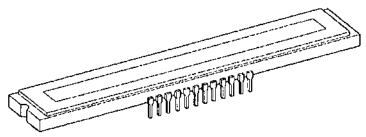
TOSHIBA CCD LINEAR IMAGE SENSOR CCD (Charge Coupled Device)

TCD1704C

The TCD1704C is a high sensitive and low dark current 7500 elements CCD image sensor.
The sensor is designed for facsimile, imagescanner and OCR. The device contains a row of 7500 elements photodiodes which provide a 24 lines / mm (600DPI) across a A3 size paper. The device is operated by 5 V (pulse), and 12 V power supply.



Weight: 17.1g (Typ.)

FEATURES

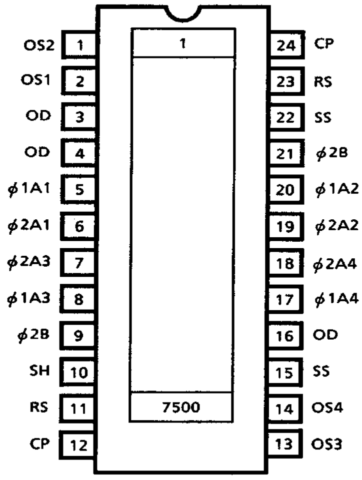
- Number of Image Sensing Elements : 7500 elements
- Image Sensing Element Size : 7 μm by 7 μm on 7 μm centers
- Photo Sensing Region : High sensitive and low voltage dark signal pn photodiode
- Clock : 2 phase (5 V)
- Package : 24 pin DIP

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}		
Clamp Pulse Voltage	V_{CP}		
Power Supply Voltage	V_{OD}	−0.3~15	
Operating Temperature	T_{opr}	0~60	°C
Storage Temperature	T_{stg}	−25~85	°C

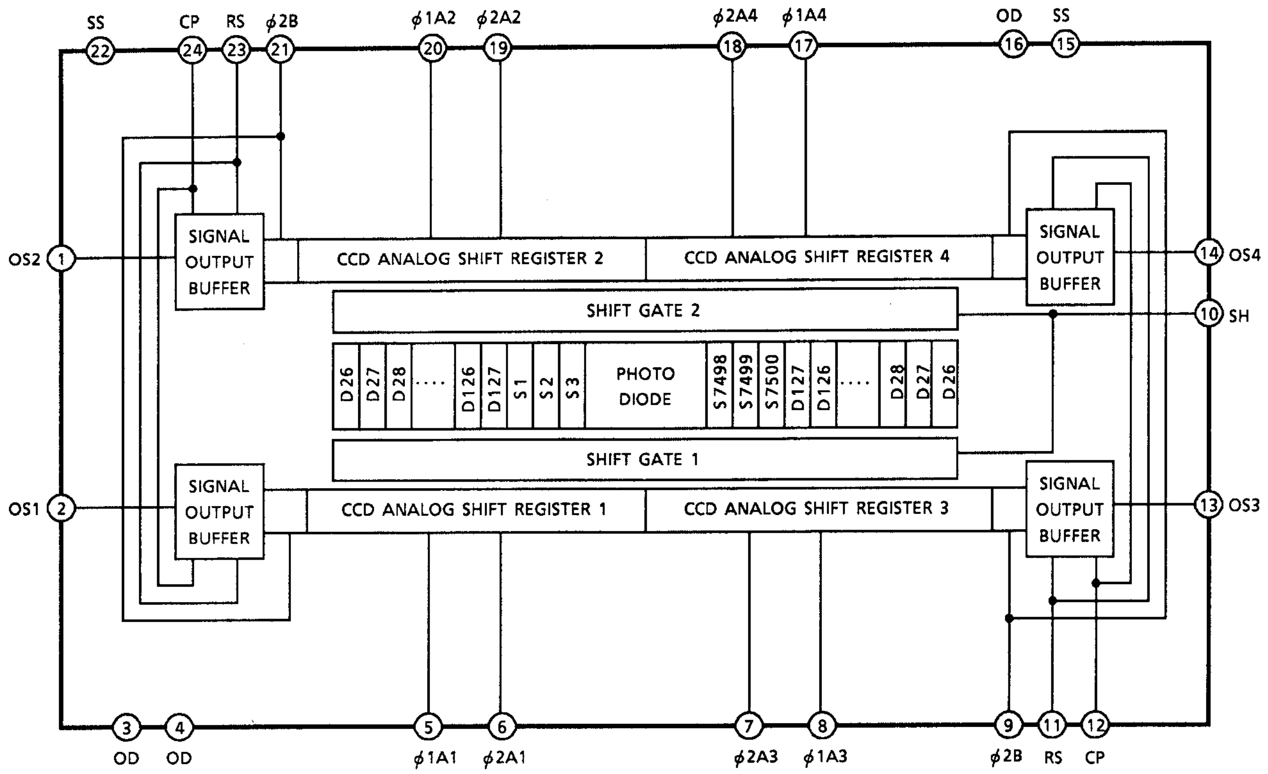
Note 1: All voltage are with respect to SS terminals (Ground).

