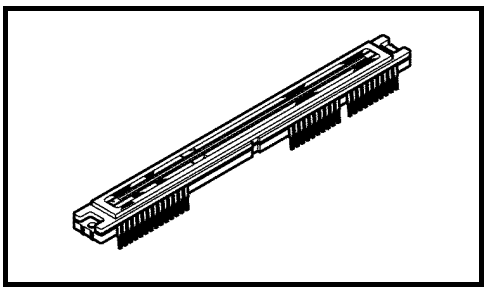
TOSHIBA CCD Linear Image Sensor CCD (Charge Coupled Device)

TCD2711DG

The TCD2711DG is a high sensitive and low dark current 7500 elements × 3 line CCD color image sensor.

The sensor is designed for color scanner.

The device contains a row of 7500 elements × 3 line photodiodes which provide a 24 lines/mm across a A3 size paper. The device is operated by 5-V pulse, and 10-V power supply.



Weight: 16.0 g (typ.)

Features

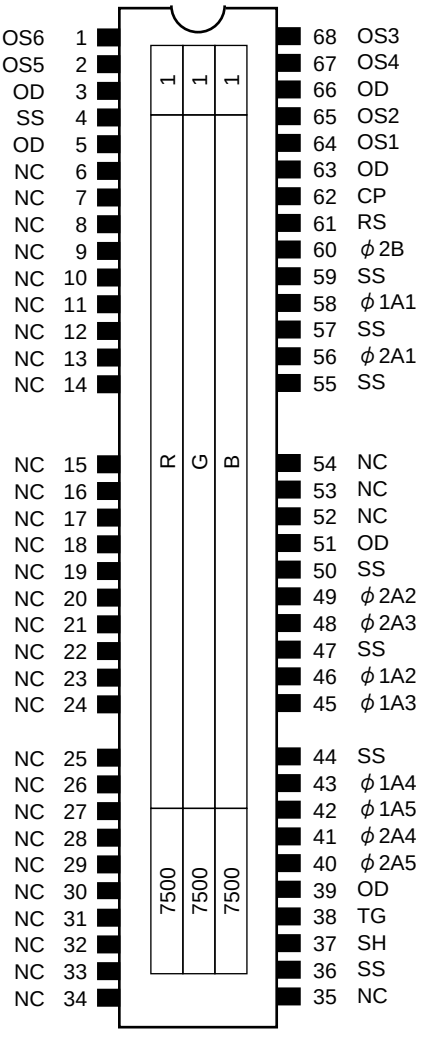
- Number of image sensing pixels: 7500 elements × 3 lines
- Image sensing pixels size: 9.325 μm by 9.325 μm on 9.325 μm center
- Photo sensing region: High sensitive pn photodiode
- Clock: 2-phase (5 V)
- Distance between photodiode array: Pixel R to pixel G : 18.65 μm (2 lines)
  Pixel G to pixel B : 18.65 μm (2 lines)
- Internal circuit: Clamp circuit
- Package: 68-pin CERDIP
- Color filter: Red, Green, Blue

Maximum Ratings (Note 1)

