

Diagonal 8mm (Type 1/2) CCD Image Sensor for EIA B/W Video Cameras

Description

The ICX428ALB is an interline CCD solid-state image sensor suitable for EIA B/W video cameras with a diagonal 8mm (Type 1/2) system. Basic characteristics such as sensitivity, smear, dynamic range and S/N are improved drastically through the adoption of EXview HAD CCD™ technology.

This chip features a field period readout system and an electronic shutter with variable charge-storage time. Also, this outline is miniaturized by using original package. This chip is compatible with the pins of the ICX248ALB and has the same drive conditions.

EXview HAD CCD™ has different spectral characteristics from the current CCD.

Features

- High sensitivity
- Low smear
- High D range
- High S/N
- High resolution and low dark current
- Excellent antiblooming characteristics
- Continuous variable-speed shutter
- Substrate bias: Adjustment free (external adjustment also possible with 6 to 14V)
- Reset gate pulse: 5Vp-p adjustment free (drive also possible with 0 to 9V)
- Horizontal register: 5V drive
- Maximum package dimensions: $\phi 13.2\text{mm}$

Device Structure

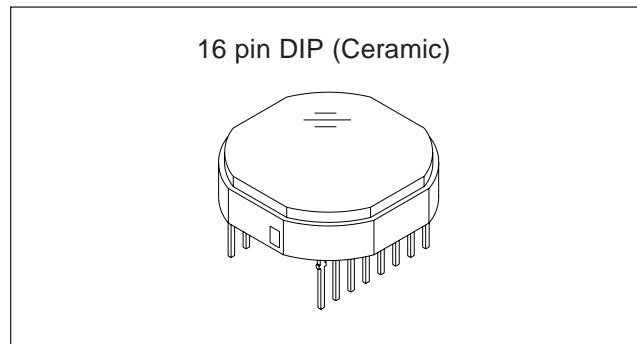
- Interline CCD image sensor
- Optical size: Diagonal 8mm (Type 1/2)
- Number of effective pixels: 768 (H) \times 494 (V) approx. 380K pixels
- Total number of pixels: 811 (H) \times 508 (V) approx. 410K pixels
- Chip size: 7.40mm (H) \times 5.95mm (V)
- Unit cell size: 8.4 μm (H) \times 9.8 μm (V)
- Optical black: Horizontal (H) direction: Front 3 pixels, rear 40 pixels
Vertical (V) direction: Front 12 pixels, rear 2 pixels
- Number of dummy bits: Horizontal 22
Vertical 1 (even fields only)
- Substrate material: Silicon

EXview HAD CCD™

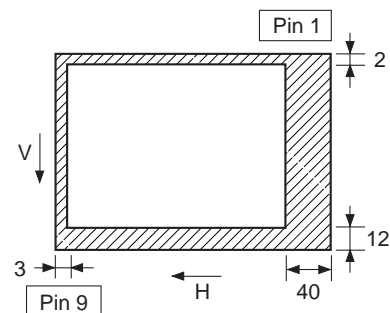
* EXview HAD CCD is a trademark of Sony Corporation.

EXview HAD CCD is a CCD that drastically improves light efficiency by including near infrared light region as a

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16 pin DIP (Ceramic)



**Optical black position
(Top View)**

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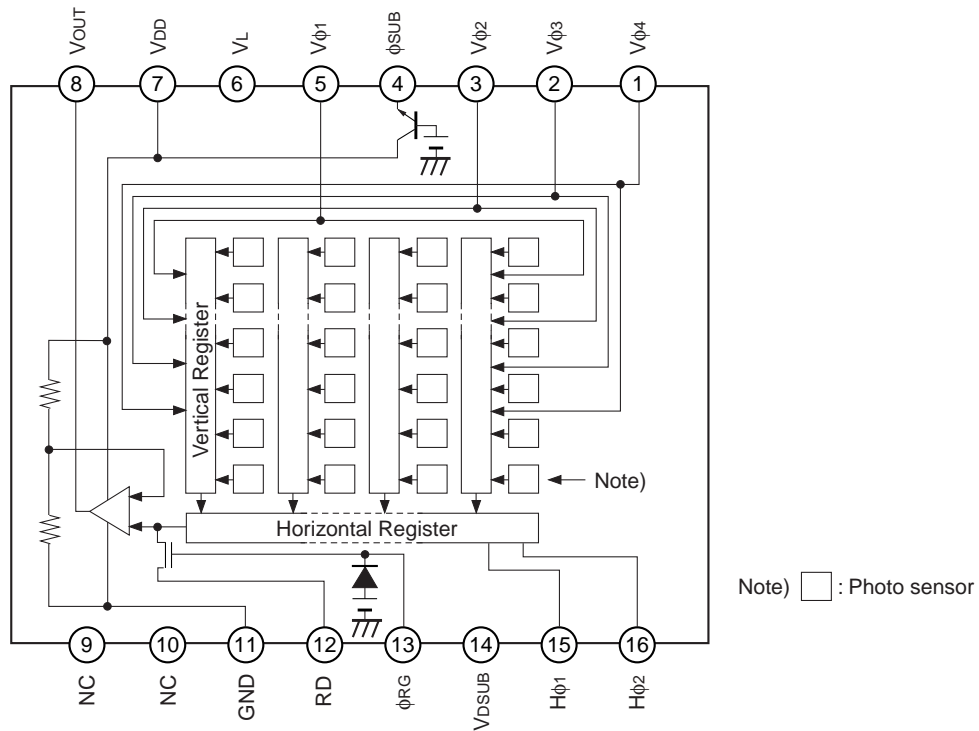
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Block Diagram and Pin Configuration

(Top View)



Pin Description

| Pin No. | Symbol | Description | Pin No. | Symbol | Description |
|---------|--------|----------------------------------|---------|--------|---------------------------------------|
| 1 | Vφ4 | Vertical register transfer clock | 9 | NC | |
| 2 | Vφ3 | Vertical register transfer clock | 10 | NC | |
| 3 | Vφ2 | Vertical register transfer clock | 11 | GND | GND |
| 4 | φSUB | Substrate clock | 12 | RD | Reset drain bias |
| 5 | Vφ1 | Vertical register transfer clock | 13 | φRG | Reset gate clock |
| 6 | VL | Protective transistor bias | 14 | VDSUB | Substrate bias circuit supply voltage |
| 7 | VDD | Output circuit supply voltage | 15 | Hφ1 | Horizontal register transfer clock |
| 8 | VOUT | Signal output | 16 | Hφ2 | Horizontal register transfer clock |

Absolute Maximum Ratings

| Item | | Ratings | Unit | Remarks |
|--|---|-------------|------|---------|
| Substrate clock $\phi_{SUB} - GND$ | | -0.3 to +50 | V | |
| Supply voltage | $V_{DD}, V_{RD}, V_{DSUB}, V_{OUT} - GND$ | -0.3 to +18 | V | |
| | $V_{DD}, V_{RD}, V_{DSUB}, V_{OUT} - \phi_{SUB}$ | -55 to +10 | V | |
| Clock input voltage | $V\phi_1, V\phi_2, V\phi_3, V\phi_4 - GND$ | -15 to +20 | V | |
| | $V\phi_1, V\phi_2, V\phi_3, V\phi_4 - \phi_{SUB}$ | to +10 | V | |
| Voltage difference between vertical clock input pins | | to +15 | V | *1 |
| Voltage difference between horizontal clock input pins | | to +17 | V | |
| $H\phi_1, H\phi_2 - V\phi_4$ | | -17 to +17 | V | |
| $\phi_{RG} - GND$ | | -10 to +15 | V | |
| $\phi_{RG} - \phi_{SUB}$ | | -55 to +10 | V | |
| $V_L - \phi_{SUB}$ | | -65 to +0.3 | V | |
| Pins other than GND and $\phi_{SUB} - V_L$ | | -0.3 to +30 | V | |
| Storage temperature | | -30 to +80 | °C | |
| Operating temperature | | -10 to +60 | °C | |

*1 +27V (Max.) when clock width < 10 μ s, clock duty factor < 0.1%.

