TOSHIBA CCD Linear Image Sensor　CCD (Charge Coupled Device)

TCD2712DG

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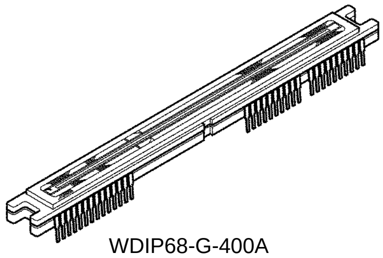
The TCD2712DG is a high sensitive and low dark current 7500 elements × 3 lines output CCD color linear image sensor.

The device contains a row of 7500 elements × 3 lines photodiodes which provide 24 lines/mm across a A3 size paper. The device is operated by 5.0 V pulse and 10 V power supply.

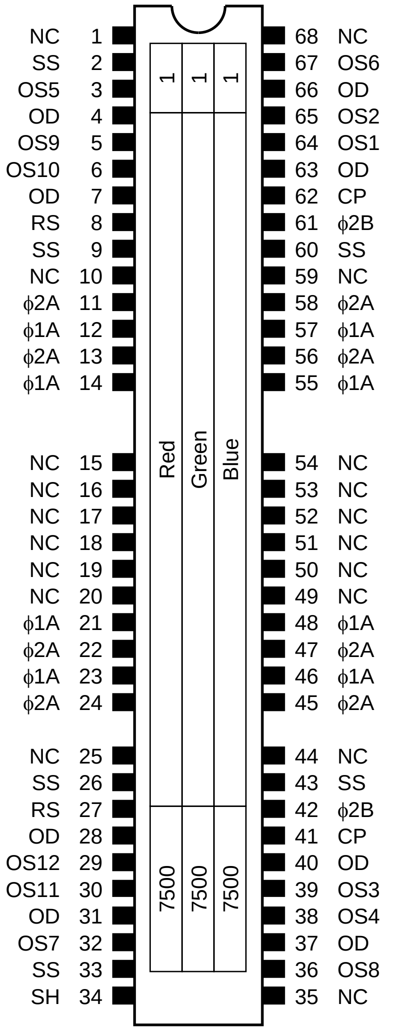


WDIP68-G-400A

Features

- Number of Image Sensing Elements: 7500 elements × 3 lines
- Image Sensing Element 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)
- Power Supply Voltage: 10 V (typ.)
- Distance between Photodiode Array : 37.3 μm (4 lines) R array – G array, G array – B array
- Internal Circuit: Clamp circuit
- Package: 68 pin CERDIP
- Color Filter: Red, Green, Blue

Pin Connections (top view)

