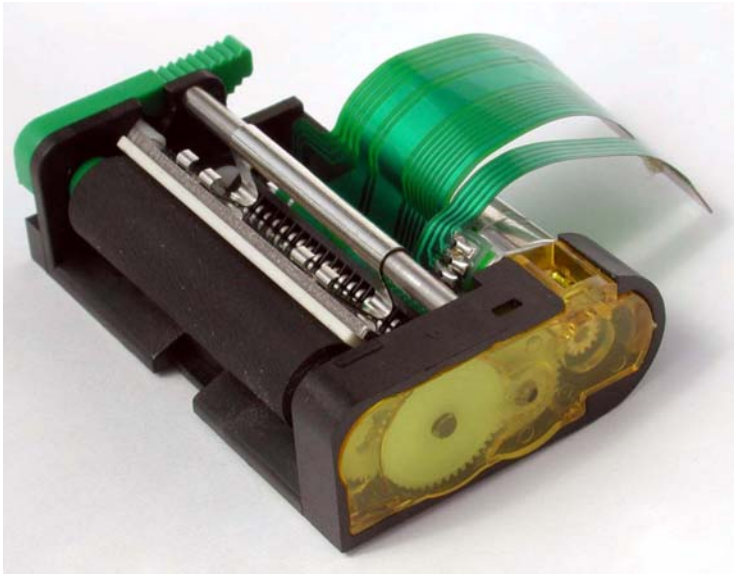
MP105

Technical reference



1. Introduction

1.1. MP105

The MP105 thermal line printer mechanism is the smallest 1 inch printer in the industry.

1.2. MP105 features

- Very compact printer (32mm x 48mm x 13.8mm)
- Up to 80 mm/s printing speed
- Ultra light (30g)
- Front and bottom paper loading, ideal for 1 inch width label printer
- Starting operating voltage from 4.2v
- High resolution printing (8 dots/mm)
- Compatible footprint for easy upgrade from moving head to fixed head technology
- Life of 100 millions pulses, 30 km
- Low consumption
- Low noise due to its technology (thermal)

1.3. Revision history

Rev.	Date	Page	Revision item
A	13/July/00	-	First issue
B	22 Apr 03	8	Changed VH min. value.

This manual provides complete information about MP105 thermal printer mechanism. Further information are available upon request, such as high speed printing applications and reliability figures.

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2. General characteristics

ITEM	MP105
Printing Method	Thermal dot line printing
Number of dots/line	192
Dots density (dot/mm)	8
Printing Width (mm)	24
Paper Width (mm)	38 +0/-1
Paper feed pitch (mm)	0.125
Paper Feed tension (g)	50 or more
Paper Hold tension (g)	80 or more
Dimension WxDxH (mm)	32 x 48 x 13.8
Weight (g)	Approx 30
Head temperature detection	Thermistor
Head-up detection	No
Paper end detection	Photo-interruptor
Operation voltage range (V)	Dotline: From 4.2 to 8.5 / Logic: 5V+/-5%
Current consumption (A)	At printing: 5 V: 1.9 A (Head) (64 dots ON) 0,5A (Motor) 5V: 24 mA (Head) At paper feeding : 5V: 0,4A(Motor) 5V: <50uA (Head)
Recommended Paper	KF50-HDA or equivalent
Operating temperature range (°C)	0/+50
Operating humidity (RH%)	20-85 (no condensation)
Storage temperature range (°C)	-25/+70
Storage humidity (RH%)	10-90 (no condensation)

3. Thermal Printhead and printing configuration

3.1. Outlines

Heat element structure	2 heaters/dot
Number of heat elements	192 dots
Heat element pitch	0.125 mm
Print width	24 mm (centered on paper)
Total width	34 mm
Average resistance	142 Ohms +/- 4%

3.2. Maximum conditions at 25°C

ITEM	MAXIMUM CONDITIONS		UNIT
Supply energy (25°C)	0.45	0.7	MJ/dot
Print Cycle (25°C)	2.5	5	Ms/line
Logic voltage	7		volts
Supply voltage	8.5		volts
Head Temperature	65		°C
Number of dots to be energized simultaneously[1]	192		dots

1/ If energy above 0.7 mJ is applied to one dot, the print quality of this dot may be affected (usually by making a "light" print-out).
2/ If the print cycle is less than 2.5 ms/line (above 50 mm/s), then maximum supply energy value is decreased. For these applications, please contact APS for further information.
3/ In case of double-ply paper or special low energy paper, please contact APS for further information.

