

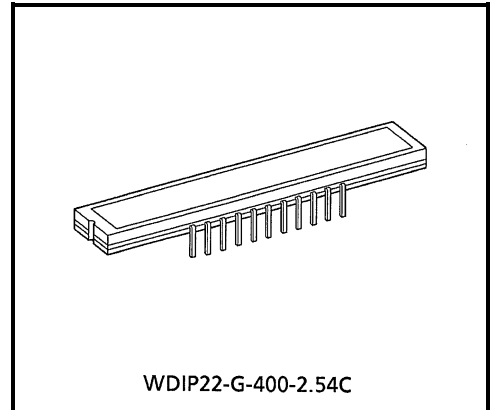
# TCD2255D

The TCD2255D is a high sensitive and low dark current 2700 elements×3 line CCD color image sensor which includes CCD drive circuit, clamp circuit and sample & hold circuit.

The sensor is designed for scanner. The device contains a row of 2700 elements×3 line photodiodes which provide a 12 lines / mm (300DPI) across a A4 size paper. The device is operated by 5V pulse and 12V power supply.

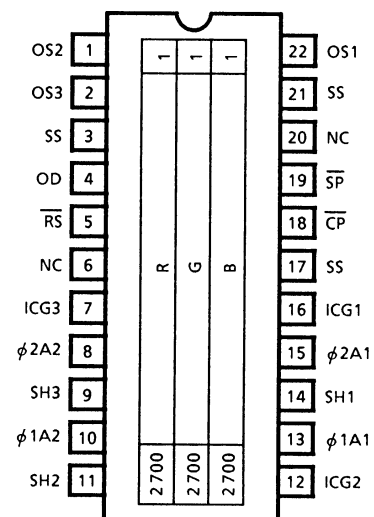
## FEATURES

- Number of Image Sensing Elements : 2700 elements×3 line
- Image Sensing Element Size : 8μm by 8μm on 8μm centers
- Photo Sensing Region : High sensitive and low dark current PN photodiode
- Distance Between Photodiode Array : 32μm (4 lines)
- Clock : 2 phase (5V)
- Power Supply : 12V Power supply voltage
- Internal Circuit : Sample & Hold circuit, Clamp circuit
- Package : 22 pin CERDIP package
- Color Filter : Red, Green, Blue



Weight: 4.5g (Typ.)

## PIN CONNECTION



(TOP VIEW)

000707EBA1

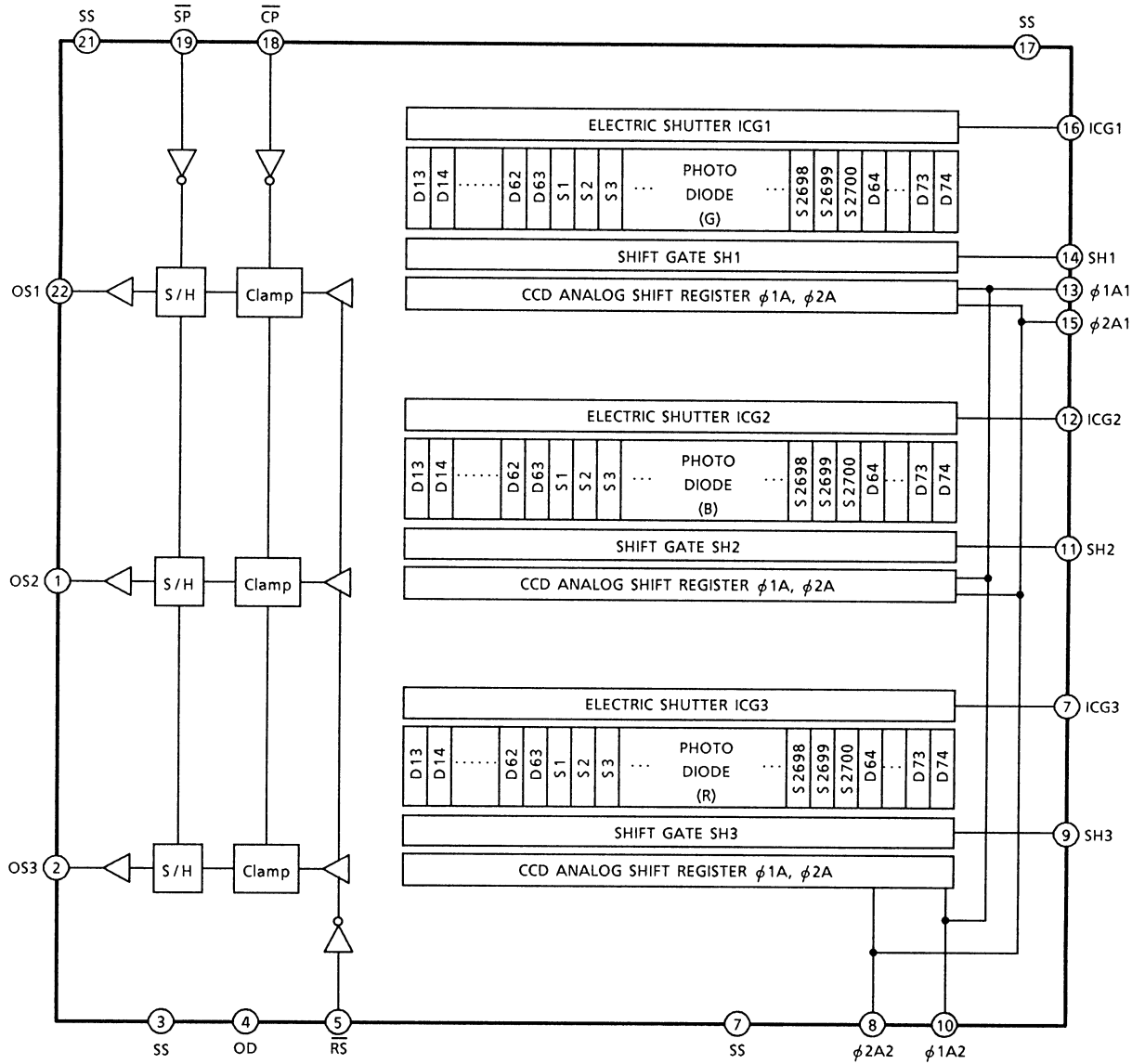
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MAXIMUM RATINGS (Note 1)

