YAEN207 *serial*

THERMAL PRINTER MECHANISM

TECHNICAL REFERENCE

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Thermal printer mechanism

YAEN207

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REVISION RECORDS

REV.	DATE	DESCRIPTION	Drawn	Checked	Approved

Contents

Chapter 1 Characters and operating precautions

1.1 Characters

1. Low voltage supply

The voltage used to drive the thermal printer head is equal to the logic voltage, or is driven by a 3.0~5.5 V single power line, the range of operating voltage is 4.2V-8.5V, so four to six NI-Cd batteries or Ni-MH batteries can also be used. Two li-ion batteries can be used.

2. Low volume Compact and light

The mechanism is compact and light, dimensions: 67.3mm (width) * 31.5mm (depth) * 18.5mm (height)

3. Printing with High resolution

A high-density printer head of 8 dots/mm make the printing clear and precise.

4. High speed printing

According to driving power and sensitivity of thermal paper, set different printing speed required. Max printing speed is 80 mm/ sec.

5. Easy paper loading

Detachable rubber roller structure makes the paper loading easier

6. Low noise

Thermal line dot printing is used to guarantee low-noise printing.

1.2 Operation precautions

1) When handling this printer, because TPH and photo interpreter is sensitive to static electricity, please take any preventive measures against static electricity, such as disposable static wrist strap, in order to prevent damages of inner parts of the printer caused by the static electricity.

2) When attaching the platen part to the platen retainer, pay attention not to flaw or damage or smear the rubber part of the platen, the platen gear, and the bearing part (particularly, don't attach any oil or grease and foreign materials on the rubber part.)

3) Never attempt to touch the thermal printer head surface with bear hands. Attaching any oil or grease such as oils from palms on the heating element part of may be shortening the lifetime of the thermal head. In case that any oil and grease or foreign materials are attached on it. Perform the cleaning immediately. In addition, pay attention not to hit it with something hard such as driver.

4) When assembling the platen to the platen retainer of the casing, make sure that the orientation is correct.

5) The thermal head and FPC are shipped as they are connected. When installing the printer, do not pull or apply any extra force in order to avoid the connected part of the thermal head and FPC from being disconnected or deviated. When connecting FPC, please make it sure under condition that the power of control circuit is off. Plug in / out FPC to control board, should less than 10 times, meanwhile make FPC parallel to connector socket.

6) Do not make FPC bend because it may cause FPC disconnection or broken. If FPC requires to be bent, it will be rework if the bending more than R1.

7) The printer has a structure such that the platen part is removed from the printer cabinet. Therefore, if any paper ejected from this printer is pulled away with an unnecessarily strong force, it may cause the platen gear to get off the track and damage the gear. Do not attempt to pull any paper ejected from the printer.

8) Wet paper can be make it jammed, pay attention to the following items when using the printer:

*Turn off the power please when it is not used
*Do not load any wet paper please.
* Turn off the power to the head immediately when condensation occurs. Use the head only after the heads is completely dried. Depending on the environment where the printer is used (the low temperature or high humidity), condensation may be caused by water vapor generated from the used paper when performing the printing of the high printing rate. Therefore, the environment should be considerably evaluated.

9) To separate the head and the platen after the paper run off, If the paper is run out during the printing, stop all actions of the printer in order to prevent the printing without the paper fed. If the printing is continued without any paper fed, it may cause the troubles of the printer.

10) When using this printer for the continuous actions, the temperature of the head printer board (the detected temperature with the thermistor) should be equal or less than 75 degrees centigrade for the temperature protection of IC inside of the printer as well as the surface temperature of the motor should be equal or less than 90 degrees centigrade for the temperature protection of the motor coil.

11) Make sure paper load smooth please.

12) Use the high quality thermal paper, for the property of the paper have big effect on printing quality. The perforated paper may cause the damage to the thermal heads and even shorten lifetime.

Chapter 2 Specifications

2.1 General specifications

Print method	Thermal dot line printing
Dots per line	384 dots
Resolution	8 dots/mm
Print width	48 mm
Paper width	57±1mm
W x D x H（mm）	67.3×31.5×18.5
Maximum printing speed	80mm/s
Paper feed pitch	0.0625mm
Head temperature detection	Via thermistor
Out-of-paper detection	Via photo interrupter
Life span (at 25℃ and rated energy) Activation pulse resistance Abrasion resistance	 110 million pulses or more (print ratio=12.5%) 50 km or more
Operating temperature range (℃)	0～50
Operating humidity (RH)	20％～85％
Storage temperature range (℃)	-20～60
Storage humidity（RH）	10%～90%

2.2 Heat element dimensions

YAEN207 contains a thermal head with 384 heat elements (dot–size)

