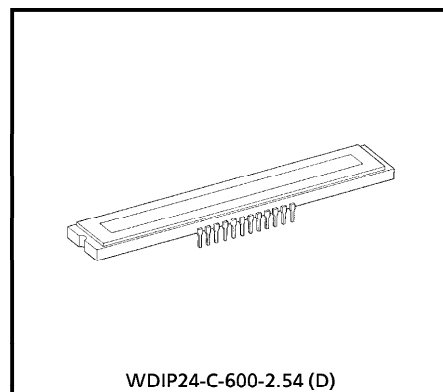


TOSHIBA CCD LINEAR IMAGE SENSOR CCD (Charge Coupled Device)

TCD2503C

The TCD2503C is a high sensitive and low dark current 5000 elements × 3 line CCD color image sensor. The sensor is designed for color scanner. The device contains a row of 5000 elements × 3 line photodiodes which provide a 16 lines/mm across a A3 size paper. The device is operated by 5 V pulse, and 12 V power supply.



WDIP24-C-600-2.54 (D)

Weight : 17.1 g (Typ.)

FEATURES

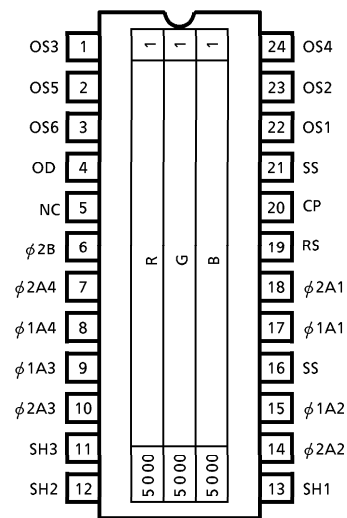
- Number of Image Sensing Element : 5000 elements × 3 line
- Image Sensing Element Size : 14 μm by 14 μm on 14 μm centers
- Photo Sensing Region : High sensitive pn photodiode
- Clock : 2 Phase (5 V)
- Distance Between Photodiode Array : 84 μm (6 lines)
- Internal Circuit : Clamp circuit
- Package : 24 pin DIP
- Color Filter : Red, Green, Blue

MAXIMUM RATINGS (Note 1)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Clock Pulse Voltage	V_{ϕ}	-0.3~8	V
Shift Pulse Voltage	V_{SH}		
Reset Pulse Voltage	V_{RS}		
Clamp Pulse Voltage	V_{CP}		
Power Supply Voltage	V_{OD}	-0.3~15	V
Operating Temperature	T_{opr}	0~60	°C
Storage Temperature	T_{stg}	-25~85	°C

(Note 1) : All voltage are with respect to SS terminals (Ground).

PIN CONNECTIONS



(TOP VIEW)