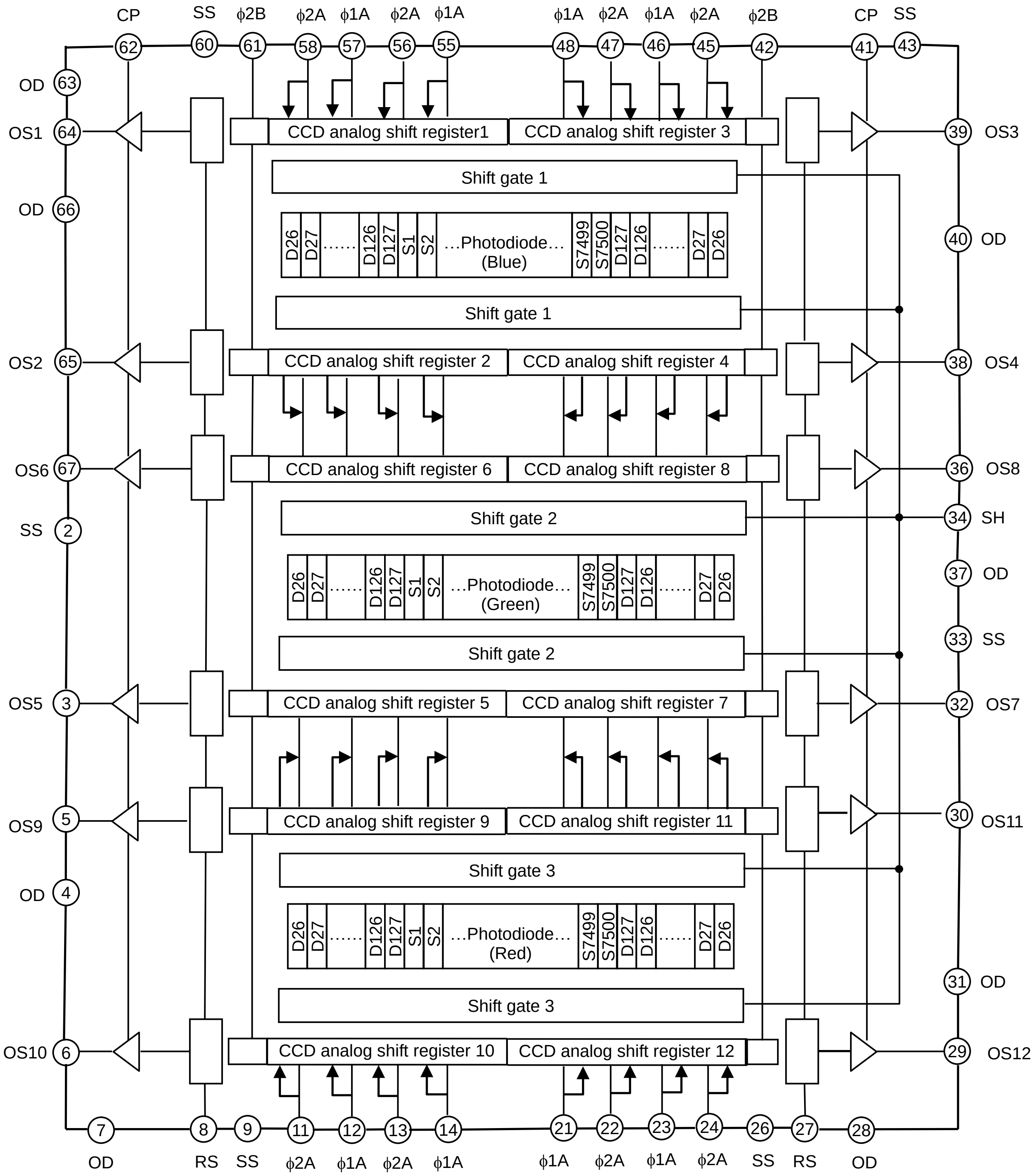


ABSOLUTE MAXIMUM RATINGS (Note 1)

Characteristics	Symbol	Rating	Unit
Clock pulse voltage	$V_{\phi A}$	−0.3 to +8.0	V
Last stage clock pulse voltage	$V_{\phi B}$		
Shift pulse voltage	V_{SH}		
Reset pulse voltage	V_{RS}		
Clamp pulse voltage	V_{CP}		
Power supply voltage	V_{OD}	−0.3 to +13.5	V
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 terminals (ground).
None of the ABSOLUTE MAXIMUM RATINGS must be exceeded, even instantaneously.
If any one of the ABSOLUTE MAXIMUM RATINGS is exceeded, the electrical characteristics, reliability and life time of the device cannot be guaranteed. If the ABSOLUTE MAXIMUM RATINGS are exceeded, the device can be permanently damaged or degraded. Create a system design in such a manner that any of the ABSOLUTE MAXIMUM RATINGS will not be exceeded under any circumstances.

