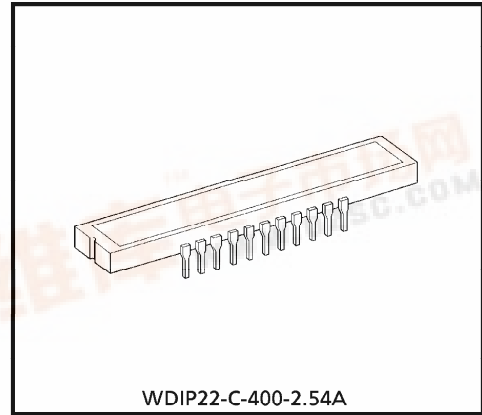


TOSHIBA CCD LINEAR IMAGE SENSOR CCD(Charge Coupled Device)

TCD2301C

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

The device contains a row of 3648 elements×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.



Weight : 4.8g (Typ.)

FEATURES

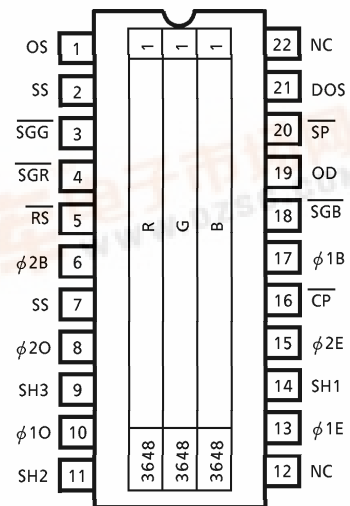
- Number of Image Sensing Elements : 3648 elements×3 lines
- Image Sensing Element Size : 8μm by 8μm on 8μm centers
- Photo Sensing Region : High sensitive pn photodiode
- Distance Between Photodiode Array : 96μm (12 Lines)
- Clock : 2 phase (5V)
- Internal Circuit : Sample & Hold circuit, Clamp circuit
- Package : 22 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} | | |
| 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 | °C |
| Storage Temperature | T_{stg} | - 25~85 | °C |