980910EBA2

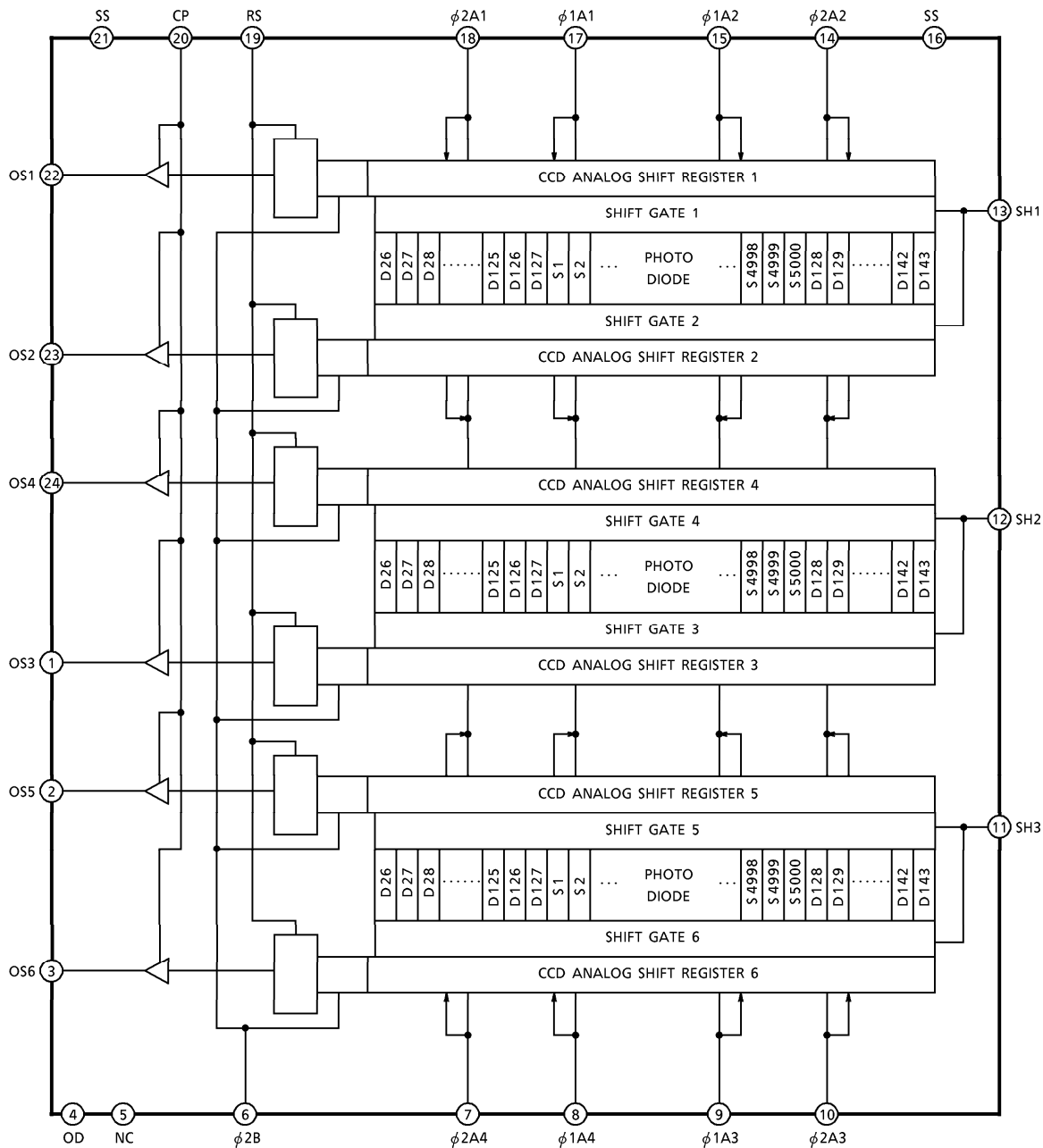
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CIRCUIT DIAGRAM



PIN NAMES

PIN No.	SYMBOL	NAME	PIN No.	SYMBOL	NAME
1	OS3	Signal Output 3 (Green)	13	SH1	Shift Gate 1
2	OS5	Signal Output 5 (Red)	14	ϕ 2A2	Clock 2 (Phase 2)
3	OS6	Signal Output 6 (Red)	15	ϕ 1A2	Clock 2 (Phase 1)
4	OD	Power (Analog)	16	SS	Ground
5	NC	Non Connection	17	ϕ 1A1	Clock 1 (Phase 1)
6	ϕ 2B	Final Stage clock (phase 2)	18	ϕ 2A1	Clock 1 (Phase 2)
7	ϕ 2A4	Clock 4 (Phase 2)	19	RS	Reset Gate
8	ϕ 1A4	Clock 4 (Phase 1)	20	CP	Clamp Gate
9	ϕ 1A3	Clock 3 (Phase 1)	21	SS	Ground
10	ϕ 2A3	Clock 3 (Phase 2)	22	OS1	Signal Output 1 (Blue)
11	SH3	Shift Gate 3	23	OS2	Signal Output 2 (Blue)
12	SH2	Shift Gate 2	24	OS4	Signal Output 4 (Green)

