EPM205-LV
EPM205-HS

Technical Reference

Preface

- This manual provides a complete technical information about **EPM205** series, thermal line printer mechanisms.
- If not specified, the data of the present specification are valid for all the types of printers, when the specification of the printer is different, according to the type, its specification is described with annotation.
- For customized printers, **A.P.S.** supplies documentation in addition to the present specification.
- The present specification is valid also for customized types, where the different condition has not effects for common data (eg. different length of elec. cables).
- More information is available upon request such as high speed printing applications and reliability figures.

- **A.P.S.** reserves the right to make changes to the product, without notice, to improve reliability, functions or design.
- **A.P.S.** does not assume any liability arising out of the application or use of the product or circuits described within.
- The warranty terms of the product are described in a separate document, ask **A.P.S.** to obtain this document.

Revision history

Rev. Index	Date	Page/Sec.	Description	Author
A	13-May-2002	-	First issue	AF
-	-	-	-	-

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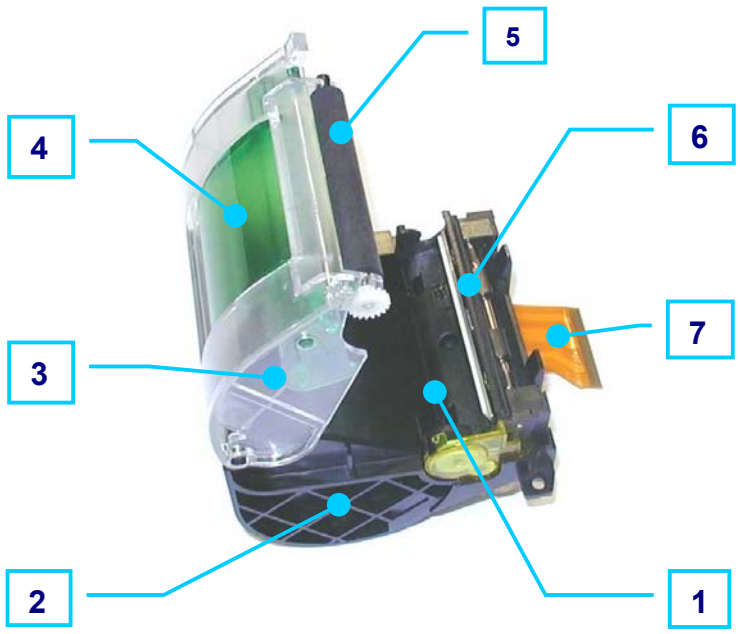
1. INTRODUCTION

The **EPM205** is a 2 inch, from 2.7V to 8.5V, Easy Loading Printing Module with an integrated paper roll housing.
The EPM module consists of a set of mechanical and electrical parts, these parts have been designed to have an high grade of integration between Printer and Housing.

The sections that form the EPM module are described in the following image.

1. Printer mechanism, easy loading type
2. Paper roll housing
3. Cover
4. Lever, for easy opening
5. Roller
6. Tear bar, for paper cutting
7. FPC for electrical connection



1.1. EPM205 features

- Patented Easy loading and Easy Door Opening System
- Ultra compact design
- Up to 80 mm/s printing speed
- Ultra light (95g)
- High resolution printing (8 dots/mm)
- Life of 100 million pulses, 50 km
- Low consumption
- Low noise due to its technology (thermal)

2. GENERAL CHARACTERISTICS

Item	Specification	
Printing method	Thermal dot line printing	
Number of dots/line	384	
Dots density (dot/mm)	8	
Printing width (mm)	48 (centred on paper)	
Paper width (mm)	58 +0/-1	
Paper roll size (mm)	Max. Ø49.5 (outside diameter)	
Paper feed pitch (mm)	0.0625 (every 1 step of the motor drive signal)	
Printing pitch (mm)	0.125 (every 2 steps of the motor drive signal)	
Paper feed tension (gf)	50 or more	
Paper hold tension (gf)	80 or more	
Dimensions W x D x H (mm)	79.1 x 77.8 x 60	
Weight (g)	Approx. 95	
Head temperature detection	Thermistor	
Head-up detection	Photo-interrupter (gathered with the paper end sensor)	
Paper end detection	Photo-interrupter	
Operating voltage range (V)	**EPM205-LV** Dots : 2.7-7.2 / Logic: 2.7-5.25 **EPM205-HS** Dots : 4.5-8.5 / Logic: 2.7-5.25	
Current consumption	At printing (5V): (64 dots ON)	1.9 A (Head dots)
		0.5 A (Motor)
		50 mA (Head Logic)
	At paper feeding (5V):	0.5 A (Motor)
		<100 µA (Head Logic)
Recommended Paper	JUJO-AF50KS-E (standard grade) JUJO-AF50KS-E3 (high sensitivity) Equivalent types can be used	
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)	

Mechanism life	Durability	Basic conditions	Maximum variations
Thermal head pulse resistance	100 million pulses	- Room temp.: 20 ÷ 25 °C - Head temp.: 65 °C max. - Rated energy	Max. 15% in resistance value (Ω) of any dot, from its initial value
Abrasion/wear resistance	50 km of paper		
Cover Group, Opening/closing cycle	2000 operations or more		-

