



THERMAL PRINTER COMPONENTS

KAONFP50 PRINTER MECHANISM SERIES

USER MANUAL

Reference **3109306 Issue A**
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EVOLUTIONS

Date	Issue	Modifications
01/2007	Z	Creation
03/2007	A	Addition of information regarding the Tear Bar

IMPORTANT

**This manual contains the basic instructions for printer operation.
Read it carefully before printer use, paying special attention
to the "Recommendations" section.**

CONTENTS

1	UNPACKING.....	5
2	OVERVIEW.....	5
3	MECHANICAL SPECIFICATIONS	7
3.1	<i>General Description.....</i>	<i>7</i>
3.2	<i>External Dimensions</i>	<i>7</i>
3.3	<i>Fixing Elements.....</i>	<i>11</i>
3.3.1	Screw Mounting:	11
3.3.2	Clip Mounting:.....	11
	<i>Flatness support</i>	<i>11</i>
3.4	<i>Flex Cable Position.....</i>	<i>12</i>
3.5	<i>Cover Integration.....</i>	<i>12</i>
3.5.1	Informations for Cover Dimensioning.....	12
3.5.2	Hinge Positioning	15
3.6	<i>Useful Measurements</i>	<i>15</i>
4	ELECTRICAL SPECIFICATIONS.....	18
4.1	<i>Nominal Power Supply.....</i>	<i>18</i>
4.2	<i>Nominal Consumption of Printer.....</i>	<i>18</i>
4.3	<i>Description of Print Head</i>	<i>18</i>
4.3.1	Function of 64 bit LSI Drivers Chart and Operation	19
4.3.2	Electrical Specifications of 64-BIT LSI Driver	21
4.3.3	<i>Print Head Connection</i>	<i>23</i>
4.4	<i>Bipolar Stepping Motor</i>	<i>24</i>
4.4.1	<i>Characteristics.....</i>	<i>24</i>
4.4.2	<i>Motor Connection.....</i>	<i>24</i>
4.4.3	Induction Sequence and Timing (paper feed).....	25
4.4.4	<i>Printing Mode.....</i>	<i>25</i>
4.5	<i>Sensor Specifications.....</i>	<i>26</i>
4.5.1	<i>End of Paper Opto-sensor</i>	<i>26</i>
4.5.2	<i>Recommended Use for Opto-sensor</i>	<i>27</i>
5	PRINTER CONTROL TECHNIQUES	28
5.1	<i>Mode 1.....</i>	<i>28</i>
5.2	<i>Mode 2.....</i>	<i>30</i>
5.3	<i>Mode 3.....</i>	<i>31</i>
6	RECOMMENDATIONS	32
6.1	<i>Mechanical Recommendations</i>	<i>32</i>
6.2	<i>Electrical Recommendations.....</i>	<i>34</i>

6.3	<i>Motor Driving Recommendations</i>	34
7	PAPER SUPPLIERS	34
8	HEATING TIME TABLE	35
8.1	<i>Real Heating Times</i>	35
8.2	<i>Acceleration curve</i>	36
8.3	<i>Heating Time Table</i>	36

1 UNPACKING

Printer mechanisms are packaged in an antistatic molded plate.
Observe precautions by handling mechanisms in electrostatic protected areas.

2 OVERVIEW

This printer is designed for the use of a clamshell cover, a latch if required, and an optional tear bar.

SUMMARY OF PRINTER SPECIFICATIONS

ITEM	VALUE	UNITS
Print method	Static thermal dot line printing	-
Print width	48	mm
Maximum print speed	see "heating time": depends on voltage, temperature and control mode	mm/sec
Paper loading	Clamshell	-
Paper width	58	mm
Maximum paper thickness	60	g/m ²
Recommended paper	/ JUJO AF50KSE3	-
Number of resistor dots	384	-
Maximum number of dots energized simultaneously	128*	-
Resolution	8	dots/mm
Paper feed pitch	2	motor steps
	0.125	mm
Head temperature detection	By thermistor	-
Out of paper detection	By opto-sensor	-
Maximum size for the roll paper	58	mm
Specified standards	UL60950-1:2003; CSA C22.2 N°60950-1-03; CB according to IEC 60950-1:2001; ROHS	

SUMMARY OF PRINTER SPECIFICATIONS (continued)

ITEM	VALUE	UNITS
Maximum duty cycle (1 sec “on” max)	See duty cycle table below	%
Storage temperature range	- 25 to + 70	°C
Operating temperature range	0 to +50	°C
Relative humidity (<i>operating</i>)	10 to 90	%
Operating voltage range VDD (<i>logic</i>)	2.7 to 5.5	V DC
Operating voltage range Vch (<i>dot</i>)	4 to 8.5	V DC
Energy Supply	0.23	MJ/dot
Current consumption: Vch (at nominal value: 5V)	29	mA per resistor dot «on»
Current consumption: Icc max at value : 5V	54	mA
Current consumption: Stepping motor (at nominal value)	500	mA per activated phase
Electrical life time**	1. 10 ⁸	pulses
Mechanical life time **	50	km
Over all dimensions ***:	Height	15,2
	Width	70
	Depth	33
Weight	40	g

* The printing density variation may become significant when the number of dots energized simultaneously becomes greater than 64. Print head is allowed to have 4.0A maximum.

** **Per AXIOHM standard test conditions (which are mainly: 5V, ≈ 25 °C, dot printing duty cycle = 30%)**

***: *Note: general tolerances ±0.2 (when no other is specified)*

Conditions	Duty cycle: ton/ton+toff
25 °C 5.2 V	98.33% for 65°C max on motor
25 °C 7.2 V	63.38%
25 °C 8.5 V	39.24%
50 °C 5.2 V	94.80% max 73°C!
50 °C 7.2 V	51.50%
50 °C 8.5 V	32.96%

3 MECHANICAL SPECIFICATIONS

3.1 General Description

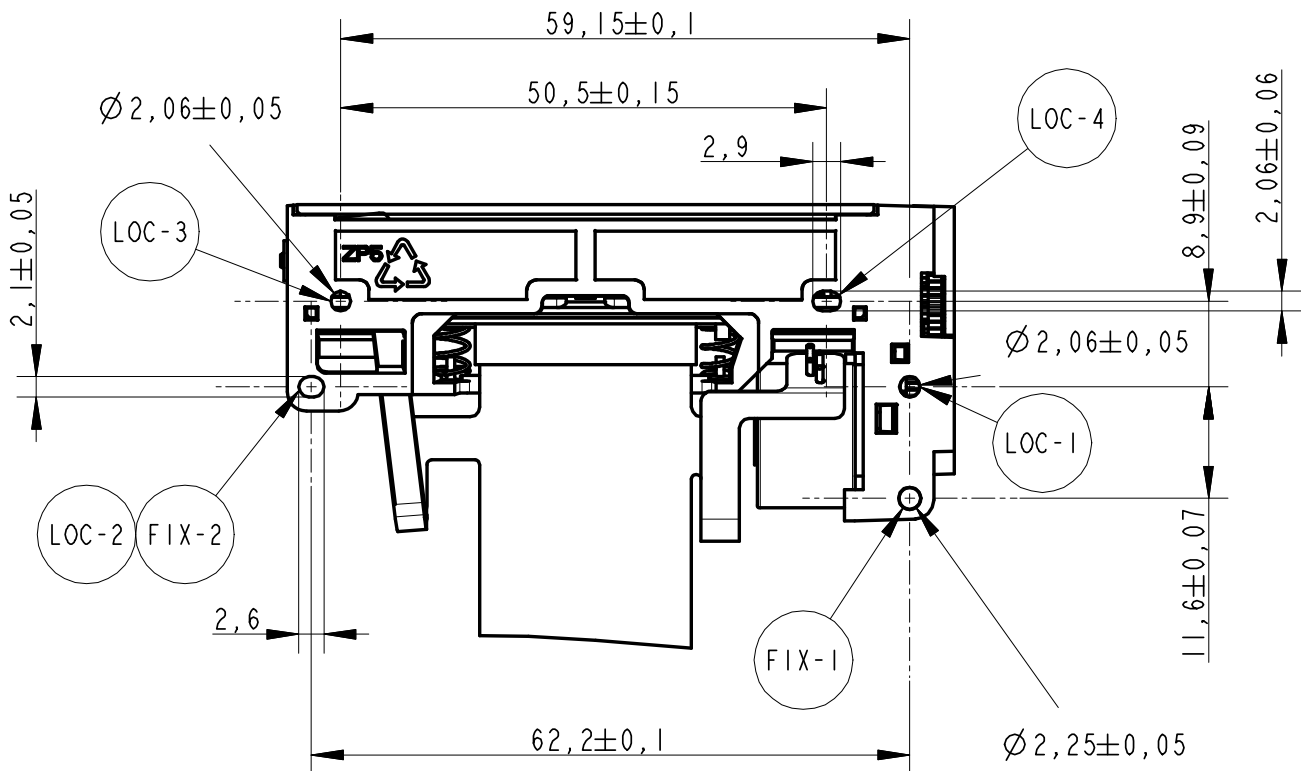
This mechanism consists of:

- Metal chassis
- Stepper motor
- Gears train
- Print head module with flex cable and opto sensor
- Platen roller with two platen bearings