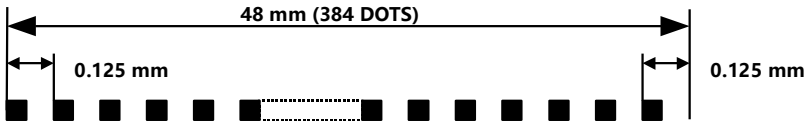


figure 2-1 Heat Element Dimensions

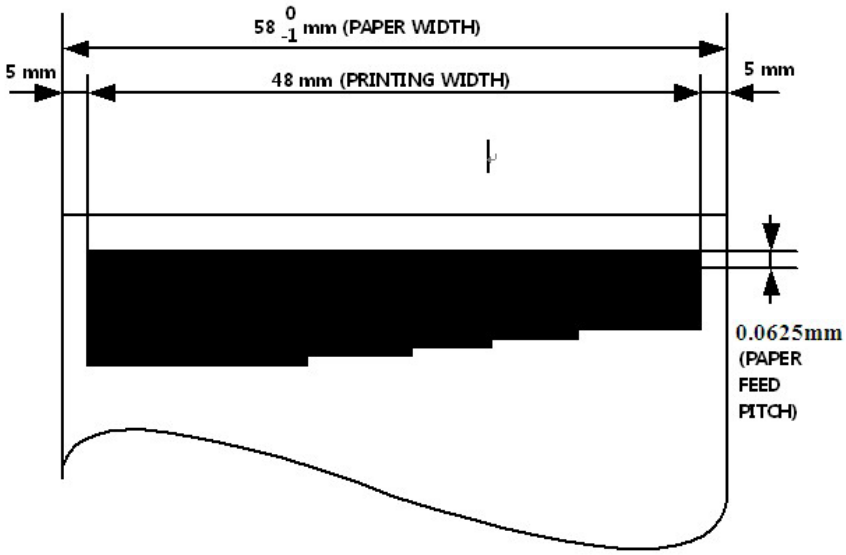


Figure 2-2 Print Area

2.3 Step motor characteristics

2.3.1 Step motor specifications

Item	Specification
Type	PM
Number of phases	2-phase
Excitation	2-2 phase
Winding resistance per phase	10Ω±7%
Rated voltage	4.2~9.5V
Drive frequency	50-1200pps(Depends driving voltage)

2.3.2 Excitation sequence

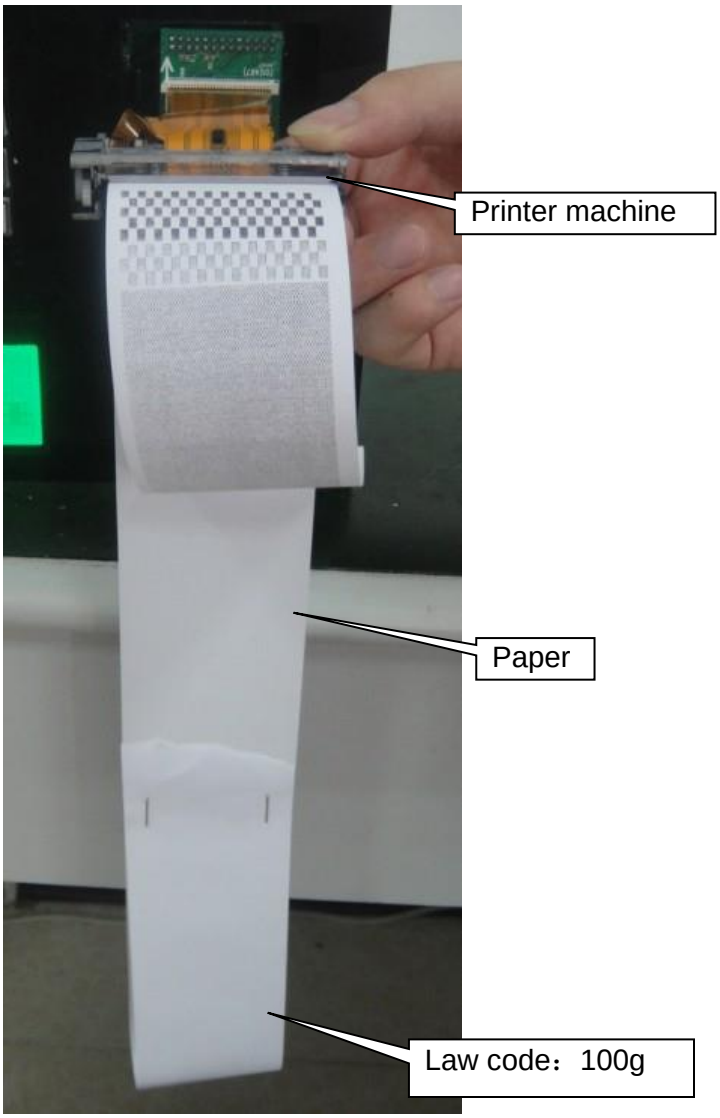
Signal name	Sequence			
	STEP1	STEP2	STEP3	STEP4
A	high	high	low	low
$\overline{A}$	low	low	high	high
B	low	high	high	low
$\overline{B}$	high	low	low	high

2.3.3 Step motor driving

There are two step motor drivings: Constant current driving and constant voltage driving
The advantages and disadvantages of constant current driving and constant voltage driving:

	Constant current driving	constant voltage driving
advantages	1、Overall drive current is relatively small, motor heat is small. 2、Drive noise is small. 3、Power-saving.	1 、 Motor driving force is relatively large 2、Circuit is simple and cheap
disadvantages	1、Motor driving force is relatively small 2、Complex circuit, slightly higher cost	1、Drive current is large, motor heat is large 2、High noise 3、Current consuming

As printer head in use for some time, transmission resistance will increase. In the design, the driving power of motor should have some tolerance which avoid shrink line Recommending when the product design is completed, please test the towing power of motor (as the chart).Under the highest driver frequency, recommend the towing power might not be less than 100grams.



There are two common methods to drive the step motor: 2-2 phase drive (Full Step), 1-2 phase drive (Half Step).

For full step driving, the drive IC charges the two windings in step motor to the predetermined current in sequence. Each plus will drive the motor to rotate with a typical step angle. These methods result in a simple drive circuit and software, but also bigger noise in low speed.

Half step drive is more complicate than full step drive,, such as charging on A phase, rotor teeth stop on stator poles, drive receive next pulse, for example, charging B phase and keep A phase in a charging situation, rotor teeth will move half step angle, stop in the middle of two nearby whole step. This can make the case without changing the motor, stepper motor angular resolution doubling. In this drive way, two phases may need to be energized, with the motor driving IC, control each step of each phase in the ratio of the current state; it can make the motor run quieter. But it also improves the complexity of control software to some extent.

