

TOSHIBA CCD LINEAR IMAGE SENSOR CCD (Charge Coupled Device)

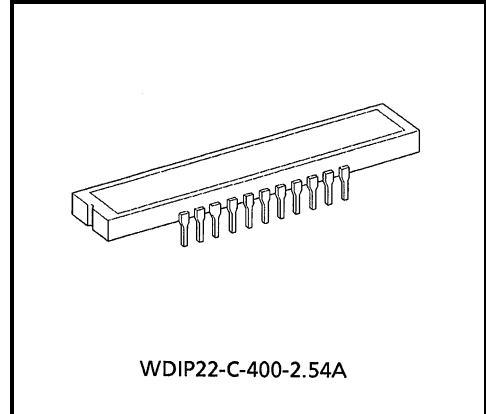
TCD2300C

The TCD2301C which includes sample-and-hold circuit and clamp circuit is a high sensitive and low dark current 3648 elements \times 3 lines CCD color image sensor. The sensor is designed for color scanner.

The device contains a row of 3648 element \times 3 lines photodiodes which provide a 16 lines / mm across a A4 size paper. The device is operated by 5V pulse, and 12V power supply.

FEATURES

- Number of Image Sensing Elements : 3648 elements \times 3 lines
- Image Sensing Element Size : 8 μ m by 8 μ m on 8 μ m centers
- Photo Sensing Region : High sensitive pn photodiode
- Distance Between Photodiode Array : 96 μ m (12 Lines)
- Clock : 2 phase (5V)
- Internal Circuit : Sample & Hold circuit, Clamp circuit
- Package : 22 pin DIP
- Color Filter : Red, Green, Blue



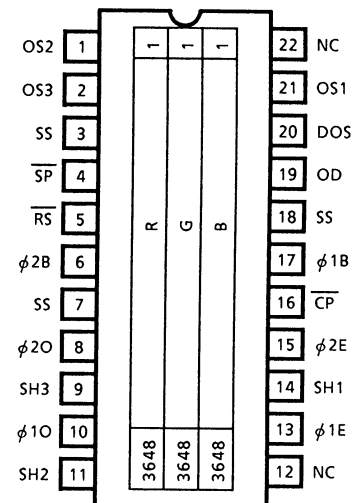
Weight: 4.8g (Typ.)

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}		
Sample and Hold Pulse Voltage	V_{SP}		
Switch Pulse Voltage	V_{SG}		
Clamp Pulse Voltage	V_{CP}		
Power Supply Voltage	V_{OD}	-0.3~15	V
Operating Temperature	T_{opr}	0~60	$^{\circ}$ C
Storage Temperature	T_{stg}	-25~85	$^{\circ}$ C

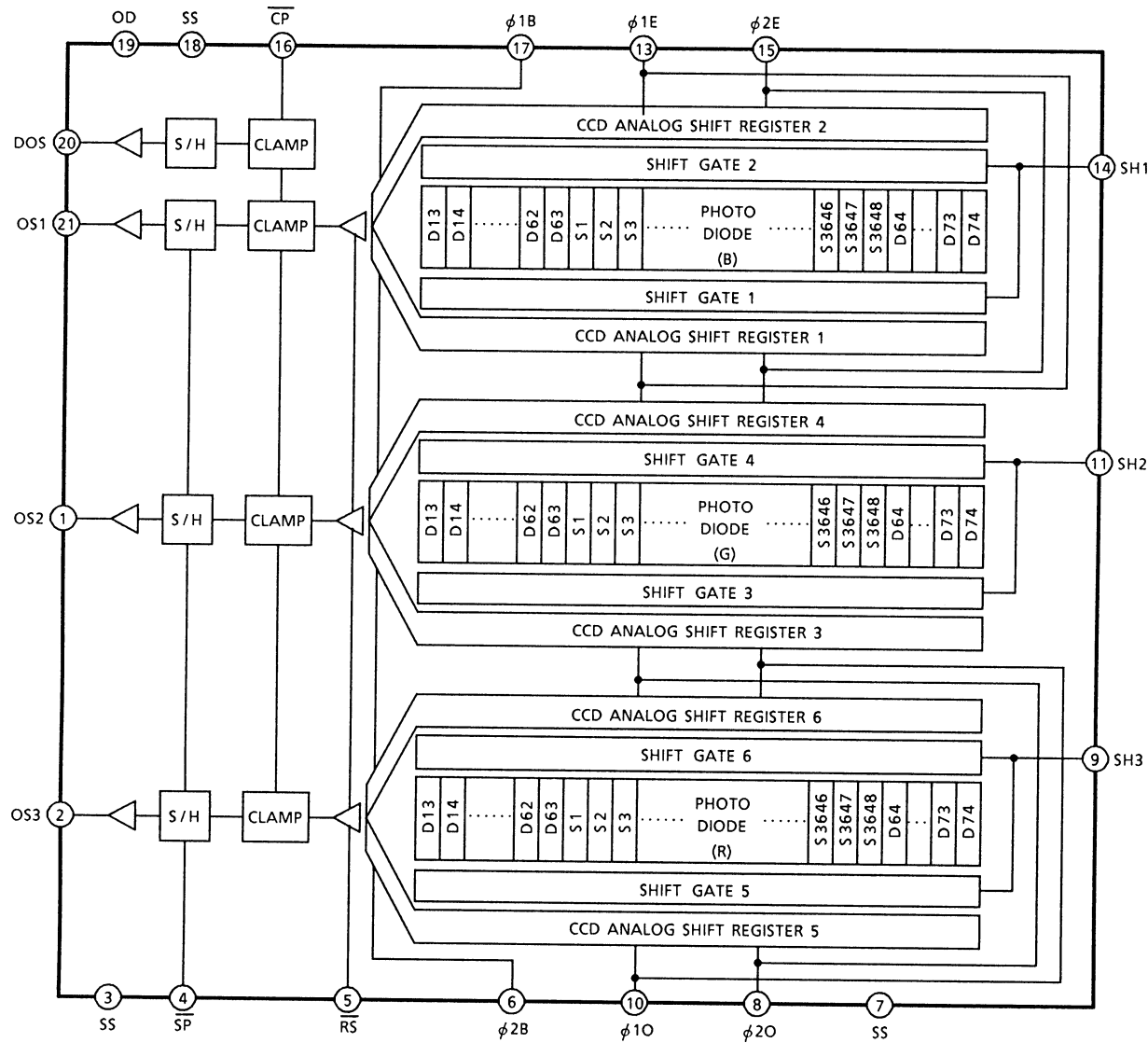
Note 1: All voltage are with respect to SS terminals (Ground).