PIN CONNECTION



(TOP VIEW)

CIRCUIT DIAGRAM



PIN NAME

φ1A1, 2, 3, 4	Clock (Phase 1)
φ2A1, 2, 3, 4	Clock (Phase 2)
φ2B	Final Stage Clock (Phase 2)
SH	Shift Gate
RS	Reset Gate
CP	Clamp Gate
OS1	Signal Output 1
OS2	Signal Output 2
OS3	Signal Output 3
OS4	Signal Output 4
OD	Power
SS	Ground
NC	Non Connection

OPTICAL / ELECTRICAL CHARACTERISTICS
(Ta = 25°C, V_{OD} = 12 V, V_{φ} = V_{SH} = V_{RS} = V_{CP} = 5 V (PULSE), f_{φ} = 1 MHz, t_{INT} (INTEGRATION TIME) = 10 ms, LIGHT SOURCE = DAYLIGHT FLUORESCENT LAMP, LOAD RESISTANCE = 100 kΩ)

CHARACTERISTIC	SYMBOL	MIN	TYP.	MAX	UNIT	NOTE
Sensitivity	R	13.6	17	20.4	V / lx·s	
Photo Response Non Uniformity	PRNU	—	3	10	%	(Note 2)
	PRNU (3)	—	5	12	mV	(Note 8)
Saturation Output Voltage	V_{SAT}	1.5	2.5	—	V	(Note 3)
Saturation Exposure	SE	0.07	0.14	—	lx·s	(Note 4)
Dark Signal Voltage	V_{DRK}	—	1	3	mV	(Note 5)
Dark Signal Non Uniformity	DSNU	—	2	4	mV	(Note 5)
DC Power Dissipation	P_D	—	800	1200	mW	
Total Transfer Efficiency	TTE	92	98	—	%	
Output Impedance	Z_o	—	0.2	1	kΩ	
Dynamic Range	DR	—	2500	—	—	(Note 6)
DC Signal Output Voltage	V_{OS}	3.5	5.0	6.5	V	(Note 7)
DC Differential Error Voltage	$\lvert V_{OSX} - V_{OSY} \rvert$	—	—	300	mV	(Note 9)
Random Noise	ND_{σ}	—	1.0	—	mV	(Note 10)

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

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

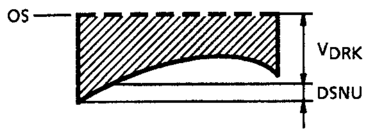
Where $\bar{\chi}$ is average of total signal outputs and $\Delta\chi$ is maximum deviation from $\bar{\chi}$ under uniform illumination. (Channel 1)

In the case of 1875 elements (Channel 2, Channel 3 and Channel 4), the condition is the same as above too.

Note 3: V_{SAT} is defined as minimum saturation output voltage of all effective pixels.

Note 4: Definition of SE : SE = $\frac{V_{SAT}}{R}$ (lx·s)

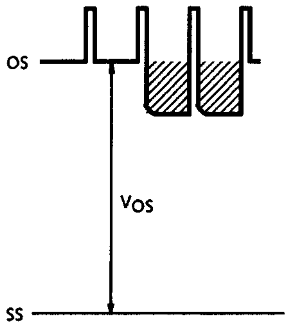
Note 5: V_{DRK} is defined as average dark signal voltage of all effective pixels.
DSNU is defined as different voltage between V_{DRK} and V_{MDK} when V_{MDK} is maximum dark signal voltage.



Note 6: 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 values.