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

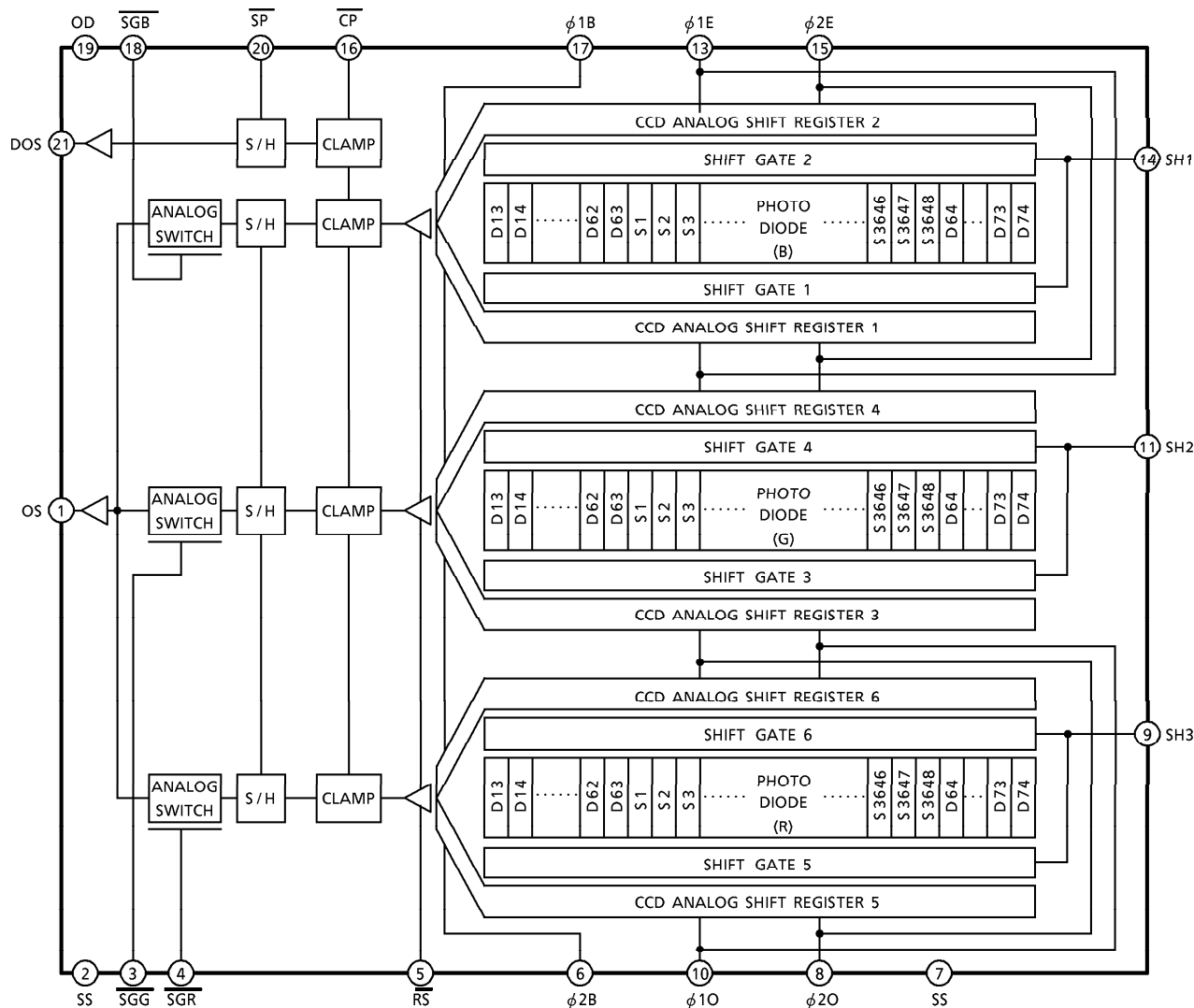
PIN CONNECTIONS



(TOP VIEW)

961001EBA2

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) | SP | Sample and Hold Gate |
| $\phi 2O$ | Clock 2 (Phase 2) | SGR | R Switch |
| $\phi 1B$ | Final Stage Clock (Phase 1) | SGG | G Switch |
| $\phi 2B$ | Final Stage Clock (Phase 2) | SGB | B Switch |
| SS | Ground | CP | Clamp Gate |
| OD | Power | OS | Signal Output |
| SH1 | Shift Gate 1 | DOS | Compensation Output |
| SH2 | Shift Gate 2 | NC | Non Connection |

961001EBA2'

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- The information contained herein is subject to change without notice.

OPTICAL / ELECTRICAL CHARACTERISTICS

(Ta = 25°C, V_{OD} = 12V, V_φ = V_{RS} = V_{SH} = V_{CP} = 5V (Pulse), f_φ = 0.5MHz, f_{RS} = 1.0MHz, Load Resistance = 100kΩ, t_{INT} (Integration Time) = 10ms, Light Source = A Light Source + CM500 Filter (t = 1.0mm))

| 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 _{OS} -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.

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

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

The amount of the incident light is shown below.

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

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

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

(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.

$$RI = \frac{\sum_{n=1}^{3647} |x_n - x_{n+1}|}{3647 \times \bar{x}} \times 100 (\%)$$

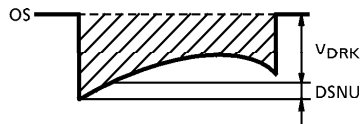
Where x_n and x_{n+1} are signal outputs of each pixel. \bar{x} is average of total signal outputs.

(Note 6) V_{SAT} is defined as minimum Saturation Output Voltage of all effective pixels.

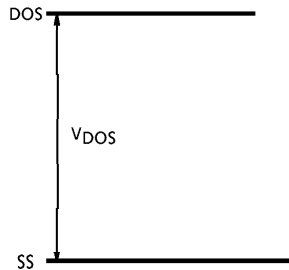
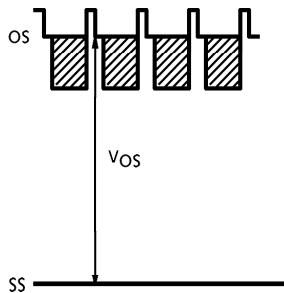
(Note 7) Definition of SE : $SE = \frac{V_{SAT}}{RG}$

(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} | $V_{\phi 0, E} \text{ "H" } - 1$ | $V_{\phi 0, E} \text{ "H" }$ | $V_{\phi 0, E} \text{ "H" }$ | V | (Note 11) |
| | "L" Level | | 0.0 | 0.2 | 0.5 | | |
| Reset Pulse Voltage | "H" Level | $\overline{V_{RS}}$ | 4.5 | 5.0 | 5.5 | V | |
| | "L" Level | | 0.0 | 0.2 | 0.5 | | |
| Sample and Hold Pulse Voltage | "H" Level | $\overline{V_{SP}}$ | 4.5 | 5.0 | 5.5 | V | (Note 12) |
| | "L" Level | | 0.0 | 0.2 | 0.5 | | |
| RGB Switch Pulse Voltage | "H" Level | $\overline{V_{SG}}$ | 4.5 | 5.0 | 5.5 | V | |
| | "L" Level | | 0.0 | 0.2 | 0.5 | | |
| Clamp Pulse Voltage | "H" Level | $\overline{V_{CP}}$ | 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) $V_{\phi 0, E} \text{ "H"}$ means the high level voltage of $V_{\phi 0}$ and $V_{\phi E}$ when SH pulse is high level.

