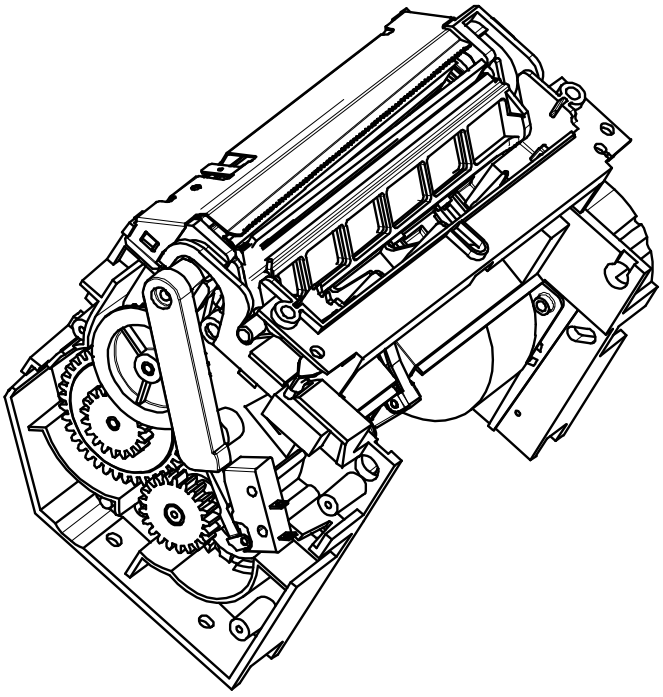
THERMAL PRINTER MECHANISMS

80/82.5 Printer Mechanism Series

XA/XB
CA/CB

USER MANUAL

Reference 3105251
Issue E
February 2009



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EVOLUTIONS

Date	Issue	Modifications
10/1997	A	Creation
01/2002	B	General update
07/2003	C	Additional qualified paper types
11/2007	D	Information on availability of sensor position with straight paper path Removal of spare part list.
02/2009	E	Addition of recommended papers

IMPORTANT

This manual contains the basic operations for running your printer.

Read it carefully before using your printer.

Pay special attention to the chapter “Recommendations”.

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CONTENTS

1 SUMMARY OF PRINTER SPECIFICATIONS

The following table provides the main specifications of the CA/XA & CB/XB mechanism series.

FEATURE	VALUE	UNITS
Printing method	Static thermal dot line printing	-
Number of resistor dots	640	-
Resolution	8	Dots/mm
Printing width	72 / 80	mm
Paper width	80 / 82.5	mm
Head temperature detection	By Thermistor	-
Number of steps / dot line	1	-
Paper feed / dot line	0.125	mm
Out of paper detection	Standard : switch Option : optical-sensor	-
Operating voltage range Vcc (logic)	4.75 - 7	V DC
Operating voltage range Vch (dot)	20 - 30	V DC
Weight (average)	600	g
Storage temperature range	- 40 to + 80	°C
Operating temperature range	- 10 to +50	°C
Relative humidity range (no condensing)	20 to 90 (up to 35°C) 20 to 80 (up to 50°C)	%
Maximum printing speed for standard version *	150	mm/s

* The printing speed of the mechanism depends on three main parameters: the driving software of the mechanism, the paper sensitivity, and the temperature at which the mechanism is used (see the chapter 6.3 "Heating time" for more details on this topic).

Two options are available for paper path:	rear paper path (with or without clamshell) straight paper path (without clamshell)

The following table provides the reliability features, according to the recommended paper reference.

RECOMMENDED PAPER / SUPPLIER	**Appelton** RESISTE 600-3.1	**Appelton** RESISTE 650-3.2	**Appelton Optima** T- 886 B	**Blumberg** T49-32	**Jujo** AP62KJ -HR	**Kanzaki** F380, P350	**Kanzaki** Lotto 462	**Kanzaki** Lotto 480	**Kanzaki** Lotto 482	**Kanzan** KLS 36	**Kanzan** KLS46
Paper thickness	74	81	82	88	80	60	83	83	83	80	80
Print head electrical lifetime*	2×10^8	2×10^8	1.4×10^8	1.2×10^8	2×10^8	2×10^8	2×10^8	2×10^8	2×10^8	2×10^8	2×10^8
Print head mechanical lifetime due to abrasion	100	100	70	100	100	100	100	100	100	100	100
General mechanical lifetime (all components except for the print head) *	150	150	150	150	150	150	150	150	150	150	150
Cutter lifetime	1×10^6	1×10^6	750 000	1×10^6	1×10^6	1.5×10^6	1×10^6	1×10^6	1×10^6	1.5×10^6	1×10^6

RECOMMENDED PAPER / SUPPLIER	Kanzan KP460	Mitsubishi TP8065	Mitsubishi TP8067	Mitsubishi TP8075	Mitsubishi TL3000	Mitsubishi TL4000	Mitsubishi F5041	Ricoh LSB 130 2002	Ricoh LB1 135 2006	Sihl 80P7CS	
Paper thickness	72	80	82	85	82	84	80	80	80	82	g / m^2
Print head electrical lifetime*	2×10^8	1.2×10^8	2×10^8	2×10^8	2×10^8	2×10^8	1×10^8	1.2×10^8	2×10^8	1.2×10^8	pulses
Print head mechanical lifetime due to abrasion	100	100	100	100	100	100	100	100	100	100	km
General mechanical lifetime (all components except for the print head) *	150	150	150	150	150	150	150	150	150	150	km
Cutter lifetime	1×10^6	1×10^6	1×10^6	1×10^6	1×10^6	1×10^6	1×10^6	1×10^6	1×10^6	600 000	cuts

For further information, please contact your Axiohm Technical Support

* The reliability of the head depends on the number of pulses applied to the dots. With the resolution of this print head (8 dots per mm), if the dots are used with 25% of duty and submitted to 2 x 10^8 pulses, the print head can reach 100 km. The number of pulses that can be applied to the head depends on the heating time. Thus for paper sensitivity, that is why this value varies according to the paper used, and why preheating may be required to achieve the print head lifetime.

Example: if the printing duty of dots is 20% with F380 paper.
The print head reliability is: ((2 x 10^8) x 5) / 8 = 1.25 x 10^8 mm = 125 km

The duty value for text printing can be estimated at about 25%.

Notes:

- These results are given with AXIOHM standard test conditions which are mainly: 24V, 25°C, and use of the recommended paper.
- For low temperature applications and/or for low sensitivity papers, preheating of the head may be implemented to improve print speed performance.

Description of the preheating process:

- Preheating of the thermal head is achieved by heating alternatively the even
- and odd points of the head with short pulses defined as follows:

- TON = 80 µs (even and odd points)
- TOFF = 1920 µs

- This pulse time is defined for heating the head without marking the paper.

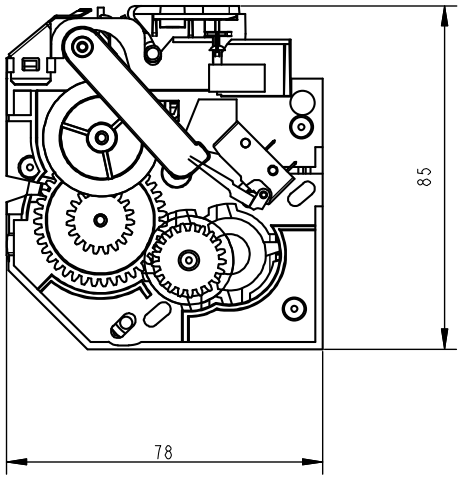
- The temperature is regulated by a hysteresis control.
- Low temperature = 30° C
- High temperature = 35° C

* Preheating only when paper is present.

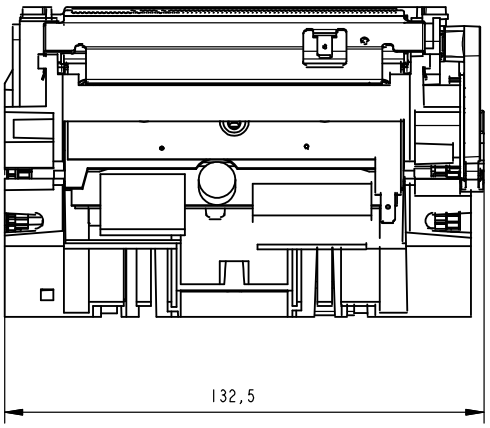
2 Mechanical Dimensions

2.1 Overall Dimensions

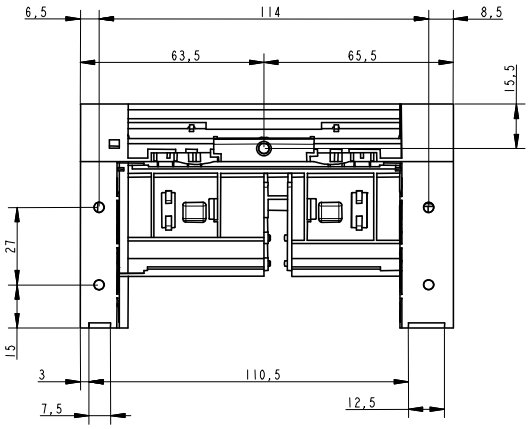
2.1.1 Dimensions without Axiohm's integrated cover