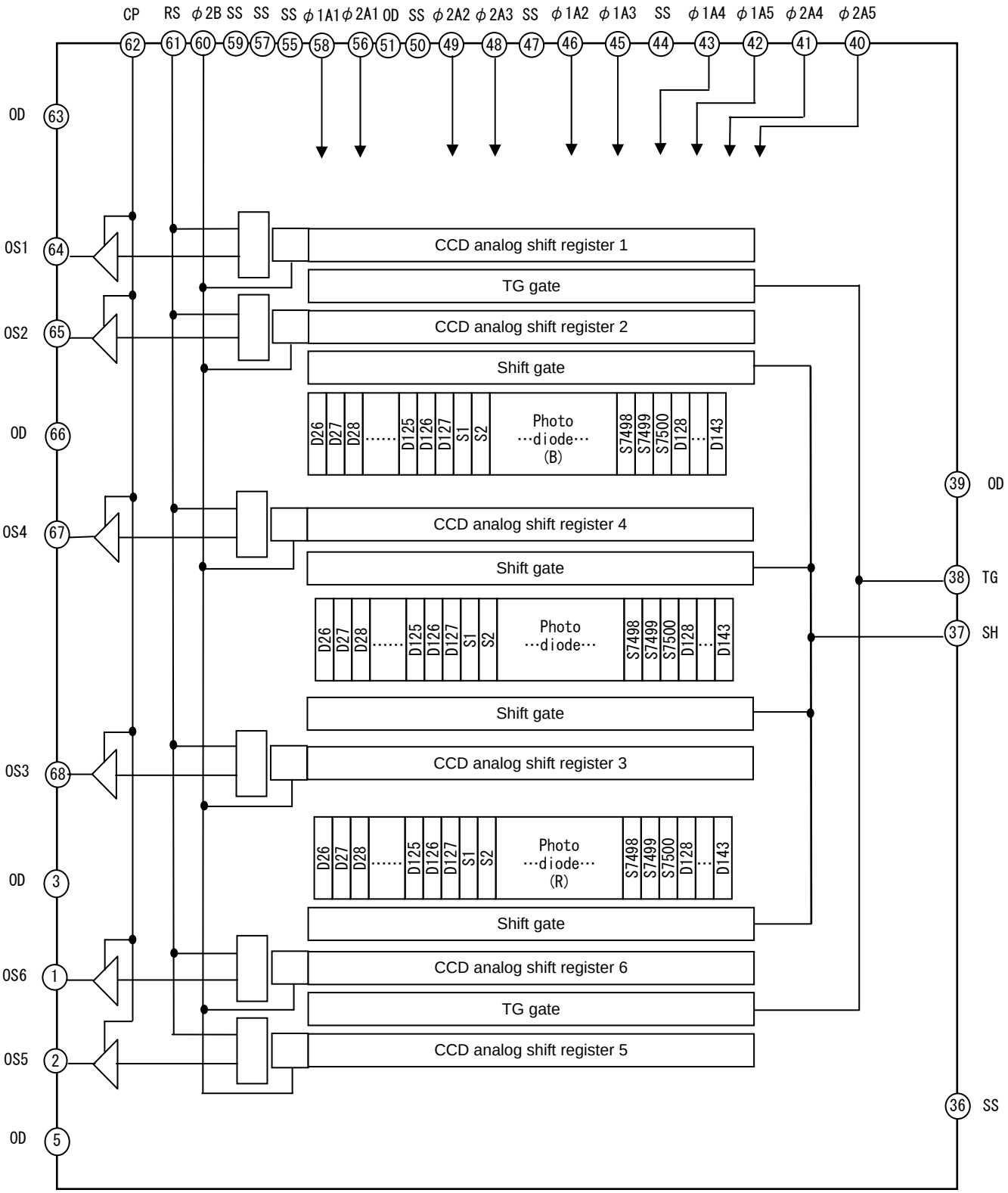
Characteristics	Symbol	Rating	Unit
Clock pulse voltage	$V_{\phi A}$	−0.3~8	V
Last stage clock pulse voltage	$V_{\phi B}$		
Shift pulse voltage	V_{SH}		
Reset pulse voltage	V_{RS}		
Clamp pulse voltage	V_{CP}		
TG pulse voltage	V_{TG}		
Power supply voltage	V_{OD}	−0.3~13.5	V
Operating temperature	T_{opr}	0~60	°C
Storage temperature	T_{stg}	−25~85	°C

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

Pin Connection(top view)



