TOSHIBA CCD Linear Image Sensor CCD (Charge Coupled Device)

TCD2569BFG

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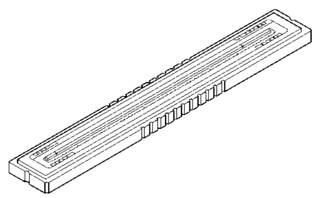
The TCD2569BFG is a high sensitive and low dark current 5340 elements × 3 lines output CCD color linear image sensor which includes clamp circuit and sample and hold circuit. The device contains a row of 5340 elements × 3 lines photodiode, which provide 24 lines / mm across a A4 size paper. The device is operated by 5.0 V (Pulse) and 10 V power supply.



WQFN22-C-R240-1.27

Features

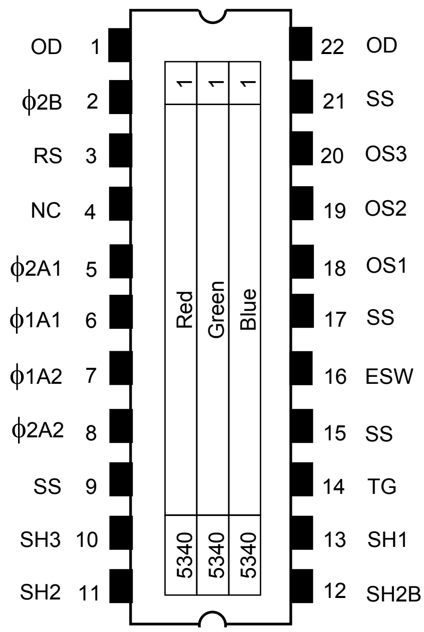
Number of Image Sensing Elements	: 5340 elements × 3 lines
Image Sensing Element Size	: 5.25 μm by 5.25 μm on 5.25 μm centers
Photo Sensing Region	: High sensitive and low dark current PN photodiode
Clock	: 2-phase (5 V)
Power Supply	: 10 V
Distance Between Photodiode Arrays	: 10.5 μm (2 lines) R array—G array, G array—B array
Internal Circuit	: Clamp circuit, Sample and hold circuit, Clip circuit
Package	: 22 PIN CLCC package
Color Filter	: Red, Green, Blue

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}		
Transfer gate pulse voltage	V_{TG}		
Enable switch pulse voltage	V_{ESW}		
Power supply voltage	V_{OD}	−0.3 to +12.0	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.

Pin Connections (top view)



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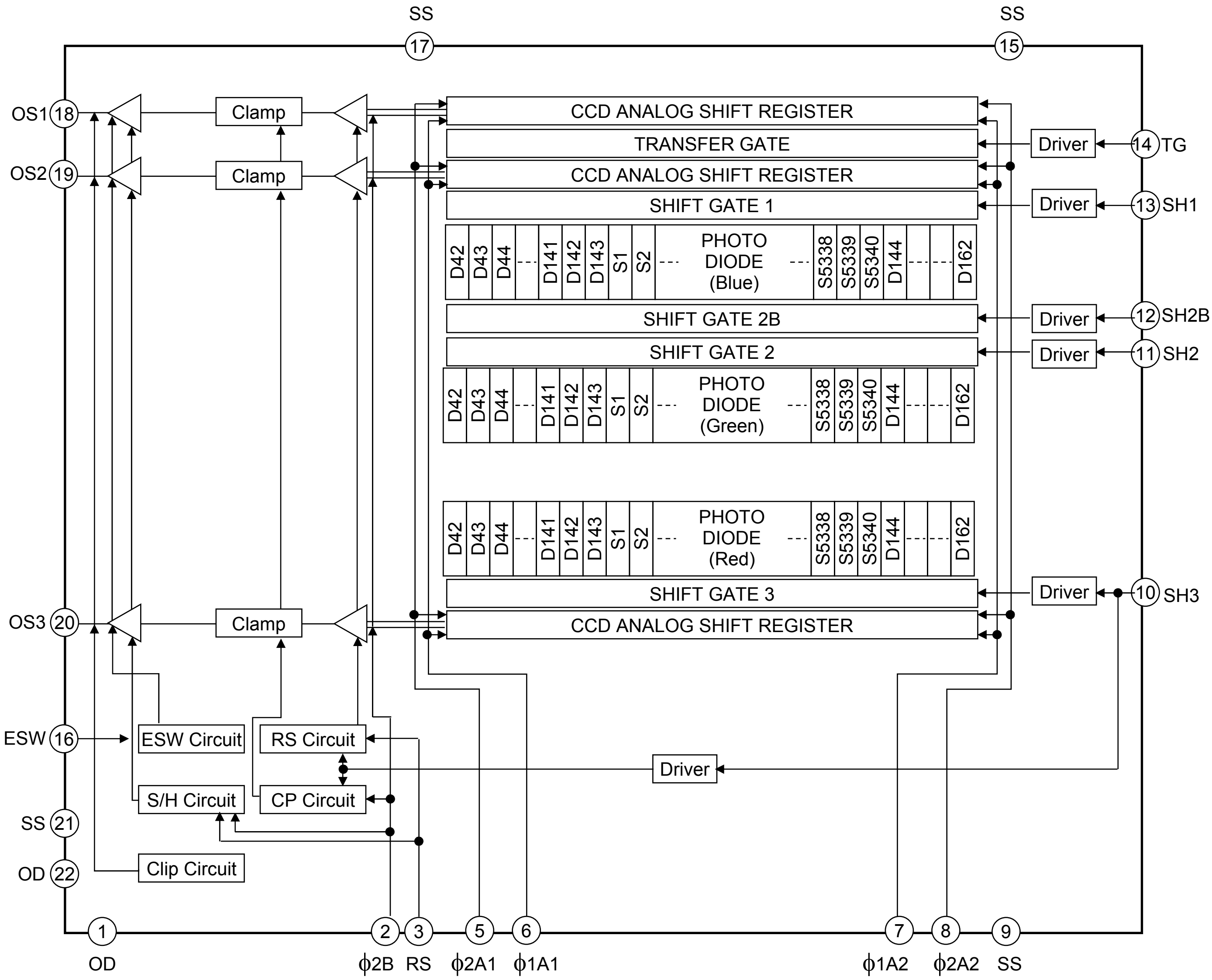
Block Diagram