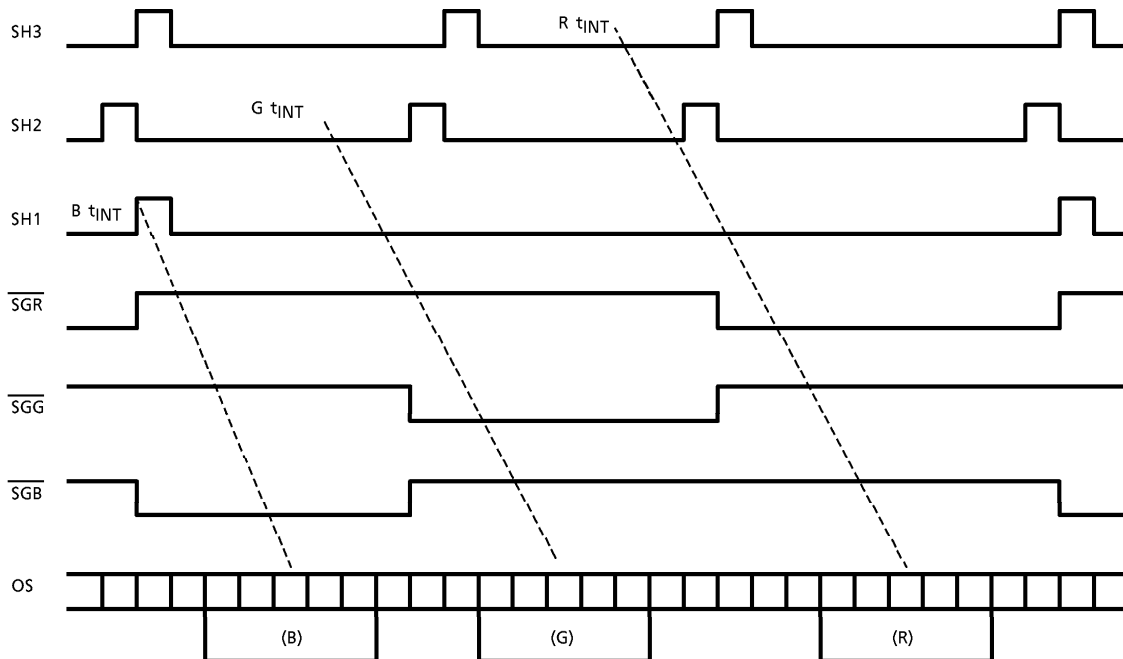
(Note 12) Supply "L" level to \overline{SP} terminal when sample-and-hold circuit is not used.

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

CLOCK CHARACTERISTICS (Ta = 25°C)

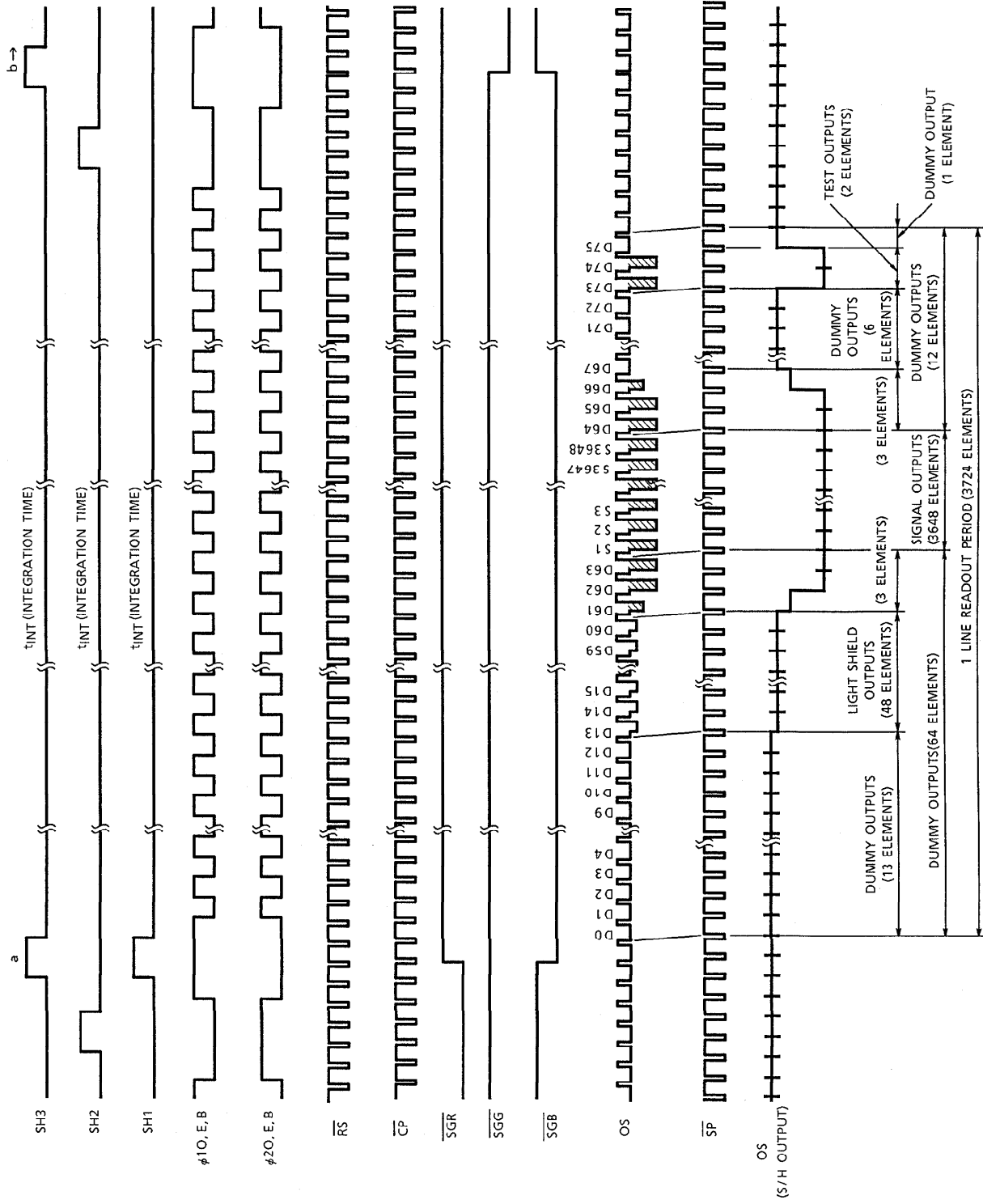
| CHARACTERISTIC | SYMBOL | MIN. | TYP. | MAX. | UNIT |
|----------------------------------|---------------------|------|------|------|------|
| Clock Pulse Frequency | f_{ϕ} | — | 0.5 | 2.0 | MHz |
| Reset Pulse Frequency | $f_{\overline{RS}}$ | — | 1.0 | 4.0 | MHz |
| Sample and Hold Pulse Frequency | $f_{\overline{SP}}$ | — | 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 |