OPTICAL / ELECTRICAL CHARACTERISTICS

($T_a = 25^\circ\text{C}$, $V_{OD} = 11\text{ V}$, $V_\phi = V_{SH} = V_{RS} = V_{CP} = 5\text{ V}$ (PULSE), $f_\phi = 1\text{ MHz}$)

LOAD RESISTANCE = $100\text{ k}\Omega$, t_{INT} (INTEGRATION TIME) = 10 ms ,

LIGHT SOURCE = A LIGHT SOURCE + CM500S FILTER ($t = 1.0\text{ mm}$)

CHARACTERISTIC		SYMBOL	MIN.	TYP.	MAX.	UNIT	NOTE
Responsivity	Red	R_R	12.1	17.3	22.5	V / lx·s	(Note 2)
	Green	R_G	15.1	21.7	28.3		
	Blue	R_B	5.0	7.2	9.4		
Photo Response Non Uniformity		PRNU (1)	—	10	20	%	(Note 3)
		PRNU (3)	—	3	12	mV	(Note 4)
Saturation Output Voltage		V_{SAT}	2.0	—	—	V	(Note 5)
Saturation Exposure		SE	—	0.18	—	lx·s	(Note 6)
Dark Signal Voltage		V_{DRK}	—	1	5	mV	(Note 7)
Dark Signal Non Uniformity		DSNU	—	2	10	mV	(Note 8)
DC Power Dissipation		PD	—	800	1200	mW	
Total Transfer Efficiency		TTE	92	—	—	%	
Output Impedance		Z_o	—	0.2	0.5	$\text{k}\Omega$	
DC Signal Output Voltage		V_{OS}	4.5	6.0	7.5	V	(Note 9)
Random Noise		$N_{D\sigma}$	—	1.3	—	mV	(Note 10)

(Note 2) : Sensivity 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.

$$PRNU (1) = \frac{\Delta\bar{x}}{\bar{x}} \times 100 (\%)$$

Where \bar{x} is average of total signal output and $\Delta\bar{x}$ is the maximum deviation from \bar{x} .

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

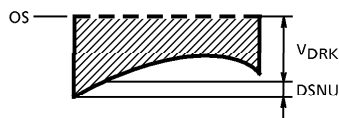
(Note 5) : V_{SAT} is defined as minimum Saturation Output voltage of all effective pixels.

(Note 6) : Definition of SE

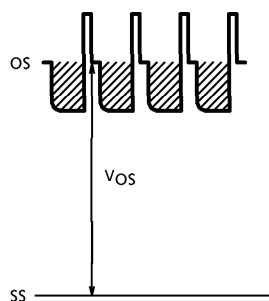
$$SE = \frac{V_{SAT}}{R_G}$$

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

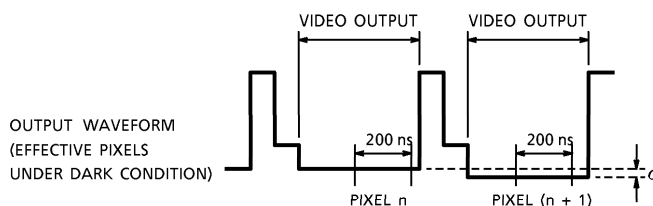
(Note 8) : DSNU is defined as different voltage between V_{DRK} and V_{MDK} , when V_{MDK} is maximum dark signal voltage.



(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 conditions) 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).

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

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

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

- 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 random noise as follows.