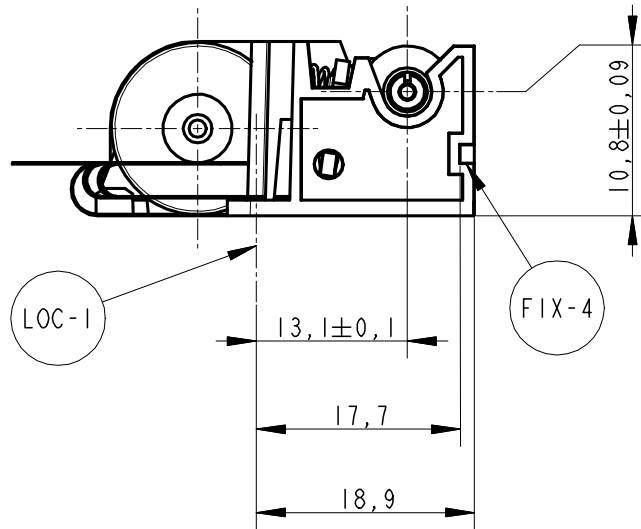
3.2 External Dimensions

LOC: Locating Points

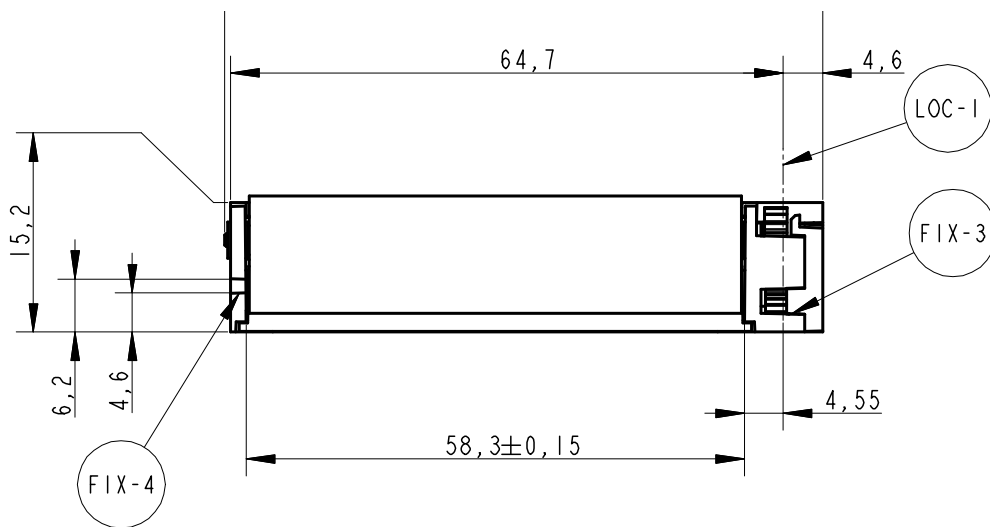
- **UNDERSIDE VIEW**



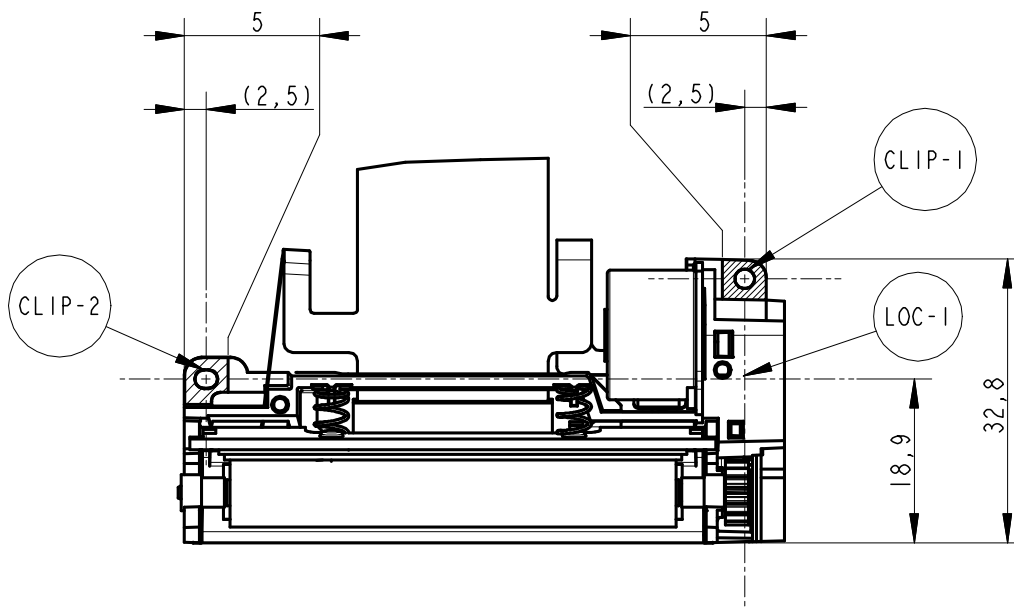
Mechanical views (continued)



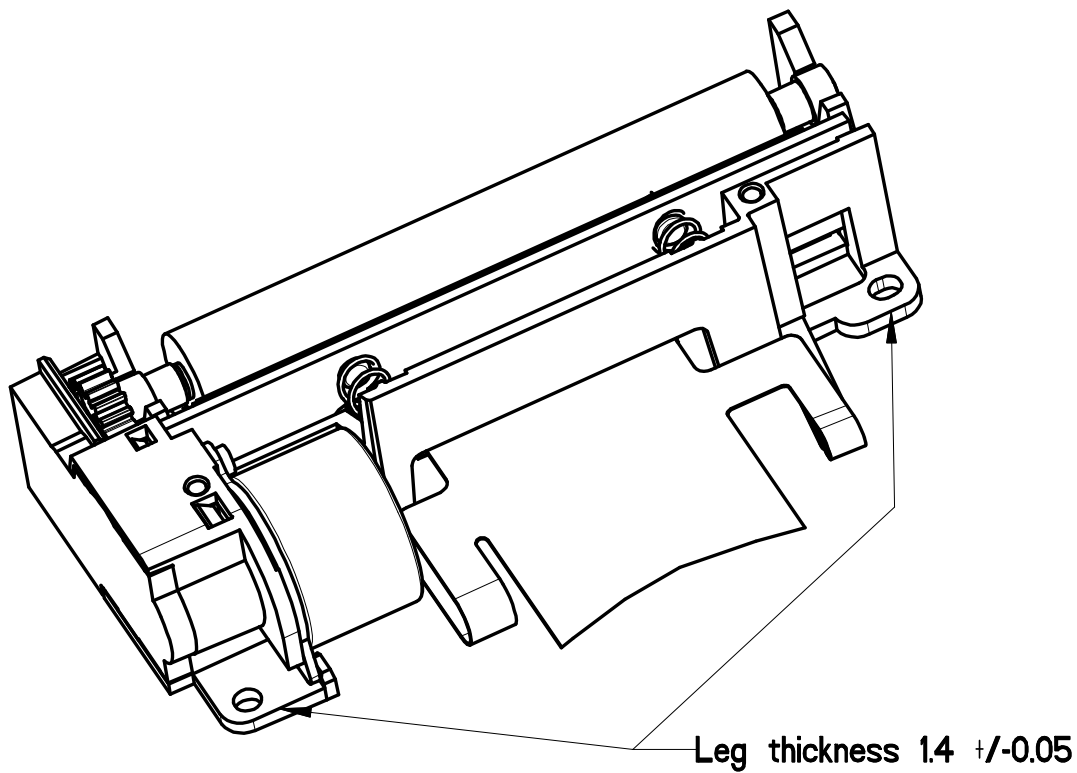
- **FRONT VIEW**

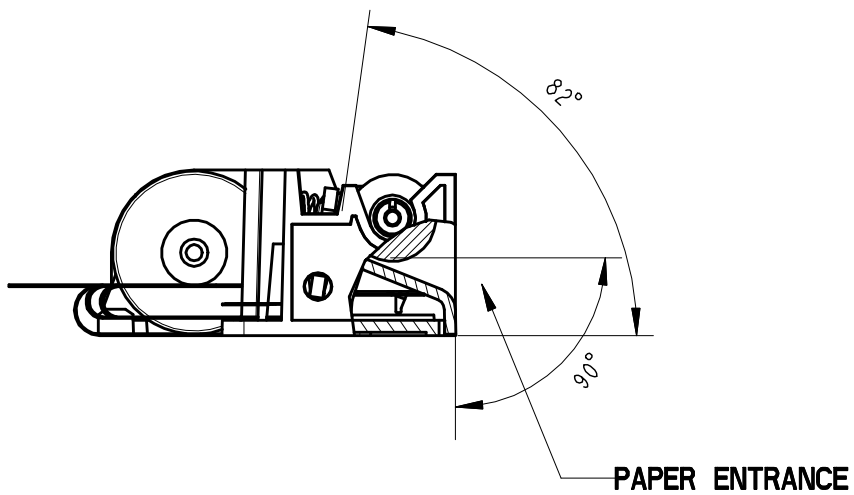
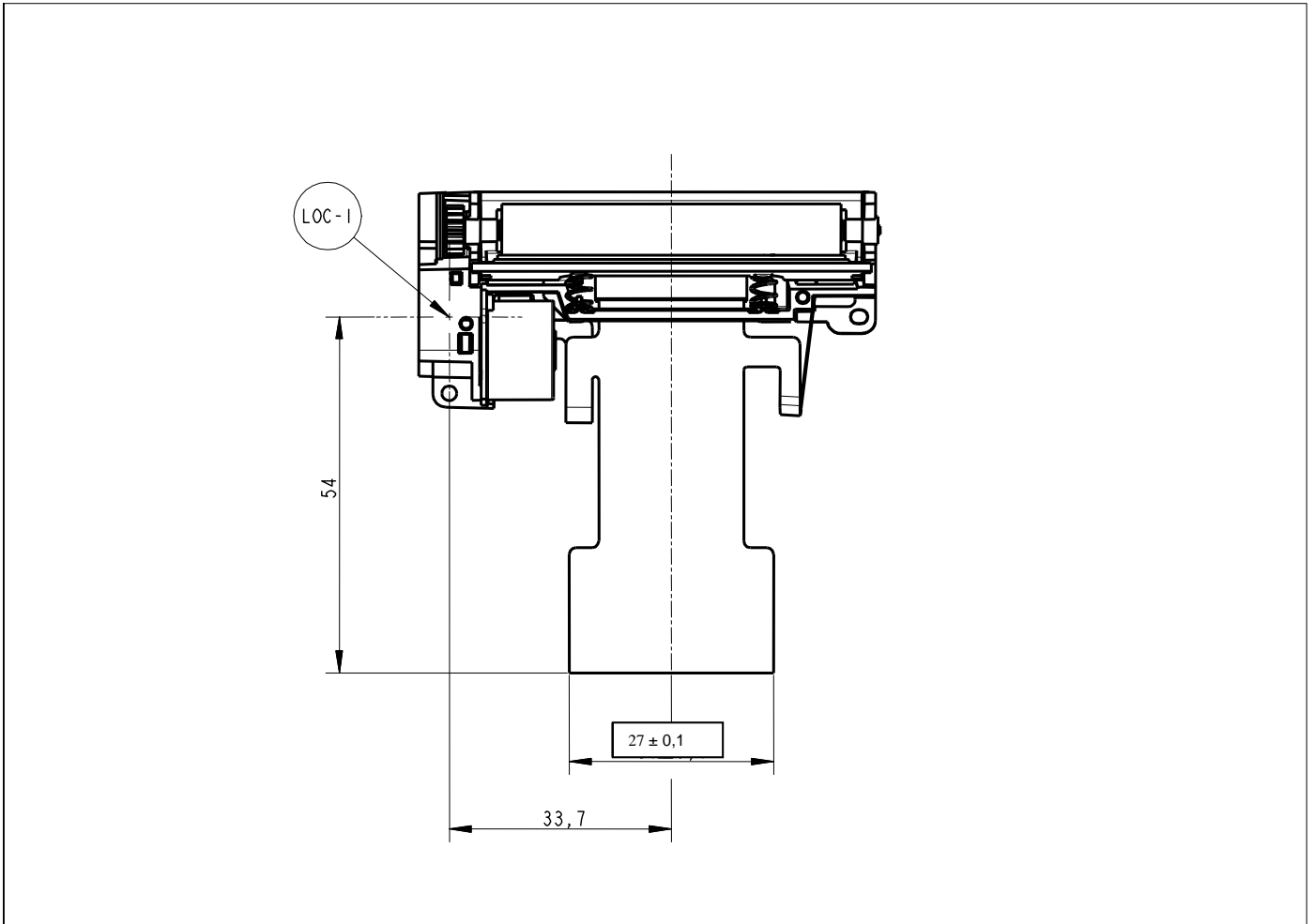


- **TOP VIEW**



- DIMENSION BACK VIEW





The printed ticket exits at 82° in comparison to the mounting plane. The paper entrance into the mechanism can be made according to the area names “Paper Entrance”.

3.3 Fixing Elements

3.3.1 Screw Mounting:

There are two possible ways to mount the printer "KAON"

a) Positioning by locating axis LOC-1 $\varnothing 2.06\text{mm}$.

The rear fixing is done with 2 screws $\varnothing 2\text{ MAX}$ in holes reference FIX-1 and FIX-2.

The front fixing is done by a hook positioned in FIX-3 (see diagrams following pages).

b) Positioning by locating axis LOC-1 $\varnothing 2.06\text{mm}$ and a oblong hole LOC-4 $\varnothing 2.06\text{mm}$.

The rear fixing is done with 2 screws $\varnothing 2\text{ MAX}$ in holes reference FIX-1 and FIX-2.