PIN CONNECTION



(TOP VIEW)

CIRCUIT DIAGRAM



PIN NAMES

$\phi 1E$	Clock 1 (Phase 1)	SH3	Shift Gate 3
$\phi 2E$	Clock 2 (Phase 2)	\overline{RS}	Reset Gate
$\phi 1O$	Clock 1 (Phase 1)	\overline{SP}	Sample and Hold Gate
$\phi 2O$	Clock 2 (Phase 2)	\overline{CP}	Clamp Gate
$\phi 1B$	Final Stage Clock (Phase 1)	OS1	Signal Output 1
$\phi 2B$	Final Stage Clock (Phase 2)	OS2	Signal Output 2
SS	Ground	OS3	Signal Output 3
OD	Power	DOS	Compensation Output
SH1	Shift Gate 1	NC	Non Connection
SH2	Shift Gate 2		

OPTICAL / ELECTRICAL CHARACTERISTICS

(Ta = 25°C, V_{OD} = 12 V, V_φ = V_{RS} = V_{SH} = V_{CP} = 5 V (Pulse), f_φ = 0.51 MHz, f_{RS} = 1.0 MHz,
Load Resistance = 100 kΩ, t_{INT} (Integration Time) = 10 ms,
Light Source = A Light Source + CM500 Filter (t = 1.0 mm))

CHARACTERISTIC	SYMBOL	MIN	TYP.	MAX	UNIT	NOTE
Sensitivity (Red)	RR	—	1.1	—	V / lx·s	(Note 2)
Sensitivity (Green)	RG	—	1.4	—	V / lx·s	(Note 2)
Sensitivity (Blue)	RB	—	0.5	—	V / lx·s	(Note 2)
Photo Response Non Uniformity	PRNU (1)	—	10	20	%	(Note 3)
	PRNU (3)	—	3	12	mV	(Note 4)
Register Imbalance	RI	—	—	3	%	(Note 5)
Saturation Output Voltage	V _{SAT}	1.0	1.5	—	V	(Note 6)
Saturation Exposure	SE	—	1.07	—	lx·s	(Note 7)
Dark Signal Voltage	V _{DRK}	—	—	2.0	mV	(Note 8)
Dark Signal Non Uniformity	DSNU	—	—	3.0	mV	(Note 9)
Total Transfer Efficiency	TTE	92	—	—	%	
Output Impedance	Z _O	—	0.5	1.0	kΩ	
DC Power Dissipation	P _D	—	500	750	mW	
DC Offset Voltage	V _{OS}	—	6.0	—	V	(Note 10)
DC Compensation Output Voltage	V _{DOS}	—	6.0	—	V	(Note 10)
DC Mismatch Voltage	V _{DOS} - V _{DOS}	—	100	300	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.

