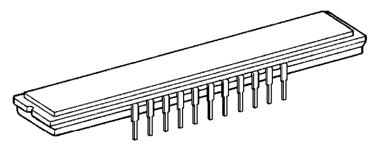
TOSHIBA CCD IMAGE SENSOR CCD (Charge Coupled Device)

TCD2903D

The TCD2903D is a high sensitive and low dark current 10680 elements × 3 line CCD color image sensor which includes CCD drive circuit and clamp circuit. The sensor is designed for scanner.
The device contains a row of 10680 elements × 3 line photodiodes which provide a 48 lines / mm (1200DPI) across a A4 size paper. The device is operated by 5 V pulse, and 12 V power supply.



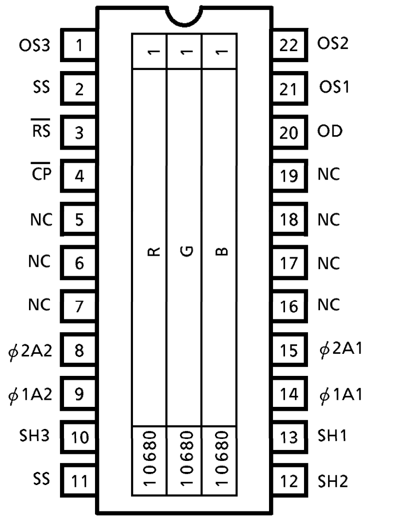
WDIP22-G-400-2.54D (F)

Weight : 5.2 g (Typ.)

FEATURES

- Number of Image Sensing Elements : 10680 elements × 3 line
- Image Sensing Element Size : 4 μm by 4 μm on 4 μm centers
- Photo Sensing Region : High sensitive and low dark current PN photodiode
- Distance Between Photodiode Array : 48 μm (12 lines)
- Clock : 2 phase (5 V)
- Power Supply : 12 V Power Supply Voltage
- Internal Circuit : Clamp circuit
- Package : 22 pin CERDIP package
- Color Filter : Red, Green, Blue

PIN CONNECTIONS



(TOP VIEW)