The front fixing is done by a hook positioned in FIX-3 (see diagrams following pages).

For options a) and b) here above, there is an optional fixing by hook in FIX-4.

3.3.2 Clip Mounting:

The positioning may be done in 2 ways:

a) By locating axis LOC-1 $\varnothing 2.06\text{mm}$ and oblong hole LOC-2 $\varnothing 2.1\text{mm}$.

b) By locating axis LOC-3 $\varnothing 2.06\text{mm}$ and oblong hole LOC-4 $\varnothing 2.06\text{mm}$.

Rear fixing is done with 2 clipping points CLIP-1 and CLIP-2.

Front fixing is done with a hook positioned in FIX-3, an optional hook can be used in FIX-4 (see diagrams following pages).

Flatness support

The mechanism "KAON" should not be put under constraint when integrated in the terminal. For this reason, the support on which it is fixed must have 0,1mm flatness.

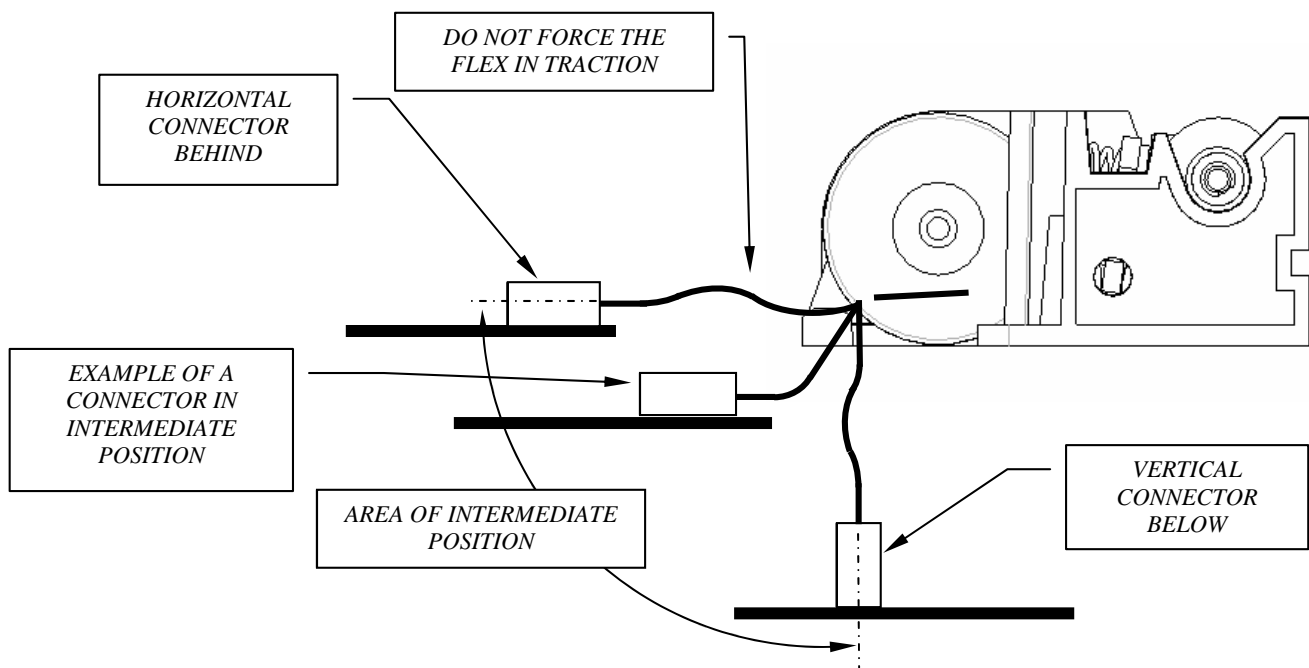
The mechanism mounting plane in the terminal may be tilted from horizontal to ease the integration.

3.4 Flex Cable Position

Connections are done via unique flex cable containing all electrical functions of the printer (thermal head, motor and opto-sensor).

The flex cable is to be connected on a 30 pin connector with a 1mm pitch. The connector can be located at the back of the printer (horizontal connection) or below the printer (vertical connection) or in another intermediate position.

WARNING: Do not put any constraint on the flex cable during integration or while connecting.



3.5 Cover Integration

The "KAON" printer can only accept paper loading by "CLAMSHELL" cover design. **The printer is not designed for the "self-load". We do not recommend the introduction of the paper by this method.**

The cover is not provided by Axiohm.

3.5.1 Informations for Cover Dimensioning

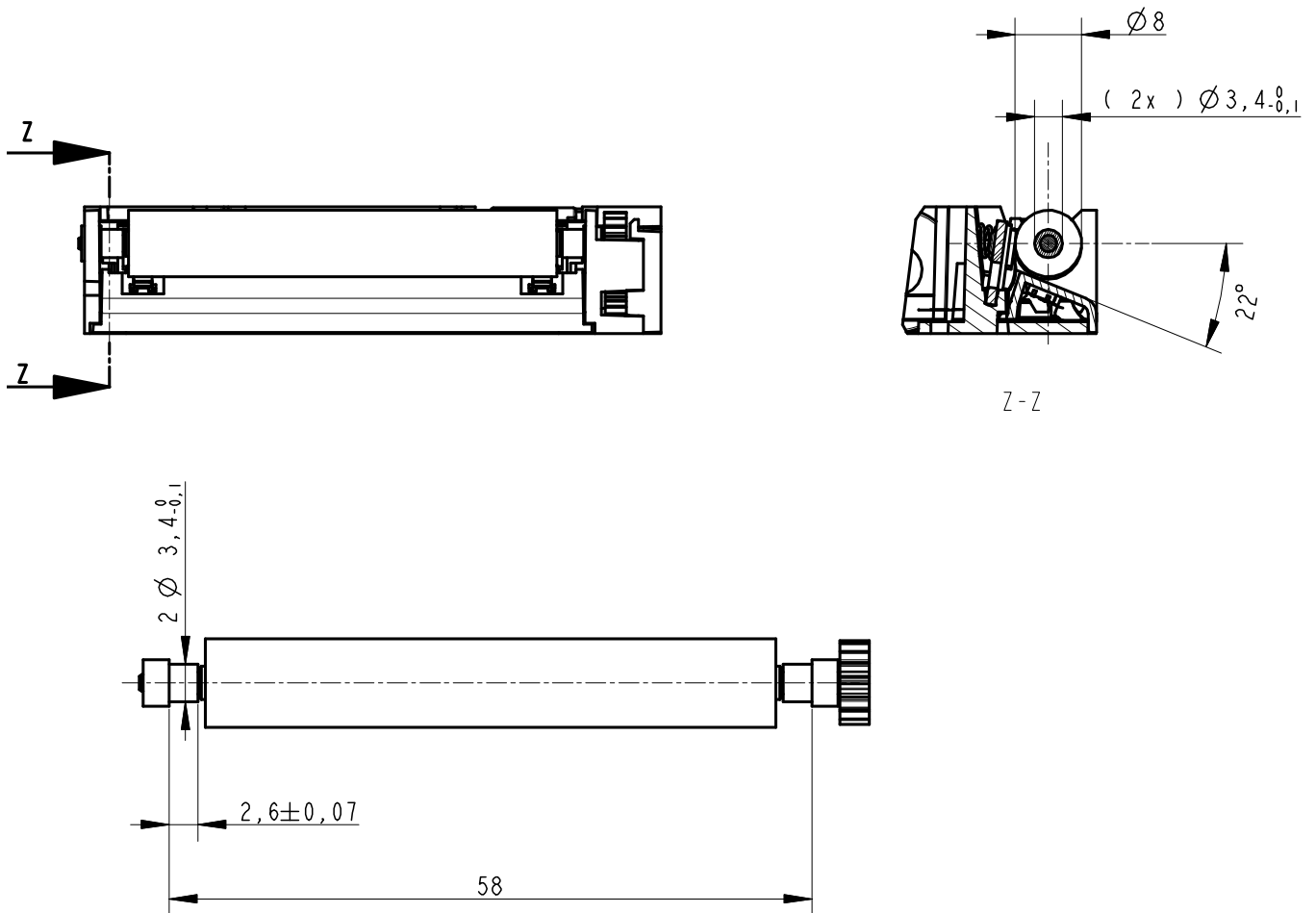
The cover (design) is essential. It must maintain the platen and allow the positioning within the printer frame ensuring good rotation of the cover itself. To do that, we made space in the platen axle (see drawings).

These drawings show the dimensions necessary for cover design.

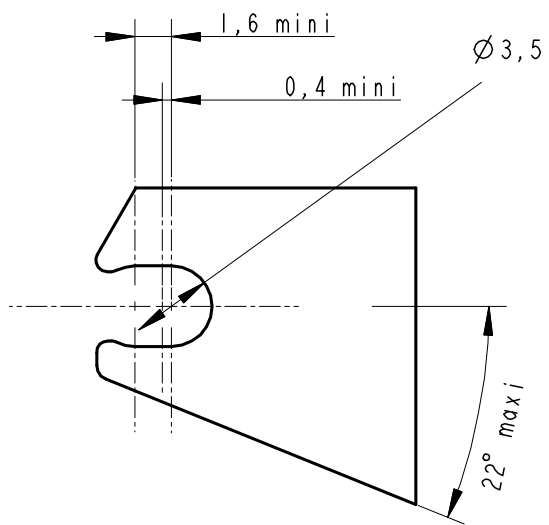
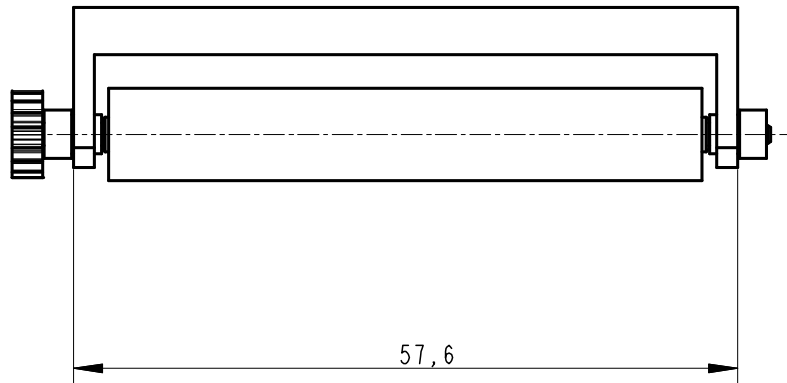
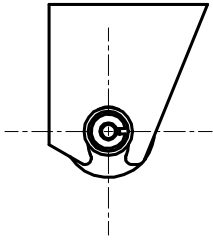
The length of the flexible part of the platen is a maximum of 51.6mm. The 58.15mm dimension is the minimum width allowed in the frame where the cover slides in.

Forks maintaining the platen must have a maximum thickness of 2.5mm and be made out of a material that supports clipping on axis, by deforming oblong shape and opening or closing effort of the cover that we measured to be of 7N average

For the cover, we recommend oblong shapes (see below drawings) to maintain the platen axle. These shapes must allow a light translation of the platen in the cover in order not to force positioning and rotating of the platen when cover is closed.