3. THERMAL HEAD AND PRINTING CONFIGURATION

3.1. Outlines

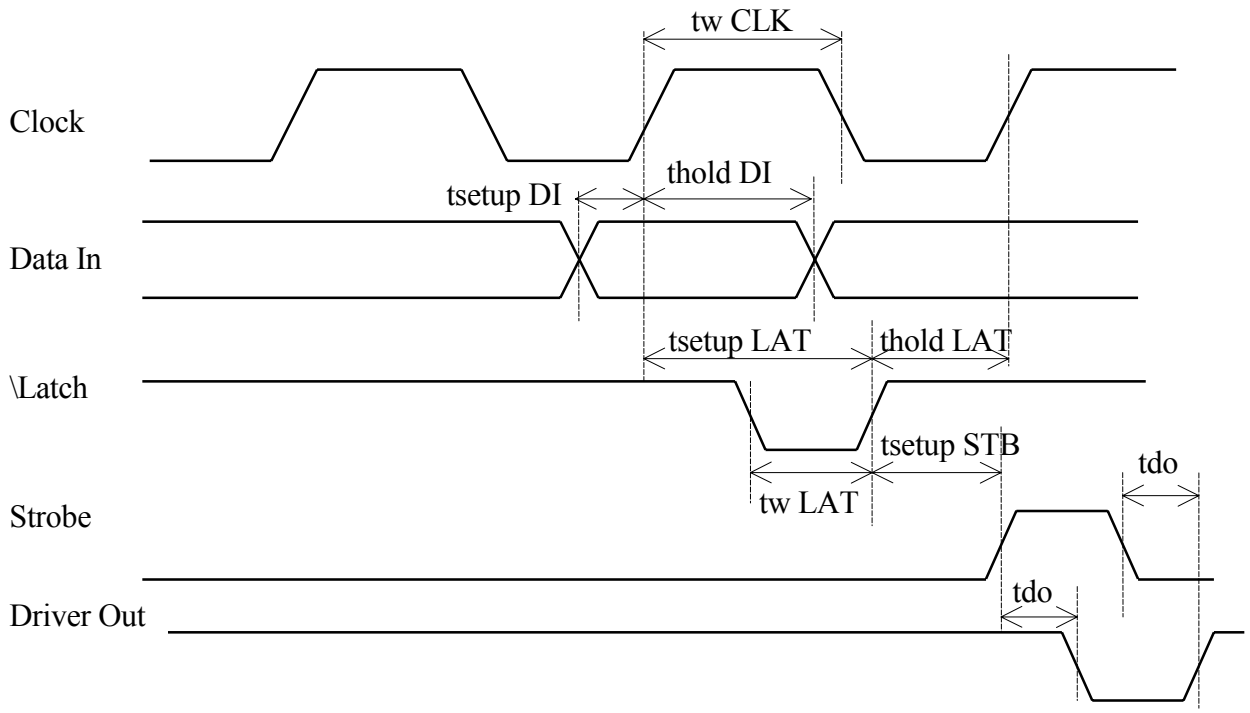
Heat element structure:	2 heaters/dot
Number of heat elements:	384 dots
Heat element pitch:	0.125 mm
Average resistance:	**LV** - 123 Ω ±4%
	HS - 176 Ω ±4%

3.2. Thermal head electrical characteristics

Item	Symbol	Min.	Typ.	Max.	Unit
Print voltage	VH	-	5.0	**LV**= 7.2 **HS**= 8.5	V
Logic voltage	Vdd	2.7	5.00	5.25	V
Logic current	Idd	-	-	48	mA
Input voltage (High)	VIH	0.8 x Vdd	-	Vdd	V
Input voltage (Low)	VIL	0	-	0.2 x Vdd	V
Data input current (DI) High	IIH DI	-	-	0.5	µA
Data input current (DI) Low	IIL DI	-	-	-0.5	µA
STB 1 to 6 input current (High)	IIH STB	-	-	30	µA
STB 1 to 6 input current (Low)	IIL STB	-	-	-0.5	µA
Clock input current (High)	IIH CLK	-	-	3	µA
Clock input current (Low)	IIL CLK	-	-	-3	µA
Latch input current (High)	IIH LAT	-	-	3	µA
Latch input current (Low)	IIL LAT	-	-	-3	µA
Data out output voltage (High)	VDOH	4.45	-	-	V
Data out output voltage (Low)	VDOL	-	-	0.05	V
Output voltage (driver out)	VOL	-	1.0	-	V
Clock frequency	f CLK	-	-	8	MHz
Clock width	tw CLK	30	-	-	ns
Data setup time	tsetup DI	30	-	-	ns
Data hold time	thold DI	10	-	-	ns
Latch width	tw LAT	100	-	-	ns
Latch setup time	tsetup LAT	200	-	-	ns
Latch hold time	thold LAT	50	-	-	ns
Data out delay time	td DO	-	-	120	ns
STB setup time	tsetup STB	300	-	-	ns
Driver out delay time	tdo	-	-	5	µs

3.3. *Timing chart*

The following chart gives the timing for driving the print-head:



3.4. Maximum conditions at 25°C

Item	Maximum conditions		Unit
	LV	HS	
Supply energy	0.26	0.2	mJ/dot
Print cycle	2.5	1.25	ms/line
Supply voltage	7.2	8.5	V
Logic voltage	7		V
Head temperature	65		°C
Number of dots to be energized simultaneously[1]	192		dots

Notes:

- If energy applied to one dot, exceed the maximum value indicated on the above table, the print quality of this dot may be definitively affected (usually makes a "light" print-out).
- If 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 A.P.S. for more information.
- When using double-ply paper or special low energy paper, please contact A.P.S. for more information.

3.5. Typical printing conditions

Item	Symbol	Electrical conditions		Unit	
		LV	HS		
Supply voltage	VH	3.6	7.2	V	64 dots fired at the same time
Power consumption	Po	0.07	0.24	W/dot	
Print cycle	S.L.T.	2.5	1.25	ms/line	
Energy consumption and ON Time at different working temperatures	Eo	0.17	0.16	mJ/dot	**5 °C**
	Ton	2.28	0.67	ms	
	Eo	0.15	0.13	mJ/dot	**25 °C**
	Ton	2.01	0.54	ms	
	Eo	0.13	0.11	mJ/dot	**45 °C**
	Ton	1.74	0.46	ms	
Supply current	Io	1.6	2.4	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 is defined as all dots printing pattern (100% black area) printed under correct paper speed.

[1] This condition satisfies the print density as defined in section 3.5

3.6. Heating time calculation

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

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

Where:

E_0 is the nominal energy
V_H is the driving voltage
R_{av} is the average resistance
N is the number of dots energized simultaneously
R_{com} is the common resistance (0.05 Ω)
R_{ic} is the driver saturated resistance (10 Ω)
R_l is the lead resistance (10 Ω)

3.7. Thermistor

When performing continuous printing, it is recommended that the supply energy be reduced so that the substrate temperature monitored through the thermistor will remain below 65°C.

The thermistor specification is the following:

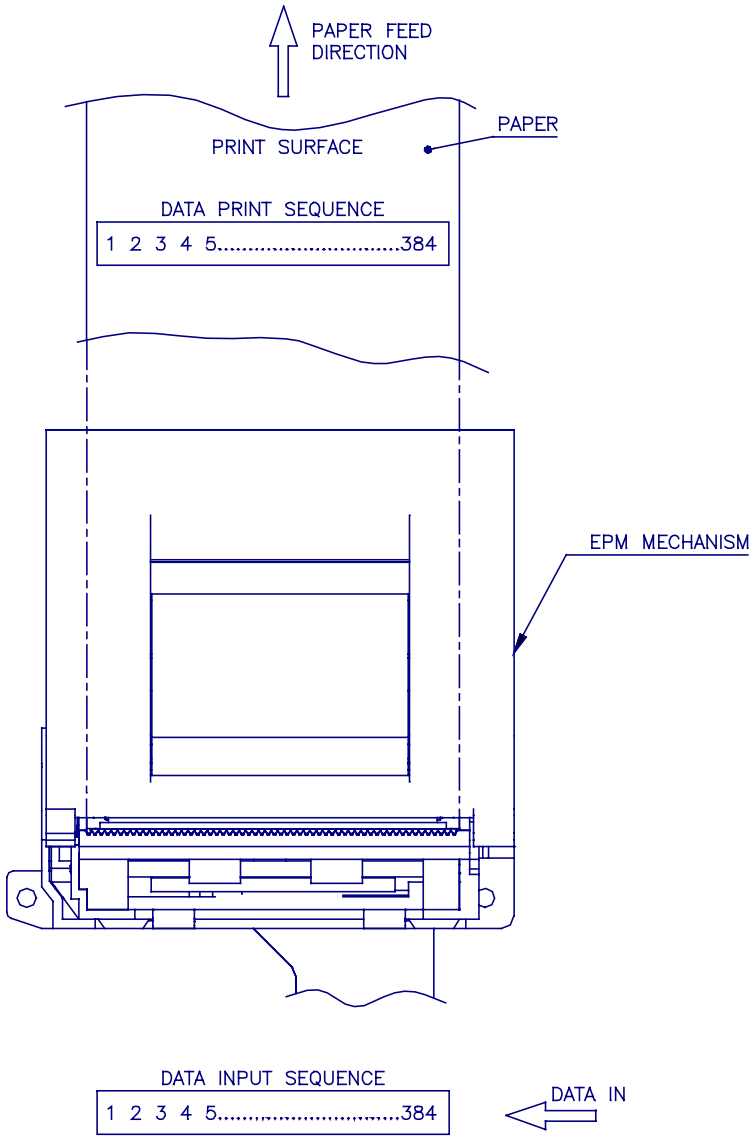
- R25, resistance at 25°C:	30 KΩ ±5%
- B value:	3950 KΩ ±2%
- Operating temperature:	-20°C to +80°C
- Time constant:	Max. 30 s (in the air)

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

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

3.8. Print position of the data

- 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).
- STB 1 to STB 6 are driving one sixth of the print-head, starting from dot 1.



3.9. Operating precautions

1- When performing continuous printing, the supply energy should be reduced so that the substrate temperature, monitored through the thermistor, will remain below 65°C.
2- All strobes signals must be disabled during the power and logic voltage ON/OFF sequence.
3- Do not touch the connector pins with naked hands.
4- The print-head substrate surface is coated with glass, for this reason, mechanical stresses, shocks, dust and scratches should be avoided to prevent damage.
5- When the print-head operation is completed, print supply voltage (including the charged voltage with capacitor) should be reduced to the ground level and maintained until next print-head operation.
6- Avoid condensation, if condensation occurs, do not switch ON the print-head power, until condensation has disappeared.
7- When plugging in and out of the connectors, avoid using excess force as damage may result (Plug in-out cycle for this connector should not exceeded 20 times). Do not pick up the mechanism by the connectors.
8- Print quality would become degraded if paper or ink residue were stuck on the heat element area. In this case, clean the print-head with an applicator and alcohol. Do not use the sandpaper as this will destroy the heating elements.
9- If sticking sound, is heard while printing, please check and adjust the paper feed mechanism and the electrical pulse program to eliminate the sound.
10- Make sure the paper does not have high abrasion factor, low sensitivity or abnormal chemicals.
11- To avoid surges and voltage losses, a 47 µF aluminium capacitor between VH and GND is necessary on customer's controller board side.

Important precautions

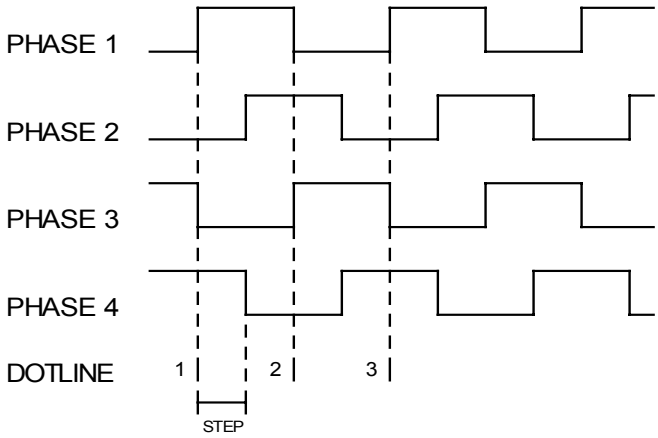
To prevent any dot element damage:
At power up make sure that logic voltage (Vdd) is present simultaneously or before VH.
At power down make sure that VH is at 0 V before removing logic voltage.

4. STEPPER MOTOR

4.1. Stepper motor Timing

The paper feed pitch for stepper motor is 2 steps for one dot-line (0.125 mm). For good print quality it is advised to keep the current into the windings between two successive dot-lines.

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, Sanyo LB1836 or LB1838 or Hitachi HA13421. Please refer to the IC's data sheet for further information. It is recommended not to exceed 0.2v like voltage drop in the stepper motor driver circuit.
Coil resistance is 12 Ω, rated current is 300 mA (5V) per phase while feeding at 10mm/s.
In case of high voltage or continuous printing application, contact APS for current application circuitry.

4.2. Paper feed speed versus voltage

The following table gives the maximum paper feed speed versus the stepper motor voltage and duty cycle for the stepper motor driving.

EPM205-LV/HS		
Motor voltage (V)	**Paper feed speed (mm/s)**	**Duty cycle (%)**
2.7	23	100
3	35	100
3.3	37	100
3.6	40	100
4	47	100
4.5	50	80
5	56	60
5.5	59	50
6	62	40
6.5	68	35
7	72	30
7.5	80	25
8	85	20
8.5	90	15

Notes:

- To avoid overheating the stepper motor, it is strongly advised to respect the on/off duty cycle as indicated above (when performing continuos printing and/or paper feeding).
- The maximum period for the ON time is 30 seconds (when the duty cycle is not 100%).
- The Duty cycle depends only on motor voltage, so, for instance: at 6V, the paper feed speed can be less than 62mm/s, but the duty cycle remains 40%.

To compute the **off Time**, apply the following formula:

$$offTime = \frac{onTime}{DutyCycle} - onTime$$

Example : supposing an **on Time** of 15s, at 6 V, from the table we obtain a duty cycle value of 40%, so:

$$offTime = \frac{15}{\left(\frac{40}{100}\right)} - 15 = 22.5s$$

On the above example, if the **EPM205** works consecutively for 15 seconds, it must rest for 22.5s to allow the motor to cool down.

5. HOW TO OPTIMIZE SPEED, CONSUMPTION AND MAX. PEAK CURRENT

The printing speed is always a compromise between 3 parameters :

- Paper feed speed (function of voltage).
- Head activation time Ton (function of voltage and temperature).
- Maximum peak current available (function of voltage and maximum number of dots simultaneously activated and directly related to power supply capabilities).

