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TOSHIBA CCD Linear Image Sensor CCD (Charge Coupled Device)

# **TCD1209DG**

TOSHIBA CCD LINEAR IMAGE SENSOR CCD(Charge Coupled Device)

## TCD1209DG

The TCD1209DG is a high sensitive and low dark current 2048 elements linear image sensor.

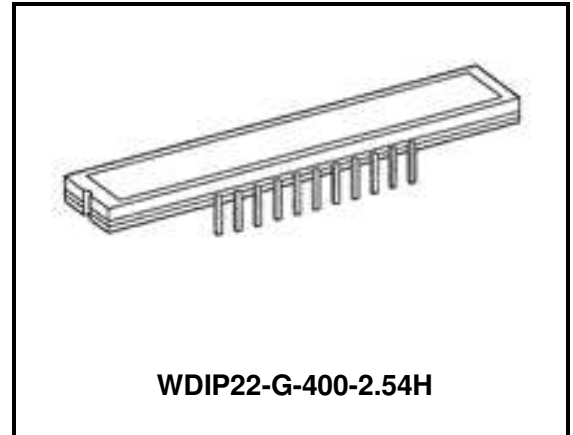
The sensor is designed for facsimile, image scanner and OCR.

The device contains a row of 2048 elements photodiodes which provide 8lines / mm (200 DPI) resolution across a B4 size paper.

The device is operated by 5V pulses and 12V power supply.

### FEATURES

- Pixel Number : 2048
- Pixel Size : 14 $\mu$ m  $\times$  14 $\mu$ m (14 $\mu$ m pitch)
- Photo Sensing element  
: High Sensitive & Low Dark Current pn Photodiode
- Clock : 2 phase (5V)
- Package : 22 Pin CERDIP



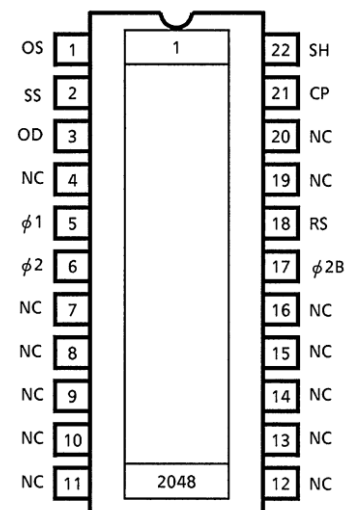
Weight: 3.7g(Typ.)

### ABSOLUTE MAXIMUM RATINGS (Note 1)

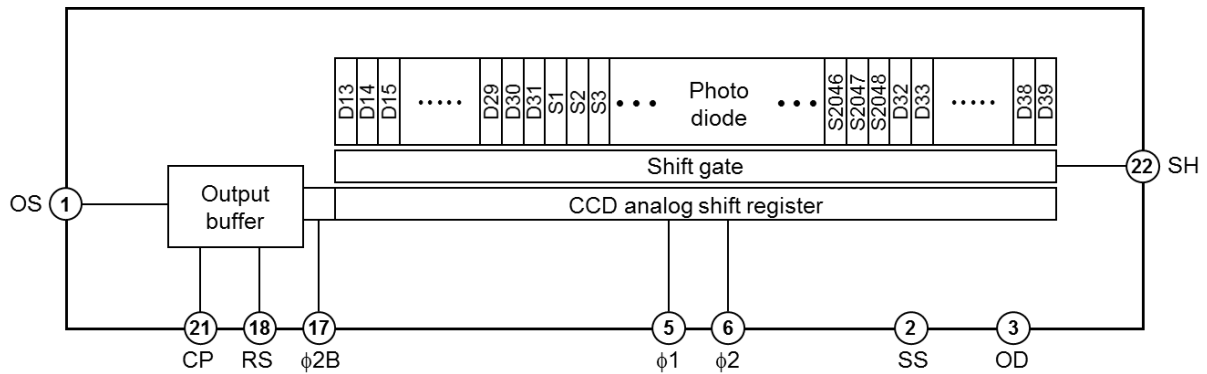
CHARACTERISTIC	SYMBOL	RATING	UNIT
Clock Pulse Voltage	$V_{\phi}$	-0.3 to +8.0	V
Shift Pulse Voltage	$V_{SH}$		
RS Pulse Voltage	$V_{RS}$		
Clamp Pulse Voltage	$V_{CP}$		
Power Supply Voltage	$V_{OD}$	-0.3 to +15.0	V
Operating Temperature	$T_{opr}$	-25 to +60	$^{\circ}$ C
Storage Temperature	$T_{stg}$	-40 to +100	$^{\circ}$ C