Pin Names

Pin No.	Symbol	Name	Pin No.	Symbol	Name
1	OD	Power supply	22	OD	Power supply
2	ϕ2B	Last stage transfer clock (phase 2)	21	SS	Ground
3	RS	Reset gate	20	OS3	Output signal 3 (Red)
4	NC	Non connection	19	OS2	Output signal 2 (Green)
5	ϕ2A1	Transfer clock 1 (phase 2)	18	OS1	Output signal 1 (Blue)
6	ϕ1A1	Transfer clock 1 (phase 1)	17	SS	Ground
7	ϕ1A2	Transfer clock 2 (phase 1)	16	ESW	Enable switch (for CCD output)
8	ϕ2A2	Transfer clock 2 (phase 2)	15	SS	Ground
9	SS	Ground	14	TG	Transfer gate
10	SH3	Shift gate 3	13	SH1	Shift gate 1
11	SH2	Shift gate 2	12	SH2B	Shift gate 2B

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Optical/Electrical Characteristics

Ta = 25°C, V_{OD} = 10 V, V_{ϕ} = V_{RS} = 5 V (pulse), V_{SH} = V_{TG} = V_{ESW} = 3.3 V (pulse), f_{RS} = 5 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	9.2	13.2	17.2	V/lx·s	(Note 2)
	Green	R_G	10.5	15.0	19.5		
	Blue	R_B	4.1	5.9	7.7		
Photo response non uniformity		PRNU (1)	—	10	20	%	(Note 3)
		PRNU (3)	—	3.0	12.0	mV	(Note 4)
Saturation output voltage		V_{SAT}	1.2	—	—	V	(Note 5)
Maximum output voltage		SIGMAX	—	—	1.8	V	(Note 6)
CCD analog shift register saturation output voltage		$CCDV_{SAT}$	4.0	—	—	V	(Note 7)
Dark signal voltage		V_{DRK}	—	2.0	7.0	mV	(Note 8)
Dark signal non uniformity		DSNU	—	9.0	14.0	mV	(Note 9)
DC power dissipation		P_D	—	550	700	mW	(Note 10)
Total transfer efficiency		TTE	92	99	—	%	—
Output impedance		Z_O	—	0.1	0.5	kΩ	—
DC signal output voltage		V_{OS}	4.0	5.4	6.5	V	(Note 11)
DC signal output voltage (V_{ESW}= "L")		EV_{OS}	0	2.8	5.0	V	(Note 11)
Random noise		$N_{D\sigma}$	—	1.4	—	mV	(Note 12)

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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 500mV 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 50mV of signal output.

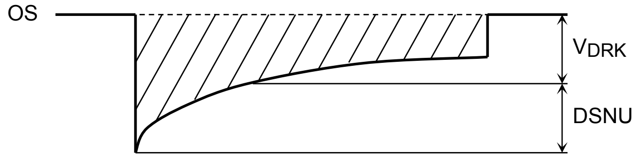
Note 5: V_{SAT} is defined as the minimum saturation output voltage of all effective pixels.

Note 6: SIGMAX is defined as the maximum output voltage of all effective pixels. Clipper circuit clips the output voltage at SIGMAX.

Note 7: $CCDV_{SAT}$ is defined as the minimum saturation output voltage of CCD analog shift register. It is a relative output voltage over the maximum output voltage (SIGMAX) by clipper circuit.

Note 8: V_{DRK} is defined as average dark signal voltage of all effective pixels.

Note 9: DSNU is defined by the difference between average value (V_{DRK}) and the maximum value of the dark voltage.



Note 10: The following formula defines P_D. I_{OD} is Direct-current consumption current.

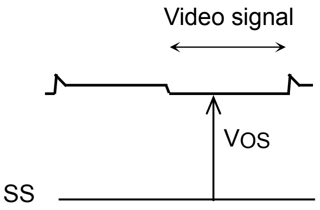
$P_D = V_{OD} \times I_{OD}$

Measurement condition: V_{OD} = 10.5 V

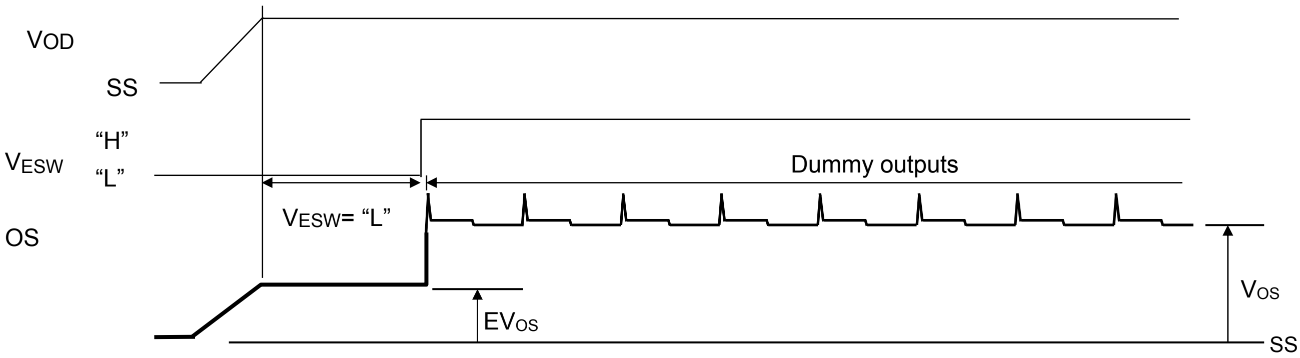
Note 11:

DC signal output voltage

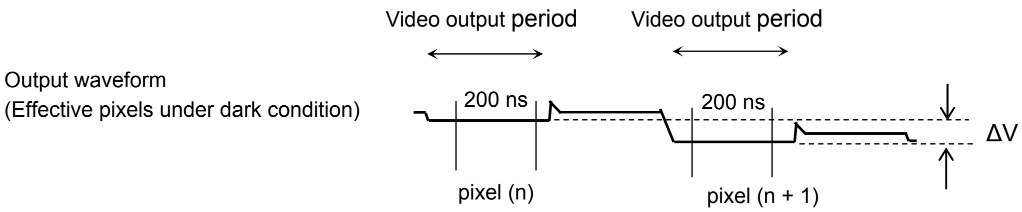
Video signal with sample and hold represents the dummy outputs period.



