

1/2 inch CCD Image Sensor for EIA B/W Camera

Description

ICX038BLA is an interline transfer CCD solid-state imager suitable for EIA 1/2 inch B/W video cameras. High sensitiveness is achieved through the adoption of HAD (Hole-Accumulation Diode) sensors.

This chip features a field integration read out system, an electronic shutter with variable charge-storage time and 20 pin Cer-DIP package.

Features

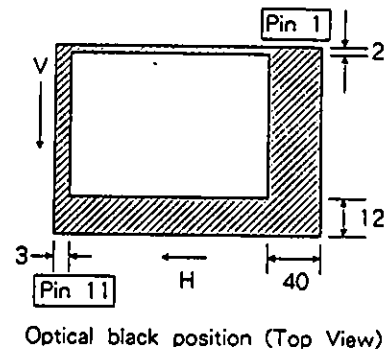
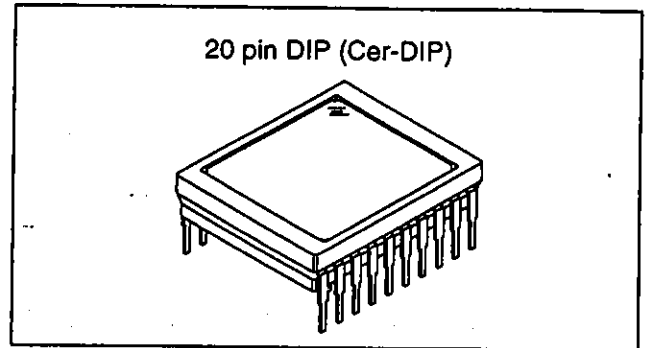
- High image, high sensitivity and low dark current (+6dB compare with ICX038ALA)
- Consecutive various speed shutter
1/60s. (Typ.), 1/100s. to 1/10000s.
- Low smear
- High antiblooming
- Horizontal register 5V drive
- Reset gate 5V drive

Device Structure

- Optical size 1/2 inch format
- Number of effective pixels 768 (H) × 494 (V) Approx. 380k pixels
- Number of total pixels 811 (H) × 508 (V) Approx. 410k pixels
- Interline transfer CCD image sensor
- Chip size 7.95mm (H) × 6.45mm (V)
- Unit cell size 8.4 μm (H) × 9.8 μm (V)
- Optical black

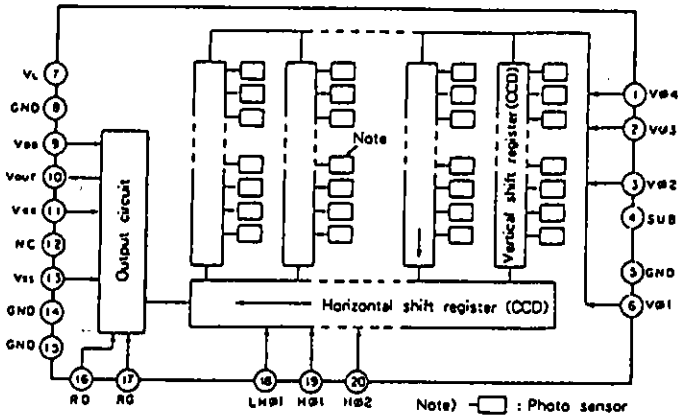
| | | |
|--------------------------|-----------------|----------------|
| Horizontal (H) direction | Front 3 pixels | Rear 40 pixels |
| Vertical (V) direction | Front 12 pixels | Rear 2 pixels |
- Number of dummy bits

| | |
|------------|---------------------|
| Horizontal | 22 |
| Vertical | 1 (even field only) |
- Substrate material Silicon

