Linear Image Sensor
Datasheet

Product Name	**P378-P**

Approval	Notes

CMOS Sensor Inc	QA	PD	Check	Eng
USA : 20045 Stevens Creek Blvd., Suite 1A, Cupertino, CA., 95014 USA Tel : +1 (408) 366-2898 Fax : +1 (408) 366-2841 Taiwan: No. 6, Lane 276, Shiyuan Rd., Daxi District, Taoyuan City, 33551, Taiwan (ROC) Tel: +886 (3) 389-6633 Fax: +886 (3) 389-6655				

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All specifications of this device are subject to change without notice

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Revision History

Rev.	Date	DCN No	Author	Description
1.0	Jun10, 2020	200167	Jeff Mai	Released
1.1	Sep 15, 2020	200208	Jeff Mai	Text and Figure correction
1.2	Jan 04, 2021		Jeff Mai	1. Updated Item 5, Table 2 2. Add Item 12 Spectral response

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CMOS Sensor Inc.

P378-P

Linear Image Sensor

1. Introduction

The P378-P image sensor is a mixed mode IC. It integrated digital circuitry, image sensor array and analog circuitry into a tiny silicon chip. An on chip timing generator provides all of the timing circuitry to operate the device. The active element array consists of 2024 active pixel sensors (APS), and 24 optical black elements (12 elements on each side) for dark voltage cancellation. The device can be select for either 3200 dpi resolution or 6400 dpi resolution. Gain select is used to select gain equals to 1, 2 or 4. There are two video outputs. They are analog output (VOUT) and reference output (VREF). User can either use one analog output alone or used both output. If used both output, a differential amplifier is used to eliminate the DC offset. The device provides a SYNC output pulse to indicate the first pixel and last pixel (# 2048). The device has a built-in power down circuitry to reduce the power consumption when the device is not used. The image sensing length is 100 um and the pixel pitch is 3.9 um. All of the photo-detectors are integrated simultaneously and the photo detector integration time can be controlled with exposure control pin EP. The device is easy to operate. In addition to the power supply, only 2 clock signals (start pulse SP and clock pulse CP) are required to operate this device.

The P378-P has a capability to readout 3200 dpi, or 6400 dpi resolution by control RE-SEL pins. For 3200 dpi resolution, two adjacent pixels are added together. Therefore, the readout time is reduced by half compare to the 6400 dpi resolution readout mode.

This device can be used in a wide variety of applications such as touch screen, multi-touch screen, bar code reader, edge detector, positioning and optical encoding, etc.

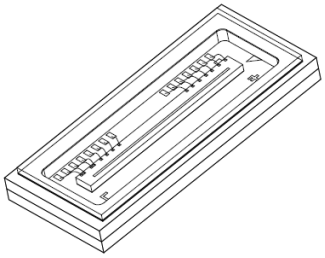

Figure 1 P378-P

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1.1 Features

- 2024 active pixels and 24 dummy pixels
- 3.9 um x 100 um rectangular pixel size
- 7901.4 um x 100 um image area
- 3200 dpi (7.8 um pixel pitch) or 6400 dpi (3.9 um pixel pitch) selectable
- External gain selectable for gain = 1, 2, or 4
- Electronic exposure time control
- Operation mode / power down mode selectable
- Conversion rate up to 3.5 uV/e for unit gain
- Speed up to 6 MHz pixel rate
- On-chip timing and clock driver
- On chip OP amplifier
- Very low fixed pattern noise
- Single 3.3 V power supply
- 3.3 V input signal interface
- One analog output and one reference output
- Package: PLCC 16 pins

1.2 Application

- Optical linear sensors
- Position detection
- Object measurement
- Rotary encoder
- Image reading