Height & Depth

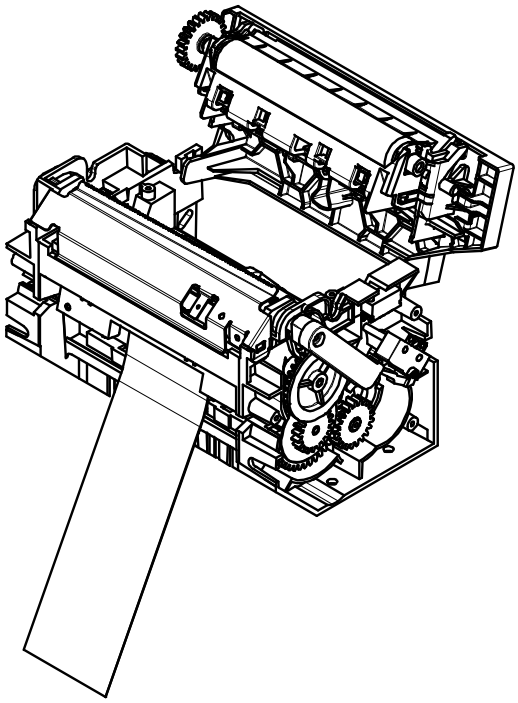


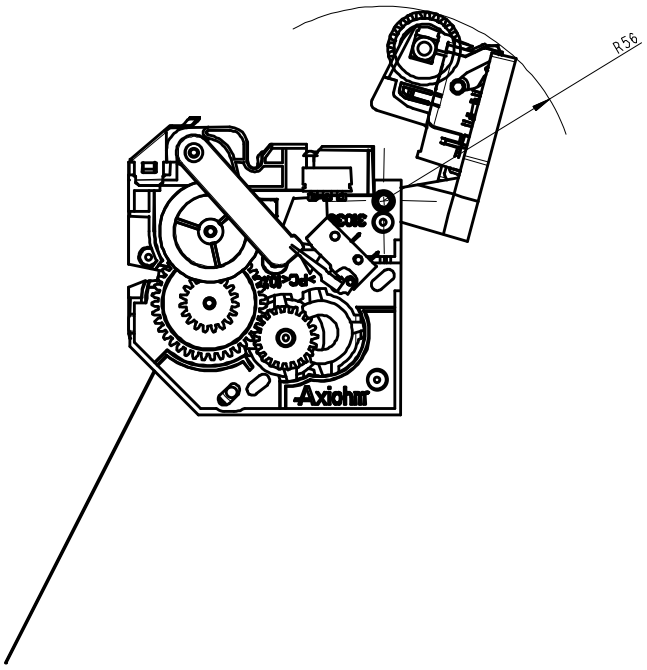
Width

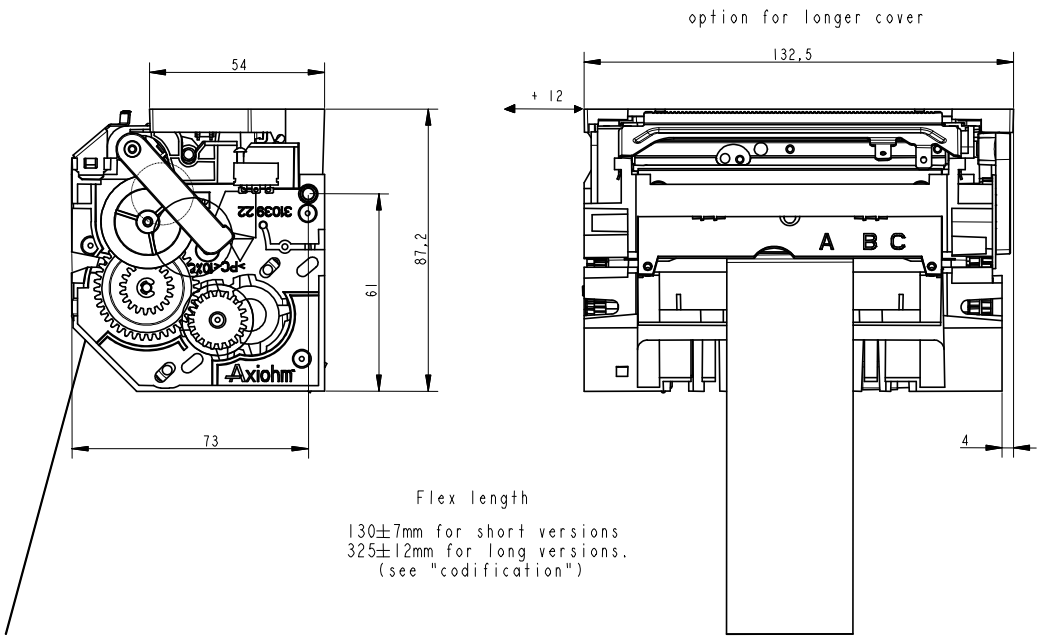


Fixing Elements

2.1.2 Dimensions with Axiohm's integrated cover



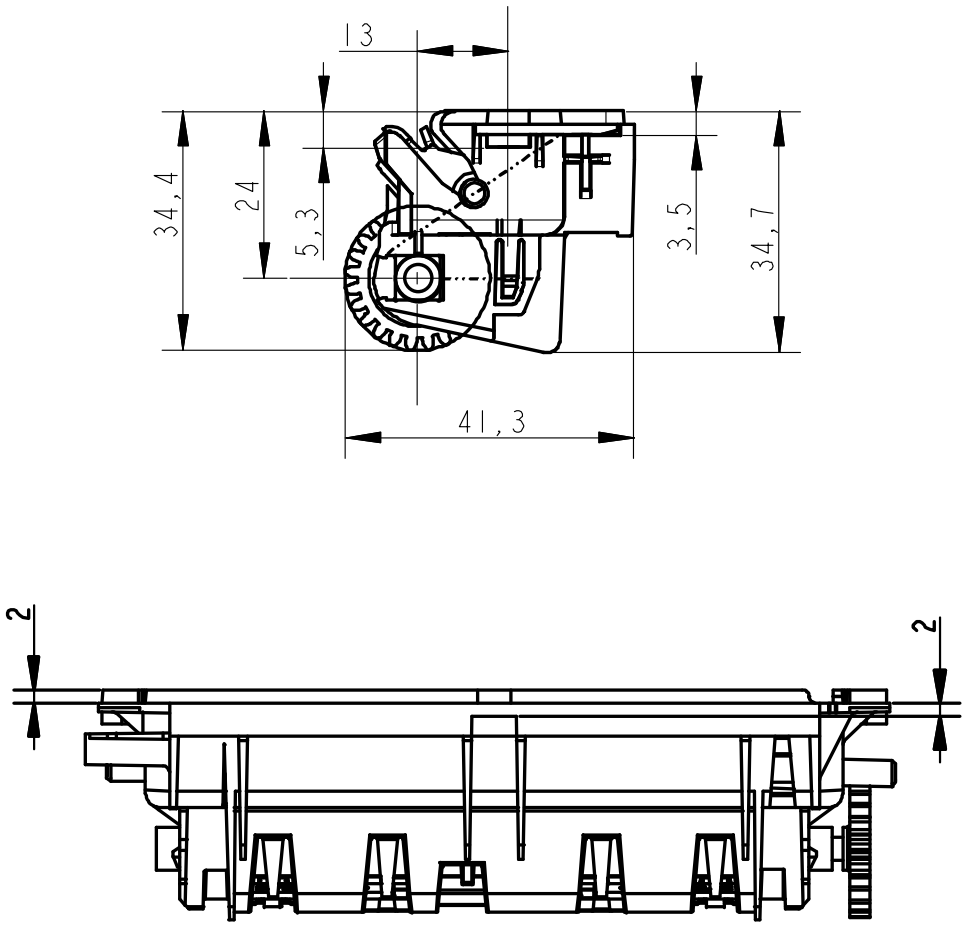


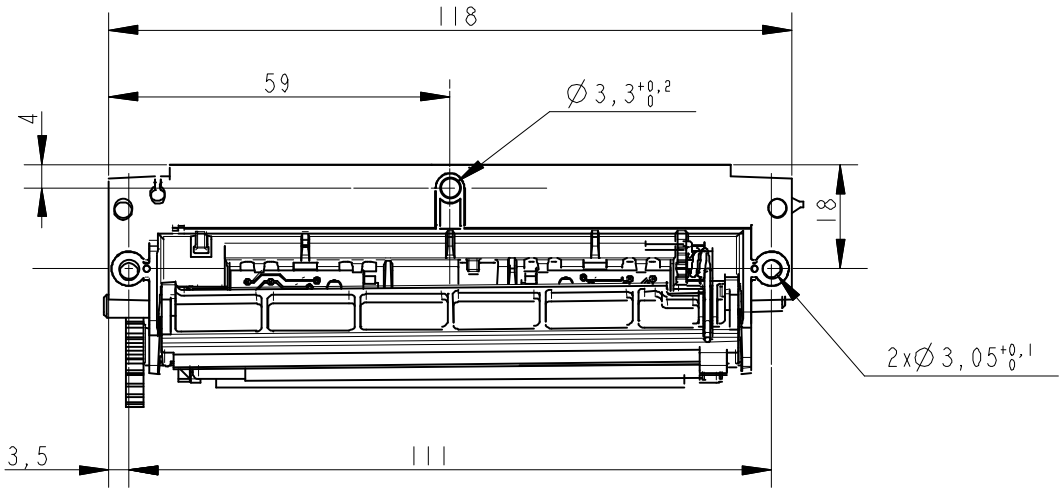


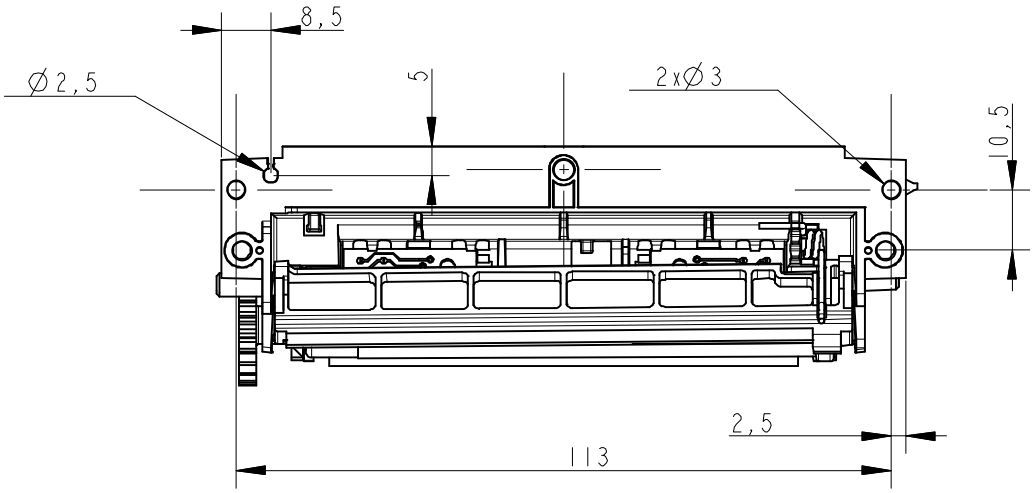
***Notes*:**

- The cover width is the same as the mechanism width (outside dimension).
- If no cutter is set on the mechanism (for CA/CB), the cover exceeds the rest of the mechanism by 4 mm as shown above.
- For easier opening, another cover is available; it exceeds by an extra 12 mm on one side of the mechanism.
- Other dimensions are the same with or without cover.

2.2 Platen holder for customised cover



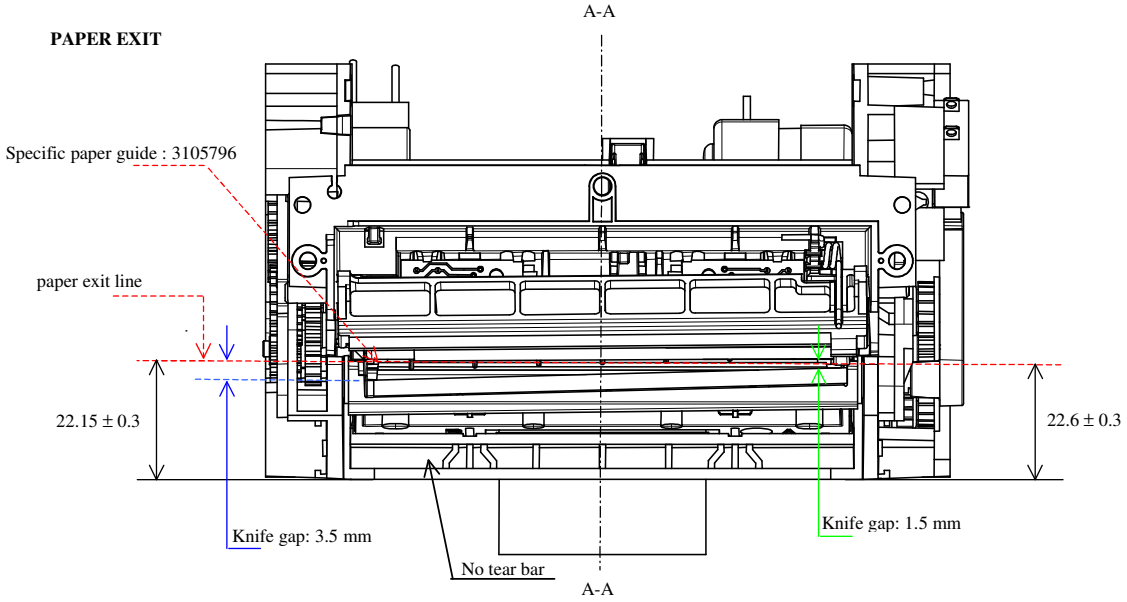

118
59
Ø3,3 +0,2 0
4
18
2xØ3,05 +0,1 0
3,5
111


8,5
Ø2,5
5
2xØ3
10,5
2,5
113

2.3 Paper entry & exit

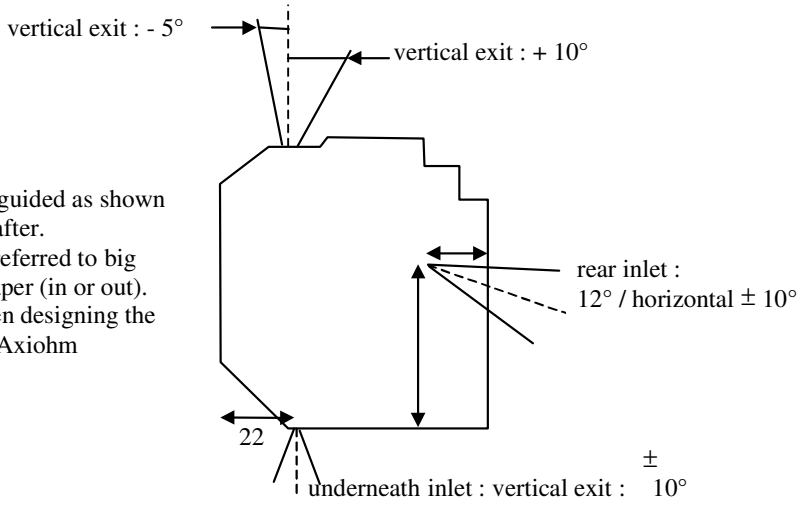
The paper must be guided to reach the mechanism paper inlet. The guide must be designed in such a way that it does not stop the paper or mark it, or create high friction.
If the application requires a paper guide at the mechanism paper exit, make sure not to bend the paper too much or this will create jam.
The design of the mechanism guide at the paper exit is optimised to avoid dust accumulation when cutting. If an exit guide is added, leave enough space so that it does not obstruct the mechanism guide and prevent the internal paper guide from working properly.

PAPER EXIT



PAPER EXIT ANGLE

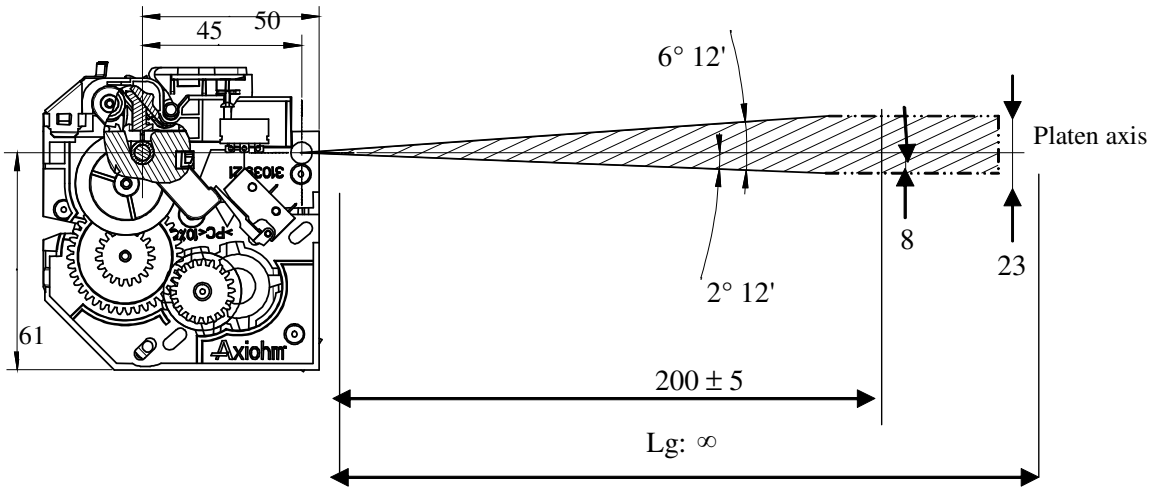
The paper should be guided as shown on the drawing here after.
Smooth curves are preferred to big angles to drive the paper (in or out).
In case of doubt, when designing the guides, contact your Axiohm representative.



2.4 Axis position for customized cover

The following drawing portrays the area in which it is possible to set the cover axis.
The position is given in reference to the platen axis (when set in the mechanism) and to the cover axis when Axiohm's cover is used.

The cover axis has to be parallel to the platen axis.



Notes:
There must be clearance in the cover hinge so that the position of the platen holder is adjusted to the mechanism, with the help of the fixed blade support axle.

The cover cannot be opened or closed if the rotating blade is not in its "open" position (cutter switch closed).

Forcing to close the cover will damage the blades.