Bias Conditions 1 [when used in substrate bias internal generation mode]

| Item | Symbol | Min. | Typ. | Max. | Unit | Remarks |
|---------------------------------------|-------------------|-------|------|-------|------|-----------------------------------|
| Output circuit supply voltage | V _{DD} | 14.55 | 15.0 | 15.45 | V | |
| Reset drain voltage | V _{RD} | 14.55 | 15.0 | 15.45 | V | V _{RD} = V _{DD} |
| Protective transistor bias | V _L | *1 | | | | |
| Substrate bias circuit supply voltage | V _{DSUB} | 14.55 | 15.0 | 15.45 | V | |
| Substrate clock | φ _{SUB} | *2 | | | | |

*1 V_L setting is the V_L voltage of the vertical transfer clock waveform, or the same supply voltage as the V_L power supply for the V driver should be used. (When CXD1267AN is used.)

*2 Do not apply a DC bias to the substrate clock pin, because a DC bias is generated within the CCD.

Bias Conditions 2 [when used in substrate bias external adjustment mode]

| Item | Symbol | Min. | Typ. | Max. | Unit | Remarks |
|--|-------------------|-------|------|-------|------|-----------------------------------|
| Output circuit supply voltage | V _{DD} | 14.55 | 15.0 | 15.45 | V | |
| Reset drain voltage | V _{RD} | 14.55 | 15.0 | 15.45 | V | V _{RD} = V _{DD} |
| Protective transistor bias | V _L | *3 | | | | |
| Substrate bias circuit supply voltage | V _{DSUB} | *4 | | | | |
| Substrate voltage adjustment range | V _{SUB} | 6.0 | | 14.0 | V | *5 |
| Substrate voltage adjustment precision | ΔV _{SUB} | -3 | | +3 | % | *5 |

*3 V_L setting is the V_L voltage of the vertical transfer clock waveform, or the same supply voltage as the V_L power supply for the V driver should be used. (When CXD1267AN is used.)

*4 Connect to GND or leave open.

*5 The setting value of the substrate voltage (V_{SUB}) is indicated on the back of the image sensor by a special code. When adjusting the substrate voltage externally, adjust the substrate voltage to the indicated voltage. The adjustment precision is ±3%. However, this setting value has not significance when used in substrate bias internal generation mode.

V_{SUB} code — one character indication

Code and optimal setting correspond to each other as follows.

| V _{SUB} code | E | f | G | h | J | K | L | m | N | P | Q | R | S | T | U | V | W |
|-----------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|------|------|------|
| Optimal setting | 6.0 | 6.5 | 7.0 | 7.5 | 8.0 | 8.5 | 9.0 | 9.5 | 10.0 | 10.5 | 11.0 | 11.5 | 12.0 | 12.5 | 13.0 | 13.5 | 14.0 |

<Example> "L" → V_{SUB} = 9.0V

DC Characteristics

| Item | Symbol | Min. | Typ. | Max. | Unit | Remarks |
|-------------------------------|-----------------|------|------|------|------|---------|
| Output circuit supply current | I _{DD} | | 5.0 | 10.0 | mA | |

Clock Voltage Conditions

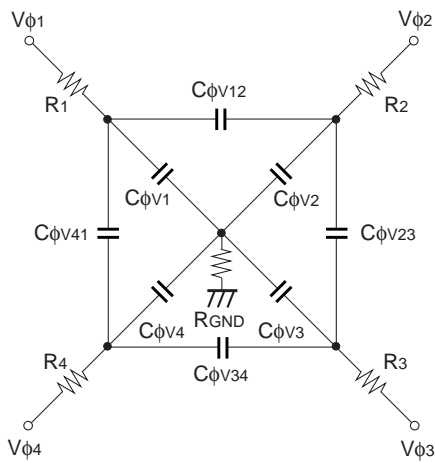
| Item | Symbol | Min. | Typ. | Max. | Unit | Waveform diagram | Remarks |
|-----------------------------------|--------------------------------------|-------|------|-------|------|------------------|--|
| Readout clock voltage | V_{VT} | 14.55 | 15.0 | 15.45 | V | 1 | |
| Vertical transfer clock voltage | V_{VH1}, V_{VH2} | -0.05 | 0 | 0.05 | V | 2 | $V_{VH} = (V_{VH1} + V_{VH2})/2$ |
| | V_{VH3}, V_{VH4} | -0.2 | 0 | 0.05 | V | 2 | |
| | $V_{VL1}, V_{VL2}, V_{VL3}, V_{VL4}$ | -9.6 | -9.0 | -8.5 | V | 2 | $V_{VL} = (V_{VL3} + V_{VL4})/2$ |
| | $V_{\phi V}$ | 8.3 | 9.0 | 9.65 | Vp-p | 2 | $V_{\phi V} = V_{VHn} - V_{VLn} (n = 1 \text{ to } 4)$ |
| | $ V_{VH1} - V_{VH2} $ | | | 0.1 | V | 2 | |
| | $V_{VH3} - V_{VH}$ | -0.25 | | 0.1 | V | 2 | |
| | $V_{VH4} - V_{VH}$ | -0.25 | | 0.1 | V | 2 | |
| | V_{VHH} | | | 0.5 | V | 2 | High-level coupling |
| | V_{VHL} | | | 0.5 | V | 2 | High-level coupling |
| | V_{VLH} | | | 0.5 | V | 2 | Low-level coupling |
| | V_{VLL} | | | 0.5 | V | 2 | Low-level coupling |
| Horizontal transfer clock voltage | $V_{\phi H}$ | 4.75 | 5.0 | 5.25 | Vp-p | 3 | |
| | V_{HL} | -0.05 | 0 | 0.05 | V | 3 | |
| Reset gate clock voltage*1 | V_{RGL} | *1 | | | V | 4 | |
| | $V_{\phi RG}$ | 4.5 | 5.0 | 5.5 | Vp-p | 4 | |
| | $V_{RGLH} - V_{RGLL}$ | | | 0.8 | V | 4 | Low-level coupling |
| Substrate clock voltage | $V_{\phi SUB}$ | 23.0 | 24.0 | 25.0 | Vp-p | 5 | |

*1 Input the reset gate clock without applying a DC bias. In addition, the reset gate clock can also be driven with the following specifications.