DC signal output voltage (V_{ESW}= "L")



Note 12: 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) level clamp in one reading are fixed as measurement points.

(2) Each of the output level 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).

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

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

(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 random noise as follows.

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

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	$V_{\phi 1A}$	4.5	5.0	5.5	V
	"L" Level	$V_{\phi 2A}$	0	0	0.25	
Last stage clock pulse voltage	"H" Level	$V_{\phi 2B}$	4.5	5.0	5.5	V
	"L" Level		0	0	0.25	
Shift pulse voltage	"H" Level	V_{SH}	2.7	3.3	5.5	V
	"L" Level		0	0	0.8	
Reset pulse voltage	"H" Level	V_{RS}	4.5	5.0	5.5	V
	"L" Level		0	0	0.25	
Transfer gate pulse voltage	"H" Level	V_{TG}	2.7	3.3	5.5	V
	"L" Level		0	0	0.8	
Enable switch pulse voltage	"H" Level	V_{ESW}	2.7	3.3	5.5	V
	"L" Level		0	0	0.8	
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.

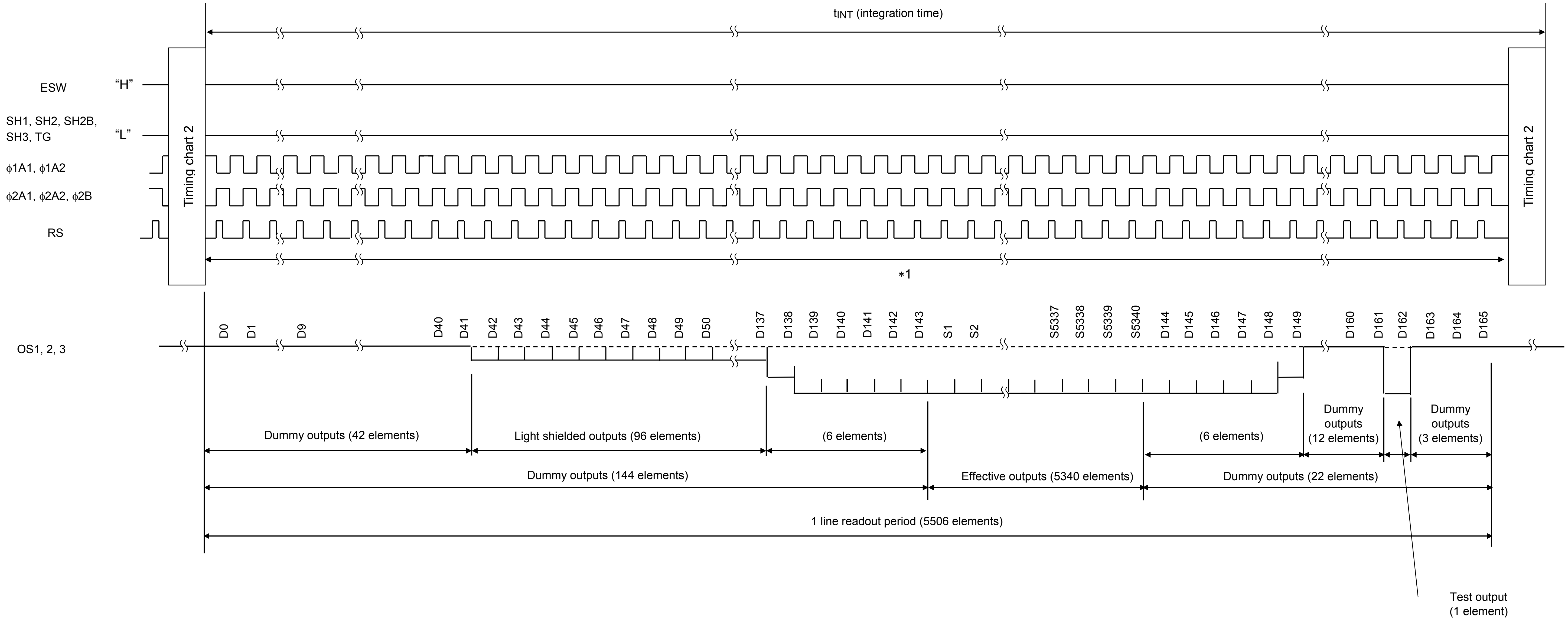
Characteristics	Symbol	Min	Typ.	Max	Unit
Clock pulse frequency	f_{ϕ}	5.0	5.0	35.0	MHz
Reset pulse frequency	f_{RS}	5.0	5.0	35.0	MHz
Clock capacitance (Note 13)	$C_{\phi 1A1}$, $C_{\phi 1A2}$	—	65	—	pF
	$C_{\phi 2A1}$, $C_{\phi 2A2}$	—	73	—	pF
Last stage clock capacitance	$C_{\phi 2B}$	—	8	—	pF
Shift gate (SH1) capacitance	C_{SH1}	—	6	—	pF
Shift gate (SH2) capacitance	C_{SH2}	—	6	—	pF
Shift gate (SH2B) capacitance	C_{SH2B}	—	6	—	pF
Shift gate (SH3) capacitance	C_{SH3}	—	16	—	pF
Reset gate capacitance	C_{RS}	—	7	—	pF
Transfer gate capacitance	C_{TG}	—	8	—	pF
Enable switch pulse capacitance	C_{ESW}	—	15	—	pF

Note 13: V_{OD} = 10V, Clock capacitance per a pin.