Circuit Diagram



Pin Names

Pin No.	Symbol	Name	Pin No.	Symbol	Name
1	NC	Non connection	68	NC	Non connection
2	SS	Ground	67	OS6	Output signal 6 (Green(Even)-F)
3	OS5	Output signal 5 (Green(Odd)-F)	66	OD	Power supply
4	OD	Power supply	65	OS2	Output signal 2 (Blue(Even)-F)
5	OS9	Output signal 9 (Red(Odd)-F)	64	OS1	Output signal 1 (Blue(Odd)-F)
6	OS10	Output signal 10 (Red(Even)-F)	63	OD	Power supply
7	OD	Power supply	62	CP	Clamp gate
8	RS	Reset gate	61	ϕ2B	Last stage clock (phase 2)
9	SS	Ground	60	SS	Ground
10	NC	Non connection	59	NC	Non connection
11	ϕ2A	Transfer clock (phase 2)	58	ϕ2A	Transfer clock (phase 2)
12	ϕ1A	Transfer clock (phase 1)	57	ϕ1A	Transfer clock (phase 1)
13	ϕ2A	Transfer clock (phase 2)	56	ϕ2A	Transfer clock (phase 2)
14	ϕ1A	Transfer clock (phase 1)	55	ϕ1A	Transfer clock (phase 1)
15	NC	Non connection	54	NC	Non connection
16	NC	Non connection	53	NC	Non connection
17	NC	Non connection	52	NC	Non connection
18	NC	Non connection	51	NC	Non connection
19	NC	Non connection	50	NC	Non connection
20	NC	Non connection	49	NC	Non connection
21	ϕ1A	Transfer clock (phase 1)	48	ϕ1A	Transfer clock (phase 1)
22	ϕ2A	Transfer clock (phase 2)	47	ϕ2A	Transfer clock (phase 2)
23	ϕ1A	Transfer clock (phase 1)	46	ϕ1A	Transfer clock (phase 1)
24	ϕ2A	Transfer clock (phase 2)	45	ϕ2A	Transfer clock (phase 2)
25	NC	Non connection	44	NC	Non connection
26	SS	Ground	43	SS	Ground
27	RS	Reset gate	42	ϕ2B	Last stage transfer clock (phase 2)
28	OD	Power supply	41	CP	Clamp gate
29	OS12	Output signal 12 (Red(Even)-L)	40	OD	Power supply
30	OS11	Output signal 11 (Red(Odd)-L)	39	OS3	Output signal 3 (Blue(Odd)-L)
31	OD	Power supply	38	OS4	Output signal 4 (Blue(Even)-L)
32	OS7	Output signal 7 (Green(Odd)-L)	37	OD	Power supply
33	SS	Ground	36	OS8	Output signal 8 (Green(Even)-L)
34	SH	Shift gate	35	NC	Non connection

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, t_{INT} (integration time) = 10 ms, light source = A light source + CM500S (t = 1.0 mm)

Characteristics		Symbol	Min	Typ.	Max	Unit	Note
Sensitivity	Red	R_R	9.9	14.1	18.3	V/lx·s	(Note 2)
	Green	R_G	15.6	22.2	28.8		
	Blue	R_B	6.4	9.1	11.8		
Photo response non uniformity		PRNU (1)	—	10	20	%	(Note 3)
		PRNU (3)	—	3	12	mV	(Note 4)
Saturation output voltage		V_{SAT}	1.5	2.0	—	V	(Note 5)
Saturation exposure		SE	0.05	0.09	—	lx·s	(Note 6)
Dark signal voltage		V_{DRK}	—	1	6	mV	(Note 7)
Dark signal non uniformity		DSNU	—	5	12	mV	(Note 8)
DC power dissipation		P_D	—	1200	1500	mW	—
Total transfer efficiency		TTE	92	98	—	%	—
Output impedance		Z_O	—	0.2	0.5	kΩ	—
DC output signal voltage		V_{OS}	4.0	5.0	6.0	V	(Note 9)
Random noise		$N_{D\sigma}$	—	1.0	—	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, where measured approximately 750 mV of signal output.

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

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

Note 4: PRNU (3) is defined as the maximum voltage with next pixel, where measured approximately 50 mV of signal output.

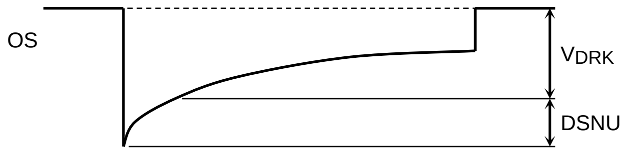
Note 5: V_{SAT} is defined as the minimum saturation output voltage of all effective pixels.

Note 6: Definition of SE:

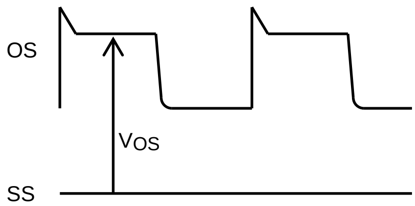
$$SE = \frac{V_{SAT}}{R_G}$$

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

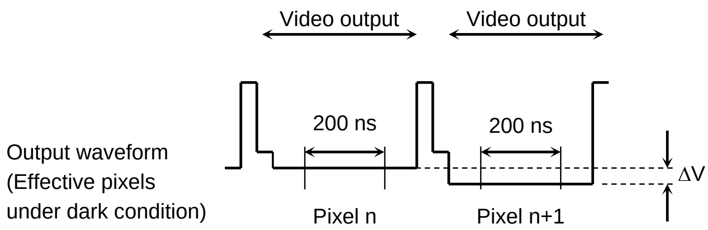
Note 8: DSNU is defined by the difference between average value (V_{DRK}) and the maximum value of the dark voltage.