Circuit Diagram



Pin Names

ピン No.	記　号	名　　称	ピン No.	記　号	名　　称
1	OS6	Output signal 6 (Red(Even))	35	NC	No connect
2	OS5	Output signal 5（Red(Odd)）	36	SS	Ground
3	OD	Power supply	37	SH	Shift gate
4	SS	Ground	38	TG	Transfer Gate
5	OD	Power supply	39	OD	Power supply
6	NC	No connect	40	φ2A5	Transfer clock (phase 2) 5
7	NC	No connect	41	φ2A4	Transfer clock (phase 2) 4
8	NC	No connect	42	φ1A5	Transfer clock (phase 1) 5
9	NC	No connect	43	φ1A4	Transfer clock (phase 1) 4
10	NC	No connect	44	SS	Ground
11	NC	No connect	45	φ1A3	Transfer clock (phase 1) 3
12	NC	No connect	46	φ1A2	Transfer clock (phase 1) 2
13	NC	No connect	47	SS	Ground
14	NC	No connect	48	φ2A3	Transfer clock (phase 2) 3
15	NC	No connect	49	φ2A2	Transfer clock (phase 2) 2
16	NC	No connect	50	SS	Ground
17	NC	No connect	51	OD	Power supply
18	NC	No connect	52	NC	No connect
19	NC	No connect	53	NC	No connect
20	NC	No connect	54	NC	No connect
21	NC	No connect	55	SS	Ground
22	NC	No connect	56	φ2A1	Transfer clock (phase 2)1
23	NC	No connect	57	SS	Ground
24	NC	No connect	58	φ1A1	Transfer clock (phase 1)1
25	NC	No connect	59	SS	Ground
26	NC	No connect	60	φ2B	Last stage clock (phase 2)
27	NC	No connect	61	RS	Reset gate
28	NC	No connect	62	CP	Clamp gate
29	NC	No connect	63	OD	Power supply
30	NC	No connect	64	OS1	Output signal 1 (Blue(Odd))
31	NC	No connect	65	OS2	Output signal 2 (Blue(Even))
32	NC	No connect	66	OD	Power supply
33	NC	No connect	67	OS4	Output signal 4 (Green(Even))
34	NC	No connect	68	OS3	Output signal 3（Green(Odd)）

Optical/Electrical Characteristics

(Ta = 25°C, V_{OD} = 10 V, V_ϕ = V_{RS} = V_{SH} = V_{CP} = 5 V (pulse), f_ϕ = 1.0 MHz, load resistance = 100 kΩ, t_{INT} (integration time) = 10 ms, light source = light source A + CM500S (t = 1.0 mm))

Characteristics		Symbol	Min	Typ.	Max	Unit	Note
Sensitivity	Red	R (R)	13.2	18.9	24.6	V/(lx·s)	(Note 2)
	Green	R (G)	14.2	20.4	26.6		
	Blue	R (B)	9.3	13.4	17.5		
Photo response non uniformity		PRNU (1)	—	10	20	%	(Note 3)
		PRNU (3)	—	3	12	mV	(Note 4)
Saturation output voltage		V_{SAT}	1.2	1.5	—	V	(Note 5)
Saturation exposure		SE	0.04	0.07	—	lx·s	(Note 6)
Dark signal voltage		V_{DRK}	—	3	6	mV	(Note 7)
Dark signal non uniformity		DSNU	—	8	12	mV	(Note 8)
DC power dissipation		P_D	—	590	900	mW	—
Total transfer efficiency		TTE	92	98	—	%	—
Output impedance		Z_O	—	0.2	0.5	kΩ	—
DC signal output voltage		V_{OS}	3.5	5.0	6.5	V	(Note 9)
Random noise		$N_{D\sigma}$	—	0.9	—	mV	(Note 10)

Note 2: Sensitivity is defined for each color of signal outputs average when the photosensitive surface is applied with the light of uniform illumination and uniform color temperature.

Note 3: PRNU (1) is defined for each color on a single chip by the expressions below when the photosensitive surface is applied with the light of uniform illumination and uniform color temperature, and the incident light is 50% of SH (typ.).

$$\mathrm{PRNU}\,(1) = \frac{\Delta X}{\overline{X}} \times 100\ (\%)$$

$\overline{X}$: Average of total signal outputs
ΔX: The maximum deviation from $\overline{X}$.

Note 4: PRNU (3) is defined as maximum voltage with next pixel, where measured 5% of SE (typ.).

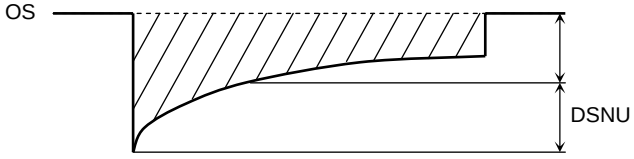
Note 5: V_{SAT} is defined as minimum saturation output voltage of all effective pixels.

