

TOSHIBA CCD Linear Image Sensor CCD (Charge Coupled Device)

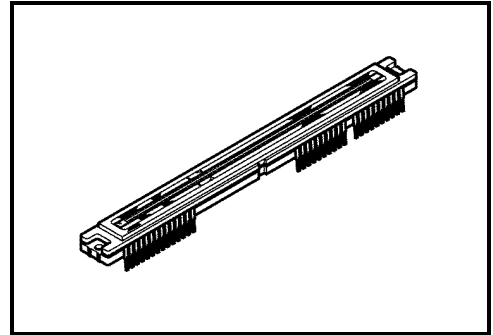
TCD1709D

The TCD1709D is a high sensitive and low dark current 7500 pixels CCD image sensor.

The sensor is designed for facsimile, imagescanner and OCR. The device contains a row of 7500 pixels photodiodes which provide a 24 lines/mm (600DPI) across a A3 size paper. The device is operated by 5-V (pulse), and 12-V power supply.

Features

- Number of image sensing pixels: 7500 pixels
- Image sensing pixel size: 7 μm by 7 μm on 7-μm center
- Photo Sensing Region
: High sensitive and low voltage dark signal pn photodiode
- Clock: CMOS 5-V drive
- Power supply voltage: 12-V power supply
- Package: 68-pin CERDIP



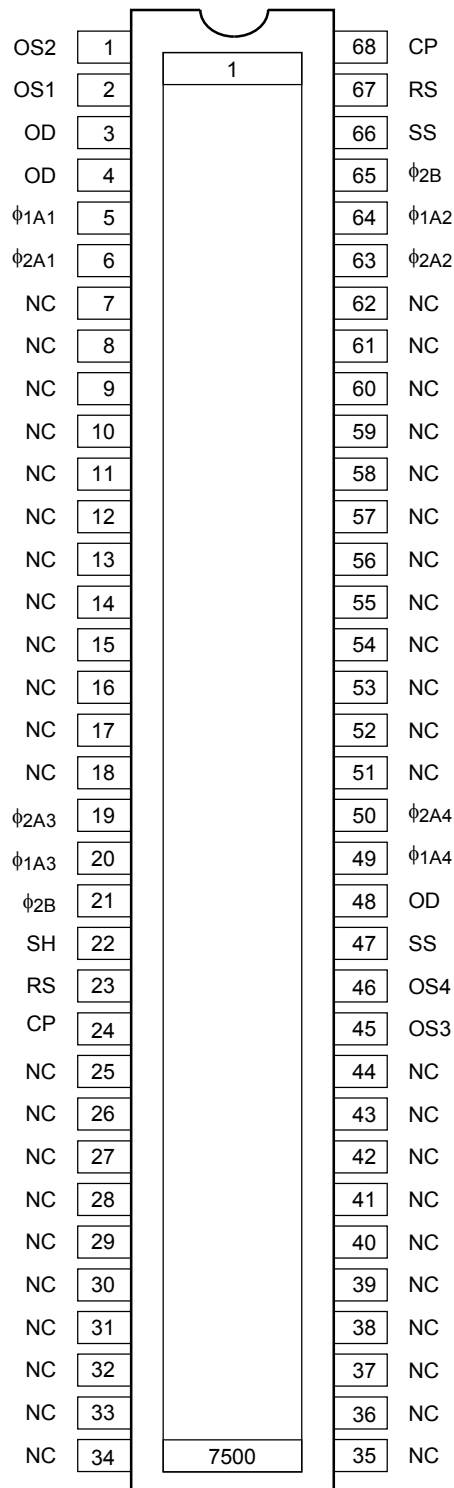
Weight: 16.0 g (typ.)