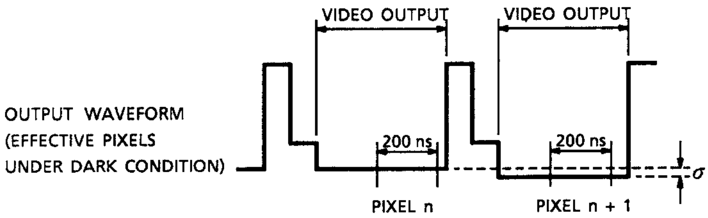
Note 7: DC signal output voltage and DC compensation output voltage are defined as follows:



Note 8: PRNU (3) is defined as maximum voltage with next pixel, where measured 5% of SE (Typ.)

Note 9: DC Differential Error Voltage is defined as follows:
Definition of DC differential Error Voltage = $|V_{OSX} - V_{OSY}|$
V_{OSX} : Maximum DC Signal Output Voltage
V_{OSY} : Minimum DC Signal Output Voltage

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 condition) 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 levels at video output periods averaged over 200 nanosecond period to get Vn and Vn + 1.

3) Vn + 1 is subtracted from Vn 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).

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

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

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

6) $\bar{\sigma}$ 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.

$$\text{Random noise} = \frac{1}{\sqrt{2}}\bar{\sigma}$$

OPERATING CONDITION

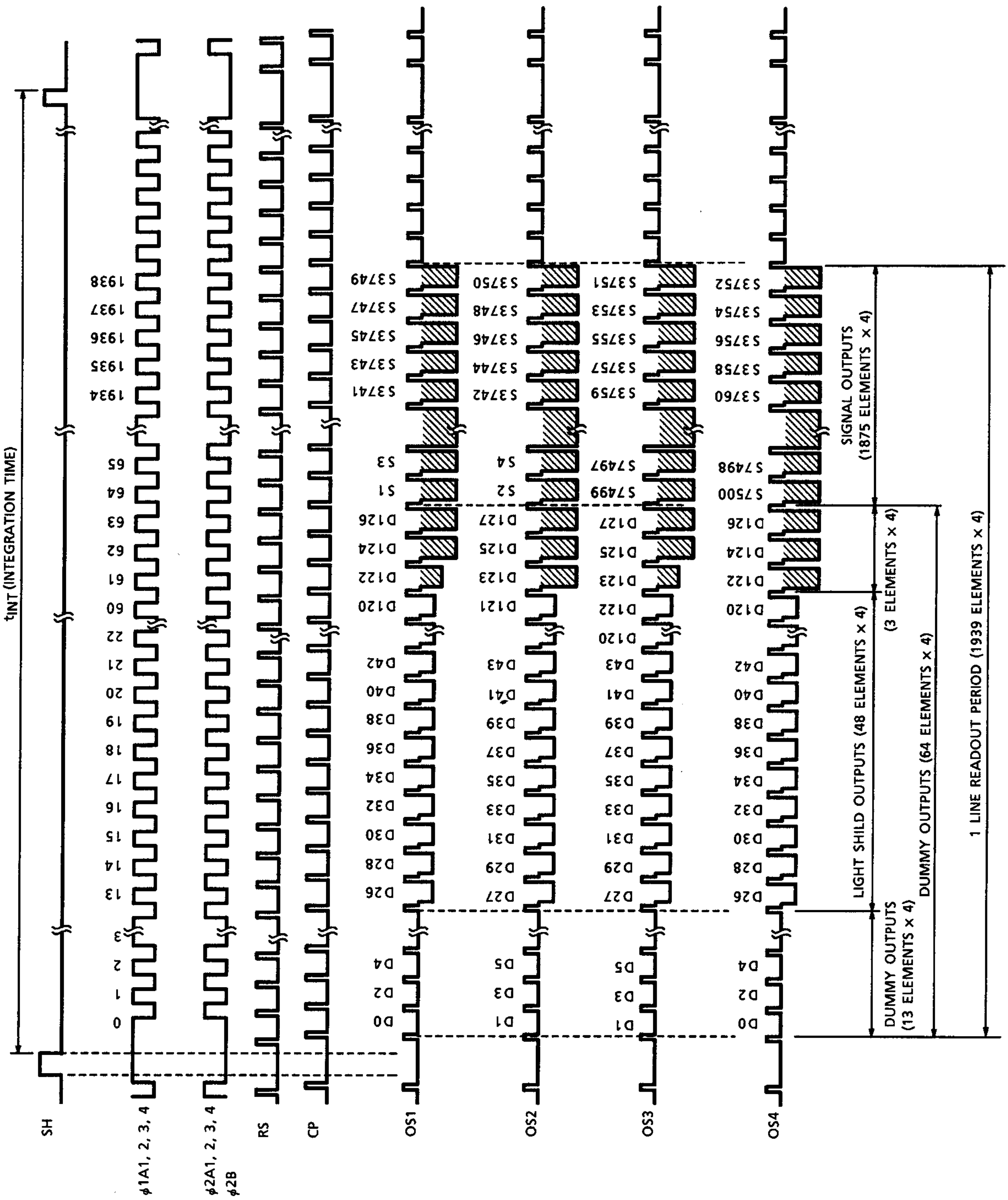
CHARACTERISTIC		SYMBOL	MIN	TYP.	MAX	UNIT
Clock Pulse Voltage	"H" Level	$V_{\varphi}1A$	4.5	5	5.5	V
	"L" Level	$V_{\varphi}2A$	0	—	0.5	
Final Stage Clock Voltage	"H" Level	$V_{\varphi}2B$	4.5	5	5.5	V
	"L" Level		0	—	0.5	
Shift Pulse Voltage	"H" Level	V_{SH}	4.5	5	5.5	V
	"L" Level		0	—	0.5	
Reset Pulse Voltage	"H" Level	V_{RS}	4.5	5	5.5	V
	"L" Level		0	—	0.5	
Clamp Pulse Voltage	"H" Level	V_{CP}	4.5	5	5.5	V
	"L" Level		0	—	0.5	
Power Supply Voltage		V_{OD}	11.4	12.0	13.0	V