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

When $\bar{\chi}$ is average of total signal output and $\Delta\bar{\chi}$ is the maximum deviation from $\bar{\chi}$. The amount of incident light is shown below.

$$\text{Red} = \frac{1}{2} \text{ SE}$$

$$\text{Green} = \frac{1}{2} \text{ SE}$$

$$\text{Blue} = \frac{1}{4} \text{ SE}$$

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

Note 5: RI 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.

$$RI = \frac{\sum_{n=1}^{3647} |\chi_n - \chi_{n+1}|}{3647 \times \bar{\chi}} \times 100(\%)$$

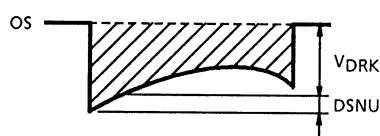
Where χ_n and χ_{n+1} are signal outputs of each pixel. $\bar{\chi}$ is average of total signal outputs.

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

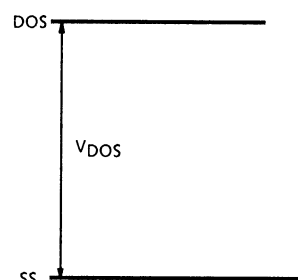
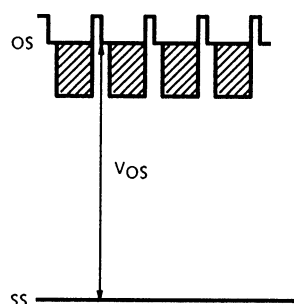
Note 7: Definition of SE: $SE = \frac{V_{SAT}}{R_G}$

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

Note 9: DSNU is defined as different voltage between V_{DRK} and V_{MDK} when V_{MDK} is maximum dark voltage.



Note 10: DC Signal Output Voltage and DC Compensation Output Voltage are defined as follows:



OPERATING CONDITION

CHARACTERISTIC		SYMBOL	MIN	TYP.	MAX	UNIT	NOTE
Clock Pulse Voltage	"H" Level	$V_{\phi 0, E}$	4.5	5.0	5.5	V	
	"L" Level		0.0	0.2	0.5		
Final Stage Clock Pulse Voltage	"H" Level	$V_{\phi B}$	4.5	5.0	5.5	V	
	"L" Level		0.0	0.2	0.5		
Shift Pulse Voltage	"H" Level	V_{SH}	$V_{\phi 0, E "H"} - 1$	$V_{\phi 0, E "H"}$	$V_{\phi 0, E "H"}$	V	(Note 11)
	"L" Level		0.0	0.2	0.5		
Reset Pulse Voltage	"H" Level	V_{RS}	4.5	5.0	5.5	V	
	"L" Level		0.0	0.2	0.5		
Sample and Hold Pulse Voltage	"H" Level	V_{SP}	4.5	5.0	5.5	V	(Note 12)
	"L" Level		0.0	0.2	0.5		
Clamp Pulse Voltage	"H" Level	V_{CP}	4.5	5.0	5.5	V	(Note 13)
	"L" Level		0.0	0.2	0.5		
Power Supply Voltage		V_{OD}	11.4	12.0	13.0	V	

Note 11: $V_{\phi 0, E "H"}$ means the high level voltage of $V_{\phi 0}$ and $V_{\phi E}$ when SH pulse is high level.