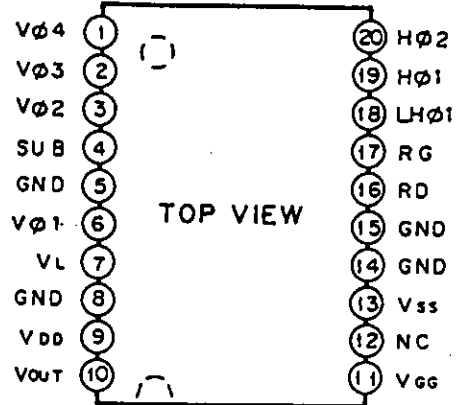


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Block Diagram



Pin Configuration (Top View)



Pin Description

| No. | Symbol | Description | No. | Symbol | Description |
|-----|--------|----------------------------------|-----|--------|--|
| 1 | Vφ4 | Vertical register transfer clock | 11 | VGG | Output amplifier gate bias |
| 2 | Vφ3 | Vertical register transfer clock | 12 | NC | |
| 3 | Vφ2 | Vertical register transfer clock | 13 | VSS | Output amplifier source |
| 4 | SUB | Substrate (Overflow drain) | 14 | GND | GND |
| 5 | GND | GND | 15 | GND | GND |
| 6 | Vφ1 | Vertical register transfer clock | 16 | RD | Reset drain bias |
| 7 | VL | Protective transistor bias | 17 | RG | Reset gate clock |
| 8 | GND | GND | 18 | LHφ1 | Horizontal register final stage transfer clock |
| 9 | VDD | Output amplifier drain supply | 19 | Hφ1 | Horizontal register transfer clock |
| 10 | VOUT | Signal output | 20 | Hφ2 | Horizontal register transfer clock |

Absolute Maximum Ratings

| Item | | Ratings | Unit | Remarks |
|--|---------------------------|-------------|------|---------|
| Substrate voltage SUB-GND | | -0.3 to +55 | V | |
| Supply voltage | VDD, VRD, VOUT, VSS - GND | -0.3 to +18 | V | |
| | VDD, VRD, VOUT, VSS - SUB | -55 to +10 | V | |
| Clock input voltage | Vφ1, Vφ2, Vφ3, Vφ4 - GND | -15 to +20 | V | |
| | Vφ1, Vφ2, Vφ3, Vφ4 - SUB | to +10 | V | |
| Voltage difference between vertical clock input pins | | to+15 | V | *(Max.) |
| Voltage difference between horizontal clock input pins | | to+17 | V | |
| Hφ1, Hφ2 - Vφ4 | | -17 to +17 | V | |
| LHφ1, RG, VGG - GND | | -10 to +15 | V | |
| LHφ1, RG, VGG - SUB | | -55 to +10 | V | |
| VL - SUB | | -65 to +0.3 | V | |
| Beside GND, SUB-VL | | -0.3 to +30 | V | |
| Storage temperature | | -30 to +80 | °C | |
| Operating temperature | | -10 to +60 | °C | |

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

Bias Conditions

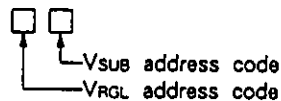
| Item | Symbol | Min. | Typ. | Max. | Unit | Remarks |
|---|--------------------|-------------------------------|------|-------|------|----------------------------------|
| Output amplifier drain voltage | V _{DD} | 14.55 | 15.0 | 15.45 | V | |
| Reset drain voltage | V _{RD} | 14.55 | 15.0 | 15.45 | V | V _{RD} =V _{DD} |
| Output amplifier gate voltage | V _{GG} | 1.75 | 2.0 | 2.25 | V | |
| Output amplifier source | V _{SS} | Ground through 390 Ω resistor | | | | ± 5% |
| Substrate voltage adjustment range | V _{SUB} | 9.0 | | 18.5 | V | * 2 |
| Fluctuation range after substrate voltage adjustment | Δ V _{SUB} | -3 | | +3 | % | |
| Reset gate clock voltage adjustment range | V _{RGL} | 1.0 | | 4.0 | V | * 2 * 6 |
| Fluctuation range after reset gate clock voltage adjustment | Δ V _{RGL} | -3 | | +3 | % | |
| Protective transistor bias | V _L | * 3 | | | | |

