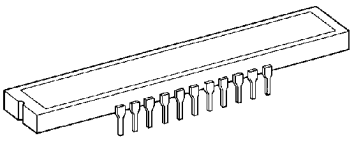
TOSHIBA CCD LINEAR IMAGE SENSOR CCD(Charge Coupled Device)

# TCD1500C

The TCD1500C is a high sensitive and low dark current 5340-elements linear image sensor. The sensor can be used for facsimile, imagescanner and OCR. The signal pre-processing circuit which is composed of Sample and Hold circuit and Pre-amplifier circuit. The device contains a row of 5340 photodiodes, which provide a 16 lines / mm (400DPI) across a A3 size paper and besides 24 lines / mm (600DPI) across a A4 size paper.



WDIP22-C-400-2.54B

Weight : 5.4g (Typ.)

**FEATURES**

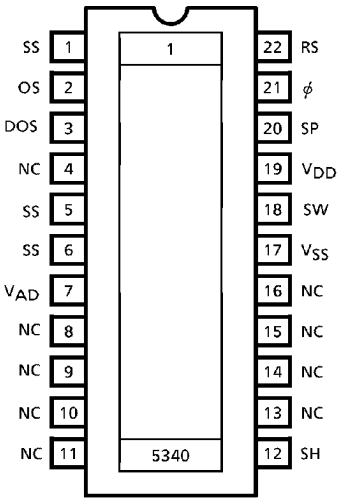
- Number of Image Sensing Elements : 5340
- Image Sensing Element Size : 7$\mu$m by 7$\mu$m on 7$\mu$m centers
- Photo Sensing Region : High sensitive pn photodiode
- Clock : 2 phase
- Internal Circuit : S / H circuit, Pre-Amplifier circuit
- Package : 22 pin cerdip

**MAXIMUM RATINGS** (Note 1)

| CHARACTERISTIC | SYMBOL | RATING | UNIT |
|---|---|---|---|
| Clock Pulse Voltage | $V_\phi$ | −0.3~15 | V |
| Shift Pulse Voltage | $V_{SH}$ | | V |
| Reset Pulse Voltage | $V_{RS}$ | | V |
| Sample and Hold Pulse Voltage | $V_{SP}$ | | V |
| Power Supply Voltage (Analog) | $V_{AD}$ | | V |
| Power Supply Voltage (Driver) | $V_{DD}$ | | V |
| Operating Temperature | $T_{opr}$ | −25~60 | °C |
| Storage Temperature | $T_{stg}$ | −40~100 | °C |

(Note 1) All voltage are with respect to SS and $V_{SS}$ terminals (Ground).

