When printing is started at a low temperature (especially when the temperature is very low), the first few lines may be somewhat faint because the print head is cold.

A.1.8 Using the printer at high temperature

When printing is started at a high temperature, poor print quality (such as blurred print) may result.

A.1.9 Maintenance (Refer to the M-T530/T540 technical manual in detail.)

1) Cleaning the thermal head and the platen

Paper dust, paper chips, and thermal chemicals attached to the heat elements of the print head and the platen may reduce print quality. If this occurs, clean the print head and the platen as follows:

a) Raise the print head from the platen by rotating the platen open lever (green) to the left. (Refer to Section A.1.10, Platen open mechanism.)

b) Wipe the heat elements of the print head and the platen lightly with a cotton swab soaked in alcohol solvent (ethanol, methanol, or IPA). Using other solvents may damage the print head.

c) After the alcohol evaporates completely, return the platen unit to its original position by pushing the platen cover down.

NOTE: Do not touch the print head or the motor surface just after printing, as these areas are very hot.

2) Handling paper jams

Rotate the platen open lever to raise the platen unit, and remove the jammed paper. (Refer to Section A.1.10, Head open mechanism)

Remember not to touch the print head or the motor surface just after printing, as these areas are very hot.

A.1.10 Platen open mechanism

1) To raise the platen unit, rotate the platen open lever to the right.
2) To close the platen unit, push the platen cover down.

A.2 Notes on Handling Thermal Paper

1) Usage

① Do not allow chemicals or oil to contact thermal paper, because they may cause discoloration or print fading.

② Strongly rubbing thermal paper with a piece of metal or with finger nails may also cause discoloration.

2) Storage

Avoid storing thermal paper in high temperatures and humidity. Avoid exposing thermal paper to direct sunlight, because it will gradually become discolored at about 70°C (158°F).