DC Characteristics

| Item | Symbol | Min. | Typ. | Max. | Unit | Remarks |
|--------------------------------|------------------|------|------|------|------|---------|
| Output amplifier drain current | I _{DD} | | 5 | | mA | |
| Input current | I _{IN1} | | | 1 | μA | * 4 |
| Input current | I _{IN2} | | | 10 | μA | * 5 |

* 2 Substrate voltage (V_{SUB}) - reset gate clock voltage (V_{RGL}) setting value display.
 Setting values of substrate voltage and reset gate clock voltage are displayed at the back of the device through a code address. Adjust substrate voltage (V_{SUB}) and reset gate clock voltage (V_{RGL}) to the displayed voltage. Fluctuation range after adjustment is ± 3%.

V_{SUB} code address--1 digit display
 V_{RGL} code address--1 digit display



Code addresses and actual numerical values correspond to each other as follows.

| V _{RGL} address code | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|-------------------------------|-----|-----|-----|-----|-----|-----|-----|
| Numerical value | 1.0 | 1.5 | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 |

| V _{SUB} address code | E | f | G | h | J | K | L | m | N | P | Q | R | S | T | U | V | W | X | Y | Z |
|-------------------------------|-----|-----|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| Numerical value | 9.0 | 9.5 | 10.0 | 10.5 | 11.0 | 11.5 | 12.0 | 12.5 | 13.0 | 13.5 | 14.0 | 14.5 | 15.0 | 15.5 | 16.0 | 16.5 | 17.0 | 17.5 | 18.0 | 18.5 |

<Example> "5L" → V_{RGL}=3.0V
 V_{SUB}=12.0V

* 3 V_L setting is the V_{VL} voltage of the vertical transfer clock waveform.

- *4
1. Current to each pin when 18V is applied to V_{DD}, V_{OUT}, V_{SS} and SUB pins, while pins that are not tested are grounded.
 2. Current to each pins when 20V is applied sequentially to V ϕ 1, V ϕ 2, V ϕ 3, V ϕ 4, H ϕ 1 and H ϕ 2, while pins that are not tested are grounded. However, 20V is applied to SUB.
 3. Current to each pins when 15V is applied sequentially to pins RG, LH ϕ 1 and V_{GG}, while pins that are not tested are grounded. However, 15V is applied to SUB.
 4. Current to V_L pin when it is grounded, while 30V is applied to all pins except pins that are not tested. However, GND and SUB pins are kept open.
- *5 Current to SUB pin when 55V is applied to SUB pin, while pins that are not tested are grounded.

Clock Voltage Conditions

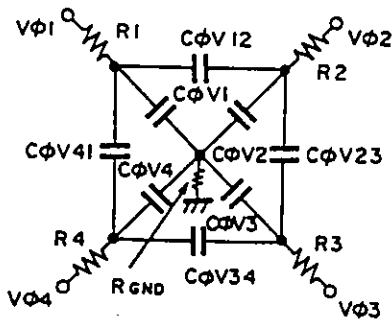
| Item | Symbol | Min. | Typ. | Max. | Unit | Waveform diagram | Remarks |
|---|--|-------|------|-------|------|--------------------|--|
| Read out clock voltage | V _{VT} | 14.55 | 15.0 | 15.45 | V | 1 | |
| Vertical transfer clock voltage | V _{VH1} , V _{VH2} | -0.05 | 0 | 0.05 | V | 2 | $V_{VH} = (V_{VH1} + V_{VH2}) / 2$ |
| | 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 ϕ V | 8.3 | 9.0 | 9.65 | V | 2 | $V_{\phi V} = V_{VHn} - V_{VLn}$ (n=1 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 ϕ H | 4.75 | 5.0 | 5.25 | V | 3 | |
| | V _{HL} | -0.05 | 0 | 0.05 | V | 3 | |
| Horizontal final stage transfer clock voltage | V _{LHH} | 4.75 | 5.0 | 5.25 | V | 4 | |
| | V _{LHL} | -0.05 | 0 | 0.05 | V | 4 | |
| Reset gate clock voltage | V ϕ RG | 4.5 | 5.0 | 5.5 | V | 5 | * 6 |
| | V _{RGLH} - V _{RGLL} | | | 0.8 | V | 5 | Low level coupling |
| Substrate clock voltage | V ϕ SUB | 23.0 | 24.0 | 25.0 | V | 6 | |