2.5 Optical Sensor Position

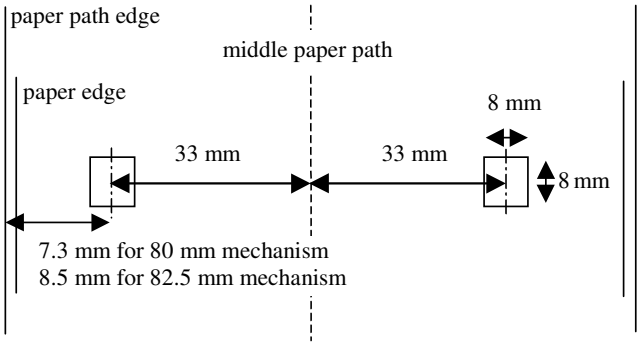
The position of the Optical sensor in relation to the paper path can be used for Paper out detection, Top of form or Hole detection management.
The following drawings give the position of the middle of the Optical sensor for left and right position.

On the mechanisms described in this manual, the optical sensors can be set either on the printed or non-printed side. This does not change the following distances as sensor-setting holes are "face to face".

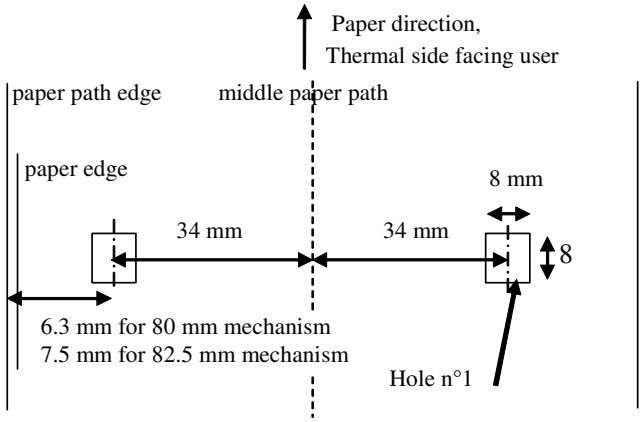
Black mark indicator:

The size of the black mark should be 8x8 mm as indicated on the drawing (both sides and for both paper paths).
Measurements: 0.7 minimum Macbeth optical density (20% max. reflectance) to 900NM* infrared light
*measure with the D filter on the Macbeth PCM II.

With Rear/Clamshell paper path



With straight paper path



Mechanisms with straight paper path and automatic cutter options have only one optical sensor position. The right optical sensor (hole n°1) is not available.

Useful distances for Top of form management

Distance from the optical sensor to the line of cut with rear paper path: 38.5 ± 1 mm
Distance from the optical sensor to the line of cut with underneath paper path: 61 ± 1 mm
Distance from the line of dots to the line of cut: 16.4 ± 1 mm

3 ELECTRICAL SPECIFICATION

3.1 General Print head Characteristics

3.1.1 Class C (2nd source print head)

Number of dots	640
Number of driver ships	10 (64 dots per ships)
Dot resistance	950 ± 3 % Ω
Maximum current per dot line (at 24V)	16.2A

3.1.2 Class A / D

Number of dots	640
Number of driver ships	10 (64 dots per ships)
Dot resistance	776 ± 6 % Ω
Maximum current per dot line (at 24V)	79.8A

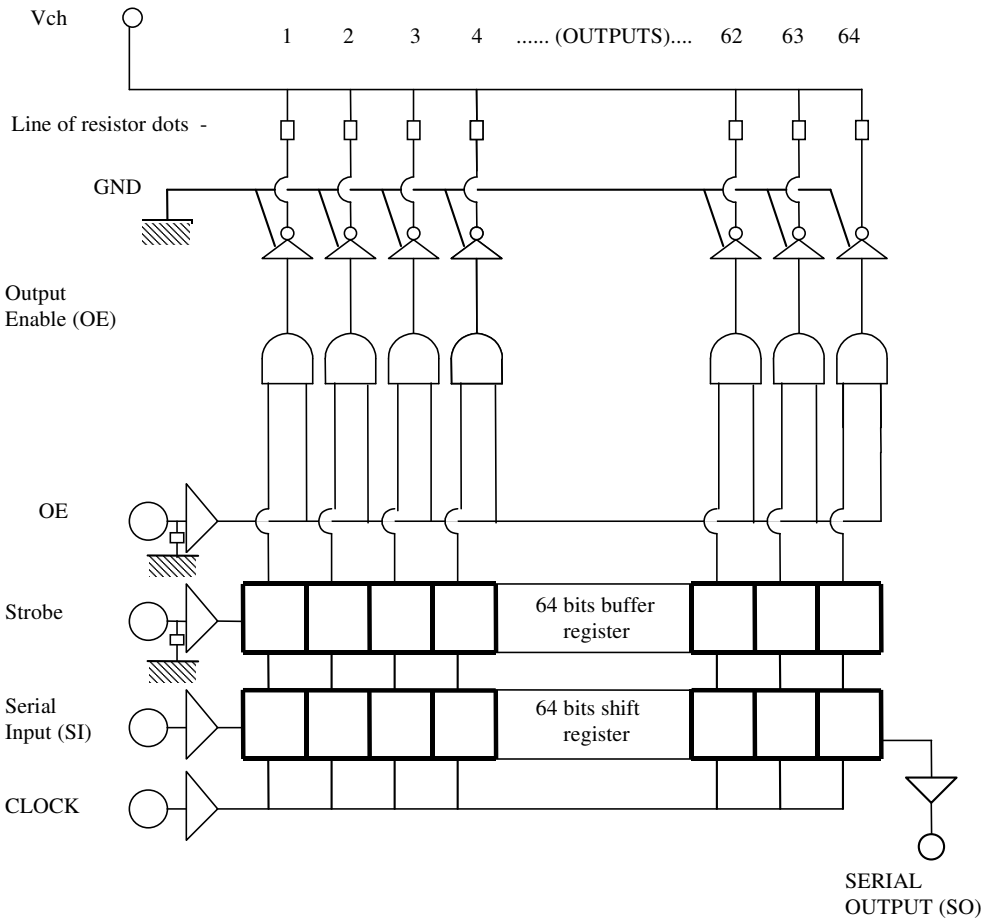
3.1.3 Class B / E

Number of dots	640
Number of driver ships	10 (64 dots per ships)
Dot resistance	824 ± 6 % Ω
Maximum current per dot line (at 24V)	18.6A

*For optimum print quality, the heating times should be adapted to each class.

See appendix 3.

3.1.4 Function of each 64 bit IC (integrated circuit)

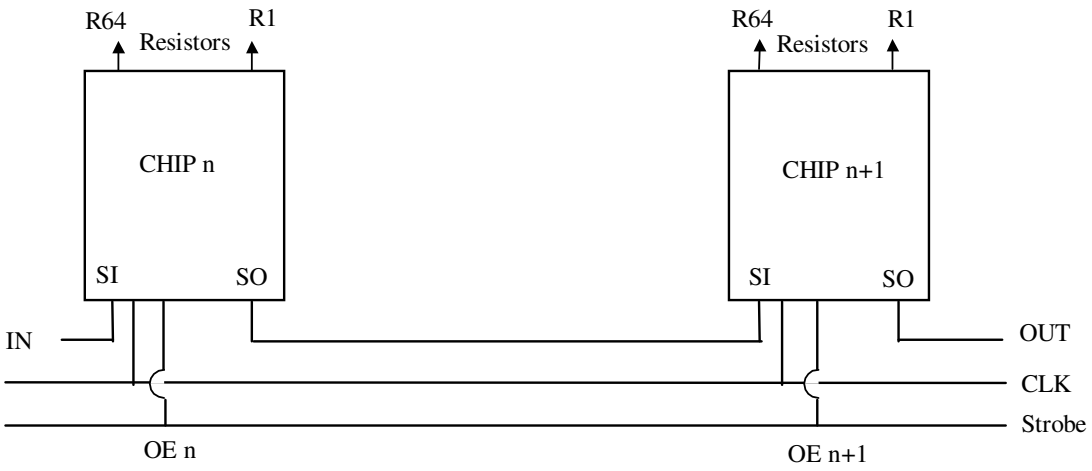


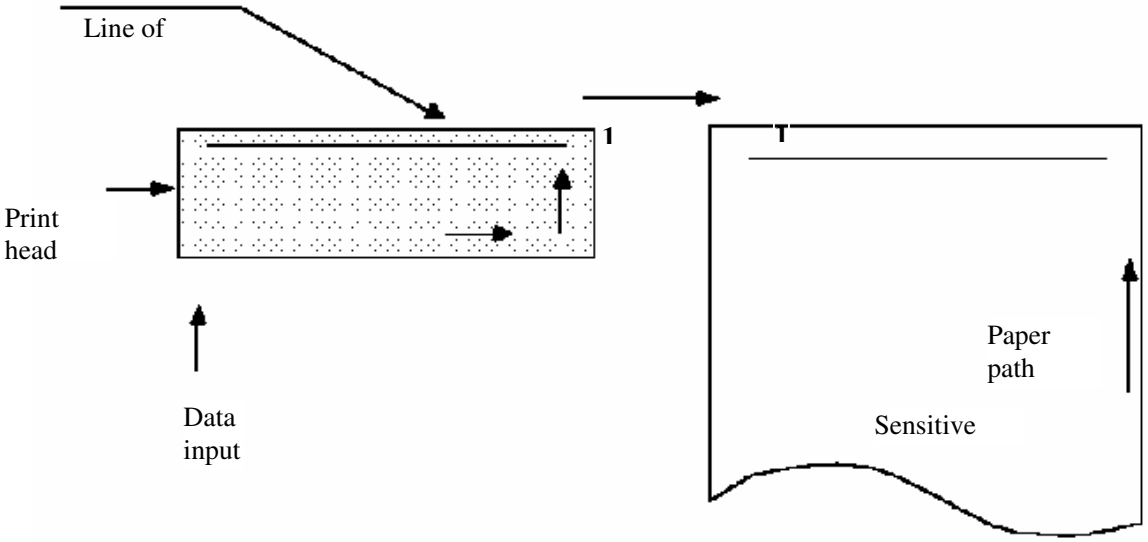
Driver IC schematic

These circuits are supplied by	4,75V to 7V logic voltage
Each circuit features	64 open collector transistors
	64-bit shift register
	64-bit memory register
Each circuit controls	64 resistor dots on the print head

The heating element power supply VCH is not connected to the Driver ICs but to the resistive line of dots itself. The driver ICs are connected via a pattern of high current gold interconnecting traces to the line of resistor dots. (Heat element structure: 2 heaters/dot)

3.1.5 Routing of data to the thermistor dots



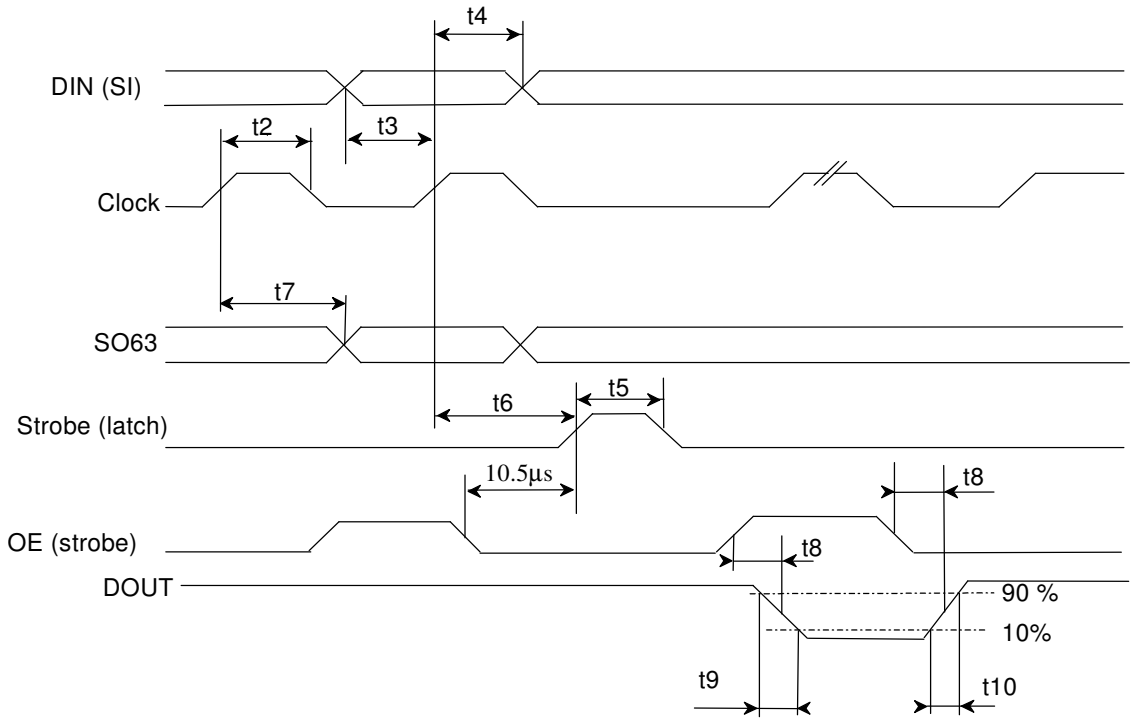


Print head bottom view

Dots print order

The first bit of data entered will be the first bit of data printed (FIFO).

3.1.6 Timing

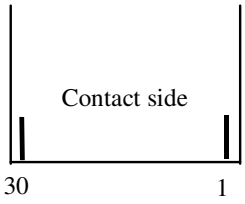


		Min	Typ	Max	
Clock frequency				6.25	Mhz
Clock pulse width	t2	70			ns
Clock SI set up time	t3	40			ns
Clock SI hold time	t4	40			ns
Latch pulse width	t5	100			ns
Clock latch setup time	t6	100			ns
SO Delay time	t7			120	ns
OE-DO delay time	t8			10.5	µs
DO fall time	t9		3.5	10	µs
DO rise time	t10		2.0	6.0	µs

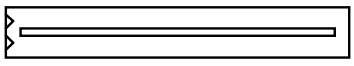
3.1.7 Print head Connection

The following table provides the standard printing speed version.

