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.

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
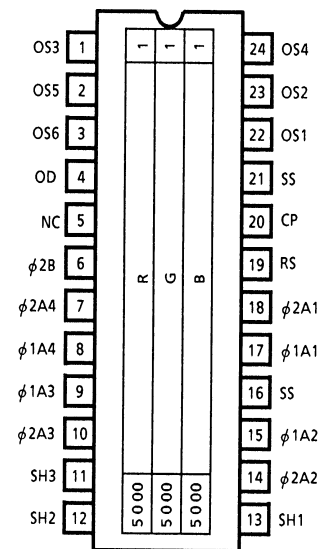- Package   : 24 pin DIP
- Color Filter   : Red, Green, Blue

WDIP24-C-600-2.54 (D)
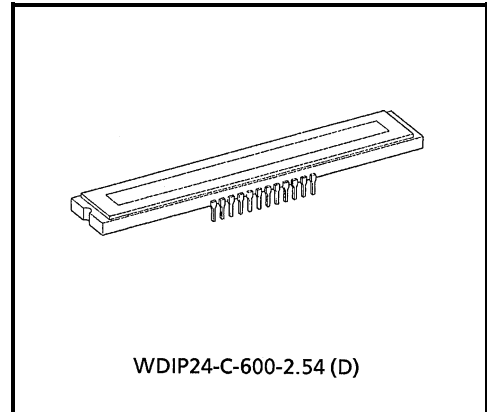
Weight: 17.1g (Typ.)

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 CONNECTION

OS3 1	24 OS4
OS5 2	23 OS2
OS6 3	22 OS1
OD 4	21 SS
NC 5	20 CP
$\phi2B$ 6	19 RS
$\phi2A4$ 7	18 $\phi2A1$
$\phi1A4$ 8	17 $\phi1A1$
$\phi1A3$ 9	16 SS
$\phi2A3$ 10	15 $\phi1A2$
SH3 11	14 $\phi2A2$
SH2 12	13 SH1

(TOP VIEW)