CLOCK CHARACTERISTICS (Ta = 25°C)

CHARACTERISTIC	SYMBOL	MIN	TYP.	MAX	UNIT
Clock Pulse Frequency	f_{φ}	—	1	20	MHz
Reset Pulse Frequency	f_{RS}	—	1	20	MHz
Clock Capacitance (Note 11)	$C_{\varphi}1A$	—	200	—	pF
	$C_{\varphi}2A$	—	200	—	
Final Stage Clock Capacitance	$C_{\varphi}B$	—	20	—	pF
Shift Gate Capacitance	C_{SH}	—	40	—	pF
Reset Gate Capacitance	C_{RS}	—	20	—	pF
Clamp Gate Capacitance	C_{CP}	—	20	—	pF

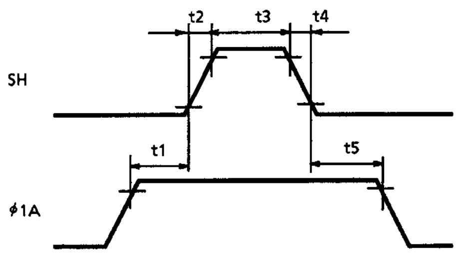
Note 11: V_{OD} = 12 V

TIMING CHART

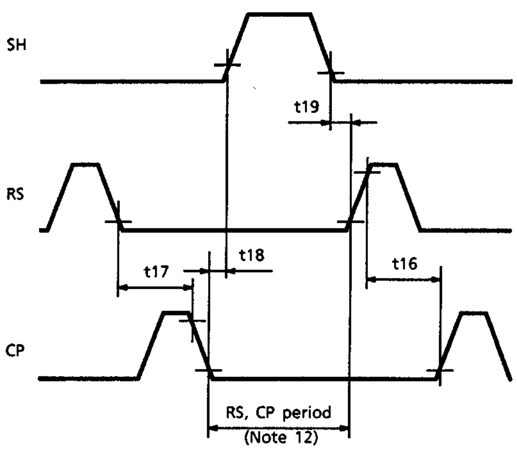


TIMING REQUIREMENTS

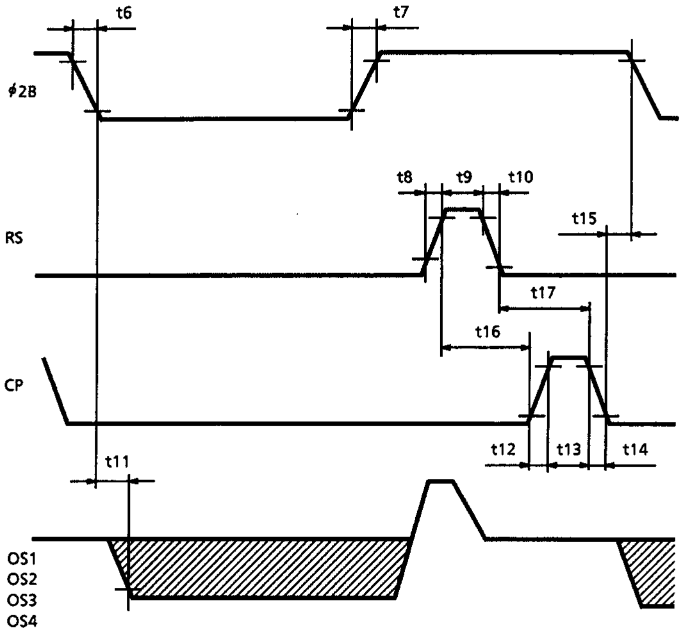
SH, $\phi 1$ Timing



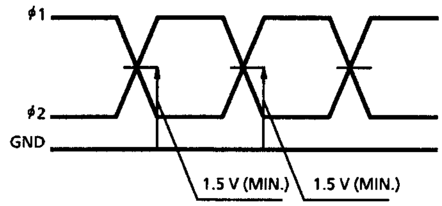
SH, RS, CP Timing



$\phi 2$, RS, CP, OS Timing



$\phi 1$, $\phi 2$ CROSS POINT



Note 12: Each RS and CP pins put to Low level during this period.

CHARACTERISTIC	SYMBOL	MIN	TYP. (Note 13)	MAX	UNIT
Pulse Timing of SH and φ1A	t1, t5	500	1000	—	ns
SH Pulse Rise Time, Fall Time	t2, t4	0	50	—	ns