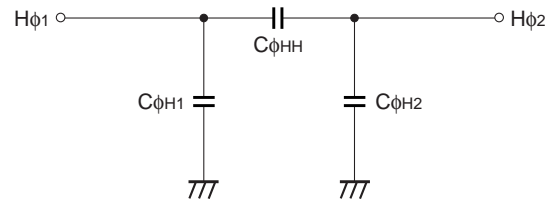
| Item | Symbol | Min. | Typ. | Max. | Unit | Waveform diagram | Remarks |
|--------------------------|---------------|------|------|------|------|------------------|---------|
| Reset gate clock voltage | V_{RGL} | -0.2 | 0 | 0.2 | V | 4 | |
| | $V_{\phi RG}$ | 8.5 | 9.0 | 9.5 | Vp-p | 4 | |

Clock Equivalent Circuit Constant

| Item | Symbol | Min. | Typ. | Max. | Unit | Remarks |
|---|------------------------|------|------|------|----------|---------|
| Capacitance between vertical transfer clock and GND | $C\phi V1, C\phi V3$ | | 2700 | | pF | |
| | $C\phi V2, C\phi V4$ | | 2700 | | pF | |
| Capacitance between vertical transfer clocks | $C\phi V12, C\phi V34$ | | 820 | | pF | |
| | $C\phi V23, C\phi V41$ | | 330 | | pF | |
| Capacitance between horizontal transfer clock and GND | $C\phi H1$ | | 100 | | pF | |
| | $C\phi H2$ | | 91 | | pF | |
| Capacitance between horizontal transfer clocks | $C\phi HH$ | | 47 | | pF | |
| Capacitance between reset gate clock and GND | $C\phi RG$ | | 11 | | pF | |
| Capacitance between substrate clock and GND | $C\phi SUB$ | | 680 | | pF | |
| Vertical transfer clock series resistor | $R1, R3$ | | 91 | | Ω | |
| | $R2, R4$ | | 100 | | Ω | |
| Vertical transfer clock ground resistor | R_{GND} | | 68 | | Ω | |



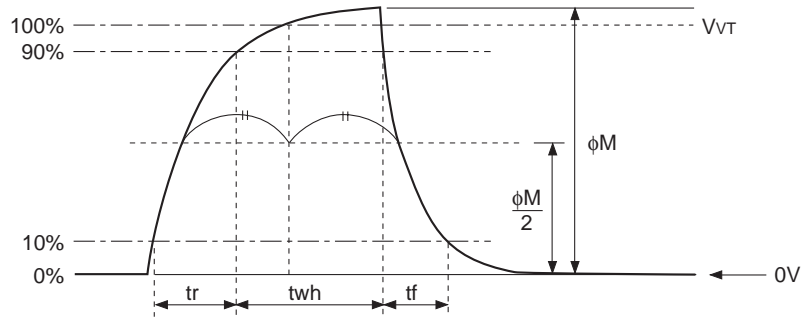
Vertical transfer clock equivalent circuit



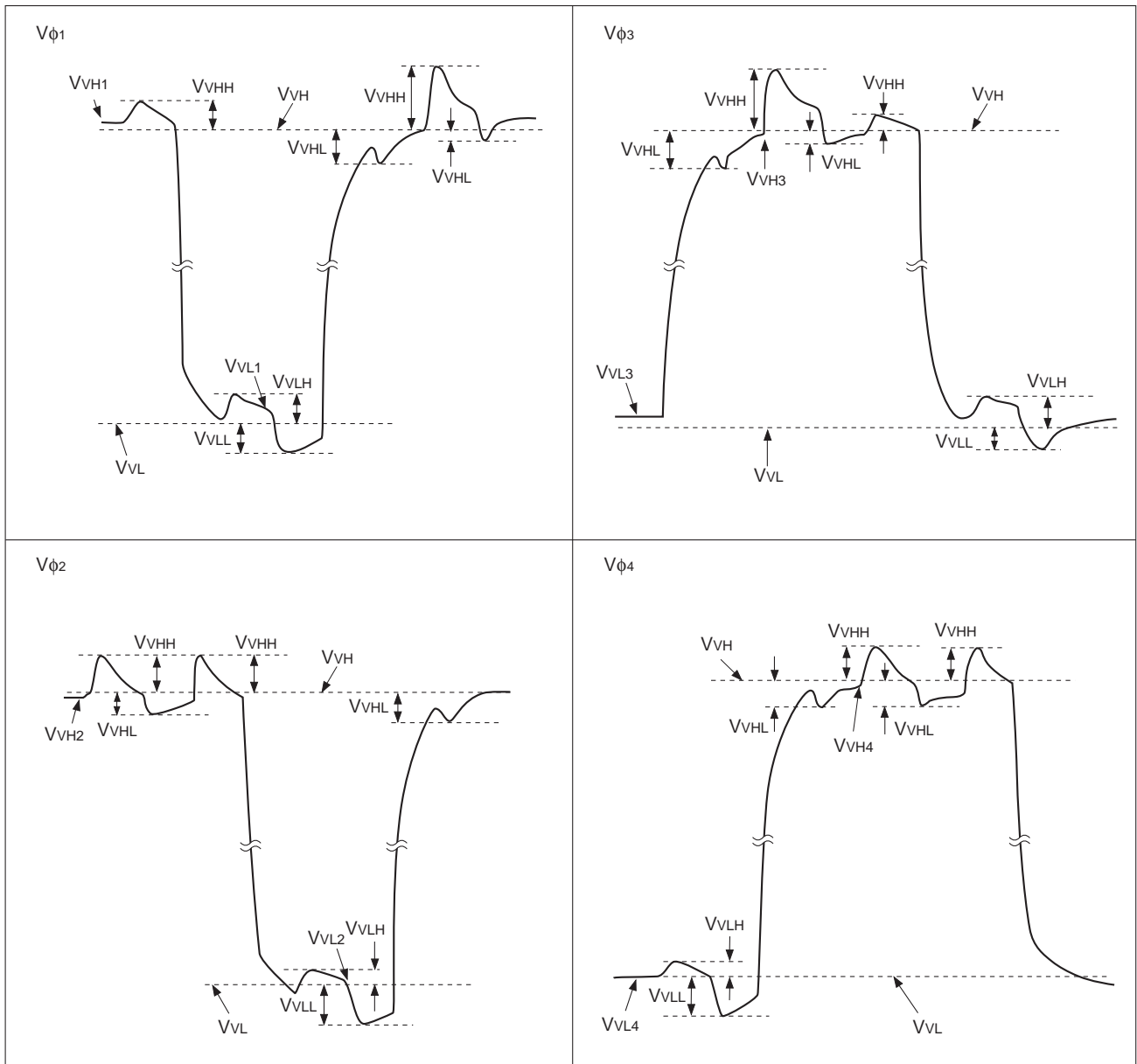
Horizontal transfer clock equivalent circuit

