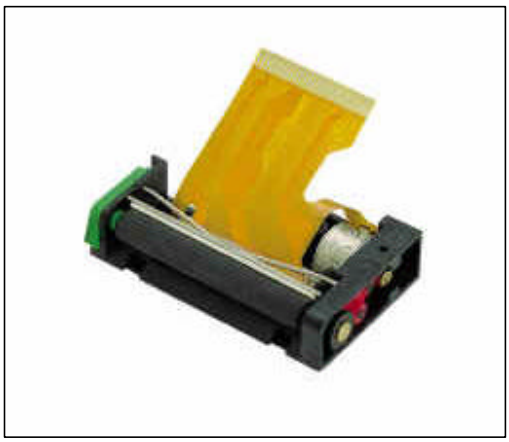
# MP 205

Technical reference



# 1. Introduction

## *1.1. MP 205*

The MP205 thermal printer mechanism is the smallest low voltage printer in the industry. The unique feature of combined lever/spring function offers a very compact solution with easy paper jam clerance.

## *1.2. MP 205 features*

- Very compact printer (height is 15mm, width is 68.2, depth is 41mm)
- Up to 60 mm/s printing speed
- Ultra light (40g)
- Starting operating voltage (logic and dots) from 3v up to 8.5v
- High resolution printing (8 dots/mm)
- Life of 100 millions pulses, 50 kms
- Low consumption
- Low noise due to its technology (thermal)
- Easy jam clearance due to patented lever/spring

## *1.3. Revision history*

| Rev. | Date | Page | Revision item |
|---|---|---|---|
| - | 02/05/97 | - | Preliminary |
| A | 13/08/97 | 12 | FPC connector |
| B | 17/DEC/98 | 9, 12 | Stepper motor – FPC connectors |
| C | 11/June/99 | 10,11 | Stepper motor control |
| D | 05/JUN/00 | All | LV-HS versions + FPC 1mm pitch option |

This manual provides complete information about MP 205 thermal printer mechanism. Further information are available upon request, such as high speed printing applications and reliability figures.

A.P.S. reserves the right to make changes without notice to the product to improve reliability, function or design. A.P.S. does not assume any liability arising out of the application or use of any product or circuit described herein.

## TABLE OF CONTENTS

## 2. General characteristics

| ITEM | MP 205 |
|---|---|
| Printing Method | Thermal dot line printing |
| Number of dots/line | 384 |
| Dots density (dot/mm) | 8 |
| Printing Width (mm) | 48 |
| Paper Width (mm) | 58 +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) | 68.2 x 28(left side)/41(right side) x 15 |
| Weight (g) | 40 |
| Head temperature detection | Thermistor |
| Head-up detection | No |
| Paper end detection | Photo-interruptor |
| Operation voltage range (V) | MP 205-LV Dots : 3-7.2/Logic: 2.7-5.25<br>MP 205-ST Dots : 4.5-8.5/Logic :4.75-5.25<br>MP 205-HS Dots : 4.5-8.5/Logic : 2.7-5.25 |
| Current consumption (A) | At printing: 5 V: 1.9 A (Head)<br>(64 dots ON) 0,5A (Motor)<br>5V: 50 mA (Head)<br>At paper feeding : 5V: 0,6A(Motor)<br>5V: <100uA (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 | 384 dots |
| Heat element pitch | 0.125 mm |
| Print width | 48 mm (centered on paper) |
| Total width | 54 mm |
| Average resistance | LV - 123 Ohms +/-4% (2.7v-7.2v low voltage)<br><br>ST - 142 Ohms +/- 4% (5v standard)<br>HS - 176 Ohms +/-4% (7.2v high speed) |

## *3.2. Maximum conditions at 25°C*

| ITEM | MAXIMUM CONDITIONS | | | UNIT |
|---|---|---|---|---|
| | LV | ST | HS | |
| Supply energy (25°C) | 0.26 | 0.7 | 0.2 | mJ/dot |
| Print Cycle (25°C) | 2.5 | 5.0 | 1.25 | ms/line |
| Supply voltage | 7.2 | 8.5 | 8.5 | volts |
| Logic voltage | 7 | | | volts |
| Head Temperature | 65 | | | °C |
| Number of dots to be energized simultaneously[1] | 192 | | | dots |

1/ If energy above the maximum energy 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.

