SII

Seiko Instruments

PT502P01/PT500GA1
GATE ARRAY

TECHNICAL REFERENCE

PREFACE

This reference manual contains the specifications and functional descriptions of the chip set (the PT502P01 CPU and PT500GA1 Gate Array) that controls the LTP5000 series line thermal printers. It is recommended that the user thoroughly read this manual to become familiar with the equipment prior to use.

Fully investigate the industrial proprietary rights of the sample circuits described in this manual before using.

CHAPTER 1

FEATURES

The PT502P01 CPU and PT500GA1 Gate Array form a chip set that serves the intended purposes only when they are used as a pair.

The PT502P01 CPU and PT500GA1 Gate Array chip set:

- Achieves printing with less current by using division control according to the number of dots to be activated.

- Accepts both parallel and serial input.

- Drives the motor using two power supplies to avoid overheating the motor.

- Measures the thermal head resistance and automatically adjusts the energy used for printing.

- Provides high quality printing by automatically adjusting the print density according to the temperature and voltage.

- Detects abnormal head resistance, voltage, temperature, etc.

- Provides various character functions, including double-width/double-height, reverse printing, underlining, and character spacing control.

- Permits superimposing of character data and bit image data.

- Provides a ruler line function which allows ruler lines and characters to be easily overlaid.

- Provides a selection of two print speeds.

- Makes the control circuit compact by integrating peripheral ICs into the gate array.

- Supports printing on two-ply thermal paper.

- Loads paper automatically using the autoloading function.

- Cuts paper fully or partially using the autocutter unit control function.

CHAPTER 2

GENERAL SPECIFICATIONS

This chapter provides the general specifications for the PT502P01 and PT500GA1. For detailed information, refer to Chapters 4 and 9.

2.1 TYPE AND DIMENSIONS

PT502P01   :80-pin flat package, 25.2 mm (W) × 19.2 mm (D) × 2.15 mm (H)

PT500GA1   :100-pin flat package, 25.2 mm (W) × 19.2 mm (D) × 2.15 mm (H)

2.2 STRUCTURE

C-MOS LSI

2.3 DATA TRANSMISSION

Parallel and serial data transmission modes are available.

Parallel   :8-bit parallel, modified Centronics

Asynchronous serial :150, 300, 600, 1200, 2400, 4800, 9600, 19200 bps selectable

2.4 PRINT FUNCTIONS

Applicable models   :Six LTP5000 series models selectable

Print method   :Thermal line dot method

For number of dots/characters per line, maximum print speed and print resolution, see Table 2-1.

Table 2-1 Number of Dots/Characters per Line, Print Speed and Print Resolution

Model	Number of Dots per Line	Number of Characters per Line[1]	Maximum Print Speed (mm/sec)	Print Resolution (dot/mm)
LTP5242	448	28	50	8
LTP5246	448	28	25	8
LTP5347	576	36	50	8
LTP5437	640	40	50	6
LTP5442	832	52	50	8
LTP5446	832	52	25	8

[1] When character spacing is 4 dots.

Available character types	:IBM compatible character set and Japanese *kana* character set (348 characters total) Setting can be changed using the 24 (V) x 12 (H) dot matrix function pin or function code
Line spacing	:16 dot lines (programmable)
Character spacing	:4 dots (programmable)

2.5 CONTROL FUNCTIONS

- Paper feed in forward or reverse direction (switch-selectable)

- Automatic measurement of thermal head resistance

- Automatic adjustment of energy applied to the thermal head

- Thermal head position and paper detection

- Emergency stop at abnormal temperatures or voltages

- Test print and HEX dump

- Selection using function codes   :Interface mode 0 and 1

- Two selectable cutting modes   :full cut and partial cut using function codes ESC + i and ESC + m

2.6 OPERATING VOLTAGE

5 V ± 5% DC

2.7 OPERATING FREQUENCY

16 MHz ± 0.5%

2.8 CURRENT CONSUMPTION (V_{CC} = 5 V, STANDBY MODE)

PT502P01 :24 mA maximum
PT500GA1 :5 mA maximum

CHAPTER 3

CONTROL FUNCTIONS

3.1 THERMAL HEAD DRIVE OPERATION

Generally, when the line thermal head is operating, it is divided into several blocks which are activated one after another in succession. As a result, the number of simultaneously activated dots decreases, thus reducing the needed current capacity of the power supply.

For the line thermal head of an LTP5000 series printer mechanism, one line is divided into 3 to 6 blocks called physical blocks. A strobe signal is allocated to each physical block to activate it. To actually drive the head, physical blocks are activated in groups. The group of physical blocks is called a logical block.

For the PT502P01/PT500GA1, either dynamic division or fixed division can be selected as the method of division for driving the head. The selection is made through a function pin (pin 43 on the PT500GA1).

(1) Dynamic division

The CPU counts the number of dots activated in each physical block and groups the physical blocks into logical blocks so that the number does not exceed the specified maximum number of activated dots. The maximum number of activated dots is specified in units of 64 dots by pins 39, 41, and 42 on the PT500GA1. The CPU determines logical blocks each time it prints a single dot line.

When the maximum number of activated dots is smaller than the number of dots in the largest physical block (128 to 192 dots), the way the PT502P01 drives the thermal head differs depending on the interface mode, mode 0 or mode 1, specified by pins 37 and 38 on the PT500GA1. The way the PT502P01 drives the thermal head in each interface mode is described in the following paragraphs.

In interface mode 0, the maximum number of activated dots is always the value set on the PT500GA1. However, because the largest physical block is 128 to 192 dots, if the maximum number of activated dots is set to a value smaller than the number of dots in the largest physical block, a single line of data must be divided and sent to the thermal head in multiple transmissions, until all data is printed. This method of data transfer (hereafter called "data masking transfer") is performed automatically by internal software. Table 3-1 indicates the conditions in which data masking transfer occurs.

Table 3-1 Conditions in Which Data MaskingTransfer Occurs

Specified Dot Count	PT500GA1 Pin Nos. 39 41 42	LTP5242	LTP5246	LTP5347	LTP5437	LTP5442	LTP5446
64	Low Low Low	○	○	○	○	○	○
128	Low Low High	○	○			○	○
192	Low High Low						
256	Low High High						
320	High Low Low						
384	High Low High						
448	High High Low						
512	High High High						

○ indicates when data masking transfer occurs.

Figure 3-1 shows how the dots are activated by data masking transfer, when the maximum number of activated dots on the LTP5242 is specified as 64 and when all dots are activated.

1st PHYSICAL BLOCK (192 DOTS) 2nd PHYSICAL BLOCK (128 DOTS) 3rd PHYSICAL BLOCK (128 DOTS)

64	64	64		64	64		64	64	(DOTS)	

1st ACTIVATION
2nd
3rd
4th
5th
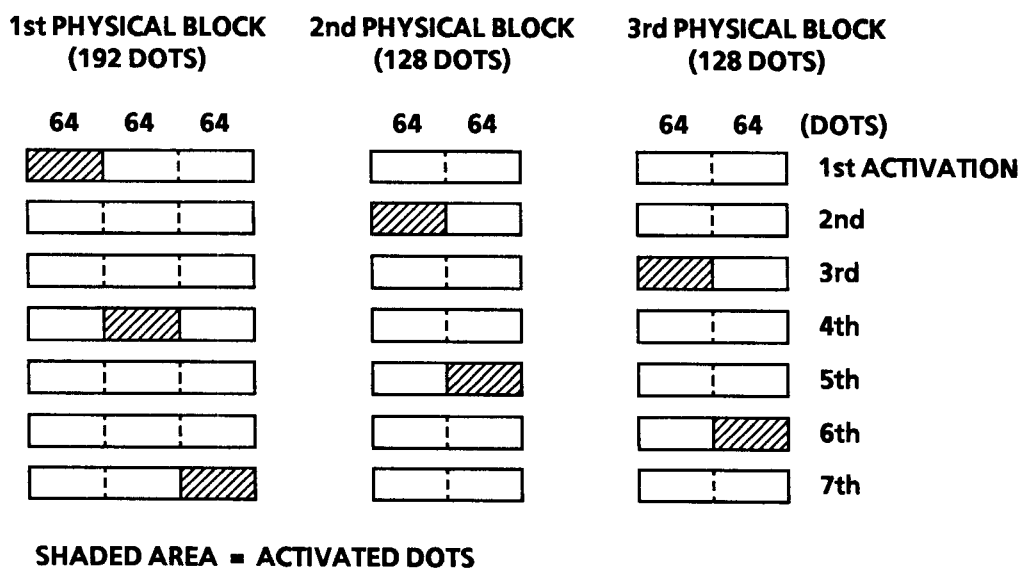6th
7th

SHADED AREA = ACTIVATED DOTS

Figure 3-1 Data Masking Transfer When All Dots are Activated on the LTP5242
(Maximum Number of Activated Dots = 64)

When the maximum number of activated dots is equal to or more than the number of dots in the largest physical block, print data is transferred to the thermal head at one time and dots are activated in logical blocks. Figure 3-2 shows how the dots are activated by dynamic division when the maximum number of activated dots on the LTP5242 is specified as 192 and when all dots are activated.

1st PHYSICAL BLOCK (192 DOTS) 2nd PHYSICAL BLOCK (128 DOTS) 3rd PHYSICAL BLOCK (128 DOTS)

1st ACTIVATION
2nd
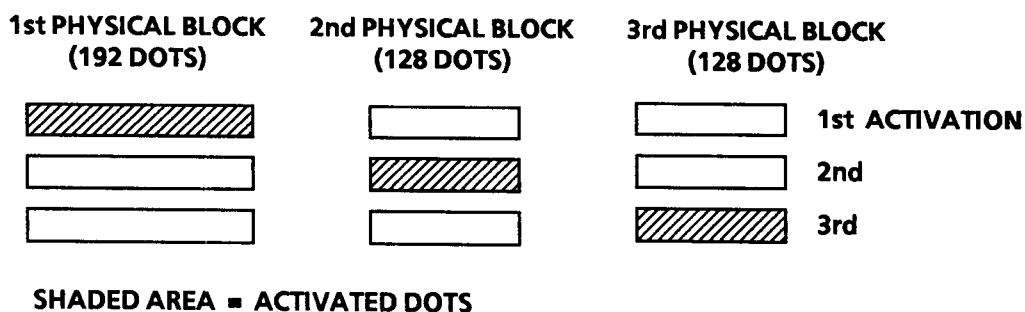3rd

SHADED AREA = ACTIVATED DOTS

Figure 3-2 Dynamic Division When All Dots are Activated on the LTP5242
(Maximum Number of Activated Dots = 192)

Because faster print speed is given priority in interface mode 1, if the specified maximum number of activated dots is smaller than the number of dots in the largest physical block on the thermal head, the maximum number of activated dots us rounded up to the number of dots in the largest physical block .

Print data is transferred to the thermal head at one time and dots are activated in physical blocks.

Table 3-2 shows the maximum number of dots actually activated simultaneously in mode 1.

Table 3-2 Maximum Number of Activated Dots for Dynamic Division in Mode 1

Specified Dot Count	PT500GA1 Pin Nos. 39 41 42	Physical Block (= Maximum Number of Activated Dots)					
		LTP5242	LTP5246	LTP5347	LTP5437	LTP5442	LTP5446
64	Low Low Low	192	192	128	128	160	160
128	Low Low High	192	192	128	128	160	160
192	Low High Low	192	192	192	192	192	192
256	Low High High	256	256	256	256	256	256
320	High Low Low	320	320	320	320	320	320
384	High Low High	384	384	384	384	384	384
448	High High Low	448	448	448	448	448	448
512	High High High	448	448	512	512	512	512

The advantage of dynamic division is that the maximum number of activated dots can be specified according to the capacity of the power supply used. The printer can be operated with a small capacity power supply when the maximum number of activated dots is small. However, this process may increase the number of divisions and may lower print speed, depending on the content of the print data. This becomes obvious especially for block transfer. On the other hand, printing speed becomes faster when the maximum number of activated dots is larger, which, however, requires a larger power supply capacity.

NOTE

To maintain high print quality when printing ruler lines or bit images, set the maximum number of activated dots to a value at which block transfer will not be performed. Also, avoid block transfer when using two-ply thermal paper, otherwise the paper may stick to the thermal head.

(2) Fixed division

For each printer model, the physical blocks which compose a logical block are determined beforehand. Fixed division always activates physical blocks in the same order, thereby realizing higher print quality.

For the fixed division method, the number of logical blocks are determined as shown in Table 3-3.

Table 3-3 Number of Logical Blocks When the Fixed Division is Selected

Model	Number of Logical Blocks	
	High Printing Speed	Low Printing Speed
LTP5242	2	3
LTP5246	2	3
LTP5347	2	5
LTP5437	2	5
LTP5442	2	4
LTP5446	2	3

Note that it is impossible to print on two-ply thermal paper when using fixed division.

3.2 MOTOR DRIVE METHOD

The PT502P01 CPU and PT500GA1 Gate Array have a dual-source motor drive feature and a feature that drives the motor by 2-2 phase excitation. One motor drive step pulse causes the printer mechanism to feed one dot line.

The PT502P01 and PT500GA1 employ a dual-source (Vp and Vcc) motor drive method to minimize the motor torque loss caused by the generation of heat from the motor when the printer mechanism is run in low-speed print mode. Even when the printer mechanism is to be used in high-speed print mode, it is recommended that a dual-source power supply be used since the motor will generate excessive heat, reducing the motor torque, if the speed of data input is too slow.

When the motor is started in the high speed printing mode, the motor accelerates while printing is performed to keep print quality uniform. The number of acceleration steps for the LTP5000 series printer mechanisms are listed in Table 3-4. The PT502P01 and PT500GA1 do not accelerate the motor when printing in low-speed mode.

See Section 4.11 for a sample motor control circuit. Refer also to the Technical Reference manual for the individual printer mechanism.

Table 3-4 Number of Acceleration Steps

Model	Maximum Printing Speed	Number of Acceleration Steps
LTP5242	400 pps	8
LTP5246	200 pps	4
LTP5347	400 pps	8
LTP5437	300 pps	4
LTP5442	400 pps	8
LTP5446	200 pps	4

3.3 ADJUSTMENT OF ENERGY APPLIED TO THE THERMAL HEAD

The PT502P01 and PT500GA1 automatically control the print pulse width so that the print density remains constant regardless of possible changes in head resistance, head temperature, and power supply voltage (Vp).

See Section 4.15 for the procedure on how to adjust thermal head energy. Refer also to the Technical Reference manual for the individual printer mechanism.

3.4 PRINTING ON TWO-PLY THERMAL PAPER

What is two-ply thermal paper?

A sheet of two-ply thermal paper consists of a sheet of low-sensitivity thermal paper on top of a sheet of high-sensitivity thermal paper thereby providing two copies simultaneously during one printing operation. It can be used for printing receipts, for example, where the printed result is given to the client while the copy is retained.

Printing on Two-ply Thermal Paper

Though two-ply thermal paper is very useful for some applications, it requires higher printing energy than normal thermal paper since it contains two layers of thermal paper. Consequently, the control method is also different from that used for normal thermal paper.

The PT502P01 and PT500GA1 supports printing on two-ply thermal paper. The user can select whether printing will be performed on two-ply thermal paper or normal thermal paper through a function pin on the gate array (pin 35), or a command.

Table 3-5 shows the setting of the function pin on the gate array.

Table 3-5   Selection of Thermal Paper through
the PT500GA1 Function Pin

Pin No. 35	Paper Selected
Low	Normal thermal paper
High	Two-ply thermal paper

For setting through a command, refer to code sequence **ESC + ! + n** in Section 9.5.

When the power is turned on or when the system is reset through a command or switch operation, the thermal paper that is specified by the function pin on the PT500GA1 takes precedence. After that, the thermal paper specified through a command takes precedence.

Table 3-6 Recommended Two-ply Thermal Paper

Vendor	Number
Jujo Paper Co., Ltd.	TW80KK-M

Precautions for printing on two-ply thermal paper

Because of its characteristics, two-ply thermal paper requires different handling than normal thermal paper. The following should be taken into consideration when using two-ply thermal paper:

- **The use of two-ply thermal paper is not supported during the fixed division mode.** When fixed division is selected, the normal thermal paper is always selected.

- If the maximum number of dots to be activated is small, dense printing slows down the print speed.

- Since each strobe applies two pulses, the life span of the thermal head becomes one half of the life span of activation pulse resistance.

- If paper feed is stopped immediately after dense printing, such as solid black, paper may stick to the thermal head and may adversely affect paper feed. A minimum of five dots should be fed after performing prolonged dense printing.

- The bottom layer of two-ply thermal paper is sensitive to heat. Therefore, even the nonprinted part may darken if the printer is used in a high temperature environment or if dense printing is prolonged.

- If dense printing is performed using high-speed printing, the top layer of thermal paper may become blurred.

- When high resolution is required for output, (for example, in the case of graphic images), it is recommended that a low speed be selected for both the print speed and the paper feed rate.

- Ambient temperature should be between 10° C and 50° C during operation.

- To prevent the two-ply thermal paper from sticking to the thermal head, printer mechanisms that use 24 V (LTP5242, LTP5347, LTP5437, and LTP5442) block transfer dynamic division (described in Section 3.1) should not be used. For the same reason, the maximum number of dots to be activated for printer mechanisms that use 12 V (LTP5246 and LTP5446) should be set to a value more than or equal to the following:

  LTP5246 :256 dots
  LTP5446 :448 dots

3.5 TEST PRINT

The PT502P01/PT500GA1 has a test print function. The current settings of the function pins and all available characters in the internal character set currently selected are printed when a test print is performed.

A test print can be performed by using one of the following procedures.

(1) Test print by turning the power on and off

Set the feed terminal (pin 16 on the PT502P01) to low, turn on V_{CC} and V_P (both simultaneously, or, V_{CC} first and then V_P). The test print will then start.

(2) Test print via switches

The test print can be executed while the power (V_P and V_{CC}) is on by performing the procedure below:

1. Before turning on the power, prepare normally-open switches by connecting a switch between the reset terminal (pin 28 on the PT502P01) and the GND and by connecting another between the feed terminal (pin 16 on the PT502P01) and the GND.

   Each terminal should be pulled up with a 1 to 4.7 kΩ resistor and have a 100 Ω resistor serially inserted to prevent latch-up (see Figure 7-1). Care should be taken to prevent chattering of the switch.

2. Turn on both V_{CC} and V_P (simultaneously, or, V_{CC} first and then V_P).

3. Turn on the reset terminal (low), then turn on the feed terminal (low). Next, turn off the reset terminal (high), then turn off the feed terminal (high). The test print will then start.

For a sample test print, see Figure 3-3.

```
LTP5000 series Interface
 PT502P01 [ Ver 1.00 ]
   11.Dec.1992
Copyright(C) : SII
*************************
* DIP SWITCH 1 *
1..5) Mechanism : LTP5442
       112mm,24V,8dot/mm
6) Feed   :High speed
7) Print :High speed
8) Head drive :Dynamic division
* DIP SWITCH 2 *
1..3) DDD Max dot : 192 dots
4..5) I/F mode : MODE 0
6) FONT TYPE : IBM Compatible
7) 2PLY : OFF
8) Data input : Parallel
* DIP SWITCH 3 *
1..3) Baud rate : 9600 bps
4) Bit length : 8 bit
5) Stop bit : 2 bit
6,7) Parity : None
8) Data control : Busy

* TEST PRINT *
 !"#$%&'( )*+,-./0123456789:;<=>?@ABCDEFGHIJKLMNOPQRS
TUVWXYZ[\]^_'abcdefghijklmnopqrstuvwxyz{¦}~ Çüéâäàåç
êëèïîìÄÅEæÆôöòûùÿÖÜ¢£¥₧ƒáíóúñÑªº¿⌐¬½¼¡«»▓▒░│┤╢╖╕╣║╗╝
┘┴┌├┼╞╟╚╔╩╦╠═╬╧╨╤╥╙╘╒╓╫╪┘┌█▄▌▐▀αßΓπΣσµτΦΘΩδ∞φε∩
≡±≥≤⌠⌡÷≈°∙·√ⁿ²■
```

Figure 3-3 Test Print Sample (LTP5442)

3.6 HEX DUMP

The PT502P01/PT500GA1 contains a data dump function which allows data to be printed in hexadecimal.

There are two ways to execute the hex dump:

(1) Hex dump by turning the power on and off

Set the backward feed terminal (pin number 14 of the PT502P01) to low, turn on the V_{CC} and V_P (both simultaneously, or, V_{CC} first and then V_P). The hex dump will then start.

(2) Hex dump via switches

A hex dump print can be executed while the power (V_P and V_{CC}) is on by performing the procedure below:

1. Before turning on the power, prepare normally-open switches by connecting a switch between the reset terminal (pin 28 on the PT502P01) and the GND and by connecting another between the backward feed terminal (pin 14 on the PT502P01) and the GND.

   Each terminal should be pulled up with a 1 to 4.7 kΩ resistor and have a 100 Ω resistor serially inserted to prevent latch-up (see Figure 7-1). Care should be taken to prevent chattering of the switch.

2. Turn on both V_{CC} and V_P (simultaneously, or, V_{CC} first and then V_P).

3. Turn on the reset terminal, then turn on the backward feed terminal (low). And turn off the reset terminal (high), then turn off the backward feed terminal (high). The hex dump will then start.

Data can be input in either serial or parallel.

The LTP5442 and LTP5446 start printing when they have received 16 bytes of data. The LTP5242, LTP5246, LTP5347, and LTP5437 start printing when they have received 8 bytes of data. Some data may remain in the buffer without being printed if the buffer does not become full. When data input is complete, set the feed terminal (pin 16 on the PT502P01) to low so that data remaining in the buffer will be printed.

For a sample hex dump, see Figure 3-4.

```
[ HEX DUMP MODE ]
00 0A 2A 2A 2A 2A 2A 2A 20 46 45 45 44 20 50 41
45 52 20 46 4F 52 57 41 52 44 20 42 41 43 4B 57
41 52 44 20 54 45 53 54 20 2A 2A 2A 2A 2A 2A 00
0A 1B 41 00 20 30 20 44 4F 54 20 46 45 45 44 2D
20 2D 20 2D 20 2D 20 1B 4A 00 1B 6A 18 20 30 20
20 20 20 20 20 20 20 20 20 20 20 2D 20 2D 20 2D
20 32 34 20 44 4F 54 20 42 46 45 45 44 00 0A 1B
41 00 20 35 31 20 44 4F 54 20 46 45 45 44 20 20
2D 20 2D 20 2D 20 1B 4A 33 1B 6A 4B 20 35 31 20
20 20 20 20 20 20 20 20 20 20 20 2D 20 2D 20 2D
20 37 35 20 44 4F 54 20 42 46 45 45 44 00 0A 1B
41 00 20 31 30 32 20 44 4F 54 20 46 45 45 44 20
20 2D 20 20 20 2D 20 1B 4A 66 1B 6A 7E 20 31 30
32 20 20 20 20 20 20 20 20 20 20 2D 20 2D 20 2D
20 20 20 31 32 36 20 44 4F 54 20 42 46 45 45 44
00 0A 1B 41 00 20 31 35 33 20 44 4F 54 20 46 45
45 44 20 20 2D 20 2D 20 2D 20 1B 4A 99 1B 6A B1
20 31 35 33 20 20 20 20 20 20 20 20 20 20 2D 20
2D 20 20 20 2D 20 31 37 37 20 44 4F 54 20 42 46
45 45 44 00 0A 1B 41 00 20 32 30 34 20 44 4F 54
20 46 45 45 44 20 20 2D 20 2D 20 2D 20 1B 4A CC
1B 6A E4 20 32 30 34 20 20 20 20 20 20 20 20 20
20 20 20 20 20 20 20 20 32 32 38 20 44 4F 54
20 42 46 45 45 44 00 0A 2A 2A 2A 2A 2A 2A 20 52
45 53 45 54 20 54 45 53 54 20 2A 2A 2A 2A 2A 2A
2A 00 0A 1B 57 01 41 42 43 00 0A 1B 77 01 41 42
43 00 0A 1B 49 01 41 42 43 00 0A 1B 40 41 46 54
45 52 20 52 45 53 45 54 00 0A
```

Figure 3-4 Hex Dump Print Sample (LTP5442)

CHAPTER 4

HARDWARE SPECIFICATIONS

4.1 ABSOLUTE MAXIMUM RATINGS

Tables 4-1 and 4-2 list the absolute maximum ratings of the PT502P01 CPU and PT500GA1 Gate Array, respectively.

Table 4-1 PT502P01 Absolute Maximum Ratings

Item	Symbol	Conditions	Rating
Power supply voltage	V_{CC}	—	-0.3 V to 7 V
Analog power voltage	AV_{CC}	—	-0.3 V to 7 V
Input voltage	V_I	—	-0.3 V to $V_{CC} + 0.3$ V
Output voltage	V_O	—	-0.3 V to $V_{CC} + 0.3$ V
Power consumption	P_D	$T_A = 25°$ C	500 mW
Storage temperature	T_{STG}	—	$-40°$ to 125° C

Table 4-2 PT500GA1 Absolute Maximum Ratings

Item	Symbol	Conditions	Rating
Power supply voltage	V_{CC}	—	-0.3 V to 6.5 V
Input voltage	V_I	—	-0.3 V to $V_{CC} + 0.3$ V
Output voltage	V_O	—	-0.3 V to $V_{CC} + 0.3$ V
Power consumption	P_D	$T_A = 25°$ C	500 mW
Storage temperature	T_{STG}	—	$-40°$ to 125° C

4.2 OPERATING RANGES

Tables 4-3 and 4-4 list the operating ranges of the PT502P01 CPU and PT500GA1 Gate Array, respectively.

Table 4-3 PT502P01 Operating Range Characteristics

Item	Symbol	Conditions	Rating
Power supply voltage	V_{CC}	—	4.75 V to 5.25 V
Operating temperature	T_{OPR}	—	– 10° to 70° C
External clock input frequency	$f(X_{IN})$	—	16 ± 0.08 MHz

Table 4-4 PT500GA1 Operating Range Characteristics

Item	Symbol	Conditions	Rating
Power supply voltage	V_{CC}	—	4.75 V to 5.25 V
Input voltage	V_I	—	0 V to V_{CC}
Output voltage	V_O	—	0 V to V_{CC}
Operating temperature	T_{OPR}	—	– 10° to 70° C

4.3 ELECTRICAL CHARACTERISTICS

Tables 4-5 and 4-6 list the electrical characteristics of the PT502P01 CPU and PT500GA1 Gate Array, respectively.