*6 No adjustment of reset gate clock voltage is necessary when reset gate clock is driven as indicated below. In this case, reset gate clock voltage set point displayed on back of image sensor has no meaning.

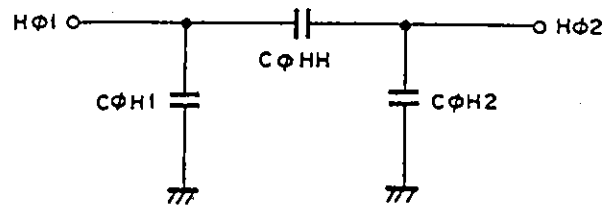
| Item | Symbol | Min. | Typ. | Max. | Unit | Waveform diagram | Remarks |
|--------------------------|------------------|------|------|------|------|------------------|---------|
| Reset gate clock voltage | V _{RGL} | -0.2 | 0 | 0.2 | V | 5 | |
| | V _{φRG} | 8.5 | 9.0 | 9.5 | V | 5 | |

Clock Equivalent Circuit Constant

| Item | Symbol | Min. | Typ. | Max. | Unit | Remarks |
|---|---|------|------|------|------|---------|
| Capacitance between vertical transfer clock and GND | C _{φV1} , C _{φV3} | | 1800 | | pF | |
| | C _{φV2} , C _{φV4} | | 2200 | | pF | |
| Capacitance between vertical transfer clocks | C _{φV12} , C _{φV34} | | 450 | | pF | |
| | C _{φV23} , C _{φV41} | | 270 | | pF | |
| Capacitance between horizontal transfer clock and GND | C _{φH1} , C _{φH2} | | 62 | | pF | |
| Capacitance between horizontal transfer clocks | C _{φHH} | | 47 | | pF | |
| Capacitance between horizontal final stage transfer clock and GND | C _{φLH} | | 8 | | pF | |
| Capacitance between reset gate clock and GND | C _{φRG} | | 8 | | pF | |
| Capacitance between substrate clock and GND | C _{φSUB} | | 400 | | pF | |
| Vertical transfer clock serial resistor | R ₁ , R ₂ , R ₃ , R ₄ | | 68 | | Ω | |
| Vertical transfer clock ground resistor | R _{GND} | | 15 | | Ω | |



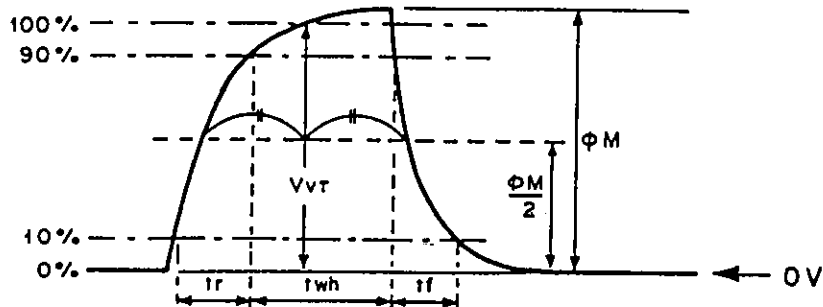
Vertical transfer clock equivalent circuit