Drive Clock Waveform Conditions

(1) Readout clock waveform



(2) Vertical transfer clock waveform

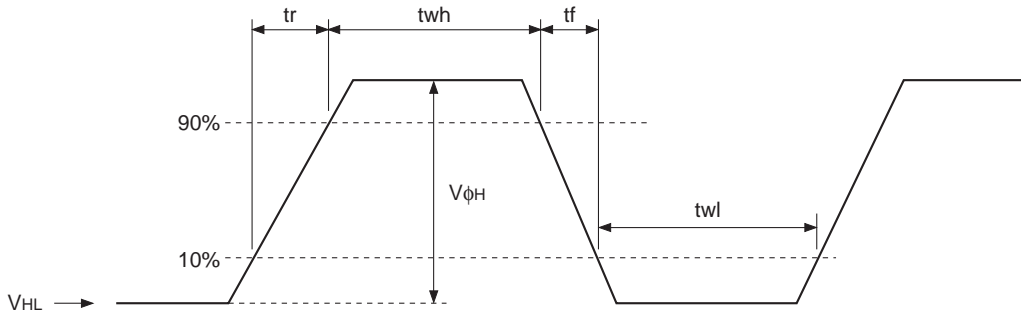


$$V_{vH} = (V_{vH1} + V_{vH2})/2$$

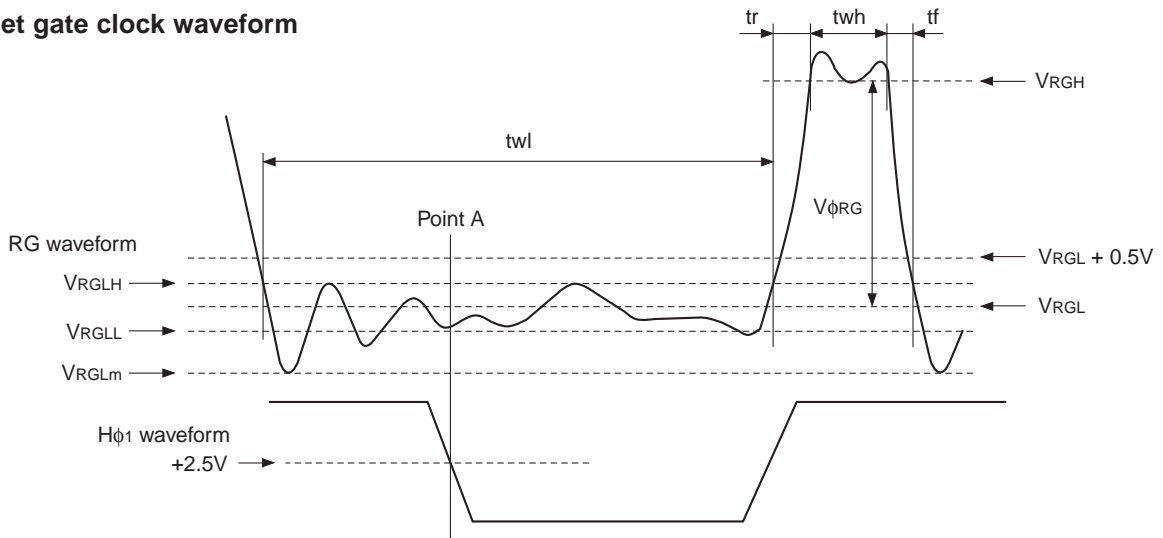
$$V_{vL} = (V_{vL3} + V_{vL4})/2$$

$$V_{\phi V} = V_{vHn} - V_{vLn} \quad (n = 1 \text{ to } 4)$$

(3) Horizontal transfer clock waveform



(4) Reset gate clock waveform



V_{RGLH} is the maximum value and V_{RGLL} is the minimum value of the coupling waveform during the period from Point A in the above diagram until the rising edge of RG. In addition, V_{RGL} is the average value of V_{RGLH} and V_{RGLL} .

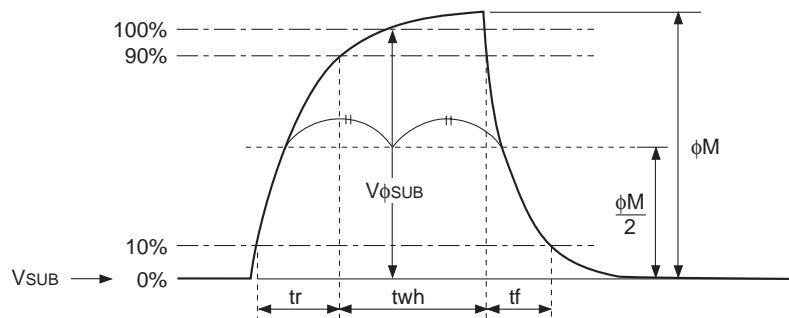
$$V_{RGL} = (V_{RGLH} + V_{RGLL})/2$$

Assuming V_{RGH} is the minimum value during the period t_{wh} , then:

$$V_{\phi RG} = V_{RGH} - V_{RGL}$$

Negative overshoot level during the falling edge of RG is V_{RGLm} .

(5) Substrate clock waveform



Clock Switching Characteristics

| Item | Symbol | twh | | | twl | | | tr | | | tf | | | Unit | Remarks | |
|---------------------------|--|--------------|------|------|------|------|------|------|------|------|------|------|------|---------|----------------------|----|
| | | Min. | Typ. | Max. | Min. | Typ. | Max. | Min. | Typ. | Max. | Min. | Typ. | Max. | | | |
| Readout clock | V_T | 2.3 | 2.5 | | | | | 0.5 | | | 0.5 | | | μ s | During readout | |
| Vertical transfer clock | $V_{\phi 1}, V_{\phi 2}, V_{\phi 3}, V_{\phi 4}$ | | | | | | | | | | 15 | | 250 | ns | *1 | |
| Horizontal transfer clock | During imaging | H_{ϕ} | | 20 | | | 20 | | | 15 | 19 | | 15 | 19 | ns | *2 |
| | During parallel-serial conversion | $H_{\phi 1}$ | | 5.38 | | | | | 0.01 | | | | 0.01 | | μ s | |
| | | $H_{\phi 2}$ | | | | | 5.38 | | | 0.01 | | | | 0.01 | | |
| Reset gate clock | ϕ_{RG} | 11 | 13 | | | | 51 | | | 3 | | | 3 | ns | | |
| Substrate clock | ϕ_{SUB} | 1.5 | 1.8 | | | | | | | 0.5 | | | 0.5 | μ s | When draining charge | |

*1 When vertical transfer clock driver CXD1267AN is used.

*2 $tf \geq tr - 2ns$.

| Item | Symbol | two | | | Unit | Remarks |
|---------------------------|--------------------------|------|------|------|------|---------|
| | | Min. | Typ. | Max. | | |
| Horizontal transfer clock | $H_{\phi 1}, H_{\phi 2}$ | 16 | 20 | | ns | *3 |

*3 The overlap period for twh and twl of horizontal transfer clocks $H_{\phi 1}$ and $H_{\phi 2}$ is two.

Image Sensor Characteristics

(Ta = 25°C)

| Item | Symbol | Min. | Typ. | Max. | Unit | Measurement method | Remarks |
|----------------------|--------------|------|------|------|------|--------------------|---------------|
| Sensitivity1 | S1 | 1120 | 1400 | | mV | 1 | |
| Sensitivity2 | S2 | 4500 | 5500 | | mV | 2 | |
| Saturation signal | Vsat | 1000 | | | mV | 3 | Ta = 60°C |
| Smear | Sm | | -126 | -115 | dB | 4 | |
| Video signal shading | SH | | | 20 | % | 5 | Zone 0 and I |
| | | | | 25 | % | 5 | Zone 0 to II' |
| Dark signal | Vdt | | | 2 | mV | 6 | Ta = 60°C |
| Dark signal shading | ΔVdt | | | 1 | mV | 7 | Ta = 60°C |
| Flicker | F | | | 2 | % | 8 | |
| Lag | Lag | | | 0.5 | % | 9 | |

Zone Definition of Video Signal Shading

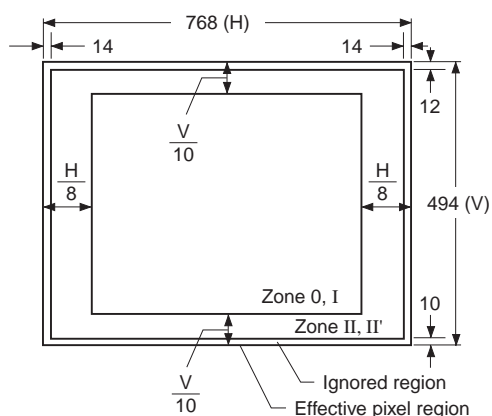


Image Sensor Characteristics Measurement Method

◎ Measurement conditions

- 1) In the following measurements, the device drive conditions are at the typical values of the bias and clock voltage conditions. (when used with substrate bias external adjustment, set the substrate voltage to the value indicated on the device.)
- 2) In the following measurements, spot blemishes are excluded and, unless otherwise specified, the optical black level (OB) is used as the reference for the signal output, which is taken as the value of Y signal output or chroma signal output of the measurement system.