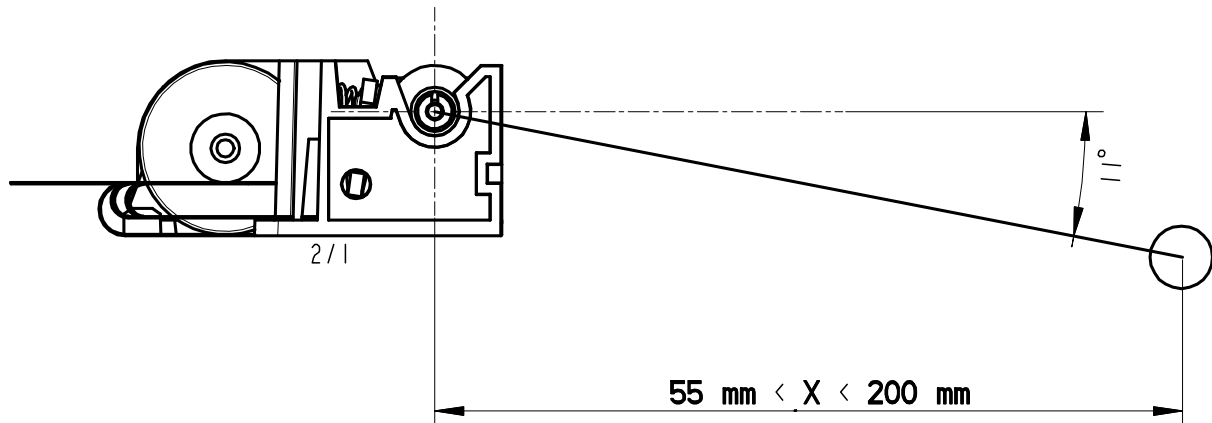
Mechanical views (continued)



3.5.2 Hinge Positioning

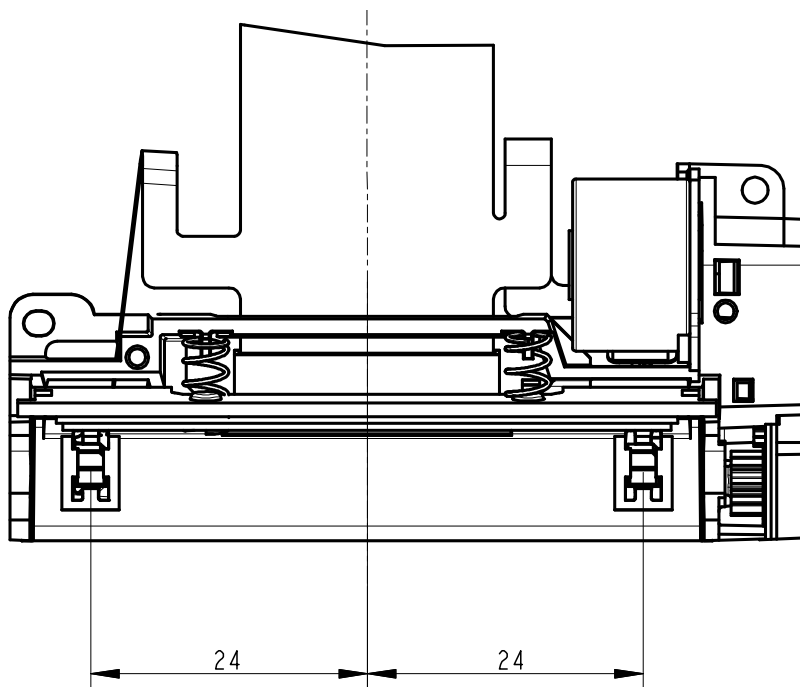
The zone where the hinge is located must be between 2 planes passing on the platen axis with a 25° maximum angle. The superior plane must not be inclined of less than 5° from the mounting plane. Therefore, the inferior plane must not be inclined more than 30° from the mounting plane (see below drawings).

At the cover's hinge, you must leave axial and radial space to allow the platen to locate the printer frame without constraint.



3.6 Useful Measurements

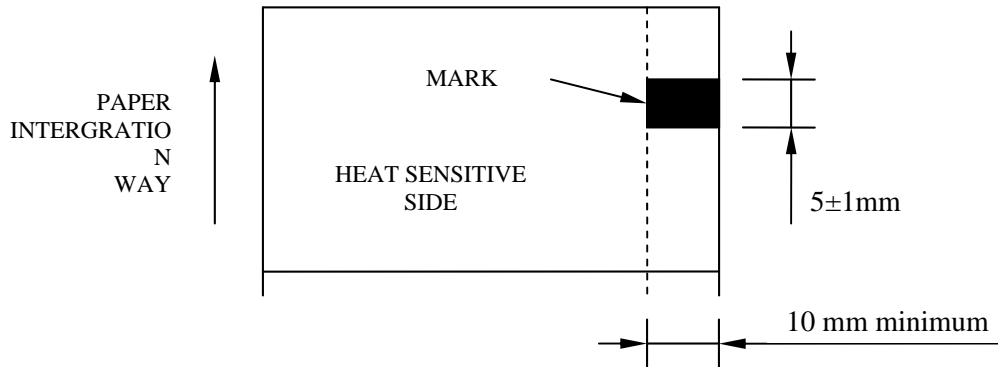
An infra-red opto sensor detects paper presence. It is located at 24 mm of the paper center. There is two version of the KAON mechanism, one with the sensor on the left, the other with the sensor on the right.



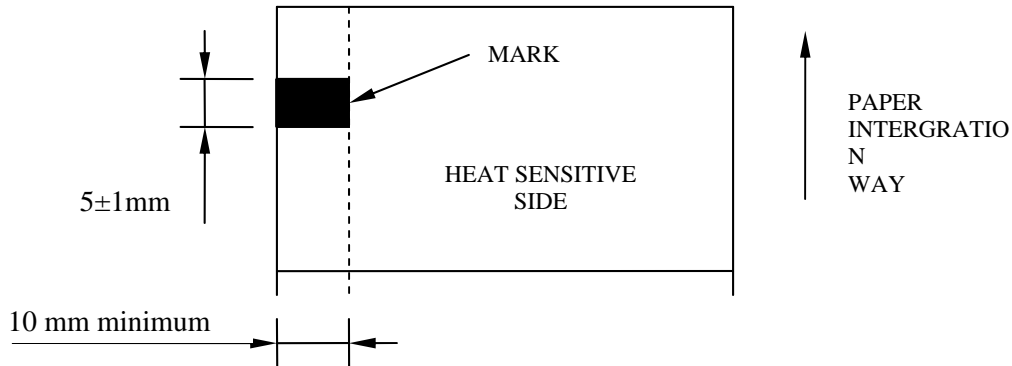
The KAON mechanism can not make paper feed back movement.

The KAON mechanism is able to recognize the « black marks ».

The black mark must be on the side of the impression and have a width of 5 ± 1 mm and a minimal height of 10mm (see diagram below).



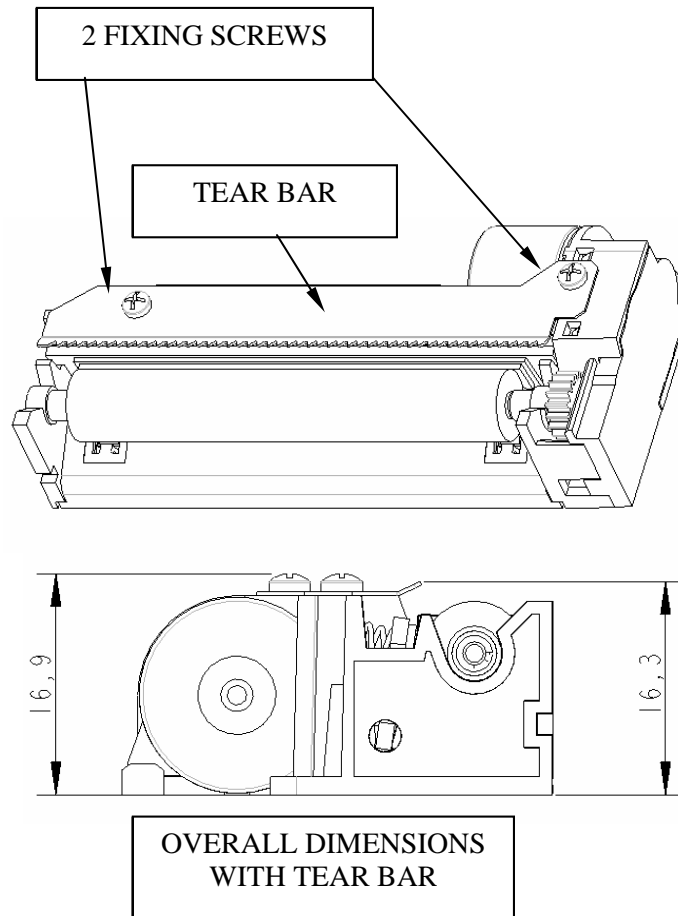
OPTO SENSOR VERSION ON THE RIGHT



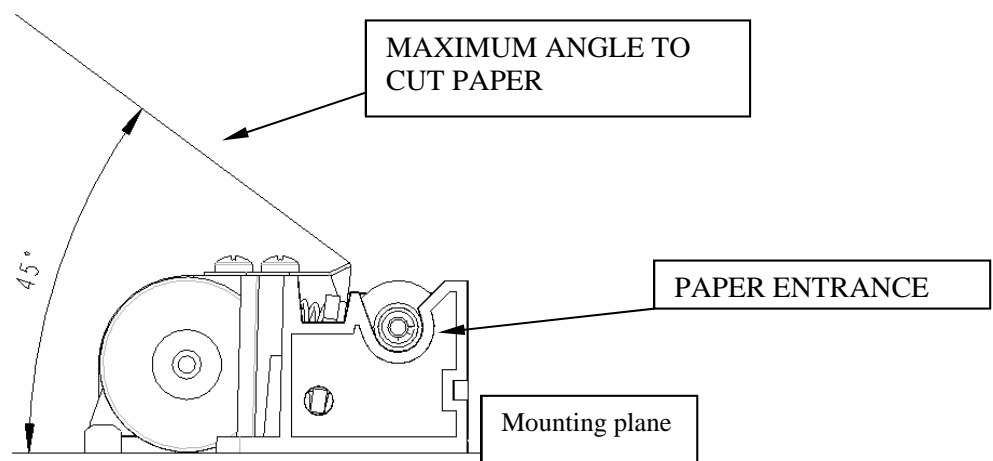
OPTO SENSOR VERSION ON THE LEFT

ACCESSORIES

The Kaon mechanism can be provided with an optional metal tear bar which is screwed to the printer frame. This option will be developed based on customer request.



If the customer chooses to carry out himself this function, the tear bar must not be settled on the lid or any other moving part compared to the printer



To use the tear bar, it is important to pull the paper according to an angle lower than 45° compared to the mounting plane otherwise platen roller may be ejected

4 ELECTRICAL SPECIFICATIONS

4.1 Nominal Power Supply

		Value	Units
Print head:	Logic (VDD)	3 to 5	V DC
	Dot line	4 to 8.5	-
Stepping motor		4 to 8.5	-

4.2 Nominal Consumption of Printer

		Value	Units
Print head:	Heating current / dot (Vch)	28,4	mA
	Logic current (VDD) All high	26,6	mA
	Stepping motor current (2 activated phases)	1000	mA

4.3 Description of Print Head

	Value	UNIT
Driver chips	6	-
Operating range (VDD)	3 to 5 * ¹	V DC
Mean dot resistance ($\pm 4\%$)	176	Ω
Nominal dot supply voltage	5 (min = 4, max = 8.5)	V DC
Nominal Heating current per dot (at 5V)	28.4 * ²	mA

*¹ Filter any transient signal and parasitic on this line. Separate VDD from Vch because Vch can go lower than 4.75 Volts. VDD must be connected to the same power supply than the other KAON circuits which drive the printer.