Timing table of motor driving

STEP	Time(ms)	STEP	Time(ms)
1	2.890	10	0.687
2	1.786	11	0.651
3	1.381	12	0.621
4	1.157	13	0.600
5	1.014	14	0.572
6	0.914	15	0.552
7	0.838	16	0.533
8	0.777	17	0.516
9	0.728	18	0.500

2.4 Thermal head specifications

2.4.1 General characteristics

Item	Specification
Print width	48 mm
Number of heater elements	384 dots
Heater resolution	8 dots/mm
Heater pitch	0.125 mm
Heater resistance	$\overline{R}$ =176 Ω ±3%
Number of data inputs	1 serial input
Logic signals	6 STROBE and 1 LATCH

2.4.2 Maximum parameter

Parameter	Symbol	Specification		Unit	Conditions
Scanning Line Time	SLT	1.25	2.50	ms/line	
Supply Energy	Eo max1	0.33	0.46	mJ/dot	
	Eo max2	0.23	0.37	mJ/dot	
Supply voltage	Vset max	8.5		V	Voltage among the connector terminals Never exceed Drive IC's high voltage limit, 10V.
	Vset min	4.0		V	
Supply Power	Pomax	0.34		W/dot	
Supply Current	Iomax	2.8		A	64 dots,is pulsed.
Number of STROBE	STRmax	6		-	
Number of heating Dots at Same Time	Ndotmax	64		dots	
Storage Temp.		-40～+80		℃	
Operation Temp. *3		-30～+70		℃	The temperature at 70℃ is defined as detecting it from Thermistor.
Humidity		10～90		%RH	Condensation should be avoided.
Substrate Temperature	Tmax	70		℃	Temperature detected by Thermistor.

Note: *1 Only on condition that neighboring 2 dots are pulsed at same time.

*2 On condition that neighboring above 3 dots are pulsed at same time.

*3 Under the both condition of less than 0℃ and greater than 50℃, printing become to have less quality. Therefore the condition is with the limits of working, but it is without guarantee of printing quality.

2.4.3 Characteristics recommended

Item		Symbol	Recommended conditions	
Supply Voltage		Vset	7.2V	
Supply power		Po	0.24W/dot	
Scanning Line Time		SLT	1.25ms/line	2.50ms/line
Supply energy	5℃	Eo (ts)	0.19mJ/dot(0.79ms)0.19mJ/dot(0.79ms)	0.29mJ/dot(1.21ms)
	25℃		0.15mJ/dot(0.63ms)	0.24mJ/dot(1.00ms)
	40℃		0.12mJ/dot(0.50ms)	0.19mJ/dot(0.79ms)
Supply current		Io	2.4A	

*4 Printing duty is equal or less than 16%.

2.4.4 Electrical characteristics

Table-1-1 Electrical Characteristics(1)

VDD=5.0V±10%,T=25℃

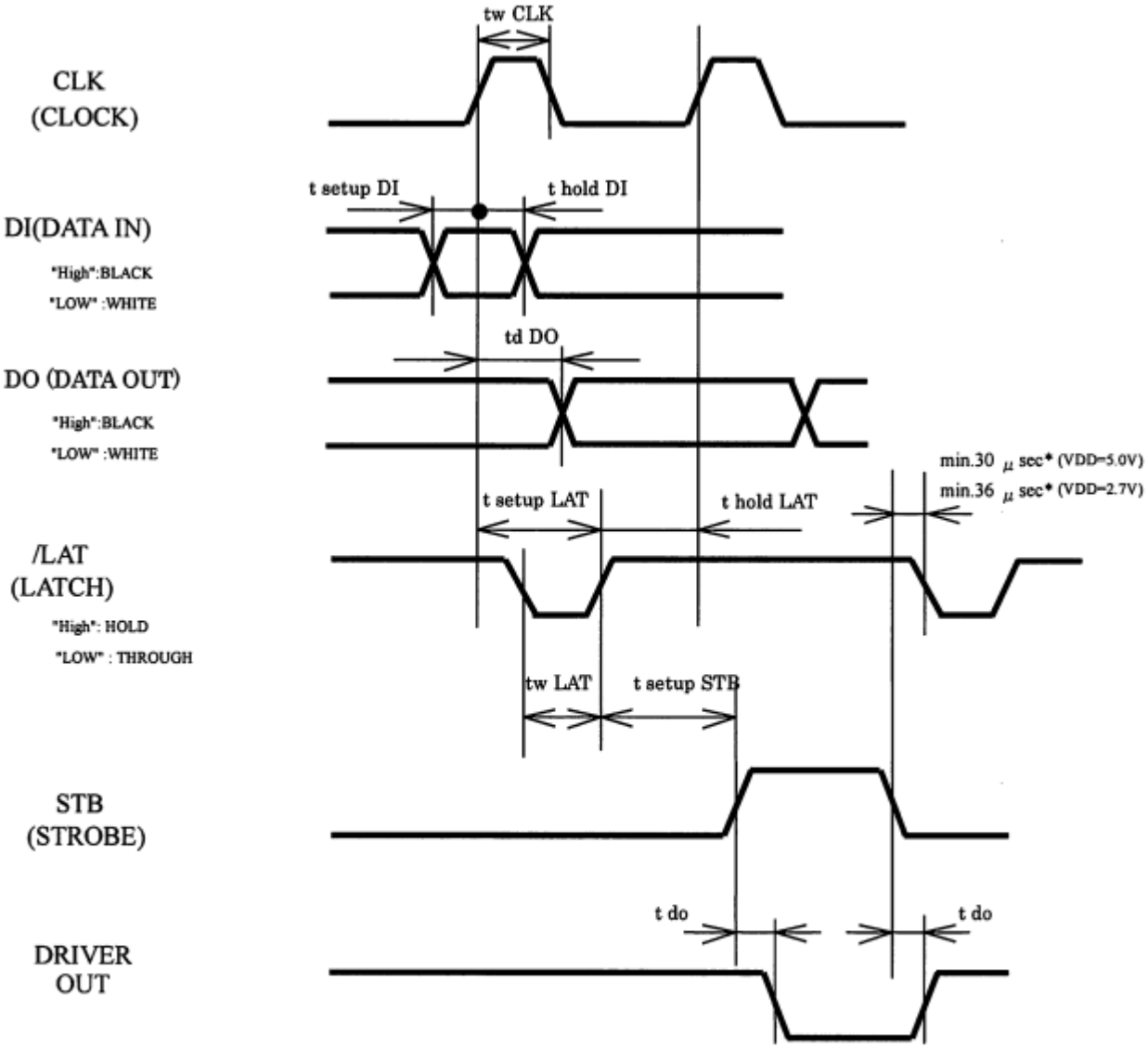
Item	Symbol	Standard			Unit	Condition
		MIN	TYP	MAX		
Average Resistance Value	Rave	169	176	183	Ω	Standard printing conditions
Output Supply Voltage	Vset	4.0	-	8.5	V	
Supply Voltage	VDD	4.5	5.0	5.5	V	
Supply Current	IDD	-	-	42	mA	ALL-HIGH
High Level Input Voltage	V_{IH}	VDD*0.8	-	VDD	V	
Low Level Input Voltage	V_{IL}	0	-	VDD*0.2	V	
High Level Input Current	I_{IH}	-	-	1.0	μA	SI, CLOCK,/LATCH
		-	-	55	μA	STROBE
Low Level Input Current	I_{IL}		-	1.0	μA	
High Level Output Voltage	V_{OH}	4.1	-	-	V	
Low Level Output Voltage	V_{OL}		-	0.4	V	
High Level Output Current	I_{OH}		-	0.5	mA	
Low Level Output Current	I_{OL}	-	-	0.5	mA	
DO Leakage Current	I_{LEAK}	-	-	0.04	mA	ALL-LOW
CLOCK Frequency	t1		-	10	MHz	See 2.4.5
CLOCK Pulse Width	t2	45	-	-	ns	
CLOCK-SI Setup Time	t3	30	-	-	ns	
CLOCK-SI Hold Time	t4	30		-	ns	
LATCH Pulse Width	t5	100	-	-	ns	
CLOCK-LATCH Setup Time	t6	100	-	-	ns	
CLOCK-SO Delay Time	t7	-	-	70	ns	
STROBE-LATCH Removal Time	t8	12.3	-	-	μs	
STROBE-DO Delay Time	t9		-	10.0	μs	
DO Fall Time	t10		-	4.0	μs	
DO Rise Time	t11		-	4.5	μs	