Table 4-5 PT502P01 Electrical Characteristics
$(V_{CC} = 5$ V, $T_A = 25°C$, f $(X_{IN}) = 16$ MHz)

Item	Symbol	Conditions	Rating		
			MIN	STD	MAX
Output voltage "H"	V_{OH}	$I_{OH} = -10$ mA	3 V	—	—
Output voltage "L"	V_{OL}	$I_{OL} = 10$ mA	—	—	2 V
Hysteresis (HTE)	(V_T+)-(V_T-)	—	0.4 V	—	1 V
Hysteresis (RESET)	(V_T+)-(V_T-)	—	0.2 V	—	0.5 V
Hysteresis (Xin)	(V_T+)-(V_T-)	—	0.1 V	—	0.3 V
Input current "H"	I_{IH}	$V_I = 5$ V	—	—	5 μA
Input current "L"	I_{IH}	$V_I = 0$ V	—	—	-5 μA
Power supply current	I_{CC}	$f(X_{IN}) = 16$ MHz	—	12 mA	24 mA

Table 4-6 PT500GA1 Electrical Characteristics $(T_A = 25°C)$

Item	Symbol	Conditions	Rating		
			MIN	STD	MAX
Input voltage "H"	V_{IH}	$V_{CC} = 5.5$ V [1] $V_{CC} = 5.5$ V [2]	2.2 V 3.85 V	— —	5.5 V 5.5 V
Input voltage "L"	V_{IL}	$V_{CC} = 4.5$ V [1] $V_{CC} = 4.5$ V [2]	0 0	— —	0.8 V 1.35 V
Hysteresis	(V_T+)-(V_T-)	$V_{CC} = 5.0$ V [2]	0.5 V	—	1.6 V
Input current "H"	I_{IH}	$V_{CC} = 5.5$ V, $V_I = 5.5$ V	—	—	1 μA
Input current "L"	I_{IL}	$V_{CC} = 5.5$ V, $V_I = 0$ V	—	—	1 μA
Output voltage "H"	V_{OH}	$V_{CC} = 5.0$ V, $I_O < 1$ μA	4.95 V	—	—
Output voltage "L"	V_{OL}	$V_{CC} = 5.0$ V, $I_O < 1$ μA	—	—	0.05 V
Output current "H"	I_{OH}	$V_{CC} = 4.5$ V, $V_{OH} = 4.1$ V	—	—	-2 mA
Output current "L"	I_{OL}	$V_{CC} = 4.5$ V, $V_{OL} = 0.4$ V	6 μA	—	—
Pull-up resistance	R_U	$V_{CC} = 5.0$ V, $V_I = 0$ V [3]	50 kΩ	—	500 kΩ
Power supply current (standby)	I_{DD}	$V_I = V_{SS}$, V_{CC} $I_O = 0$ μA	—	—	5 mA

[1] Input terminals other than ID0-ID7 and STB
[2] ID0-ID7 and STB
[3] RES0, RES1, DP10-DP17, DP20-DP27, DP30-DP37, Φ, MODE, SDAT, SCLK, and KNJ0 to KNJ7

4.4 PIN DESCRIPTION

Figures 4-1 and 4-2 show the pin configurations of the PT502P01 CPU and PT500GA1 Gate Array, respectively. These figures are top views of the ICs. Tables 4-7 and 4-8 contain the pin definitions for the PT502P01 and PT500GA1, respectively.
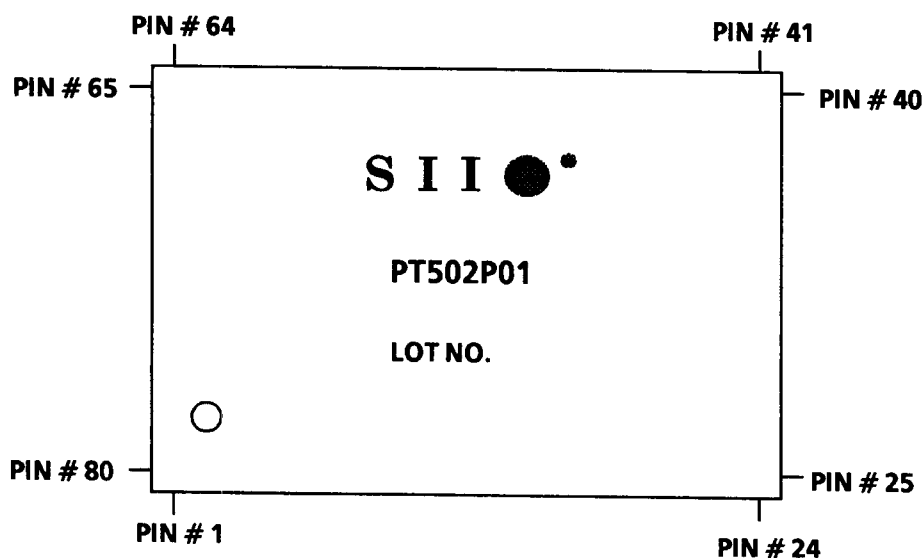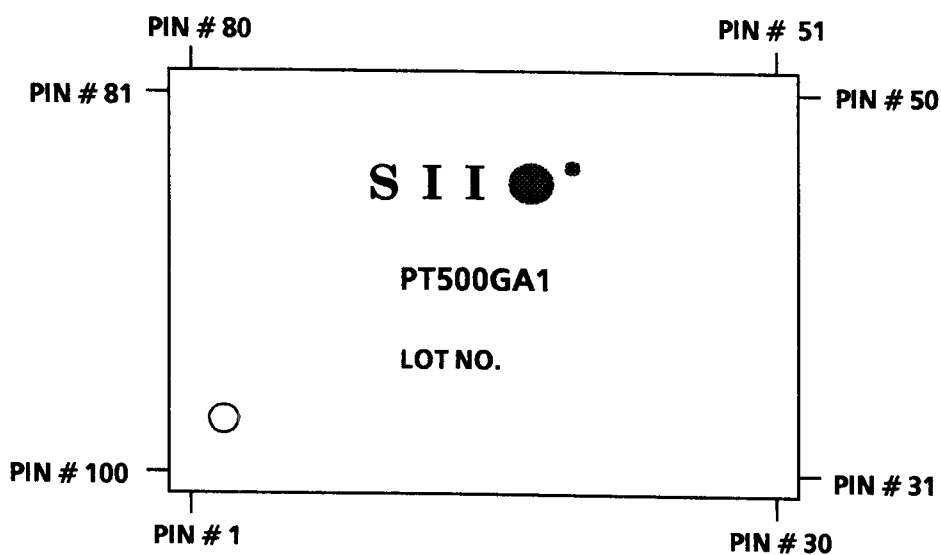
Figure 4-1 PT502P01 Pin Configuration

Figure 4-2 PT500GA1 Pin Configuration

Table 4-7 PT502P01 Pin Definitions

| Pin No.	Signal Name	I/O[1]	Function	Connected to Gate Array Pin	Logic[2]
1	SVP	I	Vp detection	—	—
2	ERROR	O	Error signal	—	L
3	BUSY	O	Centronics data reception enabled	—	H
4	ACK	O	Centronics data reception complete	—	L
5	ECUT	O	Autocutter enable	—	H
6	HTE	I	Head temperature error	—	L
7	INT0	I	Centronics data interrupt	12 (INT0)	—
8	CUT1	O	Motor control terminal 1 for cutter	—	L
9	CUT2	O	Motor control terminal 2 for cutter	—	L
10	HDC	I	Head dot counter	98 (HDC)	—
11	HLATCH	O	Head latch	—	L
12	HVCCSW	O	Head Vcc	—	H
13	HVPSW	O	Head Vp	—	H
14	BFEED	I	Backward feed	—	L
15	MCOM1	O	Motor common	—	H
16	FEED	I	Feed	—	L
17	SENCUT	O	Cutter sensor input	—	L
18	MOTOR1	O	Motor $\Phi 1$	—	H
19	MOTOR2	O	Motor $\Phi 2$	—	H
20	MOTOR3	O	Motor $\Phi 3$	—	H
21	MOTOR4	O	Motor $\Phi 4$	—	H
22	OPE	O	Out-of-paper error	—	H
23	Φ	O	Φ	94 (Φ)	—
24	RDY	I	(Must be pulled up to Vcc through a 10 kΩ resistor.)	—	—
25	HOLD	I	(Must be pulled up to Vcc through a 10 kΩ resistor.)	—	—
26	BYTE	I	(Must be pulled up to Vcc through a 10 kΩ resistor.)	—	—
27	CNVSS	I	(Must be connected to GND.)	—	—

[1] I :Input   O :Output
[2] L :Low   H :High

Table 4-7 PT502P01 Pin Definitions (Continued)

Pin No.	Signal Name	I/O[1]	Function	Connected to Gate Array Pin	Logic[2]
28	RESET	I	Reset	—	L
29	Xin	—	Clock input (16 MHz)	—	—
30	Xout	—	Clock output (16 MHz)	—	—
31	$\overline{E}$	O	Enable clock	93 (E)	L
32	VSS	—	Ground	—	—
33	P33	O	NC (Reserved)	—	—
34	ALE	O	ALE	92 (ALE)	H
35	P31	O	NC (Reserved)	—	—
36	R/$\overline{W}$	O	R/W	90 (R/W)	—
37	DA7	I/O	A23/D7	89 (DA7)	H
38	DA6	I/O	A22/D6	88 (DA6)	H
39	DA5	I/O	A21/D5	87 (DA5)	H
40	DA4	I/O	A20/D4	86 (DA4)	H
41	DA3	I/O	A19/D3	85 (DA3)	H
42	DA2	I/O	A18/D2	84 (DA2)	H
43	DA1	I/O	A17/D1	83 (DA1)	H
44	DA0	I/O	A16/D0	82 (DA0)	H
45	A15	O	NC (Reserved)	—	—
46	A14	O	A14	—	H
47	A13	O	A13	—	H
48	A12	O	A12	—	H
49	A11	O	A11	—	H
50	A10	O	A10	—	H
51	A9	O	A9	—	H
52	A8	O	A8	—	H
53	A7	O	A7	—	H
54	A6	O	A6	—	H
55	A5	O	A5	—	H

[1] I :Input O :Output
[2] L :Low H :High

Table 4-7 PT502P01 Pin Definitions (Continued)

| Pin No.	Signal Name	I/O[1]	Function	Connected to Gate Array Pin	Logic[2]
56	A4	O	A4	—	H
57	A3	O	A3	—	H
58	A2	O	A2	81 (A2)	H
59	A1	O	A1	80 (A1)	H
60	A0	O	A0	79 (A0)	H
61	HDATA	O	Head data output	96 (SDAT)	H
62	DPI	I	Optional DIP switch data input (must be pulled up to Vcc through a 10 kΩ resistor when not used.)	—	H
63	HCLK	O	Optional DIP switch clock/head clock	97 (SCLK)	⌐
64	DPL	O	Optional DIP switch data load	—	L
65	TXD0	O	RS-232C (Xon/Xoff)	—	H
66	RXD0	I	RS-232C (Data input)	—	H
67	SBSY	O	RS-232C (Busy output)	—	H
68	P80	O	NC (Reserved)	—	—
69	Vcc	—	Vcc	—	—
70	AVcc	—	Vcc	—	—
71	VREF	—	(Must be connected to Vcc.)	—	—
72	AVSS	—	Ground	—	—
73	VSS	—	Ground	—	—
74	SEN	I	Print density control (−15% to +35%)	—	—
75	HS	I	Head-up detection	—	L
76	SVcc	I	Reference voltage detection	—	—
77	PS	I	Paper detection	—	H
78	SHVP	I	Head Vp voltage	—	—
79	SHR	I	Head resistance measurement	—	—
80	STH	I	Head thermistor detection	—	—

[1] I :Input   O :Output
[2] L :Low   H :High   ⌐ : Leading edge

Table 4-8 PT500GA1 Pin Definitions

Pin No.	Signal Name	I/O[1]	Characteristics	Function	Logic[2]
1	RES1	I	TTL level input (with pull-up)	Head strobe disable	L
2	RES0	I	TTL level input (with pull-up)	Head strobe disable	L
3	N.U	—	NC	—	—
4	HDS7	O	NC	Reserved	—
5	HDS6	O	NC	Reserved	—
6	HDS5	O	CMOS output	Printer mechanism head strobe signal	H
7	HDS4	O	CMOS output	Printer mechanism head strobe signal	H
8	HDS3	O	CMOS output	Printer mechanism head strobe signal	H
9	HDS2	O	CMOS output	Printer mechanism head strobe signal	H
10	HDS1	O	CMOS output	Printer mechanism head strobe signal	H
11	HDS0	O	CMOS output	Printer mechanism head strobe signal	H
12	INT0	O	CMOS output	Centronics interrupt signal	H
13	BUSY	I	TTL level input	BUSY request signal	L
14	PBUSY	O	CMOS output	BUSY signal	H
15	ID7	I	CMOS level Schmitt input	Centronics data input signal	H
16	Vcc	—	Vcc	5 V	—
17	ID6	I	CMOS level Schmitt input	Centronics data input signal	H
18	ID5	I	CMOS level Schmitt input	Centronics data input signal	H
19	ID4	I	CMOS level Schmitt input	Centronics data input signal	H
20	ID3	I	CMOS level Schmitt input	Centronics data input signal	H
21	ID2	I	CMOS level Schmitt input	Centronics data input signal	H
22	ID1	I	CMOS level Schmitt input	Centronics data input signal	H
23	ID0	I	CMOS level Schmitt input	Centronics data input signal	H
24	STB	I	CMOS level Schmitt input	Centronics strobe input signal	⌐

[1] I :Input   O :Output
[2] L :Low   H :High   ⌐ : Leading edge

Table 4-8 PT500GA1 Pin Definitions (Continued)

Pin No.	Signal Name	I/O[1]	Characteristics	Function	Logic[2]
25	DP37	I	TTL level input (with pull-up)	BUSY control select	H
26	DP36	I	TTL level input (with pull-up)	Parity enable/disable select	H
27	DP35	I	TTL level input (with pull-up)	Parity odd/even select	H
28	N.U	—	NC	—	—
29	DP34	I	TTL level input (with pull-up)	Stop bit select	H
30	DP33	I	TTL level input (with pull-up)	Data length select	H
31	DP32	I	TTL level input (with pull-up)	Baud rate select	H
32	DP31	I	TTL level input (with pull-up)	Baud rate select	H
33	DP30	I	TTL level input (with pull-up)	Baud rate select	H
34	DP27	I	TTL level input (with pull-up)	Data receive mode select	H
35	DP26	I	TTL level input (with pull-up)	Paper type select	H
36	DP25	I	TTL level input (with pull-up)	Character set select	H
37	DP24	I	TTL level input (with pull-up)	Interface mode select	H
38	DP23	I	TTL level input (with pull-up)	Interface mode select	H
39	DP22	I	TTL level input (with pull-up)	Dynamic division mode maximum dot count select	H
40	GND	—	Ground	—	—
41	DP21	I	TTL level input (with pull-up)	Dynamic division mode maximum dot count select	H
42	DP20	I	TTL level input (with pull-up)	Dynamic division mode maximum dot count select	H
43	DP17	I	TTL level input (with pull-up)	Print mode select	H
44	DP16	I	TTL level input (with pull-up)	Maximum print speed select	H
45	DP15	I	TTL level input (with pull-up)	Paper feed rate select	H
46	DP14	I	TTL level input (with pull-up)	Printer mechanism model select	H
47	DP13	I	TTL level input (with pull-up)	Printer mechanism model select	H
48	DP12	I	TTL level input (with pull-up)	Printer mechanism model select	H

[1] I :Input   O :Output
[2] L :Low   H :High

Table 4-8 PT500GA1 Pin Definitions (Continued)

Pin No.	Signal Name	I/O[1]	Characteristics	Function	Logic[2]
49	DP11	I	TTL level input (with pull-up)	Printer mechanism model select	H
50	DP10	I	TTL level input (with pull-up)	Printer mechanism model select	H
51	$\overline{\text{XCS5}}$	O	NC	Reserved	—
52	$\overline{\text{XCS4}}$	O	NC	Reserved	—
53	N.U	—	NC	—	—
54	$\overline{\text{XCS3}}$	O	NC	Reserved	—
55	$\overline{\text{XCS2}}$	O	NC	Reserved	—
56	$\overline{\text{XCS1}}$	O	NC	Reserved	—
57	$\overline{\text{XCS0}}$	O	CMOS output	External RAM enable	L
58	KNJ7	I	NC (with internal pull-up)	Reserved	—
59	KNJ6	I	NC (with internal pull-up)	Reserved	—
60	KNJ5	I	NC (with internal pull-up)	Reserved	—
61	KNJ4	I	NC (with internal pull-up)	Reserved	—
62	KNJ3	I	NC (with internal pull-up)	Reserved	—
63	KNJ2	I	NC (with internal pull-up)	Reserved	—
64	KNJ1	I	NC (with internal pull-up)	Reserved	—
65	V_{CC}	—	V_{CC}	5 V	—
66	KNJ0	I	NC (with internal pull-up)	Reserved	—
67	A23	O	NC	Reserved	—
68	A22	O	NC	Reserved	—
69	A21	O	NC	Reserved	—
70	A20	O	NC	Reserved	—
71	A19	O	NC	Reserved	—
72	A18	O	NC	Reserved	—
73	A17	O	NC	Reserved	—
74	A16	O	NC	Reserved	—
75	$\overline{\text{WR}}$	O	CMOS output	Write enable	L

[1] I :Input   O :Output
[2] L :Low   H :High

Table 4-8 PT500GA1 Pin Definitions (Continued)

Pin No.	Signal Name	I/O¹	Characteristics	Function	Logic²
76	RD	O	CMOS output	Read enable	L
77	DBEN	O	NC	Reserved	—
78	N.U	—	NC	—	—
79	A0	I	TTL level input	Address bus	H
80	A1	I	TTL level input	Address bus	H
81	A2	I	TTL level input	Address bus	H
82	DA0	I/O	TTL level input CMOS output	Data bus	H
83	DA1	I/O	TTL level input CMOS output	Data bus	H
84	DA2	I/O	TTL level input CMOS output	Data bus	H
85	DA3	I/O	TTL level input CMOS output	Data bus	H
86	DA4	I/O	TTL level input CMOS output	Data bus	H
87	DA5	I/O	TTL level input CMOS output	Data bus	H
88	DA6	I/O	TTL level input CMOS output	Data bus	H
89	DA7	I/O	TTL level input CMOS output	Data bus	H
90	R/W̄	I	TTL level input	Read/write input signal	—
91	GND	—	Ground	—	—
92	ALE	I	TTL level input	ALE input signal	H
93	Ē	I	TTL level input	Enable clock input signal	L
94	Φ	I	TTL level input (with pull-up)	Phase input signal Φ	—
95	MODE	I	TTL level input (with pull-up)	Must be pulled up with a 4.7 kΩ resistor.	—
96	SDAT	I	TTL level input (with pull-up)	Head data input signal	H
97	SCLK	I	TTL level input (with pull-up)	Head clock input signal	H
98	HDC	O	CMOS output	Head data counter output	H
99	OPWR	O	NC	Reserved	—
100	OPRD	O	NC	Reserved	—

¹ I :Input   O :Output
² L :Low   H :High

4.5 POWER CONNECTION

The PT502P01 CPU and PT500GA1 Gate Array power pins must be connected as listed in Tables 4-9 and 4-10.

Table 4-9 PT502P01 Power Pin Connection

Pin No.	Symbol	Connected to
69	V_{CC}	V_{CC}
70	V_{CC}	V_{CC}
72	AVss	GND
73	Vss	GND

Table 4-10 PT500GA1 Power Pin Connection

Pin No.	Symbol	Connected to
16	V_{CC}	V_{CC}
40	GND	GND
65	V_{CC}	V_{CC}
91	GND	GND

NOTE

A 0.01 μF to 0.1 μF bypass capacitor must be connected across the V_{CC} and GND pins of both the PT502P01 and PT500GA1.

4.6 TREATMENT OF UNUSED PINS

The unused pins on the PT502P01 CPU and PT500GA1 Gate Array are listed below. These pins should not be connected to anything.

PT502P01
Pins 33, 35, 45, and 68

PT500GA1
Pins 3, 4, 5, 28, 51, 52, 53, 54, 55, 56, 58, 59, 60, 61, 62, 63, 64, 66, 67, 68, 69, 70, 71, 72, 73, 74, 77, 78, 99, and 100

4.7 RESET CIRCUIT

When the reset terminal (pin 28) is reset to high after being held low for longer than 2 microseconds at 5 V ± 5%, the PT502P01 CPU will return from the reset state and then initiate a programmed start sequence. The reset circuit must be designed so that the reset input voltage is 0.9 V or below at the point when the power voltage exceeds 4.75 V, as shown in Figure 4-3.

In the PT500GA1 Gate Array, when $\overline{RES1}$ (pin 1) is set to low, gate array terminals HDS0 to HDS5 (pins 6 to 11) are forced to low and the thermal head is turned off.

An example of a reset circuit is shown in Figure 4-4.
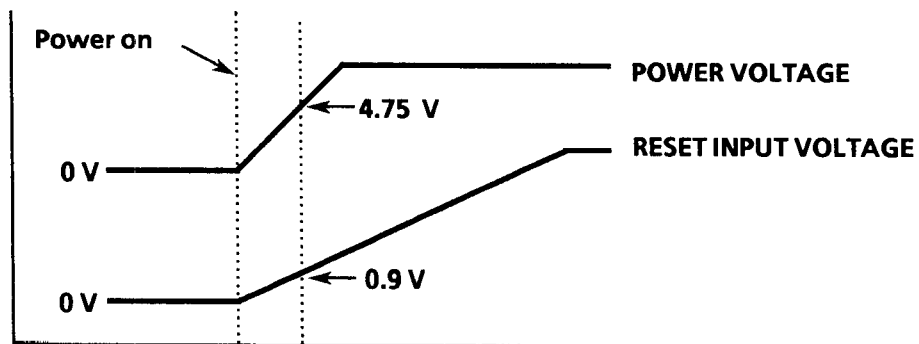
Figure 4-3 Power-on Reset Condition
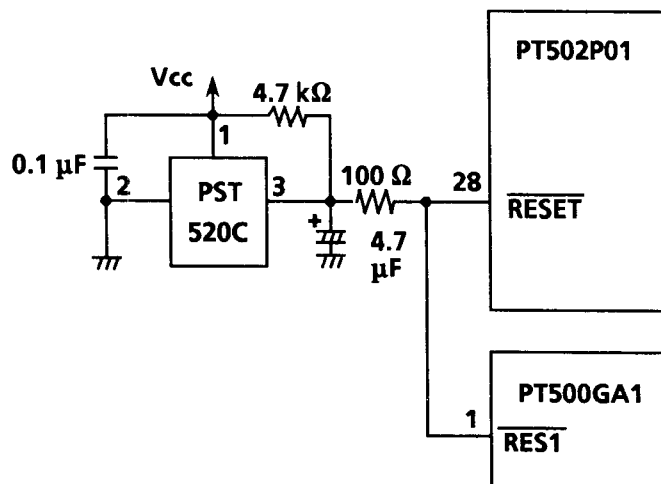
Recommended reset IC: PST520C (Mitsumi Electric Co., Ltd.)

Figure 4-4 Sample Reset Circuit

4.8 OSCILLATOR CIRCUIT

The PT502P01 CPU is provided with an internal oscillator circuit that generates necessary clocks. The internal clock ϕ is developed by dividing by two the frequency of the clock input to the clock input terminal Xin (pin 29). The bus cycle operation is based on the clock whose rate is obtained by further dividing by two the resulting internal clock ϕ. The internal oscillator circuit requires a ceramic or crystal resonator as an external device.

Figure 4-5 shows an example of an internal oscillator configuration using a ceramic resonator.

Figure 4-6 shows an example of an internal oscillator configuration that makes use of an external clock signal.
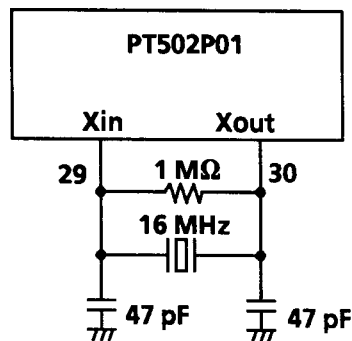
Recommended ceramic resonator: CSA16.00MX040 (Murata MFG. Co., Ltd.)

Figure 4-5 External Ceramic Resonator Circuit
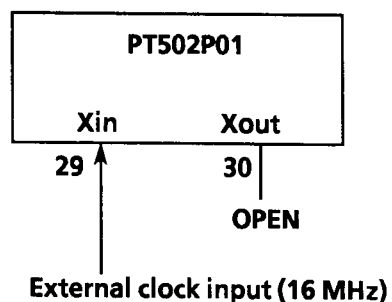
Figure 4-6 External Clock Input Circuit

4.9 PAPER DETECTION

The PT502P01 uses the input signal from the photo-interrupter mounted in the printer mechanism to check for paper.

The paper detector on the printer mechanism sets PS (pin 77 on the CPU) to low when paper exists, and sets it to high when out of paper.

When the PS terminal goes to high, the PT502P01 stops print operation and puts the printer in standby mode. At that time, the PT502P01 retains the print data. When the feed terminal (pin 16) is set to low after paper is installed, the PT502P01 resumes printing from the beginning of the line where the printing was suspended.