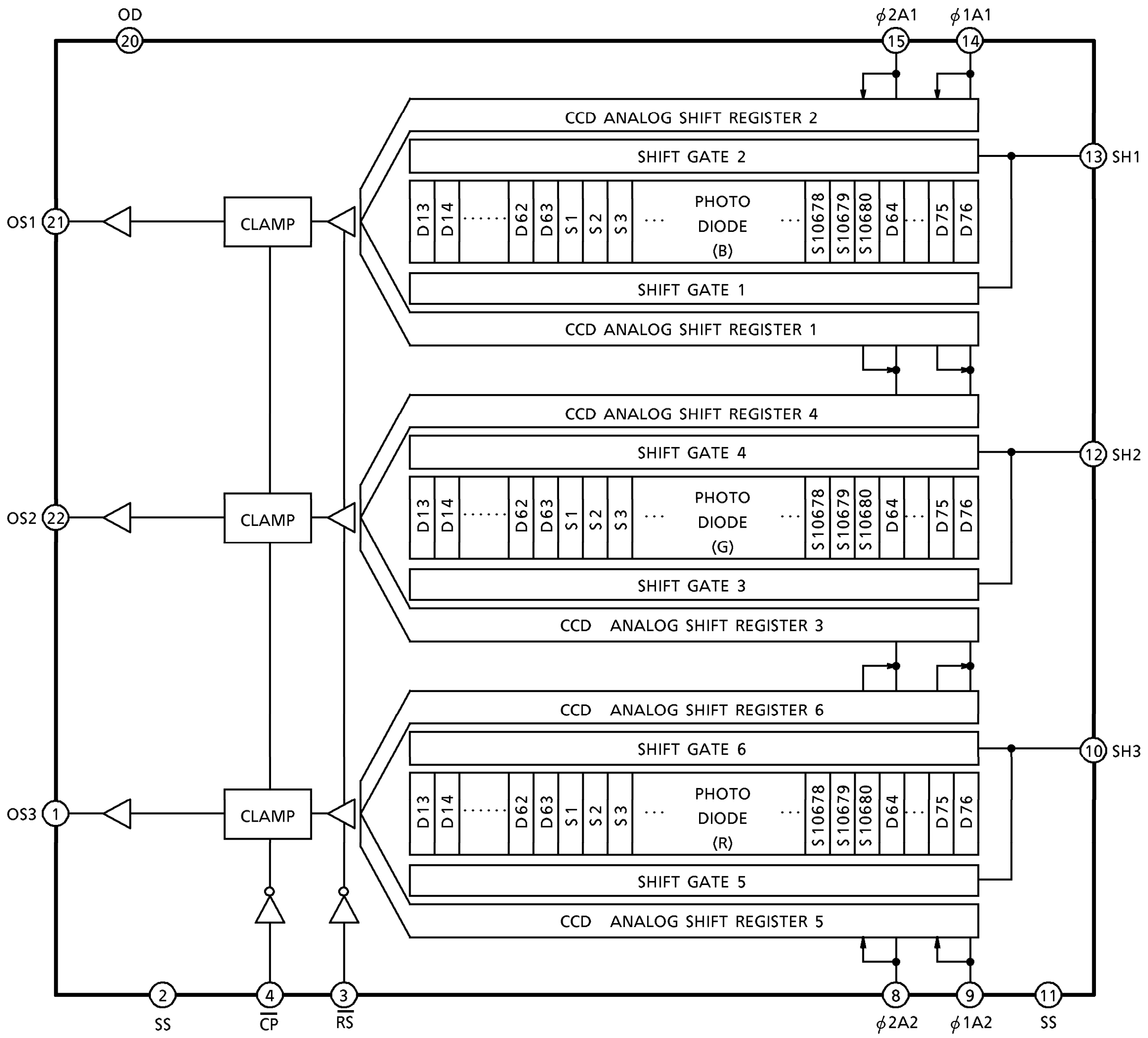
MAXIMUM RATINGS (Note 1)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Clock Pulse Voltage	$V_{\phi A}$	−0.3~8.0	V
Shift Pulse Voltage	V_{SH}		
Reset Pulse Voltage	$V_{\overline{RS}}$		
Clamp Pulse Voltage	$V_{\overline{CP}}$		
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).

000707EBA2

CIRCUIT DIAGRAM



PIN NAMES

PIN No.	SYMBOL	NAME	PIN No.	SYMBOL	NAME
1	OS3	Signal Output 3 (Red)	22	OS2	Signal Output 2 (Green)
2	SS	Ground	21	OS1	Signal Output 1 (Blue)
3	$\overline{RS}$	Reset Gate	20	OD	Power
4	$\overline{CP}$	Clamp Gate	19	NC	Non Connection
5	NC	Non Connection	18	NC	Non Connection
6	NC	Non Connection	17	NC	Non Connection
7	NC	Non Connection	16	NC	Non Connection
8	ϕ2A2	Clock 2 (Phase 2)	15	ϕ2A1	Clock 1 (phase 2)
9	ϕ1A2	Clock 2 (Phase 1)	14	ϕ1A1	Clock 1 (phase 1)
10	SH3	Shift Gate 3	13	SH1	Shift Gate 1
11	SS	Ground	12	SH2	Shift Gate 2

OPTICAL / ELECTRICAL CHARACTERISTICS

(Ta = 25°C, V_{OD} = 12 V, $V\phi$ = V_{SH} = $V_{\overline{RS}}$ = $V_{\overline{CP}}$ = 5 V (PULSE), $f\phi$ = 0.5 MHz, $f_{\overline{RS}}$ = 1 MHz, t_{INT} = 11 ms, LIGHT SOURCE = A LIGHT SOURCE + CM500S FILTER (t = 1 mm), LOAD RESISTANCE = 100 kΩ)