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

### 3.3. Typical printing conditions

| Item | Symbol | Electrical conditions | | | Unit | | |
|---|---|---|---|---|---|---|---|
| | | LV | ST | HS | | | |
| Supply voltage | Vh | 3.6 | 5.0 | 7.2 | V | | |
| Power consumption | Po | 0.07 | 0.123 | 0.24 | W/dot | 64 | dots |
| Print cycle | S.L.T | 2.5 | 5.0 | 1.25 | ms/line | fired | at the |
| Energy consumption | Eo | 0.17 | 0.36 | 0.16 | mJ/dot | 5° | same |
| (on time) | (Ton) | (2.28) | (2.96) | (0.67) | ms | C | time |
| | | 0.15 | 0.31 | 0.13 | mJ/dot | 25° | |
| | | (2.01) | (2.53) | (0.54) | ms | C | |
| | | 0.13 | 0.28 | 0.11 | mJ/dot | 45° | |
| | | (1.74) | (2.28) | (0.46) | ms | C | |
| Supply current | Io | 1.6 | 1.9 | 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 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:

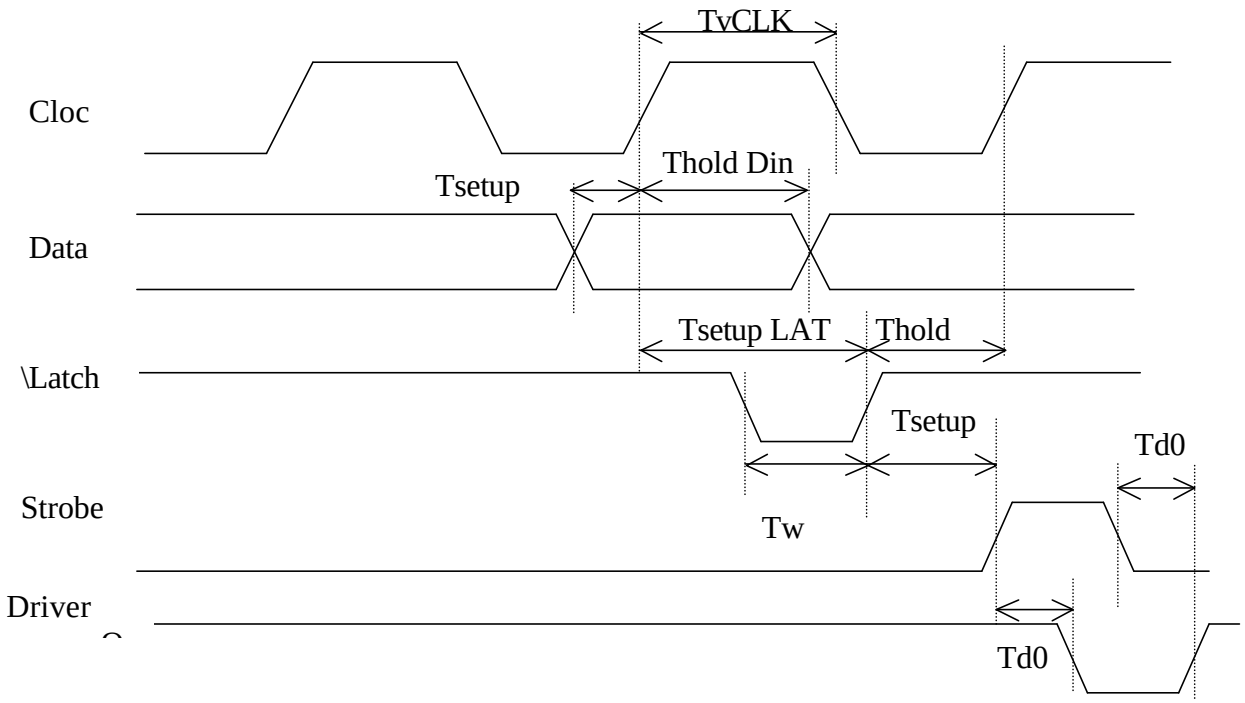
$E_0$ is the nominal energy (0.31 mJ)
$V_H$ is the driving voltage (5 v)
$R_{av}$ is the average resistance (142 Ohms)
$N$ is the number of dots energized simultaneously
$R_{com}$ is the common resistance (0.05 Ohm)
$R_{ic}$ is the driver saturated resistance (15 Ohms)
$R_l$ is the lead resistance (10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