A sample paper detection circuit is shown in Figure 4-7.
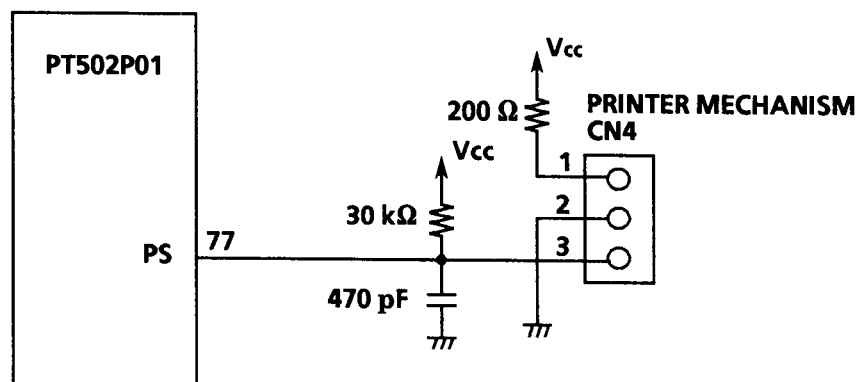
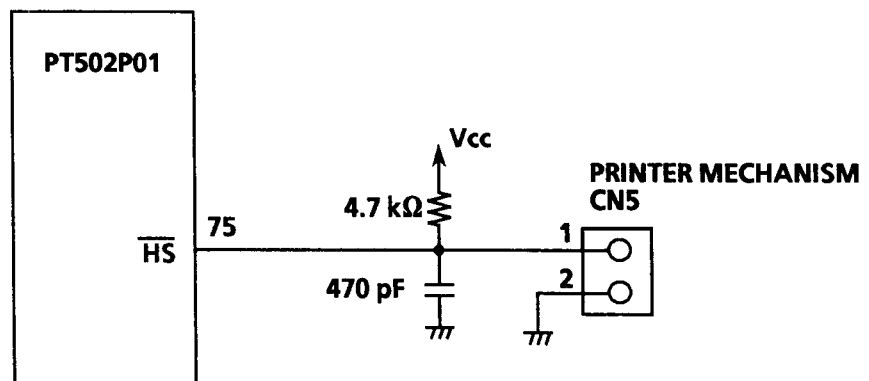Figure 4-7 Sample Paper Detection Circuit

4.10 HEAD-UP DETECTION CIRCUIT

The PT502P01 uses the input signal from the touch sensor mounted in the printer mechanism to check whether the thermal head is up or down.

The head-up detector is open when the head is in the down position and closed when the head is in the up position.

When the thermal head is in the up position, the $\overline{HS}$ terminal (pin 75) on the CPU becomes low. At that time, the PT502P01 stops print operation and puts the printer in standby mode. While in standby mode, the PT502P01 retains the print data. When the head returns to the down position, the PT502P01 resumes printing about one second later from the beginning of the line where printing was suspended.

A sample head-up detection circuit is shown in Figure 4-8.

Figure 4-8 Sample Head-up Detection Circuit

4.11 MOTOR CONTROL CIRCUIT

It is recommended that two power supplies be used with the PT502P01 to control the motor. By detecting V_p voltage variation and automatically controlling the applied V_p pulse width of the motor, the influence of voltage variation can be minimized and motor heat can be reduced.

When the print speed is set to high, acceleration control is automatically executed to prevent the print pitch from being too small at motor start up.

See Figures 4-9 and 4-11 for examples of motor control circuits, Figure 4-10 for the motor start/stop timing, and Figure 4-12 for the motor startup timing (under acceleration control).

(1) Dual-source drive mode
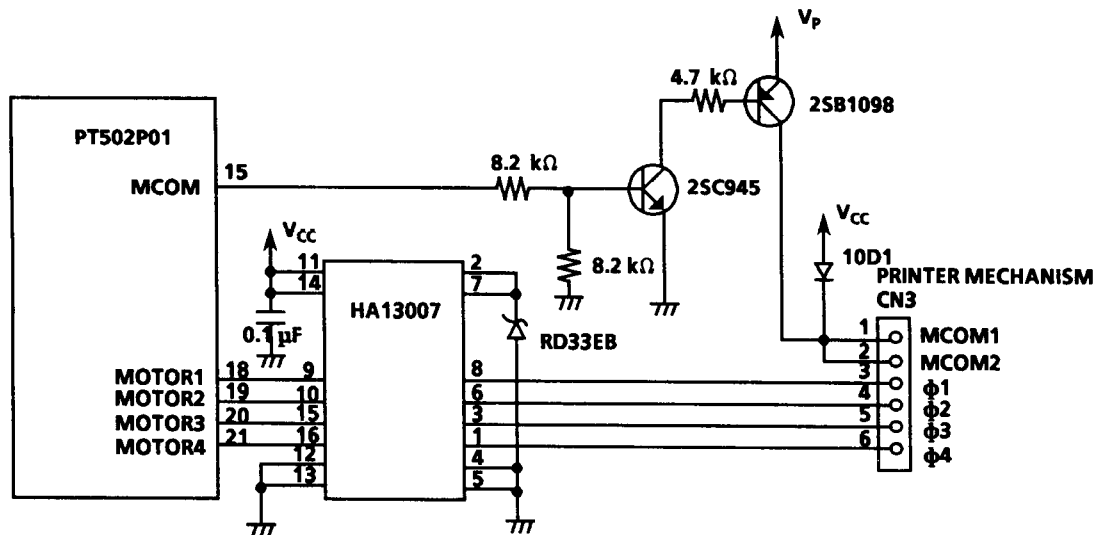
Determine the type of transistors, diodes, and resistors according to the resistance of the motor winding resistance used in the printer mechanism.

The following are recommended: HA13007 (Hitachi, Ltd.) as the motor driver IC, 2SB1098 (NEC Corp.) and 2SC945 (NEC Corp.) as the transistors, 10D1 (Nihon Inter Electronics Corp.) as the diode, and RD33EB (NEC Corp.) as the zener diode.

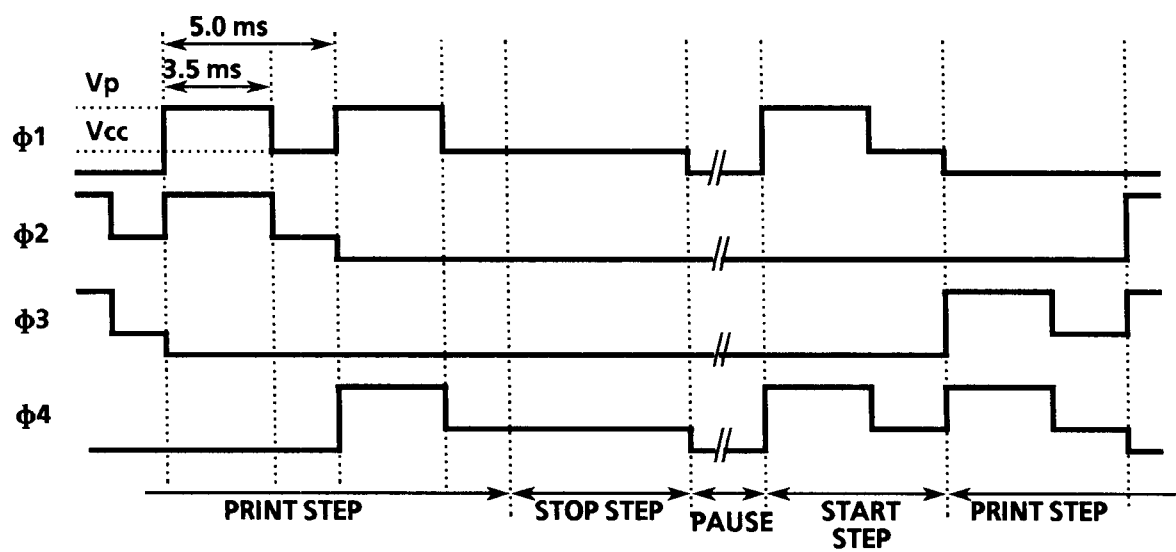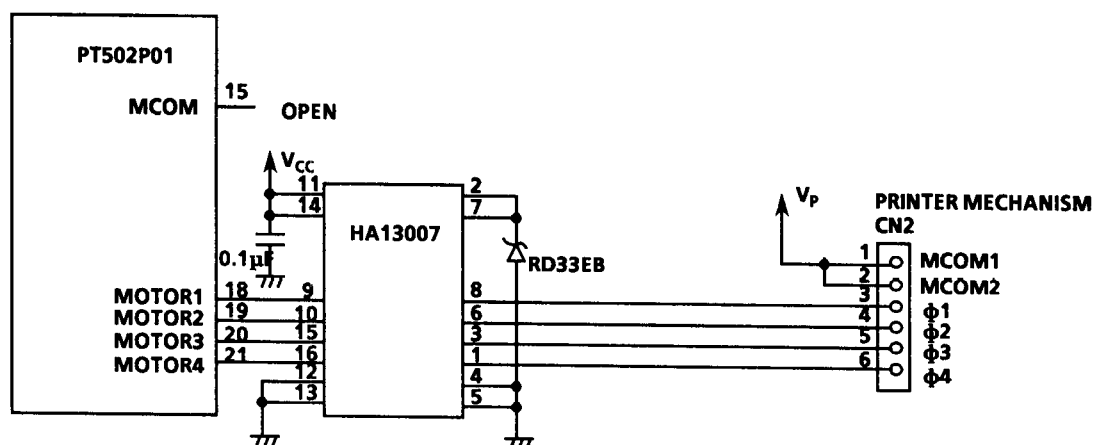Figure 4-9 Sample Motor Control Circuit (Dual-source Drive Mode)

Figure 4-10 Motor Start/Stop Timing (24-V, 8 dot/mm Mechanism at Low Print Speed)

(2) Single-source drive mode

The dual-source control block of the dual-source drive circuit may be omitted if all the following conditions are satisfied:

- maximum print speed is set to "High",

- the print mode is set to "Fixed division", and

- the CPU is to receive print data at a sufficiently higher speed than the print speed.

In this case, however, the motor may generate more heat than usual, resulting in reduced motor torque.

The recommended motor driver IC is HA13007 (Hitachi, Ltd.) and the recommended zener diode is RD33EB (NEC Corp.).

Figure 4-11 Sample Motor Control Circuit (Single-source Drive Mode)
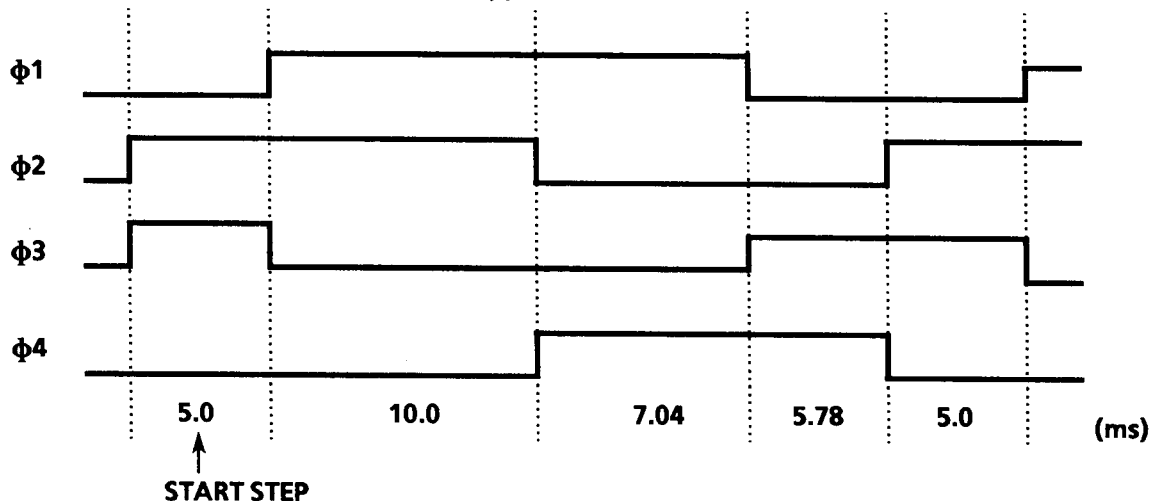
(3) Motor acceleration control

Only when the print speed is set to high does the PT502P01/PT500GA1 accelerate the print speed when the motor is started. By this, the PT502P01/PT500GA1 maintains constant print quality from the time the motor is started and prevents print pitch from being too small.

Figure 4-12 shows the acceleration control timing at the time the motor is started for both a 24-V, 8 dot/mm mechanism and a 12-V mechanism.

When driving a 24-V, 8 dot/mm mechanism at 400 pps:
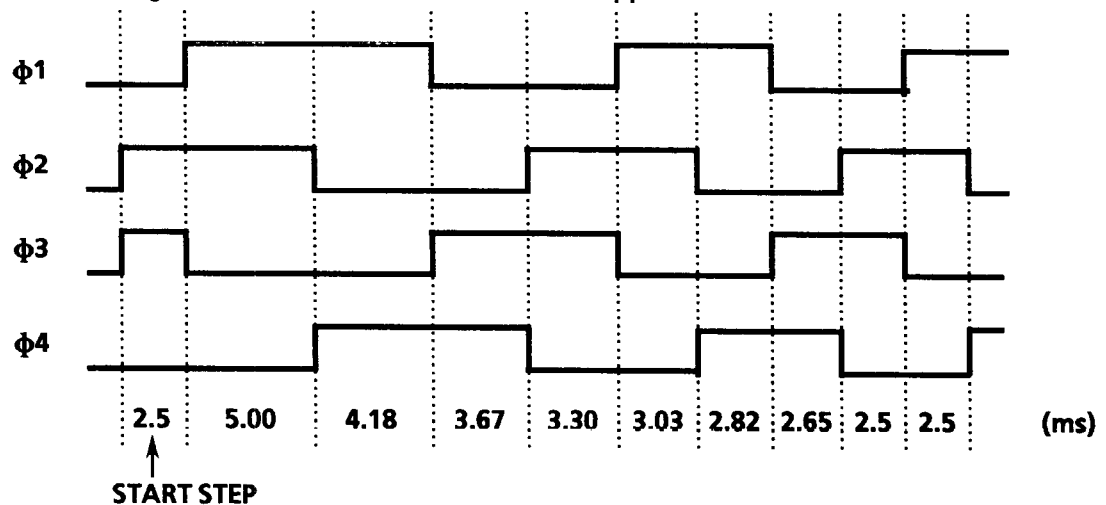
When driving a 12-V mechanism at 200 pps:

For both the 24-V, 8 dot/mm and 12-V mechanisms, the phase which was executed in the pause step is output again in the start step.

Figure 4-12 Motor Start Timing (Under Acceleration Control)

4.12 AUTOLOADING

What is autoloading?

The autoloading function utilizes the printer's paper detection sensor and paper feed motor to automatically load paper. When the paper is inserted into the paper inlet, the paper feed motor automatically starts and feeds the paper out from the thermal head.

The PT502P01 CPU has the autoloading function so the usual procedures for inserting the paper as described below are not required.

1. Raise the thermal head to the up position using head up lever.
2. Insert the paper into the paper inlet.
3. Lower the thermal head to the down position.

The design for the outer case, frame, etc., are simplified since the head-up lever is not required.

The procedures for using the autoloading function are given below.

1. Make sure the PE signal (Pin 22 on the CPU) is high.
   If paper is on the thermal head, the PE signal will be low. Remove the paper. The PE signal will go to high.

2. With the thermal head in the down position, insert the paper into the paper inlet until the PE signal goes to low.
   The paper will be loaded automatically.
   If the thermal head is in the up position, autoloading will not function.

3. After autoloading has been completed, change the feed input terminal (Pin 16 on the CPU) to low to put the printer in print ready status.

4.13 HEAD CONTROL CIRCUIT

(1) Resistance measurement circuit

The PT502P01 has a function for measuring the resistance of the thermal head. Based on the measurement, the PT502P01 determines how much energy to apply and detects problems. To use this function, the resistance measurement circuit is necessary.

(2) V_P interrupt circuit

This circuit interrupts V_P to prevent electrolytic corrosion of the thermal head and to enable the detection of the resistance mentioned above.

Electrolytic corrosion may significantly shorten the life of the thermal head. Thermal paper ordinarily contains electrolytic material to prevent sheets from sticking to each other due to static electricity. If there is too much of this electrolytic material, high temperatures and humidity cause the material to ionize, resulting in electrolytic corrosion of the thermal head.

A sample resistance measurement circuit and V_P interrupt circuit are shown in Figure 4-13. These circuits operate in the following manner:

- Interrupts V_P at TR1. It is still necessary to apply Vp to the fifth terminal of the printer mechanism head connector.

- Turns on TR2 to apply V_{CC} to the heat elements and measure the resistance. The head resistance is measured only once at initialization.

- When measurement ends, TR2 goes off and initialization is performed. When initialization is completed, the PT502P01 prepares for data input (standby mode). While in standby mode, V_P remains interrupted.

- When data is input and the printing conditions have been met, TR1 is turned on to start printing.

- If the PT502P01 receives no data for five seconds after printing has ended, the PT502P01 interrupts V_p and enters standby mode.

NOTE

The V_P interrupt circuit may be omitted. However, doing so makes it more likely that electrolytic corrosion will occur. In addition, the PT502P01 CPU will also be unable to measure head resistance. In this case, the head resistance terminal (pin 79 on the CPU) must be connected to GND. Pins 12 and 13 on the CPU may be left open.

Since the PT502P01 CPU regards head resistance as the standard resistance for the printer mechanism, it is necessary to adjust the drive energy adjustment terminals according to the normal head resistance for the printer mechanism to be used (refer to the Technical Reference manual for the appropriate printer mechanism model).
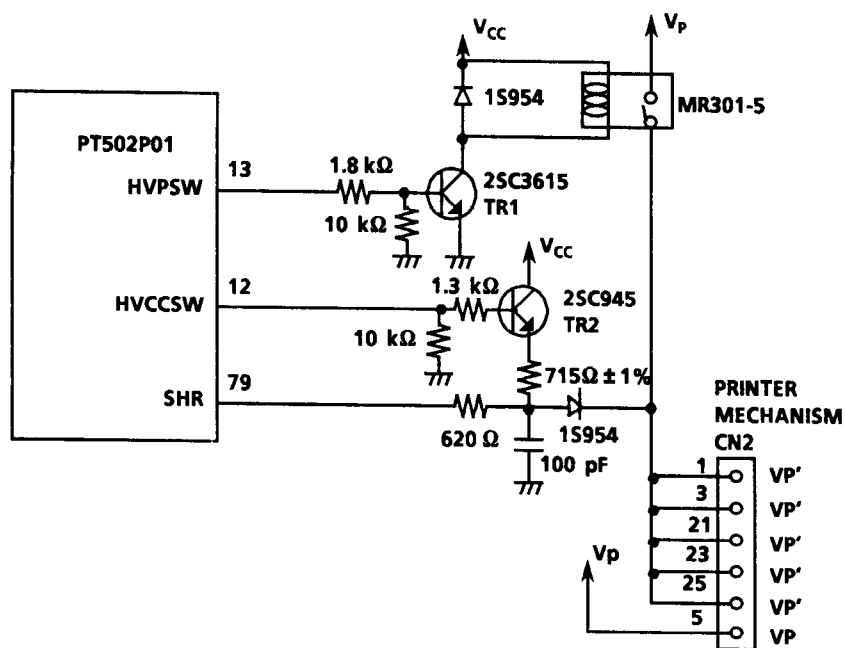
Recommended transistor: TR1: 2SC3615 (NEC Corp.)
                                        TR2: 2SC945 (NEC Corp.)
Recommended relay: MR301-5 (NEC Corp.)

TR1 forms an emitter follower. Place a pull-down resistor on the HVCCSW side.

Figure 4-13 Resistance Measuring and V_P Interrupt Circuits

(3) Head temperature measurement circuit

The PT502P01 and PT500GA1 measure the temperature of the thermal head by using the head temperature detection circuit. The PT502P01 determines the level of energy to be applied to the head according to the input signal from the thermistor mounted on the printer mechanism. The PT502P01 prevents the thermal head from deteriorating or being damaged due to high temperature.

Although the temperature of the head is monitored by the CPU, the hardware also can stop thermal head output by sending a strobe signal from the comparator, such as in the case when the CPU loses operational control.

Figure 4-14 shows a sample circuit that detects the temperature of the thermal head.
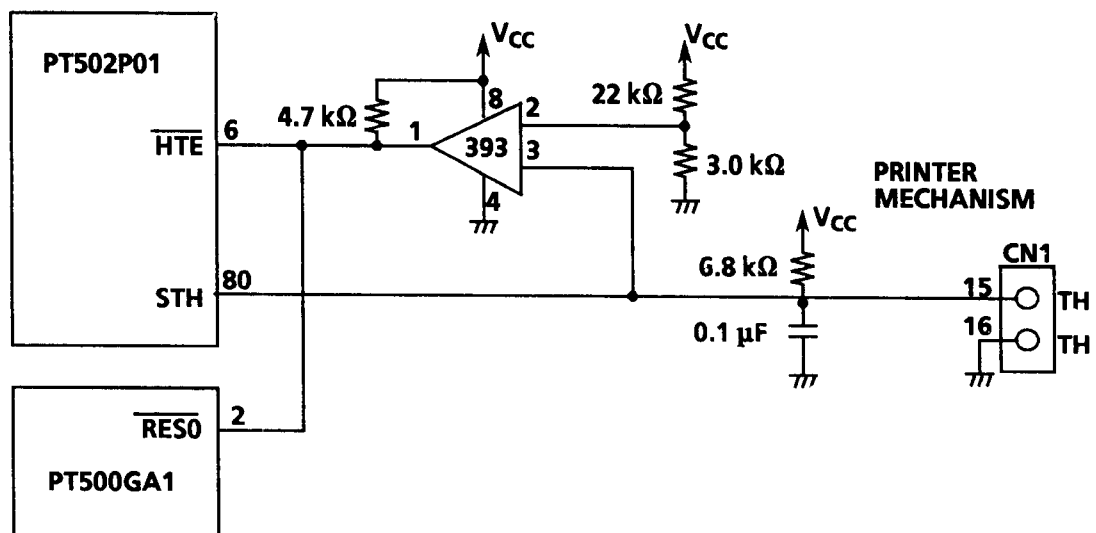

Recommended IC: μPC393C (NEC Corp.)

Figure 4-14 Sample Head Temperature Detection Circuit

(4) Connecting to the thermal head

The PT502P01 CPU and PT500GA1 gate array require that the head latch, head data, and head clock lines, which require high-speed operation, be connected to the CPU and gate array through a bus buffer. Figure 4-15 shows an example of a buffer between the PT502P01/PT500GA1 and the thermal head.
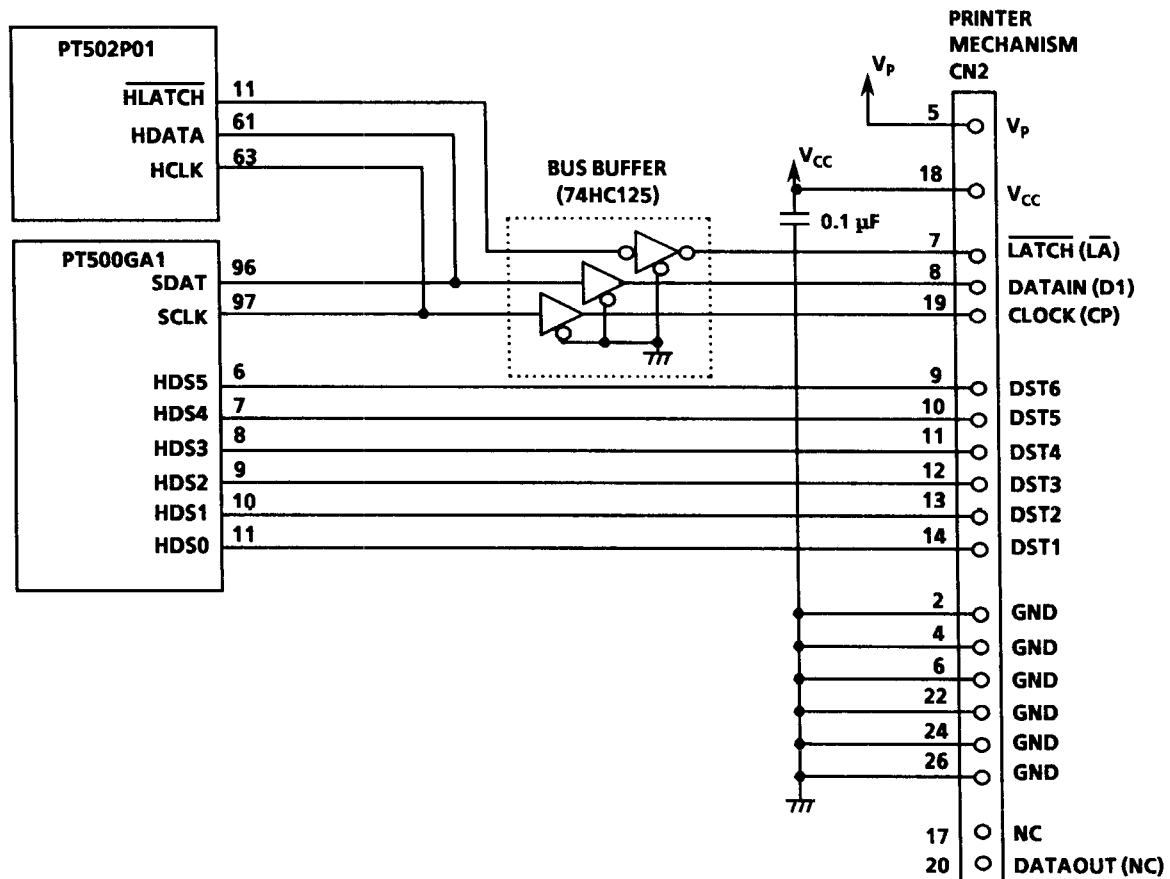
Vp and Vcc are connected to the same ground.

Figure 4-15 Sample Head Connection Diagram

4.14 VOLTAGE MEASUREMENT CIRCUIT

The PT502P01 has the capability to measure Vp and reference voltages. This capability determines the energy to be applied to the thermal head and to check for various errors. The PT502P01 will not function normally unless a voltage measurement circuit such as the one shown below is implemented. Be sure to implement the Vp and head Vp measurement circuits.

Figures 4-16 through 4-19 show examples of voltage measurement circuits.
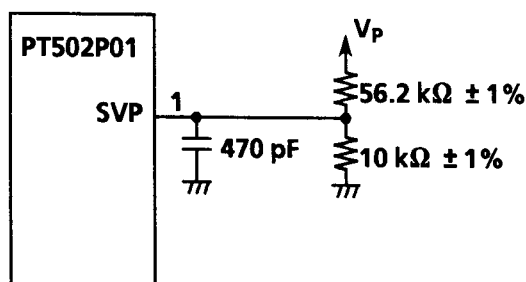
Figure 4-16 Sample Vp Voltage Measurement Circuit
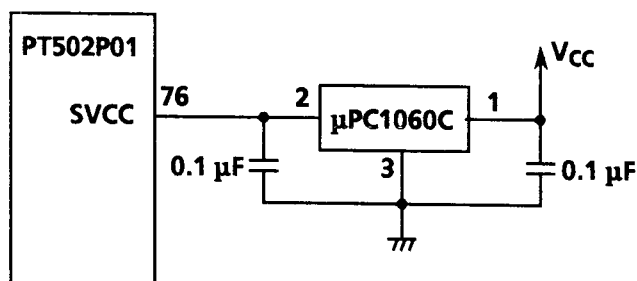
Recommended IC: µPC1060C (NEC Corp.)