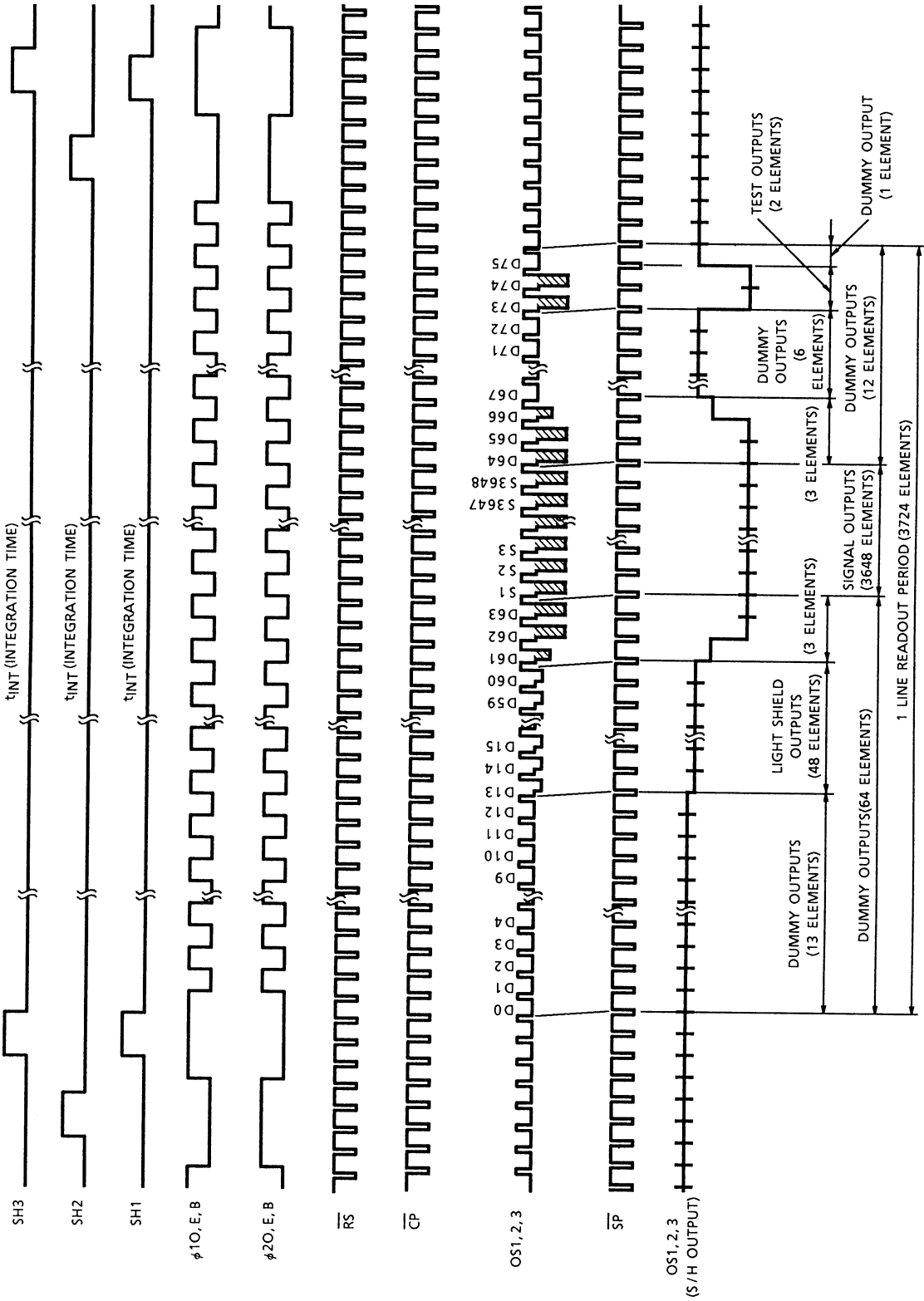
Note 12: Supply "L" level to \overline{SP} terminal when sample-and-hold circuit is not used.

Note 13: Supply \overline{SH} (inversed pulse of SH) to \overline{CP} terminal when clamp circuit is not used.

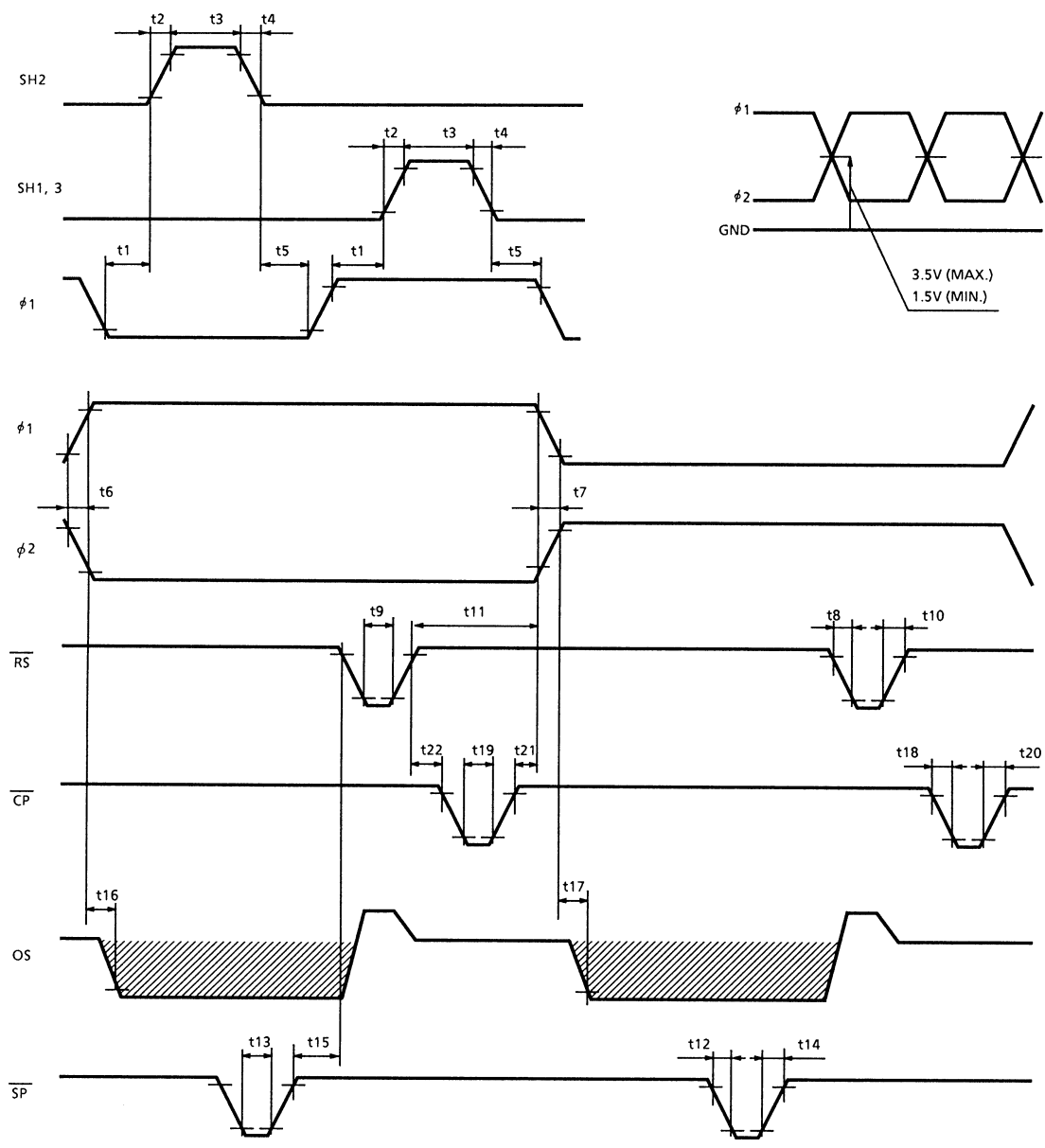
CLOCK CHARACTERISTICS (Ta = 25°C)