CHARACTERISTIC		SYMBOL	MIN.	TYP.	MAX.	UNIT	NOTE
Sensitivity	Red	$R_{(R)}$	1.8	2.6	3.4	V / lx·s	(Note 2)
	Green	$R_{(G)}$	1.7	2.5	3.3		
	Blue	$R_{(B)}$	0.9	1.3	1.7		
Photo Response Non Uniformity		PRNU (1)	—	15	20	%	(Note 3)
		PRNU (3)	—	3	12	mV	(Note 4)
Register Imbalance		RI	—	1	—	%	(Note 5)
Saturation Output Voltage		V_{SAT}	3.2	3.6	—	V	(Note 6)
Saturation Exposure		SE	0.97	1.44	—	lx·s	(Note 7)
Dark Signal Voltage		V_{DRK}	—	0.5	2.0	mV	(Note 8)
Dark Signal Non Uniformity		DSNU	—	2.0	7.0	mV	(Note 8)
DC Power Dissipation		P_D	—	310	450	mW	
Total Transfer Efficiency		TTE	92	98	—	%	
Output Impedance		Z_O	—	0.3	1.0	kΩ	
DC Compensation Output Voltage		V_{OS}	5.0	6.0	7.0	V	(Note 9)
Random Noise		$N_{D\sigma}$	—	0.8	—	mV	(Note 10)
Reset Noise		V_{RSN}	—	0.3	1.0	V	(Note 9)
Masking Noise		V_{MS}	—	0.2	1.0	V	(Note 9)

(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 output and $\Delta\chi$ is the maximum deviation from $\overline{\chi}$. The amount of incident light is shown below.

Red = 1 / 2 · SE
Green = 1 / 2 · SE
Bule = 1 / 4 · SE

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

(Note 5) : Register imbalance is defined as follows.

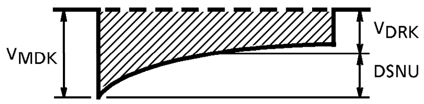
$$\text{RI} = \frac{\sum_{n=1}^{10679} |\chi n - \chi (n+1)|}{10679 * \overline{\chi}} * 100\ (\%)$$

(Note 6) : V_{SAT} is defined as minimum saturation output of all effective pixels.

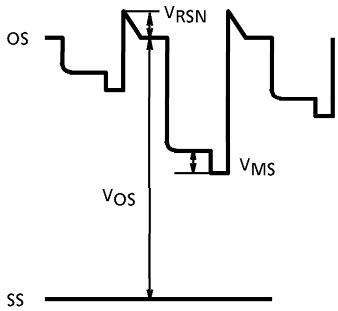
(Note 7) : Definition of SE

$$SE = \frac{V_{SAT}}{R_G} \text{ (lx·s)}$$

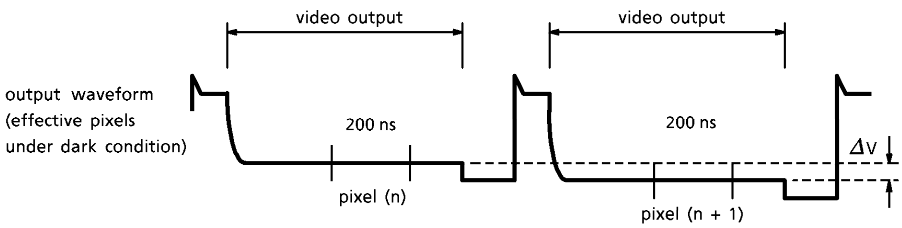
(Note 8) : V_{DRK} is defined as average dark signal voltage of all effective pixels.
DSNU is defined as different voltage between V_{DRK} and V_{MDK} when V_{MDK} is maximum dark signal voltage.



(Note 9) : DC signal output voltage is defined as follows.
Reset Noise 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 level at video output periods averaged over 200ns 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).

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

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

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

7) $\overline{\sigma}$ 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.