APPLICATION NOTE

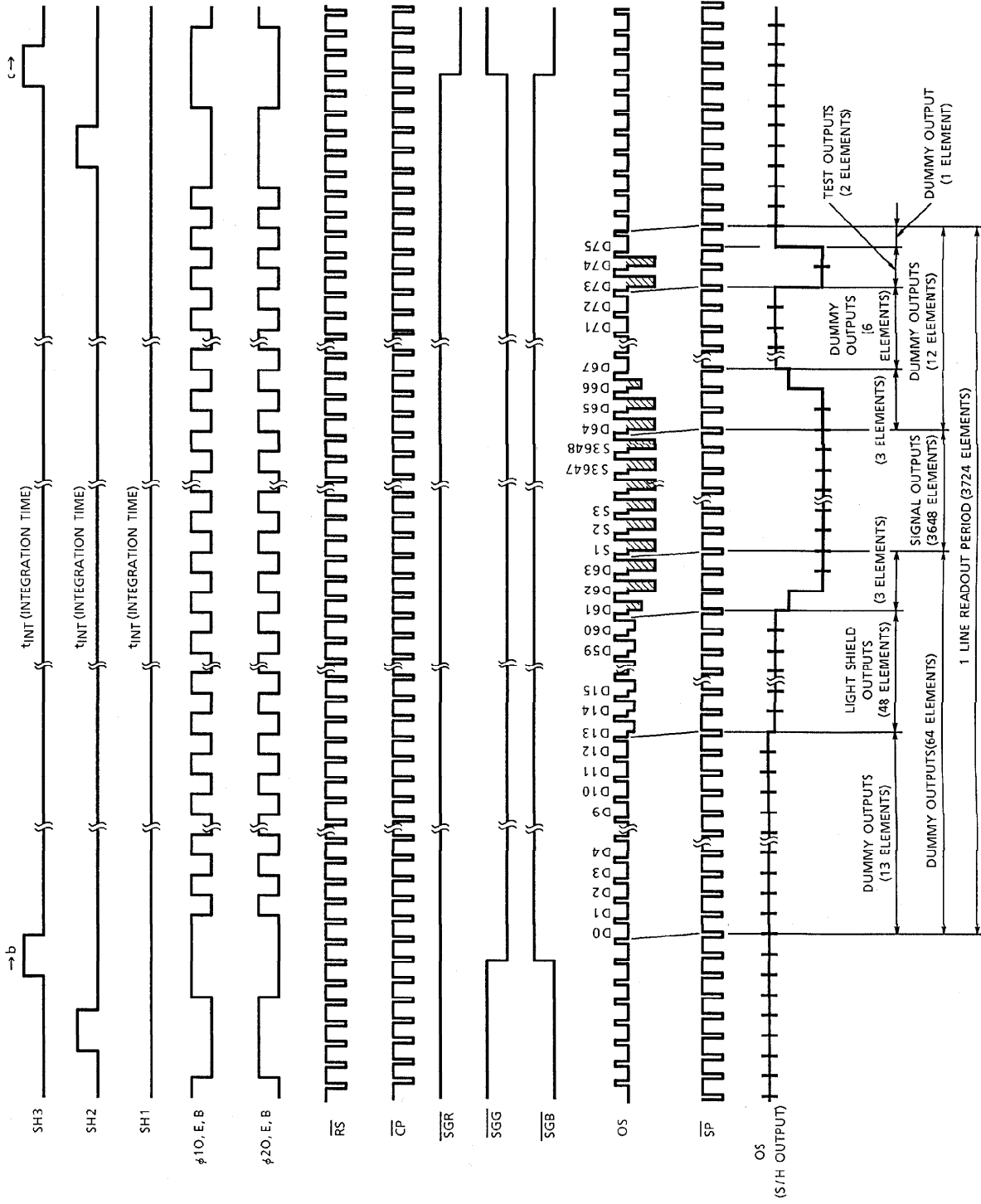


- a) You drive TCD2301C by above timing, so you can get the three output signal of nearly equal level.
- b) In switching " \overline{SGR} ", " \overline{SGG} " and " \overline{SGB} ", asynchronous switching operation with clock pulse, shift pulse or any other input pulses timing, is possible. (It is not necessary to switch above timing shown in figure.) But care should be taken not to make more than two switches to "L" level at the same time.