*² The print density variation may become significant when the number of dots energized simultaneously becomes greater than 64

4.3.1 Function of 64 bit LSI Drivers Chart and Operation

The LSI power and multiplexing circuit drivers located on the thermal print head provide power control from logic signals and the DC power supply voltage.

These circuits are supplied by **3.3 or 5 V** logic voltage. Take care to filter transient and parasitic on all logic lines. Undetermined states can happen and destroy the head. The power source should be disconnected from the logic source. The logic source must be connected to the same source as the KAON circuits in charge of controlling the printer.

Each circuit features 64 open collector transistors, a 64-bit shift register and a 64-bit memory register. Each circuit controls 64 resistor dots on the print head.

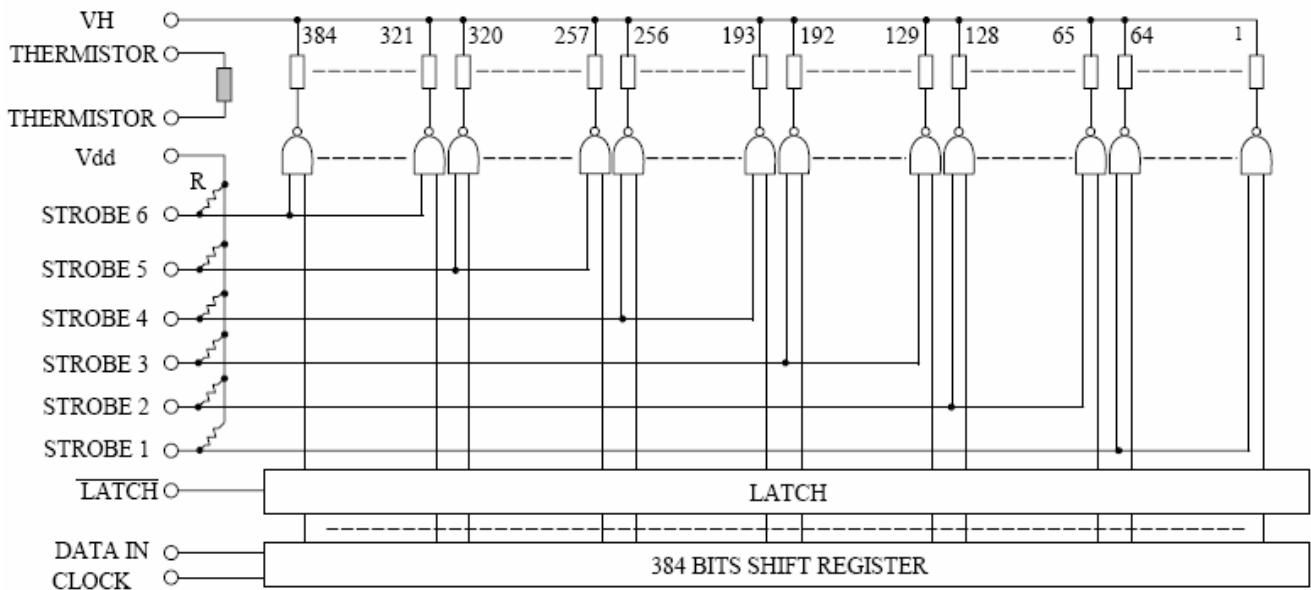


Figure 1 driver chart

Note: see page 11 and 12 for the available signals on the printer connection.

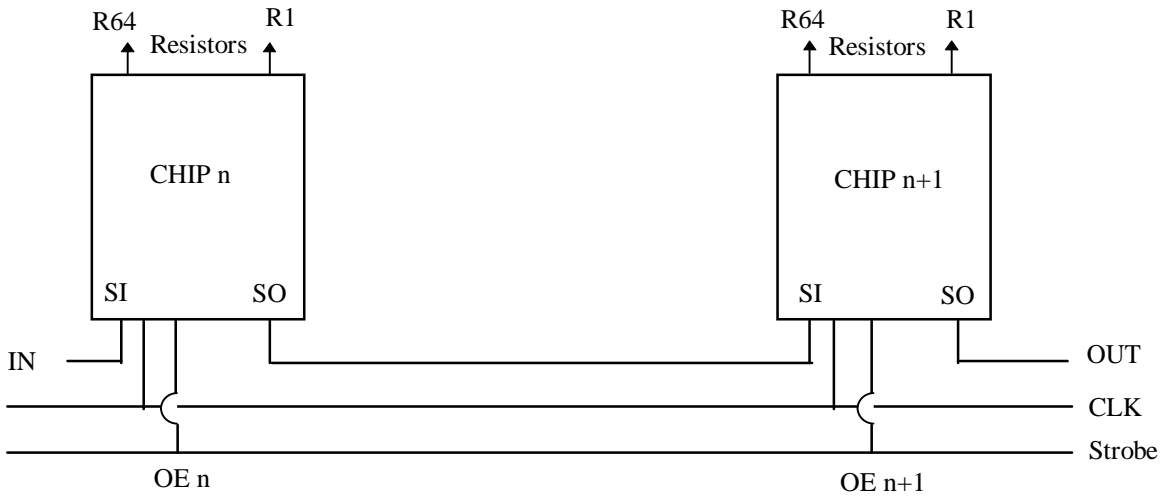


Figure 2 Routing of data to the thermistor dots

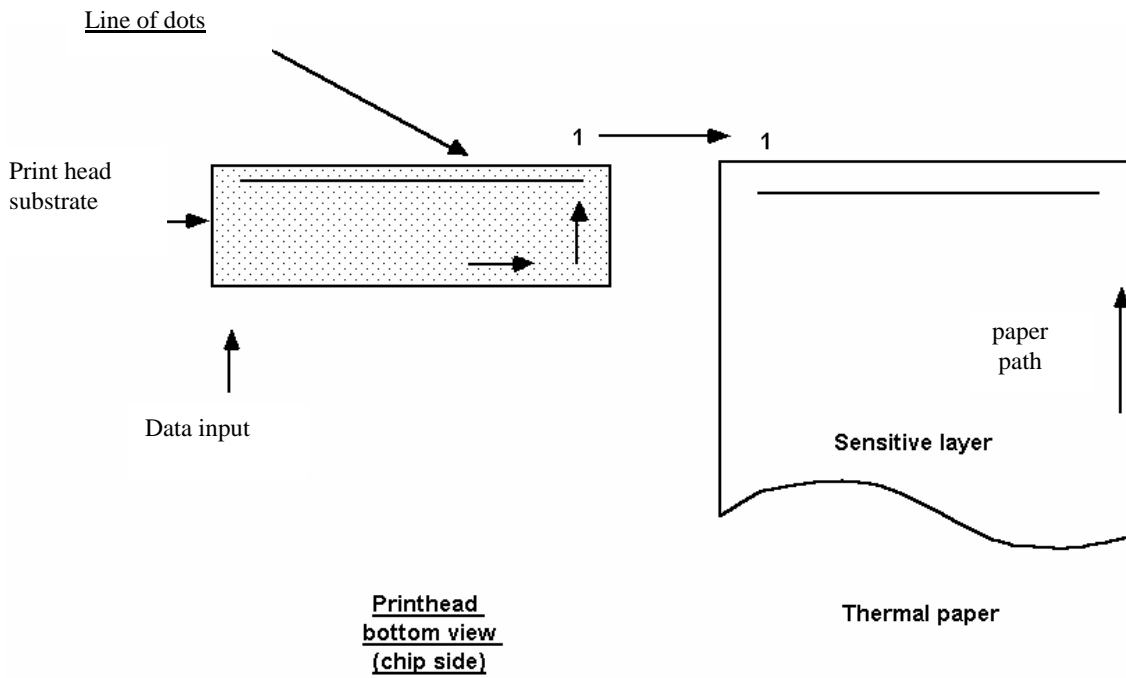


Fig.3 Dots print order

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

4.3.2 Electrical Specifications of 64-BIT LSI Driver

4.3.2.1 General Electrical Description of Drivers

Description of drivers	MIN	MAX	UNIT
Max voltage at outputs 1 to 64		8.5	Volt
Max voltage any other pin		5.5	Volt
Max output current		40	mA
Total max output current (64 dots "On")		2.6	A
Max leakage current/driver when stand-by mode		64	μ A

4.3.2.2 Other

The specifications given below are given for the following conditions:

Logic voltage on chip: $2.7\text{ V} < \text{VDD} < 5.5\text{V}$ (care should be taken to filter any transient signal or parasitic in order to keep the driver in a known state: failure to observe this may result in head destruction)

Clock frequency (max.): 5 MHz

Logic Current (5 V)	Conditions	Values	Symbol
Min high-level input voltage	VDD = 5 V	0.8 x VDD	Vih
Max high-level input voltage	VDD = 5 V	VDD	Vih
Min low-level input voltage		0	Vil
Max low-level input voltage		0.2 x VDD	Vil
Max high-level input current	Vih = VDD	0.5 μ A	Iih
Max. low-level input current	Vil = 0	0.5 μ A	Iil
Min. high-level output voltage		4.45 V	Voh
Max. low-level output voltage		0.05 V	Vol

4.3.2.3 Timing

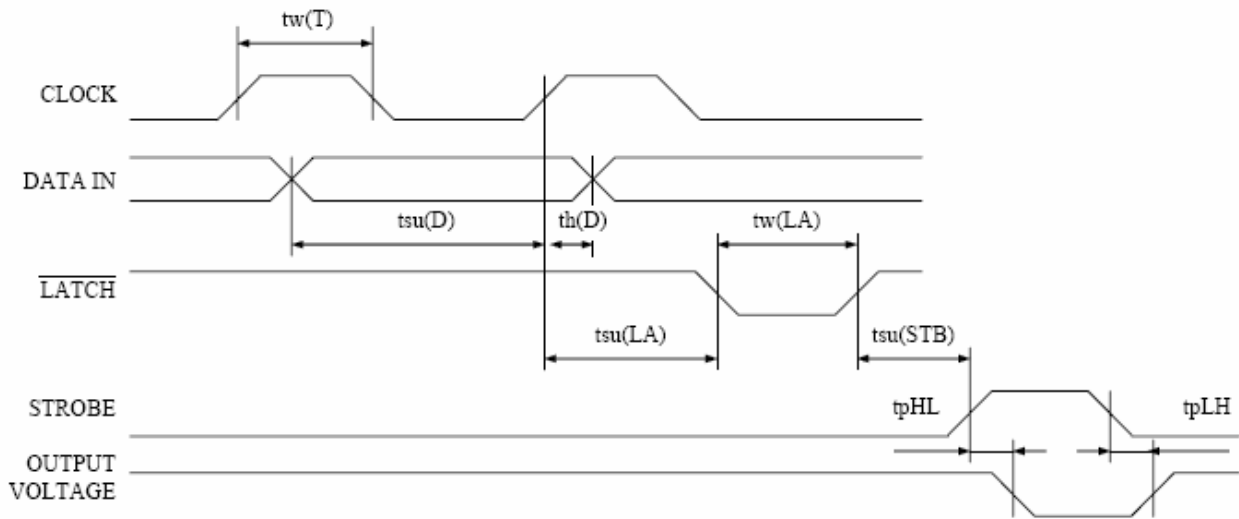


Fig.4 LSI driver timing chart

Note: All these inputs are CMOS compatible.