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2. Function Block Diagram

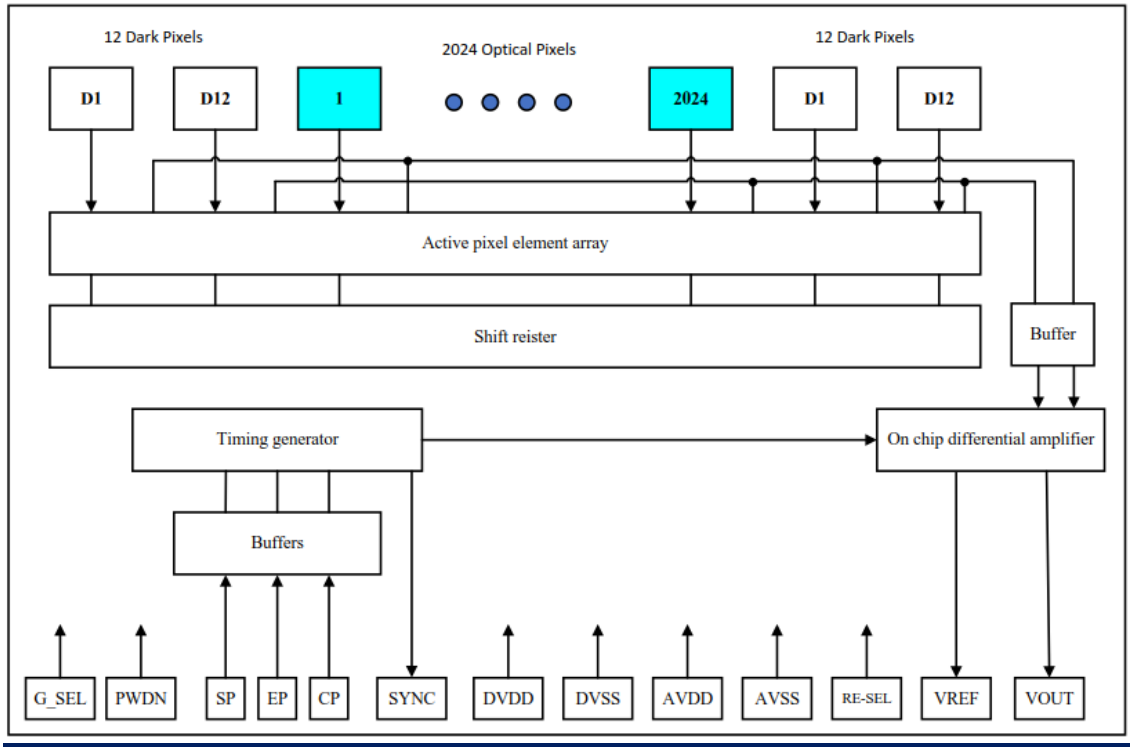
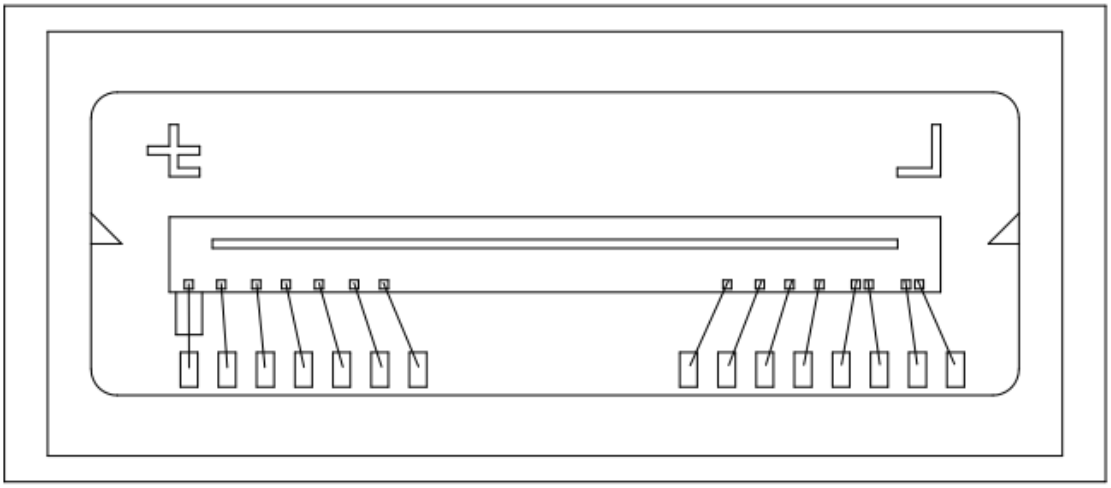


Figure 2 Function Block Diagram

3. Chip Drawing and Pin Assignment

TOP VIEW



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BOTTOM VIEW

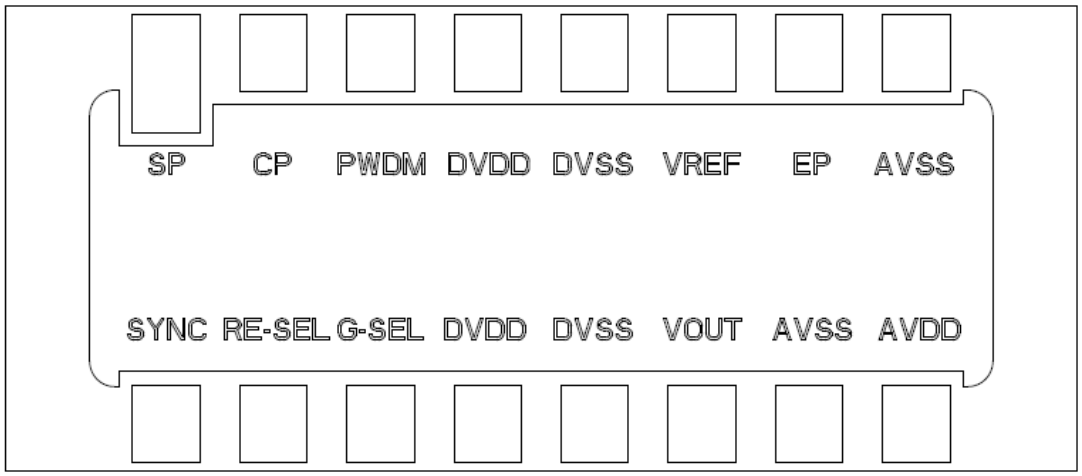

Figure 3 Pin Assignment Diagram

4. Pin Description

Pin Number	Symbol	I/O	Description
1	SP	I	Start pulse input
2	CP	I	Clock pulse input
3	PWDN	I	Power down input / L= Operation; H = Power Down
4	DVDD	I	Digital power supply = 3.3 V
5	DVSS	I	Digital ground = 0 V
6	VREF	O	Reference voltage output
7	EP	I	Exposure control pulse
8	AVSS	I	Analog ground = 0 V
9	AVDD	I	Analog power supply = 3.3 V
10	AVSS	I	Analog ground = 0 V
11	VOUT	O	Analog (Video) signal output
12	DVSS	I	Digital ground = 0 V
13	DVDD	I	Digital power supply = 3.3 V

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14	G_SEL	I	Gain select / L = x 4; H = x 2; Pulse = x 1
15	RE_SEL	I	Resolution select / L = 3200 dpi; H = 6400 dpi
16	SYNC	O	Sync output pulse

Table 1 Pin Description

Resolution select: Low for 3200 dpi resolution; High for 6400 dpi resolution
Gain select: Low for gain = x 4; High for gain = x 2; Connected to SP for gain = x 1
Power down: Low is operation; High is power down

5. Electrical and Optical Characteristics

Test Conditions:
Measured at f_{clk} (CP) = 5.0 MHz, AVDD = DVDD = VDD = 3.3 V, t_{int}*(1) = 555 us, λ*(2) = 650 nm, Gain Select*(3) = 2, Resolution*(4) select = 6400 dpi, T_A*(5) = 25 ℃, Light intensity = 10 LUX.