For a given voltage it is easy to determine the maximum paper feed speed (MaxPFS), as indicated on the table of section 4.1. So, if the two others parameters (current and Ton) are not limiting, maximum paper feed speed (MaxPFS) becomes equal to maximum printing speed (MaxPS).

MaxPFS gives a time (by inverting) known as S.L.T. (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 method of driving the head is a critical point in a thermal printing application. There are two basic methods to limit 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. This method is easy implement, however the printing speed will be very slow because the MaxPS will be the invert of the activation time multiplied by the number of blocks the head is divided into.

   Example: at 6 V with the **EPM205**, the activation time is $2.53ms*(5^2/6^2) = 1.76ms$. If the maximum current available for the head is 2.4A, the maximum number of dots to be simultaneously activated will be 2.4A/(6V/160Ω)=64 dots. So the number of activation per S.L.T. will be 384/64=6, giving a S.L.T. of $6*1.76ms=10.6ms$. Therefore, the MaxPS will be $1/(8*10.6*10^{-3}) = 11.8$ mm/s. and MaxPFS is 62mm/s. So there is a big margin and the printing speed is relatively slow.

2. Divide the head dynamically performed by counting the number of dots actually activated. The software counts the actual number of "black" dots while loading the print-head. When the number of black dots reaches the maximum value (in this example the value will be 64) the software fills the remaining dots with "0" and activates the strobes line. As a result the activation is the maximum number of black dots allowed, by the given value, thereby optimizing the number of times the head needs to be activated. Printing standard text, the average number of black dots is generally less than 64 and sometimes reach 128.

   Example: referring to the above example, the MaxPS is multiplied by 6, or sometimes by 3. Let take that 30% of the lines contains from 64 to 128 black dots, the average MaxPS will be $62*0.7 + (11.8*3)*0.3 = 54$ mm/s, getting very close to the MaxPFS, and optimizing all the parameters.

6. SENSORS

6.1. Door open

In order to optimize and decrease the number of elements of the **EPM**, the opto sensor performs dual functions - door open and end of paper detection. The shape and distance from the opto sensor to the paper is designed in a way that as soon as the door is opened, the distance between the paper and the sensor increases, and this causes the end of paper sensor to trigger.

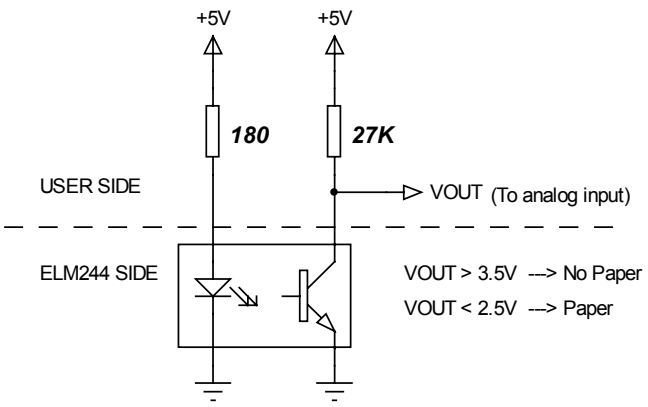
6.2. End of paper sensor

The **EPM205** has an end of paper sensor achieved by a photo-transistor. Arrange the circuitry so that no energy is applied to the head when there is no paper. If the head is energized when there is no paper and the head is in the down position, then both roller and head may be strongly damaged.

OPTO characteristics:

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	-	440	µA
Rise time	T_R	V_{CE} = 2V I_C = 0.1 mA R_L = 1KΩ	-	30	-	µs
Fall time	T_F		-	25	-	µs

One possible interfacing is as follows:



7. PIN OUT ASSIGNMENT

One flexy cable is gathering all signals. The pitch at the end of the flexy is 1mm.
FPC connector can be: JST 27FMN-BMT-TF

EPM205-LV-HS		
Pin number	**Signal name**	**Function**
1	CO	Collector of photo-transistor
2	VF	Anode of photo-sensor
3	L-GND	Gnd for logic
4	VH	Dot-line voltage
5	VH	Dot-line voltage
6	DI	Data input
7	STB6	Sixth strobe
8	STB5	Fifth strobe
9	STB4	Fourth strobe
10	P-GND	Gnd for dot-line
11	P-GND	Gnd for dot-line
12	P-GND	Gnd for dot-line
13	P-GND	Gnd for dot-line
14	TM	Thermistor first terminal (second is Gnd)
15	STB3	Third strobe
16	STB2	Second strobe
17	STB1	First strobe
18	Vdd	Logic voltage
19	CLK	Serial clock
20	\LAT	Latch
21	DO	Data output
22	VH	Dot-line voltage
23	VH	Dot-line voltage
24	SM4	Fourth phase of stepper motor
25	SM3	Third phase of stepper motor
26	SM2	Second phase of stepper motor
27	SM1	First phase of stepper motor

Note: For pin #1 position, refer to the drawings at the end of this document

8. MECHANICAL & HOUSING

8.1. Overall dimensions and fixing points

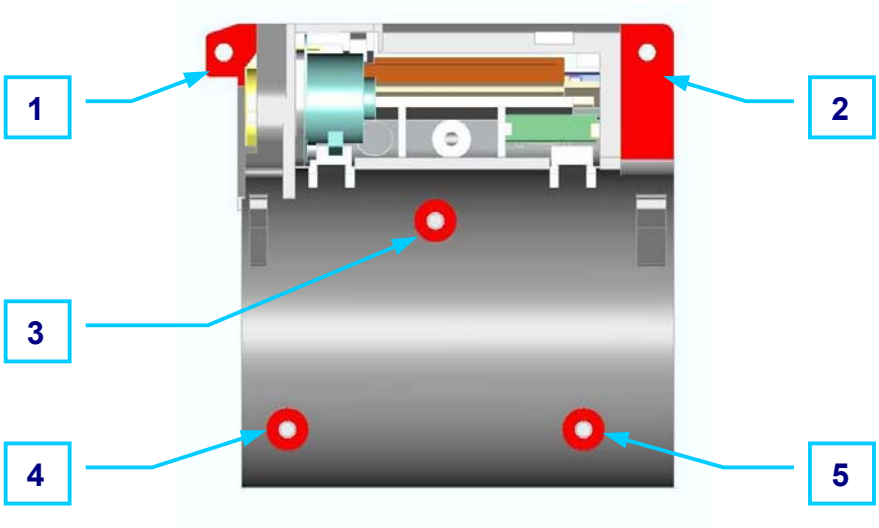
See attached drawings for overall dimensions and recommended screws.
3D-IGES file, for mechanical details, is available upon request, ask APS for more information.