| 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           | $V_{\overline{CP}}$ |          |      |
| Sample and Hold Pulse Voltage | $V_{\overline{SP}}$ |          |      |
| Electrical Shutter Voltage    | $V_{ICG}$           |          |      |
| 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).

CIRCUIT DIAGRAM



## PIN NAMES

| PIN No. | SYMBOL          | NAME                    | PIN No. | SYMBOL          | NAME                    |
|---------|-----------------|-------------------------|---------|-----------------|-------------------------|
| 1       | OS2             | Signal Output 2 (Green) | 22      | OS1             | Signal Output 1 (Blue)  |
| 2       | OS3             | Signal Output 3 (Red)   | 21      | SS              | Ground                  |
| 3       | SS              | Ground                  | 20      | NC              | Non Connection          |
| 4       | OD              | Power                   | 19      | $\overline{SP}$ | Sample and Hold Gate    |
| 5       | $\overline{RS}$ | Reset Gate              | 18      | $\overline{CP}$ | Clamp Gate              |
| 6       | NC              | Non Connection          | 17      | SS              | Ground                  |
| 7       | ICG3            | Electric Shutter Gate 3 | 16      | ICG1            | Electric Shutter Gate 1 |
| 8       | $\Phi_{2A2}$    | Clock 2 (Phase 2)       | 15      | $\Phi_{2A1}$    | Clock 1 (Phase 2)       |
| 9       | SH3             | Shift Gate 3            | 14      | SH1             | Shift Gate 1            |
| 10      | $\Phi_{1A2}$    | Clock 2 (Phase 1)       | 13      | $\Phi_{1A1}$    | Clock 1 (Phase 1)       |
| 11      | SH2             | Shift Gate 2            | 12      | ICG2            | Electric Shutter Gate 2 |

## OPTICAL / ELECTRICAL CHARACTERISTICS

( $T_a = 25^\circ\text{C}$ ,  $V_{OD} = 12\text{V}$ ,  $V_\phi = V_{RS} = V_{SH} = V_{CP} = 5\text{V}$  (pulse),  $f_\phi = 1.0\text{MHz}$ ,  $f_{RS} = 1.0\text{MHz}$ ,  
**LOAD RESISTANCE = 100k $\Omega$** ,  $t_{INT}$  (INTEGRATION TIME) = 10ms,  
**LIGHT SOURCE = A LIGHT SOURCE+CM500S FILTER (t = 1.0mm) )**

| CHARACTERISTIC                | SYMBOL        | MIN  | TYP. | MAX  | UNIT       | NOTE      |
|-------------------------------|---------------|------|------|------|------------|-----------|
| Sensitivity                   | $R_R$         | 9.1  | 13.0 | 16.9 | V / (lx·s) | (Note 2)  |
|                               | $R_G$         | 11.4 | 16.3 | 21.2 |            |           |
|                               | $R_B$         | 4.0  | 5.7  | 7.4  |            |           |
| Photo Response Non Uniformity | PRNU (1)      | —    | 10   | 20   | %          | (Note 3)  |
|                               | PRNU (3)      | —    | 2.5  | 10   | mV         | (Note 4)  |
| Image Lag                     | IL            | —    | 0.01 | —    | %          | (Note 5)  |
| Saturation Output Voltage     | $V_{SAT}$     | 1.7  | 2.0  | —    | V          | (Note 6)  |
| Saturation Exposure           | SE            | —    | 0.12 | —    | lx·s       | (Note 7)  |
| Dark Signal Voltage           | $V_{DRK}$     | —    | 3    | 9    | mV         | (Note 8)  |
| Dark Signal Non Uniformity    | $D_{SNU}$     | —    | 4    | 12   | mV         | (Note 8)  |
| DC Power Dissipation          | $P_D$         | —    | 200  | 300  | mW         |           |
| Total Transfer Efficiency     | TTE           | 92   | —    | —    | %          |           |
| Output Impedance              | $Z_o$         | —    | 0.4  | 1.0  | k $\Omega$ |           |
| DC Signal Output Voltage      | $V_{OS}$      | 3.0  | 5.0  | 7.0  | V          | (Note 9)  |
| Random Noise                  | $N_{D\sigma}$ | —    | 0.7  | —    | mV         | (Note 10) |
| Reset Noise                   | $V_{RS}$      | —    | 1.5  | —    | 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.