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

OPERATING CONDITION

CHARACTERISTIC		SYMBOL	MIN.	TYP.	MAX.	UNIT
Clock Pulse Voltage	"H" Level	$V_{\phi A}$	4.5	5.0	5.5	V
	"L" Level		0	—	0.5	
Final Stage Clock Pulse Voltage	"H" Level	$V_{\phi B}$	4.5	5.0	5.5	V
	"L" Level		0	—	0.5	
Shift Pulse Voltage (Note 11)	"H" Level	V_{SH}	$V_{\phi A}{}^{\text{H}} - 0.5$	$V_{\phi A}{}^{\text{H}}$	$V_{\phi A}{}^{\text{H}}$	V
	"L" Level		0	—	0.5	
Reset Pulse Voltage	"H" Level	V_{RS}	4.5	5.0	5.5	V
	"L" Level		0	—	0.5	
Clamp Pulse Voltage	"H" Level	V_{CP}	4.5	5.0	5.5	V
	"L" Level		0	—	0.5	
Power Supply Voltage		V_{OD}	10.5	11.0	13.0	V

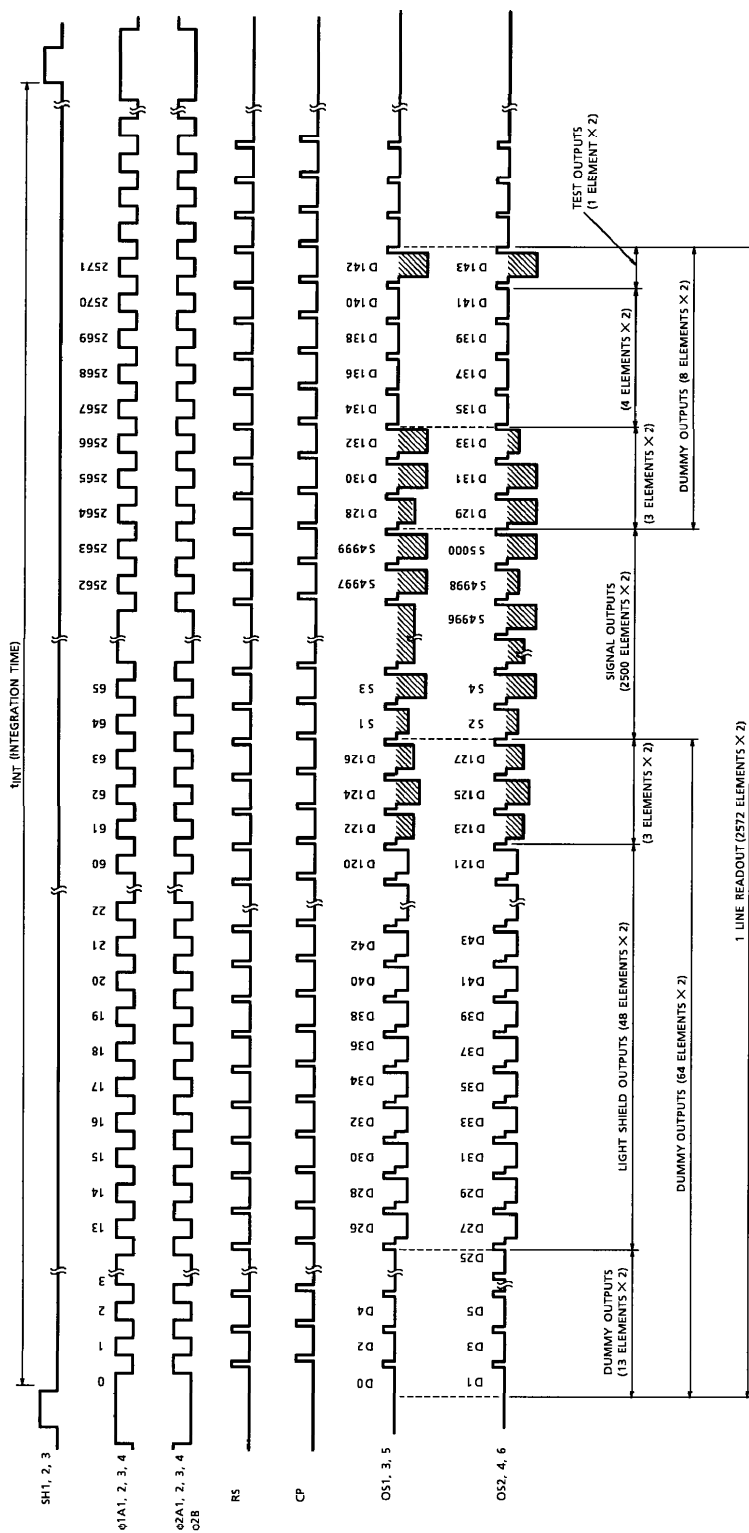
(Note 11) : $V_{\phi A}{}^{\text{H}}$ means the high level voltage of $V_{\phi A}$ when SH pulse is high level.