Note 9: DC output signal 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 ns 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).

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

5) Procedure 2), 3) and 4) are repeated 10 times to get sigma value.
6) 10 sigma values are averaged.

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

7) $\bar{\sigma}$ 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.

$$ND\sigma = \frac{1}{\sqrt{2}}\bar{\sigma}$$

Recommended Operating Conditions (Ta = 25°C)

For best performance, the device should be used within the Recommended Operating Conditions.

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

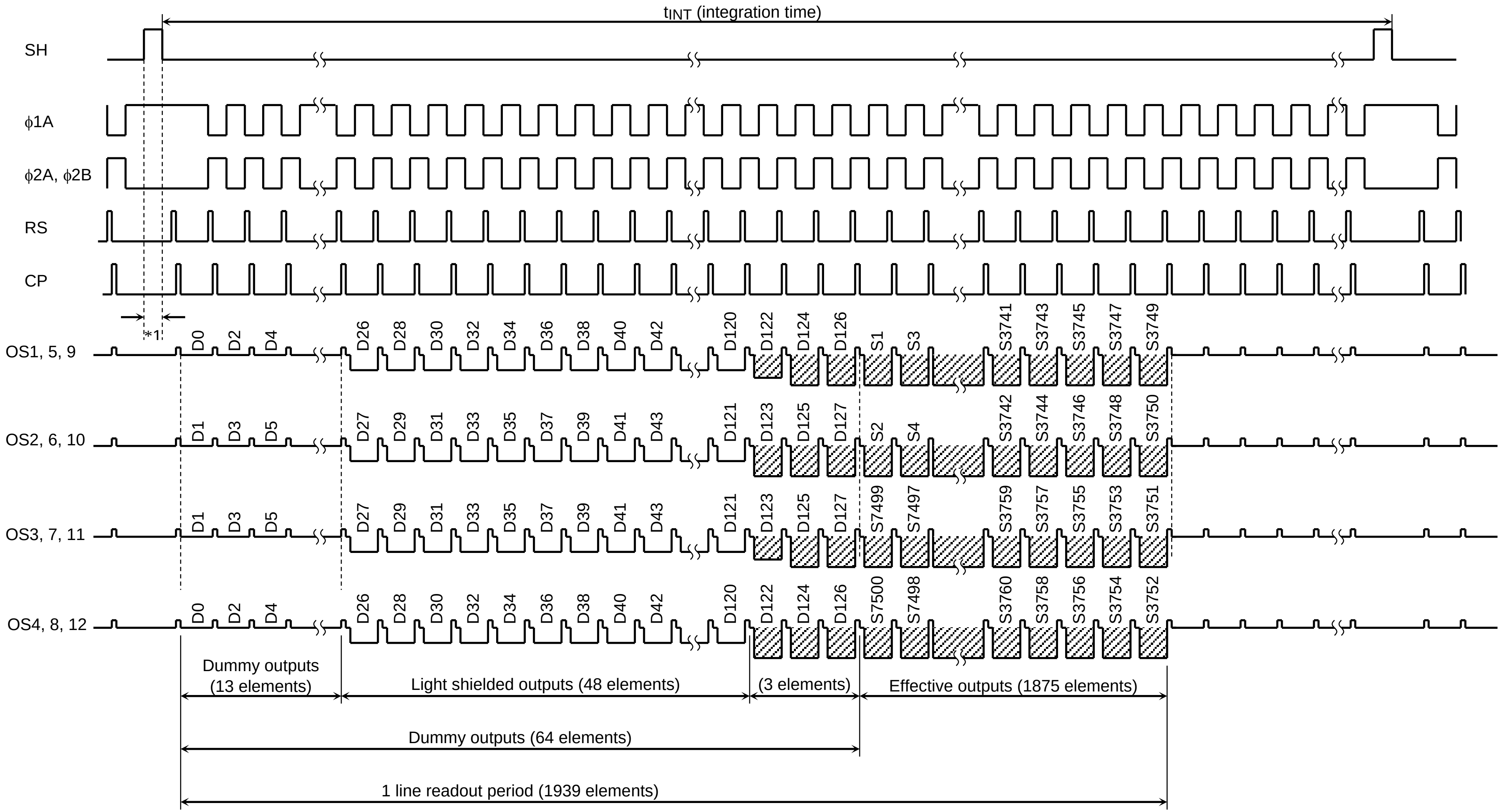
Clock Characteristics (Ta = 25°C)

For best performance, the device should be used within the Recommended Operating Conditions.