The mechanism has to be fixed using the fixing points provided for this purpose.
There are two possibilities:

- Using points 1-2-4-5 (all of them simultaneously).
- Using points 3-4-5 (all of them simultaneously).

To avoid any kind of deformation or distortion, a flat surface for contact areas is required, if not, the print quality and printer's life will be drastically reduced.
Points 3-4-5 are on the same plane, at the mounting base of the EPM.
Points 1-2 are on the same plane and have a 19.2mm distance from the mounting base plane (see also attached drawing).
The image below, shows the matching areas to be used for fixing, they are highlighted in red colour.

Bottom view of EPM205



8.2. Mounting precautions

Orientation according to figure A-B is to be preferred, reliability and life tests have been based only according to this orientation.
Alternatively, it is possible to choose different orientation angles as shown in figures C-D-E.

FIGURE A

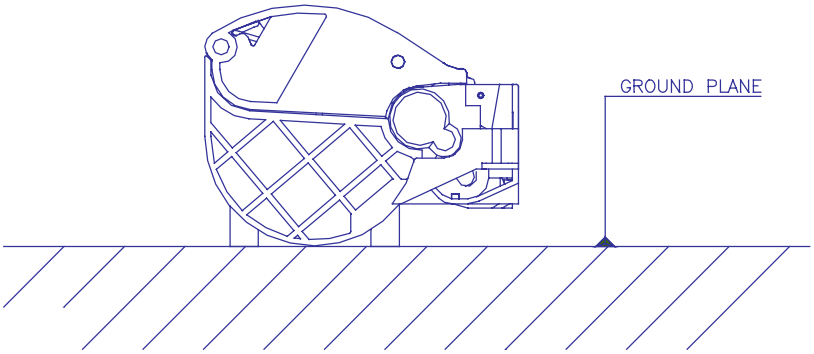
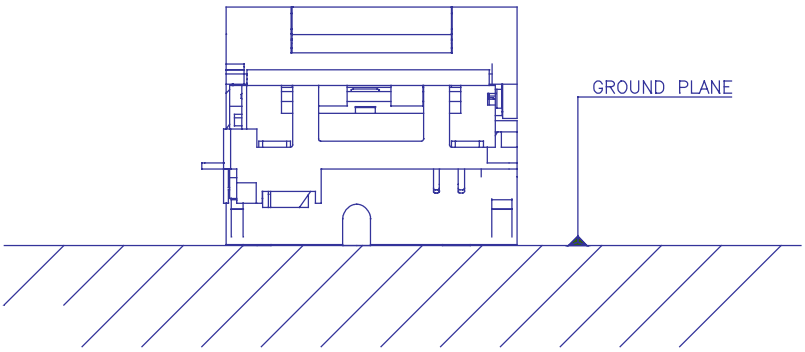


FIGURE B



Mounting precautions (continued)

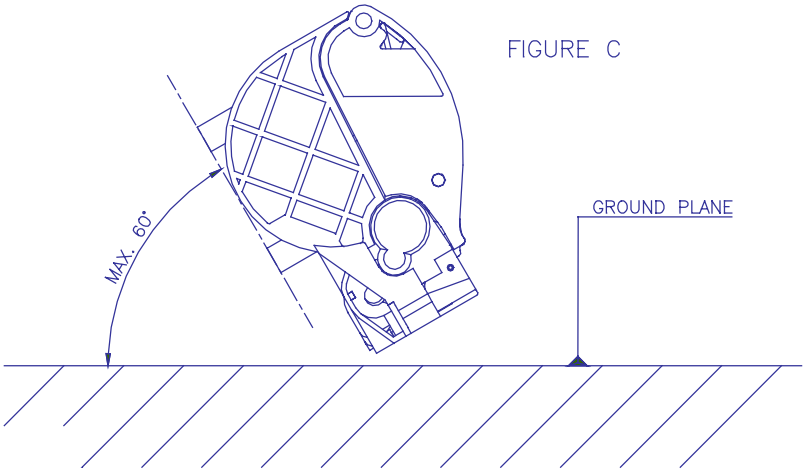


FIGURE C

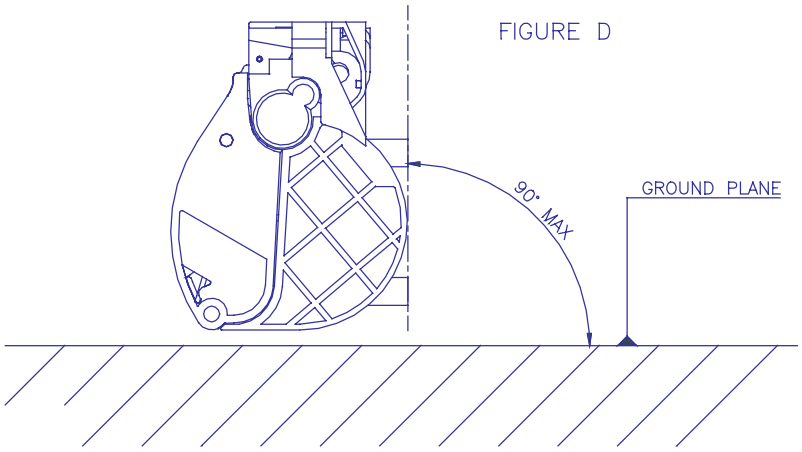
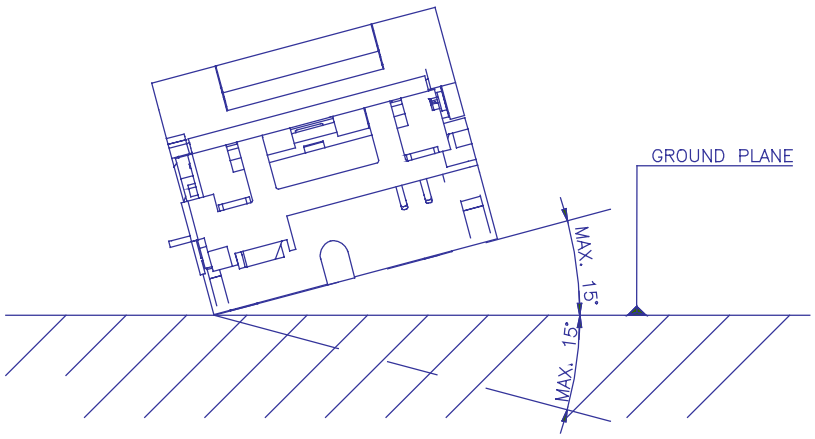


FIGURE D

Mounting precautions (continued)