Mode

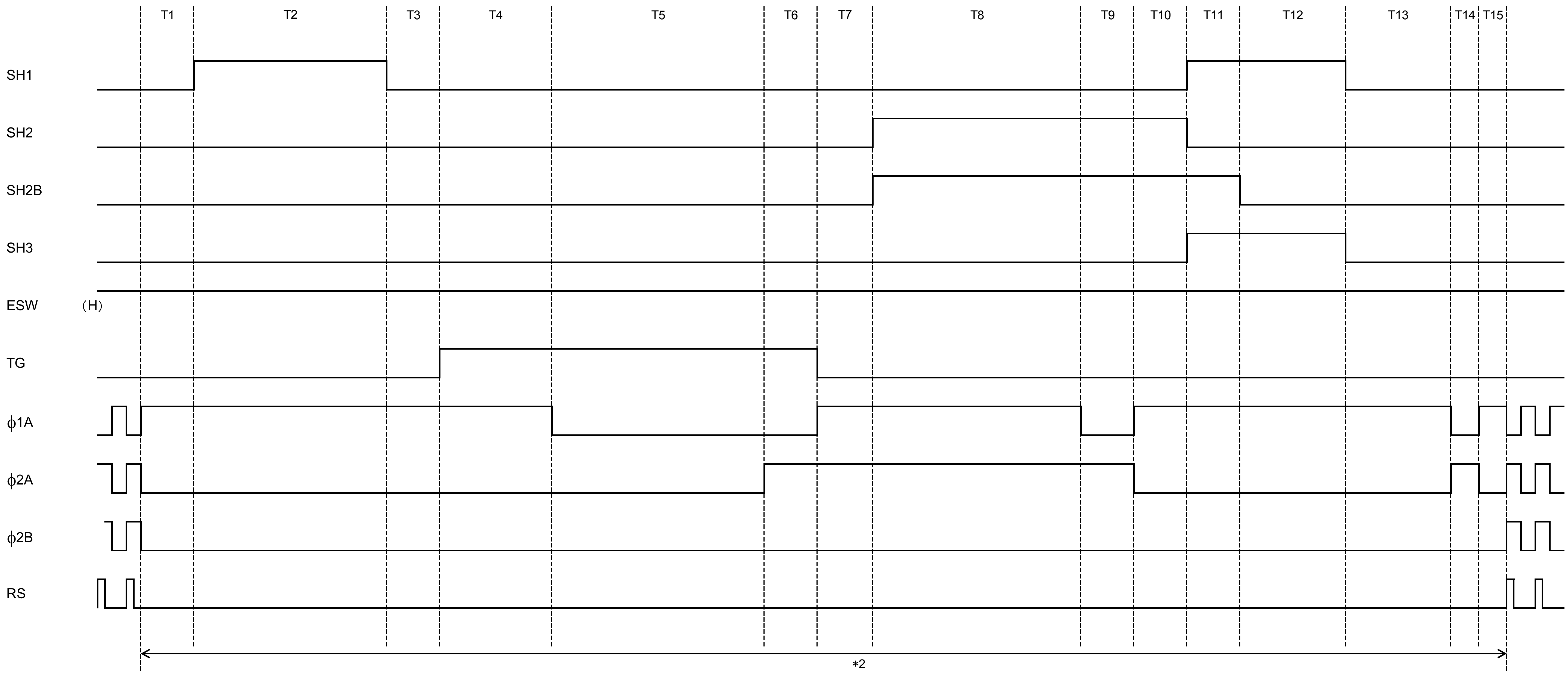
V_{ESW}	CCD output
"H"	CCD output
"L"	EVos

Timing Chart 1: (Refer to the Timing Chart 2)



*1: Keep the SH1, SH2, SH2B, SH3 and TG pins Low, and keep the ESW pin High.

Timing Chart 2: Vertical Transfer Period



*2: Keep the RS pin Low.

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Timing Requirements 1 (Vertical Transfer Period)

Timing address	Min	Typ.	Max	Unit
T1	100	200	−	ns
T2	600	1200	−	
T3	100	200	−	
T4	400	800	−	
T5	1200	3200	−	
T6	100	200	−	
T7	100	200	−	
T8	1000	2000	−	
T9	100	200	−	
T10	100	200	−	
T11	100	200	−	
T12	500	1000	−	
T13	500	1000	−	
T14	50	100	−	
T15	50	100	−	
Vertical transfer time	5.0	10.8	−	μs