Table-1-2 Electrical Characteristics(2)

VDD=2.7V～3.6V,T=25℃

Item	Symbol	Standard			Unit	Condition
		MIN	TYP	MAX		
Average Resistance Value	Rave	169	176	183	Ω	Standard printing conditions
Output Supply Voltage	Vset	4.0	-	8.5	V	
Supply Voltage	VDD	2.7	3.3	3.6	V	
Supply Current	IDD	-	-	42	mA	ALL-HIGH
High Level Input Voltage	V_{IH}	VDD*0.8	-	VDD	V	
Low Level Input Voltage	V_{IL}	0	-	VDD*0.2	V	
High Level Input Current	I_{IH}	-	-	1.0	μA	SI, CLOCK,/LATCH
		-	-	22	μA	STROBE
Low Level Input Current	I_{IL}		-	1.0	μA	
High Level Output Voltage	V_{OH}	2.3	-	-	V	
Low Level Output Voltage	V_{OL}		-	0.4	V	
High Level Output Current	I_{OH}		-	0.5	mA	
Low Level Output Current	I_{OL}	-	-	0.5	mA	
DO Leakage Current	I_{LEAK}	-	-	0.04	mA	ALL-LOW
CLOCK Pulse Width	t1		-	10	MHz	See 2.4.5
CLOCK Pulse Width	t2	45	-	-	ns	
CLOCK-SI Setup Time	t3	30	-	-	ns	
CLOCK-SI Hold Time	t4	30		-	ns	
LATCH Pulse Width	t5	100	-	-	ns	
CLOCK-LATCH Setup Time	t6	100	-	-	ns	
CLOCK-SO Delay Time	t7	-	-	70	ns	
STROBE-LATCH Removal Time	t8	24.5	-	-	μs	
STROBE-DO Delay Time	t9		-	20.0	μs	
DO Fall Time	t10		-	8.0	μs	
DO Rise Time	t11		-	9.0	μs	

2.4.5 Timing chart



*If delay time for Driver Out can not be secured enough, there is a possibility that VH would fluctuate greatly. Please design the circuit so that VH does not exceed peak voltage (Vp).

2.4.6 Equation:

Calculate the printing energy using this equation：

$$P_0 = I_0^{\,2} \times R_{ave} = \frac{V_H^{\,2} \times R_{ave}}{(R_{com} \times N + R_{ave} + R_{ic} + R_{lead})^2}$$

$$T_{on} = E_0 \div P_0$$

or

$$P_0 = E_0 \div T_{on}$$

$$V_H = \sqrt{(P_0 \div R_{ave})} \times (R_{com} \times N + R_{ave} + R_{ic} + R_{lead})$$

$R_{ave} = R_{res} + R_{lead}$ *3:	Average resistance	(Ex.)	176	(Ω)
N :	Number of dots firing at same time	(Ex.)	64	(dots)
R_{com} :	Common resistance	(Ex.)	0.05	(Ω)
R_{ic} :	Driver saturated resistance	(Ex.)	9	(Ω)

*3 R_{res}: Heater resistance, R_{lead}: Lead resistance

2.4.7 Thermistor resistance

Electrical requirements;

1) Resistance R_{25} : 30kΩ ± 5% at 25℃
2) B value : 3950K ± 2%
3) Resistance vs. Temperature : Fig.4