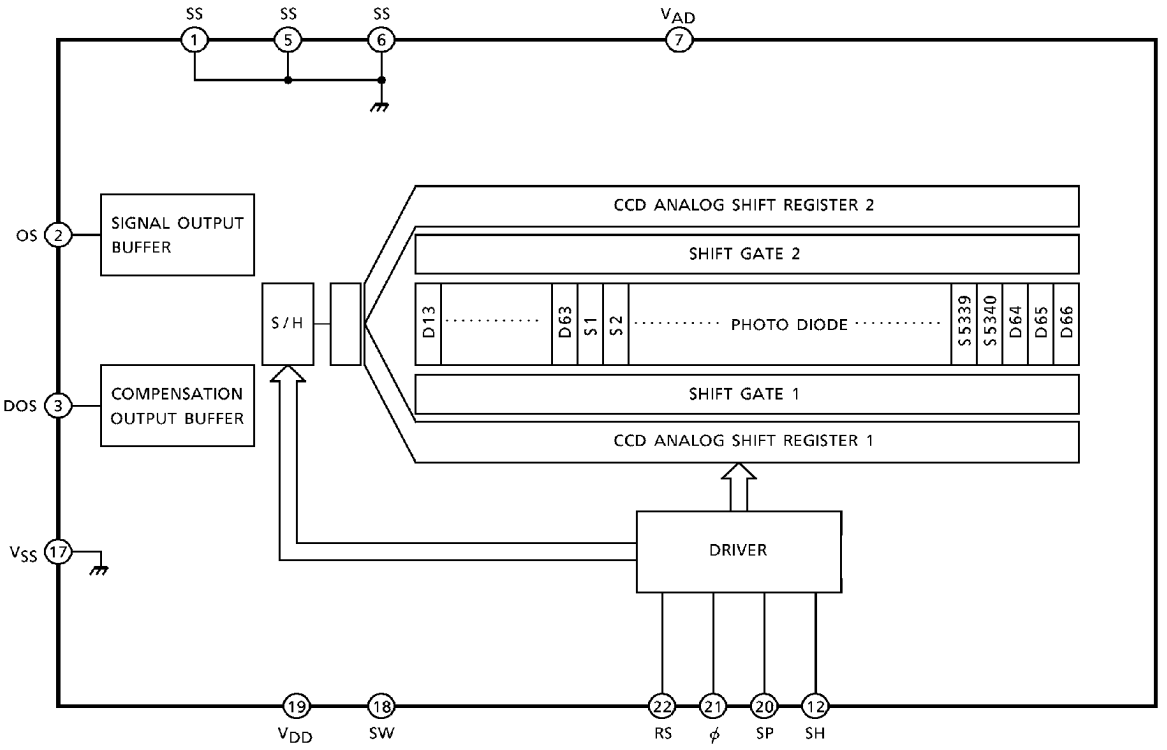
**PIN CONNECTIONS**




(TOP VIEW)

961001EBA2

## CIRCUIT DIAGRAM




## PIN NAMES

| | |
|---|---|
| $\phi$ | Clock |
| SH | Shift Gate |
| RS | Reset Gate |
| SP | Sample Hold Gate |
| OS | Signal Output |
| DOS | Compensation Output |
| $V_{AD}$ | Power (Analog) |
| $V_{DD}$ | Power (Driver) |
| SS | Ground (Analog) |
| $V_{SS}$ | Ground (Driver) |
| SW | Final Clock Select Switch |
| NC | Non Connection |

**OPTICAL / ELECTRICAL CHARACTERISTICS**

(Ta = 25°C, $V_{AD}$ = 12V, $V_{DD}$ = 12V, $V\phi = V_{SH} = V_{RS}$ = 5V (PULSE), $f\phi$ = 0.5MHz, $f_{RS}$ = 1MHz, $t_{INT}$ (INTEGRATION TIME) = 10ms, LIGHT SOURCE = DAYLGIHT FLUORESCENT LAMP)

| CHARACTERISTIC | SYMBOL | MIN. | TYP. | MAX. | UNIT | NOTE |
|---|---|---|---|---|---|---|
| Sensitivity | R | 3.8 | 4.8 | 5.8 | V / lx·s | |
| Photo Response Non Uniformity | PRNU | — | — | 10 | % | (Note 2) |
| | PRNU (3) | — | 3 | 8 | mV | (Note 3) |
| Register Imbalance | RI | — | — | 3 | % | (Note 4) |
| Saturation Output Voltage | $V_{SAT}$ | 1.0 | 1.5 | — | V | (Note 5) |
| Saturation Exposure | SE | 0.17 | 0.3 | — | lx·s | (Note 6) |
| Dark Signal Voltage | $V_{DRK}$ | — | — | 2 | mV | (Note 7) |
| Dark Signal Non Uniformity | DSNU | — | — | 3 | mV | (Note 7) |
| Analog Current Dissipation | $I_{AD}$ | — | — | 20 | mA | |
| Driver Current Dissipation | $I_{DD}$ | — | — | 10 | mA | |
| Total Transfer Efficiency | TTE | 92 | — | — | % | |
| Output Impedance | $Z_O$ | — | 0.5 | 1 | kΩ | |
| Dynamic Range | DR | — | 1500 | — | | (Note 8) |
| DC Signal Output Voltage | $V_{OS}$ | 3.5 | 4.5 | 6.0 | V | (Note 9) |
| DC Compensation Output Voltage | $V_{DOS}$ | 3.5 | 4.5 | 6.0 | V | (Note 9) |
| DC Mismatch Voltage | $\lvert V_{OS}-V_{DOS}\rvert$ | — | — | 100 | mV | |

(Note 2) Measured at 50% of SE (Typ.)

Definition of PRNU : $PRNU = \frac{\Delta\chi}{\overline{\chi}} \times 100\ (\%)$

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

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

(Note 4) Measured at 50% of SE (Typ.)
RI is defined as follows:

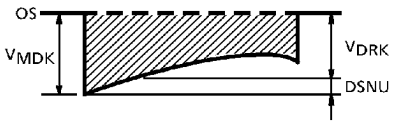
$$RI = \frac{\sum_{n=1}^{5339} |\chi n - \chi n + 1|}{5339 \times \overline{\chi}} \times 100\ (\%)$$

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

(Note 5) $V_{SAT}$ is defined as minimum saturation output voltage of all effective pixels.