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

OPERATING CONDITION

CHARACTERISTIC		SYMBOL	MIN.	TYP.	MAX.	UNIT	NOTE
Clock Pulse Voltage	"H" Level	$V\phi A$	4.75	5.0	5.5	V	
	"L" Level		0	0	0.3		
Shift Pulse Voltage	"H" Level	V_{SH}	$V\phi A$"H" − 0.5	$V\phi A$"H"	$V\phi A$"H"	V	(Note 11)
	"L" Level		0	0	0.5		
Reset Pulse Voltage	"H" Level	$V_{\overline{RS}}$	4.5	5.0	5.5	V	
	"L" Level		0	0	0.5		
Clamp Pulse Voltage	"H" Level	$V_{\overline{CP}}$	4.5	5.0	5.5	V	
	"L" Level		0	0	0.5		
Power Supply Voltage		V_{OD}	11.4	12.0	13.0	V	

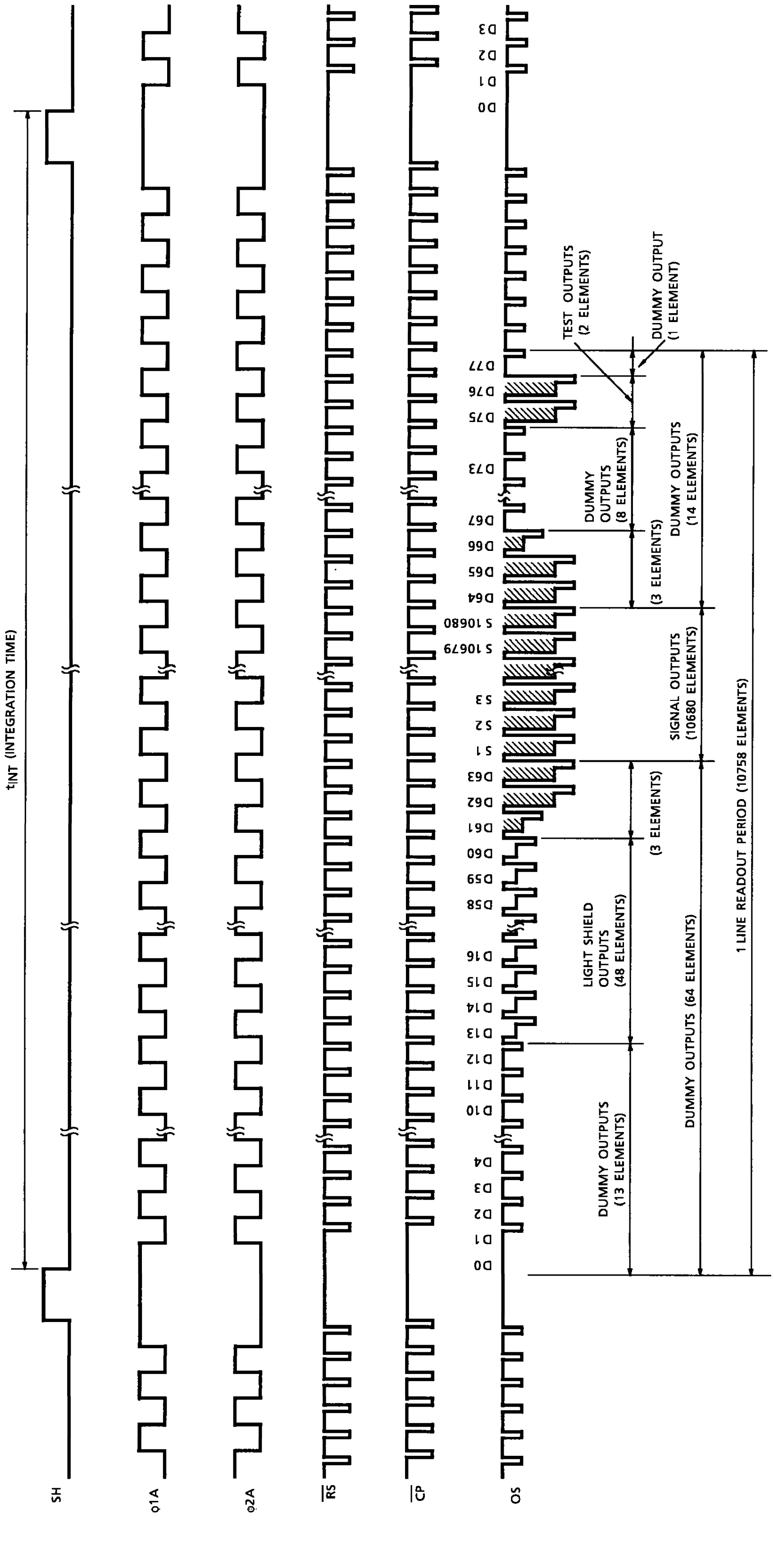
(Note 11) : $V\phi A$"H" means the high level voltage of $V\phi A$ when SH pulse is high level.