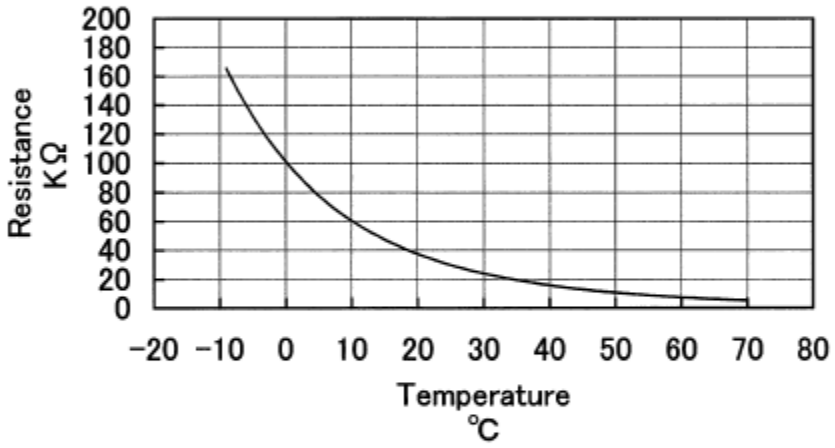
Rating;

1) Operating temperature : -20 ～ +80℃
2) Time constant: Max. 30sec (in the air)

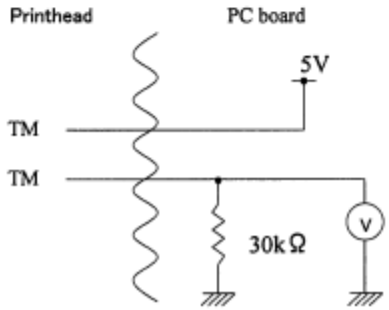
Fig.4 Temperature characteristic of Thermistor

$$R_X=R_{25}*EXP\{B*(1/T_X-1/T_{25})\}$$

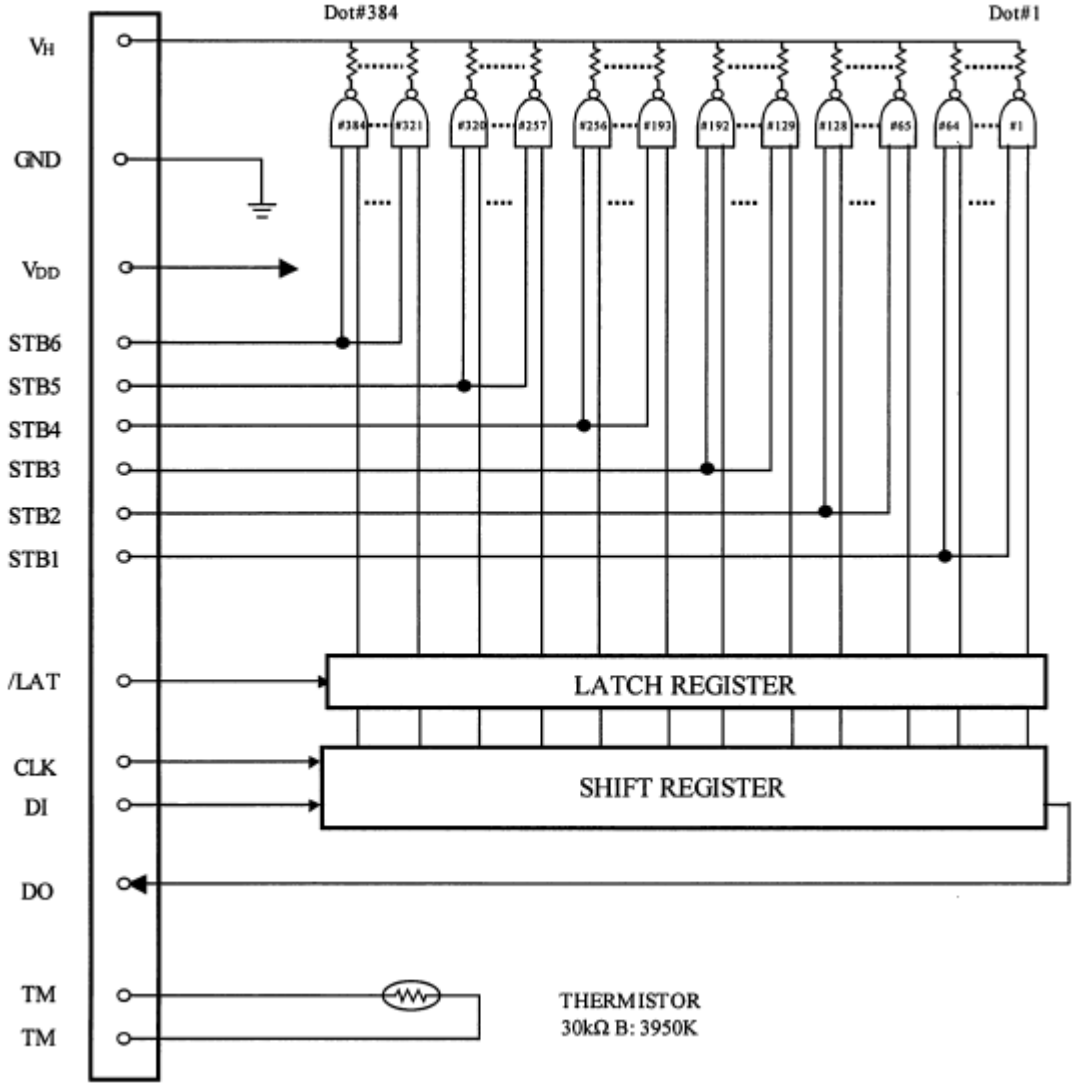
(T; Absolute temperature)



Recommended Circuit



2.4.8 Structure figure



2.4.9 Operating precautions

In order to prevent the printer head does not appear hot spot overheating and burned up phenomenon, when we designing products, need to pay attention to several points as follows:

In hardware terms:

1. When the power on, the order should be VDD-VH.
2. When the power is on or stand by, make sure that the STROBE signal is in invalid state.
3. Make sure if program is abnormal (such as system halted), VH voltage should be shut off automatically.
4. During the printing, Detecting thermistor temperature, make sure that the thermal printer head (TPH) is not overheated.

In software terms:

1. STROBE time should not be too long.
2. In the following two cases, do not start:
   ① when the motor is stationary; ② When the paper is out.
3. When the power is on or completed each printing task, it is recommended to send data to the printer blank line, so it can protect when some hardware failure on the control board will not damage the printer.
4. Over-temperature protection:The printer stops working when heating temperature greater than 75℃,and start working again when the temperature reached 60℃.