(Note 6) Definition of SE : $SE = \frac{V_{SAT}}{R}$ (lx·s)

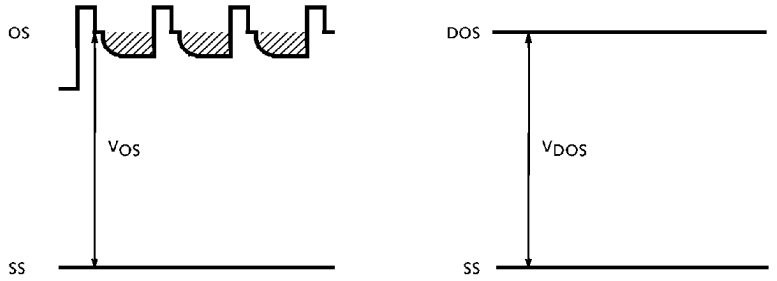
(Note 7) $V_{DRK}$ is defined as average dark signal voltage of all effective pixels.
DSNU is defined as different voltage between $V_{DRK}$ and $V_{MDK}$ when $V_{MDK}$ is maximum dark signal voltage.




(Note 8) Definition of DR : $DR = \frac{V_{SAT}}{V_{DRK}}$

$V_{DRK}$ is proportional to $t_{INT}$ (Integration Time).
So the shorter $t_{INT}$ condition makes wider DR value.

(Note 9) DC signal output voltage and DC compensation output voltage are defined as follows:



**OPERATING CONDITION**

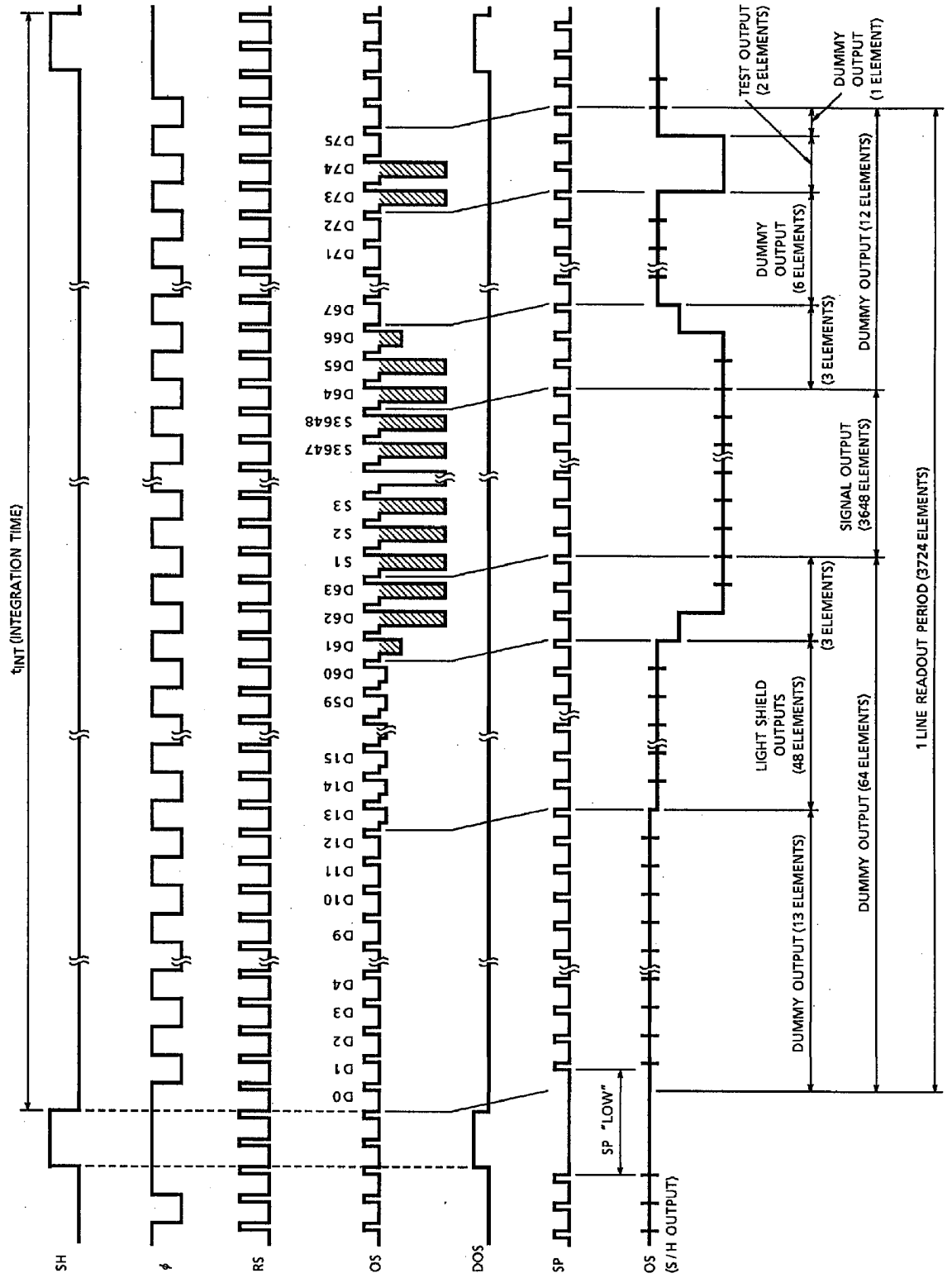
| CHARACTERISTIC | | SYMBOL | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|
| Clock Pulse Voltage | "H" Level | $V_{\phi}$ | 4.5 | 5.0 | 5.5 | V |
| | "L" Level | | 0 | — | 0.5 | |
| Shift Pulse Voltage | "H" Level | $V_{SH}$ | 4.5 | 5.0 | 5.5 | V |
| | "L" Level | | 0 | — | 0.5 | |
| Reset Pulse Voltage | "H" Level | $V_{RS}$ | 4.5 | 5.0 | 5.5 | V |
| | "L" Level | | 0 | — | 0.5 | |
| Sample and Hold Pulse Voltage (Note 9) | "H" Level | $V_{SP}$ | 4.5 | 5.0 | 5.5 | V |
| | "L" Level | | 0 | — | 0.5 | |
| Switch Voltage | "H" Level | $V_{SW}$ | 4.5 | 5.0 | 5.5 | V |
| | "L" Level | | 0 | — | 0.5 | |
| Power Supply Voltage (Analog) | | $V_{AD}$ | 11.4 | 12 | 13 | V |
| Power Supply Voltage ((Driver) | | $V_{DD}$ | 11 | 12 | 13 | V |