A reference voltage of 2.5 V is generated. This voltage serves as the reference for measuring the SVP and SHVP levels. The V_{CC} sensing circuit may be omitted if V_{CC} is guaranteed to be 5 V ± 1%. In such a case, the PT502P01 CPU assumes a V_{CC} of 5.0 V when the SVCC pin is connected to GND.

Figure 4-17 Sample Reference Voltage Sensing Circuit
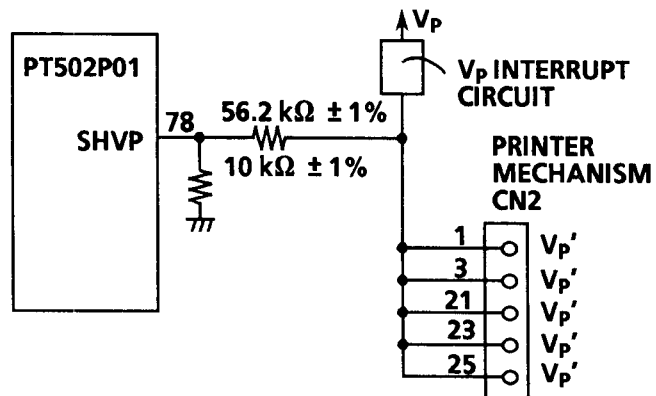
Figure 4-18 Sample Head V_P Voltage Measurement Circuit
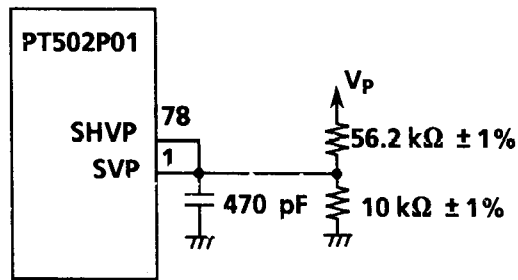
SHVP and SVP may share the same circuit when the V_P interrupt circuit is omitted.

Figure 4-19 Sample Head V_P Voltage Measuring Circuit
(When the V_P Interrupt Circuit is Omitted)

4.15 ADJUSTMENT OF APPLIED ENERGY

The PT502P01 automatically adjusts the energy applied to the thermal head according to the temperature of the thermal head and the voltage. In addition, it is provided with a terminal that is used to compensate for the change in energy applied to the thermal head due to a difference in the quality of paper used.

The rate at which energy is applied can be adjusted between −15% and +35% and is set in advance in accordance with the printer mechanism. (See the Technical Reference manual for each printer mechanism.)

NOTE

At the rated energy setting, the adjustment rate is set to 0% of the rated energy if SEN (CPU pin 74) is connected to GND.
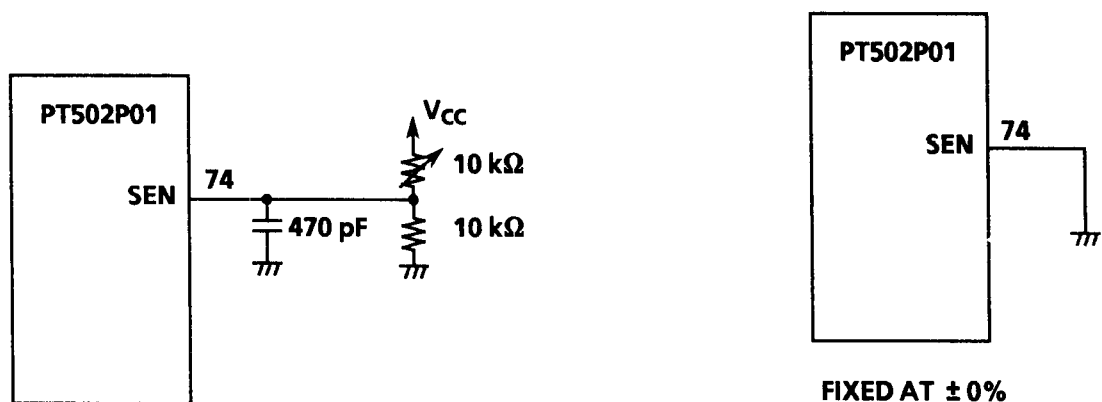
Figure 4-20 Sample Head Energy Adjustment Circuit

The adjustment rates for the energy applied by the sample circuits in Figure 4-20 are shown in Table 4-11.

Table 4-11 Head Energy Adjustment Rates Controlled
by the SEN Terminal Voltage

SEN Terminal Voltage	Adjustment Amount (%)
0 to 0.3 V_{CC}	0
0.3 to 0.5 V_{CC}	Must not be used.
0.5 V_{CC}	– 15
0.65 V_{CC}	0
1.0 V_{CC}	+ 35

NOTE

The adjustment rate for the range 0.5 to 1.0 V_{CC} is calculated using the followment equation:

Adjustment rate (%) = (SEN / V_{CC}) × 100 – 65

4.16 PARALLEL INPUT/OUTPUT CONTROL

The PT502P01 CPU and PT500GA1 Gate Array receive parallel data using an 8-bit parallel handshake method. Figure 4-21 shows the parallel data input/output timing chart for the PT502P01/PT500GA1, Figure 4-22 shows a sample input/output control circuit, and Figure 4-23 shows the data input/output timing when used with the sample input/output control circuit. Table 4-12 lists the signals used in the sample control circuit and their functions.

	MIN	MAX	UNIT
T1	40.0	–	ns
T2	40.0	–	ns
T3	40.0	–	ns
T4	–	40.0	ns
T5	2.7	2.8	μs
T6	2.6	2.7	μs
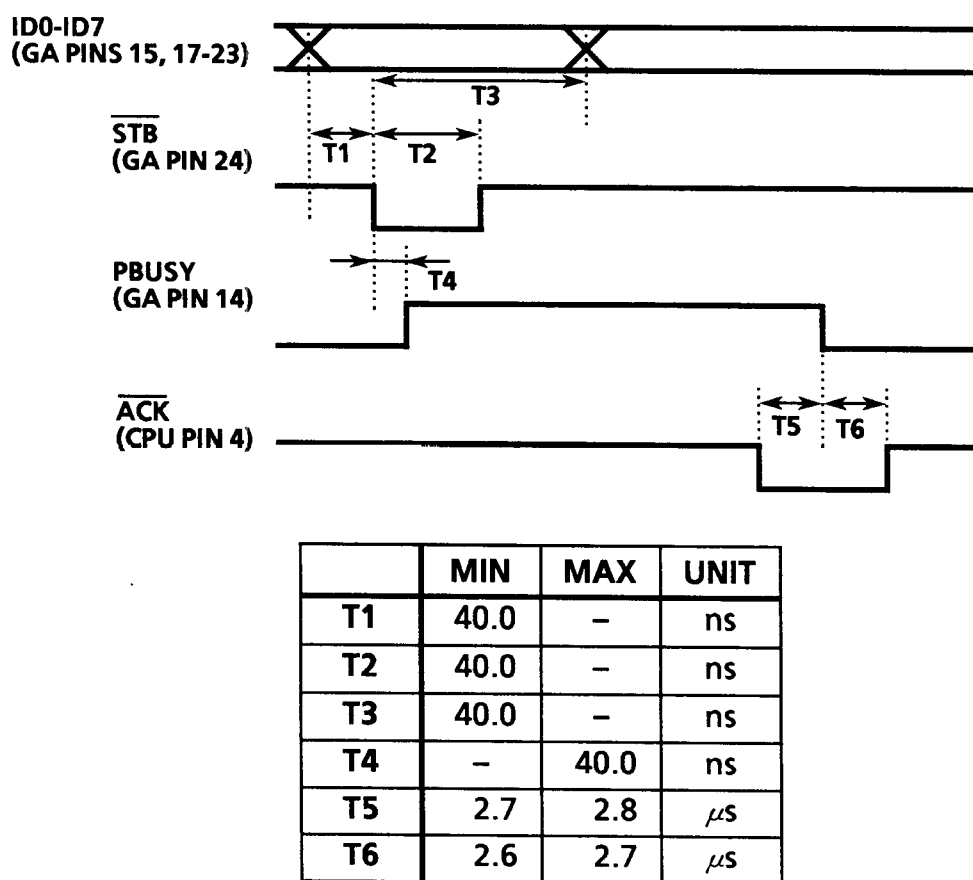
Figure 4-21 Data Input/Output Timing (Monitored at CPU and Gate Array Terminals)

Figure 4-22 Sample Parallel Input/Output Control Circuit
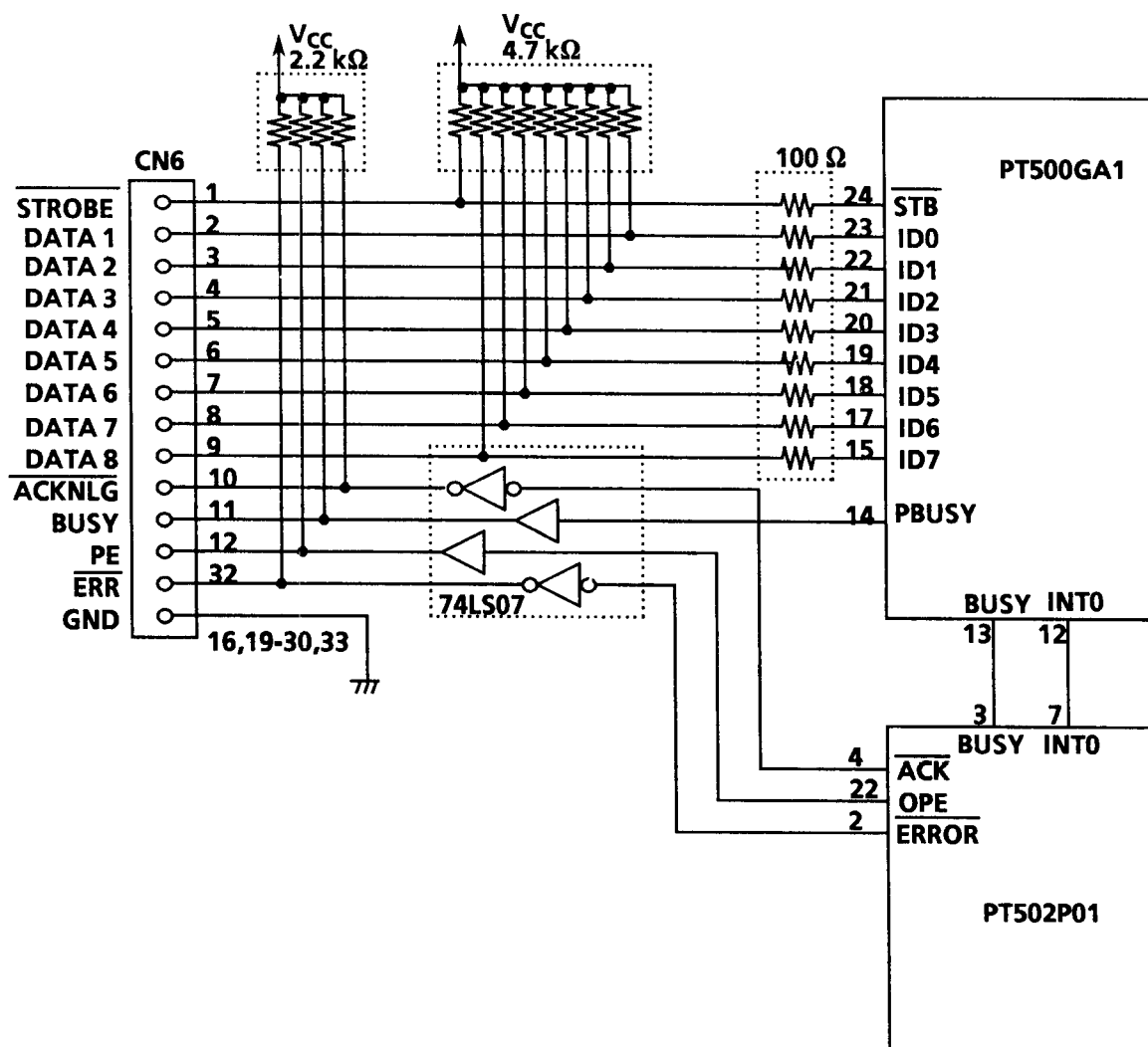
A 100Ω resistor must be inserted to prevent gate array latch-up.

When parallel input/output will not be used, gate array pins $\overline{STB}$ and ID0 through ID7 must be connected to GND. The gate array PBUSY and the CPU $\overline{ACK}$, PE, and $\overline{ERROR}$ pins must be left open. The CPU BUSY and INT0 pins must remain connected to the gate array BUSY and INT0 pins.
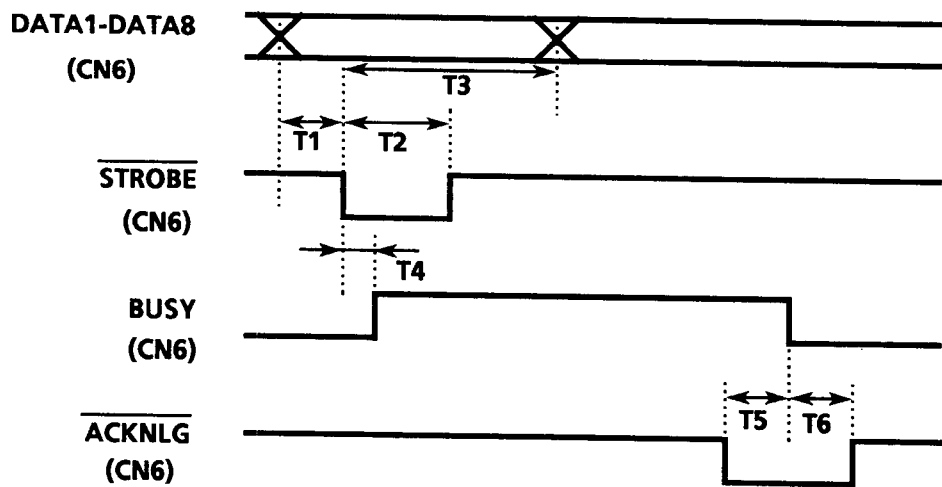
	MIN	TYP.	UNIT
T1	0.5	–	μs
T2	0.5	–	μs
T3	0.5	–	μs
T4	–	1.2	μs
T5	2.7	2.75	μs
T6	2.6	2.65	μs

Figure 4-23 Data Input/Output Timing for the Sample Circuit

Table 4-12 Sample Parallel Input/Output Control Circuit Signal Description

Signal Name	CN6 Pin No.	I/O	Description
$\overline{\text{STB}}$	1	I	Strobe signal used to read parallel data. Data is read in on the high-to-low transition of this signal.
DATA 1	2	I	Carries parallel data. High = logic 1 Low = logic 0
DATA 2	3	I	
DATA 3	4	I	
DATA 4	5	I	
DATA 5	6	I	
DATA 6	7	I	
DATA 7	8	I	
DATA 8	9	I	
$\overline{\text{ACKNLG}}$	10	O	Low on this line indicates that parallel data has been received.
BUSY	11	O	Low on this line indicates that the gate array is ready to receive data.
PE	12	O	High on this line indicates that paper has been used up.
$\overline{\text{ERR}}$	32	O	Low on this line indicates that an error has occurred in the printer mechanism.

4.17 SERIAL INPUT/OUTPUT CONTROL

The input and output of serial data is performed using asynchronous serial communication. The PT502P01 sends and receives serial data at the TTL level. Figure 4-24 shows the serial input/output timing for the PT502P01 and PT500GA1, Figure 4-25 shows a sample serial input/output control circuit, and Table 4-13 summarizes the signals used in the sample circuit and their functions.

T1: 40 μs typical

T2: Typical 1-bit transmission time (1/baud rate)

when the buffer becomes full after 31_H has been transmitted with two stop bits and no parity bit
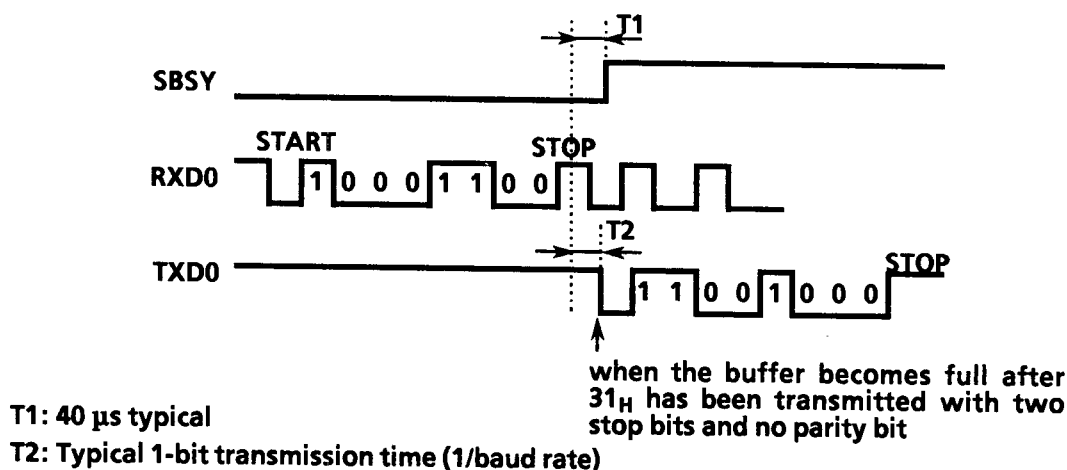
Figure 4-24 Data Input/Output Timing (Monitored at CPU Terminals)
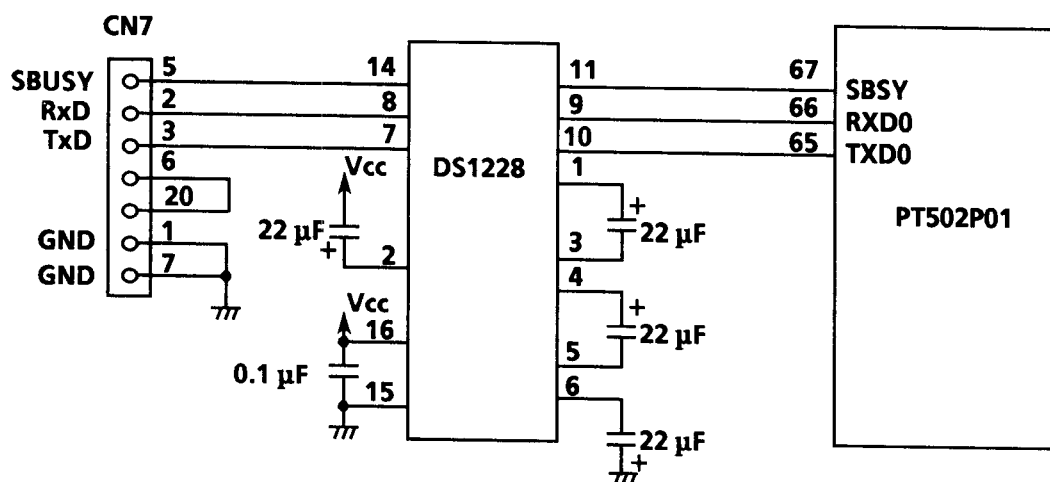
Recommended IC: DS1228 (Dallas Semiconductor Corp.)

When serial input/output will not be used, pull the CPU's RXD0 pin with a 10 k-ohm resistor. The CPU's SBSY and TXD0 pins may be left open.

Figure 4-25 Sample Serial Input/Output Control Circuit

Table 4-13 Sample Serial Input/Output Control Circuit Signal Description

Signal Name	CPU Pin No.	I/O	Description
RXD0	66	I	Receives serial data from the computer according to the externally defined transmission conditions (baud rate, character length, etc.).
SBSY	67	O	Indicates whether or not the CPU is ready to receive serial data. The CPU sets this pin to low when it is ready to receive data. This pin is always low when the Xon/Xoff control is selected.
TXD0[1]	65	O	Carries Xon/Xoff data when Xon/Xoff control is selected. This pin is always high when the BUSY control is selected.

[1] The computer must control the transmission of serial data so that, once it receives an Xoff (13_H) code, it refrains from sending output data until it receives an Xon (11_H) code. The conditions for sending Xon and Xoff data are identical to those which are defined using the function pins (see Section 4.18).

NOTE

The baud rates may have an error of approximately 0.2% as shown in Table 4-14 but this should cause no significant problems.

Table 4-14 Actual Baud Rates in bps (at 16 MHz Clock Rate)

Set Value	Actual Value
150	150.24
300	300.48
600	600.96
1200	1201.82
2400	2403.85
4800	4807.69
9600	9615.38
19200	19230.80

4.18 FUNCTION PINS

The function pins are used to select the PT502P01/PT500GA1 function options. The options include those which are used to define the mechanism modes, software modes, and serial input/output conditions. The function pins are pulled up in the gate array chip and connect directly when connecting them to DIP switches.

(1) Setting mechanism parameters

The functions of the pins for defining the mechanism modes are listed in Table 4-15.

Table 4-15 Mechanism Mode Function Pin Setting

Signal Name	GA Pin No.	High	Low	Function[1]
DP10 DP11 DP12 DP13 DP14	50 49 48 47 46	See Table 4-16.		Selects printer mechanism model (①).
DP15	45	High speed	Low speed	Selects paper feed rate (②).
DP16	44	High speed	Low speed	Selects maximum print speed (③).
DP17	43	Dynamic division	Fixed division	Selects print mode (④).

[1]   The circled numbers correspond to the descriptions below.

① Printer mechanism model

Five terminals are used to select the printer mechanism model. They can specify a maximum of 31 models of printer mechanism. Presently, however, only six printer models are supported as shown in Table 4-16. The PT502P01 generates an error signal and stops processing when a printer model other than those listed in Table 4-16 is selected. In such a case, the PT502P01 will not return to its normal state until a valid model is selected and a hardware reset is performed.

Table 4-16 Pin Settings for Indicating Printer Mechanism

DP14	DP13	DP12	DP11	DP10	Model
Low	Low	Low	Low	Low	LTP5442
Low	Low	Low	Low	High	LTP5347
Low	Low	Low	High	Low	LTP5246
Low	Low	Low	High	High	LTP5446
Low	Low	High	Low	Low	LTP5242
Low	Low	High	Low	High	LTP5437
High	High	High	High	High	Optional DIP switch input
Other settings					Not available

The optional DIP switch input is used to serially transfer the DIP switch settings to the CPU (through pins 62, 63, and 64) when a DIP switch cannot be mounted on the board.

In the sample circuit shown in Figure 4-26, the DIP switch settings are read sequentially starting at DIP SW1-1. When this circuit is used, other function pins may be left open.
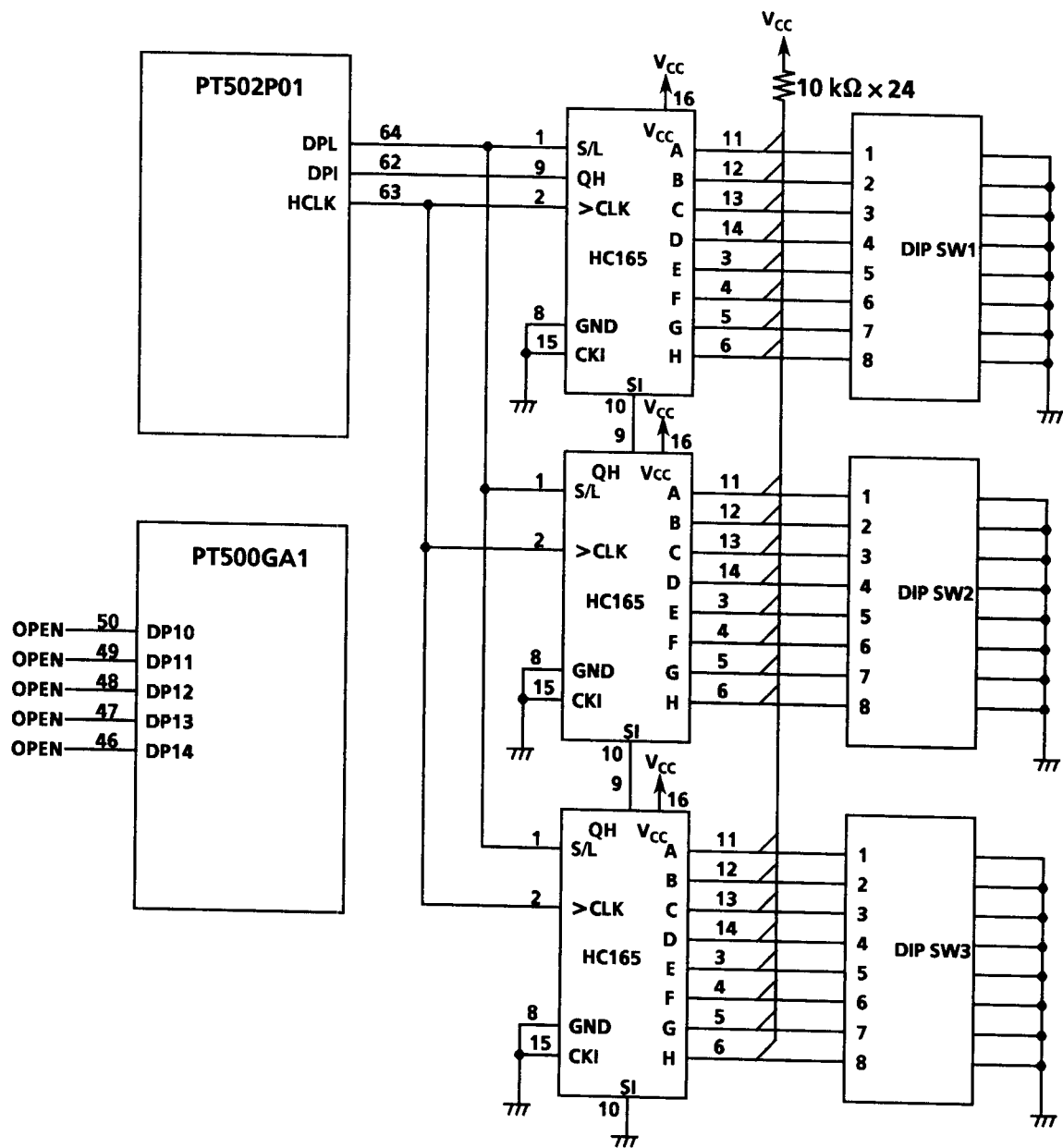
CPU pin 62 must be pulled up with a 10 kΩ resistor if this circuit is not used.