Note 6: Definition of SE:

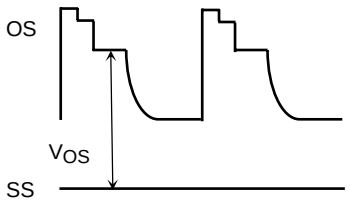
$$\mathrm{SE} = \frac{V_{SAT}}{R_G}$$

Note 7: V_{DRK} is defined as average dark signal voltage of all effective pixels.

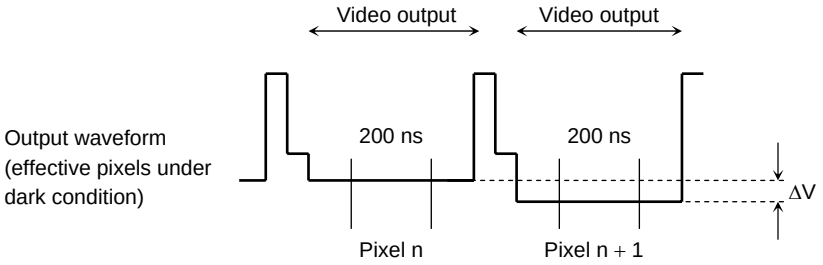
Note 8: DSNU is defined by the difference between average value (V_{DRK}) and the maximum value of the dark voltage.



Note 9: DC signal output voltage is defined as follows:



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 Vn and Vn + 1.

(3) Vn + 1 is subtracted from Vn 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).

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

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

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