Note 1: All voltage are with respect to SS terminals. (Ground)  
 None of the ABSOLUTE MAXIMUM RATINGS must be exceeded, even instantaneously.  
 If any one of the ABSOLUTE MAXIMUM RATINGS is exceeded, the electrical characteristics, reliability and life time of the device cannot be guaranteed.  
 If the ABSOLUTE MAXIMUM RATINGS are exceeded, the device can be permanently damaged or degraded.  
 Create a system design in such a manner that any of the ABSOLUTE MAXIMUM RATINGS will not be exceeded under any circumstances.

### PIN CONNECTION (TOP VIEW)



## CIRCUIT DIAGRAM



## PIN NAMES

PIN No.	SYMBOL	NAME	PIN No.	SYMBOL	NAME
1	OS	Signal Output	22	SH	Shift Gate
2	SS	Ground	21	CP	Clamp Gate
3	OD	Power	20	NC	Non Connection
4	NC	Non Connection	19	NC	Non Connection
5	$\phi 1$	Clock (Phase 1)	18	RS	Reset Gate
6	$\phi 2$	Clock (Phase 2)	17	$\phi 2B$	Final Stage Clock (Phase 2)
7	NC	Non Connection	16	NC	Non Connection
8	NC	Non Connection	15	NC	Non Connection
9	NC	Non Connection	14	NC	Non Connection
10	NC	Non Connection	13	NC	Non Connection
11	NC	Non Connection	12	NC	Non Connection

### OPTICAL / ELECTRICAL CHARACTERISTICS

Ta = 25°C, VOD = 12V, Vφ = VSH = VRS = VCP = 5V (PULSE), fφ = 1MHz,

tINT (INTEGRATION TIME) = 10ms, LIGHT SOURCE = DAYLIGHT FLUORESCENT LAMP

CHARACTERISTIC	SYMBOL	MIN	TYP.	MAX	UNIT	NOTE
Sensitivity	R	25	31	37	V/lx·s	
Photo Response Non Uniformity	PRNU(1)	—	3	10	%	(Note2)
	PRNU (3)	—	4	10	mV	(Note8)
Saturation Output Voltage	V <sub>SAT</sub>	1.5	2.0	—	V	(Note3)
Saturation Exposure	SE	0.04	0.06	—	lx·s	(Note4)
Dark Signal Voltage	V <sub>DRK</sub>	—	1.0	2.5	mV	(Note5)
Dark Signal Non Uniformity	DSNU	—	1.0	2.5	mV	(Note5)
DC Power Dissipation	P <sub>D</sub>	—	160	400	mW	
Total Transfer Efficiency	TTE	92	98	—	%	
Output Impedance	Z <sub>O</sub>	—	0.2	1.0	kΩ	
Dynamic Range	DR	—	2000	—	—	(Note6)
DC Signal Output Voltage	V <sub>OS</sub>	4.0	5.5	7.0	V	(Note7)
Random Noise	NDσ	—	0.6	—	mV	(Note9)

Note 2: Measured with 500mV signal output (typ.)

Definition of PRNU (1)

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

$\bar{\chi}$ : Average of total signal outputs

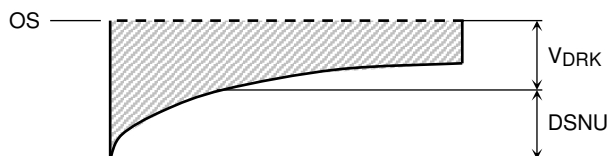
$\Delta\chi$ : The maximum deviation from  $\bar{\chi}$ .