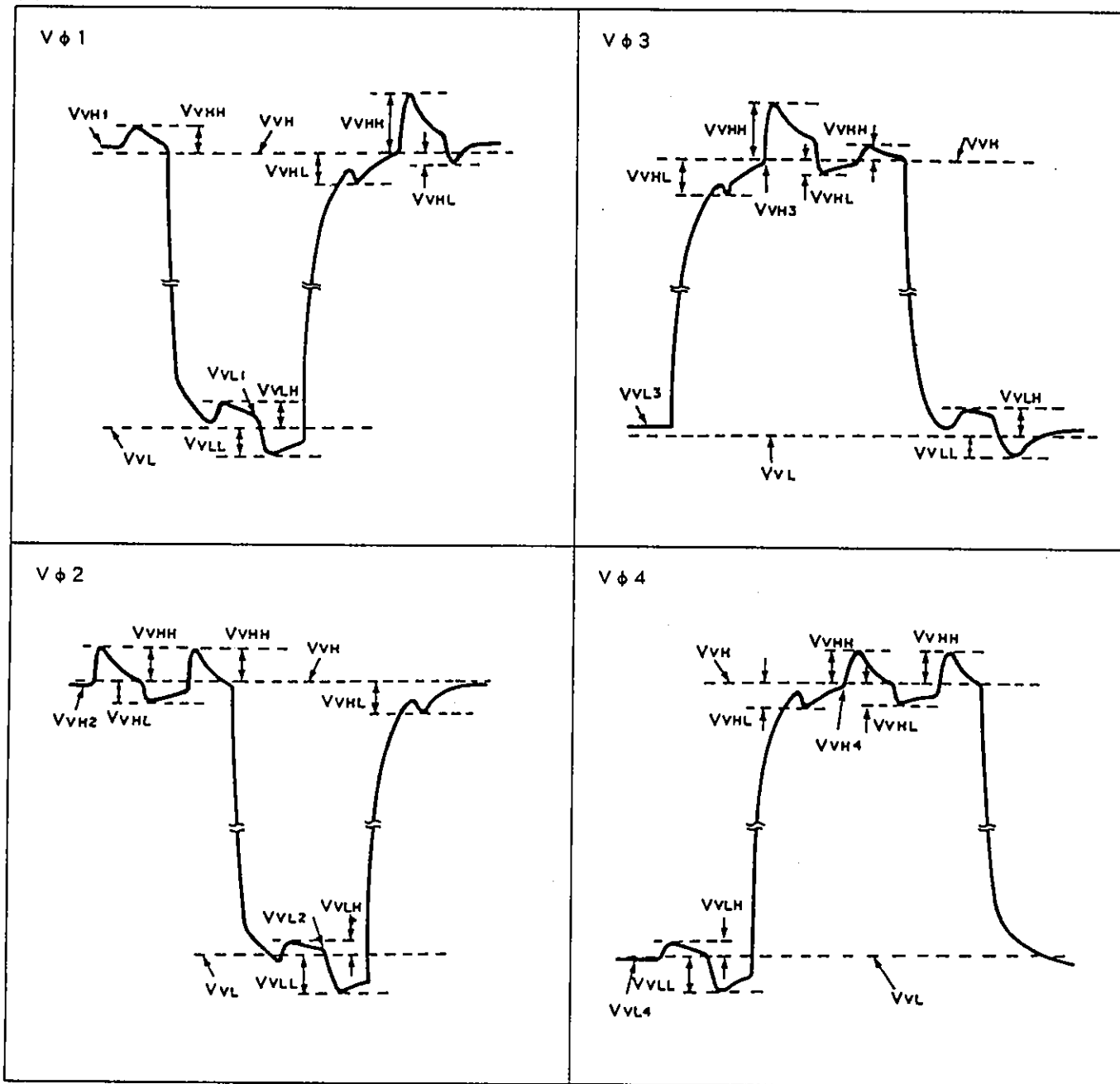
Horizontal transfer clock equivalent circuit