Pin n°	Signal	Pin n°	Signal
1	Vch (heating)	2	Vch
3	Vch	4	Vch
5	Data - in	6	N C
7	OE 5	8	OE 4
9	Thermistor 1	10	Thermistor 2
11	GND	12	GND
13	GND	14	GND
15	GND	16	GND
17	GND	18	GND
19	GND	20	OE 3
21	OE 2	22	OE 1
23	Vcc (logic)	24	Clock
25	Strobe	26	Data - Out
27	Vch	28	Vch
29	Vch	30	Vch



30 pin compatible connectors (to be fitted on the controller board)



Compatible connector suppliers and references: Molex 5597 3951 3304 straight connector

Molex 5597 3951 3303 bent connector
Stocko MZF 9390 60 3030 straight connector
Stocko MZF 8900 60 3030 bent connector

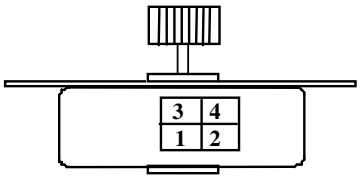
3.2 Paper Feed Motor (standard versions) Characteristics

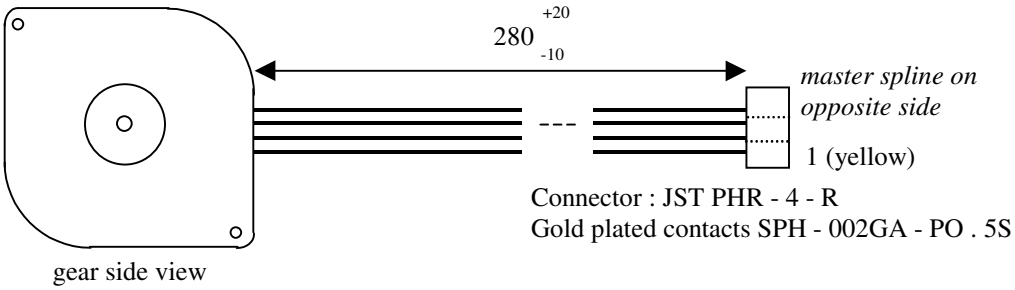
Motor for standard versions:

Recommended control voltage	24	VDC
Coil resistance	8	Ω
Number of phases	2 (Bipolar Chopper 2-2P)	
Paper feed for 1 motor step	0.125	mm
Step angle	7.5 (48 steps per revolution)	°
Recommended control current	500	mA/phase
Maximum starting frequency (with no load)	400	step/s
Maximum speed	1040	step/s
Maximum pull force	600	gr

3.2.1 Motor connections for standard versions

PIN n°	Wire color
1	yellow
2	orange
3	brown
4	black

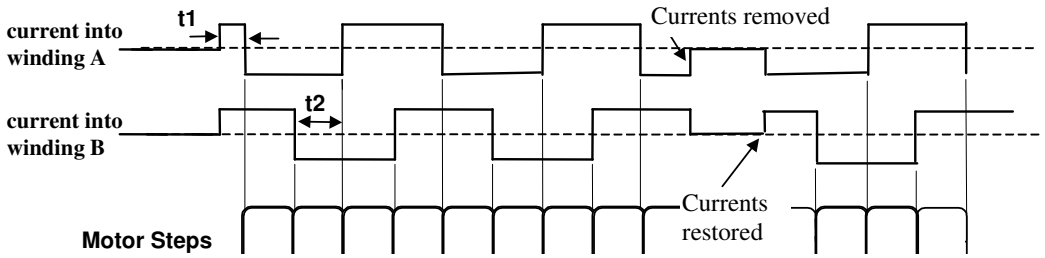




Corresponding contact to be set on the board: gold plated JST B4B-PH-K-G
tin plated JST B4B-PH-K

3.2.2 Induction sequence and timing for standard motor

	Colour			
Step	**BLACK**	**ORANGE**	**BROWN**	**YELLOW**
1	**+**	**+**	**-**	**-**
2	**-**	**+**	**+**	**-**
3	**-**	**-**	**+**	**+**
4	**+**	**-**	**-**	**+**



3.2.3 Acceleration curve for standard motor

The following table is an **example** of an acceleration curve that can be used to increase from the maximum starting frequency of motor to 130 mm/s. The curve may need to be modified, depending on the paper roll size and the bucket resistance.

This curve has been designed for a paper roll of 90 mm diameter, without axis.

step number	1	2	3	4	5	6	7	8
printing speed (mm/s)	31.25	52	62.5	69.3	71	72.6	89.25	91.9
motor speed (step/second)	250	416	500	555	568	581	714	735
step motor time (µs)	4000	2400	2000	1800	1760	1720	1400	1360

step number	9	10	11	12	13	14	15
printing speed (mm/s)	97.6	104.1	111.6	115.7	120.1	125	130
motor speed (step/second)	781	833	893	926	961	1000	1042
step motor time (µs)	1280	1200	1120	1080	1040	1000	960

It is also recommended to use this curve if lower speed is necessary or to re accelerate from medium speed.
This happens particularly when the dot line heating is divided into several dot groups (for consumption reasons or to avoid going over 60% of dots "on").

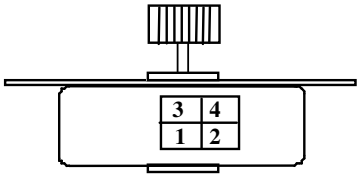
3.3 Paper Feed Motor (low noise versions) characteristics

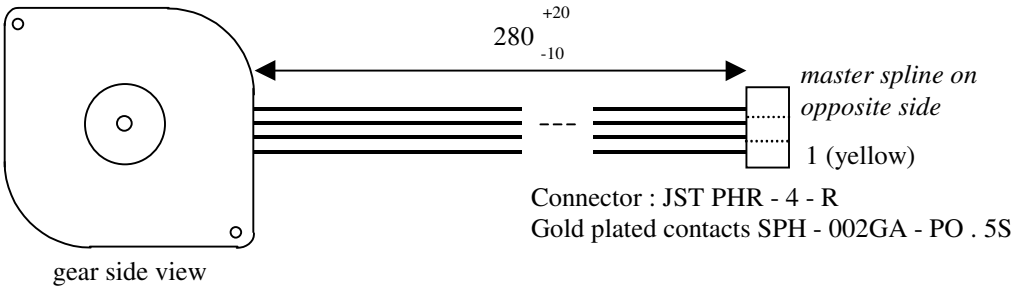
Motor for low noise versions:

Recommended control voltage	24	VDC
Coil Resistance	10	Ω
Number of phases	2 (Bipolar Chopper 2-2P)	
Paper feed for 1 motor step	0.125	mm
Step angle	3.75 (96 steps per revolution)	°
Recommended control current	500	mA/phase
Maximum starting frequency (with no load)	200	step/s
Maximum speed	1920	step/s
Maximum pull force	380	gr

3.3.1 Motor connections for low noise versions

PIN n°	Wire color
1	green
2	red
3	white
4	black

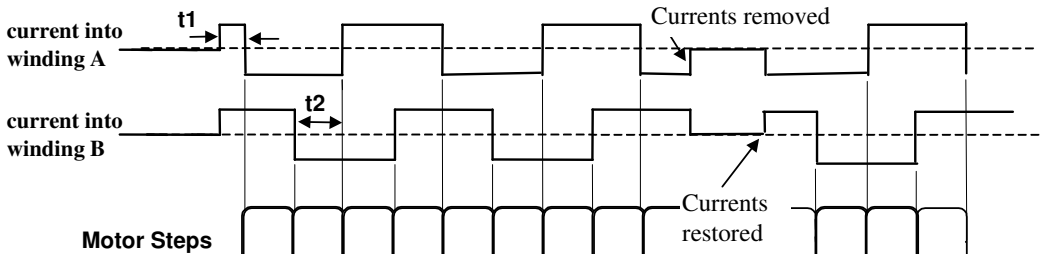




Corresponding contact to be set on the board: gold plated JST B4B-PH-K-G
tin plated JST B4B-PH-K

3.3.2 Induction sequence and timing for paper feed motors

	Colour			
Step	BLACK	RED	WHITE	GREEN
1	+	+	-	-
2	-	+	+	-
3	-	-	+	+
4	+	-	-	+



3.3.3 Acceleration curve for paper feed motors

The following table is an example of an acceleration curve that can be used to increase from the maximum starting frequency of motor to 130 mm/s. The curve may need to be modified, depending on the paper roll size and bucket resistance. This curve has been designed for a paper roll of 90mm diameter, without axis.

step number	1	2	3	4	5	6	7	8
printing speed (mm/s)	23	26	30	33	37	40	44	47
step motor time (µs)	5435	4726	4180	3748	3396	3105	2860	2650

step number	9	10	11	12	13	14	15	16
printing speed (mm/s)	51	54	58	61	64	68	71	75
step motor time (µs)	2470	2312	2173	2050	1940	1842	1753	1672

step number	17	18	19	20	21	22	23	24
printing speed (mm/s)	78	82	85	89	92	95	99	102
step motor time (µs)	1598	1530	1468	1411	1358	1309	1263	1221

step number	25	26	27	28	29	30	31	32
printing speed (mm/s)	106	109	113	116	120	123	127	130
step motor time (µs)	1181	1144	1109	1076	1045	1015	988	962

It is also recommended to use this curve if lower speed is necessary or to re accelerate from medium speed.
This happens particularly when the dot line heating is divided into several dot groups (for consumption reasons or to avoid going over 60% of dots "on").

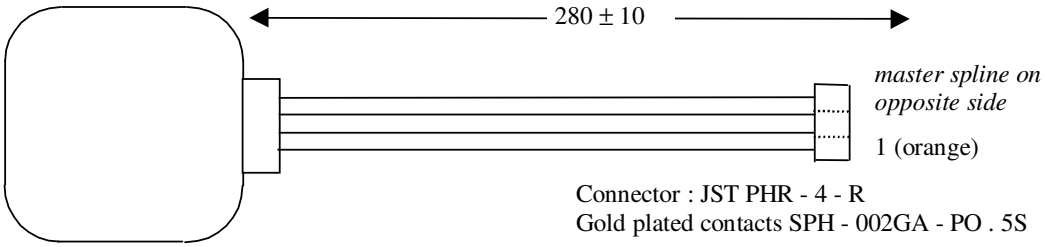
3.4 Cutter Motor Characteristics

Hybrid motor

Recommended control voltage	24	VDC
Coil Resistance	6.5 ± 10%	Ω
Number of phases	2	
Step angle	3.75 (96 steps per revolution)	°
Recommended control current	830	mA/phase

3.4.1 Motor connections

PIN n°	Wire color	Motor
1	orange	$\overline{B}$
2	blue	B
3	yellow	$\overline{A}$
4	red	A



Corresponding contact to be set on the board: gold plated JST B4B-PH-K-G
tin plated JST B4B-PH-K

3.4.2 Induction sequence and timing for cutter motor

	Colour			
Step	**RED**	**BLUE**	**YELLOW**	**ORANGE**
1	+	+	-	-
2	-	+	+	-
3	-	-	+	+
4	+	-	-	+

The timing diagram is the same as for the paper feed motor.

3.4.3 Motor Driving

A cut is obtained when the rotating blade comes into contact with the fixed blade.

The home position of the cutter rotating blade is detected by the switch.

To obtain a cut, the first motor phase must be set to "on" 40ms to avoid blade oscillations. The motor step time should then be 1.6 ms during the cut for standard paper thickness. Another 40ms at "on" should be set in the motor phase at the end of the cut.

***Note*:**

A full cut is obtained with approximately 300 motor steps (see chapter " Recommendations") For a partial cut (with versions that can achieve both partial and total cut): rotate for 135 steps forward and in reverse (see chapters "Recommendations" and "Product Codification").

A higher cutting speed can be attained with an acceleration curve applied to the motor (decreasing step time).