Characteristics	Symbol	Min	Typ.	Max	Unit
Clock pulse frequency	f_{ϕ}	0.5	1.0	30.0	MHz
Reset pulse frequency	f_{RS}	0.5	1.0	30.0	MHz
Clamp pulse frequency	f_{CP}	0.5	1.0	30.0	MHz
Clock capacitance (Note 11)	$C_{\phi A}$	—	120	—	pF
Last stage clock capacitance (Note 11)	$C_{\phi B}$	—	10	—	pF
Shift gate capacitance	C_{SH}	—	60	—	pF
Reset gate capacitance (Note 11)	C_{RS}	—	10	—	pF
Clamp gate capacitance (Note 11)	C_{CP}	—	10	—	pF

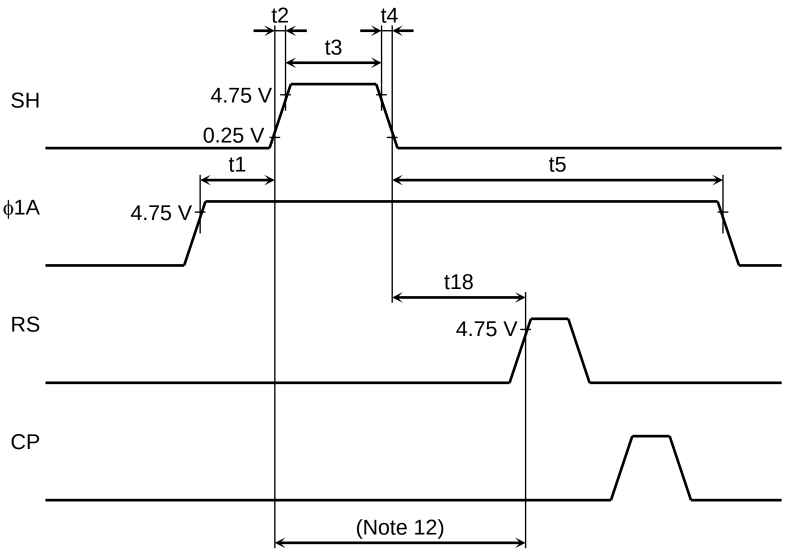
Note 11: V_{OD} = 10 V, Input capacitance per a pin.