CLOCK CHARACTERISTICS (Ta = 25°C)

CHARACTERISTIC		SYMBOL	MIN.	TYP.	MAX.	UNIT
Clock Pulse Frequency		f_{ϕ}	—	1	13	MHz
Reset Pulse Frequency		f_{RS}	—	1	13	MHz
Clamp Pulse Frequency		f_{CP}	—	1	13	MHz
Clock Capacitance	(Note 12)	$C_{\phi A}$	—	250	—	pF
Final Stage Clock Capacitance		$C_{\phi 2B}$	—	50	—	pF
Reset Gate Capacitance		C_{RS}	—	50	—	pF
Shift Gate Capacitance		C_{SH}	—	50	—	pF
Clamp Gate Capacitance		C_{CP}	—	50	—	pF

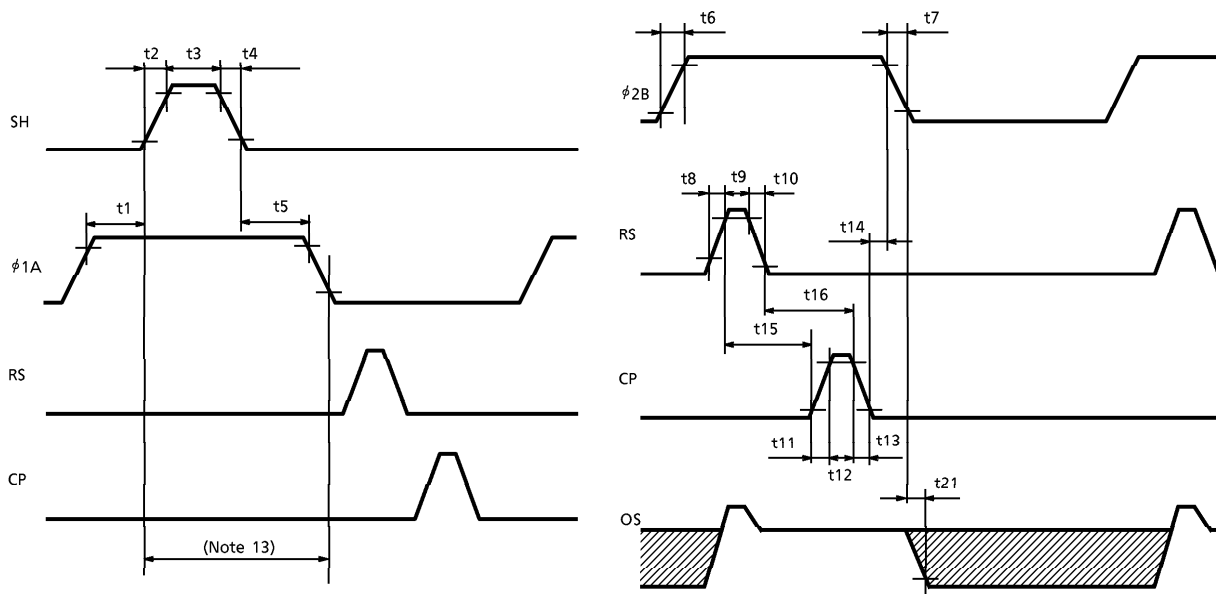
(Note 12) : $V_{OD} = 12\text{ V}$

TIMING CHART



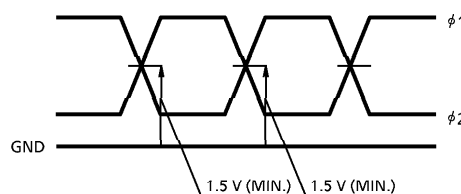
TCD2503C-7

TIMING REQUIREMENTS



(Note 13) : Each RS and CP pins put to Low level during this period.