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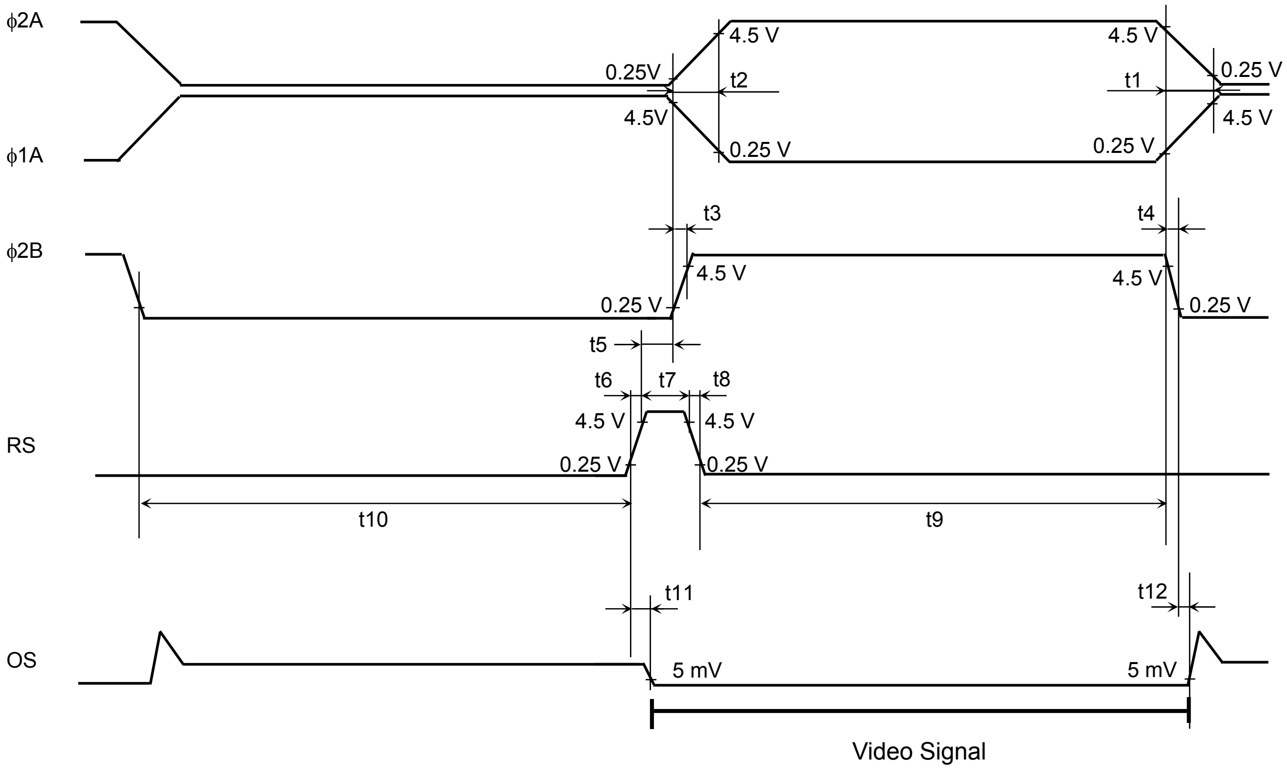
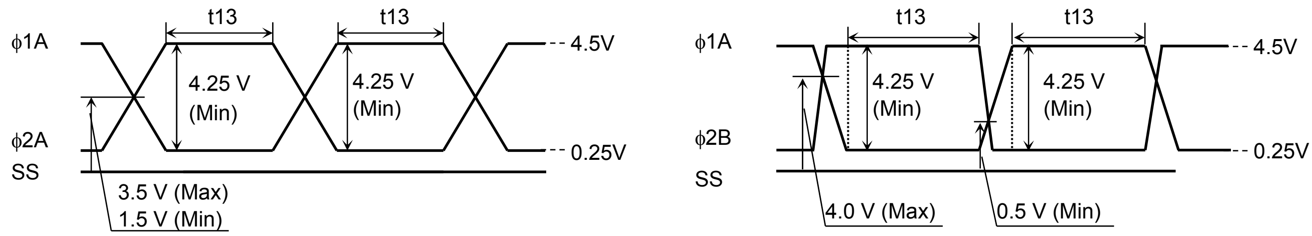
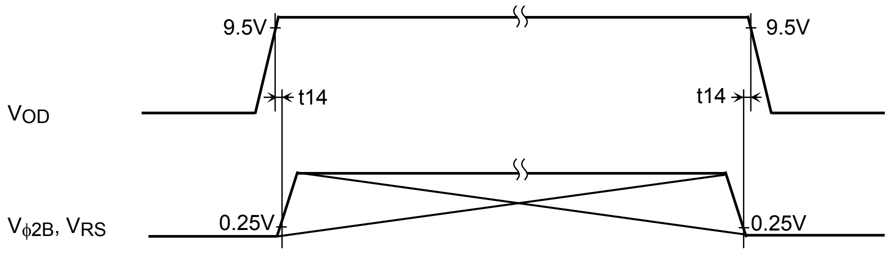
Timing Requirements 2



Cross Point Timing



Power on/off sequence

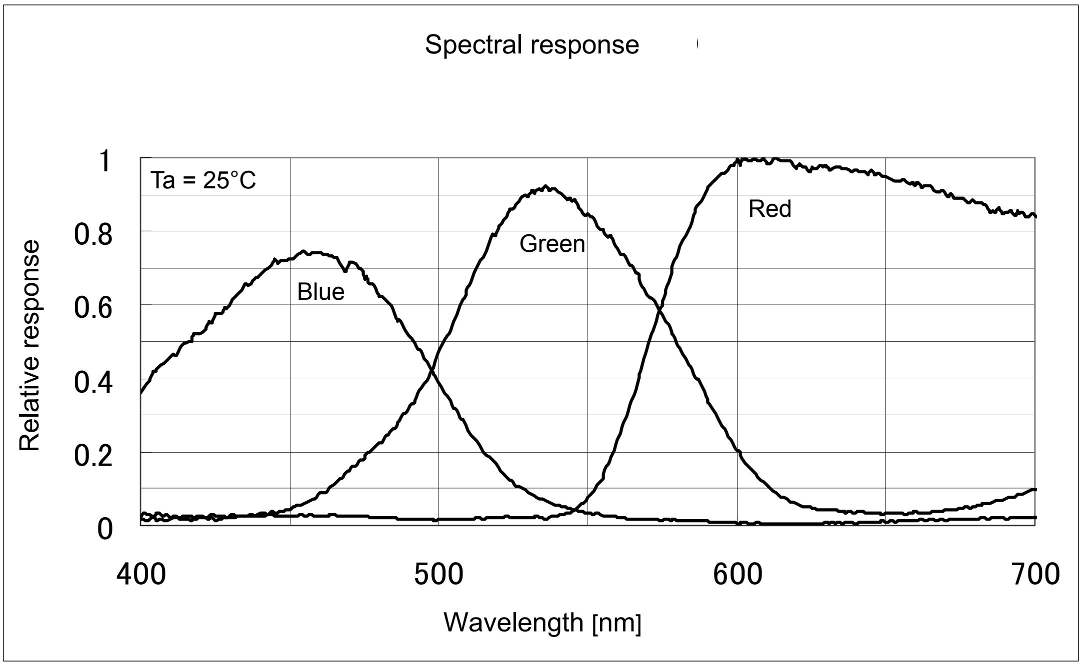


Characteristics	Symbol	Min	Typ. (Note 14)	Max	Unit
ϕ1A, ϕ2A pulse rise time, fall time	t1, t2	0	5	—	ns
ϕ2B pulse rise time, fall time	t3, t4	0	5	—	
Pulse timing of ϕ2B, RS	t5	0	0	—	
	t9	6	100	—	
	t10	8	100	—	
RS pulse rise time, fall time	t6, t8	0	2	—	
RS pulse width	t7	2	10	—	
Video data delay time	t11	—	7	—	
ϕ2B pulse, OS timing	t12	—	0	—	
ϕ1A, ϕ2A pulse width (Note 15)	t13	6	40	—	
ϕ1A, ϕ2B pulse width (Note 15)					
OD, ϕ2B, RS pulse rise time, fall time	t14	0	—	—	