CIRCUIT DIAGRAM
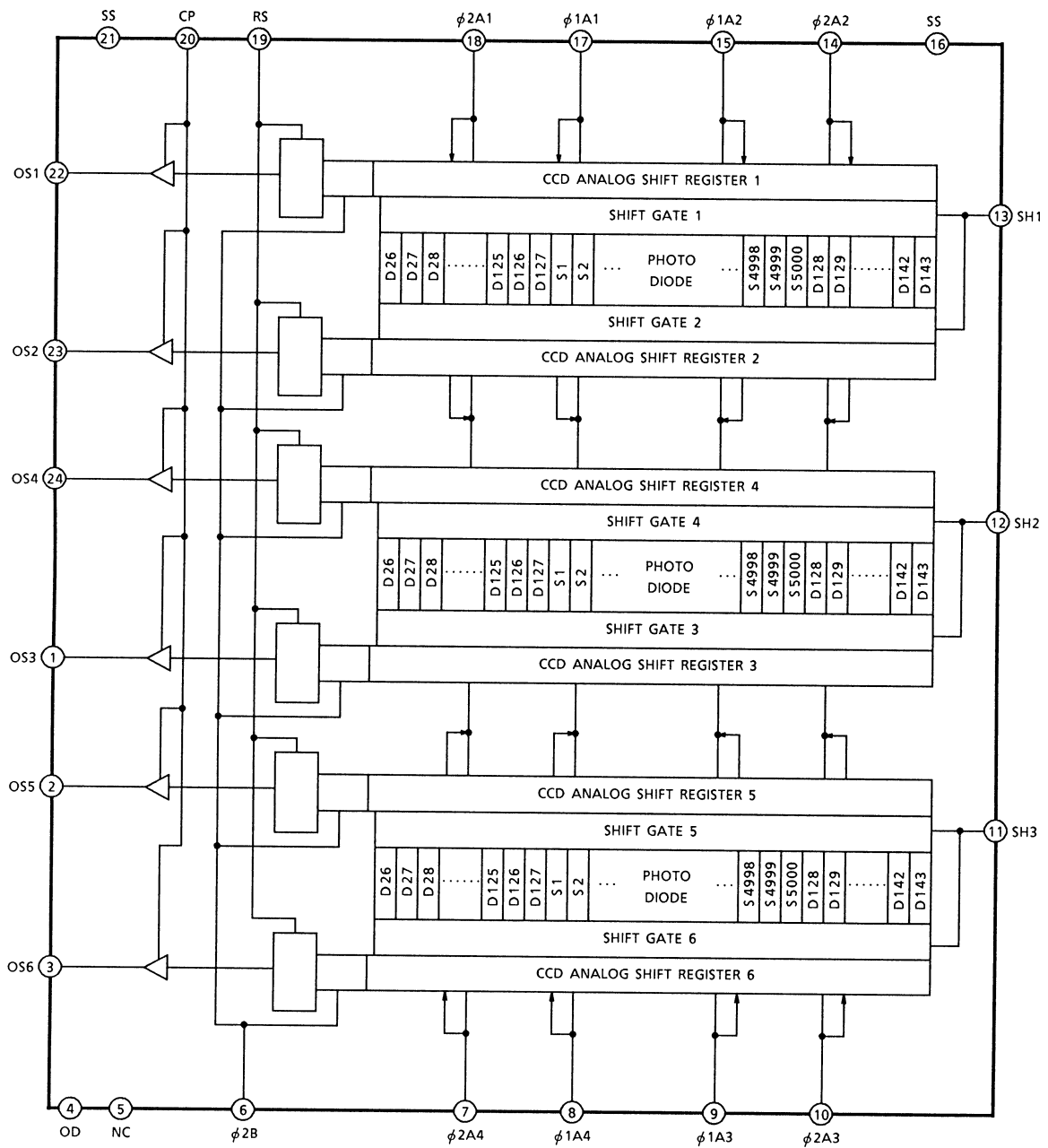
PIN NAMES

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	$\varphi 2A2$	Clock 2 (Phase 2)
3	OS6	Signal Output 6 (Red)	15	$\varphi 1A2$	Clock 2 (Phase 1)
4	OD	Power (Analog)	16	SS	Ground
5	NC	Non Connection	17	$\varphi 1A1$	Clock 1 (Phase 1)
6	$\varphi 2B$	Final Stage clock (phase 2)	18	$\varphi 2A1$	Clock 1 (Phase 2)
7	$\varphi 2A4$	Clock 4 (Phase 2)	19	RS	Reset Gate
8	$\varphi 1A4$	Clock 4 (Phase 1)	20	CP	Clamp Gate
9	$\varphi 1A3$	Clock 3 (Phase 1)	21	SS	Ground
10	$\varphi 2A3$	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
(Ta = 25°C, V_{OD} = 11V, V_{φ} = V_{SH} = V_{RS} = V_{CP} = 5V (pulse), f_{φ} = 1MHz
LOAD RESISTANCE = 100 kΩ, t_{INT} (INTEGRATION TIME) = 10 ms,
LIGHT SOURCE = A LIGHT SOURCE + CM500S FILTER (t = 1.0 mm))

CHARACTERISTIC		SYMBOL	MIN	TYP.	MAX	UNIT	NOTE
Sensitivity	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	kΩ	
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: 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.

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

Where $\overline{\chi}$ is average of total signal outputs and $\Delta\chi$ is the maximum deviation from $\overline{\chi}$.

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 : $SE = \dfrac{V_{SAT}}{R}$

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.
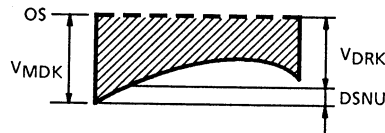
Note 9: DC Signal Output Voltage is defined as follows :
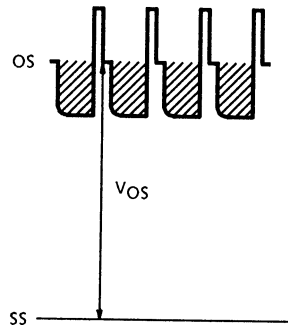
Note 10: Random noise is defined as the standard deviation (sigma) of the output level difference between two adjacent effective pixels under no illumination (i.e. dark conditions) calculated by the following procedure.
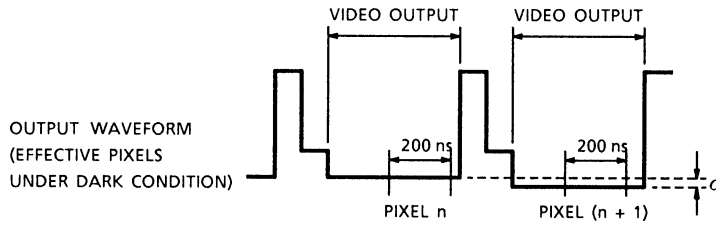
1) Two adjacent pixels (pixel n and n + 1) in one reading are fixed as measurement points.