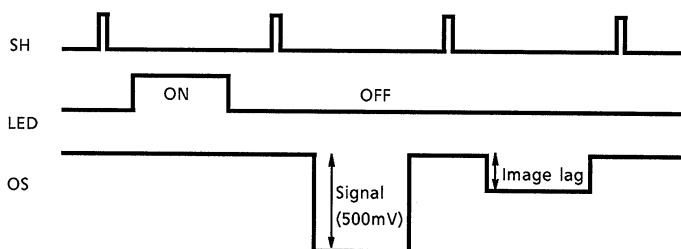
$$\text{PRNU (1)} = \frac{\Delta\bar{\chi}}{\bar{\chi}} \times 100 (\%)$$

When  $\bar{\chi}$  is average of total signal outputs 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: Image Lag is defined as follows.



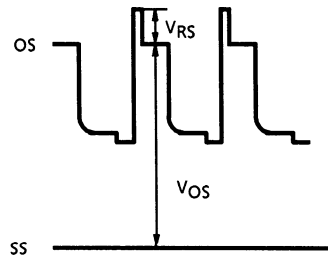
Note 6:  $V_{SAT}$  is defined as minimum saturation output of all effective pixels.

Note 7: Definition of SE :  $SE = \frac{V_{SAT}}{R_G} (lx \cdot s)$

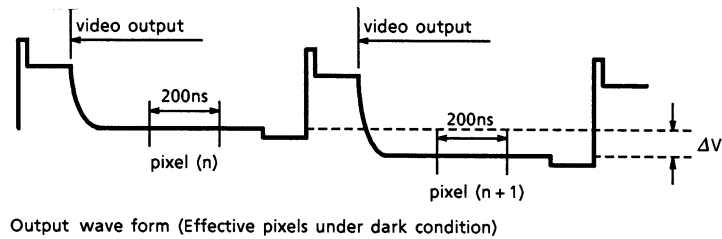
Note 8:  $V_{DRK}$  is defined as average dark signal voltage of all effective pixels. DSNU is defined as different voltage between  $V_{DRK}$  and  $V_{MDK}$  when  $V_{MDK}$  is maximum dark signal voltage.



Note 9: DC signal Output Voltage Reset Noise is defined as follows, but Reset Noise is a fixed pattern noise.



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

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

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

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

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

- 7)  $\bar{\sigma}$  value calculated using the above procedure is observed  $\sqrt{2}$  times larger than that measured relative to the ground level. So we specify the random noise as follows.

$$N_{d\sigma} = \frac{1}{\sqrt{2}} \bar{\sigma}$$

## OPERATING CONDITION

| CHARACTERISTIC                |           | SYMBOL              | MIN                           | TYP.                    | MAX                     | UNIT | NOTE      |
|-------------------------------|-----------|---------------------|-------------------------------|-------------------------|-------------------------|------|-----------|
| Clock Pulse Voltage           | "H" Level | $V_{\phi A}$        | 4.7                           | 5.0                     | 5.5                     | V    |           |
|                               | "L" Level |                     | 0                             | 0                       | 0.05                    |      |           |
| Shift Pulse Voltage           | "H" Level | $V_{SH}$            | $V_{\phi A} \text{"H"} - 0.5$ | $V_{\phi A} \text{"H"}$ | $V_{\phi A} \text{"H"}$ | V    | (Note 11) |
|                               | "L" Level |                     | 0                             | 0                       | 0.3                     |      |           |
| Reset Pulse Voltage           | "H" Level | $V_{\overline{RS}}$ | 4.5                           | 5.0                     | 5.5                     | V    |           |
|                               | "L" Level |                     | 0                             | 0                       | 0.3                     |      |           |
| Sample and Hold Pulse Voltage | "H" Level | $V_{\overline{SP}}$ | 4.5                           | 5.0                     | 5.5                     | V    | (Note 12) |
|                               | "L" Level |                     | 0                             | 0                       | 0.3                     |      |           |
| Clamp Pulse Voltage           | "H" Level | $V_{\overline{CP}}$ | 4.5                           | 5.0                     | 5.5                     | V    |           |
|                               | "L" Level |                     | 0                             | 0                       | 0.3                     |      |           |
| ICG Pulse Voltage             | "H" Level | $V_{ICG}$           | $V_{\phi A} \text{"H"} - 0.5$ | $V_{\phi A} \text{"H"}$ | $V_{\phi A} \text{"H"}$ | V    | (Note 11) |
|                               | "L" Level |                     | 0                             | 0                       | 0.3                     |      |           |
| Power Supply Voltage          |           | $V_{OD}$            | 11.4                          | 12.0                    | 13.0                    | V    |           |