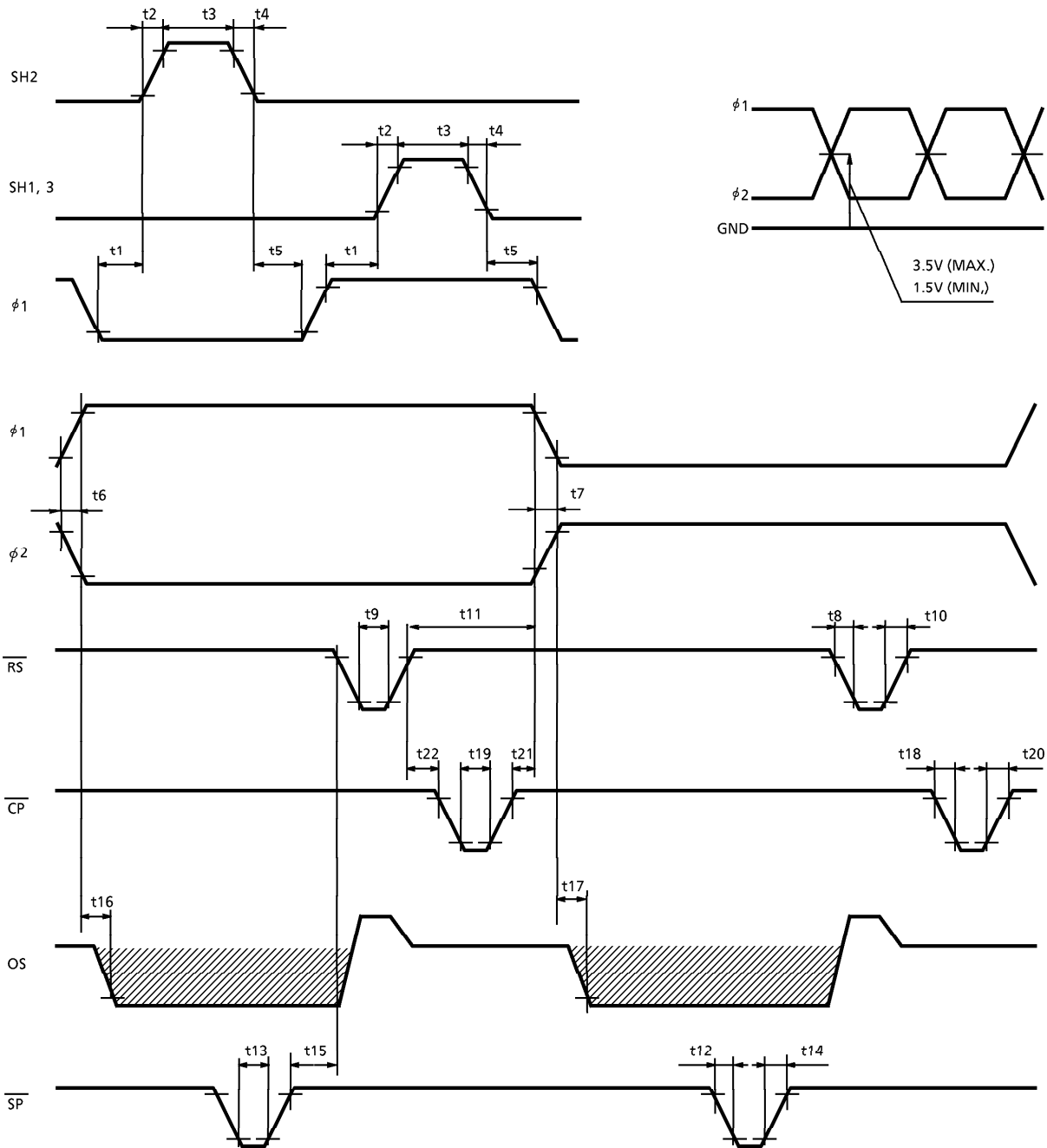
TIMING CHART 1



TIMING CHART 2



TIMING REQUIREMENTS



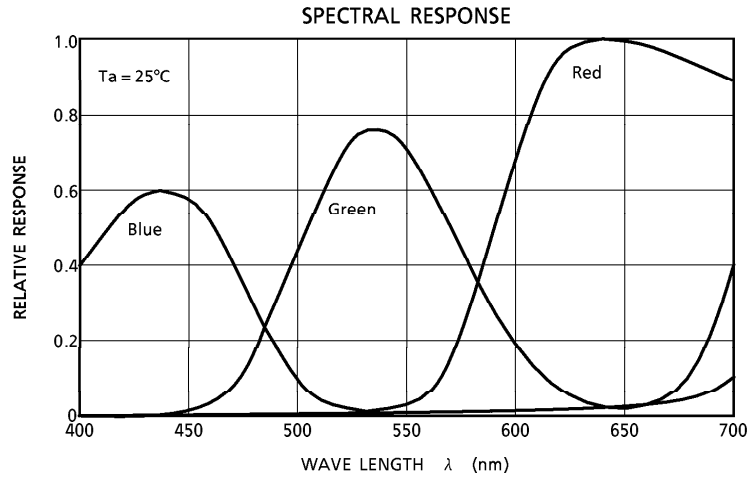
TIMING REQUIREMENTS (Cont'd)

| CHARACTERISTIC | SYMBOL | MIN. | TYP. (Note 14) | MAX. | UNIT |
|---|----------|------|-------------------|------|------|
| Pulse Timing of SH and $\phi 0$, E | t1, t5 | 0 | 1000 | — | ns |
| SH Pulse Rise Time, Fall Time | t2, t4 | 0 | 50 | — | ns |