Symbol	Description	Test Conditions	Min	Typ	Max	Unit
VDD	Power supply voltage		3.0	3.3	3.6	V
VREF	Reference output voltage			0.83		V
I_{DD}	Power supply current (operation)			16	20	mA
f_{clk}	Clock Frequency		0.5	5.0	6.0	MHz
f_{px}	Pixel rate		0.5	5.0	6.0	MHz
V_p*(6)	Bright output Voltage	Light on	1.65	1.86	2.10	V
U_p*(7)	Bright output non-uniformity	Light on	-10	-	+10	%
V_{pc}*(8)	Compensated#(1) analog output voltage	Light on	0.88	0.98	1.16	V
U_{pc}*(9)	Compensated#(1) analog output Voltage non-uniformity	Light on: pixel 1 ~ 2024	-10	-	10	%
U_{pc-adj}*(10)	Compensated#(1) analog output Voltage adjacent pixel non-uniformity	Light on: pixel 1 ~ 2024	-10		10	%
V_d*(11)	Analog output voltage at dark level	Light off	0.8	0.9	1.0	V
U_d*(12)	Dark signal nonuniformity	Light off	-	-	100	mV

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CR	Conversion rate			3.5		uV/e
V_{SAT}	Output Saturation Voltage			2.94		V
Q_{SAT}	Full well capacity			300		Ke-
R	PhotoSensitivity			530		V/(lux*s)
Vn	Read out noise @ 6400 dpi			3.7		mV_{rms}
DR	Dynamic range			55		dB
I_L	Image lag			1		%
N_L	Non-linearity			3		%

Table 2 Electrical and Optical Characteristics

Definition:

1. t_{int} is the integration time, which is equal to the interval between two start pulses.
2. λ is the wavelength of the light source.
3. Gain select is the gain of an on-chip video operation amplifier.
4. Resolution: RE_SEL = High (6400 dpi)
5. T_A is the ambient temperature.
6. $V_p = (V_{pmax} + V_{pmin}) / 2$
   where V_{pmax} is the maximum bright voltage when light-on
   V_{pmin} is the minimum bright voltage when light-on
7. U_p is the pixel-to-pixel photo response non-uniformity within the whole device
   $U_p = [(V_{pmax} - V_{pmin}) / (V_{pmax} + V_{pmin})] \times 100\ \%$
8. $V_{pc} = (V_{pcmax} + V_{pcmin}) / 2$
   where V_{pcmax} is the maximum compensated#(1) voltage of the whole array when light-on
   V_{pcmin} is the minimum compensated#(1) voltage of the whole array when light-on
9. U_{pc} is the pixel-to-pixel compensated#(1) photo response non-uniformity within a device when light-on.
   $U_{pc} = [(V_{pcmax} - V_{pcmin}) / (V_{pcmax} + V_{pcmin})] \times 100\ \%$
10. $U_{pcadj} = \text{Max}\ [|(V_{pc}(i) - V_{pc}(i+1))| / V_{pc}(i)] \times 100\%$, (i = 1, 2, 3, …, 2023)
    where $V_{pc}(i)$ is the compensated#(1) video signal output of a pixel # i
    $V_{pc}(i+1)$ is the compensated#(1) video signal output of a pixel # (i+1)
11. $V_d = (V_{dmax} + V_{dmin}) / 2$
    where V_{dmax} is the maximum dark voltage of the whole array.
    V_{dmin} is the minimum dark voltage of the whole array.
12. $U_d = V_{dmax} - V_{dmin}$
    where V_{dmax} is the maximum dark voltage of the whole array.
    V_{dmin} is the minimum dark voltage of the whole array.

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#(1) : compensated value means the light-on bright output voltage minus the light-off dark voltage for each pixel

6. Absolute Maximum Rating

Power supply voltage, VDD ---------- 6 V
Power supply current, I_{DD} ---------- 30 mA
Digital input voltage range, V_{ih} ---------- VDD
Digital input current range, I_{ih} ---------- -10 mA ~ +10 mA
Operating free-air temperature range, T_A ---------- -40 ℃ ~ 85 ℃
Storage temperature range, T_{stg} ---------- -40 ℃ ~ 85 ℃

✧ Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress rating only, and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

7. Recommended Operating Conditions

Item	Symbol	Min	Typ	Max	Unit
Power supply voltage	VDD	3.0	3.3	3.6	V
Power supply current	I_{DD}	-	16	20	mA
Input voltage	V_i	-	-	VDD	V
High level input voltage	V_{ih}	VDD x 0.7	-	VDD	V
Low level input voltage	V_{il}	0.0	-	VDD x 0.3	V
Clock frequency	f_{clk}	0.5	5.0	6.0	MHz
Pixel readout rate	f_{px}	0.5	5.0	6.0	Mpixel / sec
Sensor integration time	t_{int}	-	1.0	-	ms
Wavelength of light source	λ	400	-	1000	nm
Clock pulse high duty cycle		25	50		%
Operating free-air temperature	T_A	-40	-	85	℃