(See the following pages)

Ramp table

step number	0	1	2	3	4	5	6	7
printing speed (pps)	370	570	641	757	840	953	1136	1152

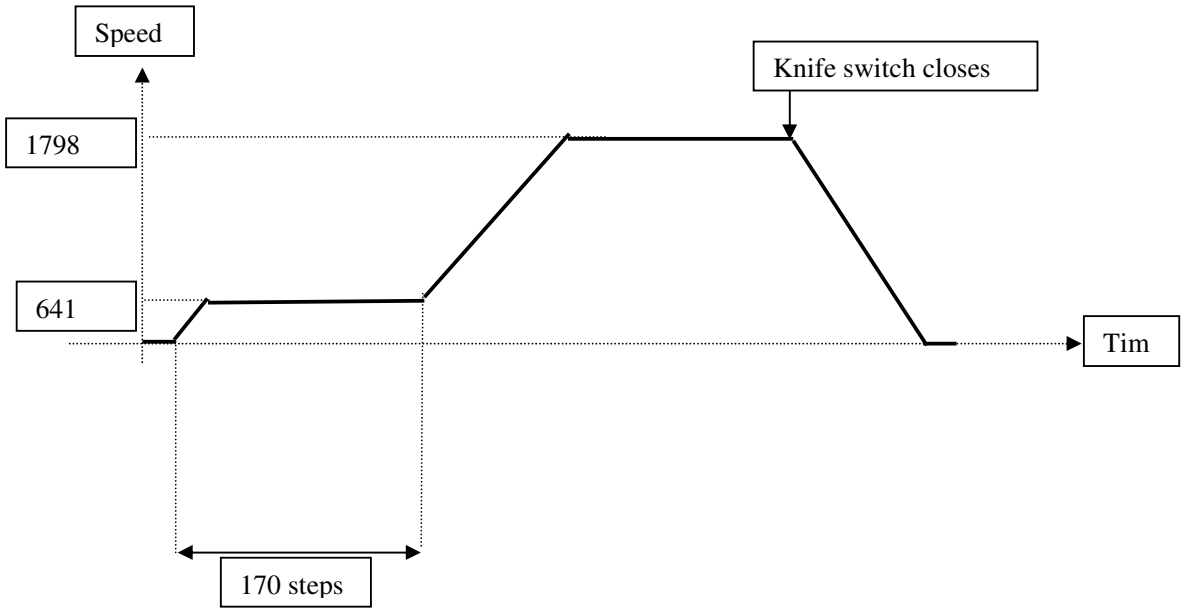
step number	8	9	10	11	12	13	14	15
printing speed (pps)	1315	1386	1526	1602	1612	1655	1689	1798

FULL CUT SEQUENCE - 60g/m^2 paper

A full cut cycle requires 7 phases:

*1 : turn on current in motor and wait 20ms
*2 : accelerate until following ramp table until speed = 641 pps
*3 : maintain speed = 641 pps until NbSteps = 140
*4 : accelerate following ramp table until speed = 1798 pps
*5 : maintain speed = 1798 pps until knife switch closes
*6 : decelerate following ramp table until knife motor fully stops
*7 : wait 20ms, then turn off current in motor

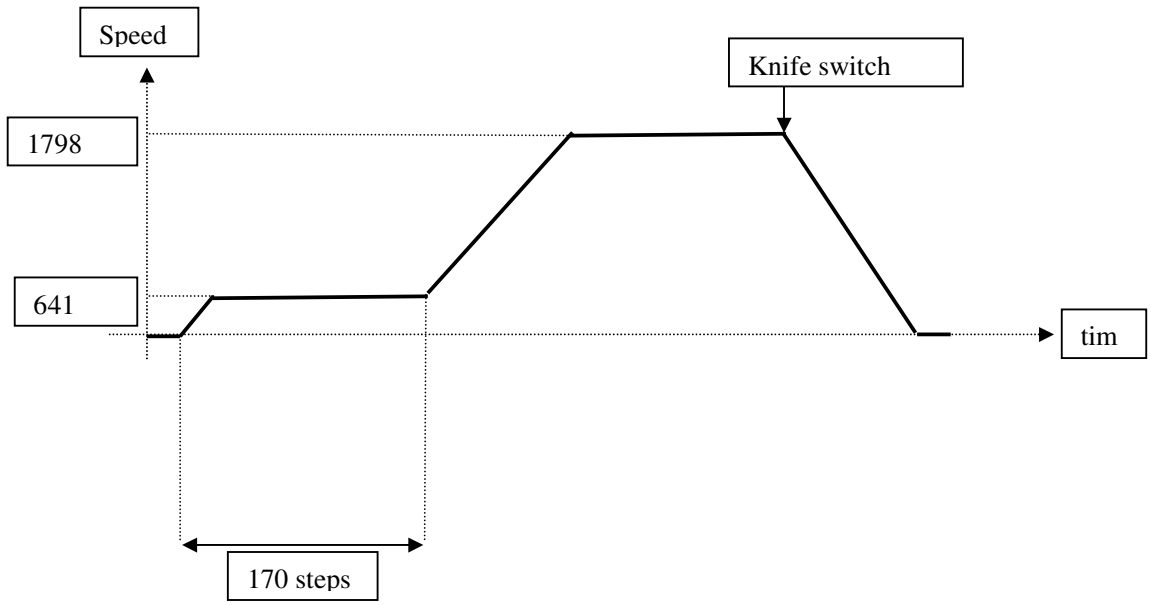
Total cycle time = **390 ms**,
Note however that the ticket is available before the end of the cycle, **300ms** after the start of the cycle.



FULL CUT SEQUENCE - 80g/m^2 paper

A full cut cycle requires 7 phases :

*1 : turn on current in motor and wait 20ms
*2 : accelerate until following ramp table until speed = 641 pps
*3 : maintain speed = 641 pps until NbSteps = 170
*4 : accelerate following ramp table until speed = 1798 pps
*5 : maintain speed = 1798 pps until knife switch closes
*6 : decelerate following ramp table until knife motor fully stops
*7 : wait 20ms, then turn off current in motor

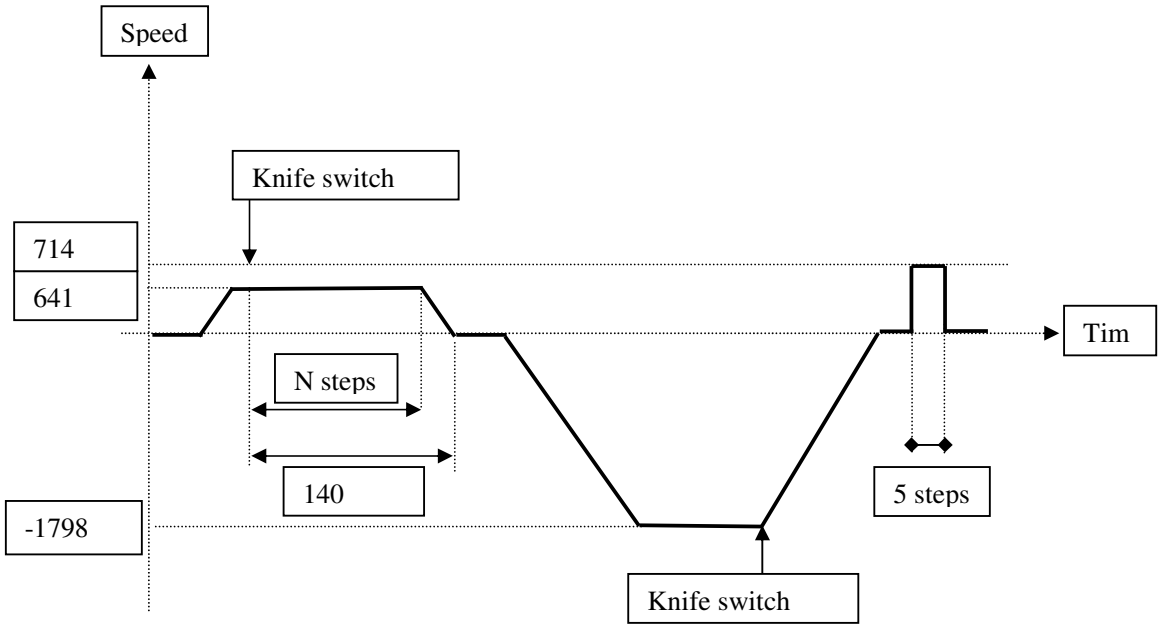


PARTIAL CUT SEQUENCE

A partial cut cycle requires 11 phases:

*1 : turn on current in motor and wait 20ms
*2 : accelerate following ramp table until speed = 641 pps
*3 : maintain speed = 641 pps for (140 – RampIndex) steps **after** knife switch opens
*4 : decelerate following ramp table until full stop
*5 : wait 80 ms
*6 : reverse motor direction and accelerate following ramp table until speed = - 1798 pps
*7 : maintain speed = -1798 pps until cover switch closes
*8 : decelerate following ramp table until full stop
*9 : wait 80 ms
*10 : run knife motor forward 5 steps at 714 pps
*11 : wait 20ms, then turn off current in motor

Total cycle time = **580 ms**



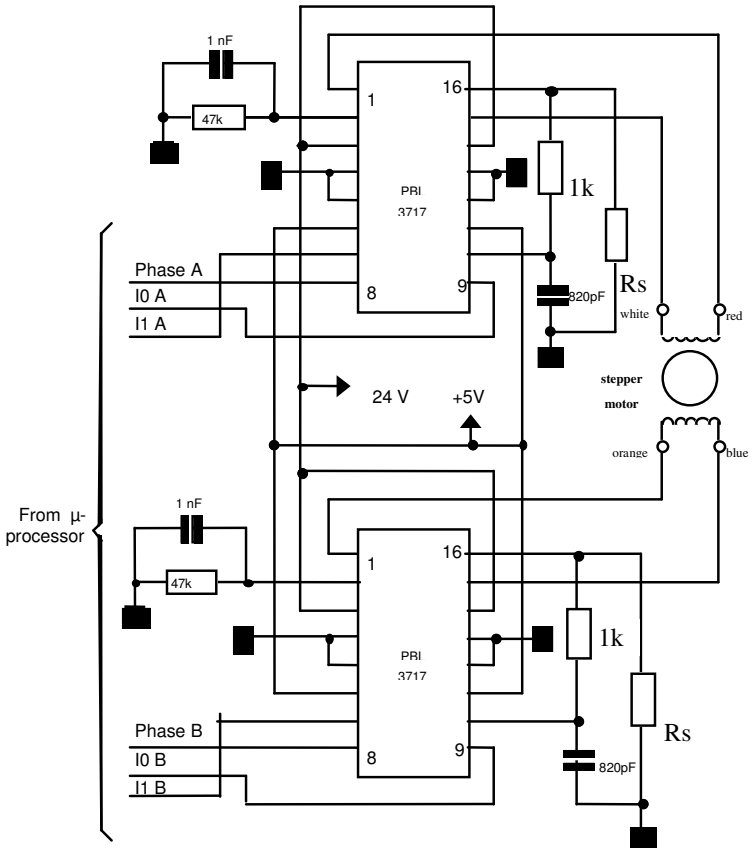
PARTIAL CUT SETTING

* In order to guarantee a constant partial cut tab (remaining paper width net cut) it may be necessary to adapt the nominal value of steps.

This parameter may vary from 125 to 145 steps according to the print mechanism.

3.5 Stepping Motors Electric Control

3.5.1 Driving schematic



Note 1:

with Rs : resistors of 0.82 ohm
with I0A and I0B = 0 and
I1A and I1B = 0 ⇒ I = 0,5 A (the required control current for paper feed).

Not 2:

with Rs : resistors of 0.5 ohm
with I0A and I0B = 0 and
I1A and I1B = 0 ⇒ I = 0,83 A (the required control current for cutter).

For other stepping motor control requirements, please contact Axiohm.

3.5.2 Driving cycle

There are 4 different conditions for the motor windings:

The sequence is:

$$AB \Longrightarrow \bar{A}B \Longrightarrow \overline{AB} \Longrightarrow A\bar{B} \Longrightarrow AB$$

Where

$\bar{A}B$ **stands for : A = positive**
B = negative

This electrical sequence corresponds to a sequence of 4 consecutive mechanical positions.
The sequence is repeated 12 times for each revolution (24 for cutter motor).

If the phase currents are switched to zero, the position in the sequence must be memorised.
When the winding currents are re-applied, the polarities corresponding to the last known position should be used.
This ensures that the motor will re-start correctly.

Once the initial winding currents have been applied, they must be maintained for a time **t1** (t1 > 2 ms).
Once this time has passed, the motor can be operated if the winding currents are changed in the usual manner.

To take-up the backlash in the gears, please operate the motor for 16 steps before printing.

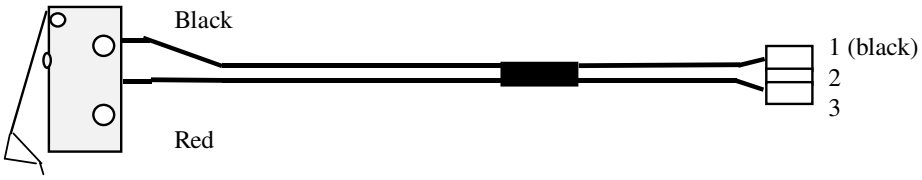
3.6 Sensors

On CA/CB / XA/XB sensors are used as follows :
End of Paper: switch or optical sensor.
The optical sensor is reflective (eight possible positions); it can be used for Top of form detection.
Cover Sensor: switch
Cutter Blade position: switch

3.6.1 End of paper switch characteristics

- contact resistance : 30 mΩ,
- maximum rating : 100 mA/250 V,
- operating temperature : -40° C +85° C.

3.6.2 End of paper switch connection



Leads length : 250 ±5 mm
Connector : JST PHR - 3 - Y (yellow) golden plated contacts SPH - 002GA - P0 . 5S

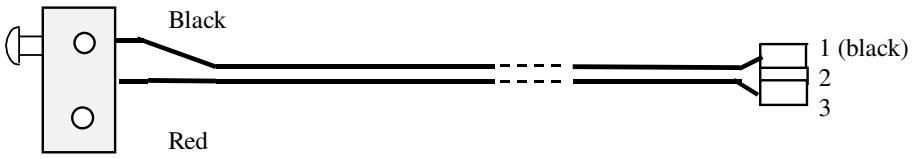
1 : Black
2 : Not Connected
3 : Red

Corresponding contact to be set on the board: gold plated JST B3B-PH-K-G
tin plated JST B3B-PH-K

Cover switch characteristics

- contact resistance : <150 mΩ,
- maximum rating : 10 mA/5 VDC,
- operating temperature : -40° C +85° C.

3.6.3 Cover switch connection



Leads length : 260 ±5 mm
Connector : JST PHR - 3 - BL (blue)
golden plated contacts
SPH - 002GA - P0 . 5S

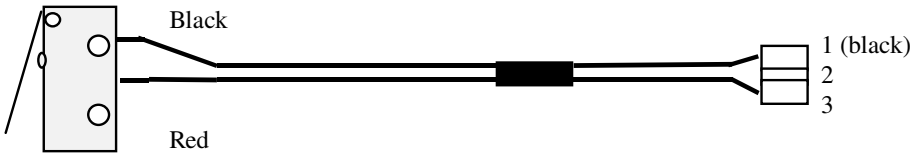
1 : Black
2 : Not Connected
3 : Red

Corresponding contact to be set on the board: same as end of paper switch

3.6.4 Cutter switch characteristics

- contact resistance : 30 mΩ,
- maximum rating : 100 mA/250 V,
- operating temperature : -40° C +120° C.