2.5 Pin assignment

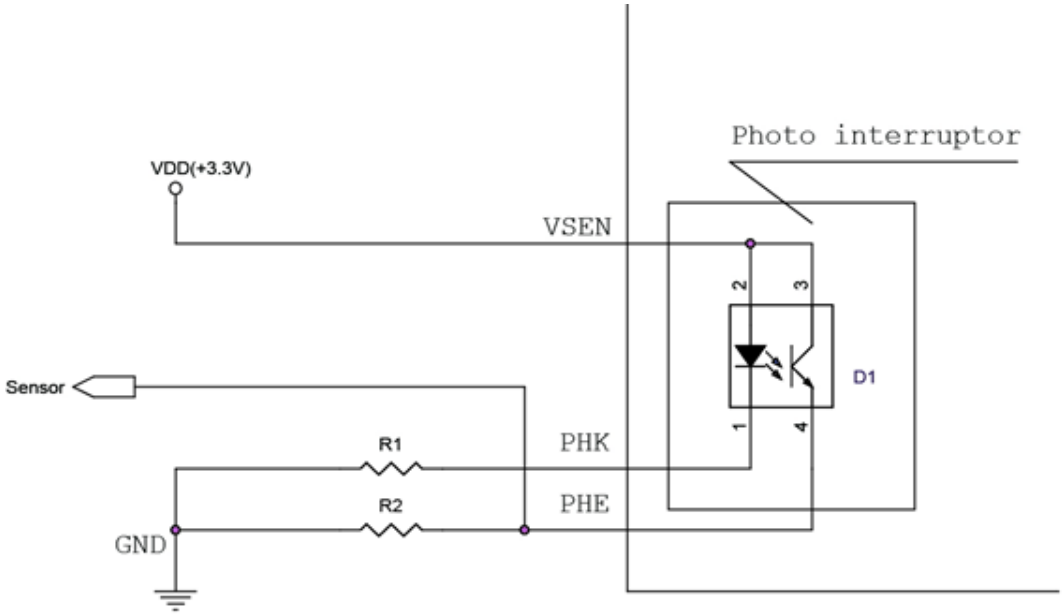
NO.	Signal name	Description
1	PHK	Cathode for photo interruptor
2	VSEN	Paper sensot power
3	PHE	Emittor for photo interruptor
4	MT/B	Stepping motor excitation signal
5	$\overline{\text{MT/B}}$	Stepping motor excitation signal
6	MT/A	Stepping motor excitation signal
7	$\overline{\text{MT/A}}$	Stepping motor excitation signal
8	VH(Vset/VP/COM)	Head drive power
9	VH(Vset/VP/COM)	Head drive power
10	DI	Data in
11	CLK	Aynchronous clock for communication
12	GND	Ground power supply for thermal head
13	GND	Ground power supply for thermal head
14	STB6	Thermal head energizing control signal
15	STB5	Thermal head energizing control signal
16	STB4	Thermal head energizing control signal
17	VDD	Logic power
18	TM	Thermally sensitive resistor input terminal
19	TM	Thermally sensitive resistor input terminal
20	STB3	Thermal head energizing control signal
21	STB2	Thermal head energizing control signal
22	STB1	Thermal head energizing control signal
23	GND	Ground power supply for thermal head
24	GND	Ground power supply for thermal head
25	/LAT	Data latch
26	DO	Data out
27	VH(Vset/VP/COM)	Head drive voltage
28	VH(Vset/VP/COM)	Head drive voltage
29	NC	--
30	NC	--

2.6 Photo interpreter specification

YAEN207 has a reflexive sensor. These two situations might destroy the reflection, and output the high level: Platen released or paper out.As follows:

When everything is normal, the sensor will output low level. The circuit driver of opto detection as follows: The logic voltage could be 3.3V or 5V.

When the paper out or platen released, do not start printer.



Absolute Maximum Ratings (Ta=25℃)

Item		Symbol	Value	Unit
Input	Power Dissipation（Ta ≤25℃）	P_D	75	mW
	Reverse Voltage	V_R	5	V
	Forward Current	I_F	50	mA
	Peak forward current(*1) Pulse width ≤ 100μs, Duty 1%	IFP	1	A
Output	Collector Power Dissipation	P_C	75	mW
	Collector Current	I_C	50	mA
	Collector-Emitter Voltage	BV_{CEO}	30	V
	Emitter-Collector Voltage	BV_{ECO}	5	V
Operating Temperature		T_{opr}	-25~+85	℃
Storage Temperature		T_{stg}	-30~+90	℃
Soldering Temperature (*2)		T_{sol}	260	℃

(*1) tw=100 μ sec, T=10msec. (*2)t=5sec

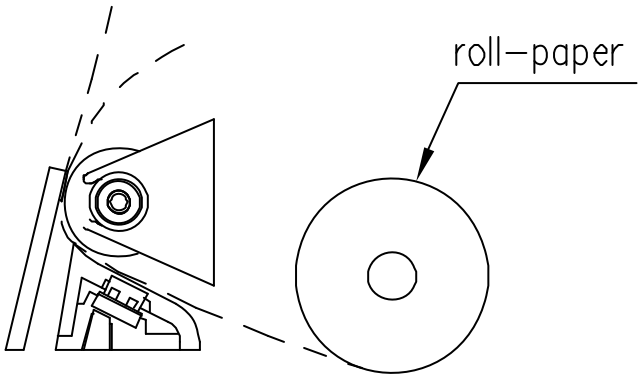
Electro-Optical Characteristics (Ta=25℃)