Note 3: V<sub>SAT</sub> is defined as the minimum saturation output voltage of all effective pixels.

Note 4: Definition of SE

$$\text{SE} = \frac{V_{\text{SAT}}}{R} (\text{lx} \cdot \text{s})$$

Note 5: V<sub>DRK</sub> is defined as average dark signal voltage of all effective pixels.



DSNU is defined by the difference between average value (V<sub>DRK</sub>) and the maximum value of the dark voltage.

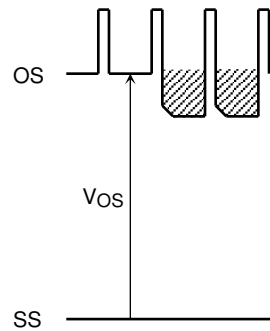
Note 6: Definition of DR

$$\text{DR} = \frac{V_{\text{SAT}}}{V_{\text{DRK}}}$$

V<sub>DRK</sub> is proportional to tINT (Integration time).

So the shorter integration time makes wider dynamic range.

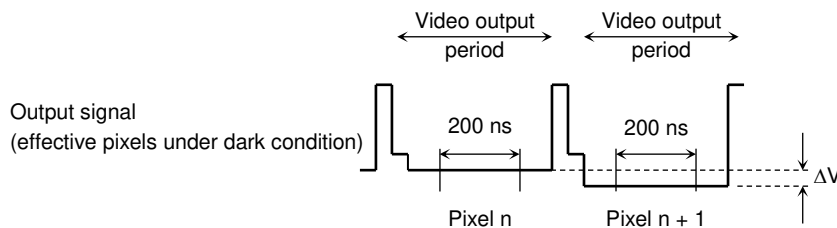
Note 7: DC signal output voltage is defined as follows:



Note 8: Measured with 50mV signal output (typ.)

PRNU (3) is defined as the maximum output level difference between two adjacent effective pixels.

Note 9: 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  $V_n$  and  $V_{n+1}$ .
- 3)  $V_{n+1}$  is subtracted from  $V_n$  to get  $\Delta V$ .
- 4) The standard deviation of  $\Delta V$  is calculated after procedure 2) and 3) are repeated 30 times (30 readings).

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

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

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

- 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

For best performance, the device should be used within the Recommended Operating Conditions.

CHARACTERISTIC		SYMBOL	MIN	TYP.	MAX	UNIT
Clock Pulse Voltage	"H" Level	$V_{\phi 1}$ $V_{\phi 2}$	4.5	5.0	5.5	V
	"L" Level		0	—	0.5	
Final Stage Clock Voltage	"H" Level	$V_{\phi 2B}$	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	
Clamp Pulse Voltage	"H" Level	$V_{CP}$	4.5	5.0	5.5	V
	"L" Level		0	—	0.5	
Power Supply Voltage		$V_{OD}$	11.4	12.0	13.0	V