CLOCK CHARACTERISTICS (Ta = 25°C)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT
Clock Pulse Frequency	$f\phi A$	0.15	0.5	5.0	MHz
Reset Pulse Frequency	$f_{\overline{RS}}$	0.3	1.0	10.0	MHz
Clamp Pulse Frequency	$f_{\overline{CP}}$	0.3	1.0	10.0	MHz
Clock Capacitance (Note 12)	$C\phi A$	—	350	450	pF
Shift Gate Capacitance	C_{SH}	—	50	100	pF
Reset Gate Capacitance	$C_{\overline{RS}}$	—	10	20	pF
Clamp Gate Capacitance	$C_{\overline{CP}}$	—	10	20	pF

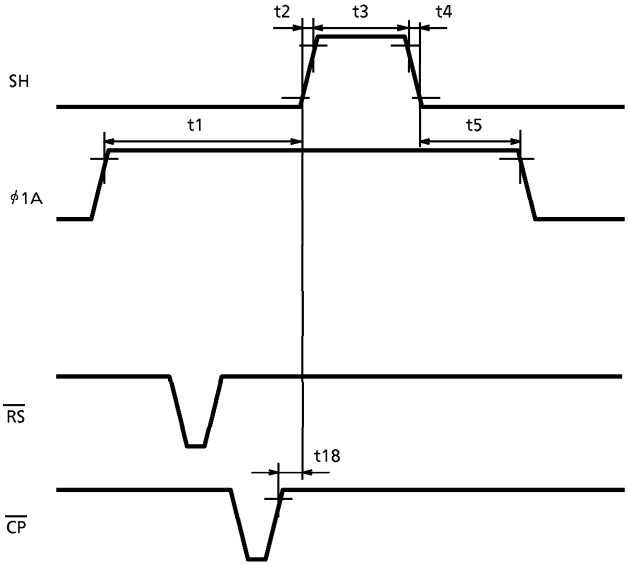
(Note 12) : V_{OD} = 12 V

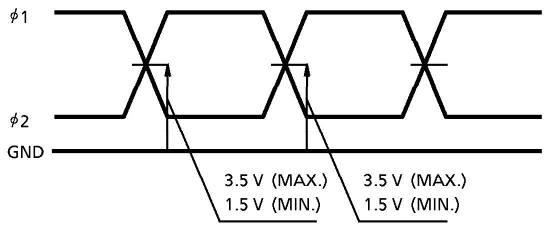
TIMING CHART

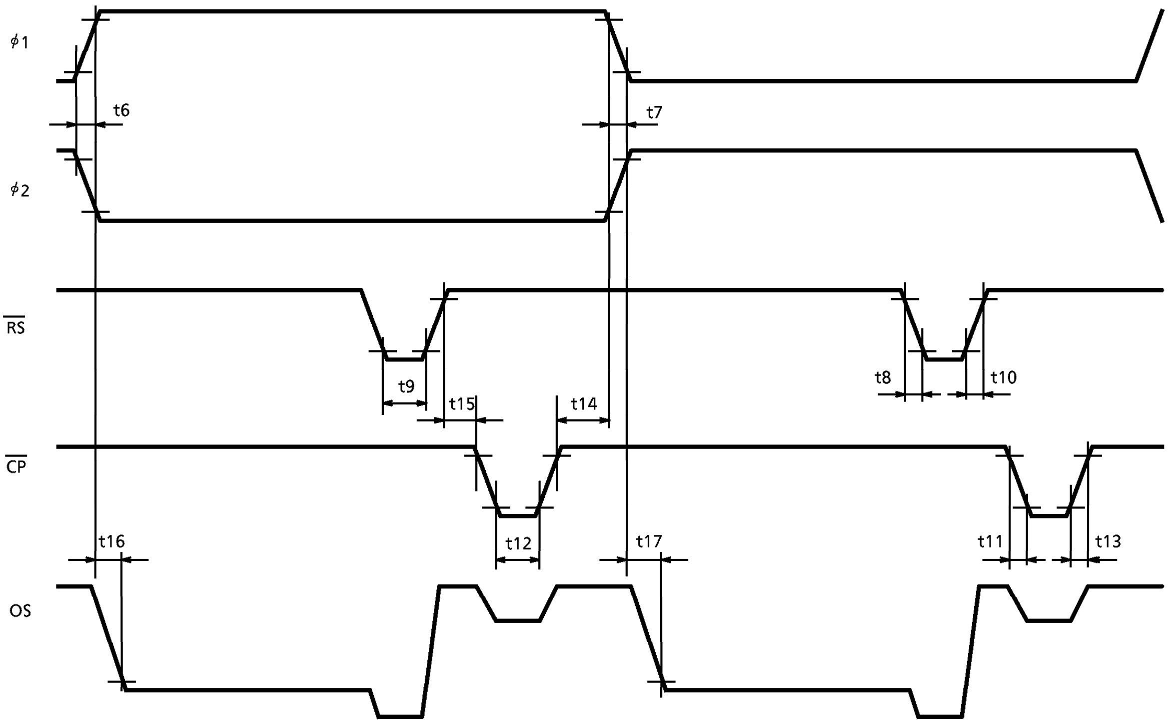


TCD2903D−7

TIMING REQUIREMENTS





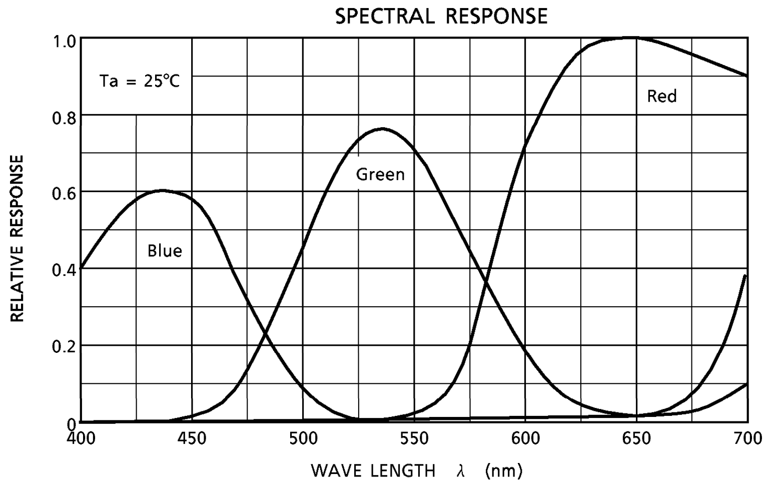


TIMING REQUIREMENTS (Cont'd)