Note 14: Measured with fRS = 5 MHz.

Note 15: Pulse width is the period when voltage difference between ϕ1A and ϕ2A is over 4.25 V.
Observe the specification strictly because of normal transfer efficiency.

Typical Spectral Response



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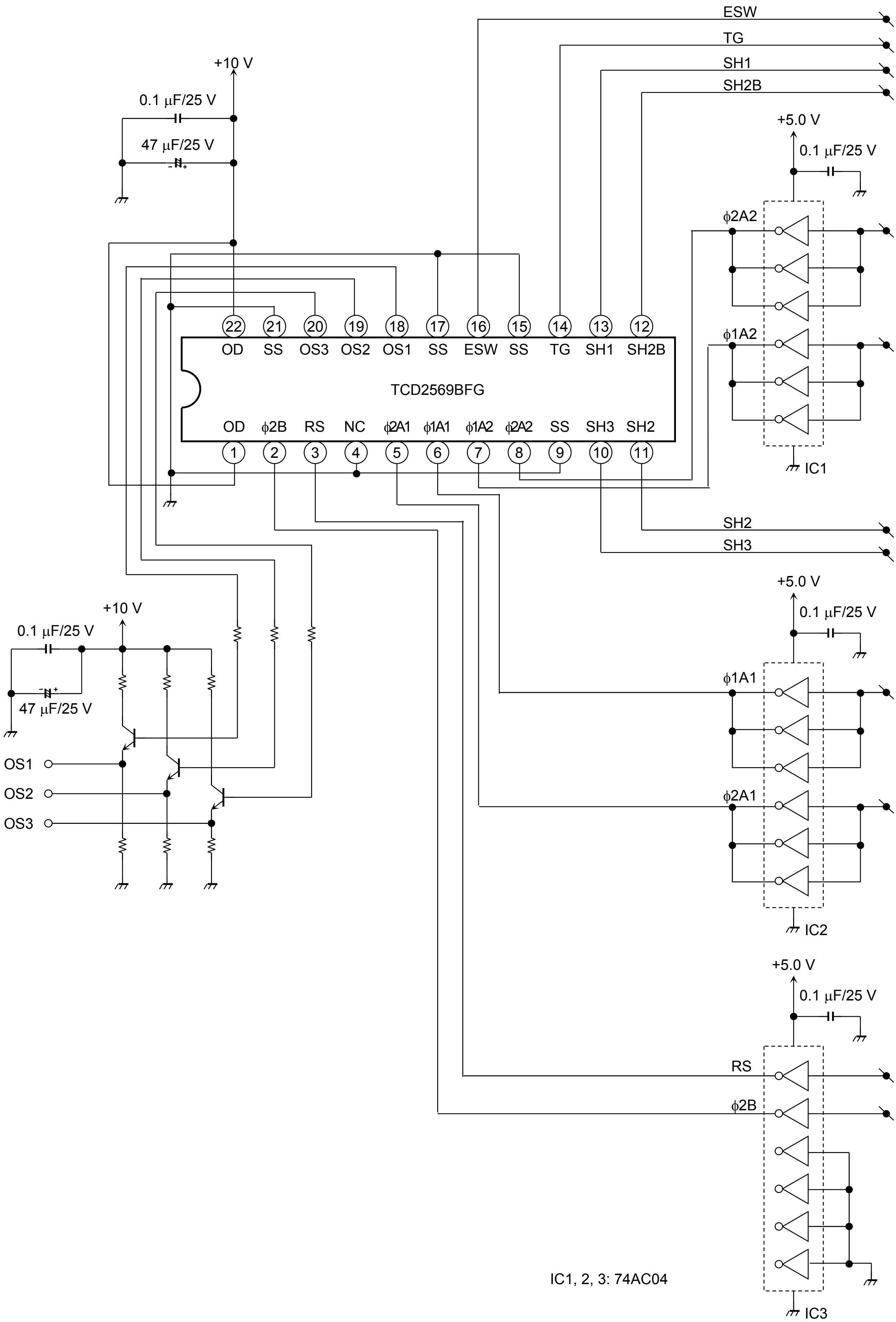
Typical Drive Circuit



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 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. Incident Light

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

3. Cloudiness of Glass Inside

CCD surface mount products may have a haze on the inside of glass, so be careful about following.
Even if the haze arises inside of glass, when it is not on the pixel area, there is no problem in quality.
Before the aluminum bag is opened, please keep the products in the environment below 30°C·90%RH. And after the aluminum bag is opened, please keep the products in the environment below 30°C·60%RH.
Please mount the products within 12 months from sealed date and within 6 months from opening the aluminum bag. (Sealed date is printed on aluminum bag.)

4. Ultrasonic Cleaning

Ultrasonic cleaning should not be used with such hermetically-sealed ceramic package as CCD because the bonding wires can become disconnected due to resonance during the cleaning process.

5. Mounting

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.

6. Window Glass Protective Tape

The window glass protective tape is manufactured from materials in which static charges tend to build up.
When removing the tape from CCD sensor after solder mounting, install an ionizer to prevent the tape from being charged with static electricity.
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 CCD to a product.
Do not reuse the tape.