Figure 4-26 Sample Optional DIP Switch Input Circuit

② Paper feed rate

The paper feed rate parameter determines the speed at which paper is fed while not printing. Paper feed rate differs depending on the mechanism model, as follows:

Model	High speed	Low speed
LTP5242	50.0 mm/sec	25.0 mm/sec
LTP5246	25.0 mm/sec	12.5 mm/sec
LTP5347	50.0 mm/sec	25.0 mm/sec
LTP5437	50.0 mm/sec	25.0 mm/sec
LTP5442	50.0 mm/sec	25.0 mm/sec
LTP5446	25.0 mm/sec	12.5 mm/sec

③ Maximum print speed

The maximum print speed parameter determines the speed at which paper is fed while printing. However, actual printing speed varies depending on the print data, data input rate, and the interface mode (selected through function pins DP23 and DP24). If the print data is complex, or if the data input rate is lower than the print speed, the maximum print speed selected cannot be attained. Moreover, in any print job, the actual print speed will not exceed the selected maximum print speed. The maximum print speed differs depending on the mechanism model, as follows:

Model	High speed	Low speed
LTP5242	50.0 mm/sec	25.0 mm/sec
LTP5246	25.0 mm/sec	12.5 mm/sec
LTP5347	50.0 mm/sec	25.0 mm/sec
LTP5437	50.0 mm/sec	25.0 mm/sec
LTP5442	50.0 mm/sec	25.0 mm/sec
LTP5446	25.0 mm/sec	12.5 mm/sec

④ Print mode

The print mode parameter selects the print head drive method. The PT502P01 supports the dynamic and fixed division methods as print modes (see Section 3.1).

(2) Setting software parameters

The function pins for defining the software modes are listed in Table 4-17.

Table 4-17 Software Mode Function Pin Settings

Signal	GA Pin No.	High	Low	Function[1]
DP20 DP21 DP22	42 41 39	See Table 4-18.		Specifies the maximum number of activated dots for dynamic division (①).
DP23 DP24	38 37	See Table 4-19.		Selects the interface mode (②).
DP25	36	Kana	IBM compatible	Selects the character set (③).
DP26	35	Two-ply	Normal	Selects the paper type (④).
DP27	34	Parallel	Serial	Selects the data receive mode (⑤).

[1] The encircled numbers correspond to the descriptions below.

① Maximum number of activated dots for dynamic division

When dynamic division is used, the maximum number of activated dots can be specified in units of 64 dots. In mode 1 (specified through DP23 and DP24), if the specified maximum number of dots is smaller than the number of dots in the largest physical block of the mechanism used, the number of dots in the largest physical block is automatically taken to be the maximum number of activated dots. For the number of dots in the largest physical block, see Table 3-2.

In mode 0, the specified maximum number of dots is always valid as described in Section 3.1.

When fixed division is used, DP20 to DP22 are disabled. For the capacity of the power supply, see Section 4.21.

Table 4-18 Pin Settings for the Maximum
Number of Dots

DP22	DP21	DP20	Maximum Number of Dots[1]
Low	Low	Low	64
Low	Low	High	128
Low	High	Low	192
Low	High	High	256
High	Low	Low	320
High	Low	High	384
High	High	Low	448
High	High	High	512

[1] The encircled numbers correspond to the descriptions below.

② Interface mode

The user can select interface modes 0 through 3 as the interface mode. Presently, the PT502P01 supports only interface modes 0 and 1.

In interface mode 0, the PT502P01 provides many print functions. This means the PT502P01 must do complex operations and thus reduces the printing speed in some situations. A reduced printing speed occurs especially when printing many characters on a line using many print functions.

Interface mode 1 provides less print functions than interface mode 0 but allows printing at a higher speed.

Table 4-19 Pin Settings for Interface
Mode Selection

DP24	DP23	Interface Mode
Low	Low	0
Low	High	1
High	Low	Must not be used.
High	High	Must not be used.

③ Character set

The PT502P01 has two standard character sets: the IBM-compatible character set and the Japanese *kana* character set.

When the power is turned on or when the system is reset through a command or switch operation, the character set that is specified by DP26 is selected. This selection is also changed through the function code sequence **ESC + t + n** (see Section 9.5).

④ Paper type

DP26 informs the printer whether two-ply thermal paper or normal thermal paper is to be used (see Section 3.4).

When the power is turned on or when the system is reset through a command or switch operation, the thermal paper that is specified by this pin is selected. This selection can be changed through the function code sequence **ESC + ! + n** (see Section 9.5).

When using fixed division, this pin is invalid, and normal thermal paper is always selected.

⑤ Data receive mode

Data receive mode specifies whether the PT502P01/PT500GA1 is to receive data in parallel or serial mode. DP30 through DP37 of the gate array are used to establish the serial transmission parameters. The parameters are ignored when the parallel data receive mode is selected.

(3) Setting serial transmission parameters

The function pins for defining the serial transmission conditions are listed in Table 4-20.

Table 4-20 Function Pins for Setting Serial Transmission Parameters

Signal	GA Pin No.	High	Low	Function[1]
DP30 DP31 DP32	33 32 31	See Table 4-21.		Selects baud rate (①).
DP33	30	8 bits	7 bits	Selects character length (②).
DP34	29	2 bits	1 bit	Selects stop bit length (③).
DP35	27	Even	Odd	Selects even/odd parity (④).
DP36	26	Enabled	Disabled	Selects parity enable/disable (④).
DP37	25	BUSY	Xon/Xoff	Selects BUSY or Xon/Xoff control (⑤).

[1]   The encircled numbers correspond to the descriptions below.

① Baud rate

The baud rate is selected by terminals DP30 to DP32 as summarized in Table 4-21.

Table 4-21 Baud Rate Settings

DP32	DP31	DP30	Baud Rate (bps)
Low	Low	Low	150
Low	Low	High	300
Low	High	Low	600
Low	High	High	1200
High	Low	Low	2400
High	Low	High	4800
High	High	Low	9600
High	High	High	19200

② **Character length**

Character length is selected through function pin DP33. Note that the PT502P01/PT500GA1 cannot normally print bit image data or character data which requires eight bits when a length of seven bits has been selected.

③ **Stop bit length**

Stop bit length is selected through function pin DP34.

④ **Parity checking mode**

Parity checking mode is selected through function pins DP35 and DP36. Pin DP36 enables or disables the parity bit. When enabled, it is necessary to select either odd or even parity using pin DP35.

⑤ **Busy control**

Function pin DP37 selects either the busy code or the Xon/Xoff code combination to control serial data transmission.

4.19 SWITCH CIRCUIT

The PT502P01 CPU is provided with pins to control the paper feed direction. By connecting switches to these pins, it is possible to control the paper feed direction externally. A sample external circuit for controlling the paper feed direction is shown in Figure 4-27.

Figure 4-27 Sample Switch Circuit

4.20 AUTOCUTTER UNIT

The ACU5000 series autocutter unit is a guillotine-type paper cutter that can be mounted to an SII LTP5000 series thermal printer. The autocutter unit can cut paper fully or partially (leaving the paper connected at one point in the center).
The PT502P01 CPU can switch the autocutter between full cut and partial cut using function codes **ESC + i** and **ESC + m**.

Refer to the *ACU5000 Series Autocutter Unit Technical Reference*, Document Number 39019-2277.

4.20.1 Connecting to the Autocutter Unit

Figure 4-28 shows a sample connection to the ACU5000 series autocutter unit.

CAUTION

Even when the PT502P01 CPU is not connected to the ACU5000 series autocutter unit, use a 4.7 kΩ pull-up resistor on pin 17 of the CPU.

Recommended IC: MB3853 (FUJITSU)

Figure 4-28 Sample Connection to the Autocutter Unit
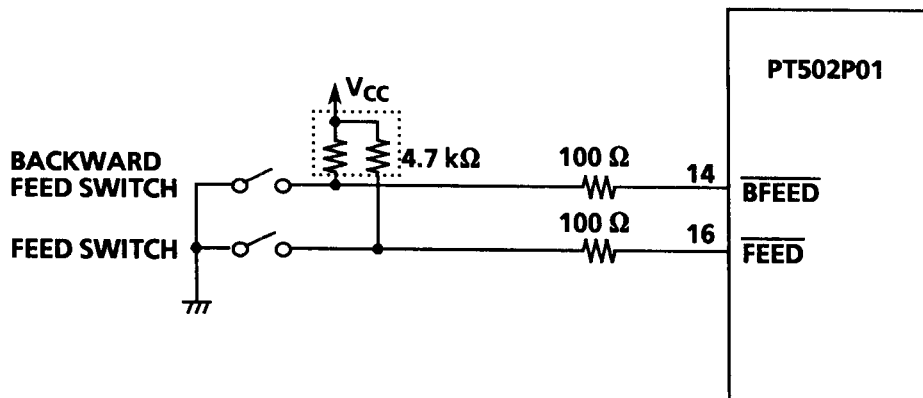
4.20.2 Initializing the Autocutter Unit

The autocutter unit will be initialized when the power is on, or when the hardware or the software is reset.
When the autocutter unit is initialized, the motor (movable edge) will rotate and the movable edge will return to home position automatically.

CAUTION

The PT502P01 CPU will not detect an error where the motor (movable edge) is locked during initialization of the autocutter unit.

When the motor (movable edge) is locked because of an external factor (paper jam etc.), cancel the lock by performing the following procedure.

Canceling Motor (movable edge) Lock

1   Make sure the motor has stopped and the movable edge is in the home position. If the movable edge is locked, the PT502P01 automatically rotates the motor in the reverse direction (the normal direction is the direction during cutting) and returns the movable edge to the home position.

2   Remove the source of the problem (paper jam, etc.) then set the feed switch input terminal (pin 16 on the CPU) to "Low".
If the movable edge has not returned to the home position, make sure the motor has stopped then insert a Phillips screwdriver into the hole shown in Figure 4-29, and turn the cross recess in the tip of the worm gear of the motor spindle until the movable edge can not be seen in the paper outlet, then remove the source of the problem.
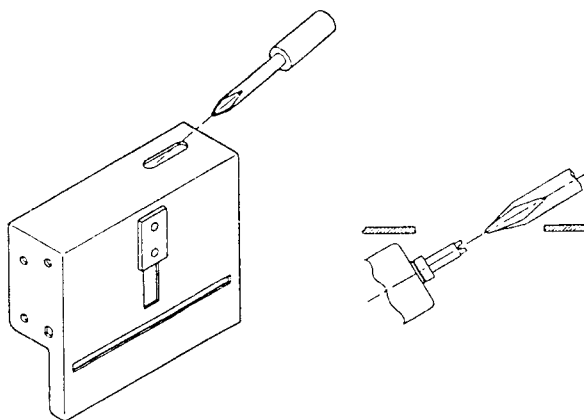
Figure 4-29 Removing the Movable Edge

4.20.3   Timing Chart for Controlling the Autocutter Unit

Figure 4-30 shows the timing chart for connecting the autocutter unit to the PT502P01 CPU.

Full-cut

1   CPU output signal
2   CPU input signal
3   Output signal to autocutter unit

① Standby mode (driving motor OFF)
② Standby mode (driving motor ON)
③ Start to move the movable edge
④ Cut the paper
⑤ End of the cutting (home position detection)
⑥ Stop the driving motor
⑦ Standby mode (driving motor ON)
⑧ Standby mode (driving motor OFF)
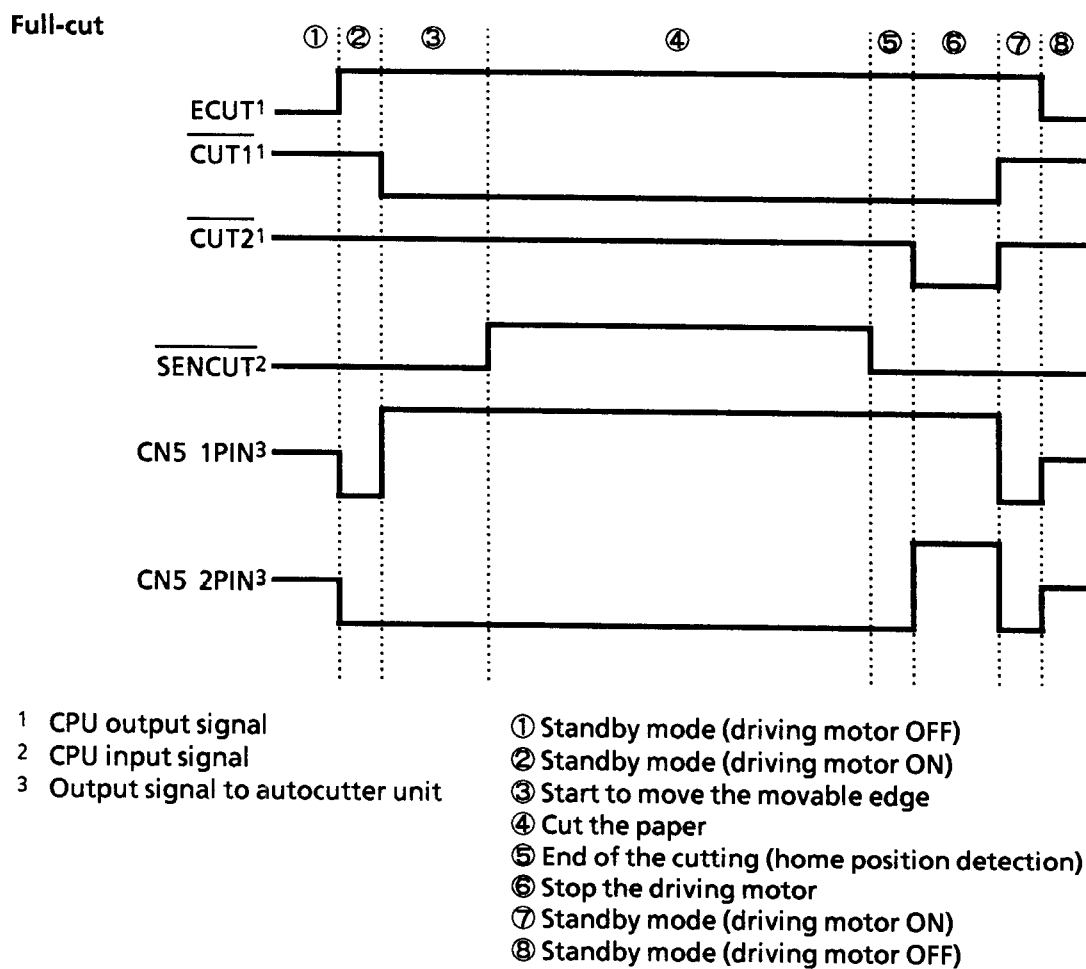
Figure 4-30 Timing Chart for Controlling the Autocutter Unit

Partial-cut
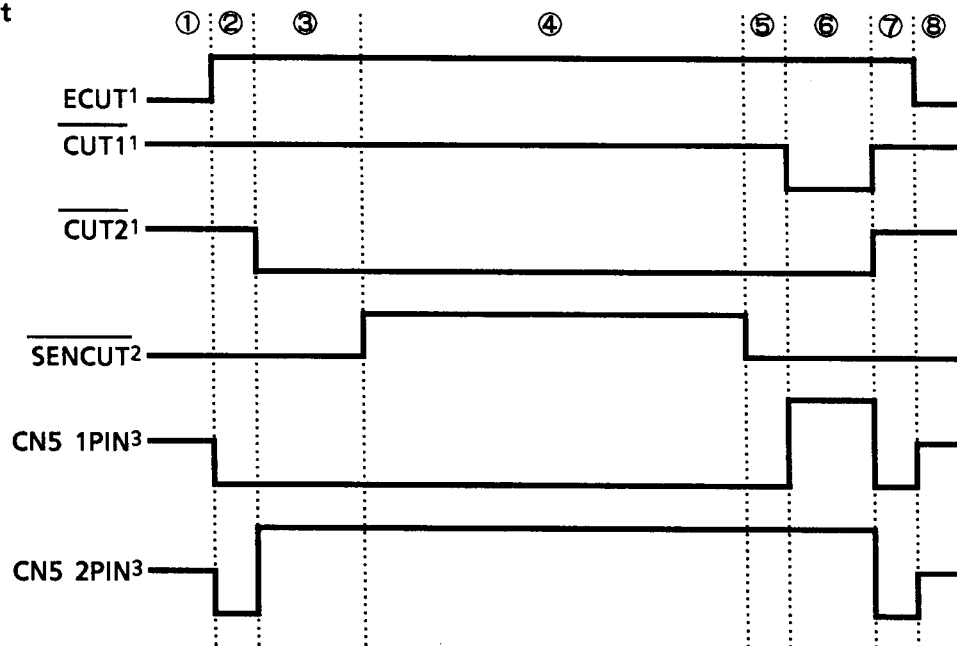
1 CPU output signal
2 CPU input signal
3 Output signal to autocutter unit

① Standby mode (driving motor OFF)
② Standby mode (driving motor ON)
③ Start to move the movable edge
④ Cut the paper
⑤ End of the cutting (home position detection)
⑥ Stop the driving motor
⑦ Standby mode (driving motor ON)
⑧ Standby mode (driving motor OFF)

Figure 4-30 Timing Chart for Controlling the Autocutter Unit (Continued)

4.21 SELECTING THE POWER SUPPLY

Determine the power supply for driving the PT502P01 and PT500GA1 by referring to Section 4.3.

The power supply for driving the printer mechanism (Vp) must satisfy the conditions given below.

V_{CC} (for circuit; 5 V)   5.00 ± 0.25 V   1.0 Amax
V_P (for thermal head and motor)

- When the LTP5242, LTP5347, LTP5437, or LTP5442 is driven with fixed division:

24.0 V ± 1.0 V

Model	High speed drive	Low speed drive
LTP5242	7.5 A max (2 blocks, 256dots)	5.7 A max (3 blocks, 192 dots)
LTP5347	11.4 A max (2 blocks, 352 dots)	4.5 A max (5 blocks, 128 dots)
LTP5437	13.9 A max (2 blocks, 384 dots)	5.2 A max (5 blocks, 128 dots)
LTP5442	12.1 A max (2 blocks, 416 dots)	7.6 A max (4 blocks, 256 dots)

The number of blocks divided and the maximum number of activated dots are indicated in parentheses.

- When the LTP5246 or LTP5446 is driven with fixed division:

12.0 V ± 1.0 V

Model	High speed drive	Low speed drive
LTP5246	8.3 A max (2 blocks, 256 dots)	6.4 A max (3 blocks, 192 dots)
LTP5446	12.3 A max (2 blocks, 416 dots)	9.1 A max (3 blocks, 288 dots)

The number of blocks divided and the maximum number of activated dots are indicated in parentheses.

- For dynamic division, use the maximum number of activated dots described in Section 3.1 and the settings listed in Tables 4-22 and 4-23, and calculate as follows:

$$\text{Power Supply Current} = \begin{pmatrix}\text{Maximum number} \\ \text{of activated dots}\end{pmatrix} \times \begin{pmatrix}\text{Maximum current} \\ \text{per dot in Table 4-22}\end{pmatrix} + \begin{pmatrix}\text{Maximum motor} \\ \text{current in Table 4-23}\end{pmatrix}$$

Table 4-22 Maximum Current per Dot

LTP5242	LTP5246	LTP5347	LTP5437	LTP5442	LTP5446
28.1 mA	31.8 mA	32.5 mA	37.3 mA	28.1 mA	31.5 mA

Table 4-23 Maximum Motor Current

LTP5242	LTP5246	LTP5347	LTP5437	LTP5442	LTP5446
278 mA	445 mA	371 mA	412 mA	412 mA	578 mA

[Example]

When driving an LTP5347 using dynamic division in mode 0 with 64 dots specified as the maximum number of activated dots:

64 dots × 32.5 mA + 371 mA = 2.45 A

As calculated above, a power supply of approximately 2.5 A maximum is required.

When driving an LTP5347 with the same specification as above in mode 1, the maximum number of activated dots is automatically regarded as 128 dots since data masking transfer is disabled in mode 1.

128 dots × 32.5 mA + 371 mA = 4.53 A

In this case, a power supply of approximately 4.6 A maximum is required.

4.22 ERROR MODE

When the PT502P01 CPU detects an error, the PT502P01 CPU will be in error mode and the terminal 2 on CPU (error terminal) will change to low.
There are three error modes: 1 – setting error; 2 – error during printing; and 3 – error with autocutter unit.

How to distinguish between a setting error and an error during printing:

Setting error is:
When the feed switch input terminal (pin 16 on the CPU) is set to low, the thermal printer does not feed paper.

Error during printing is:
When the feed switch input terminal (pin 16 on the CPU) is set to low, the thermal printer feeds paper.

The sources of the error and the corresponding recovery methods methods are listed below.

4.22.1 Setting Error

- The five Function pins (DP10 to 14 on the gate array) were used to set an invalid printer mechanism model.

  → Select a valid model and perform a hardware reset to remove the error.
  (See subsection 4.18 Function Pins)

- The power supply voltage is too high or too low.

  → 24-V type printers: Set V_P between 26.5 V and 15 V, then change the feed switch input terminal to low.

  → 12-V type printers: Set V_P between 13.4 V and 10 V, then change the feed switch input terminal to low.

- The resistance of the thermal head is abnormal, the thermal head has short circuited, or all dots of a certain physical block have become open.

  → Nonrecoverable error.

- The gate array is defective or the connection between the gate array and the printed circuit board is faulty.

  → Nonrecoverable error.

4.22.2 Error During Printing

- Thermal head temperature above 80° C or below – 10° C is detected by a thermistor.

  When the thermal head temperature is 80° C or higher.
  → When the thermistor detects that thermal head temperature has fallen below 75° C, the PT502P01 CPU automatically resumes printing from the beginning of the line where printing was suspended. The PT502P01 CPU retains the print data.

  When a thermal head temperature is – 10° C or lower.
  → When the thermistor detects that thermal head temperature has risen above – 5° C, the PT502P01 CPU automatically resumes printing from the beginning of the line where printing was suspended. The PT502P01 CPU retains the print data.

- The head-up detector indicates that the thermal head is in the up position.

  → Returns the head to the down position, the PT502P01 CPU automatically resumes printing about one second later from the top of where printing was suspended. The PT502P01 CPU retains the print data.

- The paper detector detects that the printer has run out of paper.

  → Install new paper, then set the feed switch input terminal to low. The PT502P01 CPU will resume printing from the top of where the printing was suspended. The PT502P01 CPU retains the print data.

4.22.3 Error with The Autocutter Unit

- An autocutter function code is performed without the autocutter unit connected.

  → Set the feed terminal to low to eliminate the error.

- Paper cut error

  When the movable edge is in the home position.
  → Set the feed switch input terminal (pin 16 on the CPU) to low to eliminate the error.

  When the movable edge is not in the home position.
  The motor (movable edge) is locked.
  → Cancel the lock, get rid of the source of the error, then set the feed switch input terminal (pin 16 on the CPU) to low to eliminate the error.

CHAPTER 5

OPERATION TIMING

Figure 5-1 shows the operation timing immediately after the PT502P01 and PT500GA1 are initialized.

RESET (CPU)

ERROR (CPU)

T₁

PE (CPU)

T₂

(During parallel input)

PBUSY (Gate array)

T₃ T₄ T₅

ACK (CPU)

(During serial input under BUSY control)

T₆

SBSY (CPU)

(During serial input under Xon/Xoff control)

TXD0 (CPU)

T₇ T₈

SBSY (CPU)

T_1: max. 800 ms (when no error occurs)
T_2: typ. 2.4 µs
T_3: typ.   16 µs
T_4: typ. 2.8 µs
T_5: typ. 2.8 µs
T_6: typ.   16 µs
T_7: typ.   8 µs
T_8: max. 1/(baud rate) × 1.2 seconds
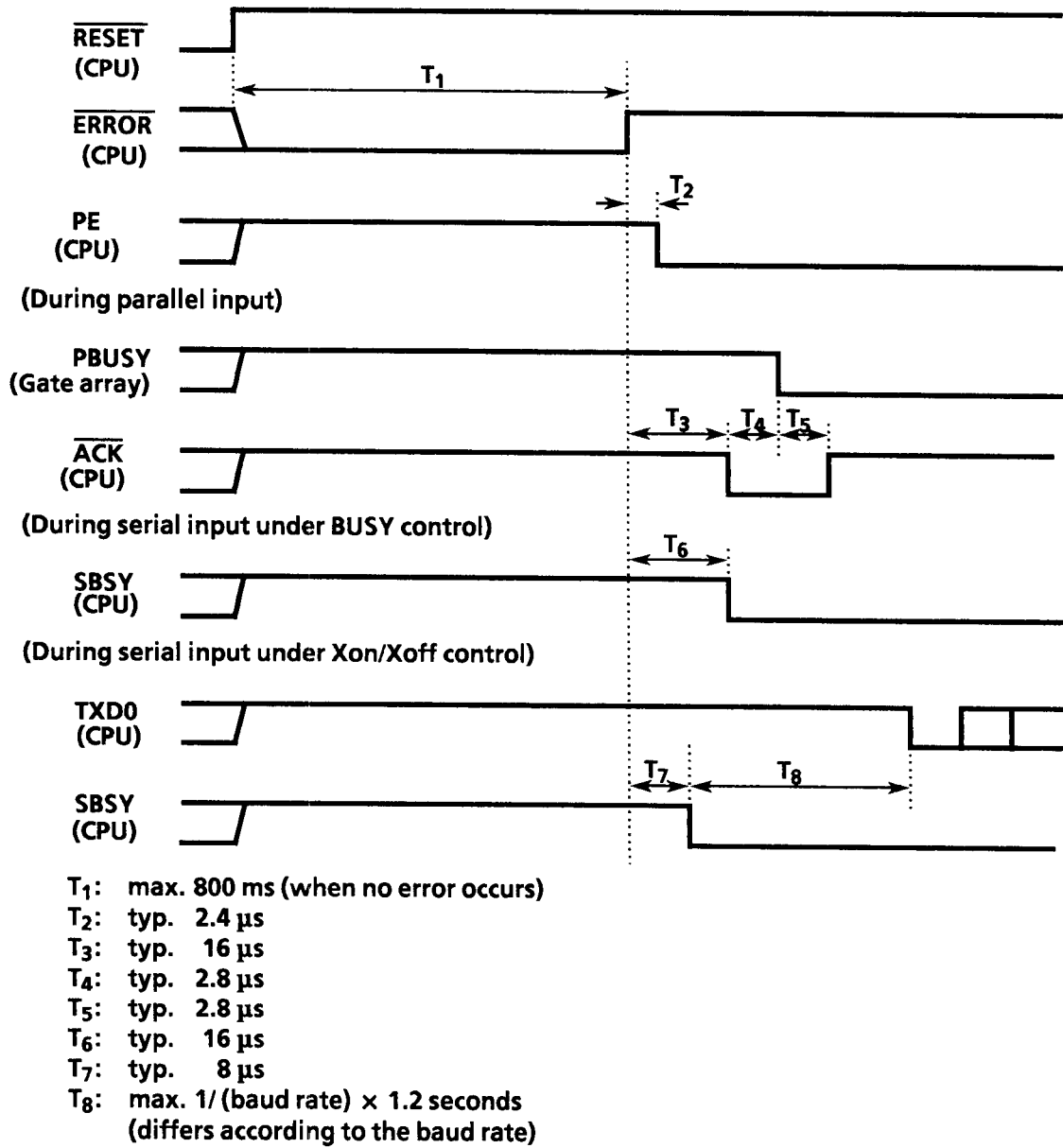   (differs according to the baud rate)

Figure 5-1 Operation Timing Immediately after Initialization
(Monitored at CPU Terminals)

During parallel input, the CPU's SBSY and TXD0 pins remain high and do not change. If an error occurs immediately after initialization, the gate array's PBUSY will be changed to low and then the signal will be output to the CPU's ACK when the error conditions are released.