Table 3 Recommended Operating Conditions

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8. Timing Diagram

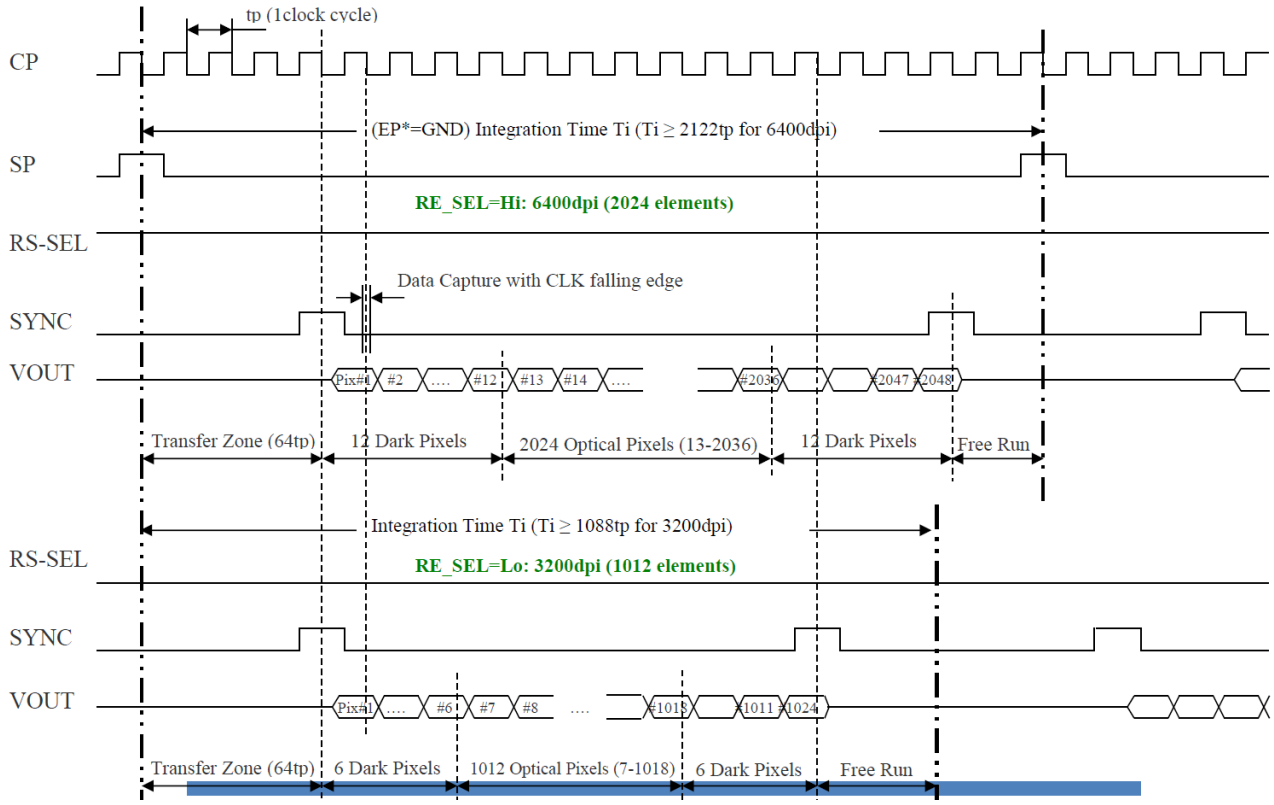

Figure 4 External Interface Timing Diagram

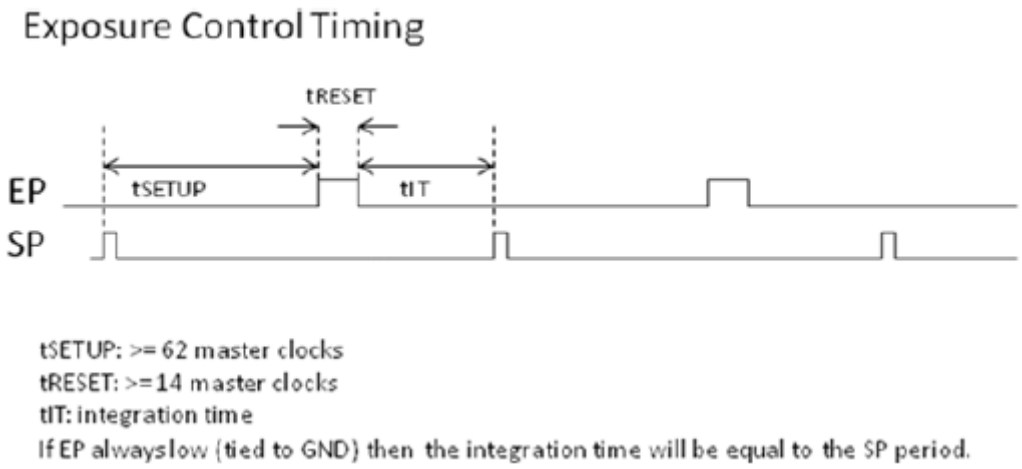

Figure 5 EP Control Timing Diagram

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G-SEL Value	Output Gain
G-SEL = Lo	X4
G-SEL = Hi	X2
G-SEL = SP	X1