Fig. 5 LSI driver symbols

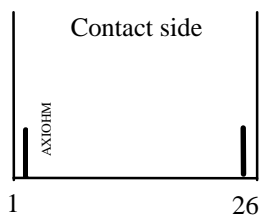
Symbol	Description	Min	Maxi	Unit
f_{MAX}	Clock frequency		5	MHZ
$tw(T)$	Clock pulse width	70		ns
$tsu(D)$	Data setup time	40		ns
$th(D)$	Data hold time	40		ns
$tsu(LA)$	Latch setup time	100		ns
$tw(LA)$	Latch pulse width	100		ns

VDD = 5V or 3.3V, Temp = 25 °C with resistive load

4.3.3 Print Head Connection

Pinout of the print head flex cable

Pin Number	Signal	Comment
1	B1	Paper feed motor B1
2	A0	Paper feed motor A0
3	A1	Paper feed motor A1
4	B0	Paper feed motor B0
5	Anode opto	Anode of end of paper opto-sensor
6	GND	GND
7	Collector opto	Collector of end of paper opto-sensor
8	Vch	Vch
9	Vch	Vch
10	Data-out	Data out
11	STROBE	Strobe signal for line print
12	GND	GND
13	GND	GND
14	OE1	OE for drivers 1,2,3
15	Thermistor1	Thermistor1
16	Thermistor2	Thermistor2
17	Vdd	Vdd
18	OE2	OE for drivers 4,5,6
19	GND	GND
20	GND	GND
21	CLOCK	Clock signal for serialising data to line
22	Data-in	Data input
23	Vch	Vch
24	Vch	Vch
25	Gnd for ESD	Ground for ESD evacuation
26	Gnd for ESD	Ground for ESD evacuation



Thickness: 300 μ

For the connection of the mechanism Axiohm recommend the following 26 pins connectors (from print head flex to board):

- JST Ref 26 FMN-BTRK-A Molex Ref :52808-2610
- JST Ref 26 FMZ-BT Molex Ref : 71226-2635

4.4 *Bipolar Stepping Motor*

This motor is used to drive the platen for paper feeding. It is a bipolar stepping motor and its characteristics are described below.

4.4.1 *Characteristics*

Recommended control voltage (voltage range: 4 to 8.5V)	5	VDC
Coil Resistance	10	Ω
Number of phases	2 (bipolar)	
Pitch angle	18°	
Number of steps per revolution	20	
Paper feed for 2 motor steps	0.112	Mm
Recommended control current	500 (=5V/10 Ω)	mA/phase
Maximum starting speed *	720 (=45mm/s)	step/s

* to go faster : an acceleration ramp up must be achieved.

* Depends on the voltage.

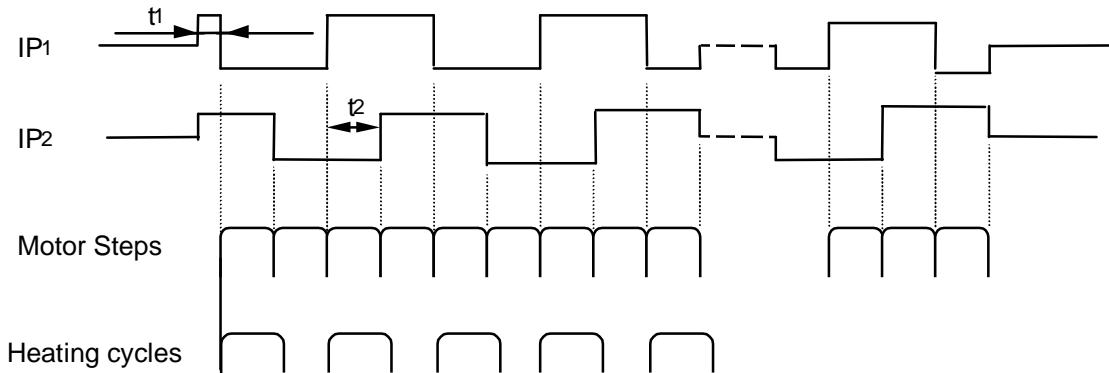
For the motor driving, see the following page and the chapter "Recommendations"

4.4.2 *Motor Connection*

The motor is connected to the main flex cable in addition to the End of paper opto sensor.
See 4.3.3 Print head connection

4.4.3 Induction Sequence and Timing (paper feed)

Motor feed timing diagram



Note that each time the motor has been stopped for more than 8 ms the next step should be longer by 1 ms in order to restart the motor in the appropriate position.

Motor initialisation:

This operation is necessary to place the motor in a good position when the printer KAON is powered on or reset. Both phases must be powered with the same current during $t_1=1$ ms. It must be followed by 16 motor steps in order to compensate the play in the gears.

4.4.4 Printing Mode

There are 4 different positions for the motor phases.

The circulation is:

$$P1 = A0B0; P2 = A1B1$$

$$P1P2 \Leftrightarrow \overline{P1}P2 \Leftrightarrow \overline{P1}\overline{P2} \Leftrightarrow P1\overline{P2} \Leftrightarrow P1P2$$

The position of the phases must be kept in memory while the phase currents are switched to zero in order to restart the motor in a good position.

$$IP = \pm 500 \text{ mA (at 5 V)}$$

$$t_2 > 1.3 \text{ ms}$$

During printing, the motor phases should be maintained. Otherwise, a paper motion can occur and induce unevenly spaced sub lines. A good way to achieve this without over heating the motor is to keep the motor phases "on" when the buffer contains data, and to release them when the buffer is empty.

4.5 Sensor Specifications

4.5.1 End of Paper Opto-sensor

This opto-sensor detects the end of paper

4.5.1.1 Electrical Characteristics

Absolute maximum ratings					
IF (mA)	VR (V)	PD(mW)	VCEO(V)	IC(mA)	PC (mW)
50	5	70	20	20	70

Operating characteristics					
	VF (V)	IR (μA)	ICEO (nA)	IC (μA)	tr (μs)
Value	Maxi 1.6	Maxi 10	Maxi 200	Mini 150 Maxi 600	Typical 5
Conditions	IF = 10 mA	VR = 5 V	VCEO = 10V	IF = 10 mA	IC = 1 mA
				VCE = 5 V	RL = 100 Ω
				VCE = 5 V	VCE = 5V

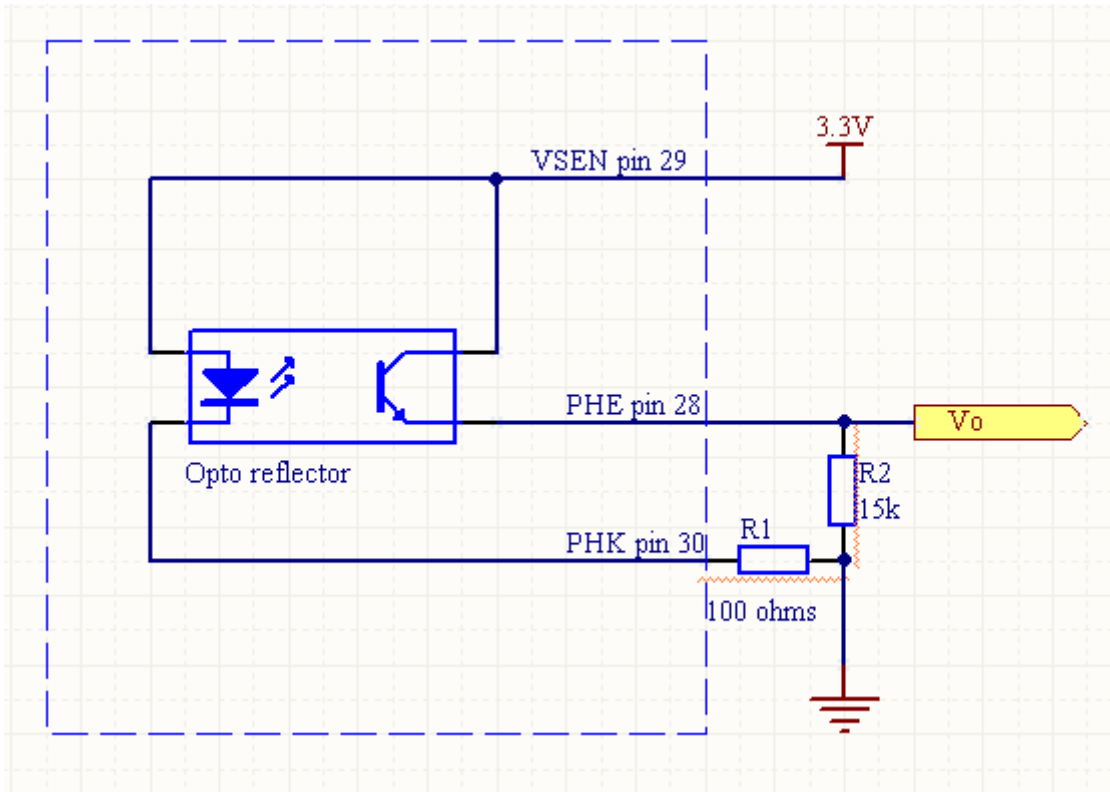
4.5.1.2 Connection

Integrated with the main flex cable, see 4.3.3

4.5.2 Recommended Use for Opto-sensor

The user should be aware that the opto-sensor characteristics have very wide tolerances. Thus, we recommend the use of the schematics below.

4.5.2.1 Opto Sensor: Sample Minimal External Circuit



Condition:

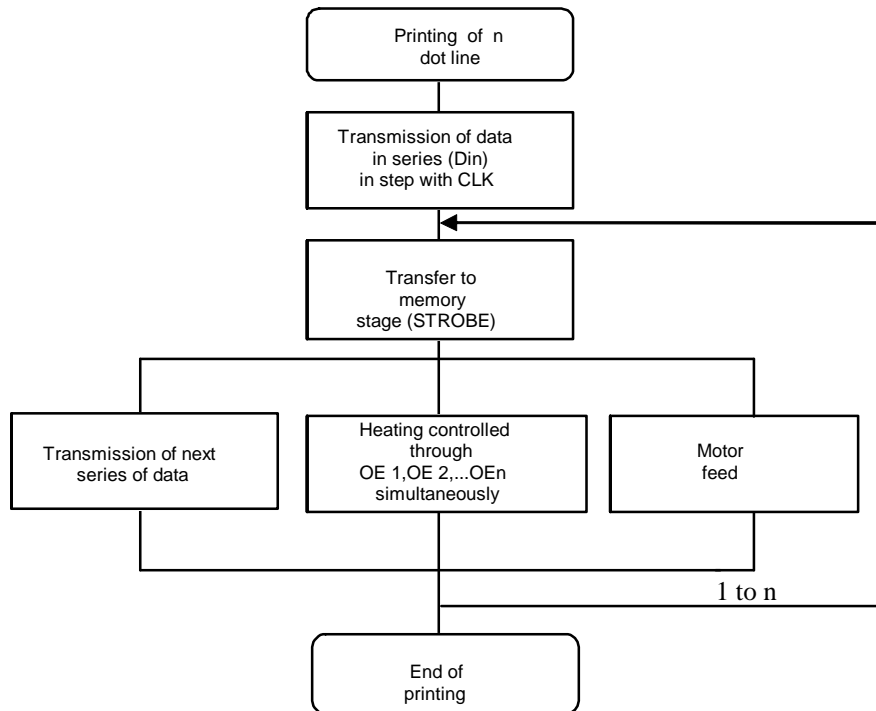
- ✓ For $I_f = 20 \text{ mA}$
 -Output signal is HIGH when paper is PRESENT $V_o > 1.7V$
 -Output signal is LOW when paper is EXHAUSTED $V_o < 1.7V$