Parameter		Symbol	Min	Typ.	Max.	Unit	Conditions
Input	Forward oltage	V_F	---	1.2	1.6	V	I_F=20mA
	Reverse Current	I_R	---	---	10	μA	V_R=5V
	Peak Wavelength	λ_P	---	940	---	nm	---
Output	Dark Current	I_{CEO}	---		100	nA	V_{CE}=10V
	C-E Saturation Voltage	$VCE_{(SAT)}$	---	---	0.4	V	I_C=2mA E_e=1mW/cm^2
Transfer Characteristics	Light Current	IC(ON)	180	---	440	μA	V_{CE}=5V I_F=10mA
	Leakage Current	ICEOD	---	---	1		
	Rise time	tr	---	20	---	μsec	V_{CE}=2V I_C=100μA R_L=1KΩ
	Fall time	tf	---	20	---	μsec	

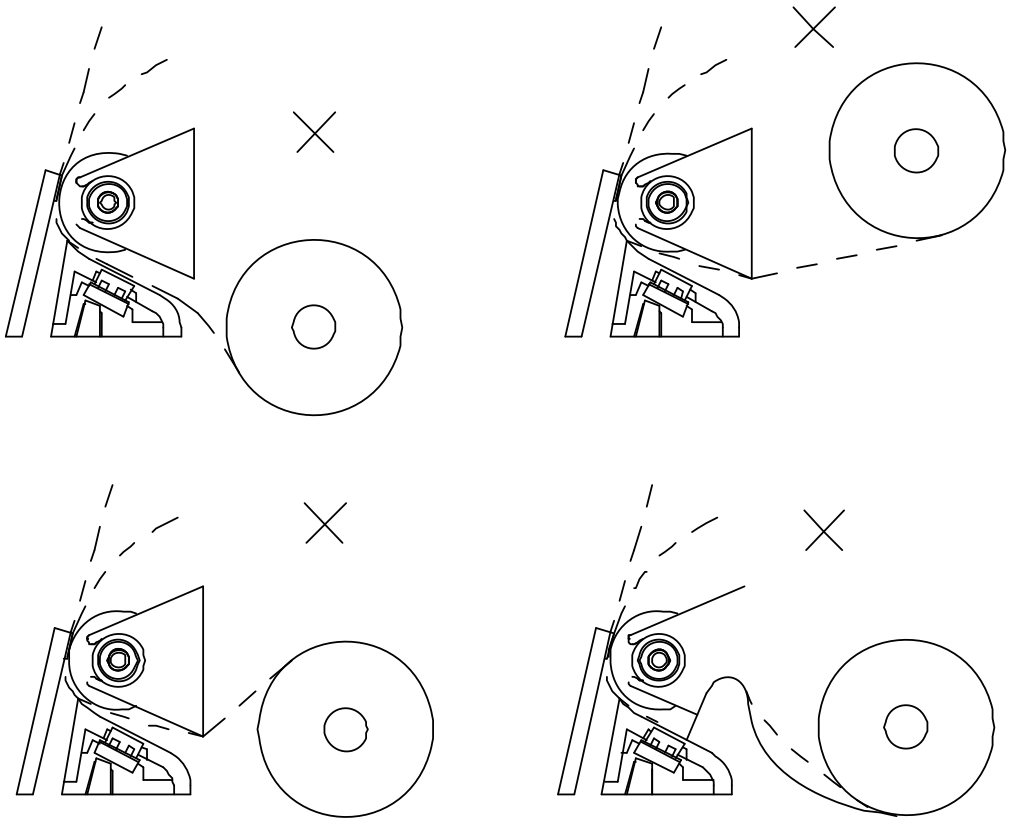
Chapter 3 Casing design guide

3.1 Thermal printer mechanism structure dimensions

3.1.1 Roll-paper mounting position

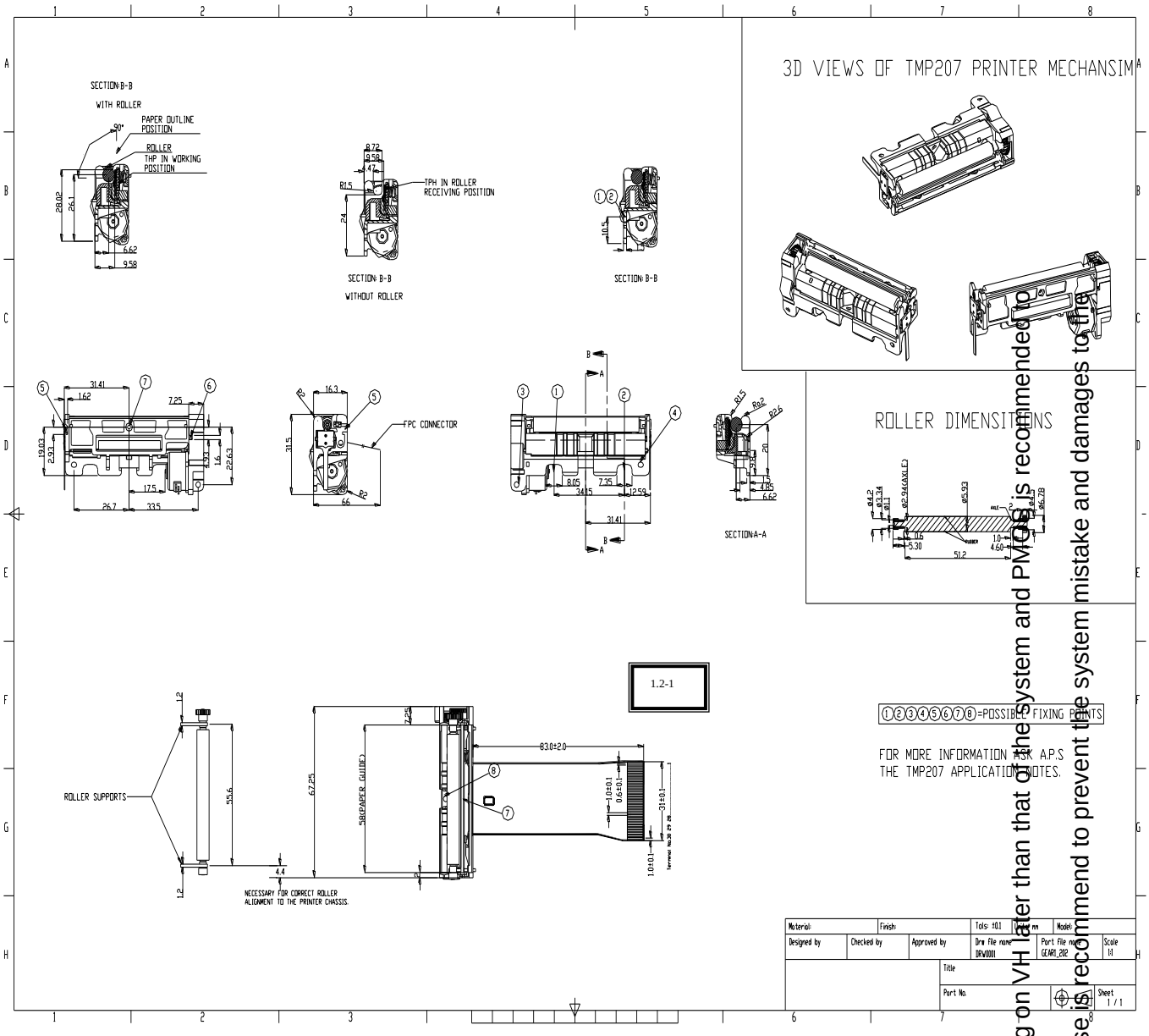


Wrong mounting