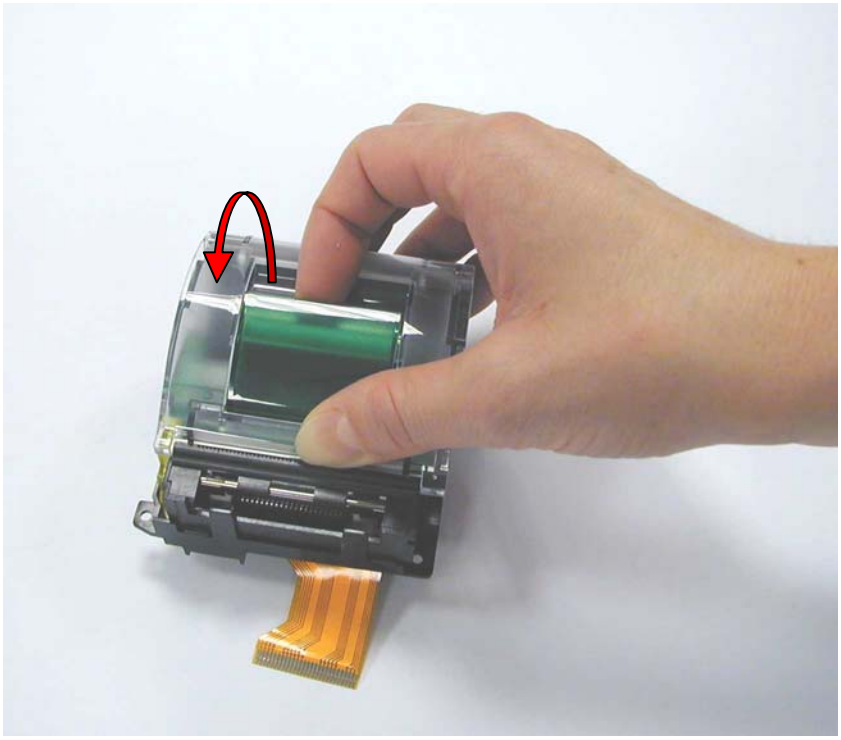
FIGURE E



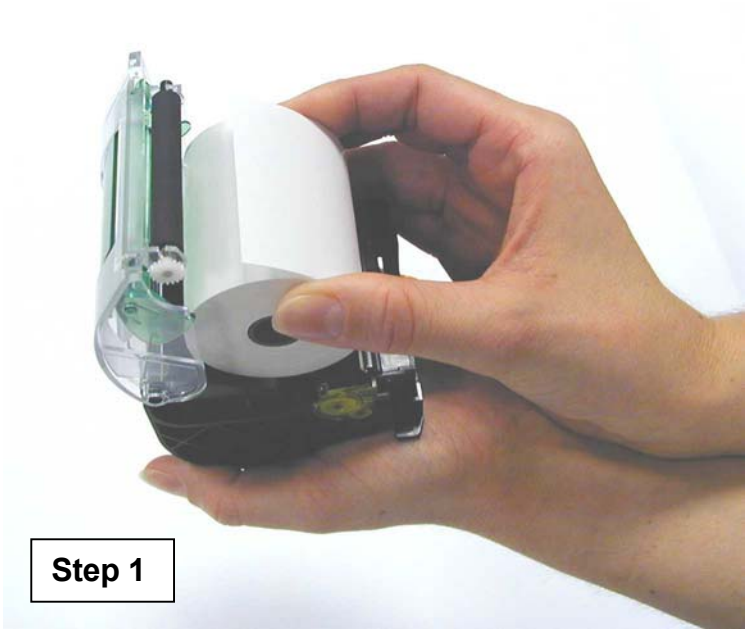
9. HANDLING THE EPM

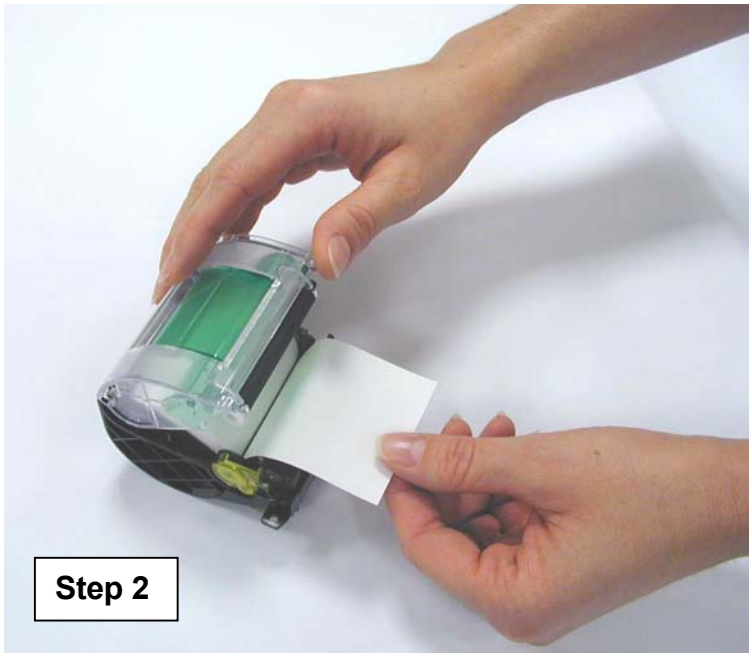
9.1. How to open the cover group

Lift the Lever, acting as indicated by the arrow, until the Cover Group is released from its locking position. To avoid damages to the Lever do not use excessive force.



9.2. How to load paper rolls





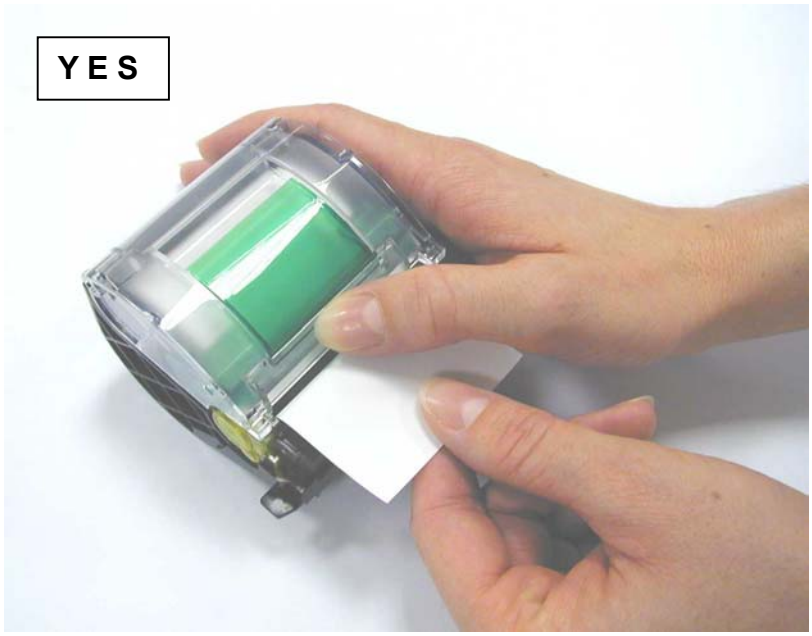
9.3. How to close the Cover Group correctly