During serial input under BUSY control, the gate array's PBUSY pin and the CPU's ACK and TXD0 pins remain high and do not change. If an error occurs immediately after the initialization, SBSY will be changed to low when the error conditions are cleared.

During serial input under Xon/Xoff control, PBUSY and ACK remain high and do not change. If no error occurs after initialization, Xon (11_H) will be output. If an error occurs after initialization, Xoff (13_H) will be output.

CHAPTER 6

PACKAGING

Figures 6-1 and 6-2 show the dimensions of the PT502P01 CPU and the PT500GA1 Gate Array, respectively.
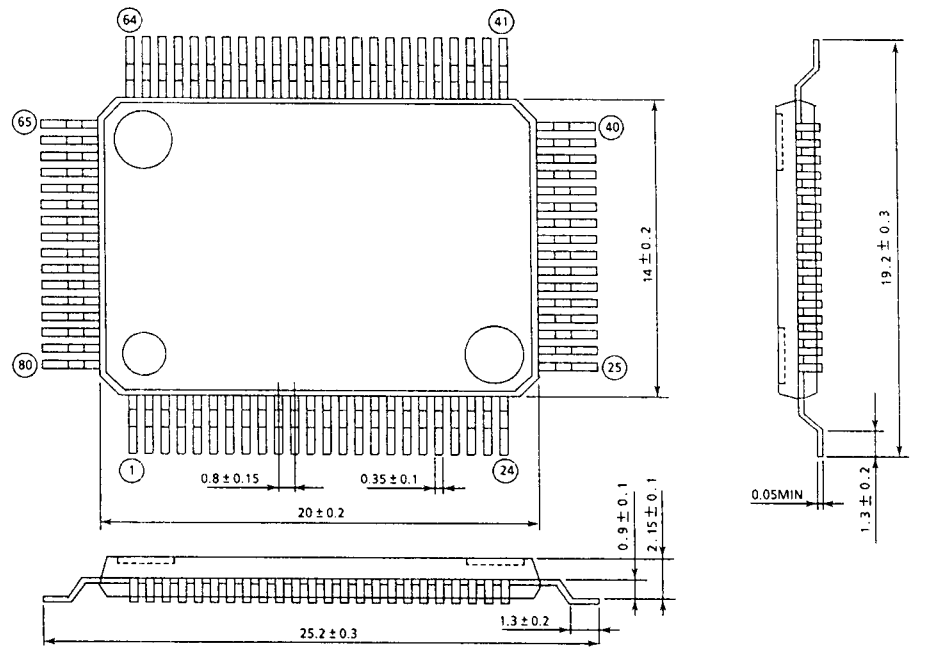
Dimension in mm

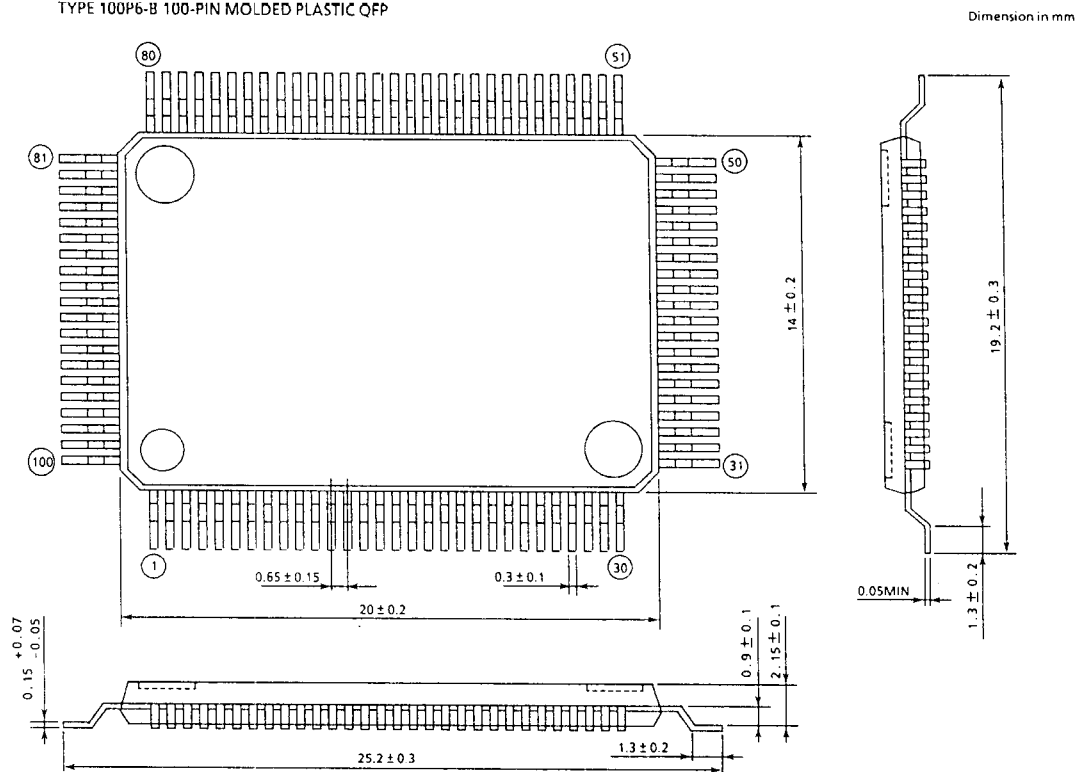## Figure 6-1 PT502P01 CPU Dimensions

Dimension in mm

Figure 6-2 PT500GA1 Gate Array Dimensions

CHAPTER 7

SAMPLE CIRCUIT DIAGRAM

Figures 7-1 and 7-2 show sample circuits for the PT502P01 CPU and PT500GA1 Gate Array and Table 7-1 lists the major parts used in the sample circuits.

Figure 7-1 Sample Circuit 1

Figure 7-2 Sample Circuit 2

Table 7-1 Major Parts Used in the Sample Circuits

Parts	Type Number	Vendor	Remarks
IC1	HD74LS07	Hitachi, Ltd.	Open collector
IC2	PST520C	MITSUMI ELECTRIC CO., LTD.	Resetting
IC3	MB3853	FUJITSU LIMITED	Motor driver for Autocutter unit
IC4	uPC1060C	NEC Corporation	2.5V reference voltage IC
IC6	DS1228	Dallas Semiconductor Corporation	RS232C driver/receiver
IC7	HA13007	Hitachi, Ltd.	Motor driver
IC9	uPC393	NEC Corporation	Comparator
IC10	TC74HC125	TOSHIBA Corporation	Bus buffer
IC12	TC7S04F	TOSHIBA Corporation	Inverter
IC13	HM62256LFP-10T	Hitachi, Ltd.	SRAM
Transistor TR1	2SA1098	NEC Corporation	
Transistor TR2,4	2SC945	NEC Corporation	
Transistor TR3	2SC3615	NEC Corporation	
Diode D1	10D1	Nihon Inter Electronics Corp.	
Diode D2,3	1S954	NEC Corporation	
Zenner diode ZD1	RD33EB-T1	NEC Corporation	33V
Ceramic resonator	CSA16.00MX040	MURATA MFG.CO,. LTD.	16MHz
Relay RL1	MR301-5	NEC Corporation	
Connector CN2	PS-26PE-D4T2-M1	Japan Aviation Electronics Industry, Ltd.	For thermal head
Connector CN3	5267-02	Molex-Japan Co., Ltd.	For Head-up detection
Connector CN4	5267-03	Molex-Japan Co., Ltd.	For paper detection
Connector CN5	5483-04AX	Molex-Japan Co., Ltd.	For Autocutter unit
Connector CN6	5267-06	Molex-Japan Co., Ltd.	For paper feed motor

CHAPTER 8

IMPLEMENTATION CONSIDERATIONS

When installing the PT502P01 CPU and the PT500GA1 Gate Array using the infrared reflow or VPS (Vapor Phase Soldering) technique, make sure that the conditions given below are satisfied.

8.1 SOLDERING TEMPERATURE CONDITIONS

(1) Infrared reflow mode

The maximum temperature of the resin surface must not exceed 240°C and the soldering time must not exceed ten seconds. Soldering must be performed at a temperature as low as possible and for as short a time as possible. Make sure that heat is distributed uniformly throughout the IC device; do not allow the resin temperature to increase or decrease in isolated areas on the IC relative to other areas. Make sure that the temperature profile (maximum resin surface temperature) of the infrared reflow furnace is as shown in Figure 8-1.

CAUTION

The board must not be subject to forced cooling after reflowing.

(2) VPS mode

Make sure that heat is distributed uniformly throughout the IC device; do not allow the resin temperature to increase or decrease locally. The temperature rise and fall rates must be from 1° to 4°C per second. The materials which make up the devices will have different temperature escalation rates, due to their different thermal characteristics, when the board on which the devices are temporarily joined using cream solder is immersed in a VPS bath. In this case, the temperature of the leads, which normally exhibit high thermal conductivity, rises first, causing the solder on the leads to melt. Consequently, it is possible that the cream solder on the board may become absorbed into the solder on the leads, resulting in open contacts. To prevent this, use a preheating process before the reflow (main soldering) process so that the temperature of the board and devices have a uniform temperature below the eutectic temperature (approximately 180°C). The recommended preheating

conditions are 150°C for 2 minutes. The preheating process provides the following advantages :

● Vapor elements (e.g., moisture) in the cream solder are evaporated, thereby improving solder quality.

● The reflow time (main soldering time) is reduced. (Optimum reflow conditions require that the device surface temperature be no higher than 215°C and that the soldering time be no longer than 10 seconds.)

Since some equipment (related to the reflow furnace, preheating process, and soldering) will not work properly in the above situation, please check to make sure that the equipment used meets the required specifications.
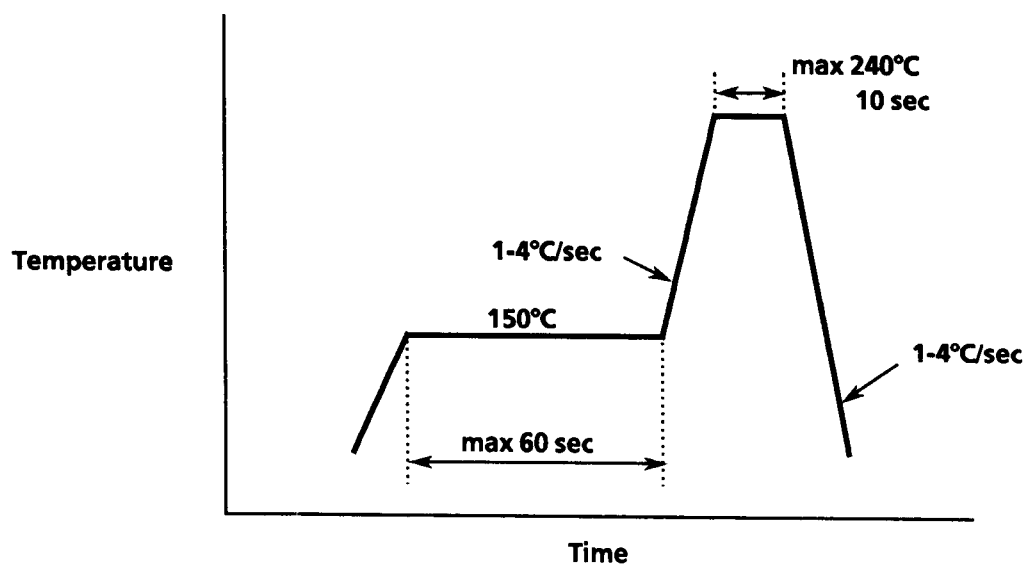

Figure 8-1 Infrared Reflow Profile

8.2 STORAGE CONDITIONS

Since the plastic mold package resin will absorb moisture if proper precautions are not taken, device reliability (especially moisture resistance) might be adversely affected if a moist device is subject to reflowing. To protect the PT502P01 CPU and PT500GA1 Gate Array devices from moisture, they are placed in a moisture-proof pack with a desiccant that satisfys condition (1) below. Take the following precautions when storing the PT502P01 and PT500GA1 before installing on the printer control board:

(1) Before opening the moisture-proof pack, store the device at a temperature no higher than 40°C and a relative humidity no higher than 60%. Keep the storage time as short as possible.

(2) After opening the moisture-proof pack, install the device as soon as possible. If the device is to be stored temporarily, even for a short period, after being taken out of the moisture-proof pack, place the device in a moisture-proof pack with a desiccant, fold the opening of the pack, and seal it with adhesive tape.

(3) When using a device that has been stored temporarily after having been taken out of the moisture-proof pack, or when using one that has been stored in conditions other than specified in (1) or for a long time in the moisture-proof pack, it is recommended that it be dried (125°C, 20 to 24 hours) before reflowing. After drying the device, install it as soon as possible.

8.3 CLEANING CONDITIONS

Although it is essential to clean flux off of the solder to ensure high system quality, improper cleaning may cause the device to be affected by the solvent, thus reducing device quality. Use of solvents that contain chlorine ions (e.g., CHLOROCEN) will result in adverse effects on device reliability. The cleaning conditions given below are recommended. It may be necessary to perform vapor blasting before and after the main cleaning.

Detergent   Clean through 750 H, Pine alpha ST100s.

Ultrasonic cleaning conditions   Frequency : 28 kHz
                                    Time   : 30 seconds or less
                                    Power   : 30 W/liter maximum

CAUTION

Do not put the printed circuit board or device in direct contact with the vibration source.

Select an appropriate frequency so that the device does not resonate.

8.4 MECHANICAL AND THERMAL STRESS

External lead fractures, moisture resistance deterioration, or internal lead pin disconnections may occur while the packages or external lead pins are being cut out or bent. Care must be taken so that excessive mechanical stress is not applied to the printed circuit board and the external leads of the IC device after the device is installed on the board.

Since the IC devices are made of various materials having different thermal expansion coefficients, quality deterioration or internal lead disconnections may occur if the devices are exposed to high temperatures for a long period or to sudden temperature changes during the soldering process. Try to keep any mechanical or thermal stress on the IC devices at a minimum.

CHAPTER 9

SOFTWARE SPECIFICATIONS

9.1 CHARACTER SET SELECTION

The PT502P01 CPU and the PT500GA1 Gate Array have two standard character sets: the IBM-compatible character set and the Japanese *kana* character set. The user can select one of these through a pin on the PT500GA1 (pin 36) or through a command (ESC + t + n). (See "(2) Setting software parameters" in Section 4.18 or "ESC + t + n" in Section 9.5.2, respectively, for details.)

When the power is turned on or when the system is reset through a command or switch operation, the internal character set that is specified by pin 36 on the PT500GA1 is selected. After that, the character set can be specified via a command.

The two internal character sets have a total of 348 characters. For a list of characters and their corresponding codes, refer to the character code table in Appendix A. The PT502P01 starts printing the data from its buffer when it receives a print code such as CR or LF or when the line buffer becomes full.

9.2 FUNCTION CODES AND CHARACTER CODES

Hexadecimal codes assigned to function codes, character codes, and those ignored are as follows:

0 through 1F$_H$:   Ignored except for LF (0A$_H$), CR (0D$_H$), SO (0E$_H$), DC3 (13$_H$), DC4 (14$_H$), CAN (18$_H$), and ESC (1B$_H$), which are treated as function codes.

20$_H$ through 7E$_H$: Character codes.

7F$_H$:   Ignored.

80$_H$ through FE$_H$: Character codes.

FF$_H$:   Ignored.

If a 256-kbit SRAM is not connected as specified, the following code sequences are ignored:

    ESC + & + n + m + p1 + p2 + ...pk
    ESC + % + n

9.3 INTERFACE MODE SELECTION

The PT502P01 supports function codes for both interface modes 0 and 1. Interface mode 0 function codes provide more printer functions (e.g., character-based qualification and superimposition) than interface mode 1 function codes but entail more processing time (meaning reduced printing speed) because of the need to perform complicated printer operations. This is true especially when many characters are to be printed on a line using many print functions.

Interface mode 1 function codes support qualification functions on a line basis only and provide neither character-based qualification nor superimposition. They allow the PT502P01 to print at a higher speed than in interface mode 0.

9.4 AVAILABLE FUNCTION CODES

The PT502P01 supports the function codes listed in Table 9-1. All function codes are available in interface mode 0. The following legend is used in the table:

    ○: Function code supported in interface mode 1.
    △: Function code supported conditionally in interface mode 1.
    ×: Function code not supported in interface mode 1.

Table 9-1 Function Codes

Function Code	Function	Mode 1	Sample
CAN	Cancel line buffer	O	
LF	Print and feed one line	O	
CR	Print and feed one line	O	See Figures 9-1 and 9-2.
SO	Turn on double-width mode (with automatic reset)	△	
DC4	Turn off double-width mode (with automatic reset)	△	
ESC + "2"	Set line spacing to 16 dots	O	
ESC + "0"	Set line spacing to 4 dots	O	See Figures 9-3 and 9-4.
ESC + "A" + n	Set line spacing to n dots	O	
ESC + "3" + n	Set line spacing to n dots	O	
ESC + " – " + n	Turn on underlining	×	
ESC + "W" + n	Select/release double-width mode	△	See Figures 9-5 and 9-6.
ESC + "w" + n	Select/release double-height mode	△	
ESC + "l" + n	Turn on/off reverse mode	△	
ESC + "V" + n1 + n2	Set MSB bit image	△	See Figures 9-7 and 9-8.
ESC + "v" + n1 + n2	Set LSB bit image	O	
ESC + SP + n	Set character spacing	×	See Figures 9-9 and 9-10.
ESC + "s" + nl + nr	Set left/right character spacing	×	
ESC + "J" + n	Print and feed paper forward n dot line(s)	O	See Figures 9-11 and 9-12.
ESC + "j" + n	Print and feed paper backward n dot line(s)	O	
ESC + "@"	Reset	O	

Table 9-1 Function Codes (Continued)

Function Code	Function	Mode 1	Sample
ESC + "t" + n	Select internal character set	○	See Figures 9-13 and 9-14.
ESC + "F" + n	Select speed	○	Not provided.
ESC + "!" + n	Select two-ply thermal paper	○	
ESC + "i"	Select full cut	○	
ESC + "m"	Select partial cut	○	
DC3 + "O"	Overwrite ruler line and character in OR mode	×	See Figures 9-15 and 9-16.
DC3 + "X"	Overwrite ruler line and character in XOR mode	×	
DC3 + "A"	Select ruler line buffer A	○	
DC3 + "B"	Select ruler line buffer B	○	
DC3 + " + "	Turn on ruler line	△	See Figures 9-17 and 9-18.
DC3 + " – "	Turn off ruler line	○	
DC3 + "P"	Print one dot line after printing line buffer data	○	
DC3 + "C"	Clear ruler line buffer	○	
DC3 + "V"	Write ruler line MSB image	○	See Figures 9-19 and 9-20.
DC3 + "v"	Write ruler line LSB image	○	
DC3 + "D" + n1 + n2	Define ruler line by dot	○	See Figures 9-21 and 9-22.
DC3 + "L" + n1 + n2 + n3 + n4	Define ruler line by line	○	
DC3 + "F" + n1 + n2	Define ruler line with repeating pattern	○	
DC3 + "("	Continue ruler line control code input	○	See Figures 9-23 and 9-24.

9.5 FUNCTION CODE DESCRIPTION

Mode 0 function codes supported by the PT502P01 are described below.

For explanations on mode 1 function codes, see the item entitled <Mode 1> in each function code description.

The program sample is coded in GW-BASIC version 2.02 (Microsoft Corporation) in mode 0. The print sample was produced by connecting in parallel an IBM PC to the PT502P01 and printing the program sample on a LTP5442.

9.5.1 One-byte Function Codes

CAN

<Mode 0>

[N a m e]	Cancel
[C o d e]	18_H or 24 decimal
[Function]	Cancels the contents of the line buffer that have been received before this code. The double-width mode with automatic reset by SO, if any, is reset. The other mode settings remain unchanged.

<Mode 1>   Functions the same as in mode 0.

LF

< Mode 0 >

[N a m e]   Line Feed

[C o d e] $0A_H$ or 10 decimal

[Function]   Provides the same function as **CR**. Any **LF** code received immediately following a **CR** is ignored.

< Mode 1 >   Functions the same as in mode 0.

CR

< Mode 0 >

[N a m e]   Carriage Return

[C o d e] $0D_H$ or 13 decimal

[Function]   Prints the contents of the line buffer, then feeds paper a predefined distance.

● Line spacing is initialized to 16 dots when power is turned on or when a reset is performed.

● The PT502P01 performs only a line feed operation when the line buffer is empty.

● Any **LF** code received immediately following a **CR** is ignored.

< Mode 1 >   Functions the same as in mode 0.

SO

<Mode 0>

[N a m e]   Double-Width (with automatic reset) ON

[C o d e]   0E$_H$ or 14 decimal

[Function]   Prints double-width characters until a **DC4, LF, CR, CAN,** or an **ESC + "W" + 0** sequence is received or when the buffer becomes full.

    ● Character spacing is also doubled.

    ● The PT502P01 enters double-width/double-height mode if double-height mode is also active.

<Mode 1>

This code is effective only when received at the beginning of a line. An **SO** code received anywhere else is ignored.

DC4

<Mode 0>

[N a m e]   Double-Width (with automatic reset) OFF

[C o d e]   14$_H$ or 20 decimal

[Function]   Resets double-width mode with automatic reset and places the PT502P01 into normal width print mode.

    ● This code affects only double-width mode.

    ● The PT502P01 is placed in this mode when initialized.

<Mode 1>

This code is effective only when received at the beginning of a line. A **DC4** code received anywhere else is ignored.

```
100  '********CODE   DEFINE**********
110  CONSOLE  ,,,,1
120  LF$ = CHR$(10):CR$ = CHR$(&HD)
130  SO$ = CHR$(&HE):DC3$ = CHR$(&H13)
140  DC4$ = CHR$(&H14):CAN$ = CHR$(&H18)
150  ESC$ = CHR$(&H1B)
160  '
170  '********* 1BYTE  CODE  TEST**********
180  LPRINT  "CANCEL  (CAN  18H)  TEST"
190  LPRINT  STRING$(52,"0");CAN$;
200  LPRINT  "NO  PRINT  THEN  (CAN)  O.K"
210  KETA1 = 52 + 1
220  LPRINT  STRING$(KETA1,"0");CAN$;
230  LPRINT  "1  LINE  PRINT  THEN  (CAN)  O.K"
240  '
250  LPRINT  "LINE  FEED  TEST";LF$;
260  LPRINT  "CARRIAGE  RETURN  TEST";CR$;LF$;
270  LPRINT  "(CR) + (LF)  TEST";CR$;LF$;
280  LPRINT  "IGNORE  (LF)  THEN  O.K!!"
290  '
300  LPRINT  "AUTO  FREE  (SO)  TEST"
310  LPRINT  SO$;STRING$(52,"A");CR$;
330  LPRINT  "FIRST  LINE  WIDE  AND  NEXT  LINE  NORMAL"
340  LPRINT  SO$;"1234";DC4$;"5678"
350  LPRINT  SO$;"1234";CR$;"5678"
360  LPRINT  SO$;"1234";CAN$;"5678"
370  LPRINT  SO$;"1234";LF$;"5678"
380  LPRINT  SO$;"1234";ESC$;"W";CHR$(0);"5678"
390  LPRINT  "1234: DOUBLE-WIDTH, 5678: NORMAL  THEN  O.K!!"
400  END
```

Figure 9-1 Program Sample 1

```
CANCEL (CAN 18H) TEST
NO PRINT THEN (CAN) O.K
OOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOO
1 LINE PRINT THEN (CAN) O.K
LINE FEED TEST
CARRIAGE RETURN TEST
(CR)+(LF) TEST
IGNORE (LF) THEN O.K!!
AUTO FREE (SO) TEST
AAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAA
FIRST LINE WIDE AND NEXT LINE NORMAL
1234 5678
1234
5678
5678
1234
5678
1234 5678
1234:DOUBLE-WIDTH, 5678:NORMAL THEN O.K!!
```

Figure 9-2 Print Sample 1

9.5.2 Escape Sequences

ESC + "2"

<Mode 0>

    [N a m e]   16-dot Line Spacing

    [C o d e] $1B_H$ + 32_H, or 27 decimal + "2"

    [Function]   Sets line spacing to 16 dots.

               • This is a default setting.