(Note 9) Supply "H" level to SP terminal when sample-and-hold circuitry is not used.

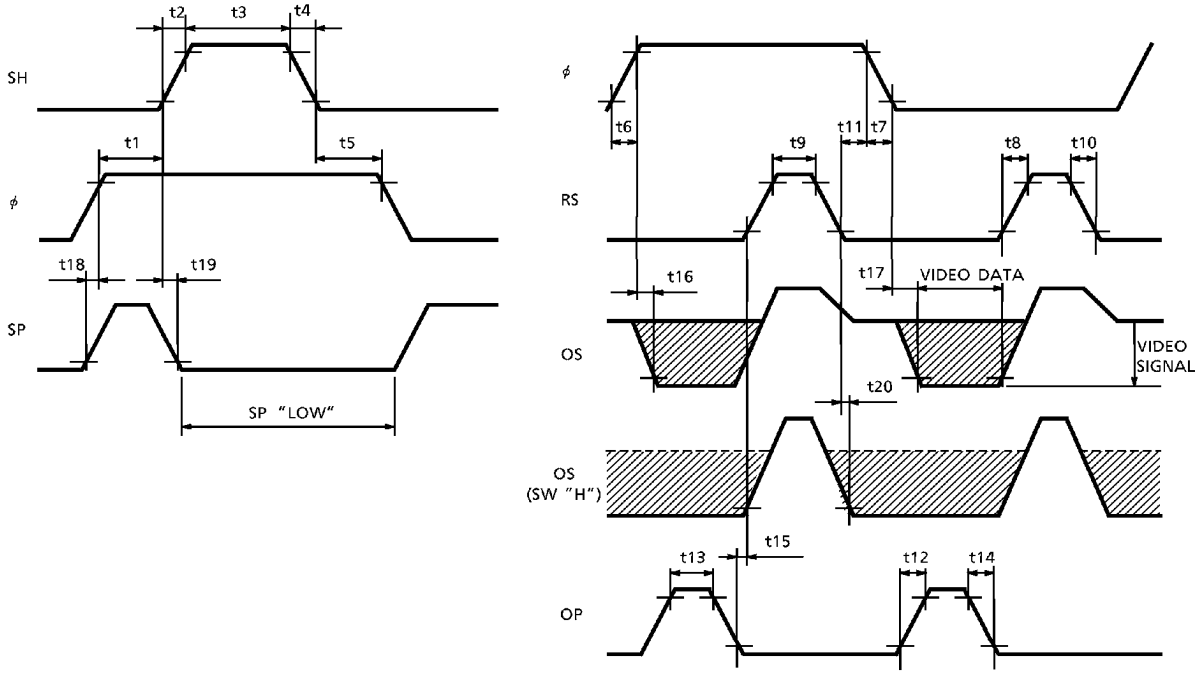
**CLOCK CHARACTERISTICS** (Ta = 25°C)