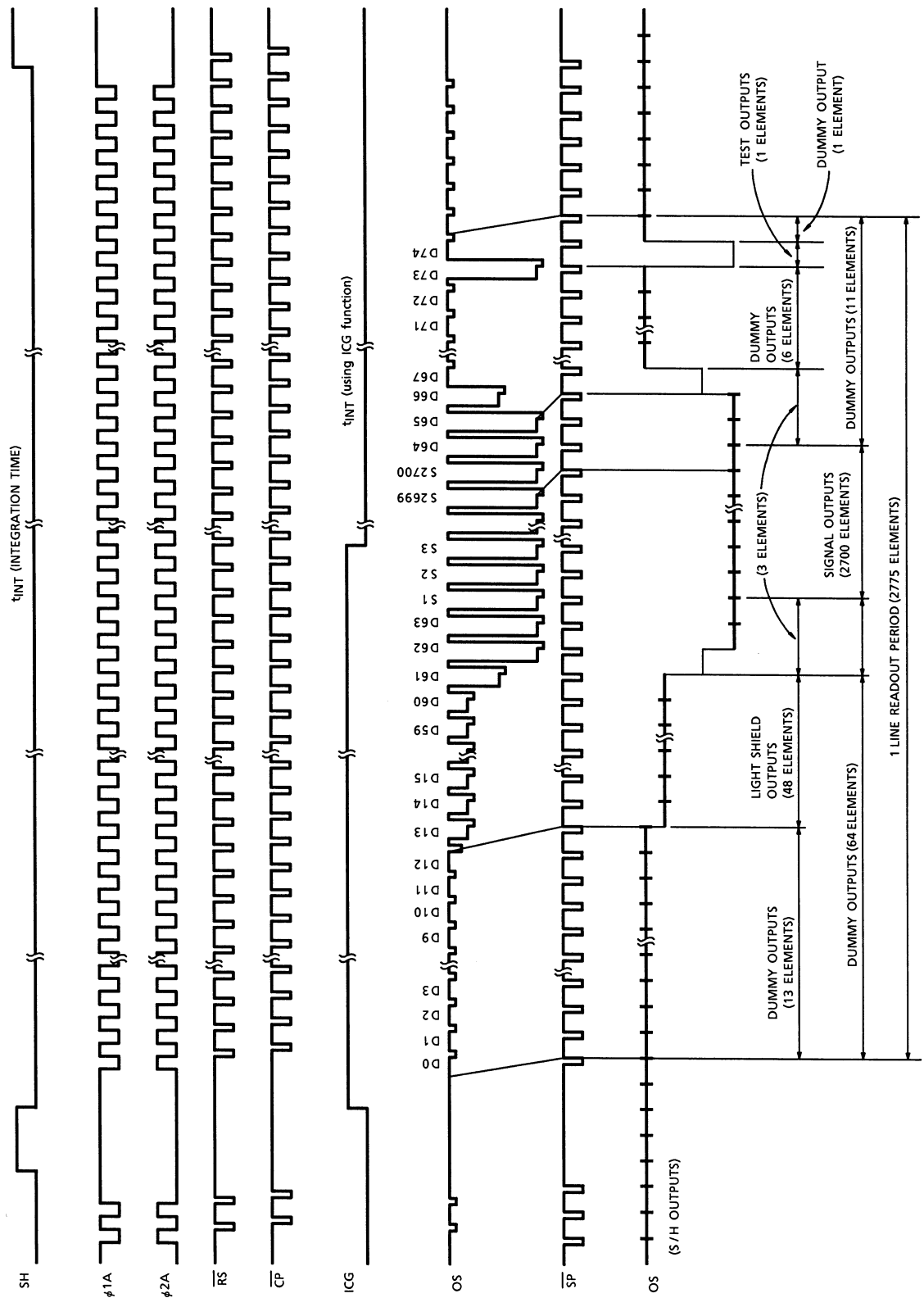
Note 11:  $V_{\phi A} \text{"H"}$  means the high level voltage of  $V_{\phi A}$  when SH pulse is high level.

Note 12: Supply "L" Level to  $\overline{SP}$  terminal when sample and hold circuitry is not used.

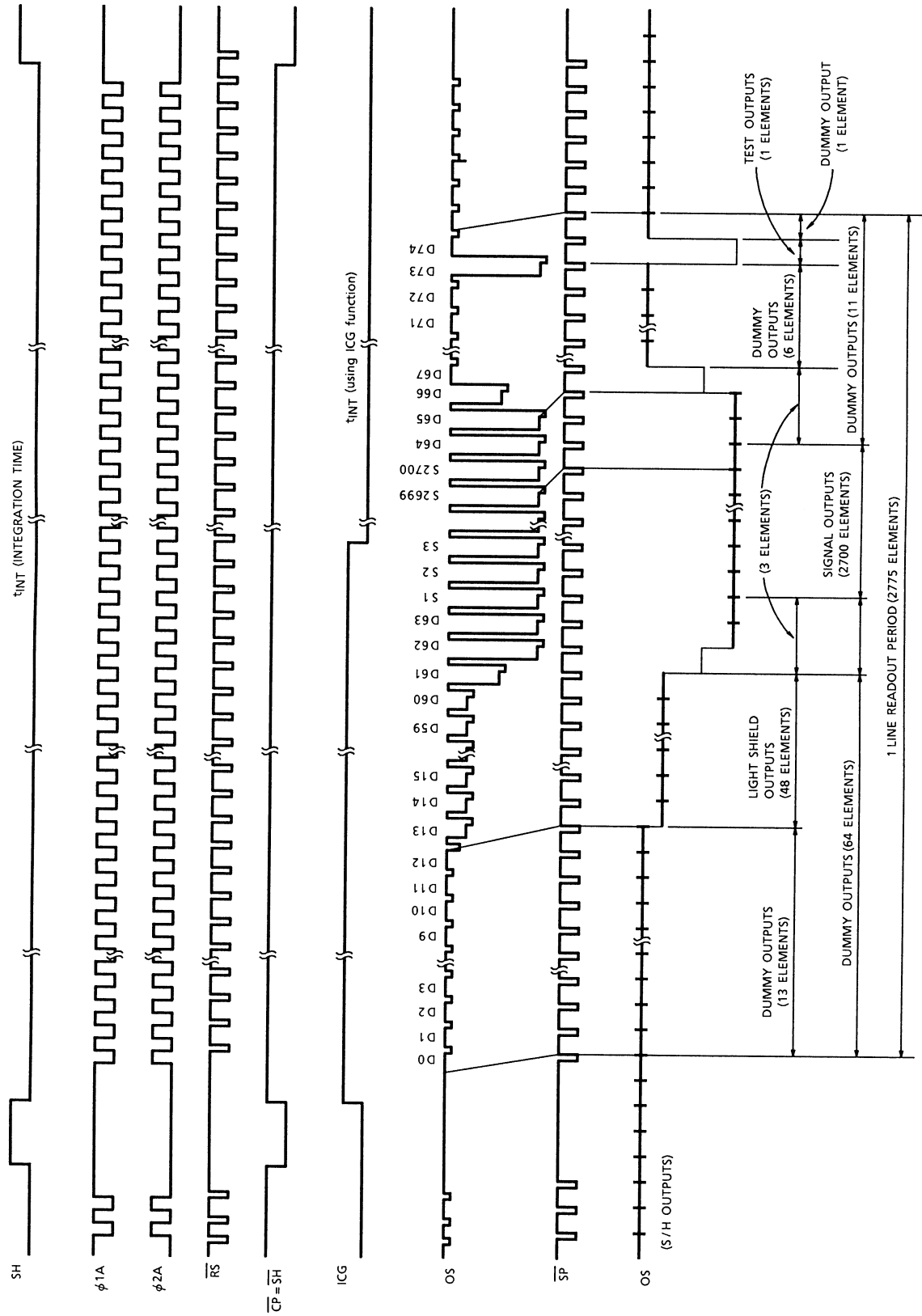
## CLOCK CHARACTERISTICS (Ta = 25°C)