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7. Soldering Temperature Profile

Good temperature profile for each soldering method is as follows. 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 and in case of the repair work not accompanied by IC removal, carry out with a soldering iron or , in reflow, only one time.

Using a soldering iron

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

Using long infrared rays reflow / hot air reflow

Please do reflow at the condition that the package surface (electrode) temperature is on the solder maker's recommendation profile. And that reflow profile is within below condition 1 to 3.

1. Peak temperature: 250°C or less.
2. Time to keep high temperature: 220 to 250°C, 30 to 40s.
3. Pre. heat: 150 to 190°C, 60 to 120s

8. 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.

9. Cleaning Method of the Window Glass Surface

Wiping Cloth

a. Use soft cloth with a fine mesh.
b. The wiping cloth must not cause dust from itself.
c. Use a clean wiping cloth necessarily.

Cleaner

When using solvents, such as alcohol, unavoidably, it is cautious of the next.

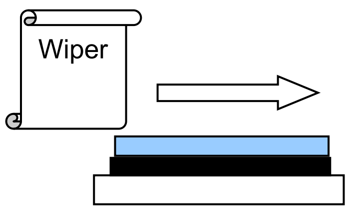
a. A clean thing with quick-drying.
b. After liquid dries, there needs to be no residual substance.
c. A thing safe for a human body.

And, please observe the use term of a solvent and use the storage container of a solvent to be clean.
Be cautious of fire enough.

Way of Cleaning

First, the surface of window glass is wiped with the wiping cloth into which the cleaner was infiltrated.
Please wipe down the surface of window glass at least 2 times or more.
Next, the surface of window glass wipes with the dry wiping cloth. Please wipe down the surface of window glass at least 3 times or more.
Finally, blow cleaning is performed by dry N_2 filtered.
If operator wipes the surface of the window glass with the above-mentioned process and dirt still remains, TOSHIBA recommends repeating the clean operation from the beginning.
Be cautious of the next thing.

a. Don't infiltrate the cleaner too much.
b. A wiping portion is performed into the optical range and don't touch the edge of window glass.
c. Be sure to wipe in a long direction and the same direction.
d. A wiping cloth always uses an unused portion.



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10. Foot Pattern on the PCB

We recommend Fig.1 's foot pattern for your PCB(Printed Circuit Board). Unit: mm

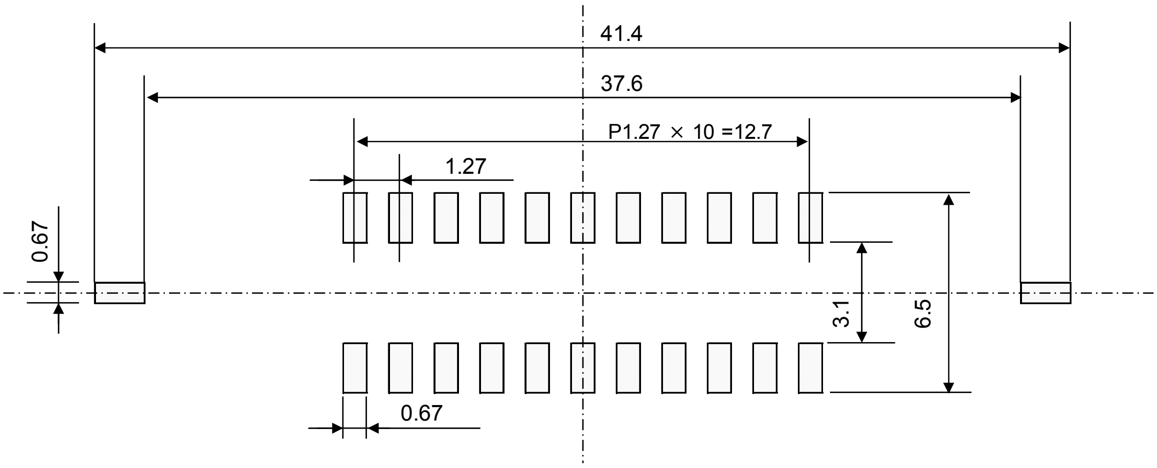


Fig. 1

11. Mask for Solder Paste Application

We recommend metal mask that have the following thickness.

・Thickness : 0.2 mm.

And we recommend that the opened area size on the metal mask is 95 % to 100 % for pads on solder.

12. Temperature cycle

After mounting, if temperature cycle stress is too much, CCD surface mount products have a possibility that a crack may arise in solder. As a method of preventing a solder crack, underfill is effective.