**!!! CAUTION!!!**
To prevent any dot element damage, at power up make sure that logic voltage is present simultaneously or before Vbat. At power down make sure that Vbat is at 0v before removing logic voltage.

The following table gives all the printhead electrical characteristics:

| ITEM | SYMBOL | MINI | TYP. | MAXI | UNIT |
|---|---|---|---|---|---|
| Print voltage | VH | - | 5.0 | ST/HS = 8.5<br>LV = 7.2 | V |
| Logic voltage | Vdd | LV/HS = 2.7<br>ST = 4.75 | 5.00 | 5.25 | V |
| Logic current | Idd | - | - | 48 | mA |
| Input voltage (High) | VIH | 0.8vdd | - | vdd | V |
| Input voltage (Low) | VIL | 0 | - | 0.2vdd | V |
| Data input current (DI) High | ILHDI | - | - | 0.5 | uA |
| Data input current (DI) Low | ILLDI | - | - | -0.5 | uA |
| STB 1 to 6 input current (High) | IIHSTR | - | - | 30 | uA |
| STB 1 to 6 input current (Low) | IILSTR | - | - | -0.5 | uA |
| Clock input current (High) | ILH CLK | - | - | 3 | uA |
| Clock input current (Low) | ILL CLK | - | - | -3 | uA |
| Latch input current (High) | IIH LAT | - | - | 3 | uA |
| Latch input current (Low) | IIL LAT | - | - | -3 | uA |
| - | - | - | - | - | - |
| - | - | - | - | - | - |
| 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 | 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 | tholdLAT | 50 | - | - | ns |
| Data out delay time | tdDO | - | - | 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 6 are driving one sixth 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:

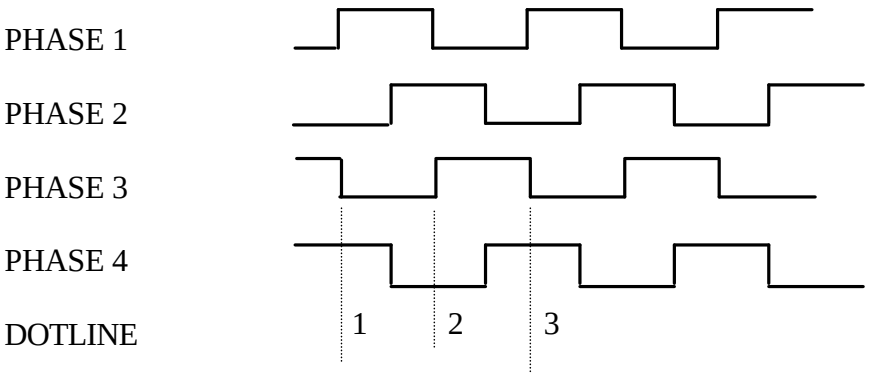
- R25, resistance at 25°C: 30 KOhms +/- 5% at 25°C
- B value: 3950 KOhms +/- 2%
- Operating temperature : -20°C to +80°C
- Time constant: Max. 30 sec (in the air)

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, 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 Ohms, rated current is 300 mA (5 volts) per phase while feeding at 10mm/s.
In case of high voltage or continuous printing application, contact APS for current application circuitry.

Note: With a maximum speed of 12 mm/s automatic paper loading can be achieved (with head in down position) at 5V.