2) Each of the output levels at video output periods averaged over 200 ns period to get Vn and V (n + 1).

3) V (n + 1) is subtracted from Vn to get ΔV.

$$\Delta V = Vn - V (n + 1)$$

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

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

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	$V_{\varphi}A$	4.5	5.0	5.5	V
	"L" Level		0	—	0.5	
Final Stage Clock Pulse Voltage	"H" Level	$V_{\varphi}B$	4.5	5.0	5.5	V
	"L" Level		0	—	0.5	
Shift Pulse Voltage (Note 11)	"H" Level	V_{SH}	$V_{\varphi}A$"H"−0.5	$V_{\varphi}A$"H"	$V_{\varphi}A$"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: $V_{\varphi}A$"H" means the high level voltage of $V_{\varphi}A$ 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)	$C_{\varphi}A$	—	250	—	pF
Final Stage Clock Capacitance	$C_{\varphi}2B$	—	50	—	pF
Reset Gate Capacitance	C_{RS}	—	50	—	pF
Shift Gate Capacitance	C_{SH}	—	50	—	pF
Clamp Gate Capacitance	C_{CP}	—	50	—	pF

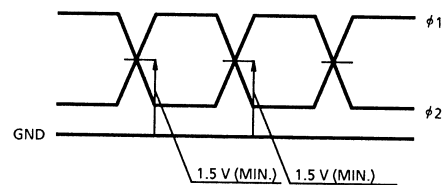Note 12: V_{OD} = 12 V

TIMING CHART
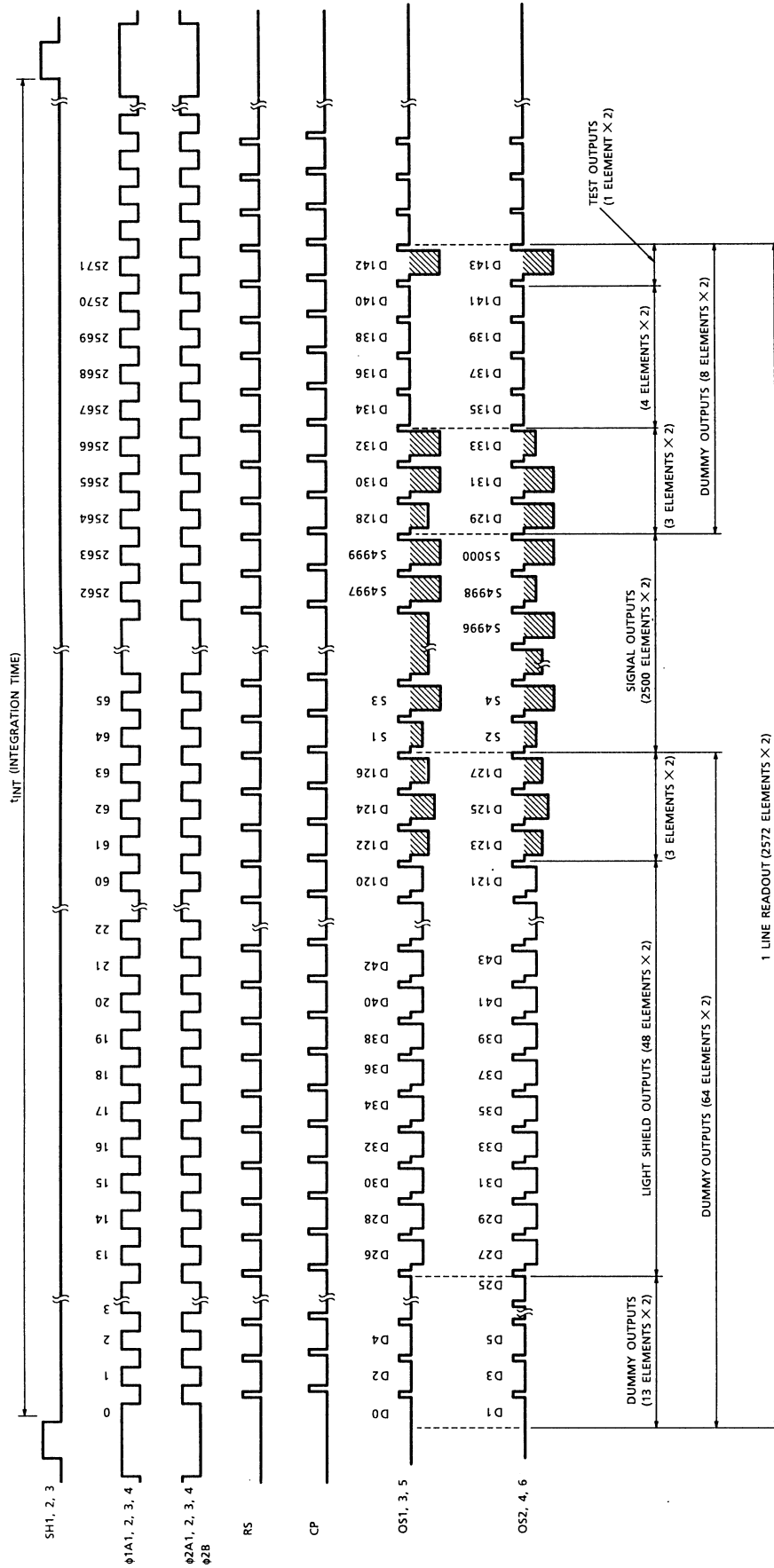
TIMING REQUIREMENTS
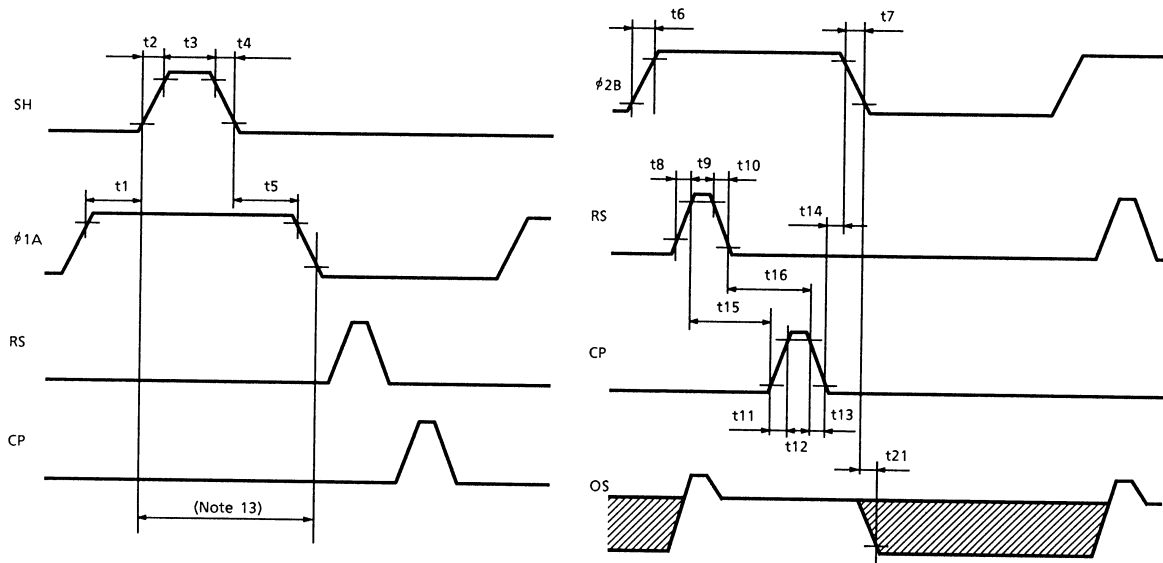
Note 13: Each RS and CP pins put to Low level during this period