| CHARACTERISTIC                   | SYMBOL              | MIN | TYP. | MAX | UNIT |
|----------------------------------|---------------------|-----|------|-----|------|
| Clock Pulse Frequency            | $f_{\phi A}$        | —   | 1.0  | 5.0 | MHz  |
| Reset Pulse Frequency            | $f_{\overline{RS}}$ | —   | 1.0  | 5.0 | MHz  |
| Clamp Pulse Frequency            | $f_{\overline{CP}}$ | —   | 1.0  | 5.0 | MHz  |
| Sample and Hold Pulse Frequency  | $f_{\overline{SP}}$ | —   | 1.0  | 5.0 | MHz  |
| Clock Capacitance                | $C_{\phi A}$        | —   | 160  | 250 | pF   |
| Shift Gate Capacitance           | $C_{SH}$            | —   | 20   | 30  | pF   |
| Reset Gate Capacitance           | $C_{\overline{RS}}$ | —   | 20   | 30  | pF   |
| Sample and Hold Gate Capacitance | $C_{\overline{SP}}$ | —   | 20   | 30  | pF   |
| Clamp Gate Capacitance           | $C_{\overline{CP}}$ | —   | 20   | 30  | pF   |
| ICG Gate Capacitance             | $C_{ICG}$           | —   | 20   | 30  | pF   |

TIMING CHART (BIT CLAMP MODE)