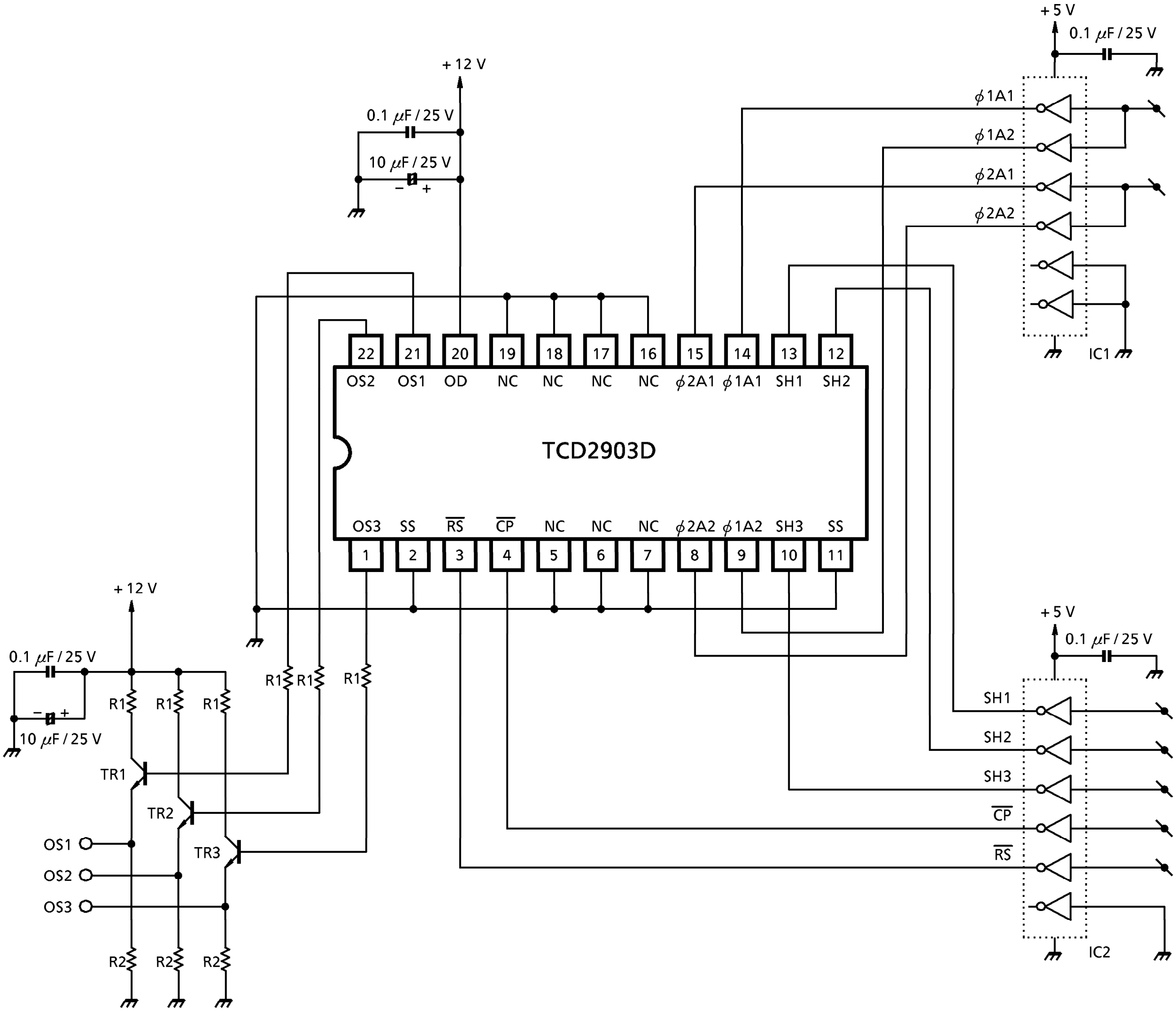
CHARACTERISTIC	SYMBOL	MIN.	TYP. (Note 13)	MAX.	UNIT
Pulse Timing of SH and ϕ1A	t1	110	1000	—	ns
	t5	200	1000	—	
SH Pulse Rise Time, Fall Time	t2, t4	0	50	—	ns
SH Pulse width	t3	1000	2000	—	ns
ϕ1, ϕ2 Pulse Rise Time, Fall Time	t6, t7	0	50	—	ns
$\overline{RS}$ Pulse Rise Time, Fall Time	t8, t10	0	20	—	ns
$\overline{RS}$ Pulse width (Note 14)	t9	15 (20)	100	—	ns
$\overline{CP}$ Pulse Rise Time, Fall Time	t11, t13	0	20	—	ns
$\overline{CP}$ Pulse width	t12	25	100	—	ns
Pulse Timing of ϕ1A, ϕ2A and $\overline{CP}$	t14	10	40	—	ns
Pulse Timing of $\overline{RS}$ and $\overline{CP}$	t15	0	100	—	ns
Video Data Delay Time (Note 15)	t16, t17	—	20	—	ns
Pulse Timing of SH and $\overline{CP}$	t18	0	500	—	ns