(6) $\bar{\sigma}$ 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.

$$N_{D\sigma} = \frac{1}{\sqrt{2}}\bar{\sigma}$$

Operating Condition (Ta = 25°C)

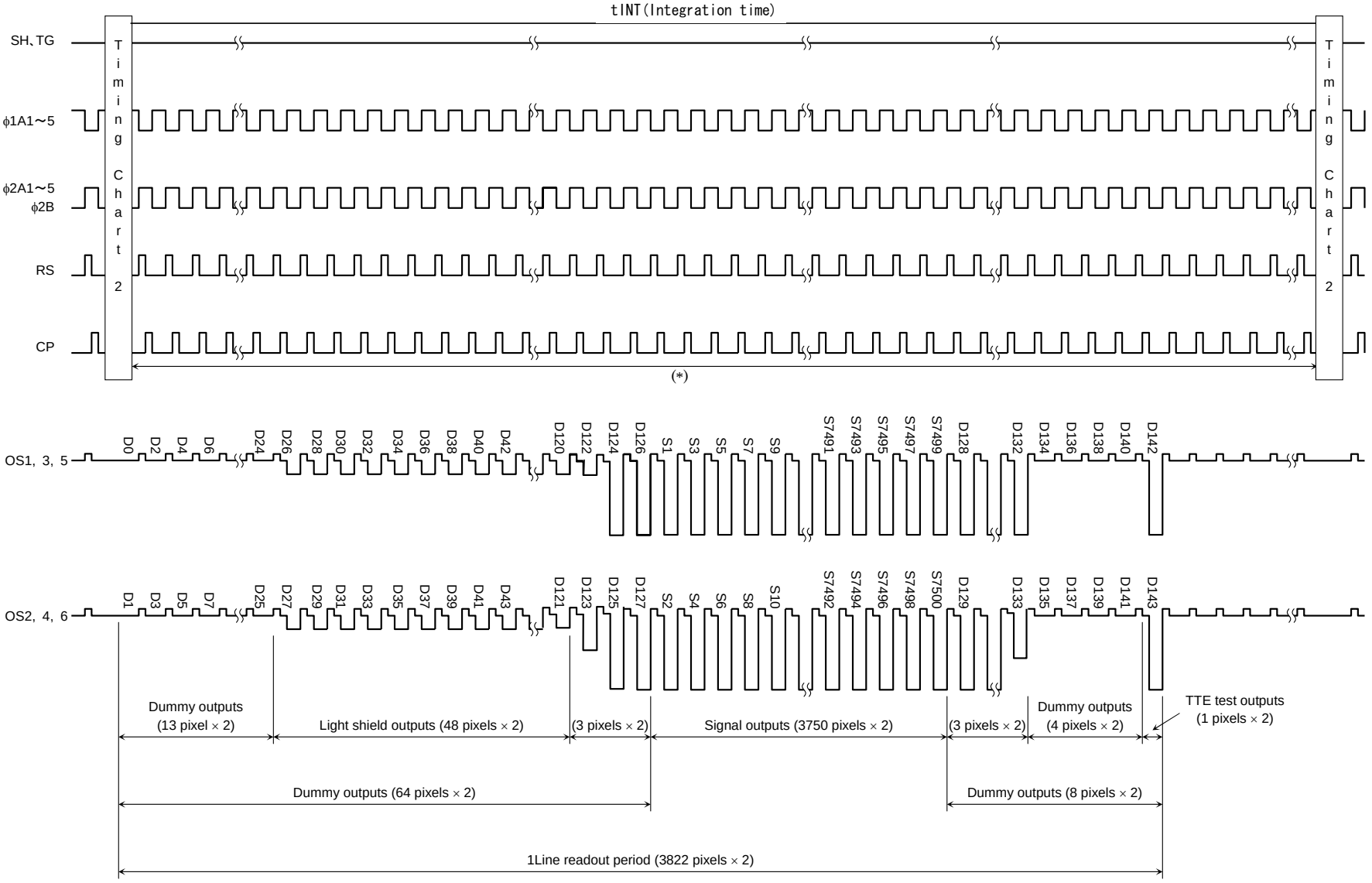
Characteristics		Symbol	Min	Typ.	Max	Unit
Clock pulse voltage	High level	$V_{\phi 1A}$、$V_{\phi 2A}$	4.75	5.0	5.5	V
	Low level		0	—	0.25	
Last stage clock pulse voltage	High level	$V_{\phi 2B}$	4.75	5.0	5.5	V
	Low level		0	—	0.25	
Shift pulse voltage	High level	V_{SH}	4.75	5.0	5.5	V
	Low level		0	—	0.25	
Reset pulse voltage	High level	V_{RS}	4.75	5.0	5.5	V
	Low level		0	—	0.25	
Clamp pulse voltage	High level	V_{CP}	4.75	5.0	5.5	V
	Low level		0	—	0.25	
TG pulse voltage	High level	V_{TG}	4.75	5.0	5.5	V
	Low level		0	—	0.25	
Power supply voltage		V_{OD}	9.5	10.0	10.5	V