Maximum Ratings (Note 1)

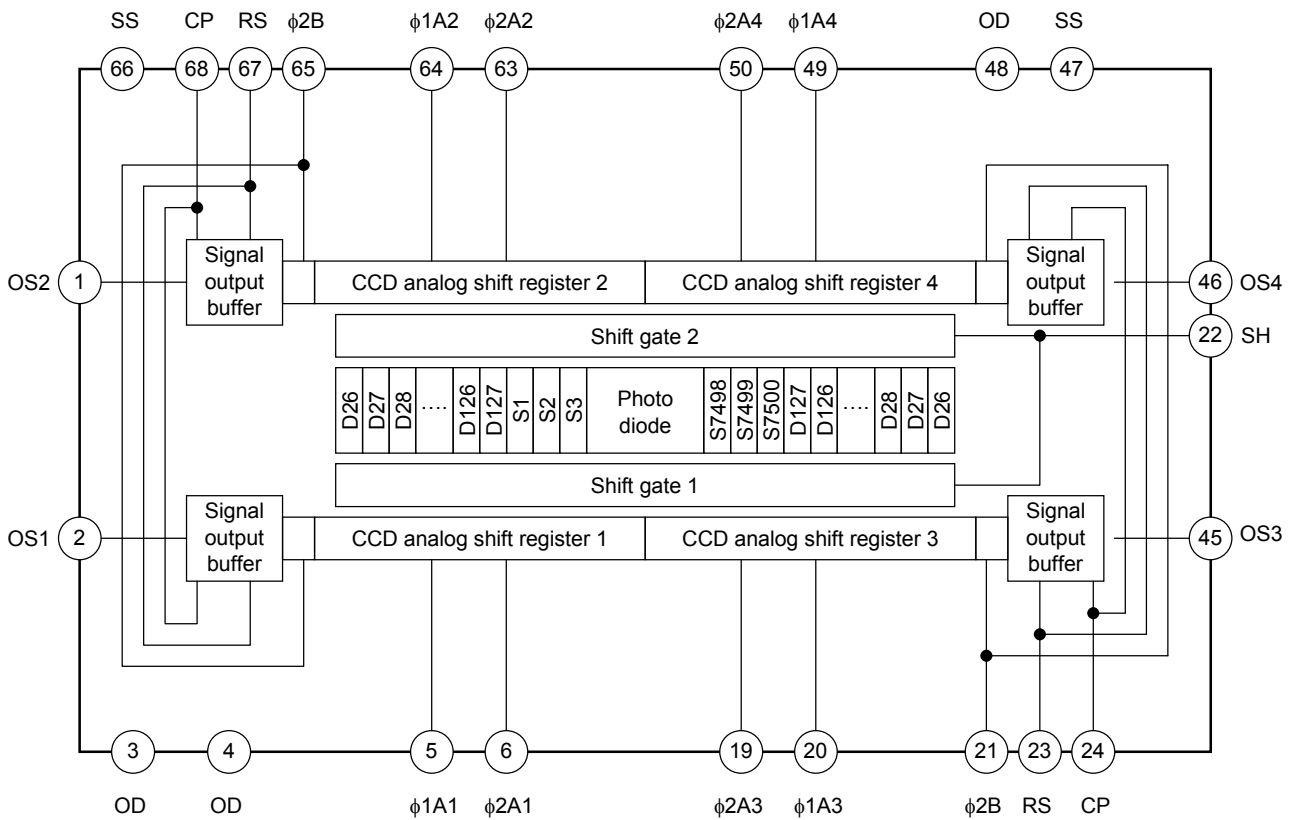
Characteristics	Symbol	Rating	Unit
Clock pulse voltage	V_{ϕ}	-0.3 to 8	V
Shift pulse voltage	V_{SH}		
Reset pulse voltage	V_{RS}		
Clamp pulse voltage	V_{CP}		
Power supply voltage	V_{OD}	-0.3 to 15	
Operating temperature	T_{opr}	0 to 60	°C
Storage temperature	T_{stg}	-25 to 85	°C

Note 1: All voltages are with respect to SS pins (ground).