◎ Definition of standard imaging conditions

- 1) Standard imaging condition I:
Use a pattern box (luminance 706cd/m², color temperature of 3200K halogen source) as a subject. (Pattern for evaluation is not applicable.) Use a testing standard lens with CM500S (t = 1.4mm) as an IR cut filter and image at F8. The luminous intensity to the sensor receiving surface at this point is defined as the standard sensitivity testing luminous intensity.
- 2) Standard imaging condition II:
This indicates the standard imaging condition I with the IR cut filter removed.
- 3) Standard imaging condition III:
Image a light source (color temperature of 3200K) with a uniformity of brightness within 2% at all angles. Use a testing standard lens and the luminous intensity is adjusted to the value indicated in each testing item by the lens diaphragm. (IR cut filter is not applicable.)

1. Sensitivity1

Set to standard imaging condition I. After selecting the electronic shutter mode with a shutter speed of 1/250s, measure the signal output (V_{S1}) at the center of the screen and substitute the value into the following formula.

$$S1 = V_{S1} \times \frac{250}{60} \text{ [mV]}$$

2. Sensitivity2

Set to standard imaging condition II. After selecting the electronic shutter mode with a shutter speed of 1/1000s, measure the signal output (V_{S2}) at the center of the screen and substitute the value into the following formula.

$$S2 = V_{S2} \times \frac{1000}{60} \text{ [mV]}$$

3. Saturation signal

Set to standard imaging condition III. After adjusting the luminous intensity to 10 times the intensity with average value of the signal output, 200mV, measure the minimum value of the signal output.

4. Smear

Set to standard imaging condition III. With the lens diaphragm at F5.6 to F8, adjust the luminous intensity to 500 times the intensity with average value of the signal output, 200mV. When the readout clock is stopped and the charge drain is executed by the electronic shutter at the respective H blankings, measure the maximum value VSm [mV] of the signal output and substitute the value into the following formula.

$$S_m = 20 \times \log \left(\frac{V_{Sm}}{200} \times \frac{1}{500} \times \frac{1}{10} \right) \text{ [dB]} \text{ (1/10V method conversion value)}$$

5. Video signal shading

Set to standard imaging condition III. With the lens diaphragm at F5.6 to F8, adjust the luminous intensity so that the average value of the signal output is 200mV. Then measure the maximum (Vmax [mV]) and minimum (Vmin [mV]) values of the signal output and substitute the values into the following formula.

$$SH = (V_{max} - V_{min}) / 200 \times 100 \text{ [%]}$$

6. Dark signal

Measure the average value of the signal output (Vdt [mV]) with the device ambient temperature 60°C and the device in the light-obstructed state, using the horizontal idle transfer level as a reference.

7. Dark signal shading

After measuring 6, measure the maximum (Vdmax [mV]) and minimum (Vdmin [mV]) values of the dark signal output and substitute the values into the following formula.

$$\Delta V_{dt} = V_{dmax} - V_{dmin} \text{ [mV]}$$

8. Flicker

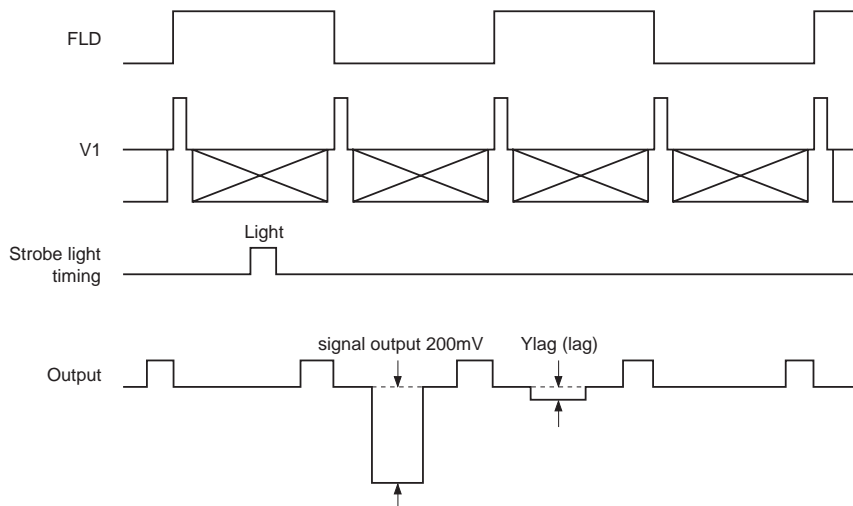
Set to standard imaging condition III. Adjust the luminous intensity so that the average value of the signal output is 200mV, and then measure the difference in the signal level between fields (ΔV_f [mV]). Then substitute the value into the following formula.

$$F_y = (\Delta V_f / 200) \times 100 \text{ [%]}$$

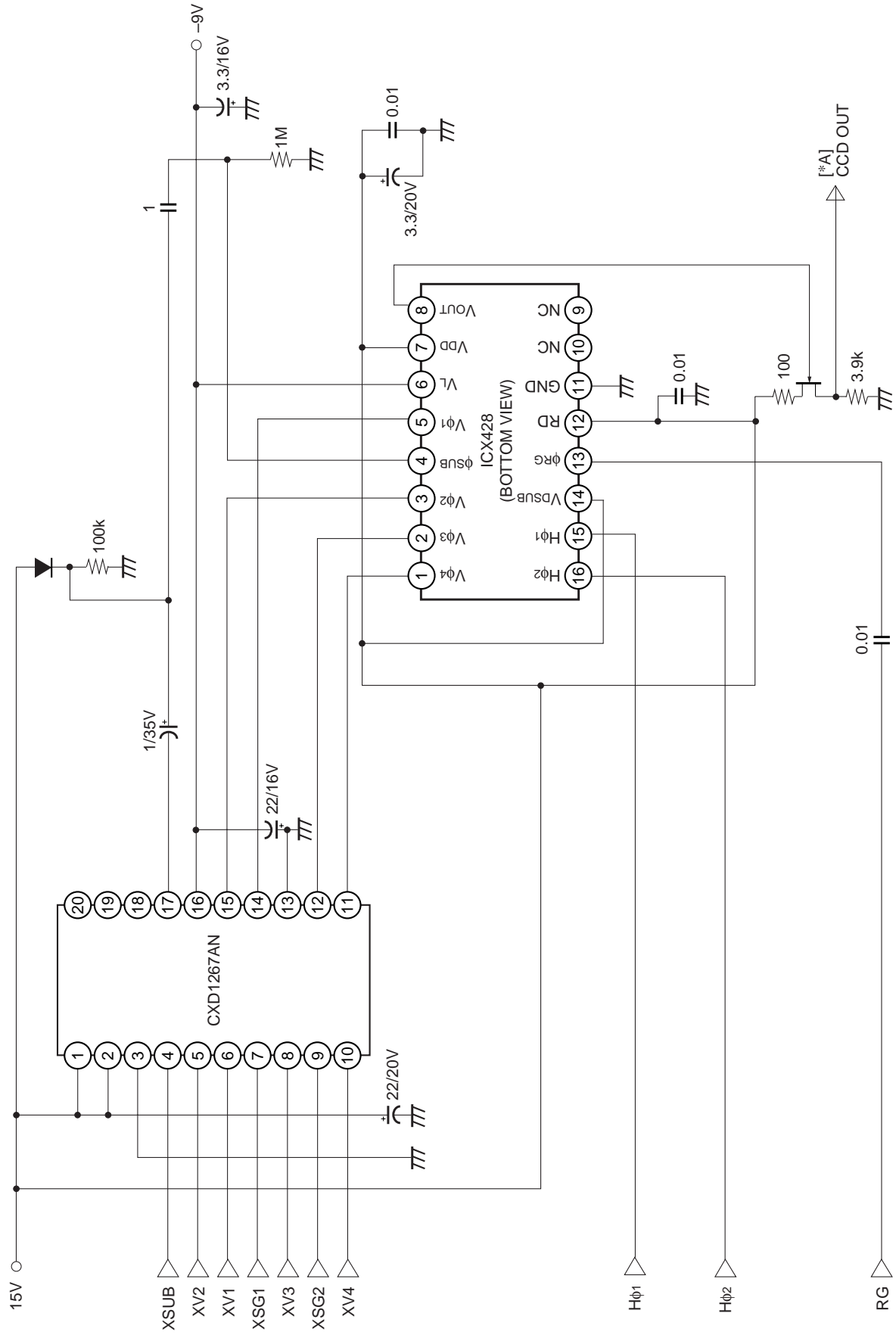
9. Lag

Adjust the signal output value generated by strobe light to 200mV. After setting the strobe light so that it strobos with the following timing, measure the residual signal (Vlag). Substitute the value into the following formula.