Drive Clock Waveform Conditions

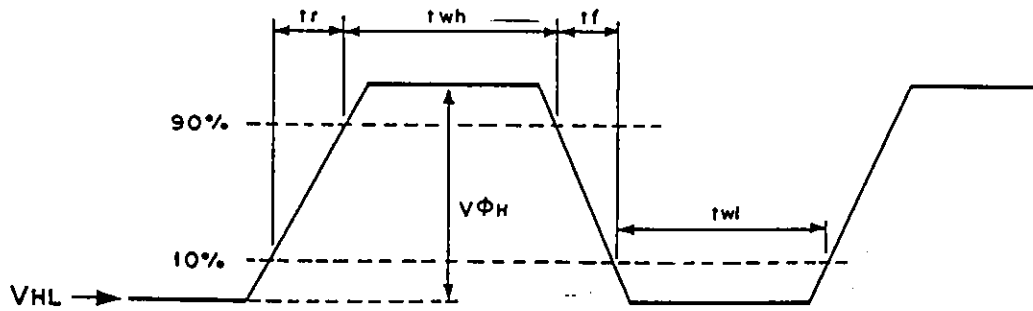
(1) Read out clock waveform



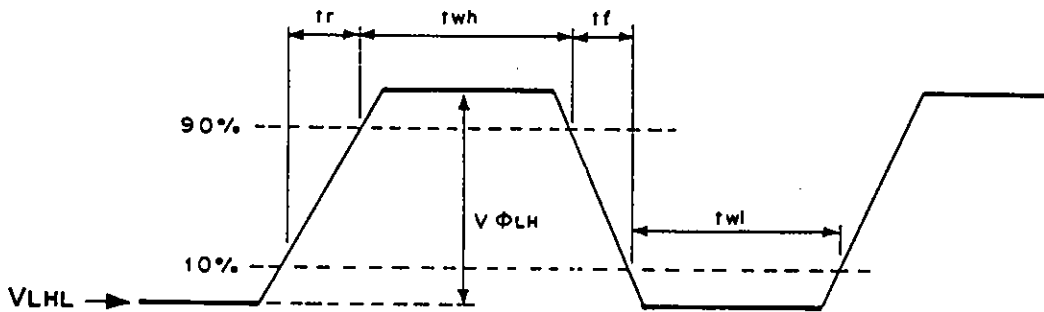
(2) Vertical transfer clock waveform



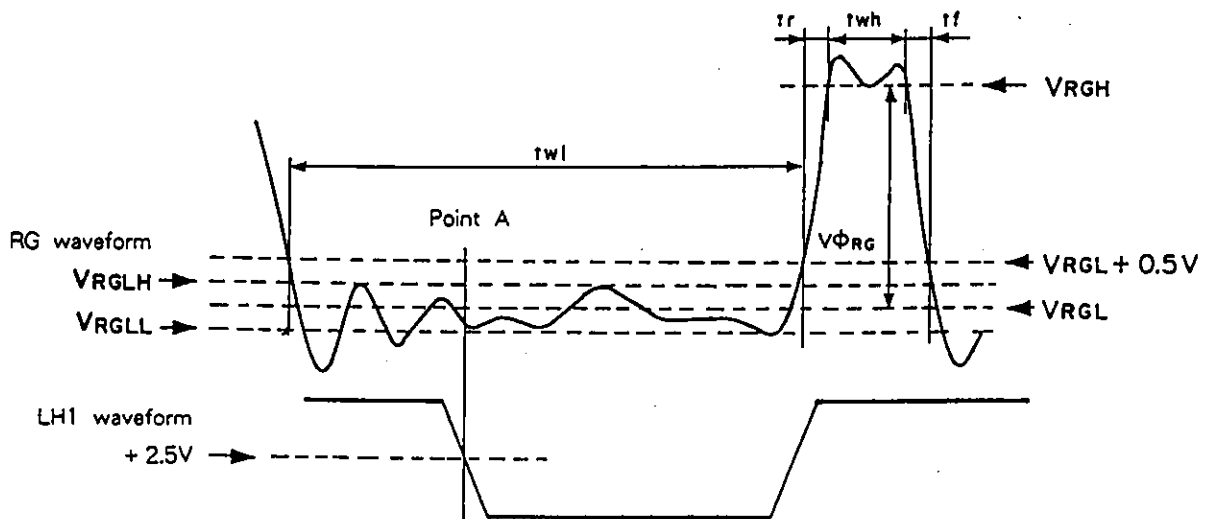
(3) Horizontal transfer clock waveform diagram