Pin Connections (top view)



Circuit Diagram



Pin Names

$\phi 1A1, 2, 3, 4$	Clock (phase 1)
$\phi 2A1, 2, 3, 4$	Clock (phase 2)
$\phi 2B$	Last stage clock (phase 2)
SH	Shift gate
RS	Reset gate
CP	Clamp gate
OS1	Output signal 1
OS2	Output signal 2
OS3	Output signal 3
OS4	Output signal 4
OD	Power supply
SS	Ground
NC	No connect

Optical/Electrical Characteristics

($T_a = 25^\circ\text{C}$, $V_{OD} = 12\text{ V}$, $V_\phi = V_{SH} = V_{RS} = V_{CP} = 5\text{ V (Pulse)}$, $f_\phi = 1\text{ MHz}$,
 t_{INT} (integration time) = 10 ms, light source = daylight fluorescent lamp,
 load resistance = 100 k Ω)

Characteristics	Symbol	Min	Typ.	Max	Unit	Note
Sensitivity	R	12	15	18	V/(lx·s)	
Photo response non uniformity	PRNU	—	3	10	%	(Note 2)
	PRNU (3)	—	5	12	mV	(Note 8)
Saturation output voltage	V_{SAT}	1.5	2.0	—	V	(Note 3)
Saturation exposure	SE	0.08	0.16	—	lx·s	(Note 4)
Dark signal voltage	V_{DRK}	—	1	3	mV	(Note 5)
Dark signal non uniformity	DSNU	—	2	6	mV	(Note 5)
DC power dissipation	P_D	—	800	1040	mW	
Total transfer efficiency	TTE	92	98	—	%	
Output impedance	Z_o	—	0.2	1	k Ω	
Dynamic range	DR	—	2500	—	—	(Note 6)
DC signal output voltage	V_{OS}	4.5	6	7.5	V	(Note 7)
DC differential error voltage	$ V_{OSX}-V_{OSY} $	—	—	300	mV	(Note 9)
Random noise	ND_σ	—	0.7	—	mV	(Note 10)

Note 2: Measured at 50% of SE (typ.)

$$\text{Definition of PRNU : PRNU} = \frac{\Delta\bar{\chi}}{\bar{\chi}} \times 100(\%)$$

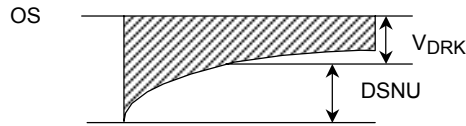
Where $\bar{\chi}$ is average of total signal outputs and $\Delta\bar{\chi}$ is maximum deviation from $\bar{\chi}$ under uniform illumination (Channel 1).

In the case of 1875 pixels (channel 2, channel 3 and channel 4), the condition is the same as above too.

Note 3: V_{SAT} is defined as minimum saturation output voltage of all effective pixels.

$$\text{Note 4: Definition of SE: SE} = \frac{V_{SAT}}{R} (\text{lx}\cdot\text{s})$$

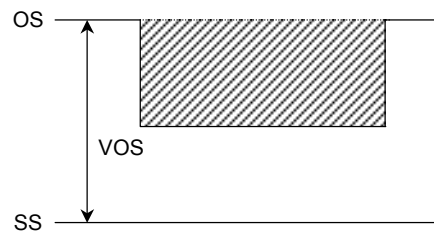
Note 5: V_{DRK} is defined as average dark signal voltage of all effective pixels.
 $DSNU$ is defined by the difference between average value (V_{DRK}) and the maximum value of the dark voltage.



Note 6: Definition of DR : $DR = \frac{V_{SAT}}{V_{DRK}}$

V_{DRK} is proportional to t_{INT} (integration time).
 So the shorter t_{INT} condition makes wider DR values.

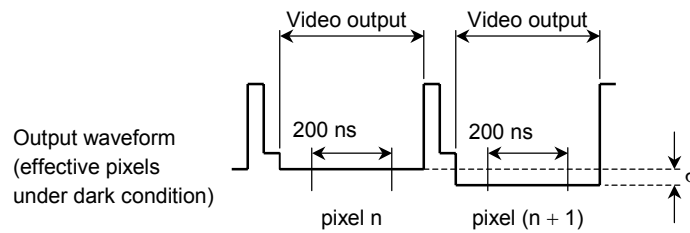
Note 7: DC signal output voltage is defined as follows:



Note 8: PRNU (3) is defined as maximum voltage with next pixel, where measured 5% of SE (typ.)