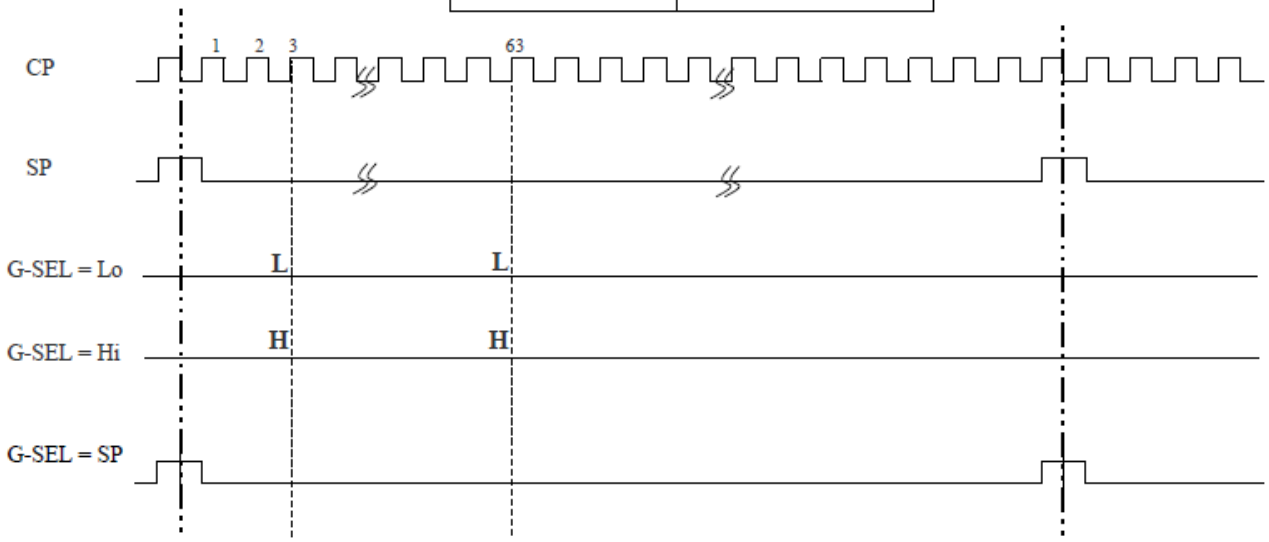

Figure 6　　Gain select Timing Diagram

9. Readout Circuitry

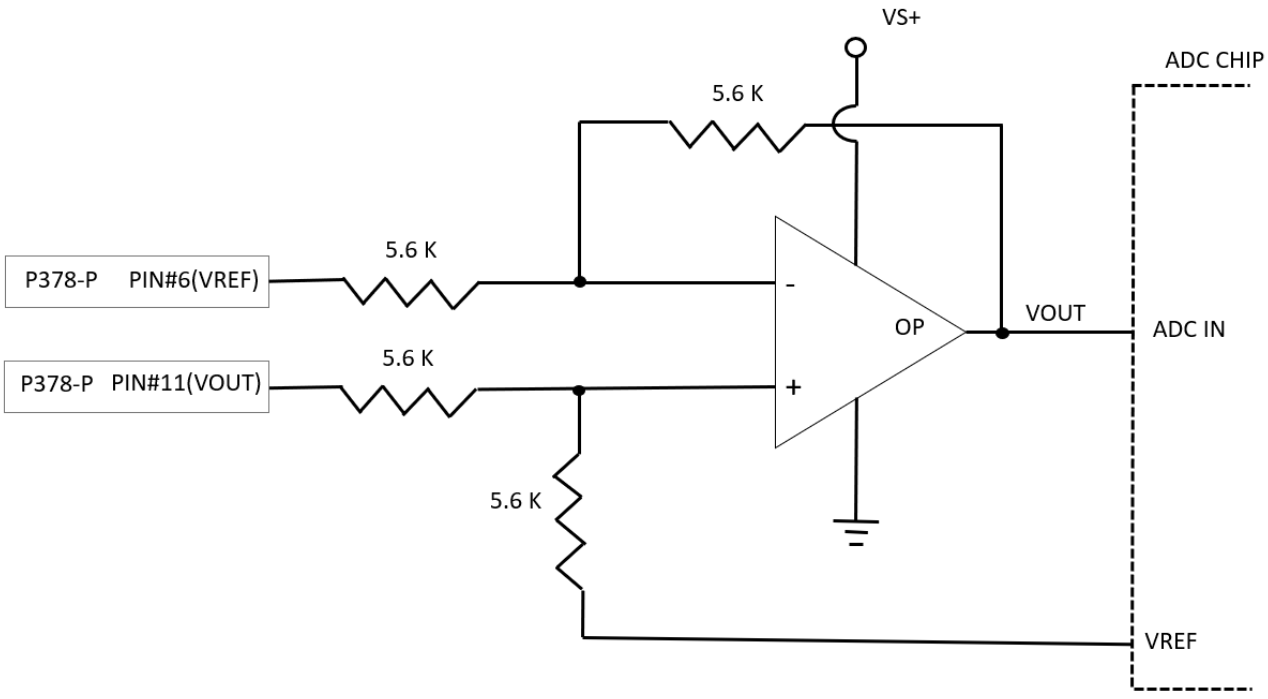

Figure 7　　Readout Circuitry

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10. Switching Characteristics :

Item	Description	Symbol	Min	Tye	Max	Unit
1	Clock cycle time	t_o	-	200	-	us
2	Clock pulse duty cycle	t_w / t_o	-	50	-	%
3	Clock pulse width	t_w	-	100	-	ns
4	SP setup time	t_{ss}	50	-	-	ns
5	SP hold time	t_{sh}	50	-	-	ns
6	Video signal delay time	t_{pd}	-	50	-	ns
7	Video signal stable time	t_s	-	150	-	ns