<Mode 1>   Functions the same as in mode 0.

ESC + "0"

<Mode 0>

    [N a m e]   4-dot Line Spacing

    [C o d e] $1B_H$ + 30_H, or 27 decimal + "0"

    [Function]   Sets line spacing to 4 dots.

<Mode 1>   Functions the same as in mode 0.

ESC + "A" + n or ESC + "3" + n

<Mode 0>

    [N a m e]   n-dot Line Spacing

    [C o d e] $1B_H$ + 41_H + n, or 27 decimal + "A" + n

                      $1B_H$ + 33_H + n, or 27 decimal + "3" + n

    [Function]   Sets line spacing to n dots.

               • "n" can take on a decimal value from 0 to 255.

<Mode 1>   Functions the same as in mode 0.

```
100 '******  ESC+2  ESC+0  ESC+A+n  ESC+3+n  ******
110 CONSOLE  ,,,,1
120 LPRINT  "****** LINE  SPACE  TEST******"
130 LPRINT  CHR$(&H1B);"0";
140 LPRINT  "SET  4  DOTS  LINE  SPACE"
150 LPRINT  "SET  4  DOTS  LINE  SPACE"
160 LPRINT  CHR$(&H1B);"2";
170 LPRINT  "SET  16  DOTS  LINE  SPACE"
180 LPRINT  "SET  16  DOTS  LINE  SPACE"
190 FOR  I=0  TO  30  STEP  5
200   LPRINT  CHR$(&H1B);"A";CHR$(I);
210   LPRINT  "SET";I;"DOTS  LINE  SPACE"
220   LPRINT  "SET";I;"DOTS  LINE  SPACE"
230 NEXT  I
240 FOR  I=0  TO  30  STEP  5
250   LPRINT  CHR$(&H1B);"3";CHR$(I);
260   LPRINT  "SET";I;"DOTS  LINE  SPACE"
270   LPRINT  "SET";I;"DOTS  LINE  SPACE"
280 NEXT  I
290 END
```

Figure 9-3 Program Sample 2

```
****** LINE SPACE TEST******
SET 4 DOTS LINE SPACE
SET 4 DOTS LINE SPACE
SET 16 DOTS LINE SPACE

SET 16 DOTS LINE SPACE

SET 0 DOTS LINE SPACE
SET 0 DOTS LINE SPACE
SET 5 DOTS LINE SPACE
SET 5 DOTS LINE SPACE
SET 10 DOTS LINE SPACE

SET 10 DOTS LINE SPACE

SET 15 DOTS LINE SPACE

SET 15 DOTS LINE SPACE

SET 20 DOTS LINE SPACE

SET 20 DOTS LINE SPACE

SET 25 DOTS LINE SPACE

SET 25 DOTS LINE SPACE

SET 30 DOTS LINE SPACE

SET 30 DOTS LINE SPACE

SET 0 DOTS LINE SPACE
SET 0 DOTS LINE SPACE
SET 5 DOTS LINE SPACE
SET 5 DOTS LINE SPACE
SET 10 DOTS LINE SPACE

SET 10 DOTS LINE SPACE

SET 15 DOTS LINE SPACE

SET 15 DOTS LINE SPACE

SET 20 DOTS LINE SPACE

SET 20 DOTS LINE SPACE

SET 25 DOTS LINE SPACE

SET 25 DOTS LINE SPACE

SET 30 DOTS LINE SPACE

SET 30 DOTS LINE SPACE
```

Figure 9-4 Print Sample 2

ESC + " – " + n

<Mode 0>

[N a m e]   Underline

[C o d e] $1B_H$ + $2D_H$ + n, or 27 decimal + " – " + n

[Function]   Turns on/off underline mode.

- n specifies the thickness of the underline.

- Only the lowest-order three bits of n are valid (selecting 1- to 7-dot line).

- n = 0 resets underline mode.

- If a line contains a character with underline turned on, line spacing is increased to the space of the underline.

- Underlining can be turned on and off many times in a line. The thickness of the underline, however, must be constant within the line. Consequently, the underline thickness that is specified last takes effect.

<Mode 1>   Not supported.

ESC + "W" + n

\<Mode 0\>

[N a m e]   Double-Width

[C o d e] $1B_H$ + 57_H + n, or 27 decimal + "W" + n

[Function]   Turns on/off double-width mode.

- Only the lowest-order bit of n is valid.

- n = 1: Turns double-width mode on.
  n = 0: Turns double-width mode off.
  Initial value of n is 0.

- The PT502P01 enters the double-width/double-height mode if the double-height mode is also selected.

- Character spacing is also doubled.

\<Mode 1\>

This code sequence becomes effective in the line immediately following the reception of the code; but if the code sequence comes at the beginning of a line, it becomes effective for that line.

ESC + "w" + n

<Mode 0>

[N a m e]   Double-Height

[C o d e]   1B$_H$ + 77$_H$ + n, or 27 decimal + "w" + n

[Function]   Turns on/off double-height mode.

● Only the lowest-order bit of n is valid.

● n = 1: Turns double-height mode on.
  n = 0: Turns double-height mode off.
  Initial value of n is 0.

● The PT502P01 enters the double-width/double-height mode if the double-width mode is also selected.

<Mode 1>   This code sequence becomes effective in the line immediately following the reception of the code; but if the code sequence comes at the beginning of a line, it becomes effective for that line.

ESC + "I" + n

<Mode 0>

[N a m e]	Reverse
[C o d e]	$1B_H$ + 49_H + n, or 27 decimal + "I" + n
[Function]	Turns on/off reverse mode.

- Only the lowest-order bit of n is valid.

- n = 1: Prints white characters on a black background.
  n = 0: Resets the reverse mode (prints black characters on a white background).
  Initial value of n is 0.

- This sequence is valid only when printing characters.

- The space between characters is printed as black.

- The space between lines remains unprinted, and underline is printed as black even in the reverse mode.

<Mode 1>

This code sequence becomes effective in the line immediately following the reception of the code; but if the code sequence comes at the beginning of a line, it becomes effective for that line.

```
100  '******  ESC + - + n   ESC + W + n   ESC + w + n   ESC + I + n  ******
110  CONSOLE  ,,,,1
120  LPRINT  "******  UNDERLINING  TEST******"
130  '
140  LPRINT  CHR$(&H1B);" - ";CHR$(5);"UNDERLINING  5  DOTS"
150  LPRINT  CHR$(&H1B);" - ";CHR$(1);"UNDERLINING  1  DOTS"
160  LPRINT  CHR$(&H1B);" - ";CHR$(0);"UNDERLINING  OFF"
161  '
170  LPRINT  "******  DOUBLE  WIDTH  TEST******"
180  '
190  LPRINT  CHR$(&H1B);"W";CHR$(1);"DOUBLE  WIDTH  ON"
200  LPRINT  CHR$(&H1B);"W";CHR$(0);"DOUBLE  WIDTH  OFF"
210  LPRINT  "******  DOUBLE  HEIGHT  TEST******"
220  LPRINT  CHR$(&H1B);"w";CHR$(1);"DOUBLE  HEIGHT  ON"
230  LPRINT  CHR$(&H1B);"w";CHR$(0);"DOUBLE  HEIGHT  OFF"
231  '
240  LPRINT  "******  REVERSE  MODE  TEST******"
250  '
260  LPRINT  CHR$(&H1B);"I";CHR$(1);"REVERSE  MODE  ON"
270  LPRINT  CHR$(&H1B);"I";CHR$(0);"REVERSE  MODE  OFF"
271  '
280  LPRINT  "******  DOUBLE  WIDTH/HEIGHT  TEST******"
290  '
300  LPRINT  CHR$(&H1B);"W";CHR$(1);"DOUBLE  WIDTH  ON"
310  LPRINT  CHR$(&H1B);"w";CHR$(1);"DOUBLE  WIDTH/HEIGHT  ON"
320  LPRINT  CHR$(&H1B);"I";CHR$(1);"REVERSE  MODE  ON"
330  LPRINT  CHR$(&H1B);"W";CHR$(0);"DOUBLE  WIDTH  OFF"
340  LPRINT  CHR$(&H1B);"w";CHR$(0);"DOUBLE  HEIGHT  OFF"
350  LPRINT  CHR$(&H1B);"I";CHR$(0);"REVERSE  MODE  OFF"
360  END
```

Figure 9-5 Program Sample 3

```
****** UNDERLINING TEST******
UNDERLINING 5 DOTS
UNDERLINING 1 DOTS
UNDERLINING OFF
****** DOUBLE WIDTH TEST******
DOUBLE  WIDTH  ON
DOUBLE WIDTH OFF
***DOUBLE HEIGHT TEST**
DOUBLE HEIGHT ON
DOUBLE HEIGHT OFF
****** REVERSE MODE TEST******
REVERSE MODE ON
REVERSE MODE OFF
****** DOUBLE WIDTH/HEIGHT TEST******
DOUBLE  WIDTH  ON
DOUBLE WIDTH/HEIGHT ON
REVERSE MODE ON
DOUBLE WIDTH OFF
DOUBLE HEIGHT OFF
REVERSE MODE OFF
```

Figure 9-6 Print Sample 3

ESC + "v" + n1 + n2

<Mode 0>

[N a m e]   LSB Bit Image

[C o d e] $1B_H$ + 76_H + n1 + n2 + DATA, or
27 decimal + "v" + n1 + n2 + DATA

[Function]   Turns on bit image printing.

● n2 (higher order byte) + n1 (lower order byte) specify the number of dot lines for bit image.

$$0 \leq n2n1 \leq FFFF_H$$

● The escape sequence is ignored if n1 = n2 = 0.

● n1 and n2 must be followed by image data.

● See the description on the MSB bit image escape sequence for the allowable byte count values.

● The PT502P01 prints bit image data so that the least significant bit appears at the left margin.

● If bit image printing is specified after character data is supplied without a line terminating with a CR or LF code, the PT502P01 overwrites the characters and bit image. In this case, all character qualification functions remain valid except that ruler lines and bit image cannot be overlapped.

Note that the PT502P01 cannot print characters normally unless n2 and n1 specifies a dot line count of 24 dot lines or more for normal size characters and 48 dot lines or more for double-height characters.

The PT502P01 prints characters and bit image in overwrite mode when specified by the sequence **DC3 + "O"** or **DC3 + "X"**.

● Any data that goes beyond the specified dot lines is treated as characters. If data is supplied less than specified, the PT502P01 may enter standby mode or handle extra codes or data bytes as bit image data. The amount of data that is specified in this sequence must be indicated.

<Mode 1>

The PT502P01 prints bit image data after printing the data from the line buffer. Overwriting image data on characters is not supported.

\<Mode 1\>   The PT502P01 prints bit image data after printing the data from the line buffer. Overwriting image data on characters is not supported.

ESC + "v" + n1 + n2

<Mode 0>

[N a m e] LSB Bit Image

[C o d e] $1B_H$ + 76_H + n1 + n2 + DATA, or
27 decimal + "v" + n1 + n2 + DATA

[Function] Turns on bit image printing.

- n2 (higher order byte) + n1 (lower order byte) specify the number of dot lines for bit image.

   $$0 \leq n2n1 \leq FFFF_H$$

- The escape sequence is ignored if n1 = n2 = 0.

- n1 and n2 must be followed by image data.

- See the description on the MSB bit image escape sequence for the allowable byte count values.

- The PT502P01 prints bit image data so that the least significant bit appears at the left margin.

- If bit image printing is specified after character data is supplied without a line terminating with a CR or LF code, the PT502P01 overwrites the characters and bit image. In this case, all character qualification functions remain valid except that ruler lines and bit image cannot be overlapped.

  Note that the PT502P01 cannot print characters normally unless n2 and n1 specifies a dot line count of 24 dot lines or more for normal size characters and 48 dot lines or more for double-height characters.

  The PT502P01 prints characters and bit image in overwrite mode when specified by the sequence **DC3 + "O"** or **DC3 + "X"**.

- Any data that goes beyond the specified dot lines is treated as characters. If data is supplied less than specified, the PT502P01 may enter standby mode or handle extra codes or data bytes as bit image data. The amount of data that is specified in this sequence must be indicated.

<Mode 1>

The PT502P01 prints bit image data after printing the data from the line buffer. Overwriting image data on characters is not supported.

```
100  '******  ESC + V + n1 + n2   ESC + v + n1 + n2   ******
110  CONSOLE  ,,,,1
120  LPRINT  "******  MSB  BIT  IMAGE  ******"
130  '
140  LPRINT  CHR$(&H1B);"V";CHR$(0);CHR$(1);        '256  DOTS  LINE  IMAGE
150  FOR  I = 0  TO  255                            '256  LINE  SET
160    LPRINT  STRING$(104,CHR$(I));                '104  BYTE  SET(LTP5442)
170  NEXT  I
180  LPRINT  "******  MSB  BIT  IMAGE  END******"
190  '
200  LPRINT  "******  LSB  BIT  IMAGE  ******"
210  '
220  LPRINT  CHR$(&H1B);"v";CHR$(0);CHR$(1);        '256  DOTS  LINE  IMAGE
230  FOR  I = 0  TO  255                            '256  LINE  SET
240    LPRINT  STRING$(104,CHR$(I));                '104  BYTE  SET(LTP5442)
250  NEXT  I
260  LPRINT  "******  LSB  BIT  IMAGE  END******"
270  '
280  LPRINT  "******  BIT  IMAGE  OVERLAPS  ******"
290  '
300  LPRINT  CHR$(&H1B);"w";CHR$(1);"OVER  LAP  CHARACTERS";
310  LPRINT  CHR$(&H1B);"V";CHR$(0);CHR$(1);        '256  DOTS  LINE  IMAGE
320  FOR  I = 0  TO  255                            '256  LINE  SET
330    LPRINT  STRING$(104,CHR$(I));                '104  BYTE  SET(LTP5442)
340  NEXT  I
350  LPRINT  CHR$(&H1B);"w";CHR$(0);
360  END
```
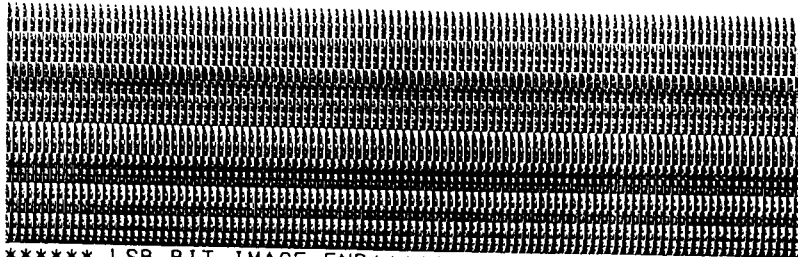
Figure 9-7 Program Sample 4

****** MSB BIT IMAGE ******
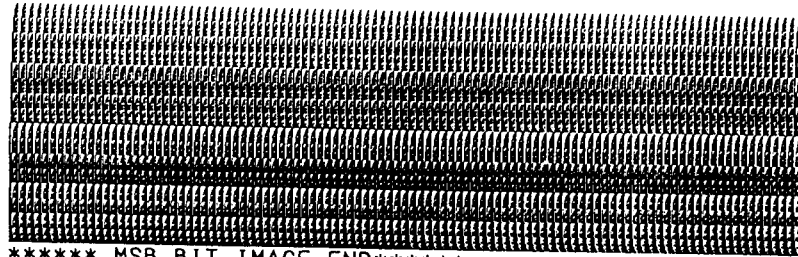
****** MSB BIT IMAGE END******

****** LSB BIT IMAGE ******

****** LSB BIT IMAGE END******

****** BIT IMAGE OVERLAPS ******
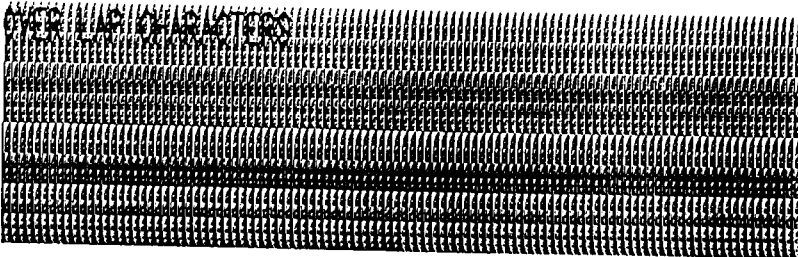
Figure 9-8 Print Sample 4

ESC + SP + n

<Mode 0>

[N a m e]   Character Spacing

[C o d e] $1B_H$ + 20_H + n, or 27 decimal + SP + n

[Function]   Sets the character spacing to n dots.

- The lowest-order 7 bits of n are valid (specifying a decimal number 0 to 127).
  Initial value of n is 4 dots.

- The specified amount of space is appended to the right side of each character. The character spacing on the left side is automatically set to zero.

<Mode 1>   Not supported.

ESC + "s" + nl + nr

<Mode 0>

[N a m e]   Left/Right Character Spacing

[C o d e] $1B_H$ + 73_H + nl + nr, or 27 decimal + "s" + nl + nr

[Function]   Sets the character spacing on the left and right sides of each character to nl and nr dots, respectively.

- The lowest-order 7 bits of nl and nr are valid (specifying a decimal number 0 to 127).

- nl specifies the character spacing on the left side and nr on the right side.
  Initial values of nl and nr are 0 and 4 dots, respectively.

<Mode 1>   Not supported.

```
100  '****** ESC+  +n    ESC+s+nl+nr ******
110  CONSOLE ,,,,1
120  LPRINT "****** CHARACTER  SPACE  TEST*****"
130  '
140  FOR I=0  TO  20  STEP  2
150    LPRINT  CHR$(&H1B);"  ";CHR$(I);"SPACE";I;"DOTS"
160  NEXT  I
170    LPRINT  CHR$(&H1B);"  ";CHR$(0);
180  LPRINT "****** CHARACTER  SPACE  LEFT  RIGHT*****"
190  '
200  FOR I=0  TO  10  STEP  2
210    J=0
220      LPRINT  CHR$(&H1B);"s";CHR$(I);CHR$(J)"LEFT";I;"RIGHT";J;"DOTS"
230  NEXT  I
240  FOR J=0  TO  10  STEP  2
250    I=0
260      LPRINT  CHR$(&H1B);"s";CHR$(I);CHR$(J)"LEFT";I;"RIGHT";J;"DOTS"
270  NEXT  J
280  FOR I=0  TO  10  STEP  2
290      LPRINT  CHR$(&H1B);"s";CHR$(I);CHR$(I)"LEFT";I;"RIGHT";I;"DOTS"
300  NEXT  I
310  LPRINT  CHR$(&H1B);"s";CHR$(0);CHR$(4);
320  END
```

Figure 9-9 Program Sample 5

```
***** CHARACTER SPACE TEST*****
SPACE 0 DOTS
SPACE 2 DOTS
SPACE 4 DOTS
SPACE 6 DOTS
SPACE 8 DOTS
SPACE 10 DOTS
SPACE 12 DOTS
SPACE 14 DOTS
SPACE 16 DOTS
SPACE 18 DOTS
SPACE 20 DOTS
***** CHARACTER SPACE LEFT RIGHT*****
LEFT 0 RIGHT 0 : 0
LEFT 2 RIGHT 0 : 0
LEFT 4 RIGHT 0 : 0
LEFT 6 RIGHT 0 : 0
LEFT 8 RIGHT 0 : 0
LEFT 10 RIGHT 0 : 0
LEFT 0 RIGHT 0 : 0
LEFT 0 RIGHT 2 : 0
LEFT 0 RIGHT 4 : 0
LEFT 0 RIGHT 6 : 0
LEFT 0 RIGHT 8 : 0
LEFT 0 RIGHT 10 : 0
LEFT 0 RIGHT 0 : 0
LEFT 2 RIGHT 2 : 0
LEFT 4 RIGHT 4 : 0
LEFT 6 RIGHT 6 : 0
LEFT 8 RIGHT 8 : 0
LEFT 10 RIGHT 10 : 0
```

Figure 9-10 Print Sample 5

ESC + "J" + n

<Mode 0>

[N a m e]   Print and Feed Forward

[C o d e]   1B$_H$ + 4A$_H$ + n, or 27 decimal + "J" + n

[Function]   Feeds the paper forward.

- n can take on a decimal value from 0 to 255.

- If the line buffer contains print data, the PT502P01 prints that data, feeds the paper by the specified line spacing, then feeds n dot lines forward.

- If the line buffer contains no data, the PT502P01 feeds the paper n dot lines forward.

<Mode 1>   Functions the same as in mode 0.

ESC + "j" + n

<Mode 0>

[N a m e]   Print and Feed Backward

[C o d e]   1B$_H$ + 6A$_H$ + n, or 27 decimal + "j" + n

[Function]   Feeds the paper backward.

- n can take on a decimal value from 0 to 255.

- If the line buffer contains print data, the PT502P01 prints that data, feeds the paper by the specified line spacing, then feeds n dot lines backward.

- If the line buffer contains no data, the PT502P01 feeds the paper n dot lines backward.

<Mode 1>   Functions the same as in mode 0.

ESC + "@"

<Mode 0>

    [N a m e]   Reset

    [C o d e] $1B_H$ + 40_H, or 27 decimal + "@"

    [Function]   Initializes the PT502P01.

                ● The contents of the line and input buffers are cleared.

                ● The download characters defined are also cleared.

<Mode 1>   Functions the same as in mode 0.

```
100  '******  ESC+J+n  ESC+j+n  ESC+@  ******
110  CONSOLE  ,,,,1
120  LPRINT  "****** FEED PAPER FORWARD BACKWARD TEST ******"
130  FOR I=0 TO &HFF-24 STEP 51
140    LPRINT CHR$(&H1B);"A";CHR$(0);                              'LINE SPACE 0
150    LPRINT I;"DOT FEED- - - - ";CHR$(&H1B);"J";CHR$(I);
160      LPRINT CHR$(&H1B);"j";CHR$(I+24);
170      LPRINT I;"              - - - -";I+24;"DOT BFEED"
180  NEXT I
190    LPRINT   "****** RESET TEST ******"
200      LPRINT CHR$(&H1B);"W";CHR$(1);"ABC"
210      LPRINT CHR$(&H1B);"w";CHR$(1);"ABC"
220      LPRINT CHR$(&H1B);"l";CHR$(1);"ABC"
230      LPRINT CHR$(&H1B);"@";
240  PRINT "HIT ANY KEY!!"
250  A$=INPUT$(1)
260  LPRINT "AFTER RESET"
270  END
```

Figure 9-11 Program Sample 6

```
****** FEED PAPER FORWARD BACKWARD TEST ******
  0 DOT FEED-------- 24 DOT BFEED
 51 DOT FEED-------- 75 DOT BFEED
102 DOT FEED-------- 126 DOT BFEED
153 DOT FEED-------- 177 DOT BFEED
204 DOT FEED-------- 228 DOT BFEED
****** RESET TEST ******
ABC
ABC
ABC

AFTER RESET
```

Figure 9-12 Print Sample 6

ESC + "t" + n

<Mode 0>

[N a m e]	Internal Character Set Select
[C o d e]	1B$_H$ + 74$_H$ + n, or 27 decimal + "t" + n
[Function]	Selects the internal character set.

● Only the lowest two bits of n are valid.

n = 1: IBM-compatible character set
n = 3: Japanese *kana* character set

This command is ignored if n has any other value.

● The default is that specified by the function pin (36) on the PT500GA1 (see Section 4.18).

<Mode 1>   Functions the same as in mode 0.

```
130 LPRINT  CHR$(&H1B);CHR$(&H74);CHR$(1);
140 FOR  I=&H20  TO  &HFE
150 LPRINT  CHR$(I);
160 NEXT  I
170 LPRINT  :LPRINT
180 LPRINT  CHR$(&H1B);CHR$(&H74);CHR$(3);
190 FOR  I=&H20  TO  &HFE
200 LPRINT  CHR$(I);
210 NEXT  I
220 END
```

Figure 9-13 Program Sample 7

Figure 9-14 Print Sample 7

ESC + "F" + n

<Mode 0>

[N a m e]   Paper Feed Rate/Print Speed

[C o d e] $1B_H + 46_H$ + n, or 27 decimal + "F" + n

[Function]   Selects paper feed rate and print speed.

- Only the lowest two bits of n are valid.

    n = 0: Low speed feed and low speed printing
    n = 1: Low speed feed and high speed printing
    n = 2: High speed feed and low speed printing
    n = 3: High speed feed and high speed printing

- The default is that specified by the function pins (44 and 45) on the PT500GA1 (see Section 4.18).

<Mode 1>   Functions the same as in mode 0.

ESC + "!" + n

<Mode 0>

[N a m e]   Two-ply Thermal Paper Select

[C o d e] $1B_H + 21_H$ + n, or 27 decimal + "!" + n

[Function]   Selects the use of two-ply thermal paper.

- n is interpreted as follows (higher bits are also valid):

    n = 1: two-ply thermal paper is selected.
    n = 0: two-ply thermal paper is deselected.
    Other values: Ignored.

- The default is the one that is specified by the function pin (35) on the PT500GA1 (see Section 4.18).

- When fixed division is selected, normal thermal paper is automatically selected and this command is ignored.

- To use this command, refer to Section 3.4.

<Mode 1>   Functions the same as in mode 0.

ESC + "i"

<Mode 0>

[N a m e]   Full cut select

[C o d e] $1B_H + 69_H$, or 27 decimal + "i"

[Function]   Selects full cut

- During cutting, the printer stops printing and loading paper.

- This function code is valid only when the ACU5000 series autocutter unit is connected to the PT502P01 CPU.
  If the function code is transmitted when the autocutter unit is not connected, it will be detected as an error.

- The interval between cuts must be more than two seconds.

<Mode 1>   Functions the same as in interface mode 0.

ESC + "m"

<Mode 0>

[N a m e]   Partial cut select

[C o d e] $1B_H + 6D_H$, or 27 decimal + "m"

[Function]   Selects partial cut (leaving the paper connected at one point in the center)

- During cutting, the printer stops printing and feeding paper.

- This function code is valid only when the ACU5000 series autocutter unit is connected to the PT502P01 CPU.
  If the function code is transmitted when the autocutter unit is not connected, it will be detected as an error.

- The interval between cuts must be more than two seconds.

<Mode 1>   Functions the same as in interface mode 0.

9.5.3 DC3 Extended Function Codes

The **DC3** extended function codes specify ruler line functions. The ruler line function is described below.