3.3. Typical printing conditions

Supply voltage : 5 volts
Power consumption : 0.123 W/dot
Print cycle : 5 ms (25 mm/s)
Energy per dot, E_0 : 0.31 mJ (from 1 to 64 dots on simultaneously)
Supply current : 3.8 A Peak (192 dots on)

[1] This condition satisfies the print density as defined in section 3.3

Item	Symbol	Electrical conditions	Unit		
Supply voltage	Vh	5.0	V		
Power consumption	Po	0.123	W/dot	64	dots
Print cycle	S.L.T	3.0	ms/line	fired	at the
Energy consumption	Eo	0.36	mJ/dot	5°	same
(on time)	(Ton)	(2.96)	ms	C	time
		0.31	mJ/dot	25°	
		(2.53)	ms	C	
		0.28	mJ/dot	45°	
		(2.28)	ms	C	
Supply current	Io	1.9	A		

The print optical density is then 1,0 minimum with a maximum variation of 0,3. This measurement is done at the full black pattern by Macbeth densitometer RD-914. Full black pattern means all dots printing pattern (100% black area) printed under correct paper speed.

3.4. General printing conditions

The following formula allows to calculate the heating time T_{on} depending on driving voltage V_H:

$$T_{on} = \frac{E_0}{P_0} = E_0 * \frac{(N * R_{com} + R_{av} + R_{ic} + R_l)^2}{V_H{}^2 * R_{av}}$$

Where:

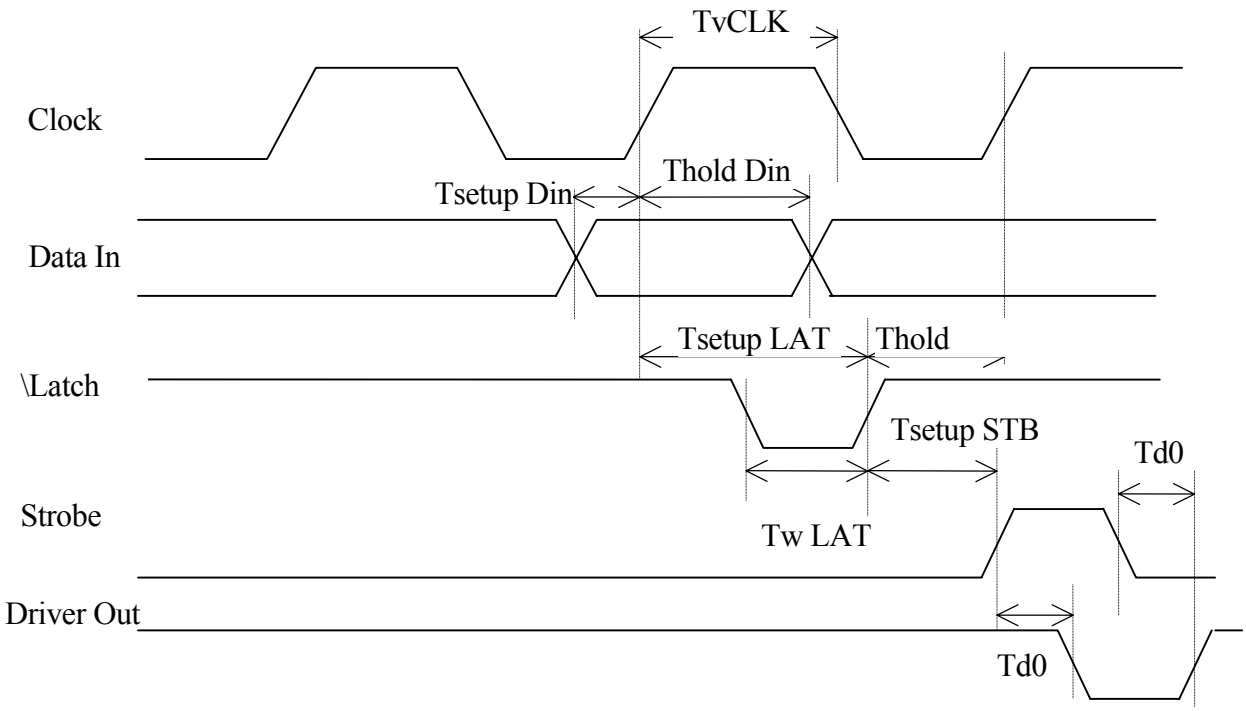
E_0 is the nominal energy (0.31 mJ)
V_H is the driving voltage (5 v)
R_{av} is the average resistance (142 Ohms)
N is the number of dots energized simultaneously
R_{com} is the common resistance (0.05 Ohm)
R_{ic} is the driver saturated resistance (15 Ohms)
R_l is the lead resistance (10 Ohms)