Timing Chart

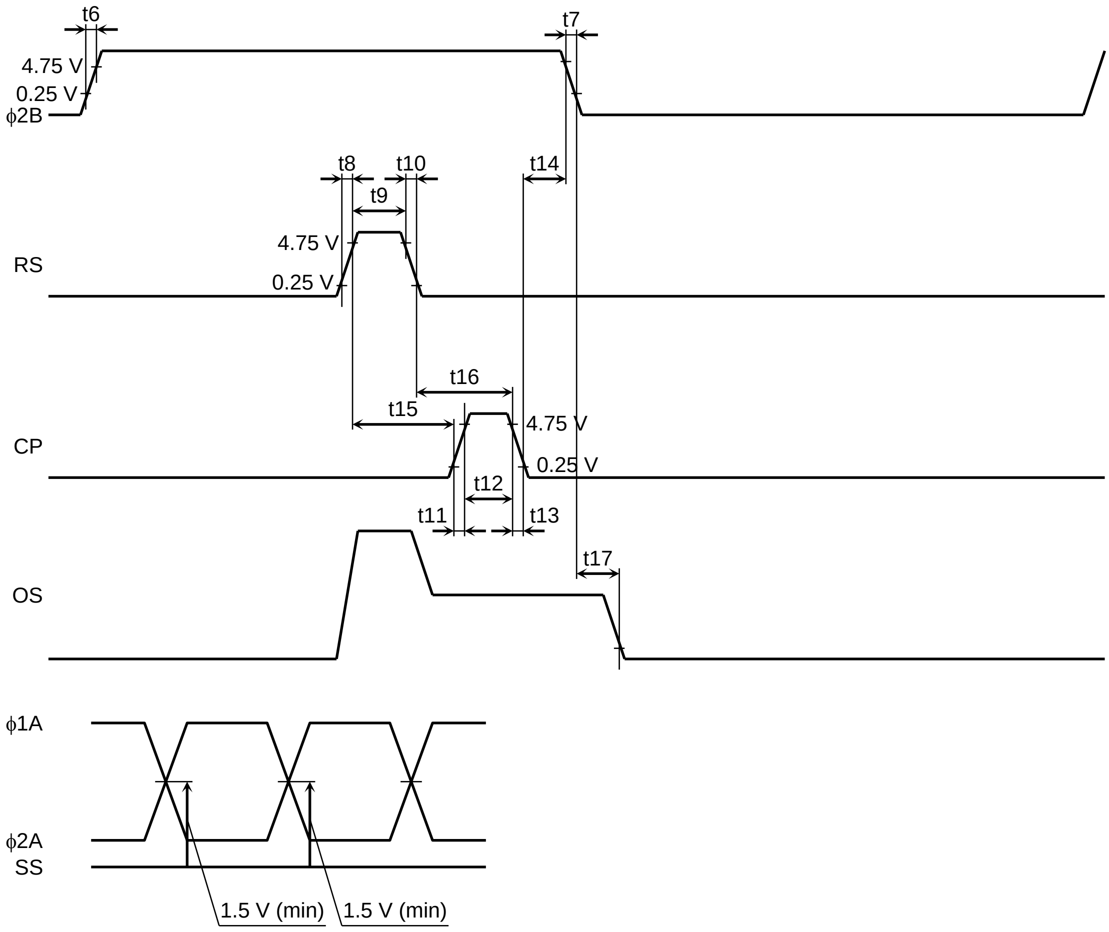


*1 Keep the RS and CP pins “L” level.

Timing Requirements



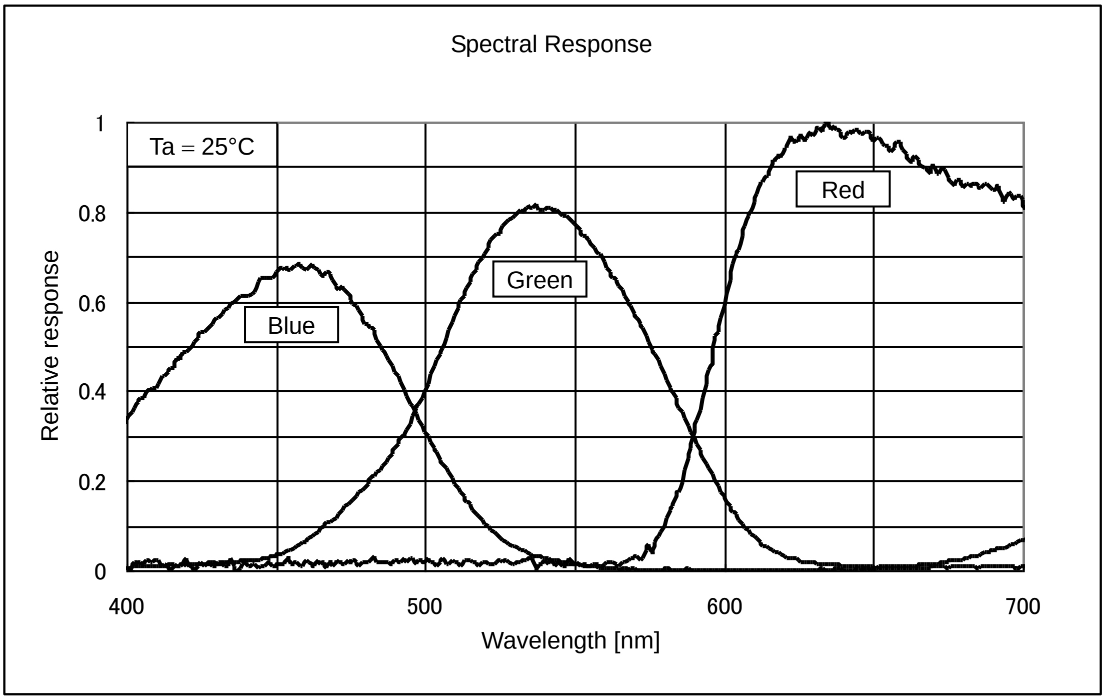
Note 12: Keep the RS and CP pins “L” level.