Note 9: DC differential error voltage is defined as follows:
 Definition of DC differential error voltage = $|V_{OSX} - V_{OSY}|$
 V_{OSX} : Maximum DC signal output voltage
 V_{OSY} : Minimum DC signal output voltage

Note 10: Random noise is defined as the standard deviation (sigma) of the output level difference between two adjacent effective pixels under no illumination (i.e. dark condition) calculated by the following procedure.



- 1) Two adjacent pixels (pixel n and n + 1) in one reading are fixed as measurement points.
- 2) Each of the output levels at video output periods averaged over 200 nanosecond period to get V_n and V_{n+1} .
- 3) V_{n+1} is subtracted from V_n to get ΔV .

$$\Delta V = V_n - V_{n+1}$$

- 4) The standard deviation of ΔV is calculated after procedure 2) and 3) are repeated 30 times (30 readings).

$$\overline{\Delta V} = \frac{1}{30} \sum_{i=1}^{30} |\Delta V_i| \quad \sigma = \sqrt{\frac{1}{30} \sum_{i=1}^{30} (|\Delta V_i| - \overline{\Delta V})^2}$$

- 5) Procedure 2), 3) and 4) are repeated 10 times to get 10 sigma values.

$$\overline{\sigma} = \frac{1}{10} \sum_{j=1}^{10} \sigma_j$$

- 6) $\overline{\sigma}$ value calculated using the above procedure is observed $\sqrt{2}$ times larger than that measured relative to the ground level. So we specify the random noise as follows.

$$\text{Random noise} = \frac{1}{\sqrt{2}} \overline{\sigma}$$

Operating Condition

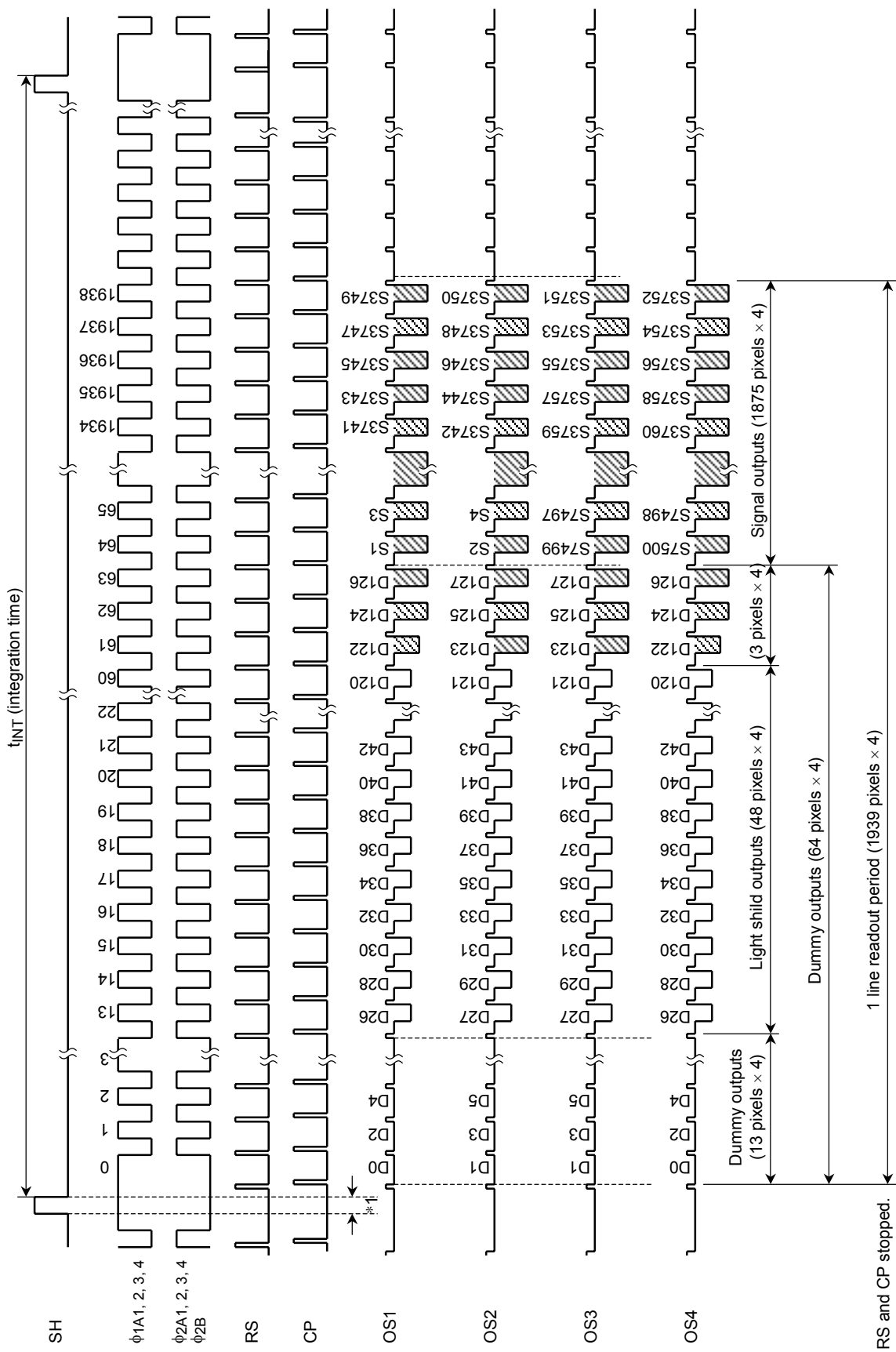
Characteristics		Symbol	Min	Typ.	Max	Unit
Clock pulse voltage	High level	$V_{\phi 1A}$ $V_{\phi 2A}$	4.5	5	5.5	V
	Low level		0	—	0.5	
Last stage clock voltage	High level	$V_{\phi 2B}$	4.5	5	5.5	V
	Low level		0	—	0.5	
Shift pulse voltage	High level	V_{SH}	4.5	5	5.5	V
	Low level		0	—	0.5	
Reset pulse voltage	High level	V_{RS}	4.5	5	5.5	V
	Low level		0	—	0.5	
Clamp pulse voltage	High level	V_{CP}	4.5	5	5.5	V
	Low level		0	—	0.5	
Power supply voltage		V_{OD}	11.4	12	13	V