Clock Characteristics (Ta = 25°C)

Characteristics	Symbol	Min	Typ.	Max	Unit
Clock pulse frequency	f_{ϕ}	0.2	1	35	MHz
Reset pulse frequency	f_{RS}	0.2	1	35	MHz
Clamp pulse frequency	f_{CP}	0.2	1	35	MHz
Clock capacitance (Note 12)	$C_{\phi 1A}$	—	153	—	pF
	$C_{\phi 2A}$	—	162	—	
Last stage clock capacitance	$C_{\phi B}$	—	3	—	pF
Shift gate capacitance	C_{SH}	—	32	—	pF
Reset gate capacitance	C_{RS}	—	5	—	pF
Clamp gate capacitance	C_{CP}	—	3	—	pF
TG gate capacitance	C_{TG}	—	5	—	pF

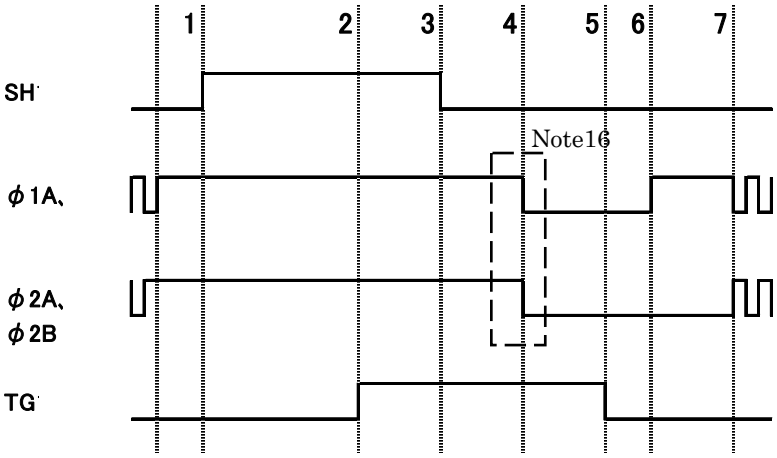
Note12: V_{OD} = 10 V

Timing Chart 1

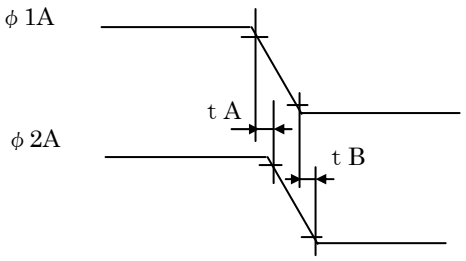


∗ Hold the SH and TG pins at Low level during this period.

Timing Chart 2(Vertical transfer period)



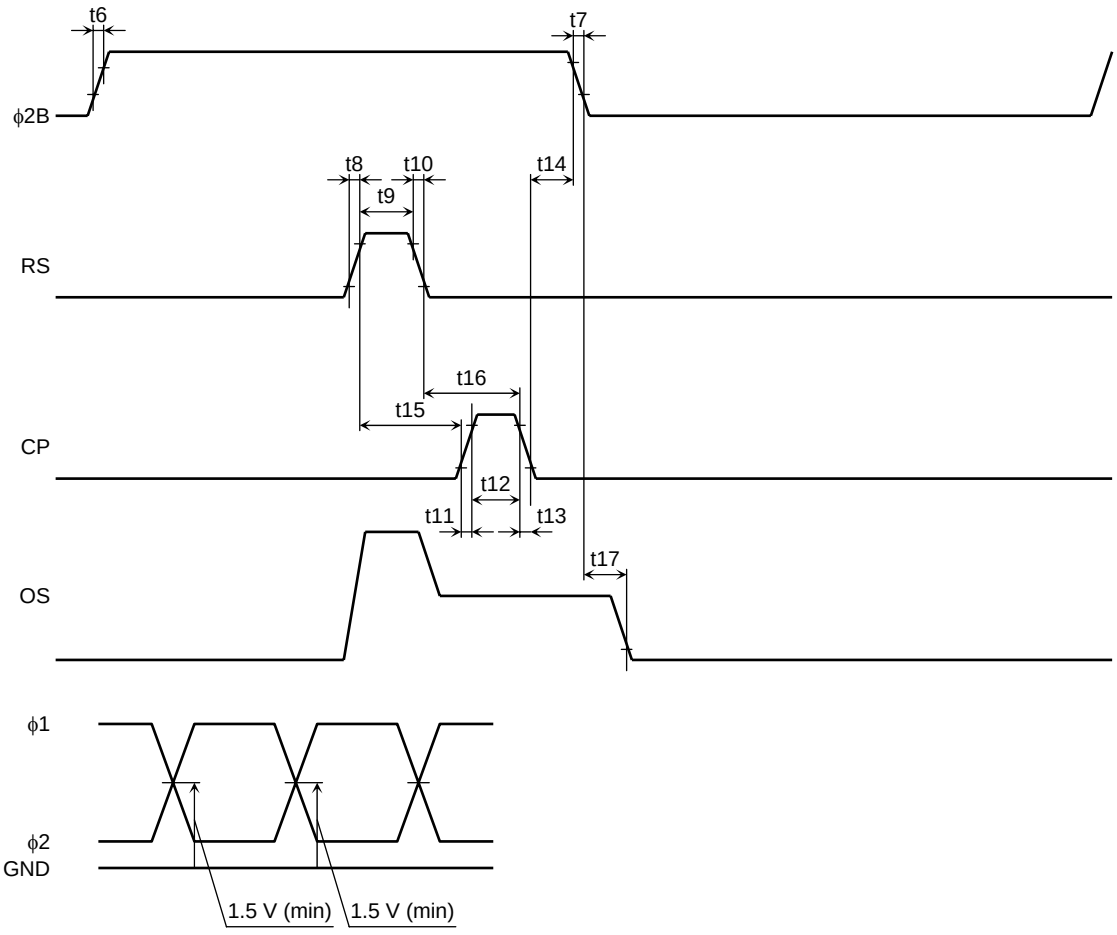
Note16) For timing address 4



※ φ2B is no care

Note 13: Each RS and CP pins put to Low level during of the above mentioned address 1-7