SH Pulse Width	t3	1000	1500	—	ns
φ2B Pulse Rise Time, Fall Time	T6, t7	0	100	—	ns
RS Pulse Rise Time, Fall Time	t8, t10	0	20	—	ns
RS Pulse Width	t9	0	100	—	ns
Video Data Delay Time (Note 14)	t11	—	15	—	ns
CP Pulse Rise Time, Fall Time	t12, t14	0	20	—	ns
CP Pulse Width	t13	10	100	—	ns
Pulse Timing of φ2B and CP	t15	0	50	—	ns
Pulse Timing of RS and CP	t16	0	100	—	ns
	t17	10	100	—	
Pulse Timing of SH and CP	t18	200	—	—	ns
Pulse Timing of SH and RS	t19	200	—	—	ns

Note 13: TYP. is the case of f_{RS} = 1.0 MHz
Note 14: Load Resistance is 100 kΩ

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 handing 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 of 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.

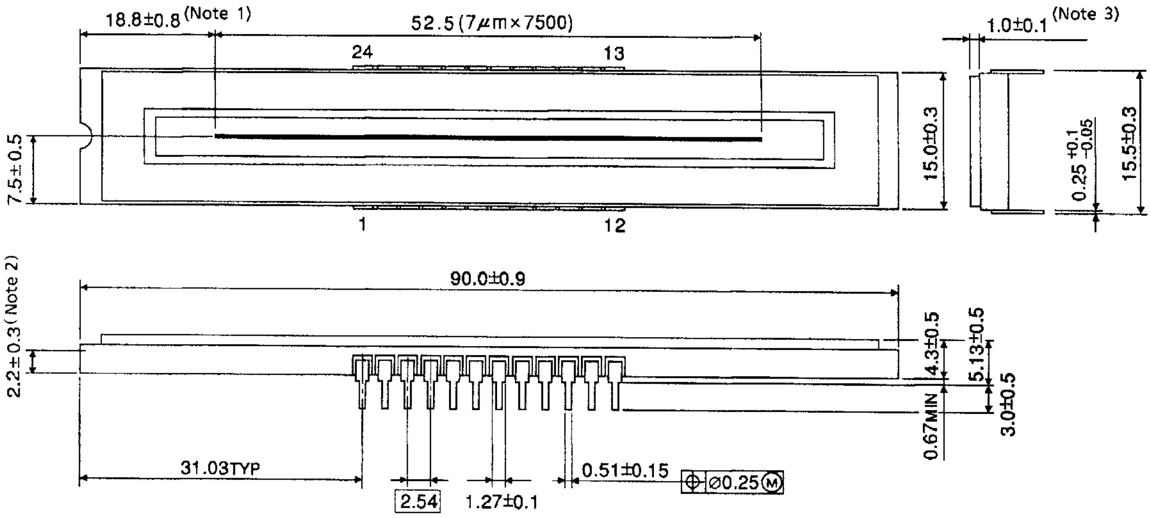
4. Soldering

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.

PACKAGE DIEMENSIONS

WDIP24-C-600-2.54 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: 17.1 g (Typ.)