Clock Characteristics (Ta = 25°C)

Characteristics		Symbol	Min	Typ.	Max	Unit
Clock pulse frequency		f_{ϕ}	—	1	25	MHz
Reset pulse frequency		f_{RS}	—	1	25	MHz
Clock capacitance	(Note 11)	$C_{\phi A}$	—	200	—	pF
Last stage clock capacitance		$C_{\phi B}$	—	20	—	pF
Shift gate capacitance		C_{SH}	—	40	—	pF
Reset gate capacitance		C_{RS}	—	20	—	pF
Clamp gate capacitance		C_{CP}	—	20	—	pF

Note 11: $V_{OD} = 12V$

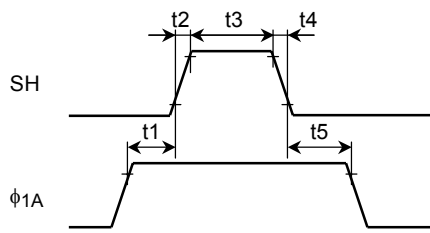
Timing Chart



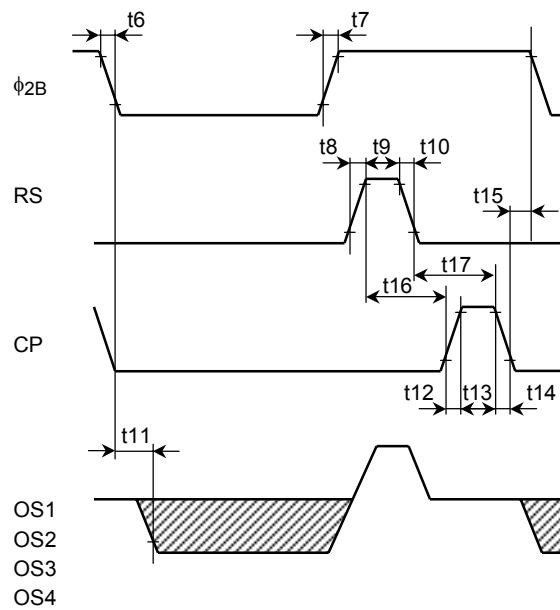
*1: RS and CP stopped.