Press on both sides of the Cover Group (simultaneously)

Y E S

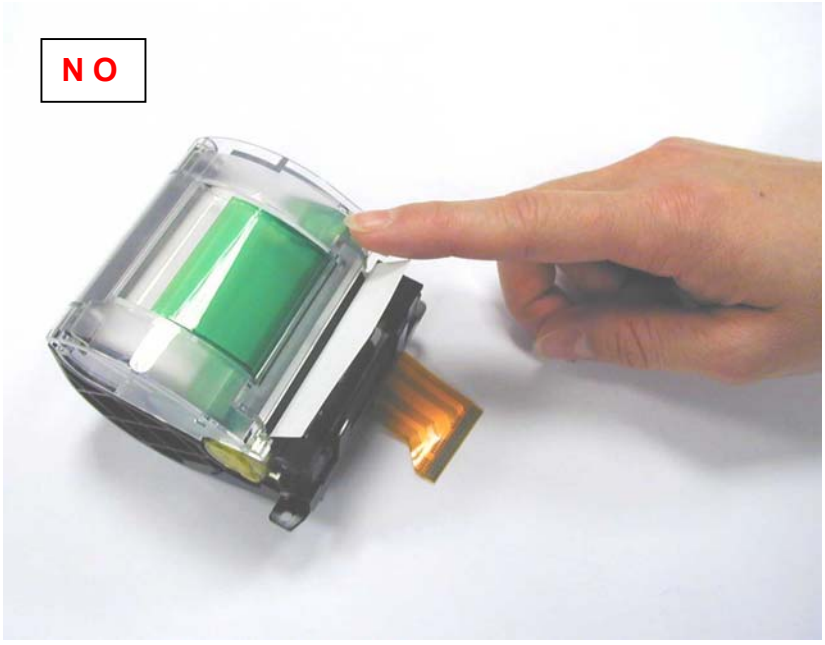
Alternatively:
Press on the middle area of Cover Group (near the paper exit).

Y E S



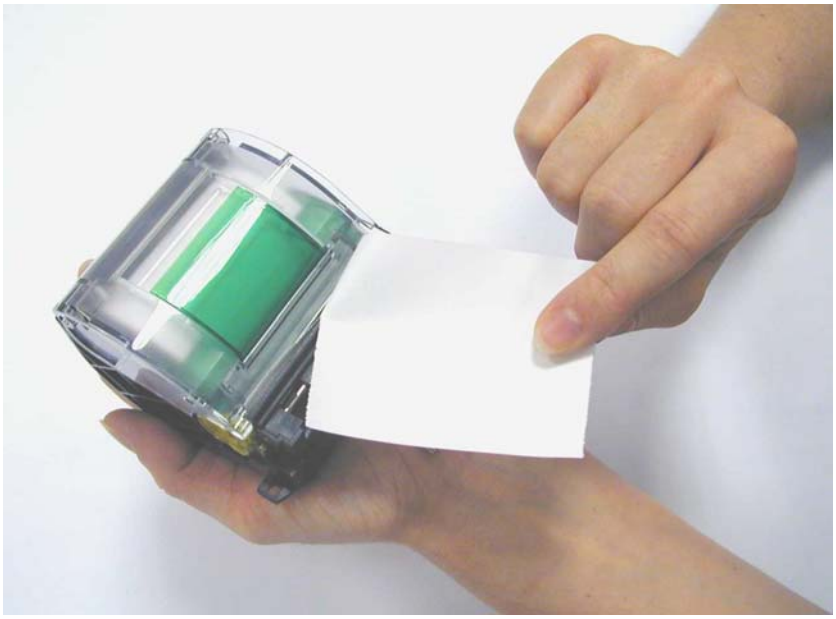
How to close the Cover Group correctly (Continued)

Do not close the Cover Group pressing only on one side.



9.4. How to cut the paper

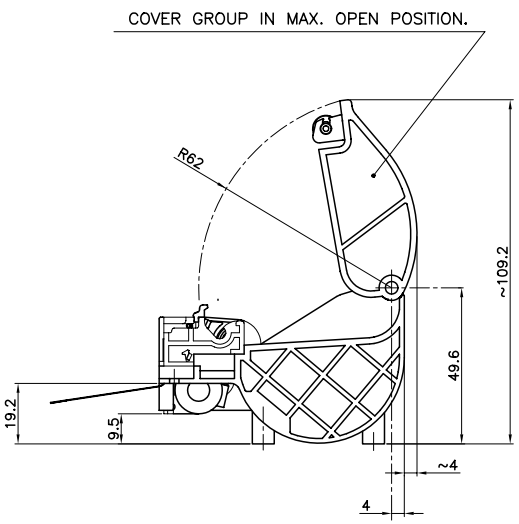
Pull the paper towards the Tear Bar from one side to the other.

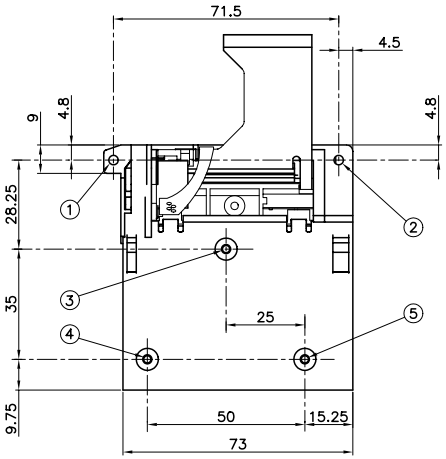


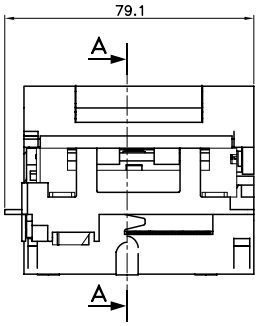
10. ORDERING CODE

Type	Ordering code
EPM205 Low Voltage (from 2.7V)	**EPM205-LV**
EPM205 High Speed (80mm/s)	**EPM205-HS**