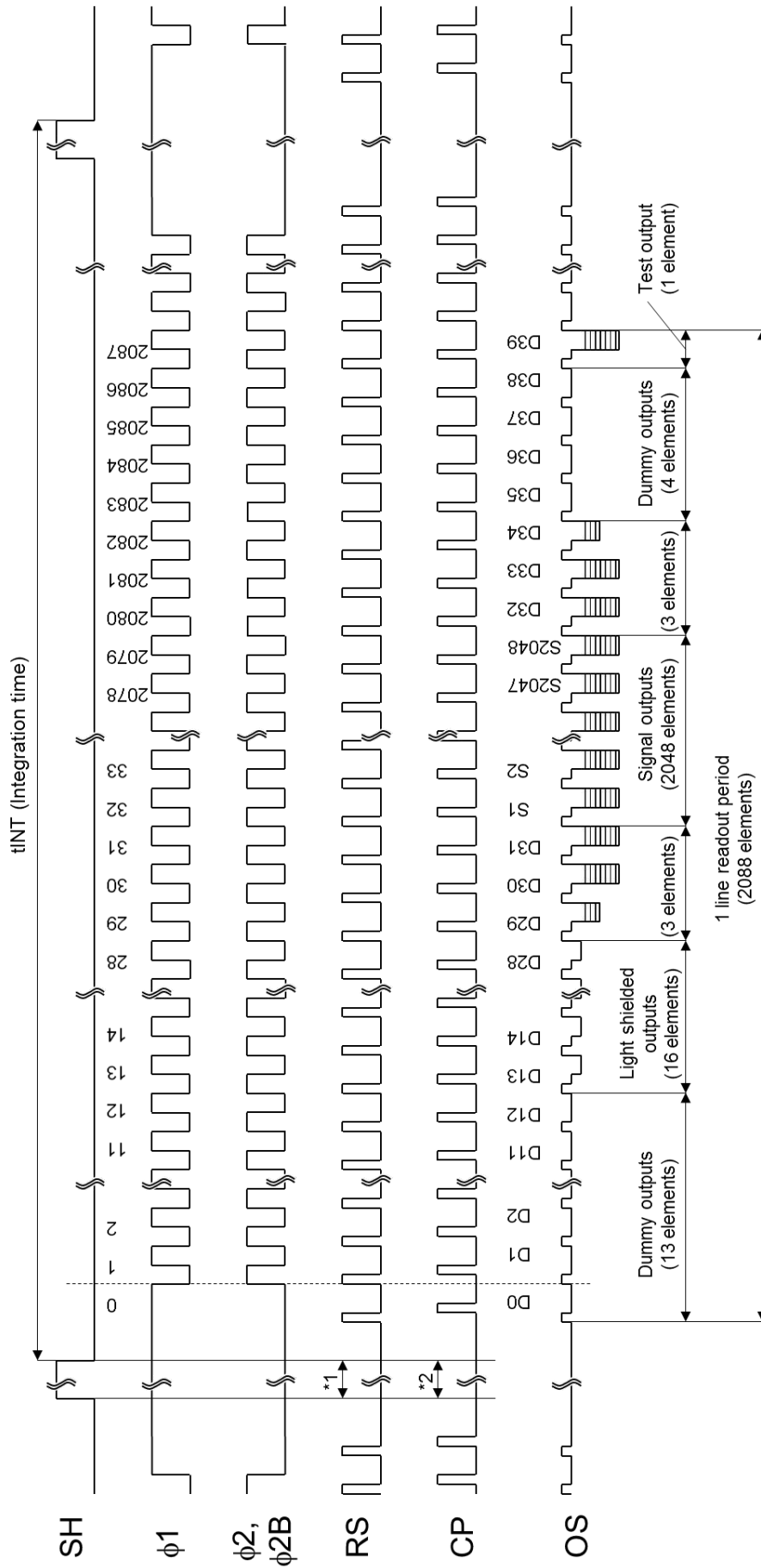
### CLOCK CHARACTERISTICS

For best performance, the device should be used within the Recommended Operating Conditions.

CHARACTERISTIC	SYMBOL	MIN	TYP.	MAX	UNIT
Clock Pulse Frequency	$f_{\phi}$	—	1	20	MHz
Reset Pulse Frequency	$f_{RS}$	—	1	20	MHz
Clock Capacitance (Note10)	$C_{\phi 1}$	—	200	—	pF
	$C_{\phi 2}$	—	200	—	
Final Stage Clock Capacitance	$C_{\phi 2B}$	—	10	20	pF
Shift Gate Clock Capacitance	$C_{SH}$	—	30	—	pF
Reset Gate Clock Capacitance	$C_{RS}$	—	10	20	pF
Clamp Gate Clock Capacitance	$C_{CP}$	—	10	20	pF

Note 10:  $V_{OD} = 12V$

## TIMING CHART



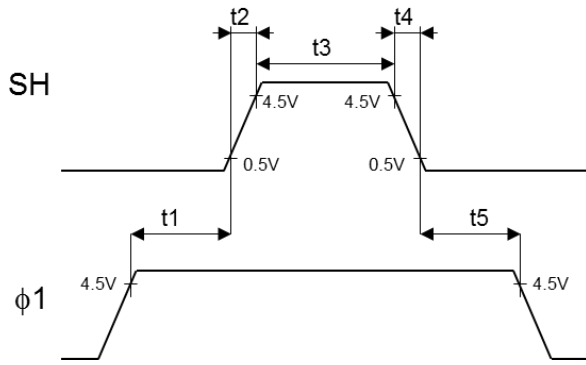
\*1: RS should be kept "L" level.