CHARACTERISTIC	SYMBOL	MIN	TYP.	MAX	UNIT
Clock Pulse Frequency	f_{ϕ}	—	0.5	2.0	MHz
Reset Pulse Frequency	$f_{\overline{RS}}$	—	1.0	4.0	MHz
Sample and Hold Pulse Frequency	$f_{\overline{SP}}$	—	1.0	4.0	MHz
Clamp Pulse Frequency	$f_{\overline{CP}}$	—	1.0	4.0	MHz
Clock Capacitance	$C_{\phi 0, E}$	—	500	—	pF
Final Stage Clock Capacitance	$C_{\phi B}$	—	10	—	pF
Shift Gate Capacitance	C_{SH}	—	200	—	pF
Reset Gate Capacitance	$C_{\overline{RS}}$	—	10	—	pF
Sample and Hold Gate Capacitance	$C_{\overline{SP}}$	—	10	—	pF
RGB Switch Pulse Capacitance	$C_{\overline{SG}}$	—	10	—	pF
Clamp Gate Capacitance	$C_{\overline{CP}}$	—	10	—	pF

TIMING CHART



TIMING REQUIREMENTS



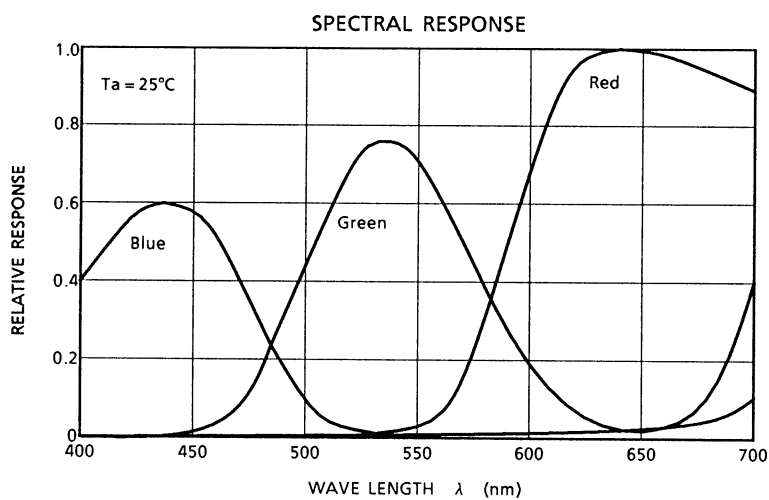
TIMING REQUIREMENTS (Cont.)