Timing Requirements

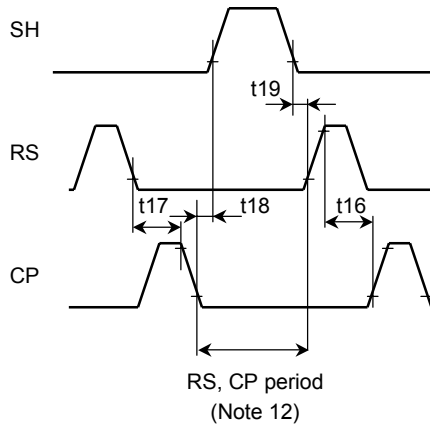
SH, ϕ_1 Timing



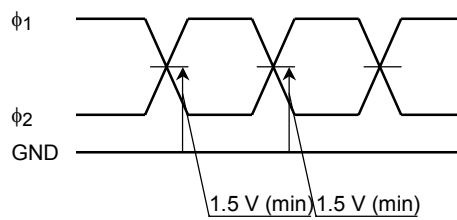
ϕ_2 , RS, CP, OS Timing



SH, RS, CP Timing



ϕ_1 , ϕ_2 Cross point



Note 12: RS and CP must be stopped during this period.

Characteristics	Symbol	Min	Typ. (Note 13)	Max	Unit
Pulse timing of SH and ϕ 1A	t1, t5	500	1000	—	ns
SH pulse rise time, fall time	t2, t4	0	50	—	ns
SH pulse width	t3	1000	1500	—	ns
ϕ 2B pulse rise time, fall time	t6, t7	0	100	—	ns
RS pulse rise time, fall time	t8, t10	0	20	—	ns
RS pulse width	t9	10	100	—	ns
Video data delay time (Note 14)	t11	—	10	—	ns
CP pulse rise time, fall time	t12, t14	0	20	—	ns
CP pulse width	t13	10	200	—	ns
Pulse timing of ϕ 2B and CP	t15	0	50	—	ns
Pulse timing of RS and CP	t16	0	0	—	ns
	t17	10	100	—	
Pulse timing of SH and CP	t18	200	—	—	ns
Pulse timing of SH and RS	t19	200	—	—	ns

Note 13: Measured with $f_{RS} = 1$ MHz.

Note 14: Load resistance is 100 k Ω .

Caution**1. Electrostatic Breakdown**

Store in shorting clip or in conductive foam to avoid electrostatic breakdown.

CCD Image Sensor is protected against static electricity, but interior puncture mode device due to static electricity is sometimes detected. In handling the device, it is necessary to execute the following static electricity preventive measures, in order to prevent the trouble rate increase of the manufacturing system due to static electricity.

- a. Prevent the generation of static electricity due to friction by making the work with bare hands or by putting on cotton gloves and non-charging working clothes.
- b. Discharge the static electricity by providing earth plate or earth wire on the floor, door or stand of the work room.
- c. Ground the tools such as soldering iron, radio cutting pliers or pincer.

It is not necessarily required to execute all precaution items for static electricity.

It is all right to mitigate the precautions by confirming that the trouble rate within the prescribed range.

2. Window Glass

The dust and stain on the glass window of the package degrade optical performance of CCD sensor.

Keep the glass window clean by saturating a cotton swab in alcohol and lightly wiping the surface, and allow the glass to dry, by blowing with filtered dry N₂. Care should be taken to avoid mechanical or thermal shock because the glass window is easily to damage.

3. Incident Light

CCD sensor is sensitive to infrared light. Note that infrared light component degrades resolution and PRNU of CCD sensor.