\*2: CP should be kept "L" level.

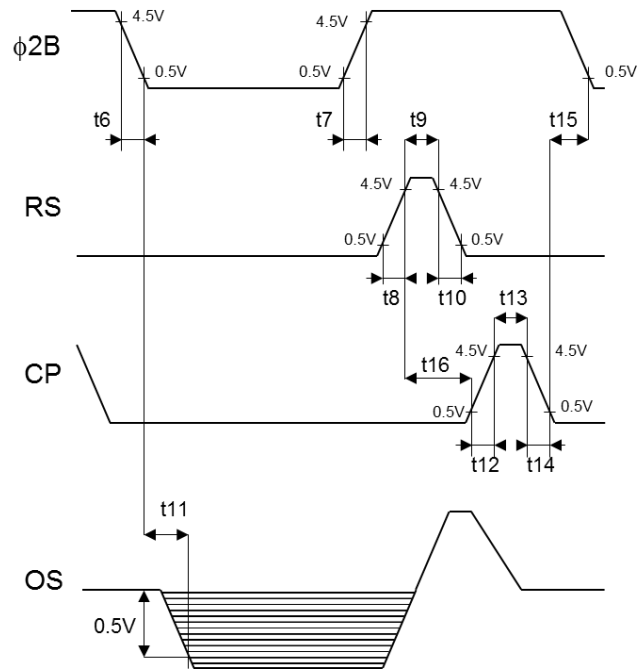


## TIMING REQUIREMENTS

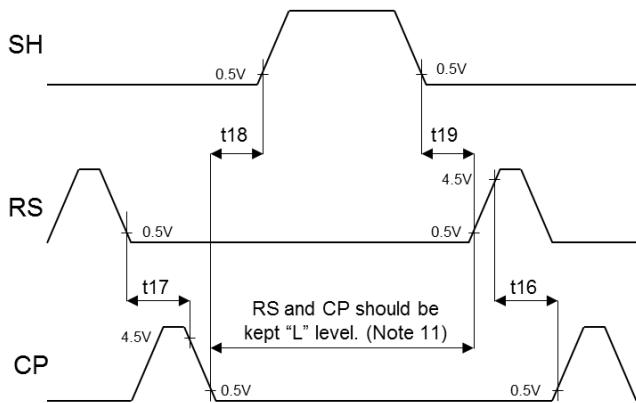
### SH, $\phi 1$ Timing



### $\phi 2B$ , RS, CP Timing

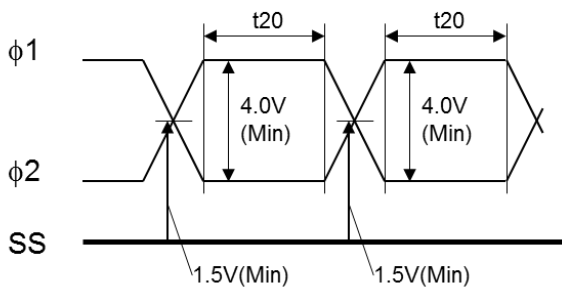


### SH, RS, CP Timing



Note 11: RS and CP should be kept "L" level on this period.