| CHARACTERISTIC | SYMBOL | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|
| Clock Pulse Frequency | $f_{\phi}$ | — | 0.5 | 4.0 | MHz |
| Reset Pulse Frequency | $f_{RS}$ | — | 1 | 8.0 | MHz |
| Sample and Hold Pulse Frequency | $f_{SP}$ | — | 1 | 8.0 | MHz |
| Clock Capacitance | $C_{\phi}$ | — | — | 10 | pF |
| Final Stage Clock Capacitance | $C_{\phi}$ | — | — | 10 | pF |
| Shift Gate Capacitance | $C_{SH}$ | — | — | 10 | pF |
| Sample and Hold Gate Capacitance | $C_{SP}$ | — | — | 10 | pF |
| Switch Capacitance | $C_{SW}$ | — | — | 10 | pF |

## TIMING CHART



**TIMING REQUIREMENTS**

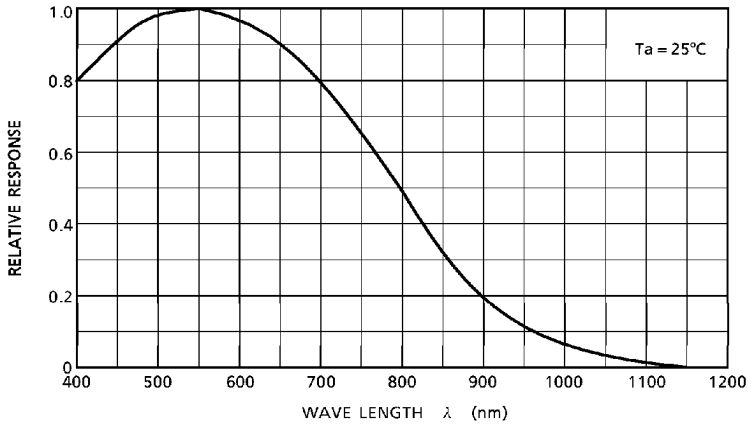



| CHARACTERISTIC | SYMBOL | MIN. | TYP. (Note 10) | MAX. | UNIT |
|---|---|---|---|---|---|
| Pulse Timing of SH and $\phi$1 | t1, t5 | 60 (Note 12) | 1000 | — | ns |
| SH Pulse Rise Time, Fall Time | t2, t4 | 0 | 50 | — | ns |
| SH Pulse Width | t3 | 500 | 1000 | — | ns |
| $\phi$ Rise Time, Fall Time | t6, t7 | 0 | 50 | — | ns |
| RS Rise Time, Fall Time | t8, t10 | 0 | 20 | — | ns |
| RS Pulse Width | t9 | 20 | 250 | — | ns |
| Pulse Timing of $\phi$ and RS | t11 | 0 | 100 | — | ns |
| SP Rise Time, Fall Time | t12, t14 | 10 | 100 | — | ns |
| SP Pulse Width | t13 | 20 | 100 | — | ns |
| Pulse Timing of SP and RS | t15 | 0 | 50 | — | ns |
| Video Data Delay Time (Note 11) | t16, t17 | — | 75 | 90 | ns |
| | t20 | — | 65 | 75 | ns |
| Pulse Timing of $\phi$ and SP | t18 | 0 | 250 | — | ns |
| Pulse Timing of SH and SP | t19 | 20 | 250 | — | ns |

(Note 10) TYP. is the case of $f_{RS}$ = 1MHz.
(Note 11) Load Resistance is 100kΩ.
(Note 12) MIN. is 0ns, when DOS is not used.