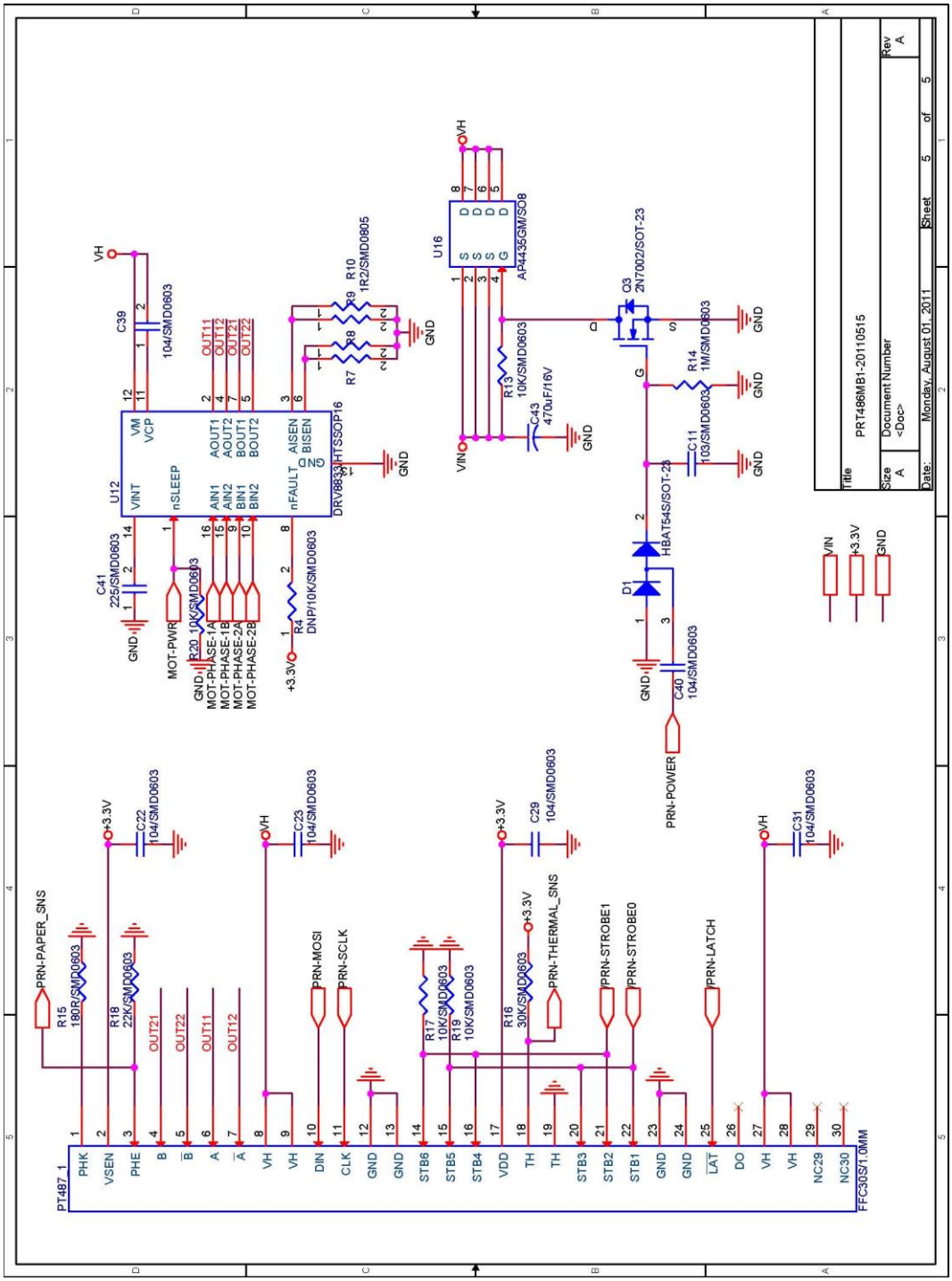
3.1.2 Overall dimensions

[Unit：mm]



3.2 DEMO circuit figure

Circuit definition
1.When designing circuit, make powering on VH later than that of the system and PMOS is recommended to add to VH.
2. In printing, trigger output high/low pulse is recommend to prevent the system mistake and damages to the printer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Monday, August 01, 2011
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PRN-MOSI
PRN-SCLK
PRN-THERMAL_SNS
PRN-STROBE1
PRN-STROBE0
PRN-LATCH
PRN-POWER
MOT-PWR
MOT-PHASE-1A
MOT-PHASE-1B
MOT-PHASE-2A
MOT-PHASE-2B
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AP4435GM/SO8
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HBAT54S/SOT-23