3.5. Operation precautions

1/ When continuous printing is performed, the supply energy should be reduced so that the substrate temperature monitored through the thermistor will remain below 65°C.
2/ When the printhead operation is finished, print supply voltage should be reduced to the ground level and remained until next printhead operation.
3/ If printing sound, for example sticking sound, please adjust the paper feed speed or pulse to avoid these kind of mechanical resonnance
4/ In order to avoid surge and voltage drops across power wires, Vh and Gnd cable length should be less than 100 mm, and 47uF aluminium capacitor is required between Vh an Gnd at controller board side.
5/ please pay attention that the paper does not have characterisitcs that could affect the printhead life (high abrasivity, too low sensitivity or abnormal chemicals)

3.6. Electrical Characteristics

The following chart gives the timing for driving the printhead:



!!! ATTENTION !!!
In order to prevent any dot element damage, the power on and off sequence must be the following:

- **Turn-on**: Make sure that the printhead voltage is applied simultaneously or after the logic voltage.
- **Turn-off**: Make sure that the printhead voltage is removed simultaneously or before the logic voltage.

The following table gives all the printhead electrical characteristics:

ITEM	SYMBOL	MIN.	TYP.	MAX.	UNIT
Print voltage	VH	4.2	5.0	8.5	V
Logic voltage	Vdd	4.75	5.00	5.25	V
Logic current	Idd	-	-	24	mA
Input voltage (High)	V_{IH}	0.8vdd	-	Vdd	V
Input voltage (Low)	V_{IL}	0	-	0.2vdd	V
Data input current (DI) High	I_{IH} DI	-	-	0.5	uA
Data input current (DI) Low	I_{IL} DI	-	-	-0.5	uA
STB 1 to 6 input current (High)	I_{IH} STR	-	-	30	uA
STB 1 to 6 input current (Low)	I_{IL} STR	-	-	-0.5	uA
Clock input current (High)	I_{IH} CLK	-	-	3	uA
Clock input current (Low)	I_{IL} CLK	-	-	-3	uA
Latch input current (High)	I_{IH} LAT	-	-	3	uA
Latch input current (Low)	I_{IL} LAT	-	-	-3	uA
Data out output voltage (High)	V_{OH} DO	4.45	-	-	V
Data out ouptput voltage (Low)	V_{OL} DO	-	-	0.05	V
Output voltage (driver out)	VOL	-	1.0	-	V
Clock frequency	fCLK	-	-	8	MHz
Clock width	twCLK	30	-	-	ns
Data setup time	tsetupDI	30	-	-	ns
Data hold time	tholdDI	10	-	-	ns
Latch width	twLAT	100	-	-	ns
Latch setup time	tsetup LAT	200	-	-	ns
Latch hold time	thold LAT	50	-	-	ns
Data out delay time	td DO	-	-	120	ns
STR setup time	tsetup STB	300	-	-	ns
Driver out delay time	tdo	-	-	5	us

Note: 1/The first bit of data (dot 1) entered is the first bit of data printed (FIFO), left side of TPH, top view (gearing side of the printer).
2/ STB 1 to STB 3 drive one third of the printhead, starting from dot 1.

3.7. Thermistor

When performing continuous printing, it is recommended that the supply energy should be reduced so that the substrate temperature monitored through the thermistor will remain below the maximum temperature shown in section 3.2.

The thermistor specification is the following:

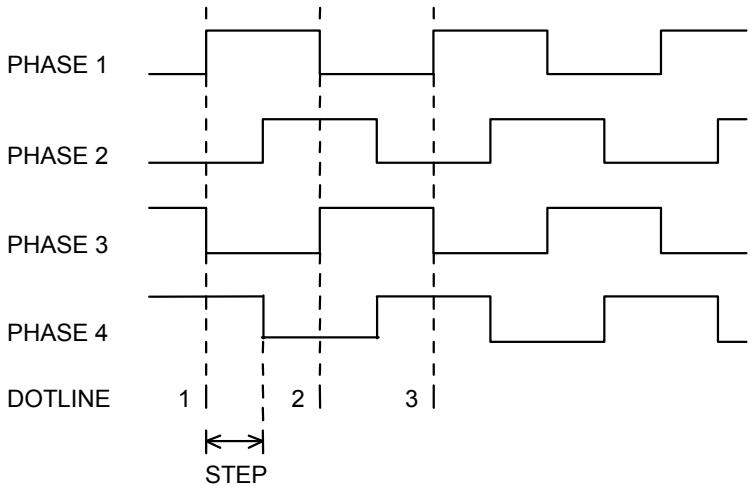
- R25, resistance at 25°C:	30	KOhms +/- 5% at 25°C
- B value:	3950	KOhms +/- 2%
- Operating temperature:	-20°C to +80°C	
- Time constant:	Max. 30 sec (in the air)	