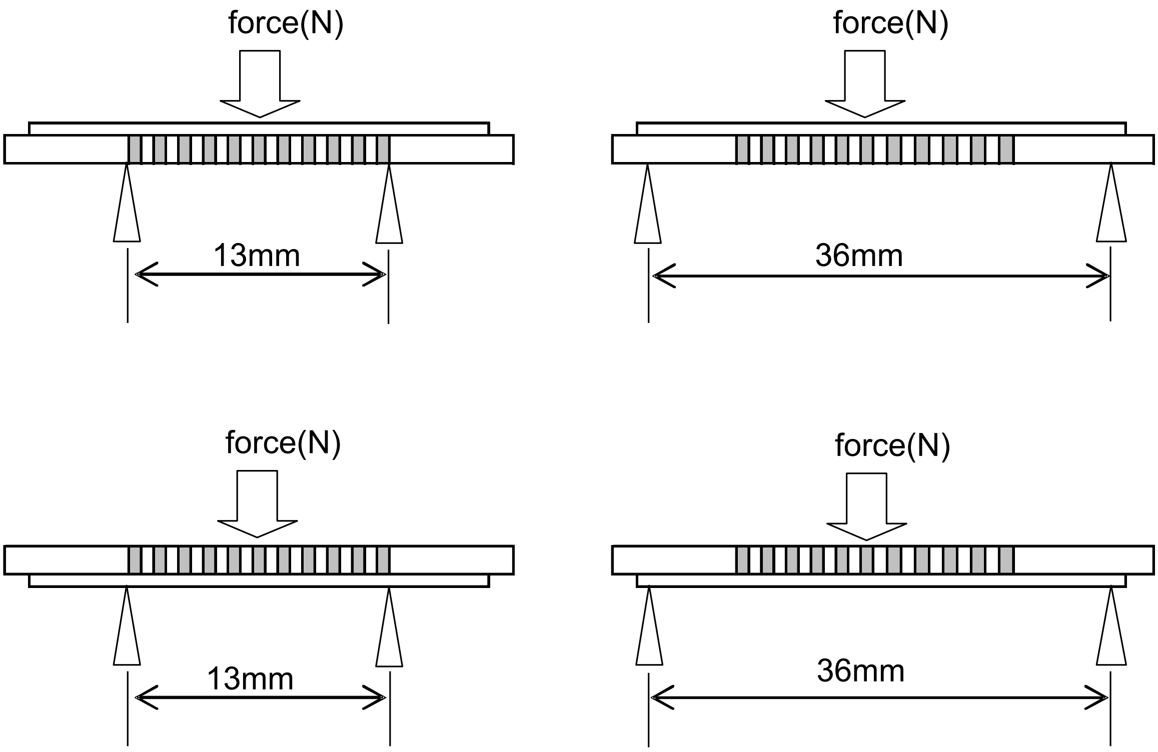
13. Reuse of a Tray

We reuse tray in order to reduce plastic waste as we can. Please cooperate with us in reusing for ecology.

14. Caution for Package Handling

Over force on CCD products may cause crack and chip removing on the product. The three point bending strength of this product is the following. (Reference data)
If the stress is loaded far from a fulcrum, the stress on the package will be increase.
When you will treat CCD on every process, please be careful particularly. For example, soldering on PCB, cutting PCB, wiping on the glass surface, optical assemble and so on.

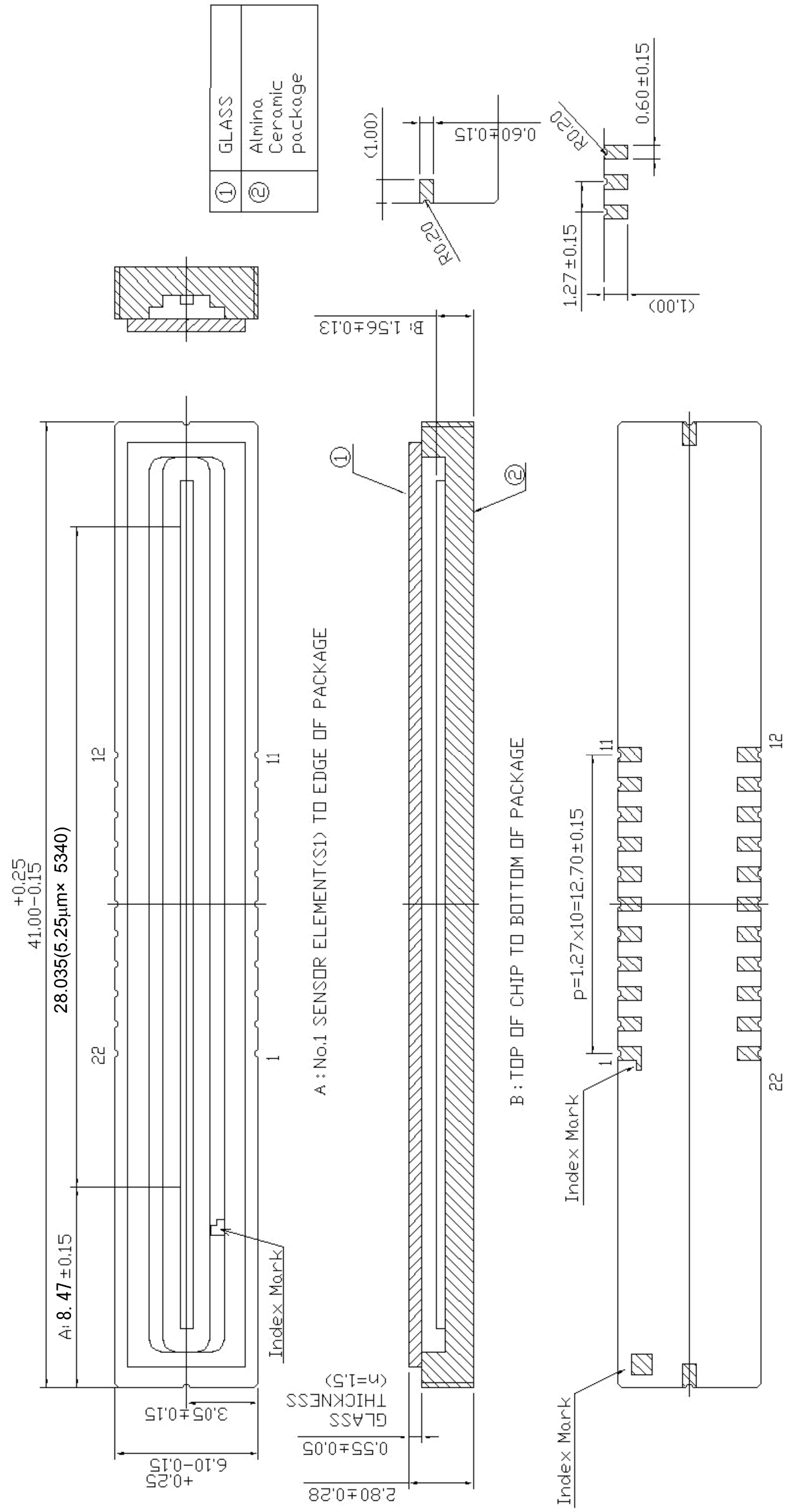
Bending Test



・22 CLCC
Bearing length 13mm : The force from upside : 300[N]
The force from downside : 200[N]
Bearing length 36mm : The force from upside : 150[N]
The force from downside : 80[N]

Package Dimensions

WQFN22-C-R240-1.27 Unit: mm



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