CHARACTERISTIC	SYMBOL	MIN.	TYP. (Note 14)	MAX.	UNIT
Pulse Timing of SH and $\phi_{1,0}$	t1, t5	0	1000	—	ns
SH Pulse Rise Time, Fall Time	t2, t4	0	50	—	ns
SH Pulse Width	t3	500	1000	—	ns
ϕ_1, ϕ_2 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	t9	40	250	—	ns
Pulse Timing of ϕ_{1B}, ϕ_{2B} and \overline{RS}	t11	120	300	—	ns
\overline{SP} Pulse Rise Time, Fall Time	t12, t14	0	20	—	ns
\overline{SP} Pulse Width	t13	70	100	—	ns
Pulse Timing of \overline{SP} and \overline{RS}	t15	0	50	—	ns
Video Data Delay Time (Note 15)	t16, t17	—	70	—	ns
\overline{CP} Pulse Rise Time, Fall Time	t18, t20	0	20	—	ns
\overline{CP} Pulse Width	t19	100	200	—	ns
Pulse Timing of ϕ_{1B}, ϕ_{2B} and \overline{CP}	t21	20	50	—	ns
Pulse Timing of \overline{RS} and \overline{CP}	t22	0	50	—	ns

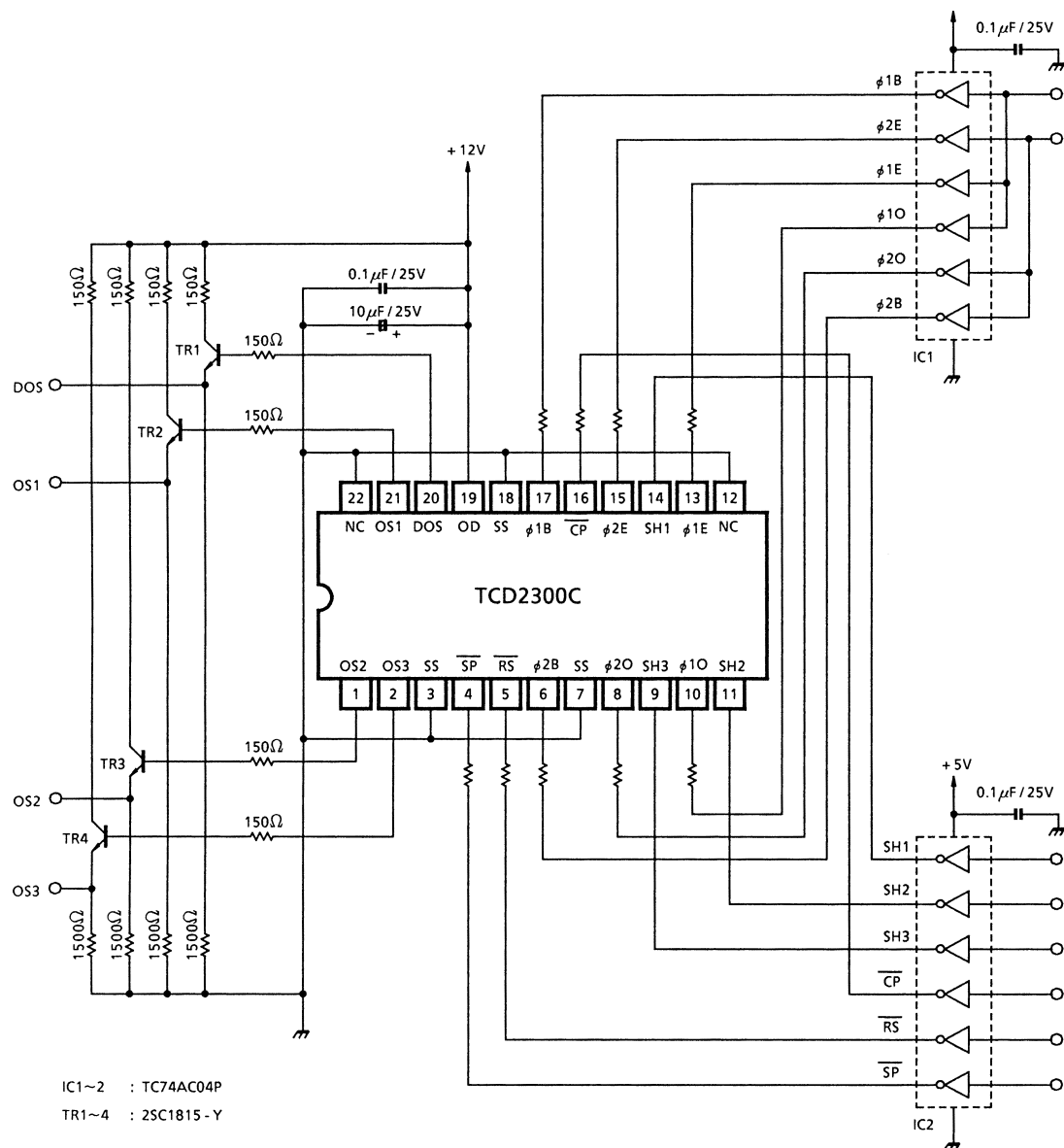
Note 14: TYP. is the case of $f_{\overline{RS}} = 1.0\text{MHz}$

Note 15: Load resistance is $100\text{k}\Omega$

TYPICAL SPECTRAL RESPONSE



TYPICAL DRIVE CIRCUIT



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 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 pliers 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.