3.6.5 Cutter switch connection



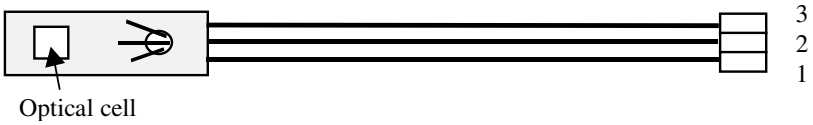
Leads length : 270 ±5 mm
Connector : JST PHR - 3 - BK (black)
golden plated contacts
SPH - 002GA - P0 . 5S

1 : Black
2 : Not Connected
3 : Red

Corresponding contact to be set on the board: same as end of paper switch

3.6.6 Optical sensors characteristics

Reflective sensor is described below.



Leads length : Different length will be available from 200 mm to 500 mm
Connector : JST PHR - 3 - BK (black) 1 : Black : Ground
golden plated contacts 2 : Orange : Diode command
SPH - 002GA - P0 . 5S 3 : Green : Transistor reception

Corresponding contact to be set on the board: same as end of paper switch

The optical cell is: Kodenshi SG105F
(see main characteristic on next page)

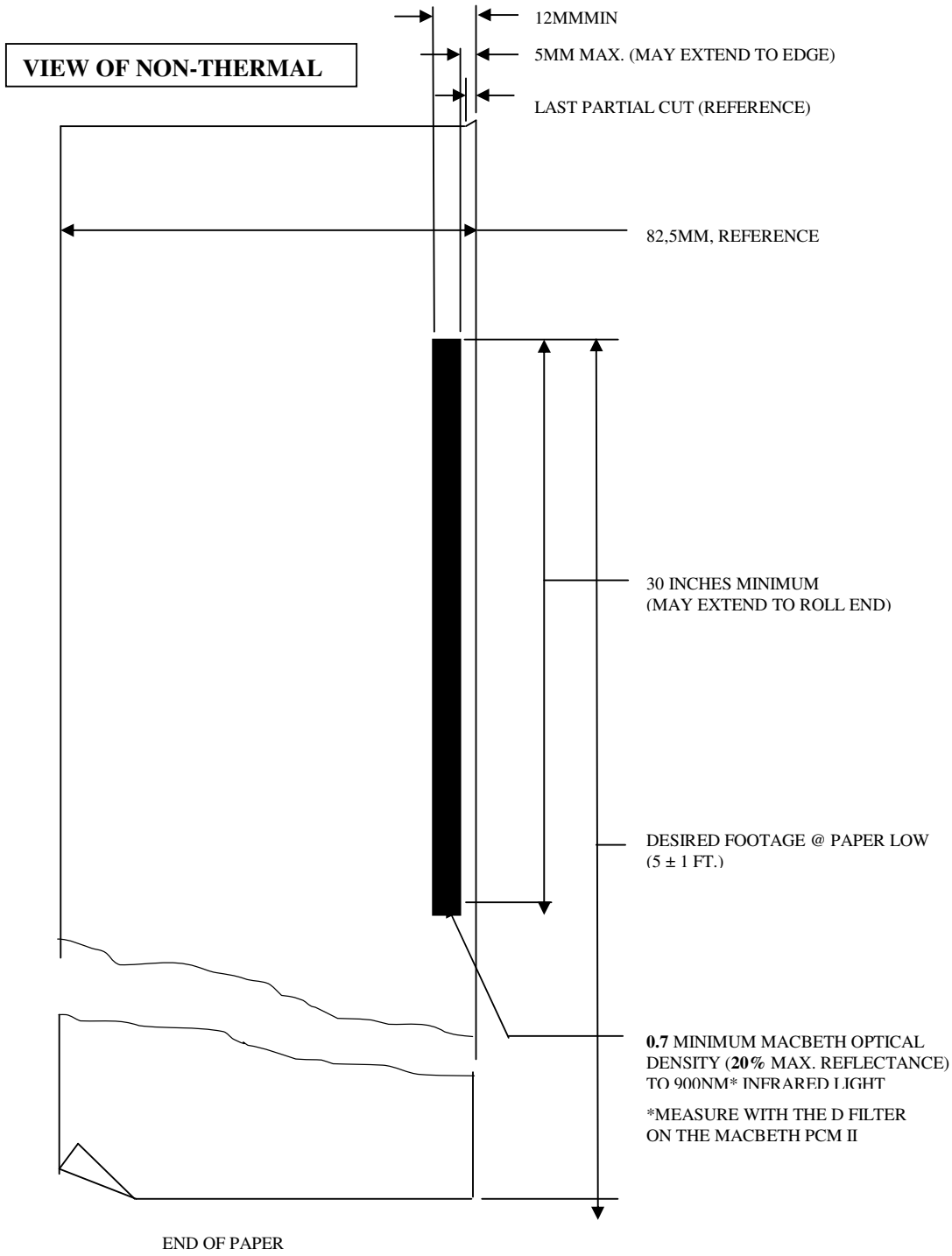
To use transmitive detection, two identical optical sensors can be placed face to face.
In this case the sensor cell will be the same as described but the connection has to be defined.

For Top of form detector :

It is recommended to have a 0.7 min. Macbeth optical density (20% max. reflectance) to 900NM* infrared light for the black mark on the paper.

* Use the D filter to measure with the Macbeth PCM II
See specifications in chapter 2.5 on Optical sensor position.

MACHINE READABLE END-OF-ROLL WARNING STRIPE



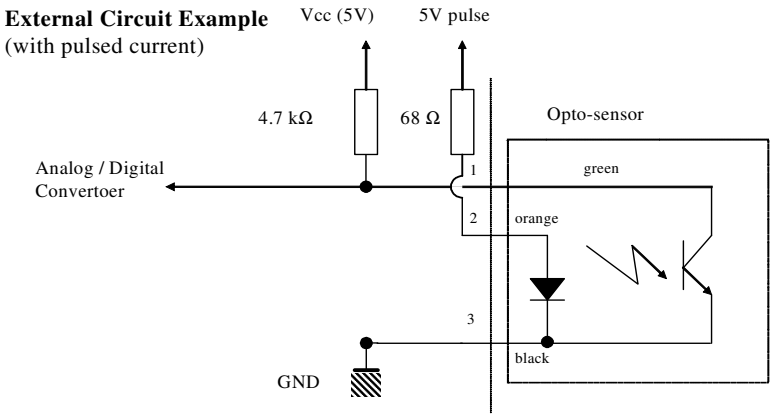
Absolute Maximum ratings

	SYMBOL	RATING	UNIT
LED			
Continuous Forward Current	**If**	**50**	**mA**
Pulsed forward current *	**IFP**	**1**	**A**
Reverse voltage	**VR**	**5**	**V**
Max. Power Dissipation at 25°C max	**P**	**75**	**mW**
PHOTO-TRANSISTOR			
Collector Emitter Voltage	**VCEO**	**30**	**V**
Collector Current	**IC**	**20**	**mA**
Collector Dissipation at 25°C max	**PC**	**50**	**Mw**

Note: Driving the sensor with pulse current allows to use higher current to improve paper detection.
*** (Time On, Time Off) T On = 100µs, T On + T Off = 10 ms**

Input/Output Conditions

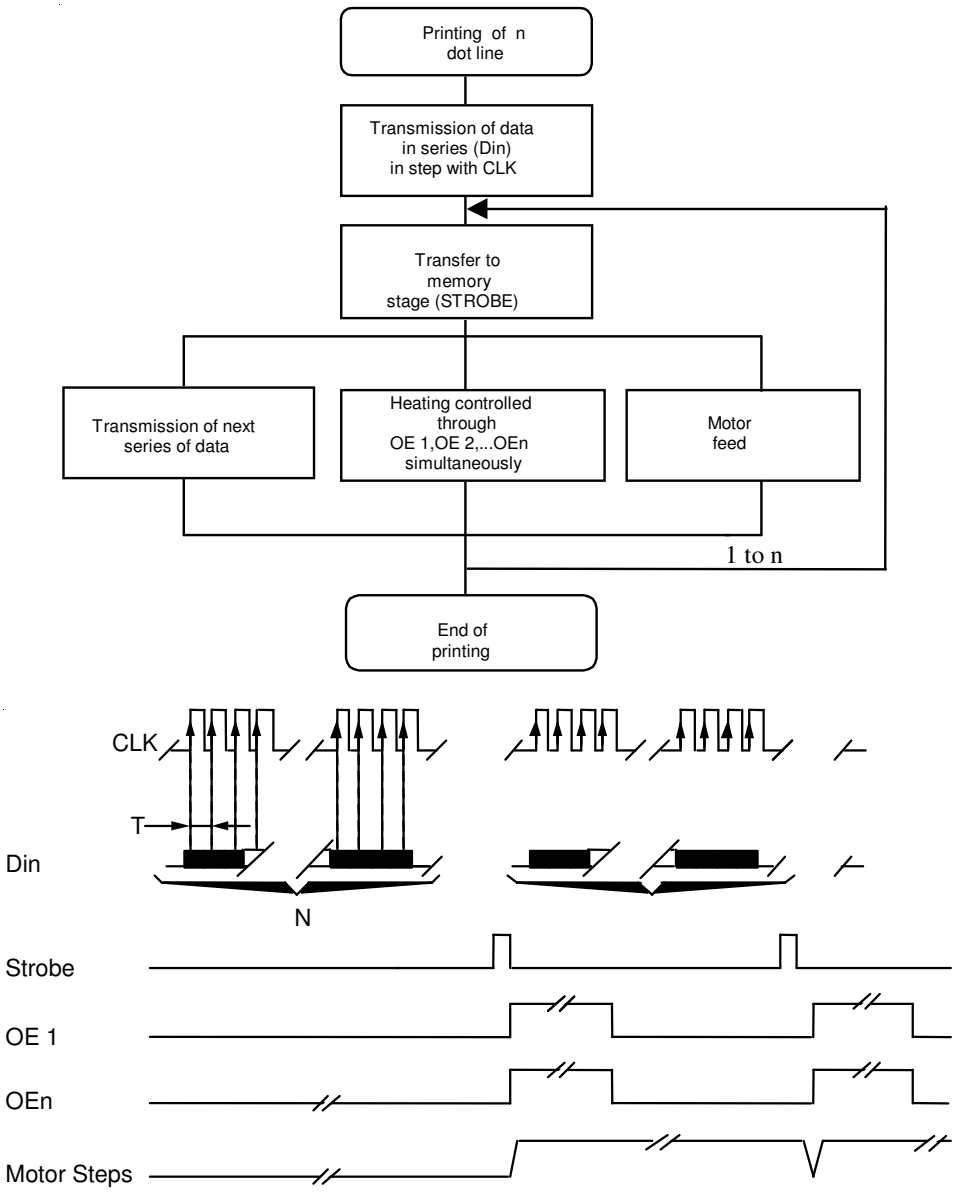
	SYMBOL	CONDITIONS	Min.	TYP.	Max.	UNIT
LED						
Forward voltage	**VF**	**IF=10 mA**			**1.3**	**V**
Reverse current	**IR**	**VR=5v**			**10**	**µA**
TRANSFER CHARAC.						
Collector dark current	**ICE0**	**VCE=10V**			**200**	**nA**
Light Current	**IL**	**VCE= 5V, IF=10mA**	**90**			**µA**
Leakage Current	**ICE0D**	**VCE= 5V, IF=10mA**			**200**	**nA**
Rise time	**tr**	**VCE= 2V, IC=100µA**		**30**		**µs**
Fall time	**tf**	**RL= 1kΩ**		**25**		**µs**
Peak wave length	**λp**			**940**		**nm**



4 PRINTER CONTROL TECHNICS

In order to operate the printer, we depict hereafter the mode that will allow driving the printer with maximum speed.

Mode: The paper feeds itself automatically during the heating cycle thereby permitting to achieve high speed (in this mode, it is recommended to use historical control).

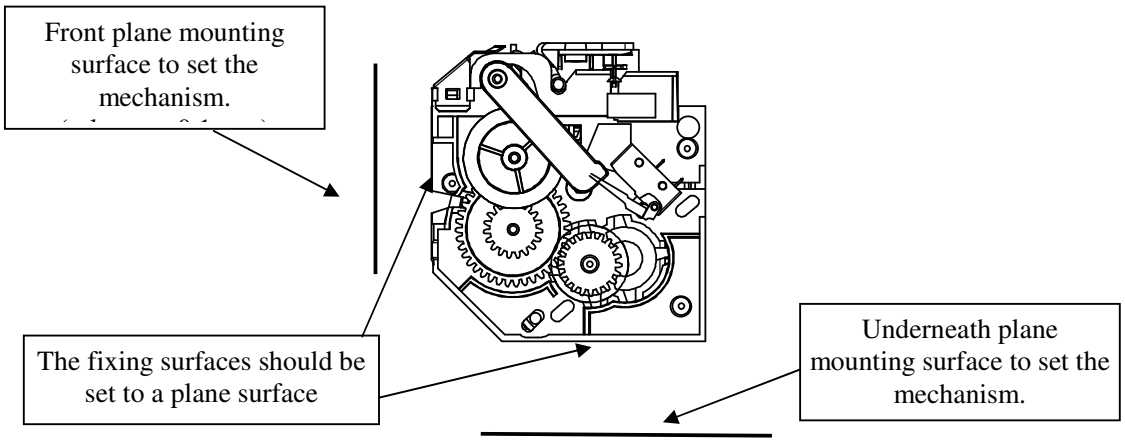


T : Clock frequency

5 RECOMMENDATIONS

5.1 Mechanical Recommendations

1 - Make sure the mechanism is fixed to a plane mounting surface as shown on next drawing. This is necessary whether the mechanism is mounted to its front or underneath surface.