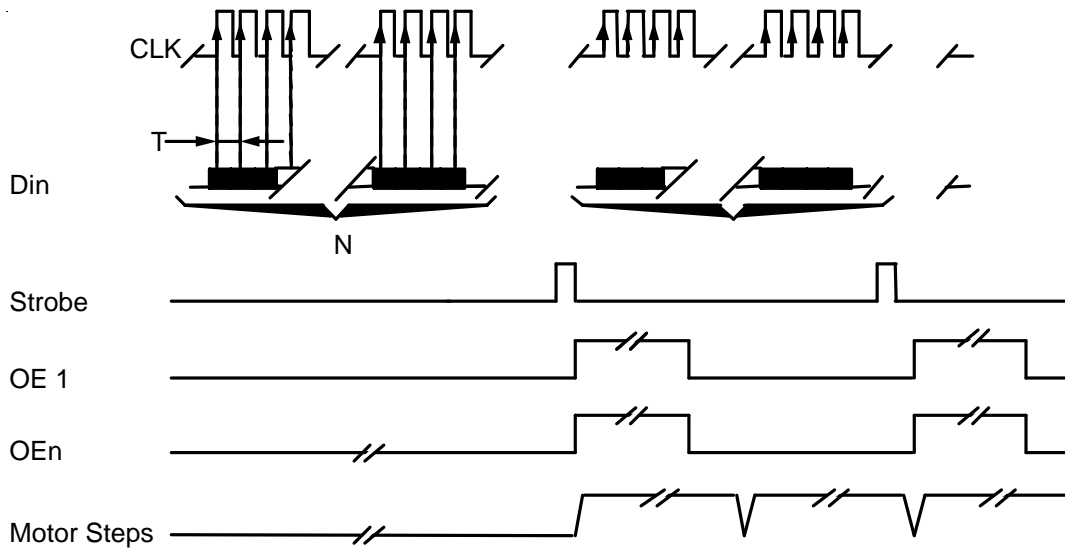
5 PRINTER CONTROL TECHNIQUES

For printer control techniques, in order to operate the printer, we depict hereafter three possible modes.

5.1 Mode 1

The paper feeds itself automatically during the heating cycle, thereby permitting high speed to be achieved (in this mode, it is recommended to use historical control, see chapter: "Heating Time").



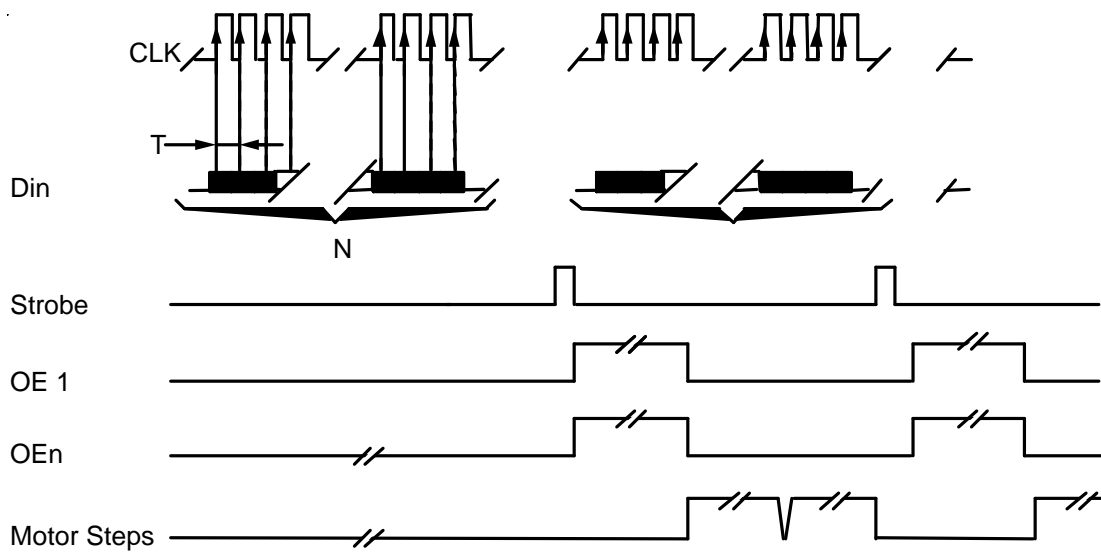
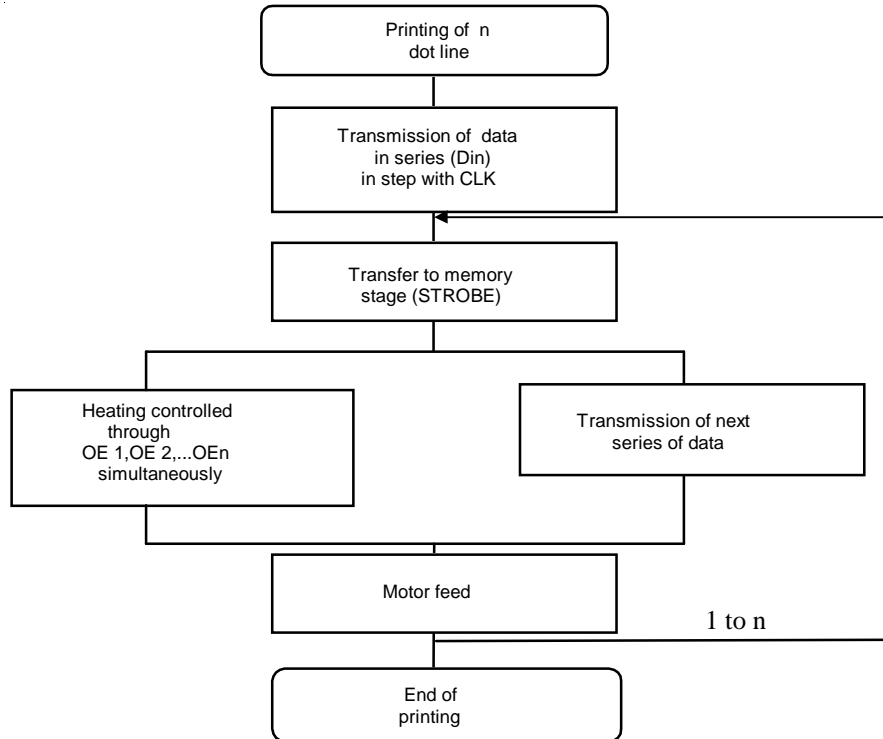


T : Clock frequency 5 MHz maximum.

Timing diagram for mode 1

5.2 Mode 2

The paper feed occurs after the heating cycle resulting in high quality printing.

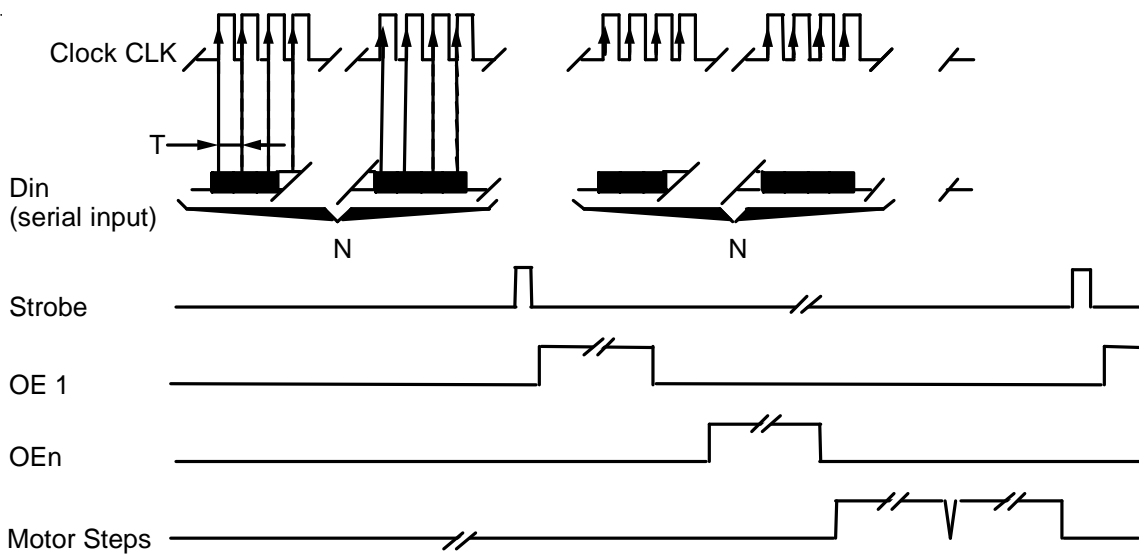
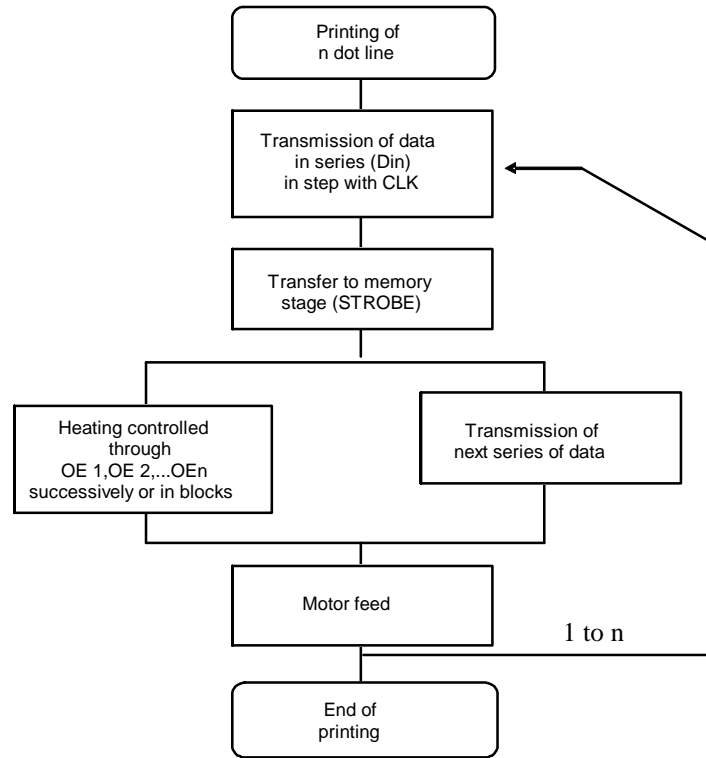


T : Clock frequency 5 MHz maximum

Timing diagram for mode 2

5.3 Mode 3

This mode is used in conditions where there is a limit of electrical current. The dot line is printed in stages heating only a portion of the line at a time. This effectively gives a reduced power consumption.



T : Clock frequency 5 MHz maximum

Timing diagram for mode 3

6 RECOMMENDATIONS

6.1 *Mechanical Recommendations*

- Never apply mechanical stress to the printer; this could result in misalignment and thus degradation of the print quality.
- The thermal print head must have 1 degree of freedom. Never prevent the print head from pivoting on its axis.
- Refer to the drawings in chapters "Cover integration" to design an easy loading Clamshell cover.
- The paper should be guided to the mechanism to make sure it is centred in the mechanism paper path (particularly when the paper width is less than 58mm).

Flatness Support:

- The « KAON » printer must not be put in constraint during integration. To achieve that, the support on which it is fixed must have a flatness of 0,15mm.