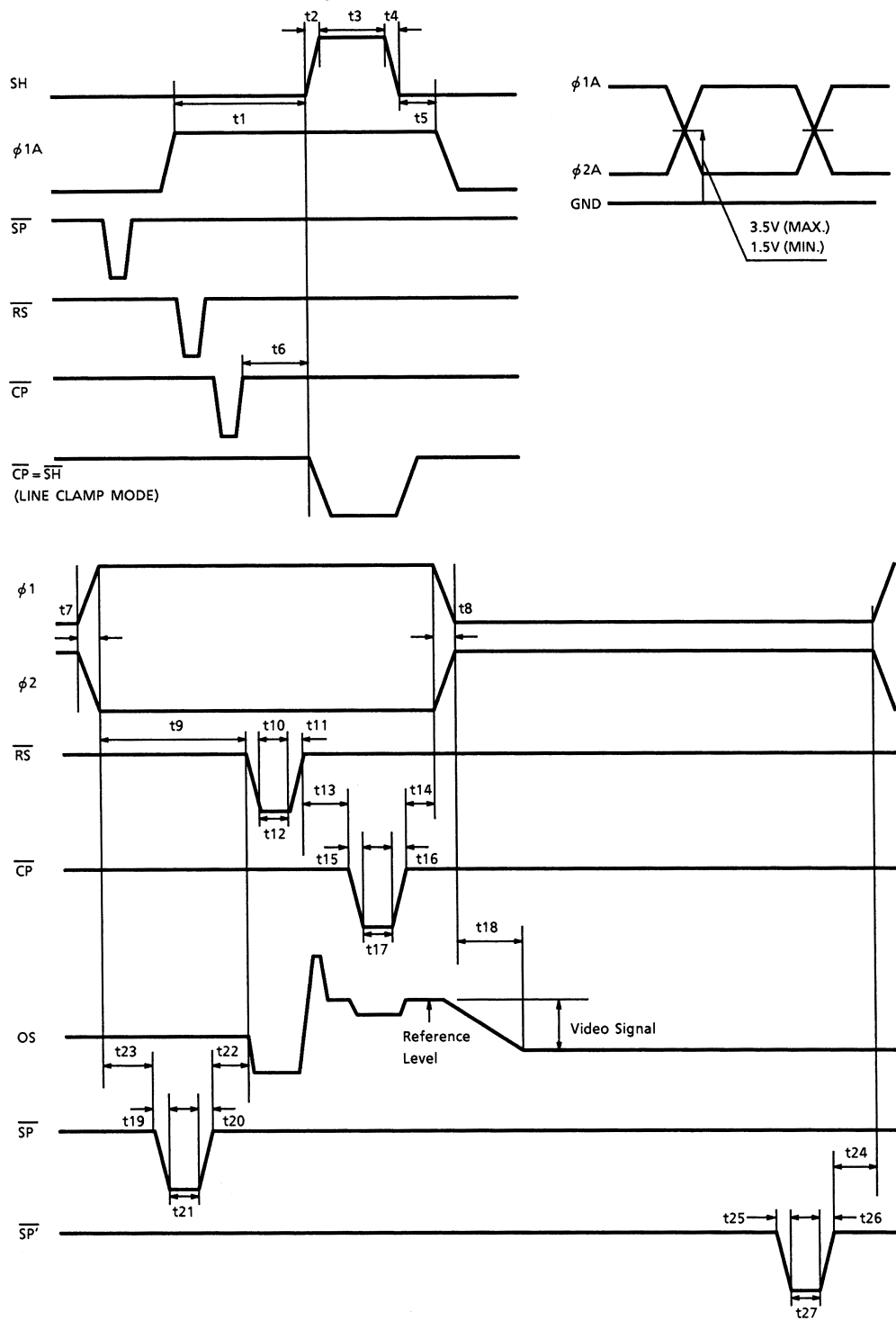


**TIMING CHART (LINE CLAMP MODE)**

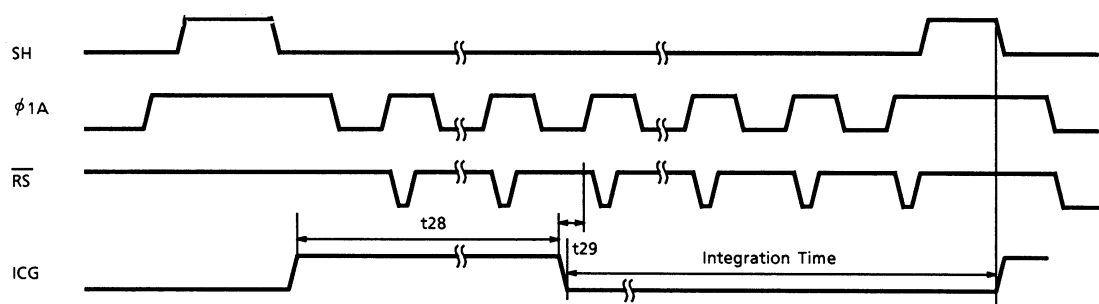




TIMING REQUIREMENTS (LINE CLAMP MODE)



## TIMING REQUIREMENTS (Cont.)



| CHARACTERISTIC                                      | SYMBOL                           | MIN  | TYP.<br>(Note 13) | MAX | UNIT    |
|---|----------------------------------|------|-------------------|-----|---------|
| Pulse Timing of SH and $\phi_1$                     | $t_1$                            | 120  | 1000              | —   | ns      |
|   | $t_5$                            | 800  | 1000              | —   |         |
| SH Pulse Rise Time, Fall Time                       | $t_2, t_4$                       | 0    | 50                | —   | ns      |
| SH Pulse Width                                      | $t_3$                            | 3000 | 5000              | —   | ns      |
| Pulse Timing of SH and $\overline{CP}$              | $t_6$                            | 0    | 500               | —   | ns      |
| $\phi_1, \phi_2$ Pulse Rise Time, Fall Time         | $t_7, t_8$                       | 0    | 20                | —   | ns      |
| Pulse Timing of $\phi_1$ and $\overline{RS}$        | $t_9$                            | 0    | 20                | —   | ns      |
| $\overline{RS}$ Pulse Rise Time, Fall Time          | $t_{10}, t_{11}$                 | 0    | 20                | —   | ns      |
| $\overline{RS}$ Pulse Width                         | $t_{12}$                         | 55   | 100               | —   | ns      |
| Pulse Timing of $\overline{RS}$ and $\overline{CP}$ | $t_{13}$                         | 10   | 30                | —   | ns      |
| Pulse Timing of $\overline{CP}$ and $\phi_1$        | $t_{14}$                         | 0    | 20                | —   | ns      |
| $\overline{CP}$ Pulse Rise Time, Fall Time          | $t_{15}, t_{16}$                 | 0    | 20                | —   | ns      |
| $\overline{CP}$ Pulse Width                         | $t_{17}$                         | 50   | 100               | —   | ns      |
| Video Data Delay Time (Note 14)                     | $t_{18}$                         | 70   | 100               | —   | ns      |
| $\overline{SP}$ Pulse Rise Time, Fall Time          | $t_{19}, t_{20}, t_{25}, t_{26}$ | 0    | 20                | —   | ns      |
| $\overline{SP}$ Pulse Width                         | $t_{21}, t_{27}$                 | 50   | 100               | —   | ns      |
| Pulse Timing of $\overline{RS}$ and $\overline{SP}$ | $t_{22}$                         | 0    | 20                | —   | ns      |
| Pulse Timing of $\phi_1$ and $\overline{SP}$        | $t_{23}, t_{24}$                 | 0    | 20                | —   | ns      |
| ICG Pulse Width                                     | $t_{18}$                         | 5    | —                 | —   | $\mu s$ |
| Pulse Timing of ICG and $\overline{RS}$             | $t_{29}$                         | 0    | 20                | —   | ns      |

Note 13: TYP. is the case of  $f_{\overline{RS}} = 1.0\text{MHz}$ .