Table 4 Switching Characteristics

11. Switch Waveforms

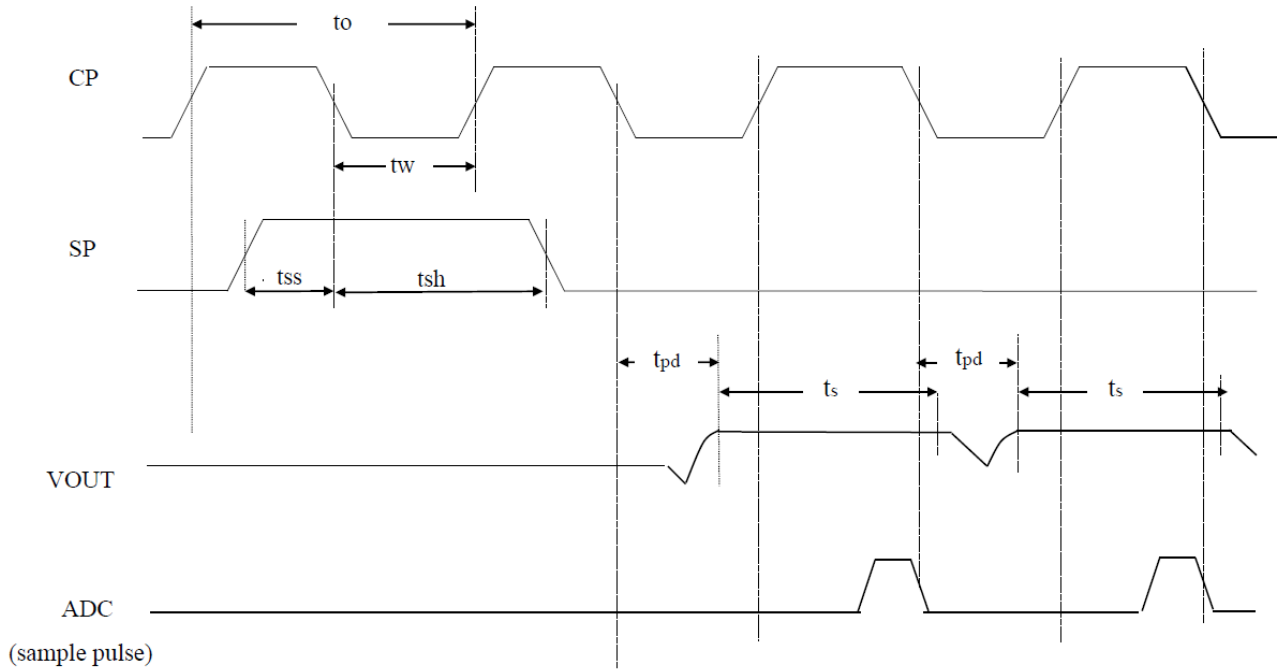

Figure 8 Switch Waveforms

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12. Spectral response

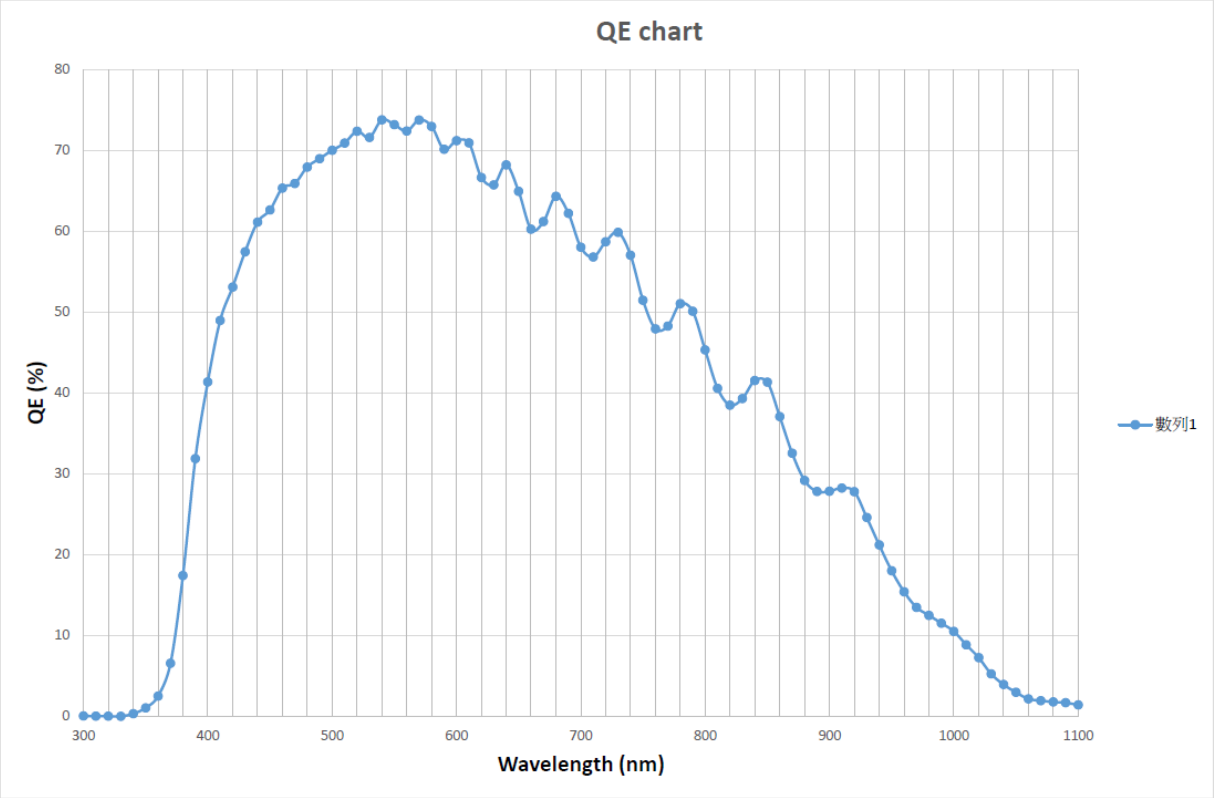

Figure 9 QE chart

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13. Dimensional outline (Unit : mm)