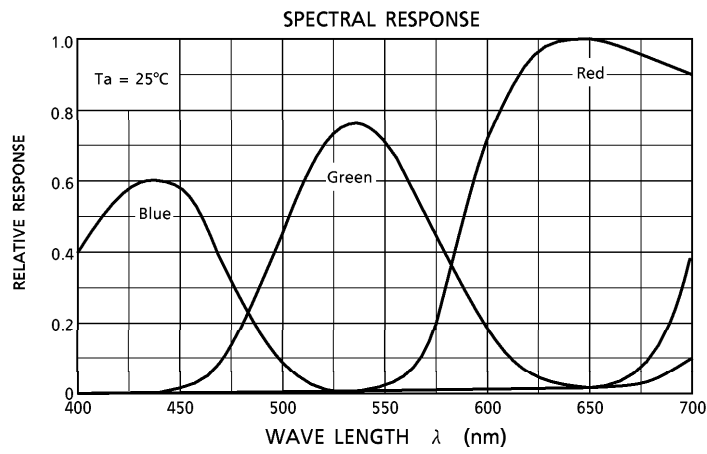
CROSS POINT



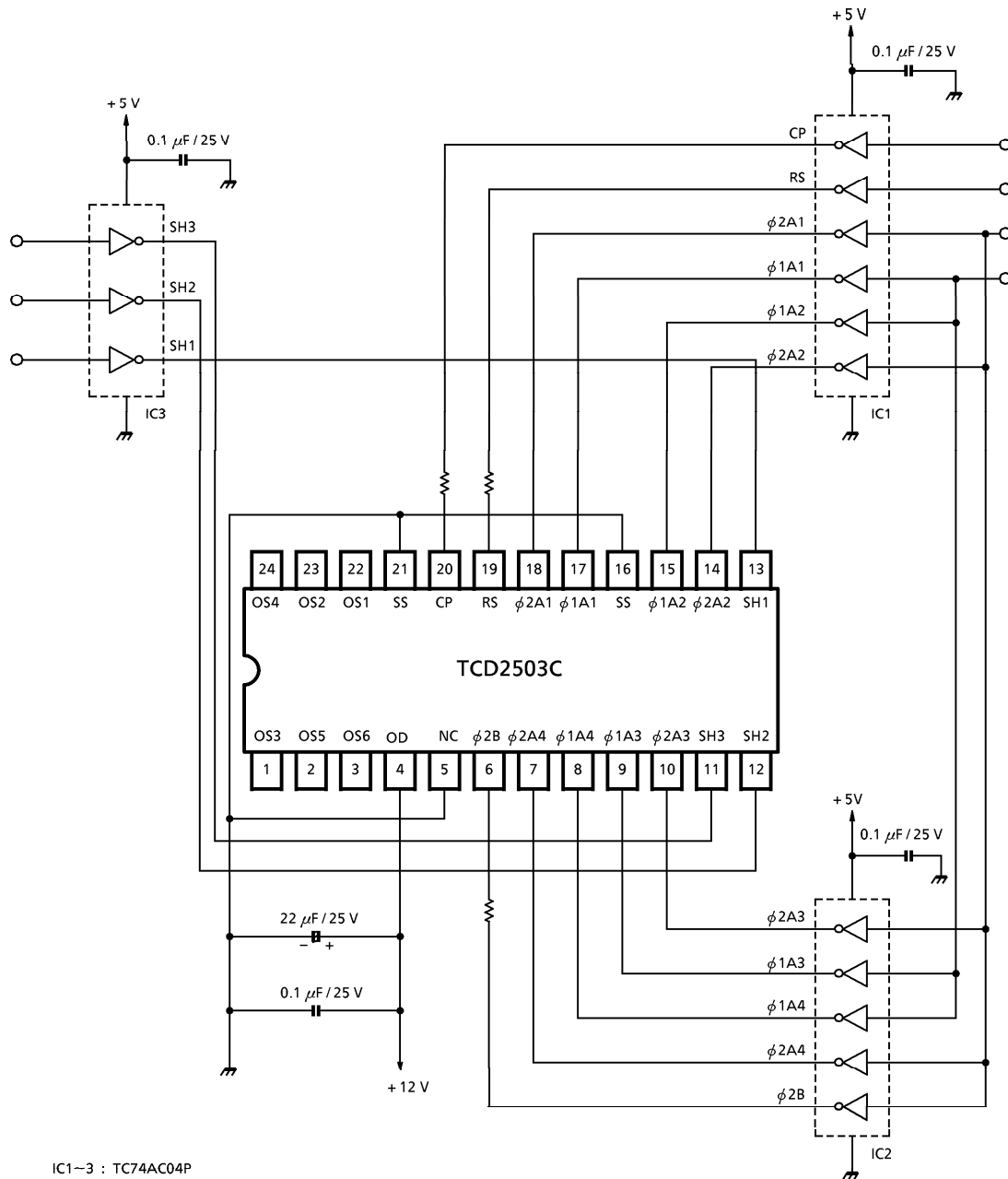
CHARACTERISTIC	SYMBOL	MIN.	TYP. (Note 14)	MAX.	UNIT
Pulse Timing of SH and $\phi 1A$	t_1	0	1000	—	ns
	t_5	500	1000	—	
SH Pulse Rise Time, Fall Time	t_2, t_4	0	50	—	ns
SH Pulse Width	t_3	1000	2000	—	ns
$\phi 1, \phi 2$ Pulse Rise Time, Fall Time	t_6, t_7	0	50	—	ns
RS Pulse Rise Time, Fall Time	t_8, t_{10}	0	20	—	ns
RS Pulse Width	t_9	10	100	—	ns
CP Pulse Rise Time, Fall Time	t_{11}, t_{13}	0	20	—	ns
CP Pulse Width	t_{12}	10	100	—	ns
Pulse Timing of $\phi 2B$ and CP	t_{14}	5	40	—	ns
Pulse Timing of RS and CP	t_{15}	0	100	—	ns
	t_{16}	10	100	—	
Video Data Delay Time (Note 15)	t_{21}	—	15	—	ns

(Note 14) : TYP. is the case of $f_{RS} = 1 \text{ MHz}$.
 (Note 15) : Load Resistance is $100 \text{ k}\Omega$.

TYPICAL PERFORMANCE CURVES



TYPICAL DRIVE CIRCUIT



IC1-3 : TC74AC04P

PRECAUTIONS FOR USE OF CCD IMAGE SENSOR**1. Static Electricity**

This device has some weakly terminals for static electricity. Therefore, please pay attention to treat this device.

CCD Image Sensor is protected against static electricity, but inferior 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 plier or pincette.

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

As the dust and stain on the glass window of the package will cause black flow on the picture, never fail to clean the glass surface before using. (Blow compressed vapor, and wipe off the dust, and dirt with soft cloth or paper slightly moistened with alcohol).

Fully take care for the handling of the device as the window glass will break or a strong friction is given to the window glass surface.

3. Incident Light

CCD image sensor has sensitivity in a wide range zone of light wave length, but its characteristics will sometimes widely change when used with long wave length input light outside the visual light zone.