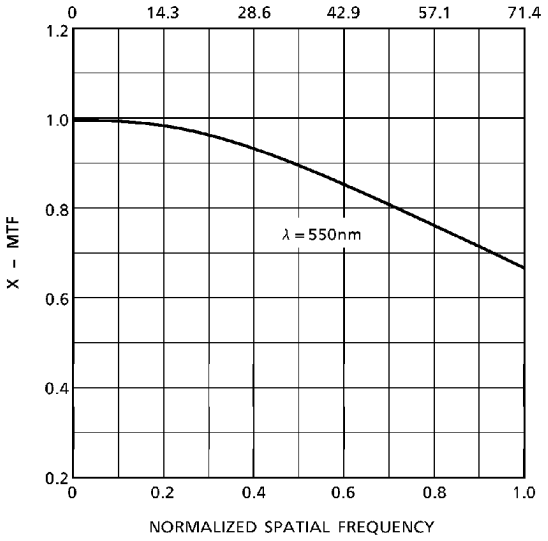
**TYPICAL PERFORMANCE CURVES**

SPECTRAL RESPONSE



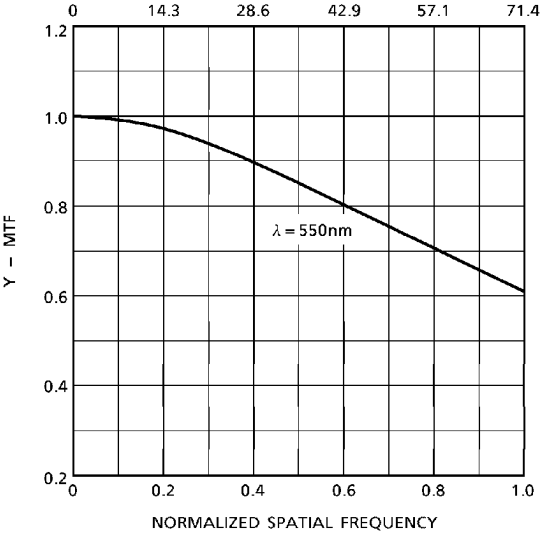

MODULATION TRANSFER FUNCTION OF X-DIRECTION

SPATIAL FREQUENCY (Cycles / mm)



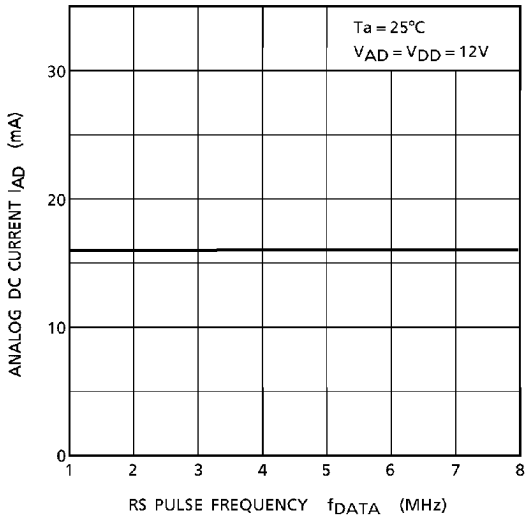

MODULATION TRANSFER FUNCTION OF Y-DIRECTION

SPATIAL FREQUENCY (Cycles / mm)