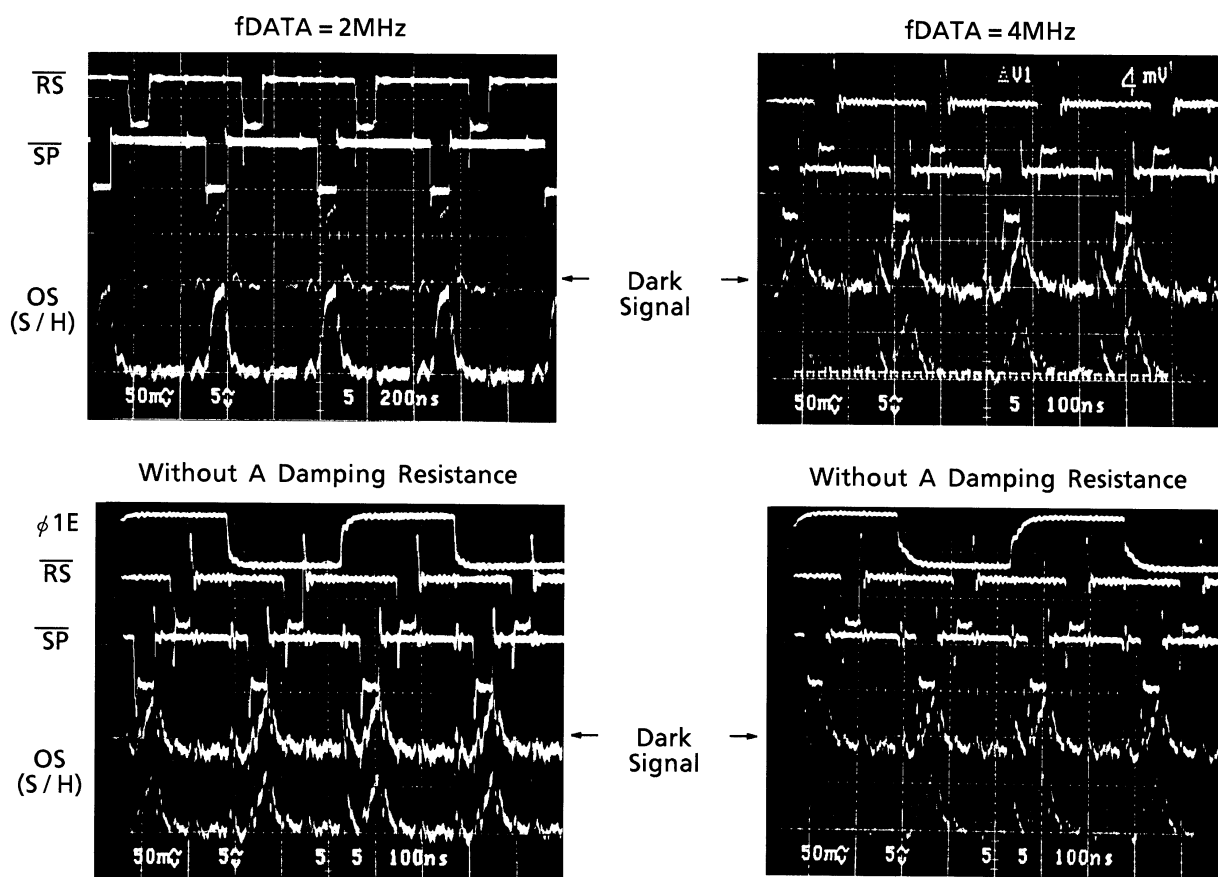
Using a soldering iron, complete soldering within ten seconds for lead temperatures of up to 260°C, or within three seconds for lead temperatures of up to 350°C.

<Application note>

EVEN-ODD UNBALANCE

When High-speed driving standard level of odd-even bits is often unbalanced. For that reason when high-speed driving CCD you should put a damping resistance in input ϕ pin.