2 - Never apply mechanical stress to the mechanism (other than the necessary stress to fix the mechanism on a plane surface as described above).
This could result in print-head misalignment and thus degrading the print quality.
Also this could change the angle between blades thus degrading cutting and cutter lifetime.

3 - The thermal print head must have 1 degree of freedom of movement. Never prevent the print head from pivoting on its axis.

5.2 Recommendations for Electronic

IMPORTANT: If the line of dots (Vch, 24 V) is supplied before the control logic (Vcc, 5V), resistor dots may be destroyed. Because the control logic has a random state, resistors might be heated for a longer period than the specified maximum burning out the heated resistor.
To avoid this, we recommend applying the heating voltage (Vch, 24V) after the logic supply voltage (Vcc, 5V). When first applying Vch, make sure the OEs level is 0 in order to avoid the dot heating before sending data.

The same precaution should be taken when shutting down. The supply voltage Vch must be switched off before the logic supply voltage Vcc. Care should be taken to allow enough time for residual capacitive charge to dissipate.

To reduce the peak current drawn from the power supply, it is recommended to use a storage capacitor of 1000 to 1200 µF/35V.

5.3 Recommendations for paper

- Use a paper classified with an AXIOHM Part number (or approved by Axiohm).
- Make sure the paper stock spool is free to turn.
- With the acceleration curve of the paper feed motor given in this manual, the paper feed motor can pull with a maximum force (see chart in chapters 3.2 and 3.3) without affecting the printing quality. For common rolls of paper (and on common supports) this force corresponds to a roll diameter of 115mm sliding in its bucket. Above this value (or if the bucket and paper path friction are high), use an axle to set the roll (maximum diameter 200mm). If bigger rolls are required contact your Axiohm representative: a specific mechanical design and/or a specific acceleration curve may be required, and the printing speed may be affected.
- The roll of paper **must** be exactly "**on line**" (perpendicular to the printer mechanism) and parallel to the paper inlet in order to avoid paper tracking. Paper inlet path must be designed to avoid obstacles on paper edges.
- The printer should not operate without paper or this will damage the surface of the rubber roller.
- Note that the sensitivity of the paper has a direct impact on the mechanism's performance (in terms of speed). Make sure the chosen paper corresponds to your needs.

5.4 Recommendation to drive cutter

Make sure your mechanism version is adapted to the required type of cut.

Depending on your mechanism (see your Axiohm representative about "Codification" description) the blades can achieve:
- total cut only,
- partial cut only,
- total and partial cut (in this case only, the software will determine the type of cut)

In case of paper jam between the blades, the cutter motor must be stopped. It is possible to prevent this jam, by counting the number of steps achieved by the stepper motor and comparing it to the standard number of steps for a cut.

5.5 Cleaning your printer

The CA/CB XA/XB printer mechanism is a high reliability unit, which requires very little maintenance, but can benefit from cleaning as follows.

Depending on the environment in which the printer is used, the printer can accumulate dust. Therefore it is necessary to clean it periodically in order to maintain good print quality.

The frequency of cleaning also depends on the environment and the use of the printer; but, the print head should be cleaned at least once a year, or up to one month in heavy duty applications.

The print head should always be cleaned immediately if the print becomes visibly fainter due to contamination of the print head.

Cleaning instructions:
Switch off printer. Never clean the head immediately after printing for the head may be hot.

Open the cover of the printer and remove the roll of paper roll.

Clean the heating dots of the head with a cotton stick containing a solvent alcohol (ethanol, methanol, or IPA), but do not touch the print head with your fingers.

Allow the solvent to dry.

Reload the paper and close the cover.

N.B.: AXIOHM can provide cleaning kits P/N: CK80000A

5.6 General Recommendations

- Ensure that there is adequate air circulation around the print head support/heat sink, for poor ventilation of the print head can degrade the print quality.
- Depending on the uses (high current set in the motor phases, integration of the mechanism in a very tight housing, high temperature), it may be necessary to set a duty cycle time to avoid overheating of the paper feed motor. In this case, tests must be made by the mechanism integrator. The temperature should not exceed 80°C on the motor frame.
- For Clamshell applications, the mechanism cannot be opened when the rotating blade is stopped in its cutting position. The rotating blade must be in such a position that the paper path is opened (cutter switch closed).
- Never open the mechanism while printing or when the cutter is operating.
- In order to prevent paper jam, it is recommended to advance the paper 1mm after the cut line when the printer is in stand by mode.
- **Duty cycle restrictions :**

  There are restrictions on the duty cycle because of the heat generated by the receipt thermal print head, when printing solid blocks (regardless of the length of the block in relation to the print line). The restrictions are ambient temperature, the percentage of time (measured over one minute) of continuous solid printing, and the amount of coverage. Another cause for duty cycle restriction is paper feed motor temperature increase due to continuous printing.

Allowable Duty Cycle (measured over one minute of continuous printing)

Amount of Solid Coverage	Ambient Temperature		
	25°C	35° C	50° C
20%	100% during the first 3 minutes of continuous printing. 50% after 3 minutes.	50%	20%
40%	50%	25%	10%
100%	20%	10%	4%

For reference:
- A typical receipt with text (contains some blank spaces) is approximately 12% dot coverage.
- A full line of text characters (every cell on the line has a character in it) is approximately 25% dot coverage.
- Graphics are approximately 40% dot coverage.
- Barcodes are approximately 50% dot coverage.
- A solid black line is 100% dot coverage.

6 APPENDICES

6.1 APPENDIX 1 : PRINT-HEAD THERMISTOR

GENERAL CHARACTERISTICS	
Maximum operating temperatures	**-50° C to + 400° C**
Rated resistance at 25° C	**Rn = 30 kΩ**
Tolerance for Rn	**5 %**
Thermal dissipation constant	**> 0.3 mW/°C**
Thermistor time constant (in air)	**t = 1.5 sec**

This thermistor has a rated value of 30 kΩ. Its resistance variation can be expressed as follows:

$R = Rn \exp B \left(\frac{1}{T} - \frac{1}{Tn}\right)$ where T is in Kelvin degrees (°K)

$B = 3950° K \pm 3\%$

Rn = reference value at temperature Tn (298° K)

Note: that printing should be stopped if the thermistor value goes over 60°C.

6.2 APPENDIX 2 : PAPER CHARACTERISTICS

6.2.1 Paper width dimensions

Paper roll width dimensions should meet the following specifications to ensure correct operation of the printer mechanism.

Product	Paper width	Tolerance
CAxx	80	± 0.5
XAxx	80	± 0.5
CBxx	82.5	± 0.3
XBxx	82.5	± 0.3

6.2.2 Recommended paper characteristics

Typical Properties of Appleton Optima T886-B

Topic	Value	Unit
Basis Weight	82.3 ± 4.1	g/m^2
Caliper	81.3 ± 7	Microns
Static temperature response for O.D. = 0.2	79.4 ± 5	°C
Static temperature response for O.D. = 1	93 ± 5	°C

(With this paper an average factor of 1.45 should be applied to the heating time given; this affects the printing speed as explained in the chapter 6.3 "Heating time calculations ")

Typical Properties of Appleton RESISTE 600-3.1

Properties	Value	Units	Test method
Basis weight	74.0 ± 3.7	g / m^2	ISO 536 (JIS P8124)
Caliper	79 ± 8	µm	ISO 534 (JIS P8124)
Brightness	82.0 min.	%	ISO 2470 (JIS P8123)
Smoothness	< 30	Sec	ISO 5627 (JIS P8119)
Image colour	Black	-	
Initial activation T°	72 ± 5	°C	O.D = 0.2
Effective activation T°	86 ± 5	°C	O.D = 1.0
Gurley Stiffness Nominal	50	mg	
Tear strength (CD)	54	g	

Typical Properties of Appleton RESISTE 650-3.2

Properties	Value	Units	Test method

Basis weight	81.4 ± 4.0	g / m^2	ISO 536 (JIS P8124)
Caliper	84 ± 8	µm	ISO 534 (JIS P8124)
Brightness	82	%	ISO 2470 (JIS P8123)
Smoothness	NA	Sec	ISO 5627 (JIS P8119)
Image colour	Black	-	
Initial activation T°	90 ± 5	°C	O.D.*) = 0.1
Effective activation T°	138 ± 5	°C	O.D.*) = 1.3
Gurley Stiffness Nominal	50	mg	
Tear strength (CD)	60	g	

Typical properties of Blumberg T49-32

Properties	Value	Units	Test method
Basis weight	88 ± 3.5	g / m^2	ISO 536 (JIS P8124)
Caliper	77 ± 3	µm	ISO 534 (JIS P8124)
Brightness	70 min.	%	ISO 2470 (JIS P8123)
Smoothness	>350	Sec	ISO 5627 (JIS P8119)
Image colour	black	-	
Initial activation T°	70 ± 5	°C	O.D.*) = 0.1
Effective activation T°	115 ± 5	°C	O.D.*) = 1.3
Tensile strength (CD)	> 2 min.	KN/m	ISO 1924 (JIS P8113)
Tear strength (CD)	> 300	mN	ISO 1924 (JIS P8116)

Typical Properties of Jujo AP62KJ-HR

Properties :	Value	Units	Test method
Basis weight	75 ± 5	g / m^2	SCAN-P6 / ISO 536
Thickness	82 ± 5	µm	SCAN-P7 / ISO 534
Brightness	80	% min.	ISO 2470
Smoothness	350	sec min.	TAPPI T 479 / ISO 5627
Image color	black	-	
Initial activation T°	80 ± 5	°C	O.D. = 0.2
Effective activation T°	110 ± 5	°C	O.D. = 1.2
Tensile strength (MD)	4.4 min	kN/m	SCAN-P38 / ISO 1924-2
Tear strength (MD)	330 min	mN	SCAN-P38 / ISO 1924-2

Typical Properties of Kanzaki F380 (used to achieve the heating timetable given in this manual):

Properties :	Value	Units	Test method
Basis weight	58 ± 5	g / m^2	ASTM D-646
Thickness	65 ± 5	µm	ASTM D-645
Brightness	77 ± 7	% min.	ASTM D-985
Smoothness	400 ± 150	sec min.	TAPPI T-479
Image color	black	-	
Initial activation T°	70 ± 5	°C	O.D. = 0.2

Effective activation T°	88 ± 5	℃	O.D. = 1
Tensile strength	1.2	kg CD min.	
Tear strength	20	g CD min.	
Moisture content	6.5 ± 1	%	ASTM D-644
Saturated density	1.05	- min.	

Typical Properties of Kanzaki P350 (the same heating time table can be used than for F380):

Topic	Value	Unit	Test Method
Basis Weight	54	g/m^2	TAPPI T-410
Caliper	58	Microns	TAPPI T-411
Brightness	84	%	TAPPI T-525
Smoothness	365	sec	TAPPI T-479
Image color	Black	-	-
Initial activation T°	70 ± 5	℃	O.D. = 0.2
Effective activation T°	85 ± 5	℃	O.D. = 0.8
Optimum activation T°	90 ± 5	℃	O.D. = 1.2

Typical Properties of Kanzaki Lotto 462

Topic	Value	Unit	Test Method
Basis Weight	83	g/m^2	TAPPI T-410
Caliper	83	Microns	TAPPI T-411
Brightness	85	%	TAPPI T-525
Smoothness	1500	sec	TAPPI T-479
Image color	Black	-	-
Initial activation T°	80 ± 5	℃	O.D. = 0.2
Effective activation T°	87 ± 5	℃	O.D. = 0.8
Optimum activation T°	100 ± 5	℃	O.D. = 1.2

Typical properties of Kanzaki Lotto 480

Properties	Value	Units	Test method
Basis weight	83.2	$g / m^{2\ avg}$	TAPPI T-410
Caliper	83.3	µm avg	TAPPI T-411
Brightness	89	% avg	TAPPI T-525
Smoothness	1500	Sec avg	TAPPI T-479
Image colour	Black	-	-
Initial activation T°	80 ± 5	℃	O.D. = 0.2
Effective activation T°	90 ± 5	℃	O.D. = 0.8
Optimum activation T°	100 ± 5	℃	O.D. = 1.2

Typical Properties of Kanzaki Lotto 482

Topic	Value	Unit	Test Method
Basis Weight	83.2	g/m^2	TAPPI T-410
Caliper	83.3	Microns	TAPPI T-411

Brightness	85	%	TAPPI T-525
Smoothness	1500	sec	TAPPI T-479
Image color	Black	-	-
Initial activation T°	80 ± 5	℃	O.D. = 0.2
Effective activation T°	87 ± 5	℃	O.D. = 0.8
Optimum activation T°	95 ± 5	℃	O.D. = 1.2

Typical Properties of Kanzan KLS 36

Topic	Value	Unit
Basis Weight	79 ± 8	g/m^2
Caliper	79 ± 8	Microns
Smoothness	500 min.	sec
Brightness	70 min	%
Static temperature response for O.D. = 0.2	75 ± 5	℃
Static temperature response for O.D. = 1	91 ± 5	℃

Typical properties of Kanzan KLS 46

Properties	Value	Units	Test method
Basis weight	78 ± 8	g / m^2	ISO 536
Caliper	84 ± 8	µm	ISO 534
Brightness	Min. 75	%	ISO 2470
Smoothness	Min. 500	Sec	ISO 5627
Image colour	Black	-	-
Initial activation T°	70 ± 5	℃	-
Effective activation T°	80 ± 5	℃	-
Tensile strength (CD)	>3.7/>2.2	KN/m	ISO 1924/0
Tear strength (CD)	>400/>400	mN	ISO 1974