| SH Pulse Width | t3 | 500 | 1000 | — | ns |
| $\phi 1$, $\phi 2$ 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 $\phi 1B$, $\phi 2B$ 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 $\phi 1B$, $\phi 2B$ and \overline{CP} | t21 | 20 | 50 | — | ns |
| Pulse Timing of \overline{RS} and \overline{CP} | t22 | 0 | 50 | — | ns |

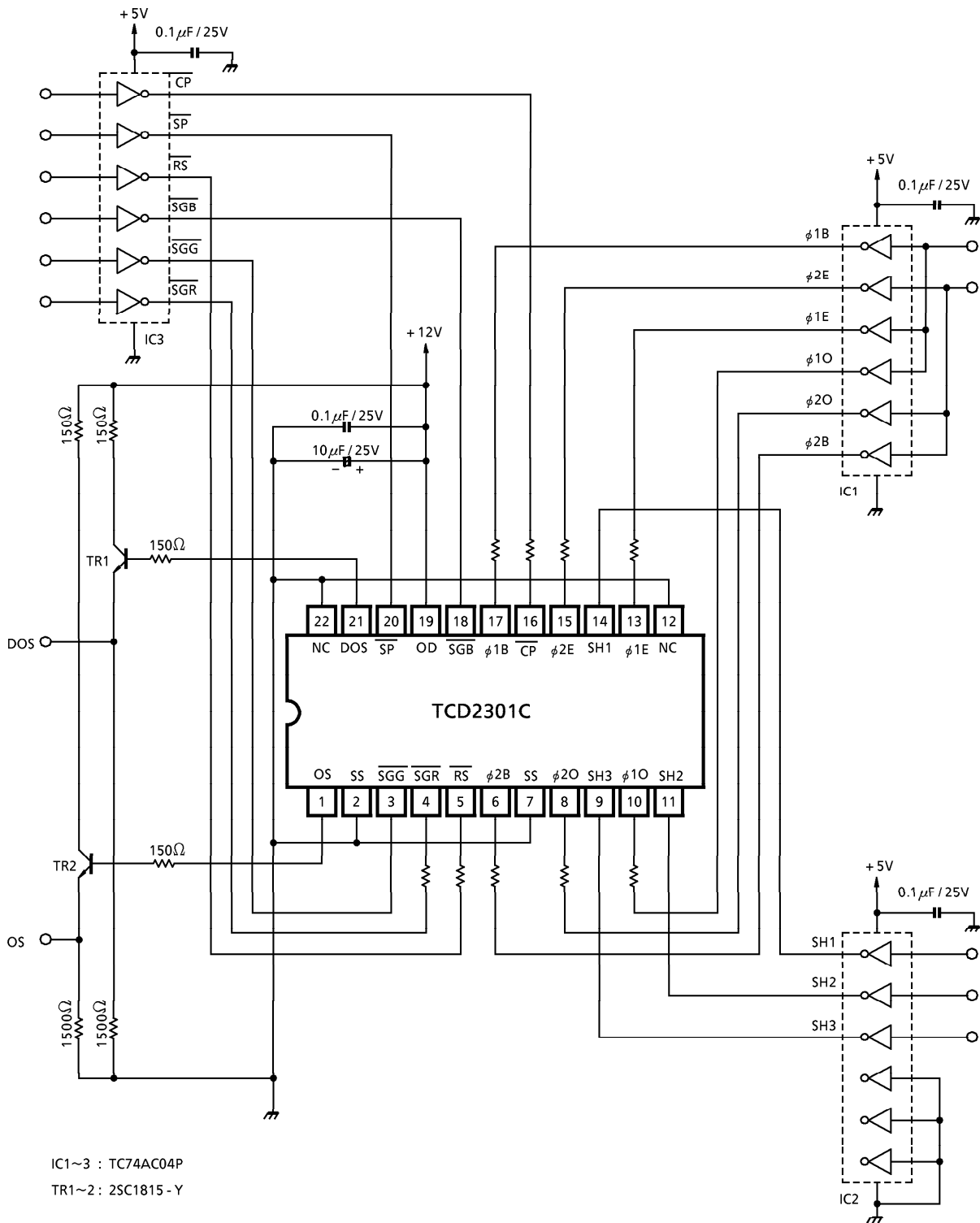
(Note 14) TYP. is the case of $f_{\overline{RS}} = 1.0\text{MHz}$