1. WAVEFORM (Sample and Hold ON)



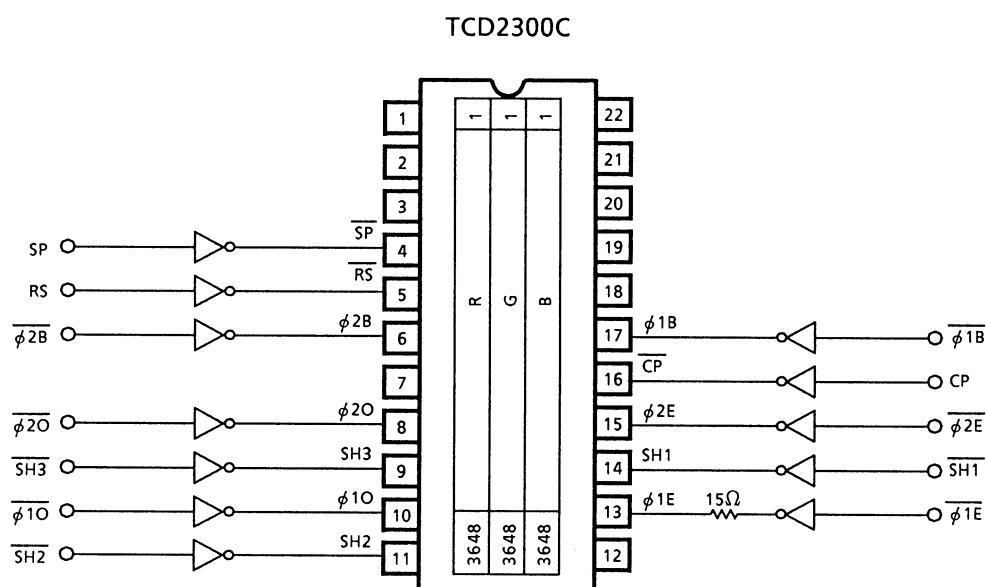
2. MEASUREMENT CONDITION

$T_a = 25^\circ\text{C}$, $V_{AD} = V_{DD} = 12\text{V}$,
 $V_{\phi 1E} = V_{\phi 10} = V_{\phi 1B} = V_{\phi 2E} = V_{\phi 20} = V_{\phi 2B} = V_{\overline{RS}} = V_{\overline{CP}} = V_{\overline{SP}} = V_{SH1} = V_{SH2} = V_{SH3} = 5\text{V}$ (Pulse),
 Light Source = Daylight Fluorescent Lamp.

Oscilloscope	Tektronix	2465A (400MHz)
Probe	P6136	10.8pF

3. DRIVE CIRCUIT (with a damping resistance)

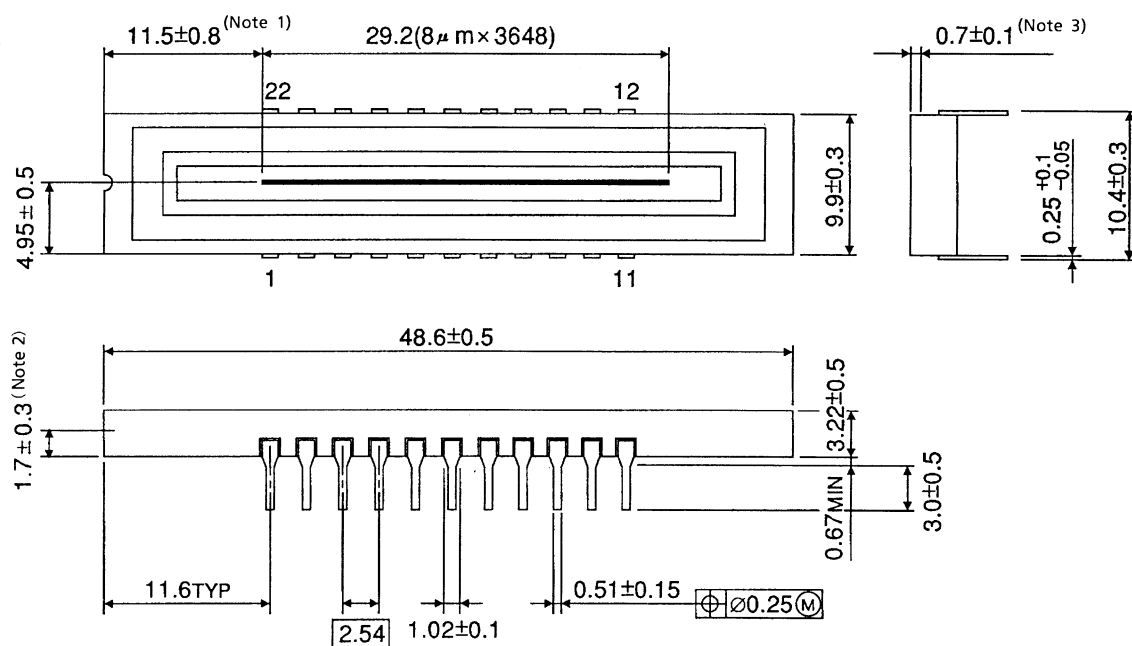
Please put a damping resistance in input $\phi 1E$ (15Ω).



PACKAGE DIMENSIONS

WDIP22-C-400-2.54A (C)

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 THICKNESS ($n = 1.5$)

Weight: 4.8g (Typ.)

RESTRICTIONS ON PRODUCT USE

000707EBA

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