CROSS POINT

CHARACTERISTIC	SYMBOL	MIN	TYP. (Note 14)	MAX	UNIT
Pulse Timing of SH and φ1A	t1	0	1000	—	ns
	t5	500	1000	—	
SH Pulse Rise Time, Fall Time	t2, t4	0	50	—	ns
SH Pulse Width	t3	1000	2000	—	ns
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	10	100	—	ns
CP Pulse Rise Time, Fall Time	t11, t13	0	20	—	ns
CP Pulse Width	t12	10	100	—	ns
Pulse Timing of φ2B and CP	t14	5	40	—	ns
Pulse Timing of RS and CP	t15	0	100	—	ns
	t16	10	100	—	
Video Data Delay Time (Note 15)	t21	—	15	—	ns

Note 14: TYP. is the case of f_{RS} = 1 MHz.
Note 15: Load Resistance is 100 kΩ.

TYPICAL PERFORMANCE CURVES

SPECTRAL RESPONSE
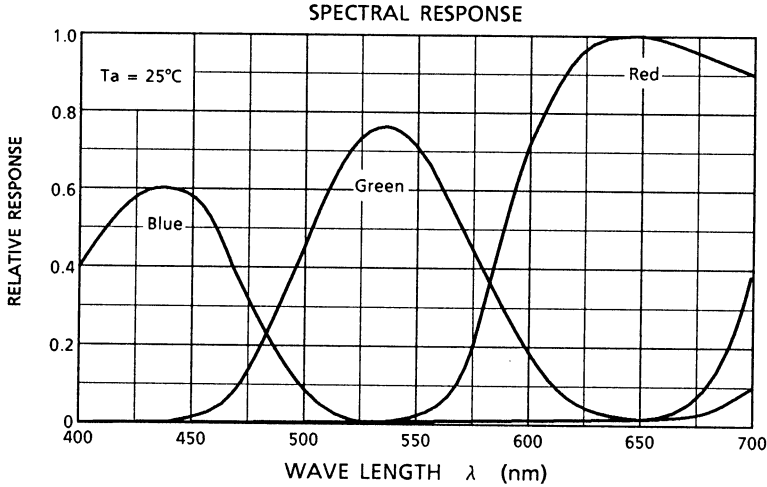