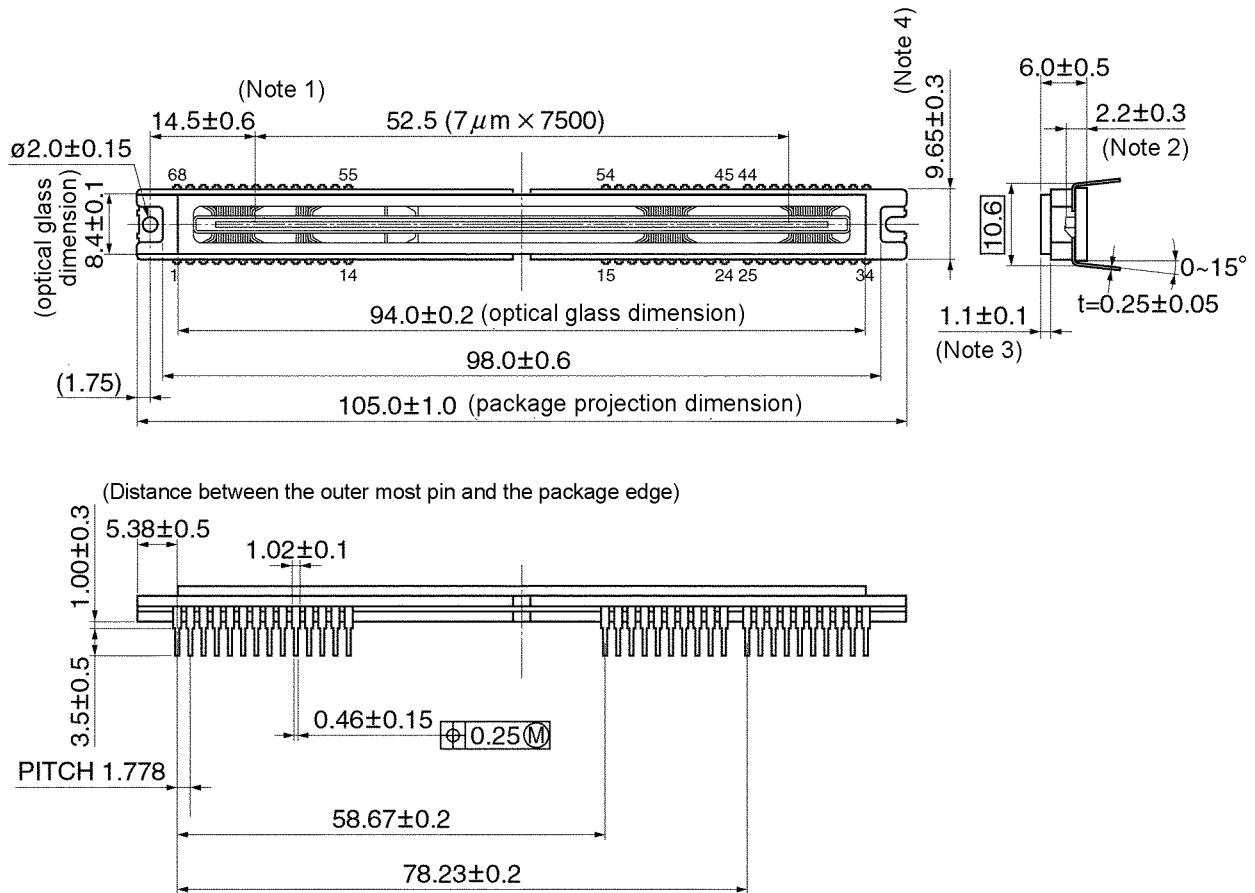
4. Soldering

Soldering by the solder flow method cannot be guaranteed because this method may have deleterious effects on prevention of window glass soiling and heat resistance.

Using a soldering iron, complete soldering within ten seconds for lead temperatures of up to 260°C, or within three seconds for lead temperatures of up to 350°C.

Package Dimensions

Unit: mm



Note 1: Distance between the center of the hole and the first pixel (S1)

Note 2: Distance between the top of the chip and bottom of the package.

Note 3: Glass thickness ($n = 1.5$)

Note 4: Dimensional tolerance is ± 0.3 mm for the 10-mm range from each ceramic edge, ± 0.4 mm for the 10-mm to 27-mm range and ± 0.5 mm for the inner range.

Weight: 16.0 g (typ.)

RESTRICTIONS ON PRODUCT USE

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