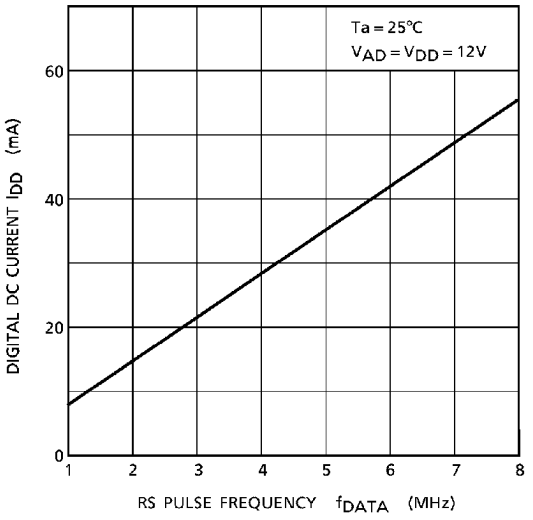


**TYPICAL PERFORMANCE CURVES (Cont'd)**

RS PULSE FREQUENCY – ANALOG DC CURRENT

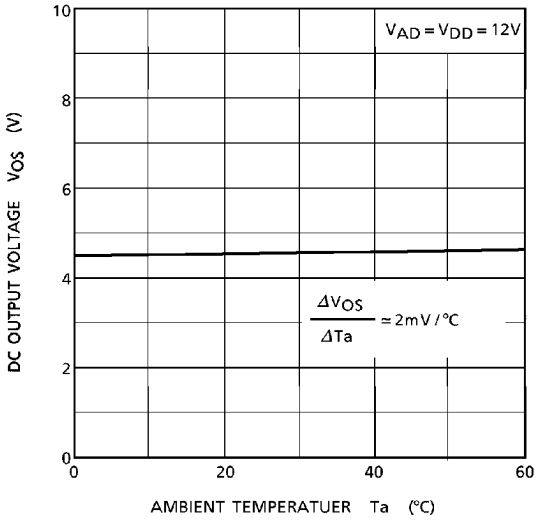



RS PULSE FREQUENCY – DIGITAL DC CURRENT

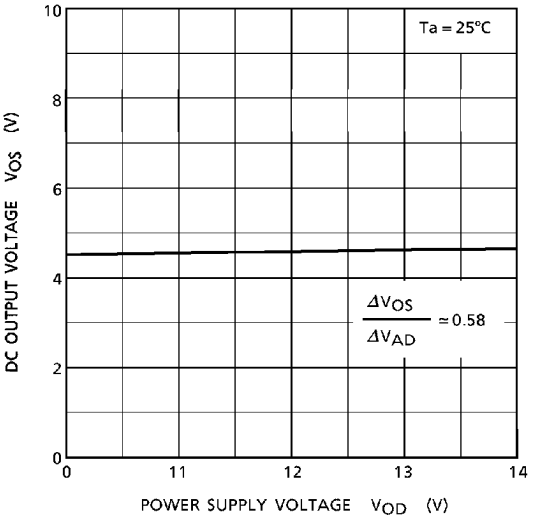


**TYPICAL PERFORMANCE CURVES (Cont'd)**

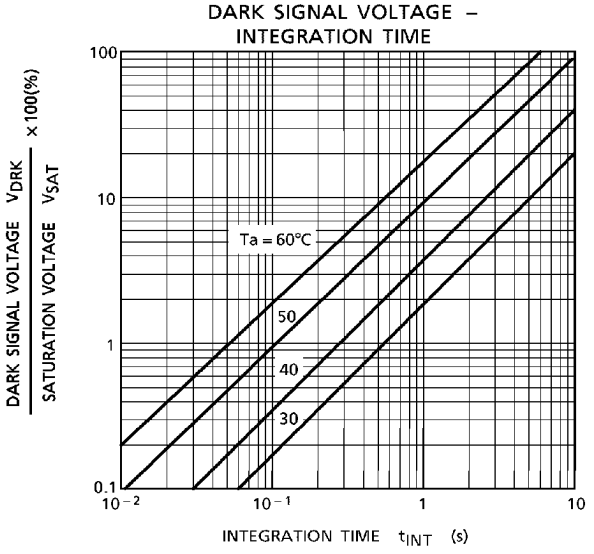
DC OUTPUT VOLTAGE – AMBIENT TEMPERATUER



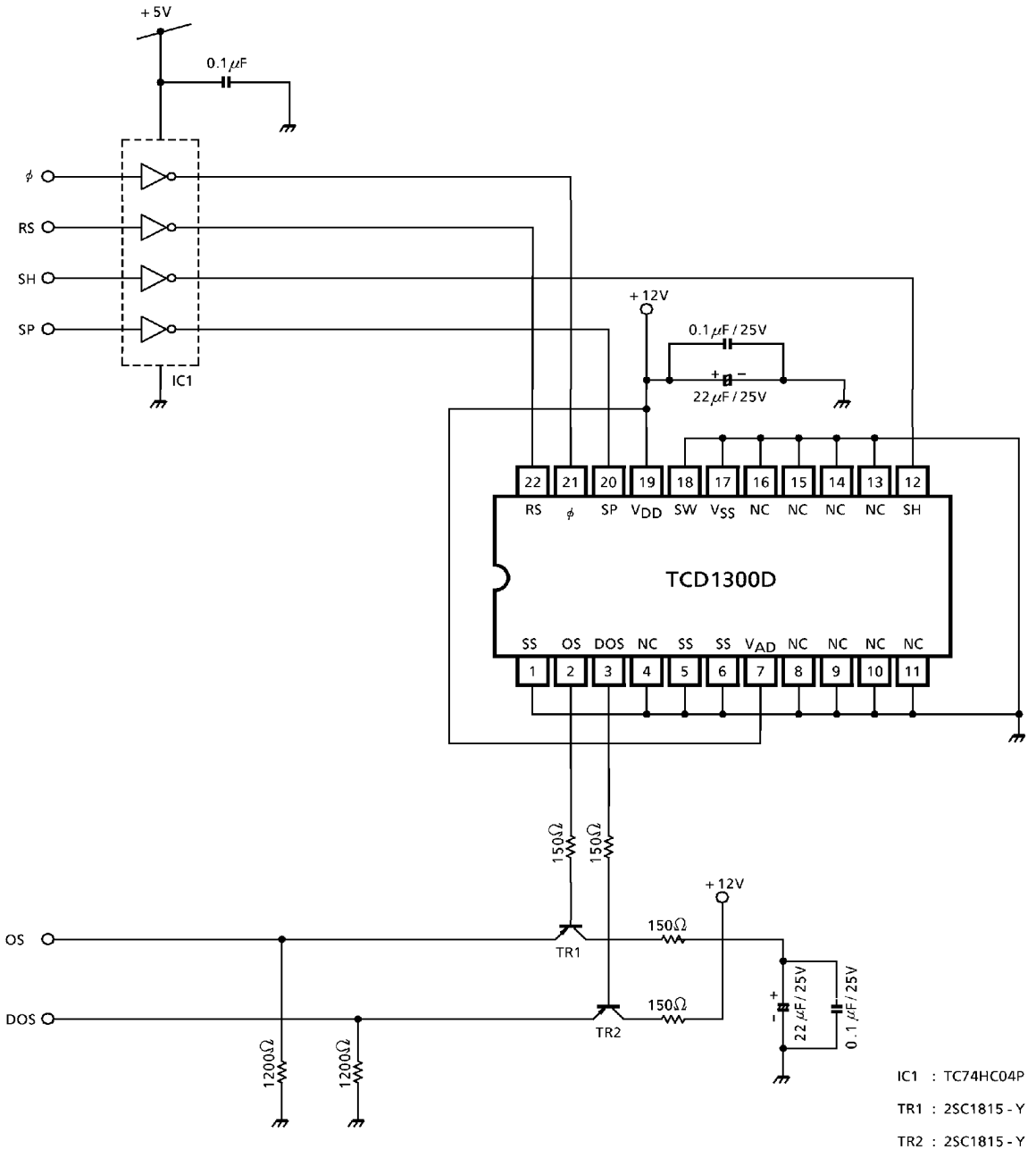

DC OUTPUT VOLTAGE – POWER SUPPLY VOLTAGE




DARK SIGNAL VOLTAGE – INTEGRATION TIME