Characteristics	Symbol	Min	Typ. (Note 13)	Max	Unit
Pulse timing of SH and ϕ1A	t1	60	1000	—	ns
	t5	500	1000	—	ns
SH pulse rise time, fall time	t2, t4	0	50	—	ns
SH pulse width	t3	1000	2000	—	ns
ϕ2B 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	8	100	—	ns
CP pulse rise time, fall time	t11, t13	0	20	—	ns
CP pulse width	t12	8	200	—	ns
Pulse timing of ϕ2B and CP	t14	0	40	—	ns
Pulse timing of RS and CP	t15	0	0	—	ns
	t16	8	100	—	ns
Video data delay time	t17	—	8	—	ns
Pulse timing of SH and RS	t18	500	—	—	ns

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

Typical Spectral Response



Cautions

1. Electrostatic Breakdown

Store in shorting clip or in conductive foam to avoid electrostatic breakdown.
CCD Image Sensor is protected against static electricity, but inferior puncture mode device due to static electricity is sometimes detected. In handing 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 of or pincer.
d. Ionized air is recommended for discharge when handling CCD image sensors.

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 N_2. 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

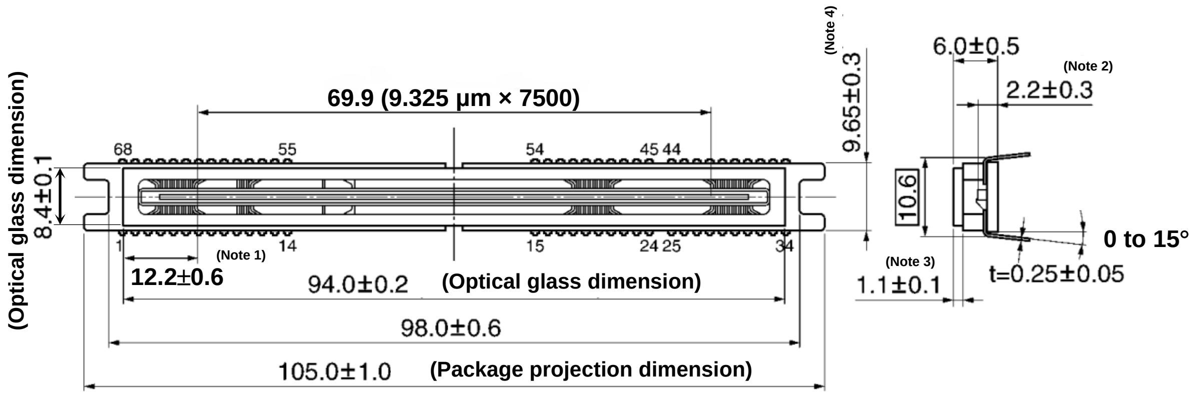
This package is sensitive to mechanical stress.
TOSHIBA recommends using IC inserters for mounting, instead of using lead forming equipment.
Since this package is not strong against mechanical stress, you should not reform the lead frame.
We recommend to use an IC-inserter when you assemble to PCB.

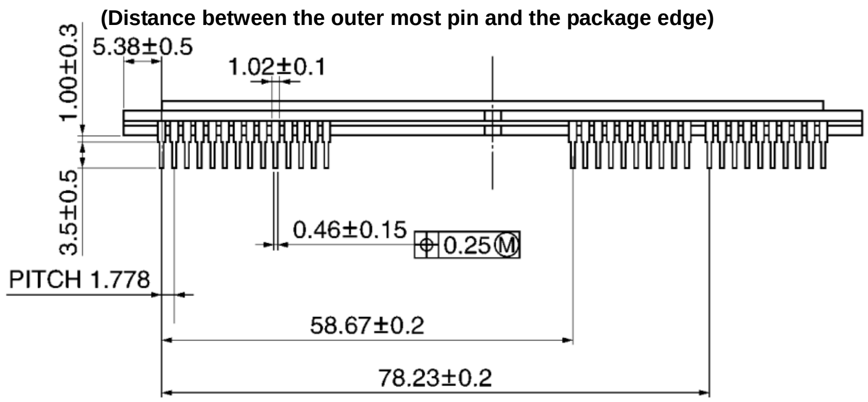
5. Soldering

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 three seconds for lead temperatures of up to 350°C.

Package Dimensions WDIP68-G-400A

Unit: mm





Note 1: Distance between the center of the first pin 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 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.

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