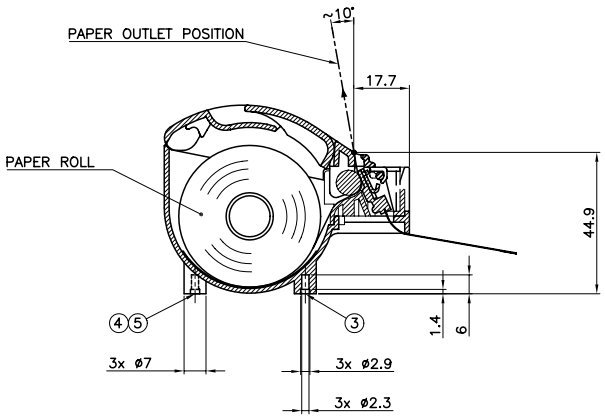
ATTACHED TO:
EPM205
TECHNICAL REFERENCE.
SHEET 1

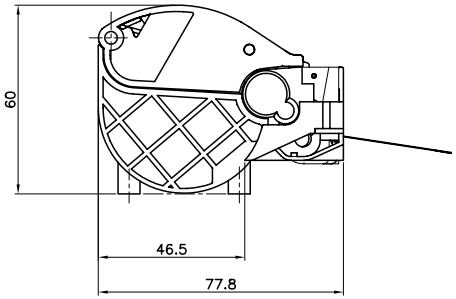




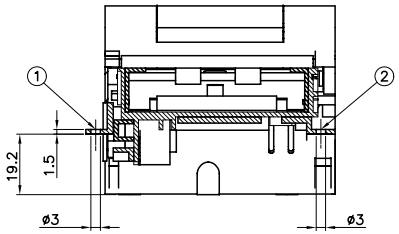


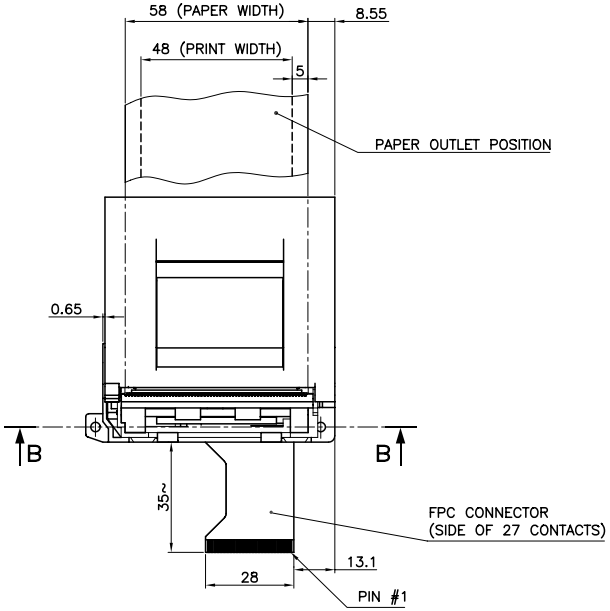
A–A





B–B





① ② ③ ④ ⑤ = POSSIBLE FIXING POINTS

DRAWING UPDATING: 03–MAG–2002

OVERALL DIMENSIONS	UNIT: mm
EPM205	APS

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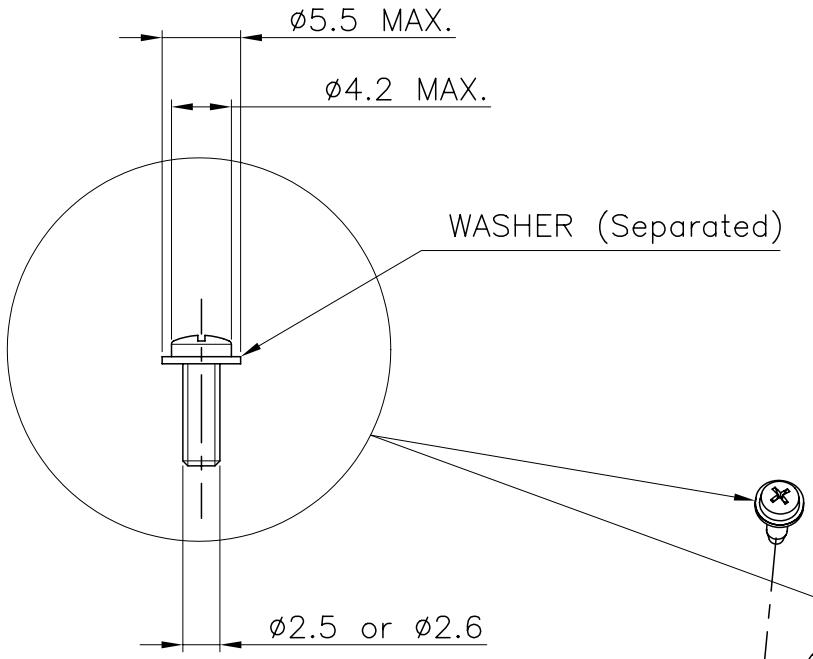
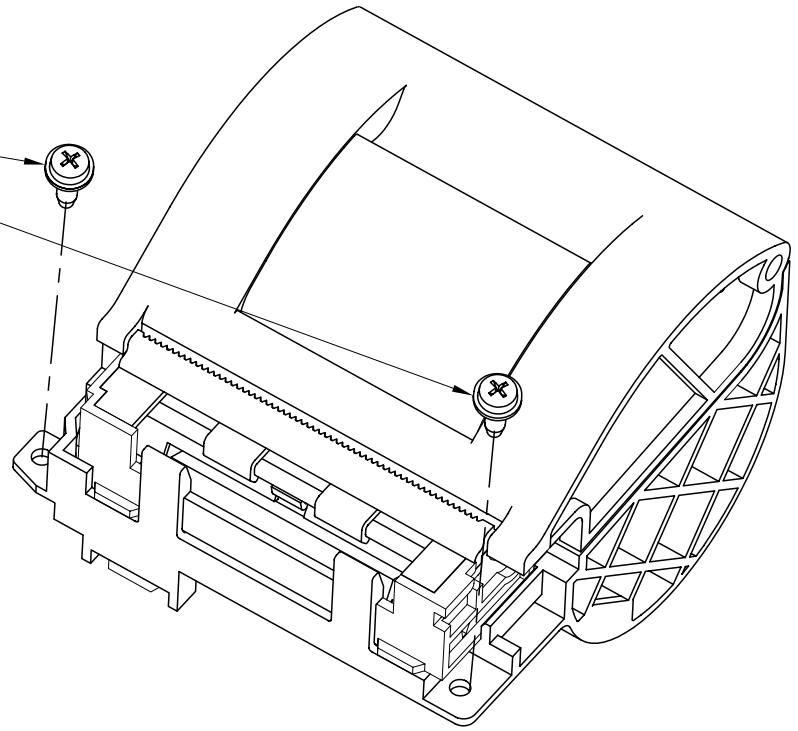
SHEET 2

RECOMMENDED SCREWS FOR FIXING

SCREW



SELF–TAPPING SCREW FOR PLASTIC
OR METRIC THREAD SCREW



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EPM205
TECHNICAL REFERENCE.
SHEET 3

RECOMMENDED SCREWS FOR FIXING