(Note 13) : TYP. is the case of $f_{\overline{RS}} = 1.0$ MHz.
(Note 14) : Line clamp Mode inside ( ).
(Note 15) : Load resistance is 100 kΩ.

TYPICAL SPECTRAL RESPONSE



TYPICAL DRIVE CIRCUIT



IC1, 2 : TC74HC04AP
TR1, 2, 3 : 2SC1815-Y
R1 : 150 Ω
R2 : 1500 Ω

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 N_2.
   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.

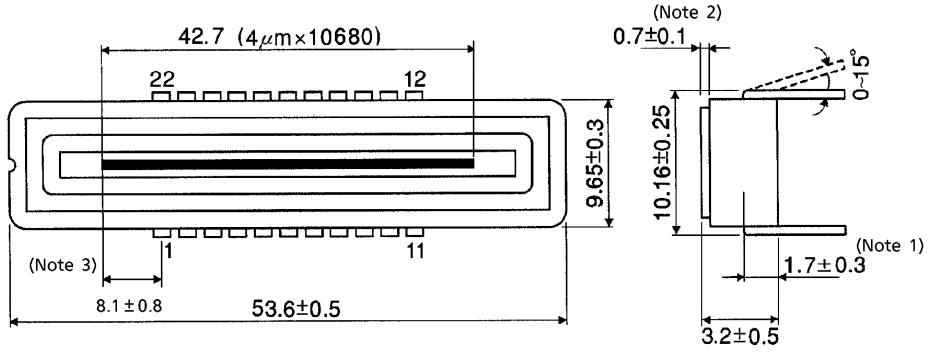
3. Incident Light

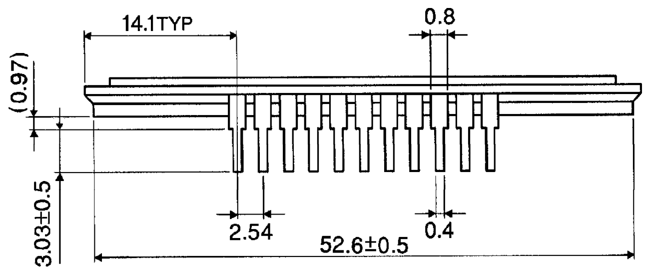
   CCD sensor is sensitive to infrared light.
   Note that infrared light component degrades resolution and PRNU of CCD sensor.

4. Lead Frame Forming
   Since this package is not strong against mechanical stress, you should not reform the lead frame.
   We recommend to use a IC-inserter when you assemble to PCB.

PACKAGE DIMENSIONS

WDIP22-G-400-2.54D (F) Unit : mm





(Note 1) TOP OF CHIP TO BOTTOM OF PACKAGE
(Note 2) GLASS THICKNESS (n = 1.5)
(Note 3) No.1 SENSOR ELEMENT (S1) TO CENTER OF No.1 PIN.

Weight : 5.2 g (Typ.)