### $\phi 1$ , $\phi 2$ Cross point



CHARACTERISTIC	SYMBOL	MIN	TYP. (Note12)	MAX	UNIT
Pulse Timing of SH and $\phi$ 1 Pulses	t1, t5	200 +t8+t12+t13 +t14+t16	500	—	ns
Rise/Fall Time of SH Pulse	t2, t4	0	50	—	ns
“H” Level Period of SH Pulse	t3	1000	1500	—	ns
Rise/Fall Time of $\phi$ 2B Pulse	t6, t7	0	100	—	ns
Rise/Fall Time of RS Pulse	t8, t10	0	20	—	ns
“H” Level Period of RS Pulse	t9	10	100	—	ns
Video Data Delay Time	t11	—	15	—	ns
Rise/Fall Time of CP Pulse	t12, t14	0	20	—	ns
“H” Level Period of CP Pulse	t13	10	100	—	ns
Pulse Timing of $\phi$ 2B and CP Pulses	t15	0	50	—	ns
Pulse Timing of RS and CP Pulses	t16	0	100	—	ns
	t17	10	100	—	
Pulse Timing of SH and CP Pulses	t18	200	—	—	ns
Pulse Timing of SH and RS Pulses	t19	200	—	—	ns
Pulse Timing of $\phi$ 1 and $\phi$ 2 Pulses	t20	17	—	—	ns

Note 12: Typical condition is on the case that  $f\phi = 1.0\text{MHz}$ .

**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.

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 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. 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.

**5. Soldering**

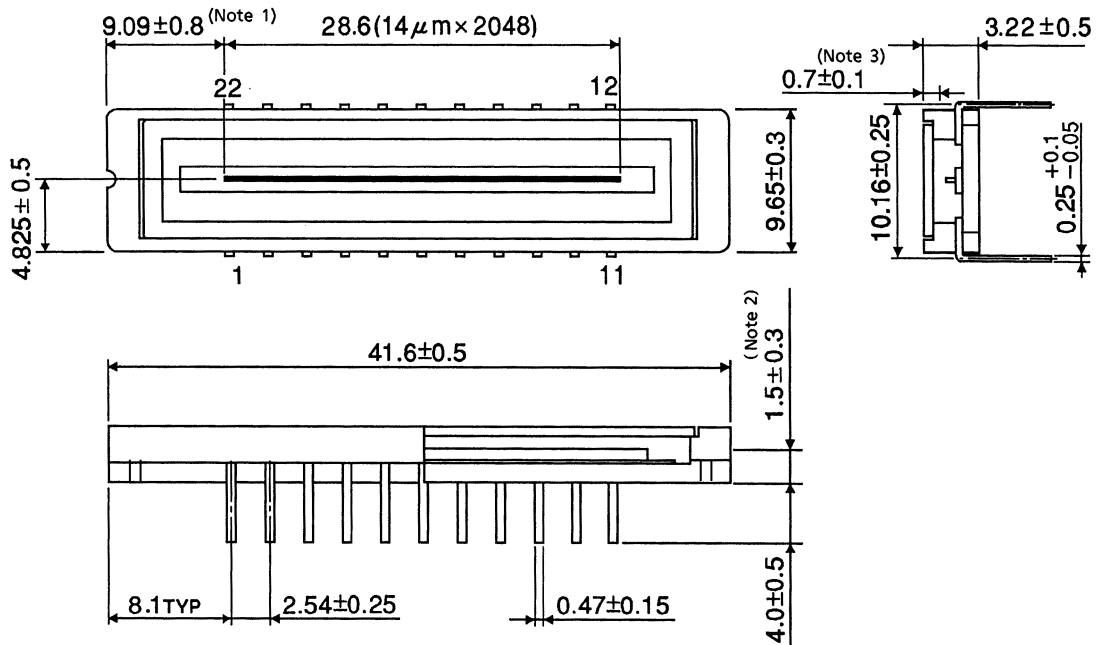
Soldering by the solder flow method cannot be guaranteed because this method may have deleterious effects on prevention of window glass soiling and heat resistance.

Using a soldering iron, complete soldering within 10 seconds for lead temperatures of up to 260°C, or within 3 seconds for lead temperatures of up to 350°C.

### PACKAGE DIMENSIONS

WDIP22-G-400-2.54H

Unit: mm



- Note 1: 1<sup>st</sup> sensing element (S1) to the edge of the package.
- Note 2: Top of the sensor chip to the bottom of the package.
- Note 3: Glass thickness (n = 1.5)

Weight: 3.7g (Typ.)

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