Note 14: Load Resistance is 100k $\Omega$ .

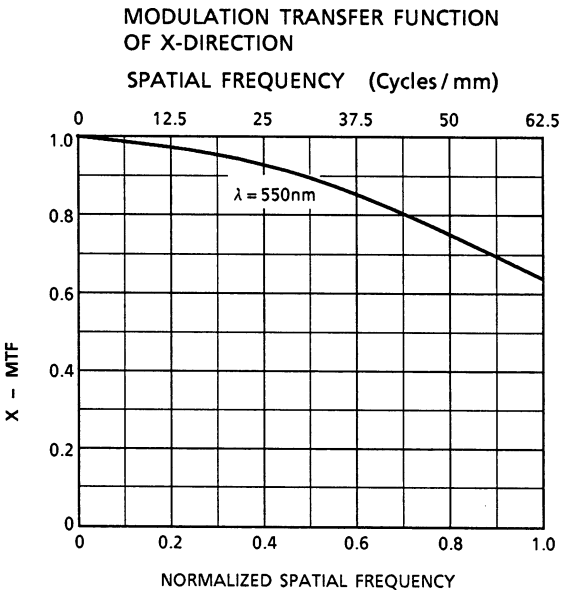
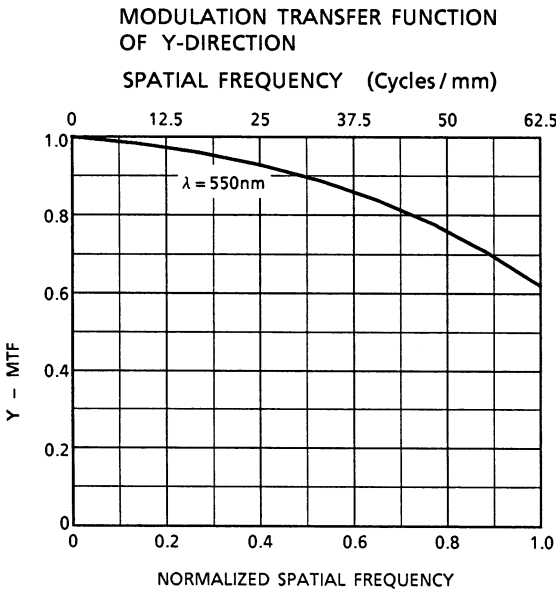
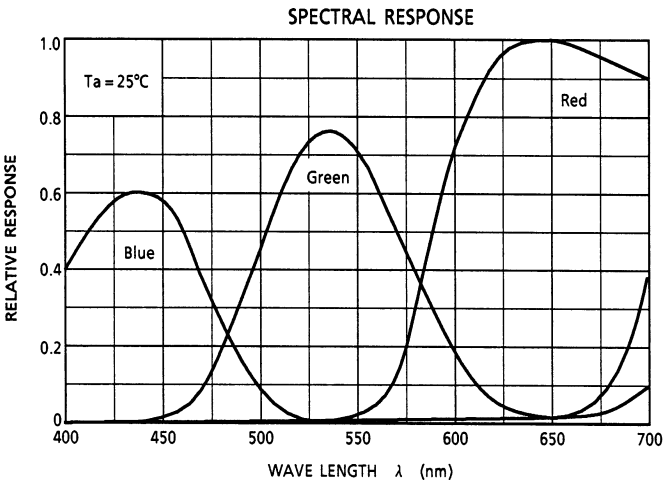
APPLICATION NOTE

|                             | ON                           | OFF                                 |
|-----------------------------|------------------------------|-------------------------------------|
| Sample & Hold Function      | $\overline{\text{SP}}$ Pulse | $\overline{\text{SP}} = \text{Low}$ |
| Electrical Shutter Function | ICG Pulse                    | ICG = Low                           |