Typical properties of Kanzan KP 460

Properties	Value	Units	Test method
Basis weight	74 ± 8	g / m^2	ISO 536
Caliper	82 ± 8	µm	ISO 534
Brightness	Min. 75	%	ISO 2470
Smoothness	Min. 250	Sec	ISO 5627
Image colour	Black	-	-
Initial activation T°	70 ± 5	℃	-
Effective activation T°	90 ± 5	℃	-
Tensile strength (MD/CD)	>3.7/>2.2	KN/m	ISO 1924/0
Tear strength (MD/CD)	>400/>400	mN	ISO 1974

Typical properties of Mitsubishi TP 8065

Properties	Value	Units	Test method
Basis weight	82 ± 5	g / m^2	ISO 536
Caliper	87 ± 5	µm	ISO 534
Brightness (R457)	92 ± 4	%	ISO 2469
Smoothness (Bekk)	750 ± 250	Sec	ISO 5627
Image colour	Black	-	-
Initial activation T°	85	°C	-
Effective activation T°	100	°C	-
Tensile strength (CD)	80 ± 10	N/15mm	ISO 1924/1
Tear strength (CD)	40 ± 10	N/15mm	ISO 1924/1

Typical properties of Mitsubishi TP 8067

Properties	Value	Units	Test method
Basis weight	82 ± 5	g / m^2	ISO 536
Caliper	84 ± 5	µm	ISO 534
Brightness (R457)	94 ± 4	%	ISO 2469
Smoothness (Bekk)	>600	Sec	ISO 5627
Image colour	Black	-	-
Initial activation T°	85	°C	-
Effective activation T°	105	°C	-
Tensile strength (mD)	90 ± 10	N/15mm	ISO 1924/1
Tear strength (CD)	45 ± 8	N/15mm	ISO 1924/1

Typical properties of Mitsubishi TP 8075

Properties	Value	Units	Test method
Basis weight	82 ± 5	g / m^2	ISO 536
Caliper	87 ± 5	µm	ISO 534
Brightness (R457)	92 ± 4	%	ISO 2469
Smoothness (Bekk)	750 ± 250	Sec	ISO 5627
Image colour	Black	-	-
Initial activation T°	80	°C	-
Effective activation T°	95	°C	-
Tensile strength (CD)	90 ± 10	N/15mm	ISO 1924/1
Tear strength (CD)	45 ± 8	N/15mm	ISO 1924/1

Typical properties of Mitsubishi TL 3000

Properties	Value	Units	Test method
Basis weight	82 ± 5	g / m^2	ISO 536
Caliper	84 ± 5	µm	ISO 534
Brightness (R457)	94 ± 4	%	ISO 2469
Smoothness (Bekk)	>600	Sec	ISO 5627
Image colour	Black	-	-
Initial activation T°	85	°C	-

Effective activation T°	105	℃	-
Tensile strength (CD)	90 ± 10	N/15mm	ISO 1924/1
Tear strength (CD)	45 ± 8	N/15mm	ISO 1924/1

Typical properties of Mitsubishi TL 4000

Properties	Value	Units	Test method
Basis weight	84 ± 5	g / m^2	ISO 536
Caliper	87 ± 5	µm	ISO 534
Brightness (R457)	92 ± 4	%	ISO 2469
Smoothness (Bekk)	750 ± 250	Sec	ISO 5627
Image colour	Black	-	-
Initial activation T°	85	℃	-
Effective activation T°	100	℃	-
Tensile strength (CD)	80 ± 10	N/15mm	ISO 1924/1
Tear strength (CD)	40 ± 10	N/15mm	ISO 1924/1

Typical properties of Ricoh LSB130

Properties	Value	Units	Test method
Basis weight	80 ± 7	g / m^2	ISO 536 (JIS P8124)
Thickness	78 ± 9	µm	ISO 534 (JIS P8124)
Brightness	70 min.	%	ISO 2470 (JIS P8123)
Smoothness	200 min.	Sec	ISO 5627 (JIS P8119)
Image colour	black	-	
Initial activation T°	70 ± 5	℃	O.D.*) = 0.1
Effective activation T°	110 ± 5	℃	O.D.*) = 1.3
Tensile strength (CD)	2.5 min.	Kgf / 15 mm	ISO 1924 (JIS P8113)
Tear strength (CD)	35 min.	gf	ISO 1974 (JIS P8116)

Typical properties of Ricoh 135LB-1

Properties	Value	Units	Test method
Basis weight	75 ± 7	g / m^2	ISO 536 (JIS P8124)
Thickness	81 ± 9	µm	ISO 534 (JIS P8124)
Brightness	NA	%	ISO 2470 (JIS P8123)
Smoothness	1000 min.	Sec	ISO 5627 (JIS P8119)
Image colour	black	-	
Initial activation T°	NA	℃	O.D.*) = 0.1
Effective activation T°	NA	℃	O.D.*) = 1.3

Tensile strength (CD)	24.5 min.	N	ISO 1924 (JIS P8113)
Tear strength (CD)	0.34 min.	N	ISO 1974 (JIS P8116)

Typical properties of Sihl PrintTherm 80 P 7 CS

Properties	Value	Units	Test method
Basis weight	82 ± 8	g / m^2	ISO 536
Caliper	83 ± 8	µm	ISO 534
Brightness	> 75	%	ISO 2470
Smoothness	> 500	Sec	ISO 5627
Image colour	Black	-	-
Initial activation T°	78	°C	-
Effective activation T°	105	°C	-

* Refer to chapter "Cleaning your printer".

6.3 APPENDIX 3 : HEATING TIME CALCULATION

6.3.1 Real heating times

Heating time versus voltage and temperature:

E0 =	0,5175
COEFA =	0,51048
COEFB =	0,88634
COEFC =	-0,008
COEFD =	1,18489
RHEAD =	776
VCE =	0,95

PAPER TYPE = RICOH LSB130

Applied Energy @ 24,2V, 24°C = 0,62 mJ

Tb = 0,7 x (COEFA x ln(4,0) + COEFB)
Tb = 1,1158

Recommended Step Volt = 0.4 V
Recommended Step Temp = 2.18 °C

<u>Heating Time :</u>
Tch = RHEAD x E0 x Tb x (COEFC x Temp + COEFD) / ((Voltage-VCE) x (Voltage-VCE))

6.3.2 Heating times approximation

See the chart below for a heating time approximation by factor.

The rank of the head must be recognised by the software. This can be done by switches on the user's circuits, for example.

The values of V and T are measured.
Compute the position of tch in the table from V, T and Rmean.
Get the value of tch at this position, and apply the corresponding factor to find the required heating time.

Heating time = tch (obtained as described above) × factor

Rank	A / D	B / C / E
Resistance (Ω)	776 ± 6%	824 ± 6% or 950 ± 3%
Factor	1	1.06

6.3.3 History control

The history coefficient depends on the speed (explained below).
It gives the reduction (in %) of the TCH (nominal heating time), which has to be applied on a dot previously heated (on N-1 or N-2 dot line).

Paper feed motor control parameters:

Min Speed =	23	mm/sec
Max Speed =	130	mm/sec
Ramp Size =	32	

Speed = MIN_SPEED + (MAX_SPEED - MIN_SPEED) x Index / (RAMP_SIZE-1)

History control :

$$Tb = 0,7 \times (COEFA \times \ln(4,0) + COEFB)$$

Tb = 1,1158

TbTmp = 0,7 x (COEFA x ln(StepTime/1000) + COEFB)

HistTmp = 110 x (Tb-TbTmp) / Tb

if (HistTmp < 0) HistCoef = 0 else HistCoef = HistTmp

Index	Step Time (µs)	Speed (mm/sec)	History Coef (%)
0	5435	23	0
1	4726	26	0
2	4180	30	0
3	3748	33	2
4	3396	37	6
5	3105	40	9
6	2860	44	12
7	2650	47	14
8	2470	51	17
9	2312	54	19
10	2173	58	21
11	2050	61	24
12	1940	64	25
13	1842	68	27
14	1753	71	29
15	1672	75	31
16	1598	78	32
17	1530	82	34
18	1468	85	35
19	1411	89	37
20	1358	92	38
21	1309	95	39
22	1263	99	41
23	1221	102	42
24	1181	106	43
25	1144	109	44
26	1109	113	45
27	1076	116	46
28	1045	120	47
29	1015	123	48
30	988	127	49
31	962	130	50

History control				
Raster (N)	1	1	1	1
Raster (N-1)	0	0	1	1
Raster (N-2)	0	1	0	1
HistoryEn	0	1	1	1

Actual heating time
=
TCH x (1 - HistoryCoef x HistoryEn)

6.4 APPENDIX 4 : HEATING TIME (CLASS A or D)

The heating timetable is presented on the following page *(given for paper: RICOH LSB 130)*
The print-head resistance to obtain this table was 776 Ω.
The timetable gives the required heating time, giving the necessary energy to obtain an optical density of 1.2.

The heating time must always be shorter than the motor cycle time.

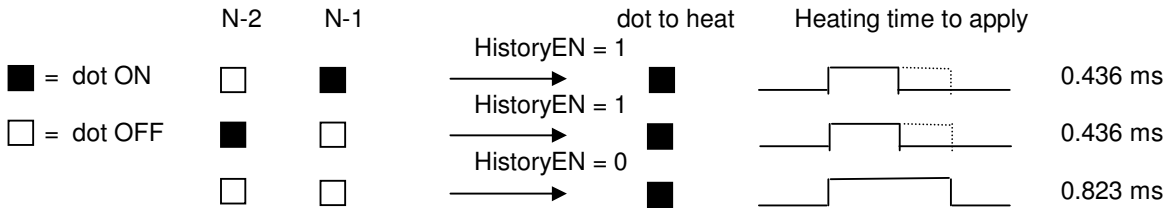
How to use the heating timetable?
The heating time can be controlled either with or without historical control as described here after.

Without historical control:
- Take the indicated heating time from the timetable (definition of voltage and temperature) and apply the reduction due to the speed (HistoryCoef). All the dots will be heated with this heating time.
- We do not take into account the history control (⇒ History EN always = 1).
- At high speed, printing quality for isolated dots might be affected with this method.

> ***Example***: at 120mm/s, 24°C and 24,2 volts
> TCH = 823 µs (from the table)
> Actual heating time = 823 (1-47 % x 1)
> Actual heating time = 436 µs
> In this mode only one serialisation of data is necessary for one dot line.

With historical control:
- In this mode, the actual heating time is different depending on if the dots have been previously heated or not. (History EN = 1 or 0)
- This method gives the best printing quality.
- With this mode, two serialisation data are necessary for one dot line.
- The first one will be all the data, and the second one will be only the dots not heated previously on lines (N-1) and (N-2).

> ***Example***: at 120 mm/s, 24°C and 24,2 volts:



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Heating time table

TCH (µs)		VOLTAGE (V)															
		21,0	21,4	21,8	22,2	22,6	23,0	23,4	23,8	24,2	24,6	25,0	25,4	25,8	26,2	26,6	27,0
TEMP (°C)	0,0	1321	1270	1221	1176	1133	1092	1053	1017	982	949	918	888	860	833	807	782
	2,2	1301	1251	1203	1158	1116	1076	1038	1002	968	935	904	875	847	820	795	771
	4,4	1281	1232	1185	1141	1099	1060	1022	987	953	921	891	862	834	808	783	759
	6,5	1263	1214	1168	1124	1083	1044	1007	972	939	908	878	849	822	796	772	748
	8,7	1243	1195	1150	1107	1066	1028	992	957	924	893	864	836	809	784	760	736
	10,9	1224	1176	1131	1089	1049	1012	976	942	910	879	850	823	797	771	748	725
	13,1	1204	1157	1113	1072	1033	995	960	927	895	865	837	810	784	759	736	713
	15,2	1185	1139	1096	1055	1016	980	945	913	881	852	824	797	772	747	724	702
	17,4	1166	1120	1078	1038	1000	964	930	897	867	838	810	784	759	735	712	690
	19,6	1146	1102	1060	1020	983	947	914	882	852	824	796	771	746	723	700	679
	21,8	1126	1083	1042	1003	966	931	898	867	838	810	783	757	733	710	688	667
	24,0	1107	1064	1023	985	949	915	883	852	823	795	769	744	720	698	676	656
	26,1	1088	1046	1006	969	933	900	868	838	809	782	756	732	708	686	665	645
	28,3	1068	1027	988	951	916	883	852	823	795	768	743	718	696	674	653	633
	30,5	1049	1008	970	934	899	867	837	807	780	754	729	705	683	661	641	621
	32,7	1029	989	952	916	883	851	821	792	765	740	715	692	670	649	629	610
	34,8	1010	971	934	900	867	835	806	778	751	726	702	679	658	637	617	599
	37,0	991	952	916	882	850	819	790	763	737	712	689	666	645	625	605	587
	39,2	971	934	898	865	833	803	775	748	722	698	675	653	632	612	593	575
	41,4	952	915	880	847	816	787	759	733	708	684	661	640	619	600	581	564
	43,5	933	897	863	830	800	771	744	718	694	670	648	627	607	588	570	553
	45,7	913	878	844	813	783	755	728	703	679	656	635	614	594	576	558	541
	47,9	894	859	826	796	766	739	713	688	665	642	621	601	582	563	546	529
	50,1	874	840	808	778	750	723	697	673	650	628	607	588	569	551	534	518
	52,3	854	821	790	761	733	706	681	658	635	614	594	575	556	539	522	506
	54,4	836	803	773	744	717	691	667	643	621	601	581	562	544	527	511	495
	56,6	816	784	755	726	700	675	651	628	607	586	567	549	531	515	499	483
	58,8	796	766	736	709	683	658	635	613	592	572	554	536	518	502	487	472
	61,0	777	747	718	692	666	642	620	598	578	558	540	522	506	490	475	460
	63,1	758	729	701	675	650	627	605	584	564	545	527	510	493	478	463	449
	65,3	738	710	683	657	633	611	589	569	549	531	513	497	481	466	451	437
	67,5	719	691	665	640	616	594	573	553	535	517	500	483	468	453	439	426