Timing Requirements 1



Characteristics	Symbol	Min	Typ. (Note 14)	Max	Unit
ϕ1, ϕ2 Pulse rise time, fall time	t6, t7	0	50	—	ns
RS pulse rise time, fall time	t8, t10	0	20	—	ns
RS pulse width	t9	6	100	—	ns
CP pulse rise time, fall time	t11, t13	0	20	—	ns
CP pulse width	t12	6	200	—	ns
Pulse timing of ϕ_{2B} and CP	t14	0	40	—	ns
Pulse timing of RS and CP	t15	0	0	—	ns
	t16	6	100	—	
Video data delay time (Note 15)	t17	—	7	—	ns

Note 14: Measured with f_{RS} = 1 MHz.

Note 15: Load resistance is 100 kΩ.

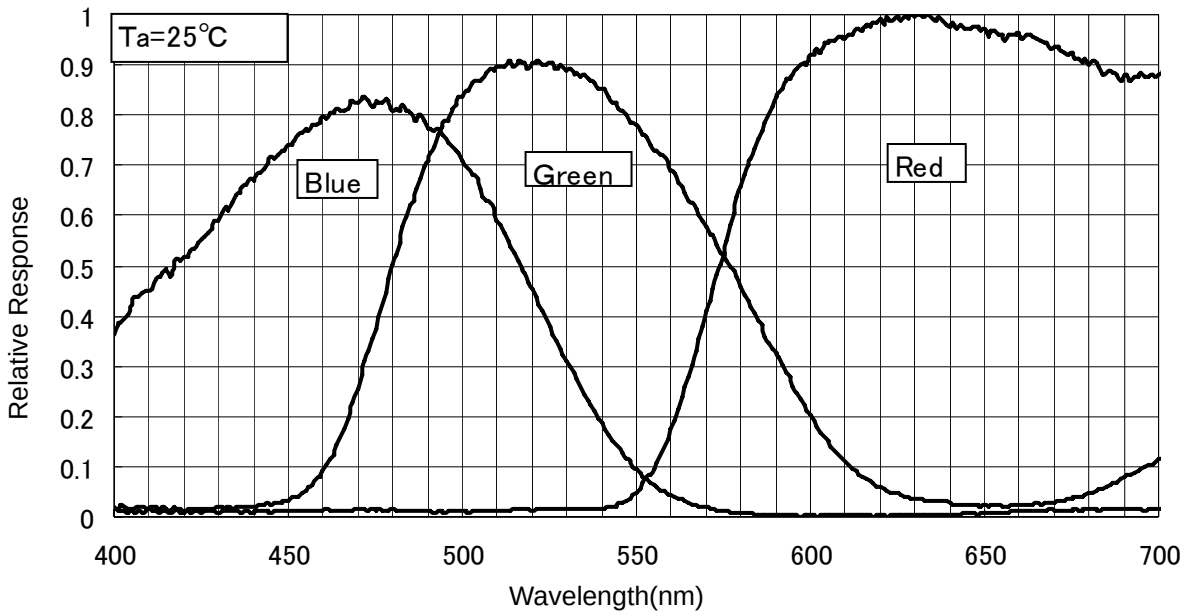
Timing Requirements 2 (Vertical transfer period)

Timing Address	Min	Typ.	Max	Unit
1	250	500	—	ns
2	1000	2000	—	ns
3	500	1000	—	ns
4	500	1000	—	ns
5	500	1000	—	ns
6	250	500	—	ns
7	500	1000	—	ns
Vertical Transfer Time	3.5	7	—	μs

Timing Address 4		Min	Typ.	Max	Unit
ϕ1A、ϕ2A	tA	−0.5	0	0.5	ns
	tB	−0.5	0	0.5	ns

Typical Spectral Response

Spectral Response(typ)



Cautions

1. Electrostatic Breakdown

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.

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 of 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.