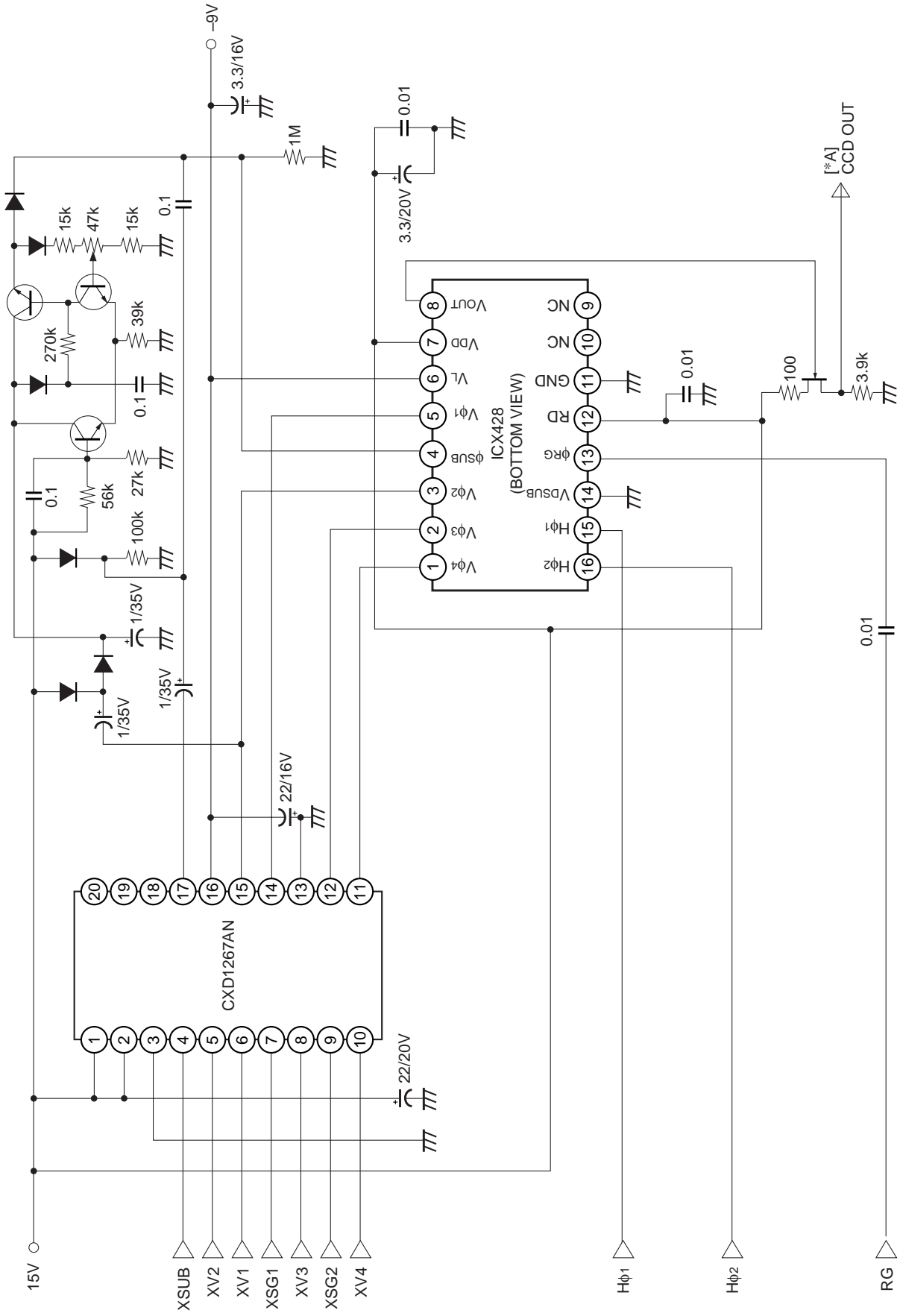
$$Lag = (V_{lag} / 200) \times 100 \text{ [%]}$$



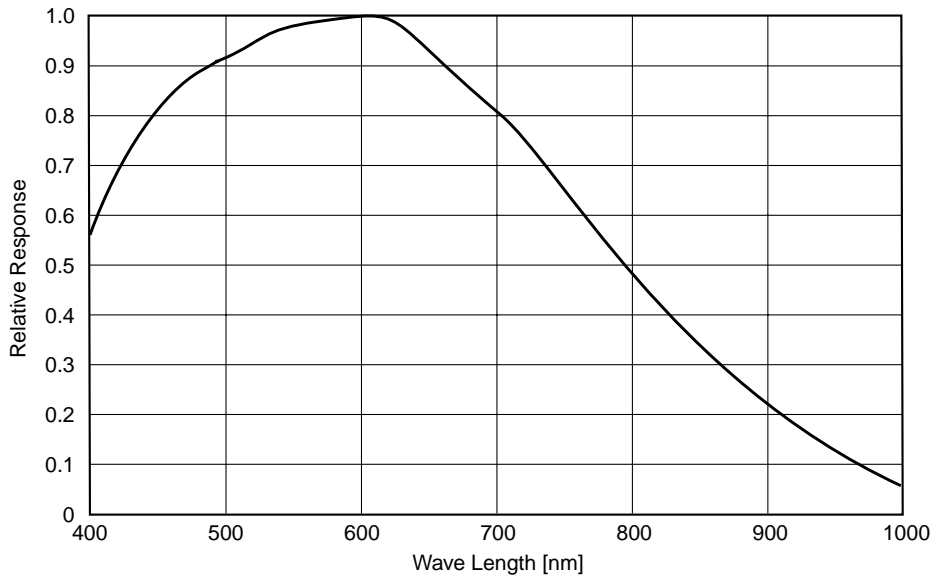
Drive Circuit 1 (substrate bias internal generation mode)