During integration, the mounting plane can be tilted according to an indifferent angle of the horizontal.

General Constraints of Integration:

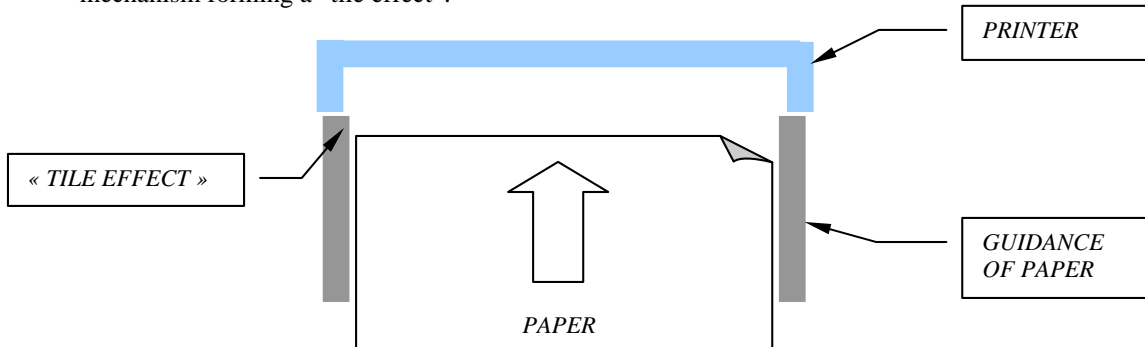
- The thermal head has a light oscillating movement around its axis during the opening or the closing of the cover. This oscillation should be taken into account if components are located close to the printhead.
- The unit's surfaces for the integration must be situated in more than 0,5mm of the pieces in movement in the printer: gears printing head, spring of head, platen, except the oblong forms or "forks" to maintain the platen.

Paper characteristics and paper guide

- « KAON » uses paper of 58mm maximum width and 68µm maximum thickness. **The paper roll must not exceed 120g weight, corresponding to a diameter of approximately 60 mm rolled on a plastic roll of Ø16mm.**

Printing width is 48mm.

To feed the paper to the printer we recommend guidance as close as possible to the entry of the printer mechanism forming a “tile effect”.



- « KAON » can not manage backward movement of paper.

If printer is used in bi-station mode (2 parallel paper rolls printed simultaneously), there is no paper detection on the opposite side of the gears. If required, it will have to be integrated into the system bucket.

6.2 *Electrical Recommendations*

When energising the thermal print head, it is important to apply the logic supply voltage first and the print head supply voltage next.

If the line of dots is supplied before the control logic, 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) after the logic supply voltage (VDD, 5V).

The same precaution should be taken when shutting down. The supply voltage Vch must be switched off before the logic supply voltage VDD.

Care should be taken to allow enough time for residual capacitive charge to dissipate.

6.3 *Motor Driving Recommendations*

* Motor driving can be achieved with voltage control or regulated current control.

When the motor is under voltage control, it is recommended to connect it to the same supply as logic current (minimum 3.3V).

If the motor is connected to the heating source power, it is recommended to control it under regulated current.

When the control voltage is greater than 5.25 V, or the current is greater than 500 mA per phase, it is necessary to determine a duty cycle time (max recommended: 15% ton/toff, with a sec “on” max) to avoid the motor temperature rising.

This has to be achieved with the customer host chassis, as the cooling depends on air volume and circulation around the motor.

This motor can be controlled either under voltage or current.

The maximum voltage is 8.5 V, the maximum current is 500 mA per phase.

The maximum temperature on the external motor frame is 80°C.

7 PAPER SUPPLIERS

Production specifications are guaranteed when used with the following paper reference

JUJO AF50KSE3

Axiohm ref: 3104208

8 HEATING TIME TABLE

8.1 Real Heating Times

Density vs Energy		At Nominal Speed & Nominal Temperature	
Voltage	6 Volts	$t1 = \frac{R_{mean}}{V \cdot 2} \times E_0$	
Temperature	23 °C		
Speed	50 mm/s		
Paper	AF50KSE3		
Eo saturation	0,299 mJ		(cf Density Sheet)
Tch (saturation heating time)	1,120 ms		
Température statique	80 °C		
Heating Time vs Speed		At Nominal Voltage & Nominal Temperature	
Voltage	6 Volts	$t2 = t1 \times (a \times \text{Log}(tm) + b)$ <p>tm = Time for motor step (ms)</p>	
Temperature	23 °C		
Paper	AF50KSE3		
Coeff "a"	0,4071		
Coeff "b"	0,6269		
Heating Time vs Temperature		At Nominal Speed & Nominal Voltage	
Voltage	6 Volts	For linear modelisation	
Speed	50 mm/s		
Paper	AF50KSE3	$t3 = t2 \times (cT + d)$	
Coeff "c"	-0,01420000		
Coeff "d"	1,32660000		
Coeff "g"	-0,00000477		For polynomial modelisation
Coeff "h"	0,00050244		
Coeff "i"	-0,02740654		
Coeff "j"	1,42268041		
			$t3 = t_2 \times (g \times T^3 + hT^2 + iT + J)$
Heating Time vs Voltage		At nominal Temperature & Speed	
Temperature	23 °C	$V' = eV + f$	
Speed	50 mm/s		
Paper	AF50KSE3		
Coeff "e"	0,9473		
Coeff "f"	0,3105		

8.2 Acceleration curve

Index	Step Time (μs)	Speed (mm/sec)	History Coef (%)
0	8332	15	0
1	5434	23	4
2	4020	31	13
3	3204	39	19
4	2657	47	25
5	2272	55	30
6	1984	63	34
7	1760	71	37

8.3 Heating Time Table

With Paper AF50KSE3

Voltage (V)			Speed (mm/s)				R= 176 Ohms								
Real	Virtual		< 20 mm/s	30 mm/s	35 mm/s	40 mm/s	50 mm/s	56 mm/s	60 mm/s	65 mm/s	70 mm/s	80 mm/s	90 mm/s	100 mm/s	
Dot line cycle			6,250	4,170	3,570	3,130	2,500	2,230	2,080	1,920	1,790	1,560	1,390	1,250	
V (V)	V (V)	T °C	T en ms												
4,50	4,57	0 °C	3,765	3,313	<None>	<None>	<None>	<None>	<None>	<None>	<None>	<None>	<None>	<None>	
4,50	4,57	10 °C	3,160	2,781	2,635	<None>	<None>	<None>	<None>	<None>	<None>	<None>	<None>	<None>	
4,50	4,57	20 °C	2,745	2,416	2,289	2,182	<None>	<None>	<None>	<None>	<None>	<None>	<None>	<None>	
4,50	4,57	25 °C	2,585	2,275	2,156	2,055	<None>	<None>	<None>	<None>	<None>	<None>	<None>	<None>	
4,50	4,57	30 °C	2,445	2,151	2,039	1,943	1,780	<None>	<None>	<None>	<None>	<None>	<None>	<None>	
4,50	4,57	40 °C	2,183	1,921	1,820	1,735	1,590	1,516	<None>	<None>	<None>	<None>	<None>	<None>	
4,50	4,57	50 °C	1,884	1,658	1,571	1,497	1,372	1,308	1,269	1,224	<None>	<None>	<None>	<None>	
5,00	5,05	0 °C	3,091	2,720	2,578	2,457	<None>	<None>	<None>	<None>	<None>	<None>	<None>	<None>	
5,00	5,05	10 °C	2,594	2,283	2,164	2,062	<None>	<None>	<None>	<None>	<None>	<None>	<None>	<None>	
5,00	5,05	20 °C	2,254	1,983	1,880	1,792	1,642	<None>	<None>	<None>	<None>	<None>	<None>	<None>	
5,00	5 °C	25 °C	2,123	1,868	1,770	1,687	1,546	1,474	<None>	<None>	<None>	<None>	<None>	<None>	
5,00	5,05	30 °C	2,007	1,766	1,674	1,596	1,462	1,394	1,352	<None>	<None>	<None>	<None>	<None>	
5,00	5,05	40 °C	1,792	1,577	1,495	1,425	1,305	1,245	1,208	1,165	<None>	<None>	<None>	<None>	
5,00	5,05	50 °C	1,547	1,361	1,290	1,229	1,126	1,074	1,042	1,005	0,973	0,910	<None>	<None>	
6,00	5,99	0 °C	2,191	1,928	1,827	1,742	1,596	1,522	<None>	<None>	<None>	<None>	<None>	<None>	
6,00	5,99	10 °C	1,839	1,619	1,534	1,462	1,340	1,277	1,239	1,196	<None>	<None>	<None>	<None>	
6,00	5,99	20 °C	1,598	1,406	1,332	1,270	1,164	1,110	1,077	1,039	1,005	<None>	<None>	<None>	
6,00	5,99	25,00	1,505	1,324	1,255	1,196	1,096	1,045	1,014	0,978	0,947	0,886	<None>	<None>	
6,00	5,99	30 °C	1,423	1,252	1,187	1,131	1,036	0,988	0,959	0,925	0,895	0,837	<None>	<None>	
6,00	5,99	40 °C	1,271	1,118	1,060	1,010	0,925	0,882	0,856	0,826	0,799	0,748	0,704	<None>	
6,00	5,99	50 °C	1,096	0,965	0,914	0,872	0,799	0,761	0,739	0,713	0,690	0,645	0,608	0,573	
7,00	6,94	0 °C	1,634	1,438	1,363	1,299	1,190	1,135	1,101	1,062	1,028	<None>	<None>	<None>	
7,00	6,94	10 °C	1,372	1,207	1,144	1,090	0,999	0,952	0,924	0,892	0,863	0,807	0,760	<None>	
7,00	6,94	20 °C	1,191	1,049	0,994	0,947	0,868	0,827	0,803	0,774	0,750	0,701	0,660	0,623	
7,00	6,94	25 °C	1,122	0,987	0,936	0,892	0,817	0,779	0,756	0,729	0,706	0,660	0,622	0,587	
7,00	6,94	30 °C	1,061	0,934	0,885	0,843	0,773	0,737	0,715	0,690	0,668	0,624	0,588	0,555	
7,00	6,94	40 °C	0,947	0,834	0,790	0,753	0,690	0,658	0,638	0,616	0,596	0,558	0,525	0,495	
7,00	6,94	50 °C	0,818	0,719	0,682	0,650	0,595	0,568	0,551	0,531	0,514	0,481	0,453	0,427	
8,50	8,36	0 °C	1,126	0,991	0,939	0,895	0,820	0,782	0,759	0,732	0,708	0,663	0,624	0,589	
8,50	8,36	10 °C	0,945	0,832	0,788	0,751	0,688	0,656	0,637	0,614	0,595	0,556	0,524	0,494	
8,50	8,36	20 °C	0,821	0,722	0,685	0,653	0,598	0,570	0,553	0,534	0,517	0,483	0,455	0,429	
8,50	8,36	25 °C	0,773	0,680	0,645	0,615	0,563	0,537	0,521	0,503	0,487	0,455	0,429	0,404	
8,50	8,36	30 °C	0,731	0,643	0,610	0,581	0,532	0,508	0,493	0,475	0,460	0,430	0,405	0,382	
8,50	8,36	40 °C	0,653	0,574	0,544	0,519	0,475	0,453	0,440	0,424	0,411	0,384	0,362	0,341	
8,50	8,36	50 °C	0,563	0,496	0,470	0,448	0,410	0,391	0,380	0,366	0,354	0,332	0,312	0,294	

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