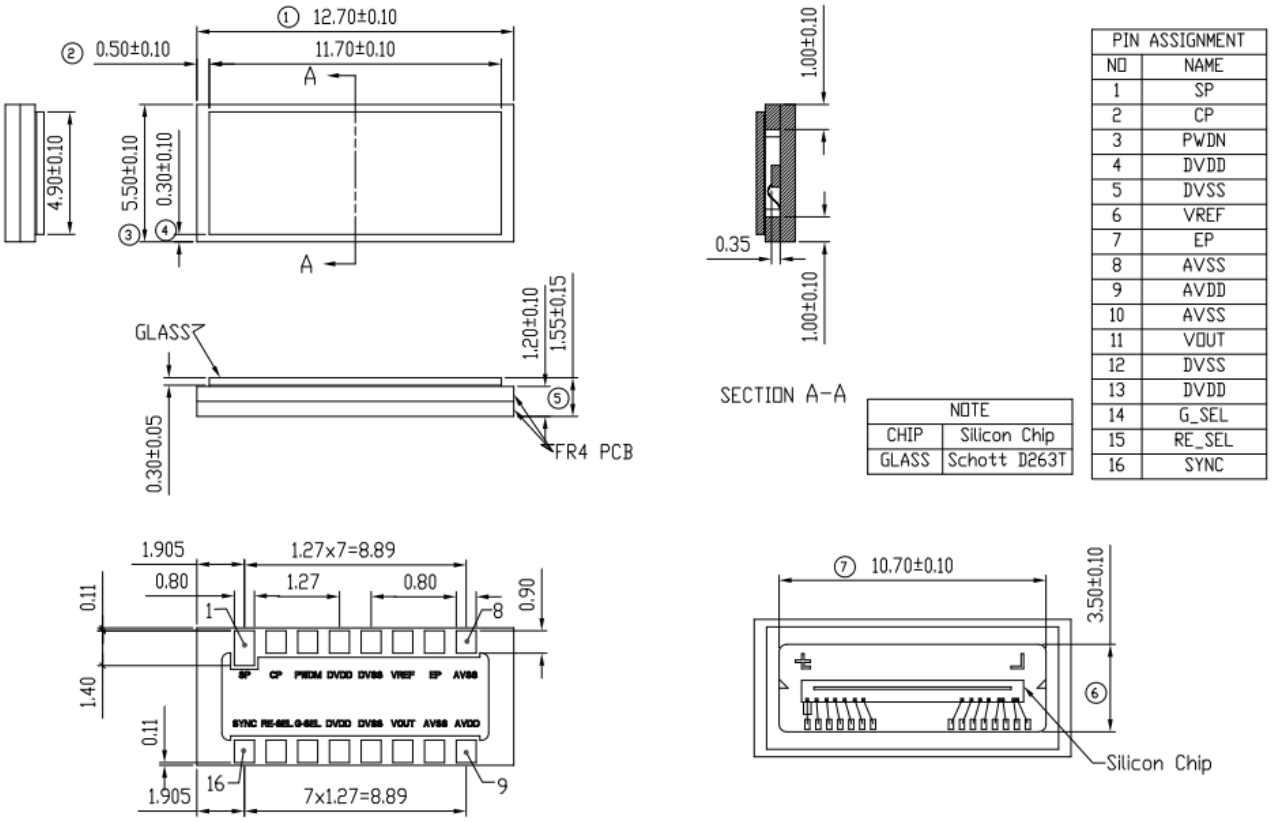

Figure 10 P378-P device dimension

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14. Standard packing specifications

(A). Tube packing method:

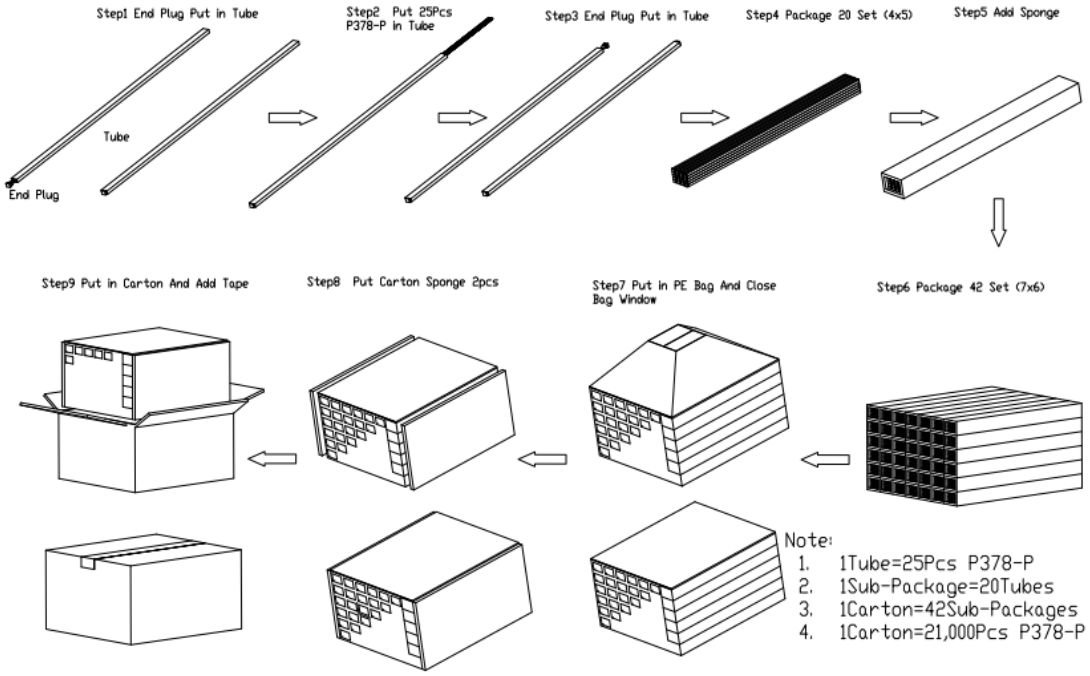

Figure 11 Tube packing method

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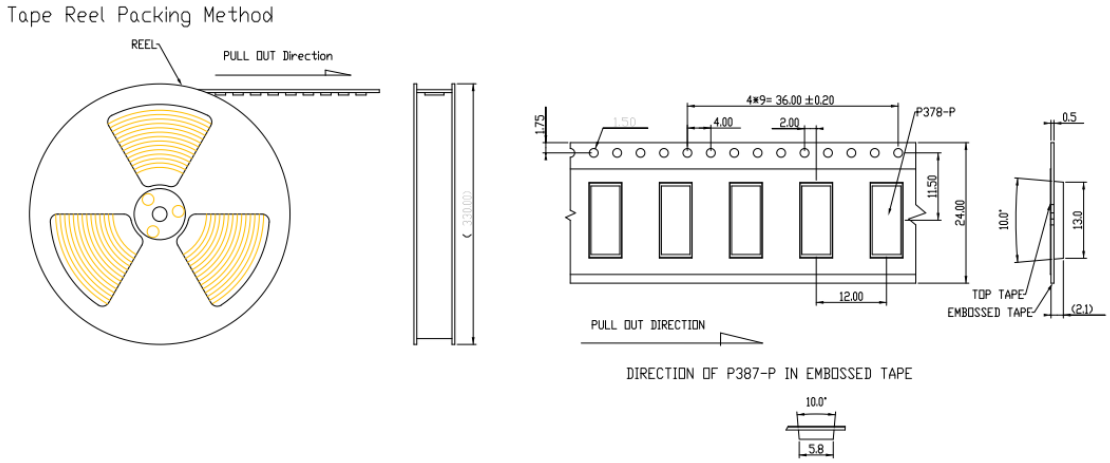
(B). Tape reel packing method:



* Note:

1. Number of 13” reel: 2000 pcs / 25 m
2. Material:

   Carrier tape: Anti-static PS < 10^{11} Ω/sq, 0.35 T, Black

   Top tape: Anti-static PET < 10^{11} Ω/sq

   Reel: Anti-static PS < 10^{11} Ω/sq (Recycle material contained)
3. Cover tape Peel force is defined by IEC60286-3.

Figure 12 Tape reel packing method

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The Standard Reflow Condition for PLCC (Surface Mount Device)

1. Storage Precautions
   1.1 Do not drop or toss device packaging. The material in it can be rendered ineffective by rough handling.
   1.2 As long as the packing bag is not opened and kept at normal temperature (5 to 35 °C) and Humidity (45 to 85 %), the product can be stored for an extended period of time (about 3 months). However, even if the packing bag is not opened, avoid storing it in locations subject to sharp or sudden fluctuations in temperature.
   1.3 Prevent destruction of the device by static electricity in the case of the bake processing for removing humidity.
   1.4 After opening moisture-proof packing, store a product in 30 °C, 60 %RH or better environment and use them within five days. If the effective usage period passed after opening the moisture-proof packing, baking should be done before use at 120°C for 3 hours. Number of baking times Up to two times.

2. Mounting Conditions Using Reflow
   2.1 Mounting method:
      2.1.1 Hot air reflow
      2.1.2 Infrared ray reflow
   2.2 Preheating condition: 150 °C to 180 °C, 90 s to 200 s
   2.3 Reflow condition:
      2.3.1 Maximum 240 °C
      2.3.2 Over 230 °C, within 30 s to 50 s
   2.4 Heating times: Only 1 time

The temperature profile is specified in terms of the temperature of top surface of the device.
This temperature profile shows the maximum guaranteed device temperature. Please set up the optimum temperature profile conditions within the Figure 12 profile.

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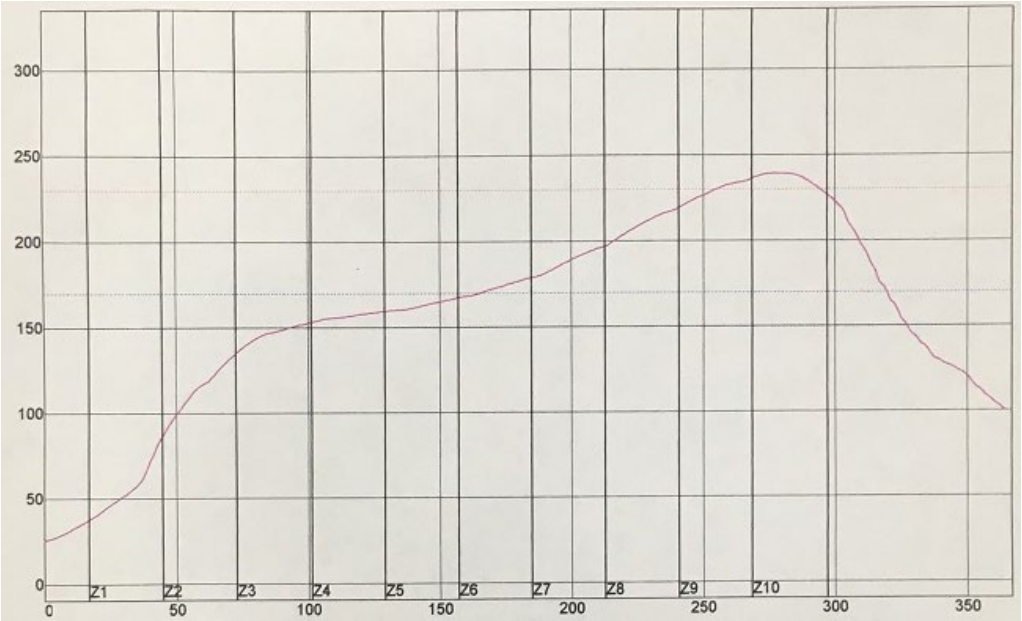

Figure 13 Example of recommended temperature profile for reflows

In addition, in case of the repair work accompanied by IC removal, since the degree of parallel may be spoiled with the left solder, please do not carry out.

3. Mounting

3.1. In the case of solder mounting, the devices should be mounted with the window glass protective tape in order to avoid dust or dirt included in reflow machine.

3.2. The window glass protective tape is manufactured from materials in which static charges tend to build up. When removing the tape from sensor after solder mounting, install an ionizer to prevent the tape from being charged with static electricity.

3.3. When the tape is removed, adhesives will remain in the glass surface. Since these adhesives appear as black or white flaws on the image, please wipe the window glass surface with the cloth into which the organic solvent was infiltrated. Then please attach sensor to a product.

3.4. Do not reuse the window glass protective tape.

3.5. The parts of glass seal area have possibility to be became clouded by reflow process however, there is no problem in quality.

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WARRANTY

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