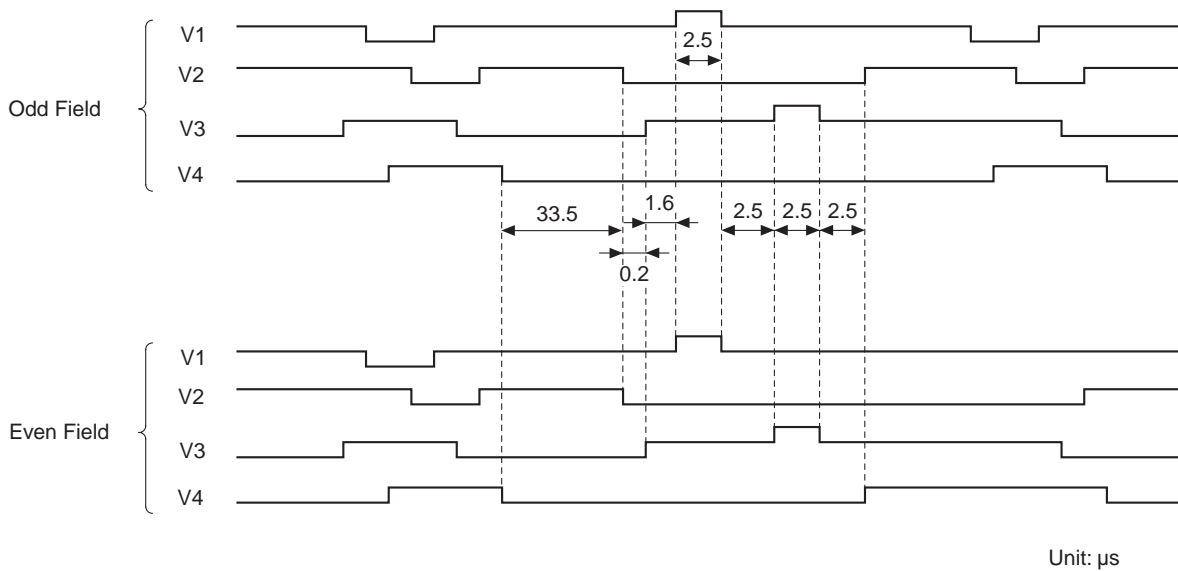
Drive Circuit 2 (substrate bias external adjustment mode)



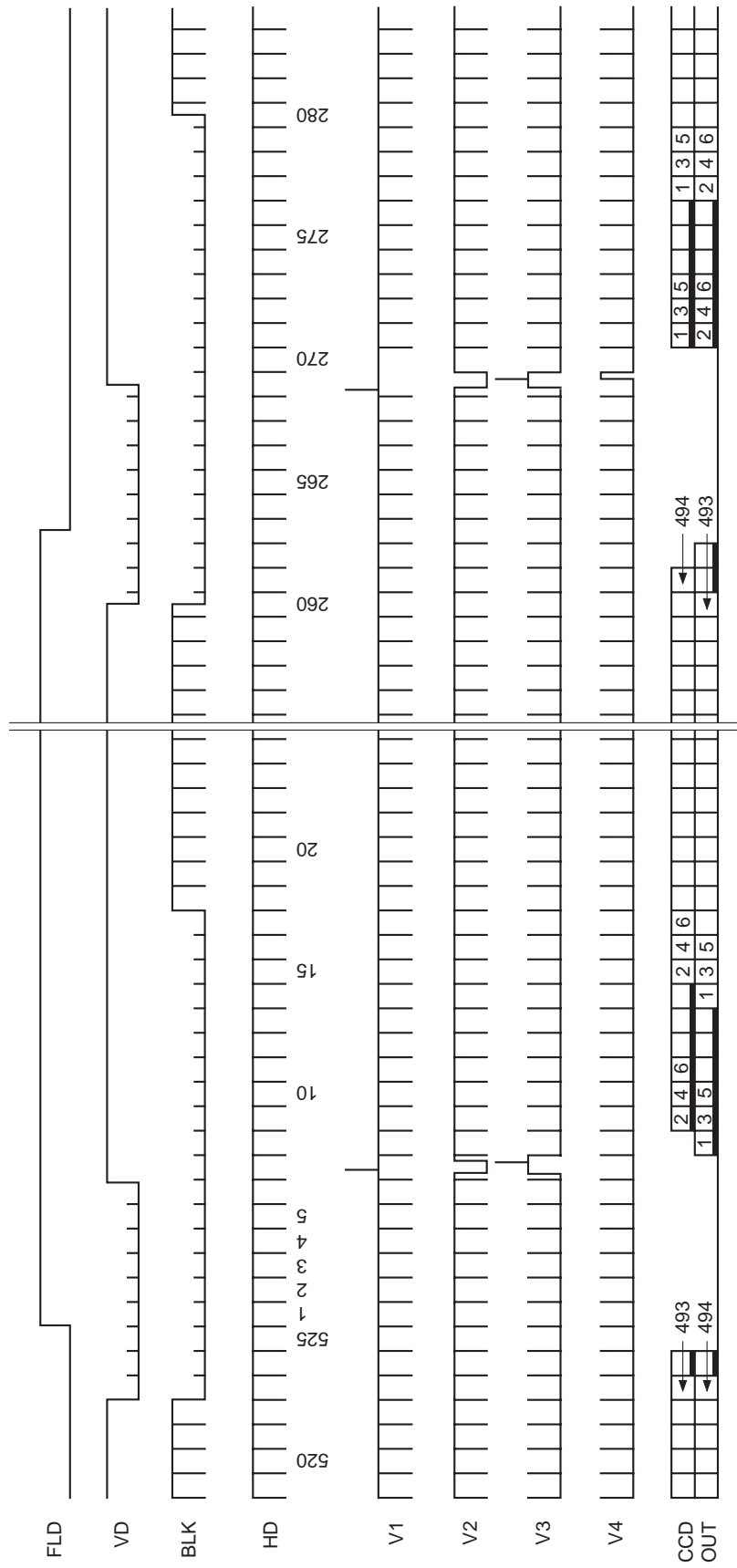
Spectral Sensitivity Characteristics (Excludes lens characteristics and light source characteristics)



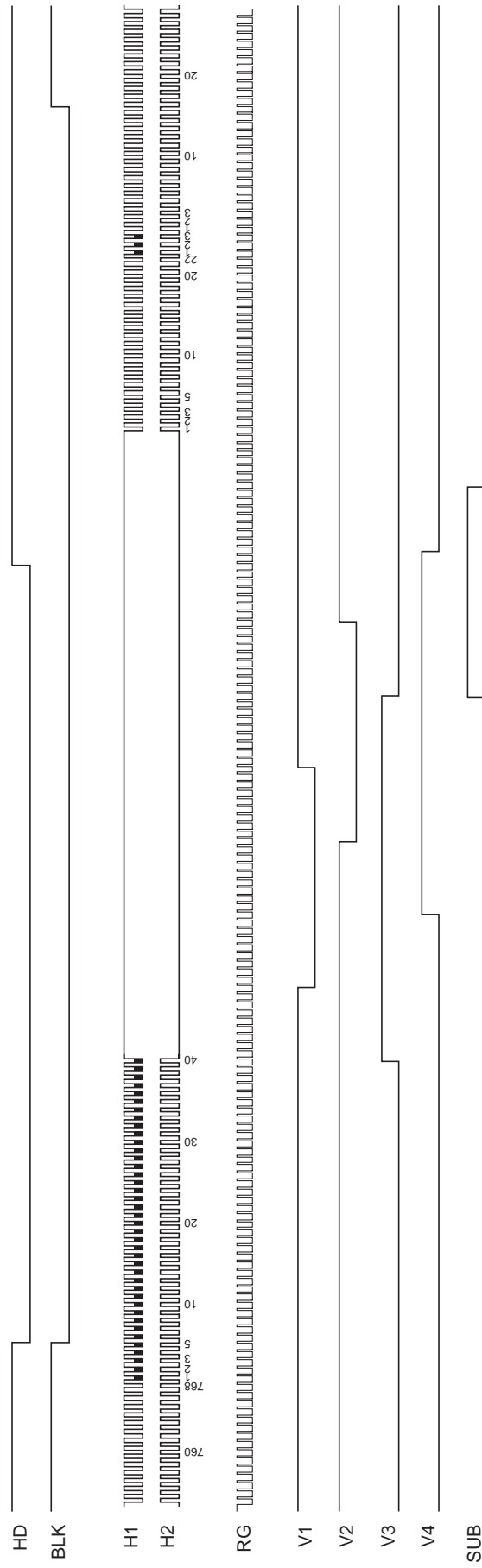
Sensor Readout Clock Timing Chart



Drive Timing Chart (Vertical Sync)



Drive Timing Chart (Horizontal Sync)



Notes on Handling

1) Static charge prevention

CCD image sensors are easily damaged by static discharge. Before handling be sure to take the following protective measures.