Then the resistance value, R, versus temperature, T (in °C), is given by this formula:

$$R(T) = R25 * e^{B*(\frac{1}{T+273}-\frac{1}{25+273})}$$

4. Stepper motor

The paper feed pitch for stepper motor is 2 steps for one dotline (0,125 mm). For good print quality you are advised to keep the current into the windings between two successive dotlines.
The timing diagram is then as follows:



There are four different positions for the stepper motor. The driving is bipolar and can be achieved with circuits like Rohm BA6845FS. Please refer to the IC's data sheet for further informations. It is recommanded not to exceed 0.2v like voltage drop in the stepper motor driver circuit.
The coil resistance is 22 Ohms and rated current is 340 mA (5 volts) when paper is fed at 20 mm/s.

Note: With a maximum speed of 8 mm/s automatic paper loading can be achieved (with head in down position) at 5V minimum.

4.1. Paper feed speed versus voltage

The following chart gives the maximum paper feed speed versus the stepper motor voltage

MP105	PAPER FEED	Duty Cycle (%)
Voltage	MP105	MP105
4.2	35	70
4.5	37	51
5	45	38
5.5	50	32
6	55	25
6.5	60	22
7	65	19
7.5	70	16
8	75	12
8.5	80	10

In order to avoid stepper motor overheat, it is strongly advised to respect the maximum ON/OFF duty cycle as indicated above. Note that the maximum period for the ON time is 30 seconds (when the duty cycle is not 100%).

Example : at 7 volts, the duty cycle must be less than 19%. So the maximum ticket length at the maximum speed is 30s at 65mm/s so 1.95 meters. Then the printer must rest for 81/19*30s = 128 seconds.

5. How to optimize speed consumption and maximum peak current

The printing speed is always a compromise between 3 parameters :

- Paper feed speed (function of voltage)
- Head activation time (function of voltage)
- Maximum peak current available (function of voltage and maximum number of dots simultaneously activated)

For a given voltage, and a maximum current available, it is easy to determine the maximum paper feed speed (MaxPFS), as indicated on the above chart. Then if the two others parameters are not limiting this speed this will also be the printing speed (MaxPS).

MaxPFS gives a time (by inverting) called SLT (scanning line time). In this time, the head must be activated. If this time is not long enough, MaxPS will be subsequently affected.

Then, the way of driving the head is a critical point in the thermal printing application. There are basically two ways of limiting the current in the head.:

1. Divide the head into fixed blocks (by 64 dots for example) and use the strobe lines to control the blocks to be activated. In this case. It is easy to implement but the printing speed will be very slow because the MaxPS will be the invert of the activation time times the number of blocks the head is divided in.

   Example: at 6 volts with the MP105, the activation time is 2.53ms*(25/36) = 1.76ms. If the maximum current available for the head is 2.4A, the maximum number of dots to be simultaneously activated will be 2.4Amps/(6volts/160Ohms)=64 dots. So the number of activation per SLT will be 192/64=3, giving a SLT of 3*1.76ms=5.28ms. then MaxPS will be 1/(8*5.28ms) = 23.7 mm/s. And MaxPFS is 55mm/s. So there is a big margin and the printing speed is relatively slow.

2. Divide the head dynamically, by counting the number of dots actually activated. The software is counting while loading the printhead, the actual number of "black" dots. When the number of black dots has reached the maximum value (in this example the value will be 64) the software will fill the remaining dots with "0" and activates the strobes line. Doing so the activation will be always done with the maximum number of black dots allowed, so optimizing the number of times the head needs to be activated. Printing standard text, the average number of black dots is usually less than 64 and sometimes reach 128.

   Example: In the same conditions of the previous example, MaxPS will be multiplied by 3, or sometimes by 3/2. Let take that 30% of the lines contains from 64 to 128 black dots, the average MaxPS will be (55(#))*0.7 + (23.7*3/2)*0.3 = 49 mm/s, getting close to the MaxPFS, and optimizing all the parameters.
   (#) : we take 55 because 11.8*6 =70.8 > MaxPFS.