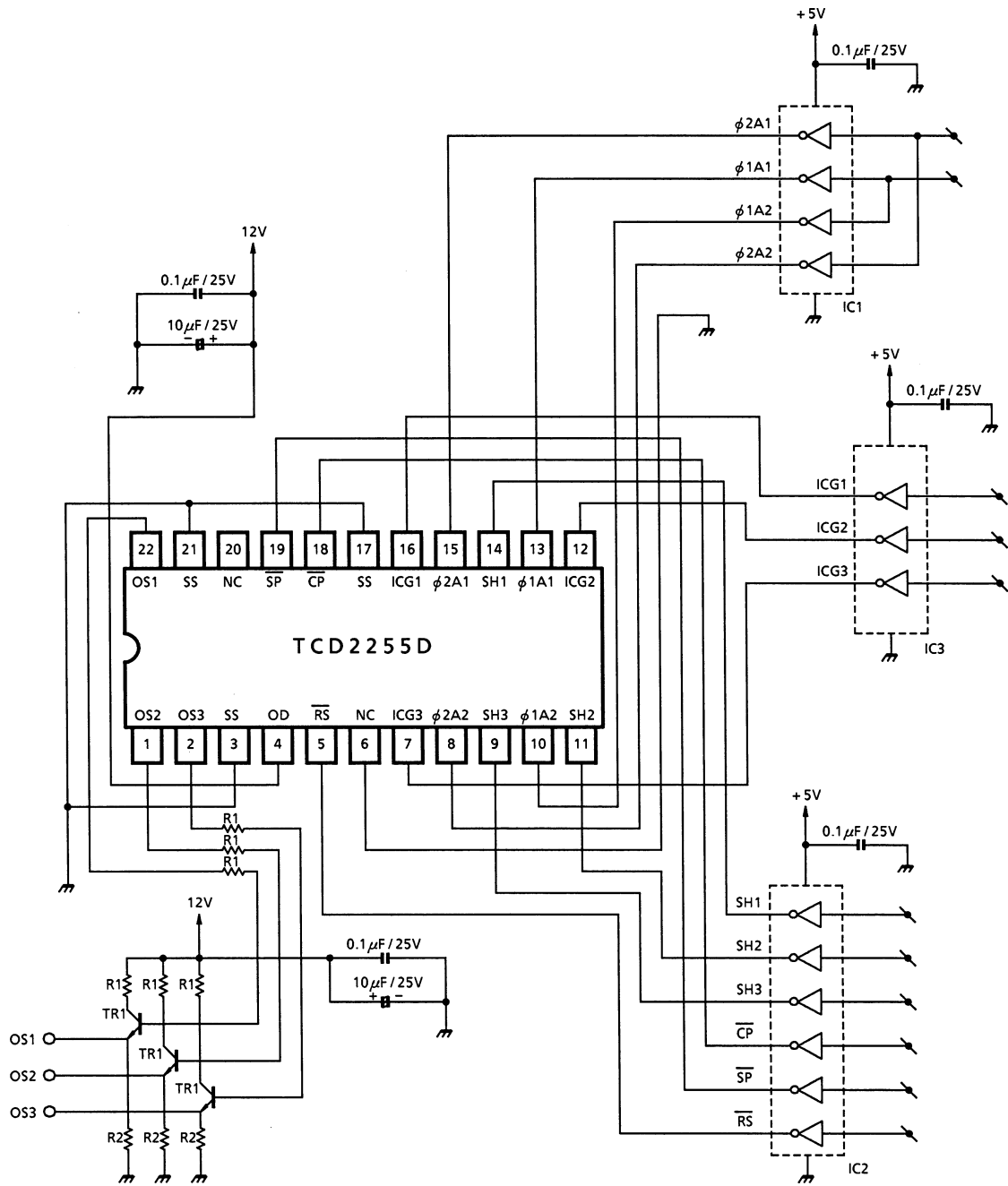
Clamp Mode Selection

|            |   |
|------------|---|
| Bit Clamp  | $\overline{\text{CP}}$ Pulse                  |
| Line Clamp | $\overline{\text{CP}} = \overline{\text{SH}}$ |

TYPICAL SPECTRAL REPONSE / MODURATION TRANFER FUNCTION



## TYPICAL DRIVE CIRCUIT



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

**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<sub>2</sub>.

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**

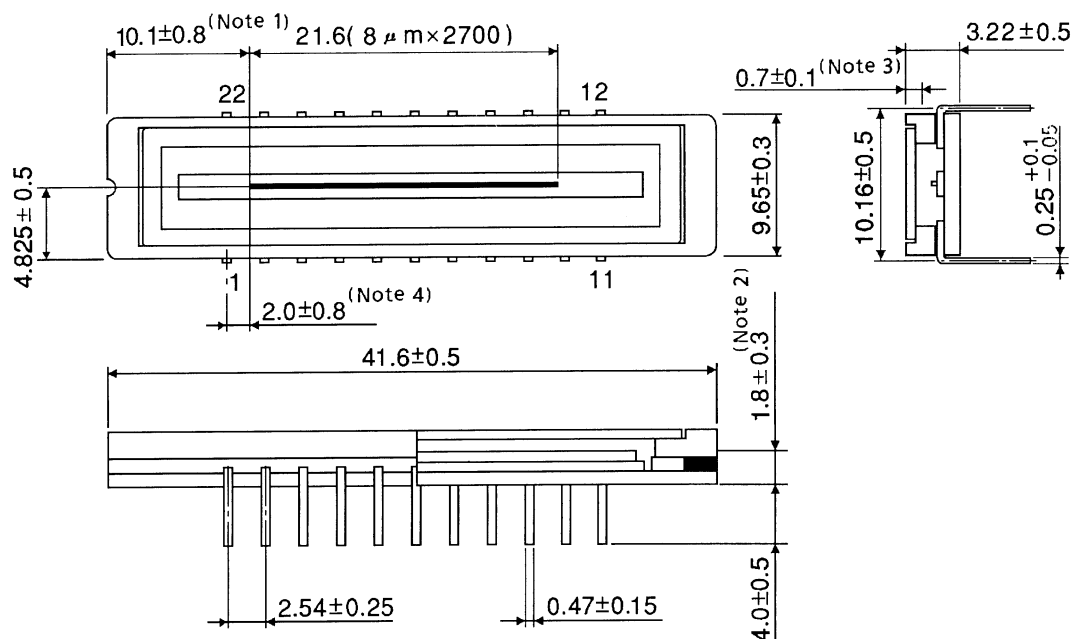
Since this package is not strong against mechanical stress, you should not reform the lead frame.

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

## PACKAGE DIMENSIONS

WDIP22-G-400-2.54C

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 ( $n = 1.5$ )

Note 4: No.1 SENSOR ELEMENT (S1) TO EDGE OF No.1 PIN.

Weight: 4.5g (Typ.)