- a) Either handle bare handed or use non-chargeable gloves, clothes or material.
Also use conductive shoes.
- b) When handling directly use an earth band.
- c) Install a conductive mat on the floor or working table to prevent the generation of static electricity.
- d) Ionized air is recommended for discharge when handling CCD image sensor.
- e) For the shipment of mounted substrates, use boxes treated for the prevention of static charges.

2) Soldering

- a) Make sure the package temperature does not exceed 80°C.
- b) Solder dipping in a mounting furnace causes damage to the glass and other defects. Use a ground 30W soldering iron and solder each pin in less than 2 seconds. For repairs and remount, cool sufficiently.
- c) To dismount an image sensor, do not use a solder suction equipment. When using an electric desoldering tool, use a thermal controller of the zero cross On/Off type and connect it to ground.

3) Dust and dirt protection

Image sensors are packed and delivered by taking care of protecting its glass plates from harmful dust and dirt. Clean glass plates with the following operations as required, and use them.

- a) Perform all assembly operations in a clean room (class 1000 or less).
- b) Do not either touch glass plates by hand or have any object come in contact with glass surfaces. Should dirt stick to a glass surface, blow it off with an air blower. (For dirt stuck through static electricity ionized air is recommended.)
- c) Clean with a cotton bud and ethyl alcohol if grease stained. Be careful not to scratch the glass.
- d) Keep in a case to protect from dust and dirt. To prevent dew condensation, preheat or precool when moving to a room with great temperature differences.
- e) When a protective tape is applied before shipping, just before use remove the tape applied for electrostatic protection. Do not reuse the tape.

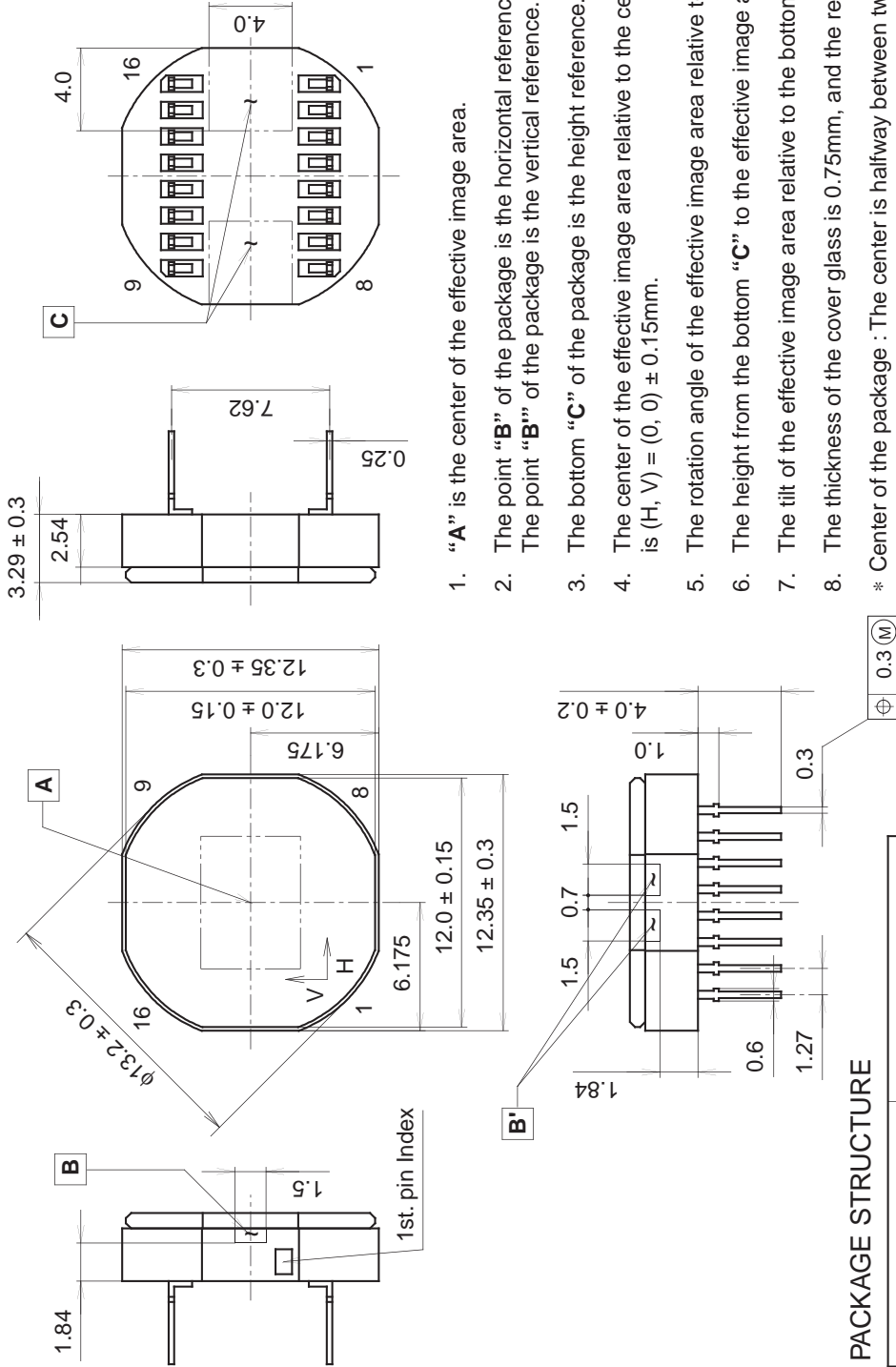
4) Do not expose to strong light (sun rays) for long periods. For continuous using under cruel condition exceeding the normal using condition, consult our company.

5) Exposure to high temperature or humidity will affect the characteristics. Accordingly avoid storage or usage in such conditions.

6) CCD image sensors are precise optical equipment that should not be subject to too much mechanical shocks.

Package Outline Unit: mm

16 pin DIP (300mil)



1. "A" is the center of the effective image area.
2. The point "B" of the package is the horizontal reference.
The point "B'" of the package is the vertical reference.
3. The bottom "C" of the package is the height reference.
4. The center of the effective image area relative to the center of the package (*) is $(H, V) = (0, 0) \pm 0.15$ mm.
5. The rotation angle of the effective image area relative to H and V is $\pm 1^\circ$.
6. The height from the bottom "C" to the effective image area is 1.41 ± 0.15 mm.
7. The tilt of the effective image area relative to the bottom "C" is less than 60μ m.
8. The thickness of the cover glass is 0.75 mm, and the refractive index is 1.5 .

* Center of the package : The center is halfway between two pairs of opposite sides, as measured from "B", "B'".

PACKAGE STRUCTURE

| | |
|------------------|--------------|
| PACKAGE MATERIAL | Ceramic |
| LEAD TREATMENT | GOLD PLATING |
| LEAD MATERIAL | 42 ALLOY |
| PACKAGE MASS | 0.90g |
| DRAWING NUMBER | AS-B4-01(E) |