6. Sensors

6.1. Head up and down

The head-up function works as follows. The wire spring that presses the head against the rubber roller can rotate. This in turn releases the pressure against the head and opens it. There is no sensor motoring the position of the spring. Please note that the life of the thermal head will not be affected as the life of the head was originally qualified with the head exposed to the air.

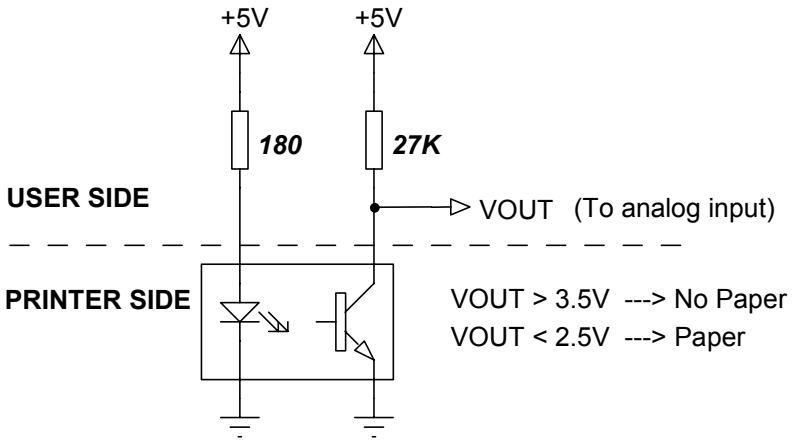
6.2. End of paper sensor

MP105 has an end of paper sensor that functions using a photo-transistor. Arrange the circuitry so that no energy is applied to the head when the mechanism runs out of paper. If the head is energized in the down position and with no paper in the mechanism, both roller and head may get severely damaged.

General specifications:

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Forward voltage (photodiode)	V_F	I_F = 10mA	-	-	1.3	V
Reverse current	I_R	V_R= 5V	-	-	10	µA
Output dark current	I_{CEO}	V_{CE}= 10V	-	-	0.2	µA
Light current	I_L	V_{CE} = 5V I_F = 10mA	180	-	660	µA
Rise Time	T_R	V_{CE} = 2 V I_C = 0.1 mA R_L = 1KΩ	-	30	-	µs
Fall time	T_F		-	25	-	µs

One possible interfacing of the opto sensor circuit is shown in the figure below.



7. Pin out assignement

7.1. Flexi-cable connector

One flexy cable is gathering all signals. The pitch at the end of the flexy is 1mm.
FPC connector can be : JST 22FMN-BMT-TF

7.2. FPC Signals

Pin Number	Signal name	Function
1	CO	Collector of photo-transistor
2	L_GND	Gnd for logic
3	VF	Anode of photo-sensor
4	VH	Dotline voltage
5	VH	Dotline voltage
6	DI	Data input
7	P-GND	Gnd for dotline
8	P-GND	Gnd for dotline
9	P-GND	Gnd for dotline
10	P-GND	Gnd for dotline
11	TM	Thermistor first terminal (second in Gnd)
12	STB3	Third strobe
13	STB2	Second strobe
14	STB1	First strobe
15	Vdd	Logic voltage
16	CLK	Serial clock
17	\LAT	Latch
18	VH	Dotline voltage
19	SM1	First phase of stepper motor
20	SM2	Second phase of stepper motor
21	SM3	Third phase of stepper motor
22	SM4	Fourth phase of stepper motor

8. Life in standard printing conditions

Life is defined as a change in the resistance value of any dots equal to 15% from their initial value.
Head temperature shall not exceed 60°C max. during normal operations.

Then:

- Pulse life : 100.10^6 Pulses
- Abrasion life: 30 kms guaranteed

9. Mechanical and housing

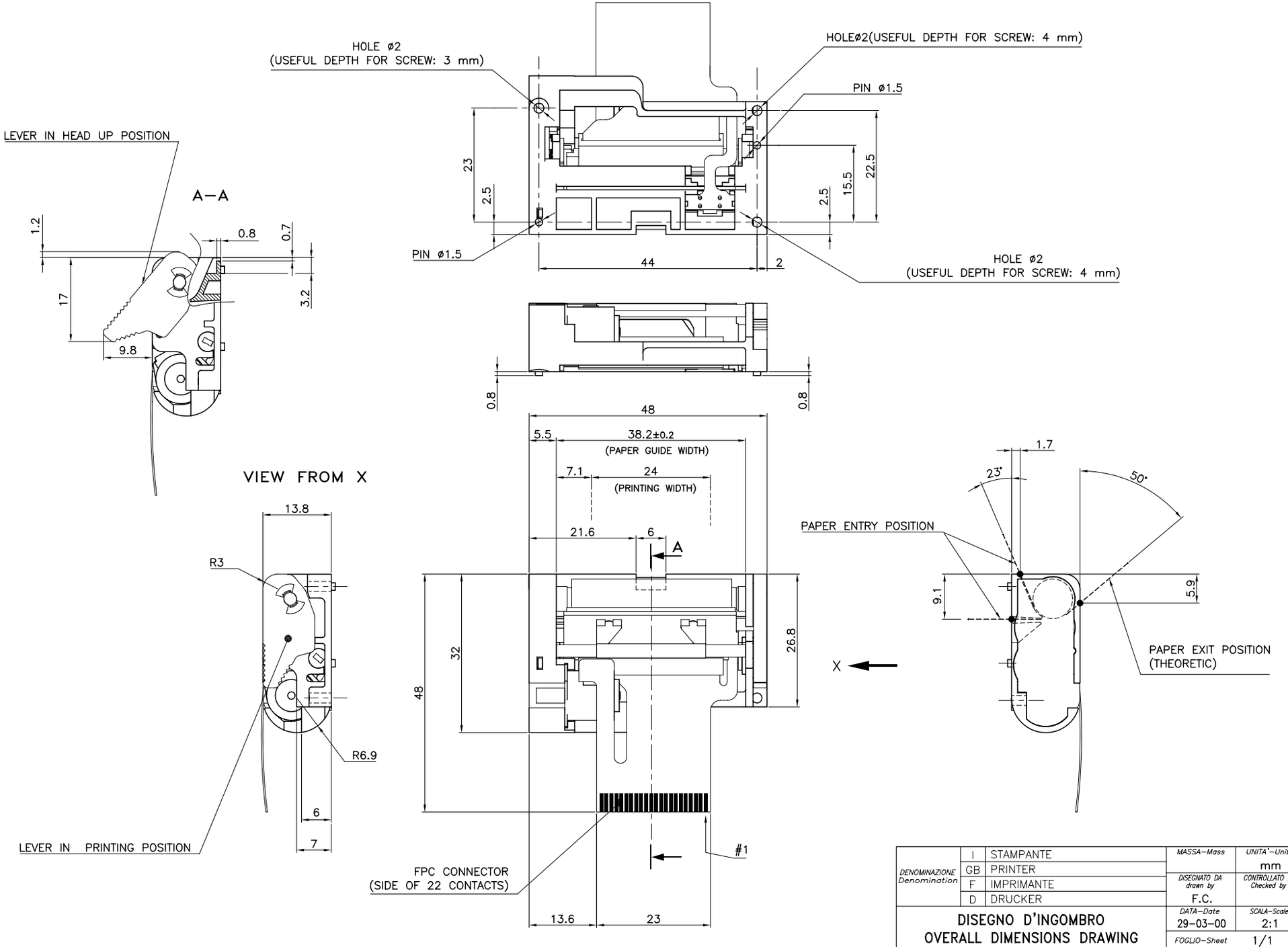
See attached drawing.

Note: The printer is delivered with the opto-sensor mounted for the front paper entry. For using the bottom paper entry, please remove the opto-sensor from its location and insert it in the vertical guide on the back of the bottom paper guide.

10. Ordering code

Type	Ordering code
MP105 standard	**MP105**

REVISIONI (Revisions) : A ▶ ISSUE. MODIFIED SOME PROFILES,OLD P.N. WAS P1162.(12-MAY-00 FC) B ▶ TDP-2000-04/FLEXI CONNECTION POSITION CORRECTED (04-SEP-00-DA)



DENOMINAZIONE Denomination	I	STAMPANTE	MASSA–Mass	UNITA'–Unit
	GB	PRINTER		mm
	F	IMPRIMANTE	DISEGNATO DA drawn by	CONTROLLATO DA Checked by
	D	DRUCKER	F.C.	
DISEGNO D'INGOMBRO OVERALL DIMENSIONS DRAWING			DATA–Date 29-03-00	SCALA–Scale 2:1
			FOGLIO–Sheet 1/1	FORMATO–Size A2
CATALOGO/Catalog MP105			N° DIS.–Draw.No 90 105 001	REV. B