(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.

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 shoutagainst mechanical stress, you should not reform the lead frame.

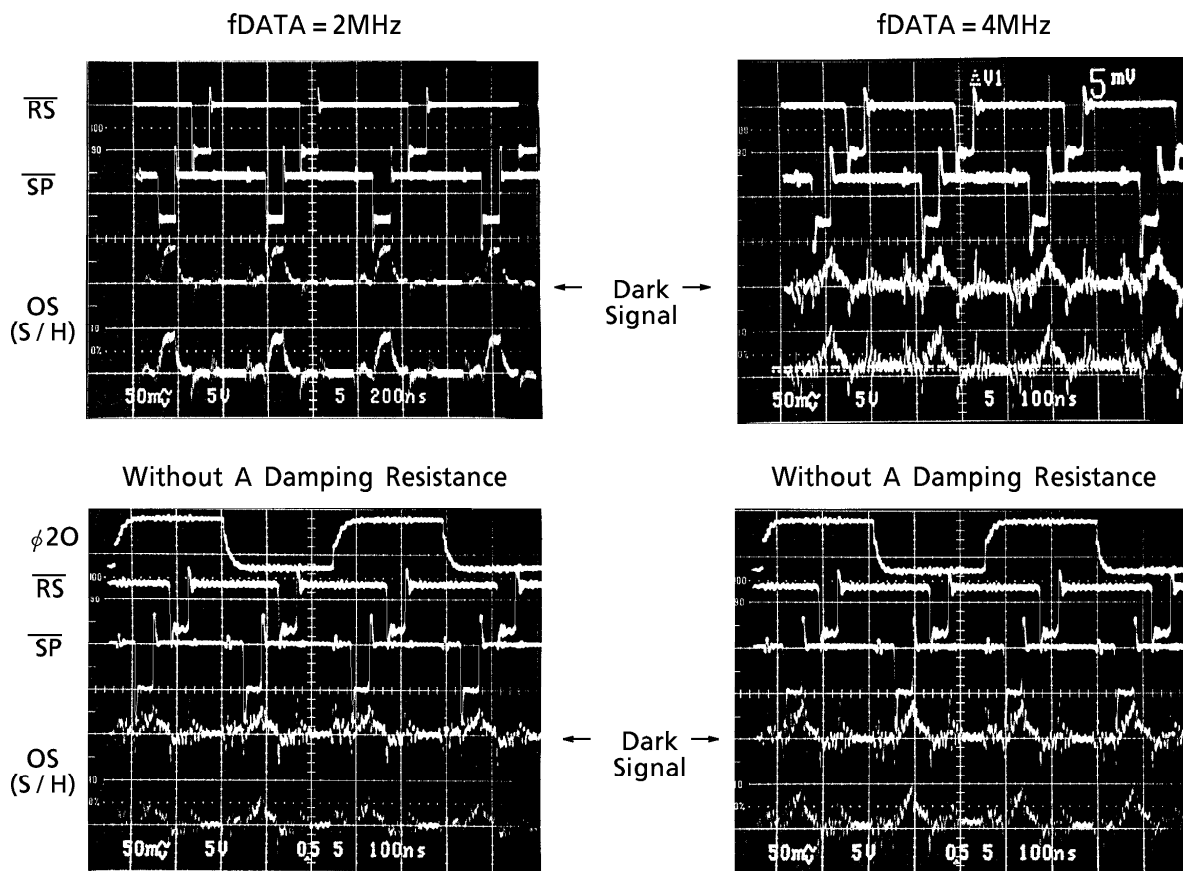
We recommend to use a IC-inserter when you assemble to PCB.