### 4.1. Paper feed speed versus voltage

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

| MP205 | PAPER FEED | Duty Cycle (%) |
|---|---|---|
| Voltage | MP 205 LV/ST/HS | MP 205 LV/ST/HS |
| 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 |

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 30%. So the maximum ticket length at the maximum speed is 30s at 72mm/s so 2.16 meters. Then the printer must rest for 70/30*45s = 70 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 MP205, 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 384/64=6, giving a SLT of 6*1.76ms=10.6ms. then MaxPS will be 1/(8*10.6ms) = 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, 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 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 = 60.2 mm/s, getting very close to the MaxPFS, and optimizing all the parameters.
   (#) : we take 62 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.

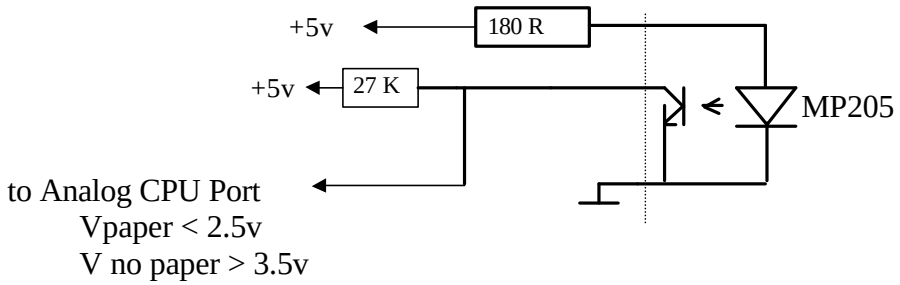
## 6.2. End of paper sensor

MP 205 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 current photodiode | $I_F$ | $V_F$ = 5v± 5% | - | 20 | 30 | mA |
| Reverse current | $I_R$ | $V_r$= 5V | - | - | 10 | uA |
| Output dark current | $I_{CEO}$ | $V_{CE}$= 10V | - | - | 0.2 | uA |
| Light current | $I_L$ | $V_{CE}$ = 5V<br>$I_F$ = 20mA | 180 | - | 660 | uA |
| Time | $T_R$ | $V_{CE}$ = 2 V<br>$I_C$ = 0.1 mA<br>$R_L$ = 1KΩ | - | 30 | - | us |
| Fall time | $T_F$ | | - | 25 | - | us |

One possible interfacing is as follows:



# 7. Pin out assignement

## *7.1. Flexi-cable*

There are 2 different FPC available, one is 1.25mm pitch the second one is longer and is 1mm pitch. Pinout from one to the other is unchanged. Please refer to the mechanical drawings attached for further information.

The following connectors can be used:

- 1 mm pitch version: 27FMN- *** (JST, LIF version), 27FAZ-***, 27FPZ-*** (JST, ZIF version)
- 1.25 mm pitch version: 27FE- *** (JST, LIF version), 39-51-3273 /3274 (MOLEX, ZIF version)

## *7.2. FPC Signals*

| 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 | Dotline voltage |
| 5 | VH | Dotline voltage |
| 6 | DI | Data input |
| 7 | STB6 | Sixth strobe |
| 8 | STB5 | Fifth strobe |
| 9 | STB4 | Fourth strobe |
| 10 | P_GND | Gnd for logic |
| 11 | P-GND | Gnd for dotline |
| 12 | P-GND | Gnd for dotline |
| 13 | P-GND | Gnd for dotline |
| 14 | TM | Thermistor first terminal (second in 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 | Dotline voltage |
| 23 | VH | Dotline 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 |

## 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 the maximum 60°C with thermistor reading.

Then:

- Pulse life : $100.10^6$ Pulses
- Abrasion life: 50 kms guaranteed

## 9. Mechanical and housing

See attached drawing.

## 10. Ordering code

| | |
|---|---|
| MP 205 Low Voltage (from 2.7v): | MP 205-LV (-SGM for 1mm pitch option) |
| MP 205 STandard 5v: | MP 205-ST (-SGM for 1mm pitch option) |
| MP 205 High Speed (80mm/s): | MP 205-HS (-SGM for 1mm pitch option) |