Line printers generally cannot print vertical lines continuously while printing characters. To compensate for this, the PT502P01 is provided with two ruler line buffers (called A and B) which have the capacity to accommodate one dot line of data and can print two types of ruler lines selectable by the user.

When the PT502P01 prints characters with the ruler line mode turned on, it always prints the dots that correspond to bits set to "1" in the ruler line buffer selected. This produces continuous vertical lines.

Ruler lines may appear in both the character and line spacing areas. Ruler line printing is disabled while the PT502P01 is feeding backward as specified by the sequence **ESC + "j"** or when feeding forward or backward as specified by the pins on the PT500GA1. The PT502P01 does not support the function to overwrite ruler lines and characters in interface mode 1.

DC3 + "O"

< Mode 0 >

[N a m e]	OR Mode Overwrite
[C o d e]	13$_H$ + 4F$_H$, or 19 decimal + "O"
[Function]	Overwrites ruler lines and characters. The PT502P01 is placed in this mode when initialized.

< Mode 1 >   Not supported.

DC3 + "X"

< Mode 0 >

[N a m e]	XOR Mode Overwrite
[C o d e]	13$_H$ + 58$_H$, or 19 decimal + "X"
[Function]	Prints the XOR of ruler lines and characters.

• A white image results when a ruler line and a character overlap.

< Mode 1 >   Not supported.

DC3 + "A"

<Mode 0>

[N a m e]   Ruler Line Buffer A

[C o d e]   13$_H$ + 41$_H$, or 19 decimal + "A"

[Function]   Selects ruler line buffer A.

● Subsequently, the PT502P01 writes ruler line data into ruler line buffer A and prints the image from ruler line buffer A when ruler line printing is turned on.

<Mode 1>   Functions the same as in mode 0.

DC3 + "B"

<Mode 0>

[N a m e]   Ruler Line Buffer B

[C o d e]   13$_H$ + 42$_H$, or 19 decimal + "B"

[Function]   Selects ruler line buffer B.

● Subsequently, the PT502P01 writes ruler line data into ruler line buffer B and prints the image from ruler line buffer B when ruler line printing is turned on.

<Mode 1>   Functions the same as in mode 0.

```
100  '******  DC3+O  DC3+X  DC3+A  DC3+B  *****

110  CONSOLE  ,,,,1
120  DC3$ = CHR$(&H13)
130  LPRINT  "******  RULER  LINE  OR  XOR  A  B  TEST  *****"
140  *OVERLAPOR
150  LPRINT  DC3$;" - ";
160  LPRINT  "RULER  LINE  OR  (DC3+O)  TEST"
170  LPRINT  DC3$;"A";DC3$;"F@@";DC3$;" +";DC3$;"X";
180  LPRINT  CHR$(&H1B);"W";CHR$(1);"XOR  OVERLAP  MODE  ABCDEFG"
190  LPRINT  DC3$;"O";
200  LPRINT  CHR$(&H1B);"W";CHR$(0);"OR  OVERLAP  MODE  ABCDEFG"
210  '
220  *OVERLAPXOR
230  LPRINT  DC3$;" - ";
240  LPRINT  "RULER  LINE  XOR  (DC3+X)  TEST"
250  LPRINT  DC3$;"B";DC3$;"Fww";DC3$;" +";DC3$;"O";
260  LPRINT  CHR$(&H1B);"W";CHR$(1);"OR  OVERLAP  MODE  ABCDEFG"
270  LPRINT  DC3$;"X";
280  LPRINT  CHR$(&H1B);"W";CHR$(1);"XOR  OVERLAP  MODE  ABCDEFG"
290  LPRINT  CHR$(&H1B);"W";CHR$(0);"XOR  OVERLAP  MODE  ABCDEFG"
300  '
310  *BUFFA
320  LPRINT  DC3$;" - ";
330  LPRINT  "RULER  LINE  A  SELECT  (DC3+A)"
340  LPRINT  DC3$;"C";DC3$;"A";
350  LPRINT  DC3$;"F00";"RULER  LINE  BUFF  A  SELECT";DC3$;" +"
360  '
370  *BUFFB
380  LPRINT  DC3$;" - ";
390  LPRINT  "RULER  LINE  B  SELECT  (DC3+B)"
400  LPRINT  DC3$;"C";DC3$;"B";
410  LPRINT  DC3$;"FUU";"RULER  LINE  BUFF  B  SELECT";DC3$;" +"
420  '
430  LPRINT  CHR$(&H1B);"W";CHR$(1);"****  TEST  END  ****"
440  LPRINT  DC3$;" - "
450  END
```

Figure 9-15 Program Sample 8

```
****** RULER LINE OR XOR A B TEST *****
RULER LINE OR (DC3+O) TEST
XOR  OVERLAP  MODE  ABCDEFG
OR OVERLAP MODE ABCDEFG
RULER LINE XOR (DC3+X) TEST
```

XOR OVERLAP MODE ABCDEFG

```
RULER LINE A SELECT (DC3+A)
RULER LINE BUFF A SELECT
RULER LINE B SELECT (DC3+B)
```

Figure 9-16 Print Sample 8

DC3 + " + "

<Mode 0>

    [N a m e]   Ruler Line ON

    [C o d e] 13_H + $2B_H$, or 19 decimal + " + "

    [Function]   Turns on ruler line printing.

        ● The PT502P01 prints ruler lines while printing characters, spacing lines, or feeding paper as specified by a CR or LF code or an ESC + "J" sequence.

    <Mode 1>   Overwrite mode is not supported but ruler lines are printed while spacing lines or feeding paper as specified by a CR or LF code or an ESC + "J" sequence.

DC3 + " – "

<Mode 0>

    [N a m e]   Ruler Line OFF

    [C o d e] 13_H + $2D_H$, or 19 decimal + " – "

    [Function]   Turns off ruler line printing.

        ● The PT502P01 prints no ruler line.

    <Mode 1>   Functions the same as in mode 0.

DC3 + "P"

<Mode 0>

    [N a m e]   Print one dot line after printing line buffer data

    [C o d e] 13_H + 50_H, or 19 decimal + "P"

    [Function]   Prints one dot line from the selected ruler line buffer after printing any data left in the line buffer. If ruler line printing is off, the PT502P01 feeds one dot line.

    <Mode 1>   Functions the same as in mode 0.

DC3 + "C"

<Mode 0>

[N a m e]   Ruler Line Buffer Clear

[C o d e] 13_H + 43_H, or 19 decimal + "C"

[Function]   Clears all bits in the selected ruler line buffer to zero.

<Mode 1>   Functions the same as in mode 0.

```
100  '******  DC3 + +   DC3 + -   DC3 + P   DC3 + C  *****
110  CONSOLE  ,,,,1
120  DC3$ = CHR$(&H13)
130  LPRINT  "*** RULER  LINE  ON/OFF  PRINT  CLEAR  TEST ***"
140  *KEION
150  LPRINT  DC3$;" - ";
160  LPRINT  "RULER  LINE  ON  (DC3 + +)  TEST"
170  LPRINT  DC3$;"B";DC3$;"FBB";"RULER  LINE  BUFF  B  ON";DC3$;" + "
180  LPRINT  DC3$;"A";DC3$;"FAA";"RULER  LINE  BUFF  A  ON";DC3$;" + "
190  '
200  *KEIOFF
210  LPRINT  DC3$;" - ";
220  LPRINT  "RULER  LINE  OFF  (DC3 + -)  TEST"
230  LPRINT  DC3$;"A";DC3$;"F@@";"RULER  LINE  BUFF  A  ON";DC3$;" + "
240  LPRINT  DC3$;"X";"RULER  LINE  BUFF  A  OFF";DC3$;" - "
250  '
260  *LIPR
270  LPRINT  DC3$;" - ";
280  LPRINT  "1DOT  LINE  PRINT  (DC3 + P)  TEST"
290  LPRINT  DC3$;"B";DC3$;"F00";"RULER  LINE  BUFF  B  ON  ";DC3$;" + "
300  FOR  I = 1  TO  &H1F
310  LPRINT  DC3$;"P";
320  NEXT  I
330  '
340  *KEICLR
350  LPRINT  DC3$;" - ";
360  LPRINT  "RULER  LINE  CLEAR  (DC3 + C)  TEST"
370  FOR  I = 1  TO  3
380  LPRINT  DC3$;"A";
390  LPRINT  DC3$;"F@@";CHR$(&H1B);"w";CHR$(1);
400  LPRINT  DC3$;" + ";"RULER  LINE  ON"
410  LPRINT  DC3$;"C";CHR$(&H1B);"w";CHR$(0);"RULER  LINE  CLEAR"
420  NEXT  I
430  END
```

Figure 9-17 Program Sample 9

```
*** RULER LINE ON/OFF PRINT CLEAR TEST ***
RULER LINE ON (DC3++) TEST
RULER LINE BUFF B ON
RULER LINE BUFF A ON
RULER LINE OFF (DC3+-) TEST
RULER LINE BUFF A ON
RULER LINE BUFF A OFF

1DOT LINE PRINT (DC3+P) TEST
RULER LINE BUFF B ON
RULER LINE CLEAR (DC3+C) TEST
RULER LINE ON
RULER LINE CLEAR
RULER LINE ON
RULER LINE CLEAR
RULER LINE ON
RULER LINE CLEAR
```

Figure 9-18 Print Sample 9

DC3 + "V"

<Mode 0>

[N a m e]   Ruler Line MSB Image

[C o d e]   13$_H$ + 56$_H$ + DATA, or 19 decimal + "V" + DATA

[Function]   Writes image data into the selected ruler line buffer.

- The image data consists of one dot line of data as with the bit image.

- The PT502P01 prints the image so that the most significant bit appears at the left margin.

- See the description on the MSB bit image escape sequence for the allowable byte count values.

<Mode 1>   Functions the same as in mode 0.

DC3 + "v"

<Mode 0>

[N a m e]   Ruler Line LSB Image

[C o d e]   13$_H$ + 76$_H$ + DATA, or 19 decimal + "v" + DATA

[Function]   Writes image data into the selected ruler line buffer.

- The image data consists of one dot line of data as with the bit image.

- The PT502P01 prints the image so that the least significant bit appears at the left margin.

- See the description on the MSB bit image escape sequence for the allowable byte count values.

<Mode 1>   Functions the same as in mode 0.

```
100  '******  DC3 + V   DC3 + v  *****
110  CONSOLE  ,,,,1
120  DC3$ = CHR$(&H13)
130  *MSB
140  LPRINT  DC3$;" - ";
150  LPRINT  "RULER  LINE  MSB  IMAGE  (DC3 + V + n)  TEST"
160  LPRINT  DC3$;"A";
170  LPRINT  DC3$;"V";
180  DL = 104                                                    '1  INE = 104  BYTE
190  FOR  I = 1  TO  DL
200  LPRINT  CHR$(I);
210  NEXT  I
220  LPRINT  DC3$;" + ";"MSB  IMAGE  RULER  LINE"
230  LPRINT  CHR$(&H1B);"w";CHR$(1);"MSB  IMAGE"
240  *LSB
250  LPRINT  CHR$(&H1B);"w";CHR$(0);
260  LPRINT  DC3$;" - ";
270  LPRINT  "RULER  LINE  LSB  IMAGE  (DC3 + v + n)  TEST"
280  LPRINT  DC3$;"B";
290  LPRINT  DC3$;"v";
300  DL = 104                                                    '1  LINE = 104  BYTE
310  FOR  I = 1  TO  DL
320  LPRINT  CHR$(I);
330  NEXT  I
340  LPRINT  DC3$;" + ";"LSB  IMAGE  RULER  LINE"
350  LPRINT  CHR$(&H1B);"w";CHR$(1);"LSB  IMAGE"
360  END
```

Figure 9-19 Program Sample 10

Figure 9-20 Print Sample 10

DC3 + "D" + n1 + n2

< Mode 0 >

[N a m e]	Define ruler line by dot
[C o d e]	13_H + 44_H + n1 + n2, or 19 decimal + "D" + n1 + n2
[Function]	Sets the dot in position n2n1 with respect to the dot coordinates on the left edge to "1."

- n1 represents the lower-order byte (0 $\leqq$ n1 $\leqq$ FF_H) and n2 the higher-order byte (0 $\leqq$ n2 $\leqq$ 03_H, i.e., the lowest two bits are valid).

< Mode 1 >   Functions the same as in mode 0.

DC3 + "L" + n1 + n2 + n3 + n4

< Mode 0 >

[N a m e]	Define ruler line by line
[C o d e]	13_H + $4C_H$ + n1 + n2 + n3 + n4, or 19 decimal + "L" + n1 + n2 + n3 + n 4
[Function]	Sets a line of dots from the n2n1th dot to the n4n3rd dot with respect to the dot coordinates on the left edge to "1."

- n1 represents the lower-order byte (0 $\leqq$ n1 $\leqq$ FF_H) and n2 the higher-order byte (0 $\leqq$ n2 $\leqq$ 03_H, i.e., the lowest two bits are valid).

- n3 represents the lower-order byte (0 $\leqq$ n3 $\leqq$ FF_H) and n4 the higher-order byte (0 $\leqq$ n4 $\leqq$ 03_H, i.e., the lowest two bits are valid).
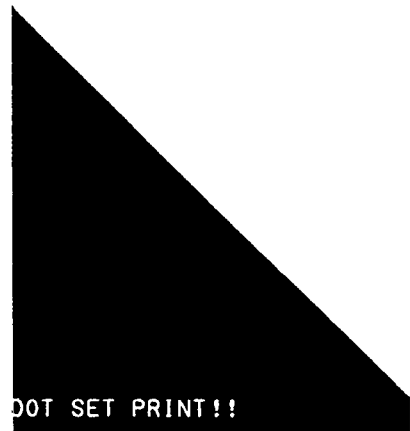
< Mode 1 >   Functions the same as in mode 0.

RULER LINE DOT SET (DC3+D+n) TEST

DOT SET PRINT!!
RULER LINE LINE SET (DC3+L+n) TEST
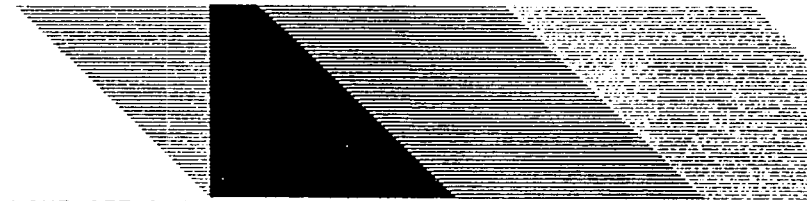
LINE SET PRINT!!
PATTERN FILL (DC3+F+n) TEST
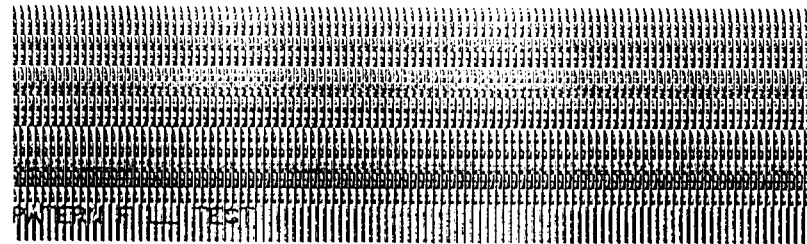
Figure 9-22 Print Sample 11

DC3 + "("

<Mode 0>

[N a m e]   Continuous Ruler Line Control Code Input

[C o d e]   13$_H$ + 28$_H$, or 19 decimal + "("

[Function]   After this code is received, the PT502P01 accepts any ruler line control code without a leading **DC3** code until a ")" code is received.

●   The PT502P01 ignores any codes other than the **DC3** extended function codes.

<Mode 1>   Functions the same as in mode 0.

Sample GW-BASIC program:

```
OPEN "LPT1:BIN" FOR OUTPUT AS #1
PRINT #1,CHR$ (&H13) ; "A" ; CHR$ (&H13) ; "+" ;
PRINT #1,CHR$ (&H13) ; "F" ; CHR$ (&H40) ; CHR$ (&H40) ;
PRINT #1,CHR$ (&H13) ; "P" ;
```

↓

```
OPEN "LPT1:BIN" FOR OUTPUT AS #1
PRINT #1,CHR$ (&H13) ; "(A+F@@P)" ;
```

DC3 + "F" + n1 + n2

<Mode 0>

[N a m e]   Define ruler line with repeating pattern

[C o d e] 13_H + 46_H + n1 + n2, or 19 decimal + "F" + n1 + n2

[Function]   Fills the selected ruler line buffer with 2 bytes of data represented by n2n1.

- n1 represents the lower-order byte $(0 \leq n1 \leq FF_H)$ and n2 the higher-order byte $(0 \leq n2 \leq FF_H)$.

- The PT502P01 prints the image so that the least significant bit of n1 appears at the left margin.

<Mode 1>   Functions the same as in mode 0.

```
100 '***** DC3+D   DC3+L   DC3+F *****
110 CONSOLE   ,,,,1
120 DC3$ = CHR$(&H13)
130 *DOTS
140 LPRINT   DC3$;" - ";
150 LPRINT   "RULER  LINE  DOT  SET  (DC3+D+n)  TEST"
160 LPRINT   DC3$;"A";
170 LPRINT   DC3$;"C";
180 LPRINT   DC3$;" + ";
190 LPRINT   DC3$;"X";
200 DL = 832/2
210 FOR  I = 1  TO  DL
220 LPRINT   DC3$;"D";CHR$(I  MOD  256);CHR$(I ¥ 256);DC3$;"P";
230 NEXT  I
240 LPRINT   DC3$;" + ";"DOT  SET  PRINT!!"
250 '
260 *LINES
270 LPRINT   DC3$;" - ";
280 LPRINT   "RULER  LINE  LINE  SET  (DC3+L+n)  TEST"
290 LPRINT   DC3$;"A";
300 LPRINT   DC3$;"C";
310 LPRINT   DC3$;" + ";
320 LPRINT   DC3$;"X";
330 DL = 832/4
340 FOR  I = 1  TO  DL
350 LPRINT   DC3$;"L";CHR$(I  MOD  256);CHR$(I  MOD  256);CHR$(DL  MOD
256);CHR$(DL ¥ 256);DC3$;"P";DC3$;"C";
360 NEXT  I
370 LPRINT   DC3$;" + ";"LINE  SET  PRINT!!"
380 '
390 *PATFL
400 LPRINT   DC3$;" - ";
410 LPRINT   "PATTERN  FILL  (DC3+F+n)  TEST"
420 LPRINT   DC3$;"A";
430 LPRINT   DC3$;"C";
440 LPRINT   DC3$;" + ";
450 LPRINT   DC3$;"X";
460 DL = 832/4
470 FOR  I = 1  TO  DL
480 LPRINT   DC3$;"F";CHR$(I  MOD  256);CHR$(I  MOD  256);DC3$;"P";
490 NEXT  I
500 LPRINT   DC3$;" + ";"PATERN  FILL  TEST"
510 END
```

Figure 9-21 Program Sample 11

```
100 '****** DC3 + (  DC3 +)  *****
110 CONSOLE  ,,,,1
120 DC3$ = CHR$(&H13)
130 '
140 *KEIREN
150 LPRINT  DC3$;" - ";
160 LPRINT  "*** CONTINUE  RULER  LINE  (DC3 + ()  )  TEST  ***"
170 LPRINT  DC3$;"(";"A";"C";" + ";"O"
180 DL = 832/4
190 FOR  I = 1  TO  DL
200 LPRINT  "F";CHR$(I  MOD  256);CHR$(I  MOD  256);"P";
210 NEXT  I
220 LPRINT  DC3$;")";"TEST  END"
230 END
```

Figure 9-23 Program Sample 12

Figure 9-24 Print Sample 12

9.6 FUNCTION CODE INDEX

Table 9-2 is an index of the function codes supported by the PT502P01.

Table 9-2 Function Code Index

Function Code	Hex	Decimal	Function	Page
CAN	<18>	<24>	Cancel line buffer	9-5
LF	<0A>	<10>	Print and feed one line	9-6
CR	<0D>	<13>	Print and feed one line	9-6
SO	<0E>	<14>	Turn on double-width mode (with automatic reset)	9-7
DC4	<14>	<20>	Turn off double-width mode (with automatic reset)	9-7
ESC + "2"	<1B><32>	<27><50>	Set line spacing to 16 dots	9-10
ESC + "0"	<1B><30>	<27><48>	Set line spacing to 4 dots	9-10
ESC + "A" + n	<1B><41>	<27><65>	Set line spacing to n dots	9-10
ESC + "3" + n	<1B><33>	<27><51>	Set line spacing to n dots	9-10
ESC + " – " + n	<1B><2D>	<27><45>	Turn on underlining	9-13
ESC + "W" + n	<1B><57>	<27><87>	Select/release double-width mode	9-14
ESC + "w" + n	<1B><77>	<27><119>	Select/release double-height mode	9-15
ESC + "I" + n	<1B><49>	<27><73>	Turn on/off reverse mode	9-16
ESC + "V" + n1 + n2	<1B><56>	<27><86>	Set MSB bit image	9-19
ESC + "v" + n1 + n2	<1B><76>	<27><118>	Set LSB bit image	9-21
ESC + SP + n	<1B><20>	<27><32>	Set character spacing	9-24
ESC + "s" + n1 + nr	<1B><73>	<27><115>	Set left/right character spacing	9-24
ESC + "J" + n	<1B><4A>	<27><74>	Print and feed paper forward n dot line(s)	9-27
ESC + "j" + n	<1B><6A>	<27><106>	Print and feed paper backward n dot line(s)	9-27
ESC + "@"	<1B><40>	<27><64>	Reset	9-28
ESC + "t" + n	<1B><74>	<27><116>	Select internal character set	9-30
ESC + "F" + n	<1B><46>	<27><70>	Select speed	9-32
ESC + "l" + n	<1B><21>	<27><33>	Select two-ply thermal paper	9-32

Table 9-2 Function Code Index (Continued)

Function Code	Hex	Decimal	Function	Page
ESC + "i"	<1B><69>	<27><105>	Select full cut	9-33
ESC + "m"	<1B><6D>	<27><109>	Select partial cut	9-33
DC3 + "O"	<13><4F>	<19><79>	Overwrite ruler line and character in OR mode	9-34
DC3 + "X"	<13><58>	<19><88>	Overwrite ruler line and character in XOR mode	9-34
DC3 + "A"	<13><41>	<19><65>	Select ruler line buffer A	9-35
DC3 + "B"	<13><42>	<19><66>	Select ruler line buffer B	9-35
DC3 + " + "	<13><2B>	<19><43>	Turn on ruler line	9-38
DC3 + " – "	<13><2D>	<19><45>	Turn off ruler line	9-38
DC3 + "P"	<13><50>	<19><80>	Print one dot line after printing line buffer data	9-38
DC3 + "C"	<13><43>	<19><67>	Clear ruler line buffer	9-39
DC3 + "V"	<13><56>	<19><86>	Write ruler line MSB image	9-42
DC3 + "v"	<13><76>	<19><118>	Write ruler line LSB image	9-42
DC3 + "D" + n1 + n2	<13><44>	<19><68>	Define ruler line by dot	9-44
DC3 + "L" + n1 + n2 + n3 + n4	<13><4C>	<19><76>	Define ruler line by line	9-44
DC3 + "F" + n1 + n2	<13><46>	<19><70>	Define ruler line with repeating pattern	9-45
DC3 + "("	<13><28>	<19><40>	Continue ruler line control code input	9-48

APPENDIX A

CHARACTER CODES

The character codes for the character sets in the PT502P01 are listed in Tables A-1 and A-2.

Table A-1 IBM Compatible Character Set

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
2 0		!	"	#	$	%	&	'	(	)	*	+	,	-	.	/
3 0	0	1	2	3	4	5	6	7	8	9	:	;	<	=	>	?
4 0	@	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
5 0	P	Q	R	S	T	U	V	W	X	Y	Z	[	\	]	^	_
6 0	`	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o
7 0	p	q	r	s	t	u	v	w	x	y	z	{	¦	}	~	
8 0	Ç	ü	é	â	ä	à	å	ç	ê	ë	è	ï	î	ì	Ä	Å
9 0	É	æ	Æ	ô	ö	ò	û	ù	ÿ	Ö	Ü	¢	£	¥	₧	ƒ
A 0	á	í	ó	ú	ñ	Ñ	ª	º	¿	⌐	¬	½	¼	¡	«	»
B 0	▦	▒	▓	│	┤	╡	╢	╖	╕	╣	║	╗	╝	╜	╛	┐
C 0	└	┴	┬	├	─	┼	╞	╟	╚	╔	╩	╦	╠	═	╬	╧
D 0	╨	╤	╥	╙	╘	╒	╓	╫	╪	┘	┌	█	▄	▌	▐	▀
E 0	α	ß	Γ	π	Σ	σ	µ	τ	Φ	θ	Ω	δ	∞	φ	∈	∩
F 0	≡	±	≥	≤	⌠	⌡	÷	≈	°	∙	·	√	ⁿ	²	■	

Table A-2 Japanese *Kana* Character Set

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
2 0		!	"	#	$	%	&	'	(	)	*	+	,	-	.	/
3 0	0	1	2	3	4	5	6	7	8	9	:	;	<	=	>	?
4 0	@	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
5 0	P	Q	R	S	T	U	V	W	X	Y	Z	[	¥	]	^	_
6 0	`	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o
7 0	p	q	r	s	t	u	v	w	x	y	z	{	¦	}	~	
8 0	▁	▂	▃	▄	▅	▆	▇	█	▏	▎	▍	▌	▋	▊	▉	┼
9 0	┴	┬	┤	├	⎺	─	│	│	┌	┐	└	┘	╭	╮	╰	╯
A 0		。	「	」	、	・	ヲ	ァ	ィ	ゥ	ェ	ォ	ャ	ュ	ョ	ッ
B 0	─	ア	イ	ウ	エ	オ	カ	キ	ク	ケ	コ	サ	シ	ス	セ	ソ
C 0	タ	チ	ツ	テ	ト	ナ	ニ	ヌ	ネ	ノ	ハ	ヒ	フ	ヘ	ホ	マ
D 0	ミ	ム	メ	モ	ヤ	ユ	ヨ	ラ	リ	ル	レ	ロ	ワ	ン	゛	゜
E 0	=	╞	╪	┥	◢	◣	◥	◤	♠	♥	♦	♣	●	○	/	\
F 0	✕	円	年	月	日	時	分	秒	〒	市	区	町	村	人	▓	