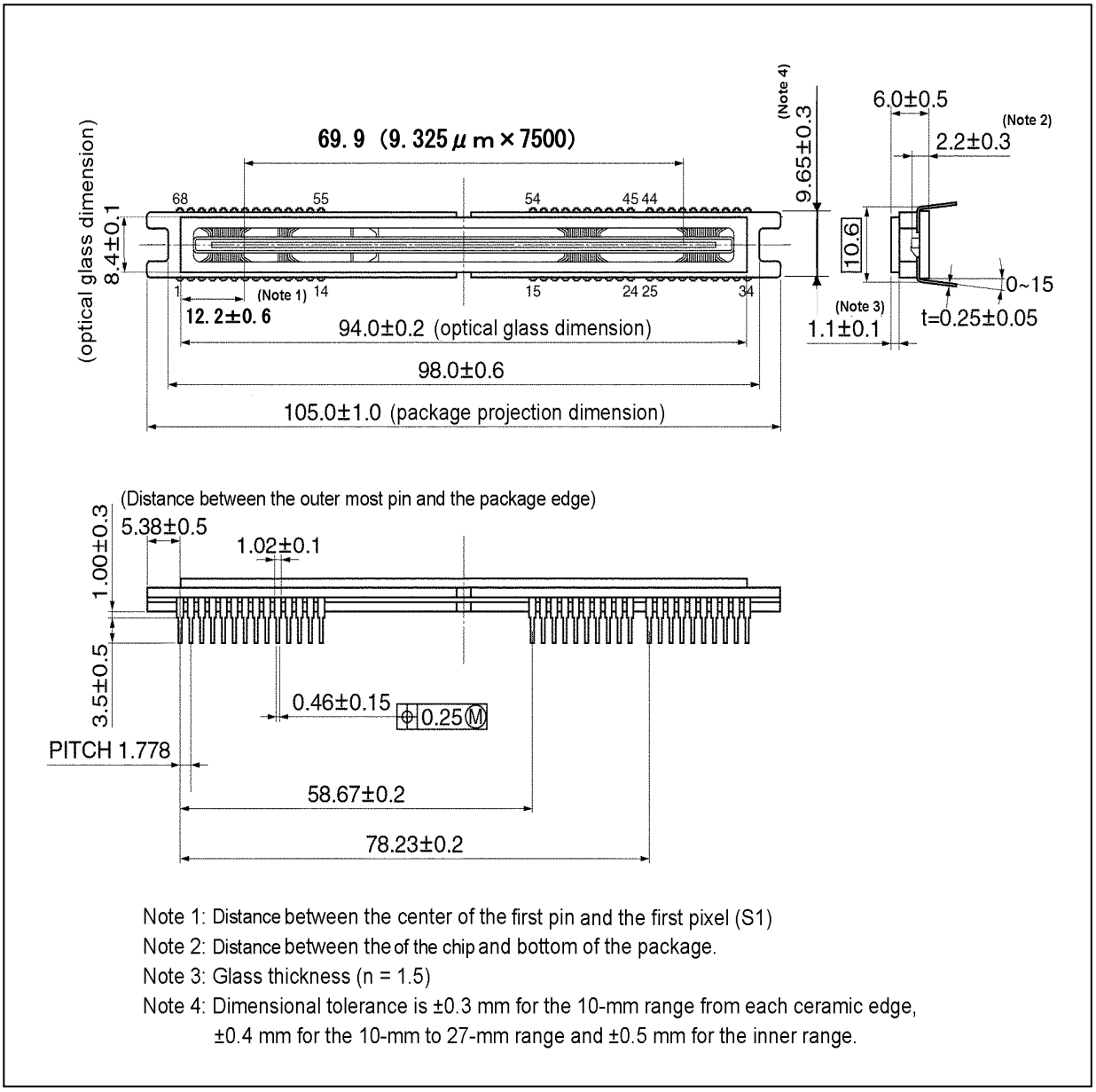
4. Mounting on a PCB

This package is sensitive to mechanical stress.
Toshiba recommends using IC inserters for mounting, instead of using lead forming equipment.

5. 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



Note 1: Distance between the center of the first pin and the first pixel (S1)
Note 2: Distance between the 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.)

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History

Rev.	Date	History
0	2009-06-30	Newly
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