TYPICAL DRIVE CIRCUIT

IC1~3 : TC74AC04P
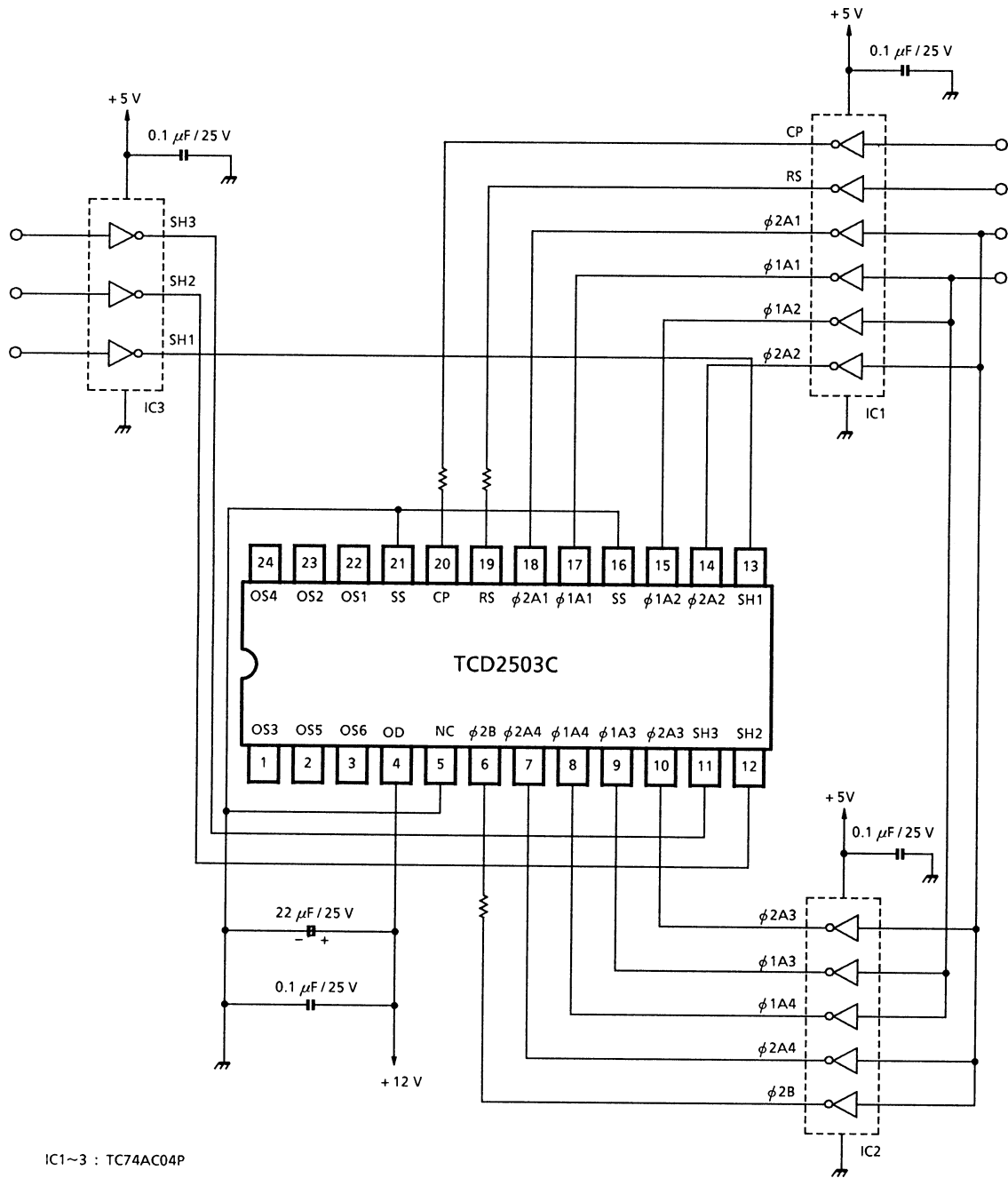
CAUTION

1. 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.

2. 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 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.

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.

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

WDIP24-C-600-2.54 (D)   Unit: mm
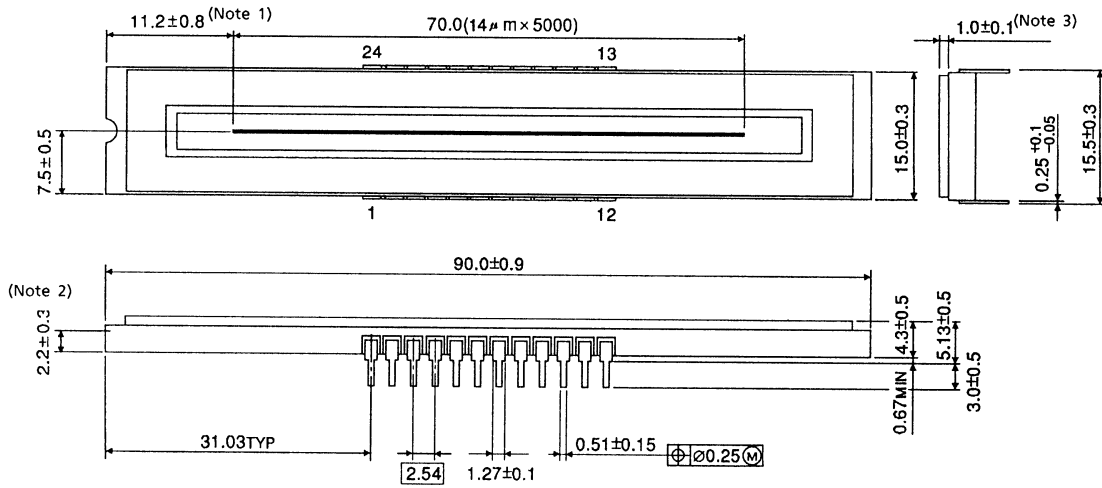
Note 1: No. 1 SENSOR ELEMENT (S1) TO EDGE OF PACKAGE.
Note 2: TOP OF CHIP TO BOTTOM OF PACKAGE.
Note 3: GLASS THICKNES (n = 1.5)

Weight: 17.1 g (Typ.)

RESTRICTIONS ON PRODUCT USE