**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 $N_2$.
   Care should be taken to avoid mechanical or thermal shock because the glass window is easily to damage.

2. Electrostatic Breakdown

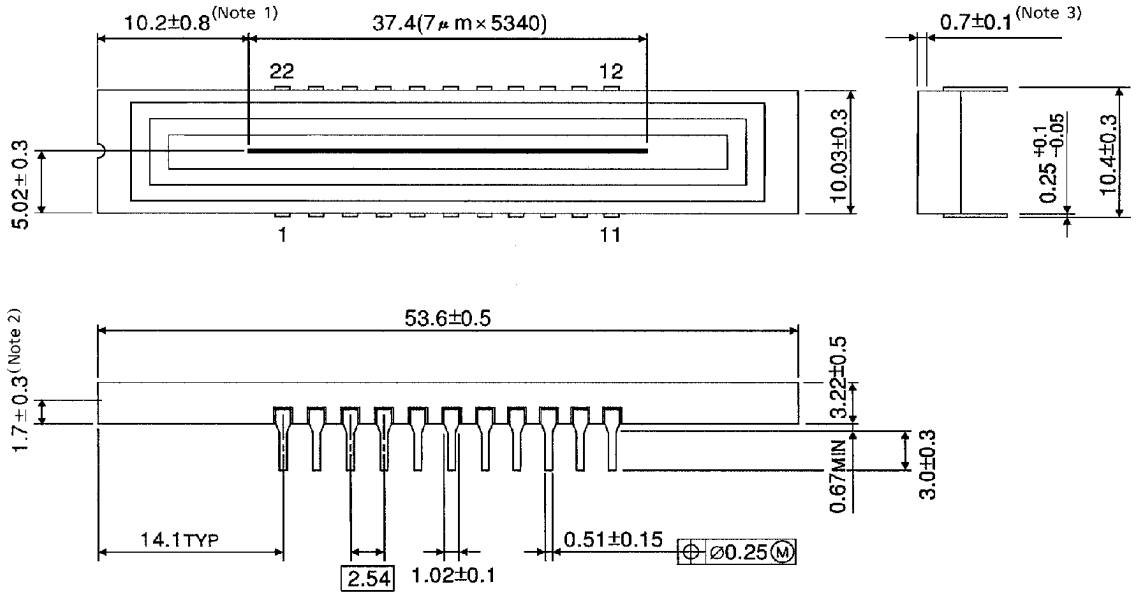
   Store in shorting clip or in conductive foam to avoid electrostatic breakdown.

3. Incident Light

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

**OUTLINE DRAWING**

WDIP22-C-400-2.54B (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 : 5.4g (Typ.)