<Application note>

EVEN-ODD UNBALANCE

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

1. WAVEFORM (Sample and Hold ON)



2. MEASUREMENT CONDITION

$T_a = 25^\circ\text{C}$, $V_{AD} = V_{DD} = 12\text{V}$,

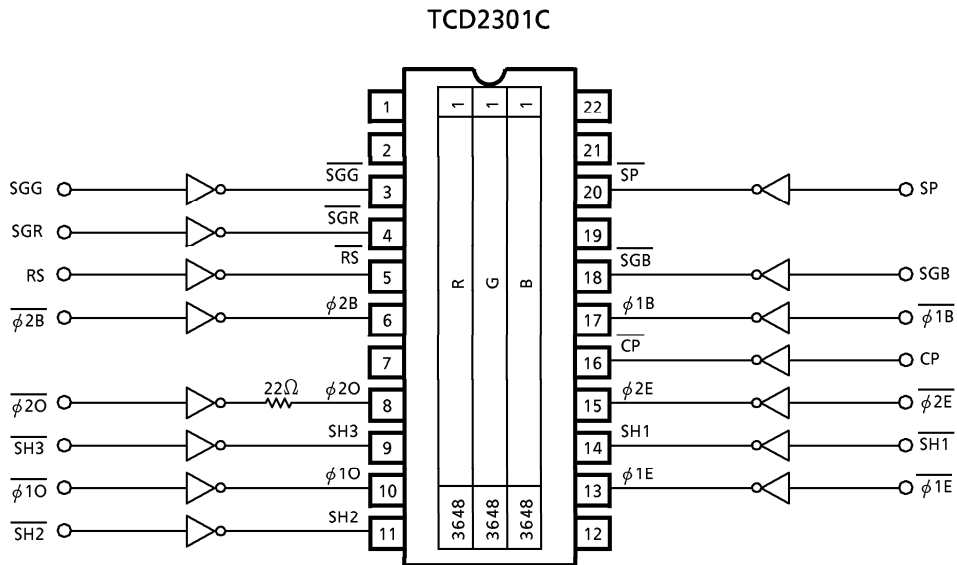
$V_{\phi 1E} = V_{\phi 10} = V_{\phi 1B} = V_{\phi 2E} = V_{\phi 20} = V_{\phi 2B} = V_{\overline{RS}} = V_{\overline{CP}} = V_{\overline{SP}} = V_{SH1} = V_{SH2} = V_{SH3} = 5\text{V}$ (Pulse),

Light Source = Daylight Fluorescent Lamp.

| | | |
|-------------|------------|----------------|
| Ocilloscope | Tektoronix | 2465A (400MHz) |
| Probe | P6136 | 10.8pF |

3. DRIVE CIRCUIT (with a damping resistance)

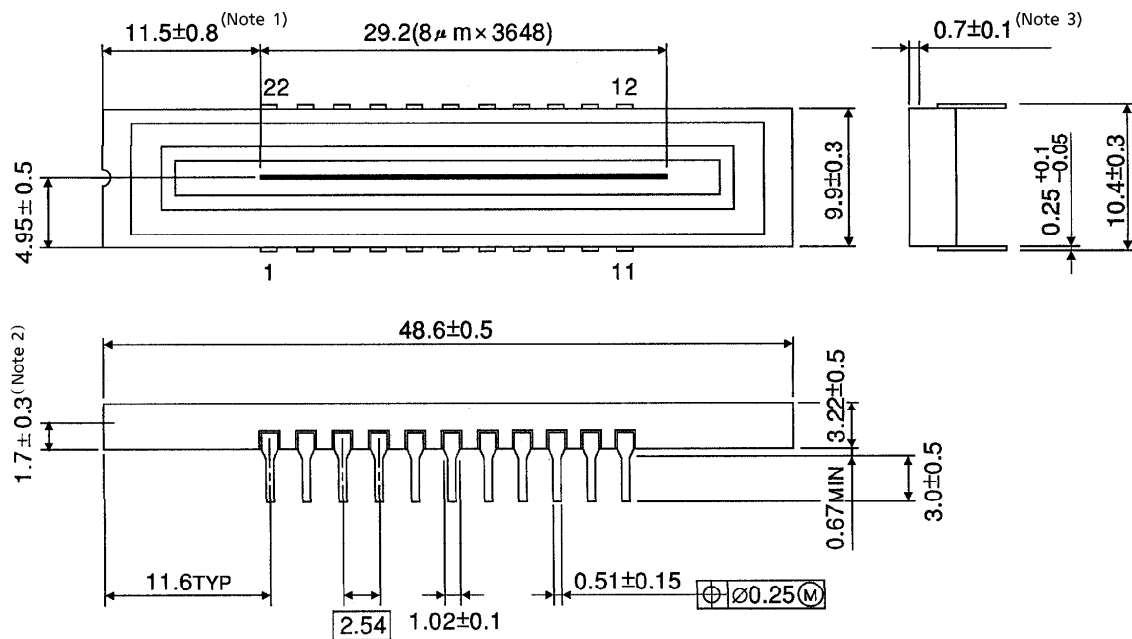
Please put a damping resistance in input $\phi 20$ (22Ω).



OUTLINE DRAWING

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 THICKNES (n = 1.5)

Weight : 4.8g (Typ.)