(4) Horizontal final stage transfer clock waveform diagram



(5) Reset gate clock waveform diagram



V_{RGLH} is the maximum value and V_{RGLL} the minimum value of the coupling waveform in the period from Point A in the diagram above to RG rise.

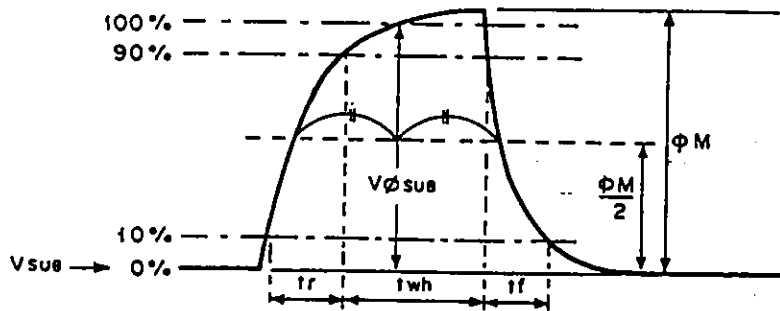
V_{RGL} is the mean value for V_{RGLH} and V_{RGLL} .

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

V_{RGH} is the minimum value for t_{wh} period.

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

(6) 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. | | |
| Read out clock | V_T | 2.3 | 2.5 | | | | | | 0.5 | | | 0.5 | | μs | During read out |
| Vertical transfer clock | $V\phi_1, V\phi_2, V\phi_3, V\phi_4$ | | | | | | | | | | 0.015 | | 0.25 | μs | *7 |
| Horizontal transfer clock | $H\phi$ | | 20 | | | 20 | | | 15 | 19 | *8 | 15 | 19 | ns | During imaging |
| Horizontal final stage clock | $LH\phi$ | | 20 | | | 20 | | | 15 | 19 | *8 | 15 | 19 | ns | During imaging |
| Horizontal transfer/horizontal final stage clock | $H\phi_1, LH\phi$ | | 5.38 | | | | | | 0.01 | | | 0.01 | | μs | During parallel serial conversion. |
| Horizontal transfer clock | $H\phi_2$ | | | | | 5.38 | | | 0.01 | | | 0.01 | | μs | |
| Reset gate clock | ϕ_{RG} | 11 | 13 | | | 51 | | | 3 | | | 3 | | ns | |
| Substrate clock | ϕ_{SUB} | 1.5 | 1.8 | | | | | | | | | | 0.5 | μs | During charge drain. |

*7 When vertical transfer clock driver CXD1250 is in use.

*8 $t_f \geq t_r - 2 \text{ ns}$

| Item | Symbol | two | | | Unit | Remarks |
|--|-------------------|------|------|------|------|---------|
| | | Min. | Typ. | Max. | | |
| Horizontal transfer clock | $H\phi$ | 16 | 20 | | ns | *9 |
| Horizontal transfer/horizontal final stage clock | $H\phi_2, LH\phi$ | 16 | 20 | | ns | *10 |

*9 "two" is the overlap period of horizontal transfer clocks $H\phi_1$ and $H\phi_2$'s twh and twl.

*10 "two" is the overlap period of horizontal transfer clock $H\phi_2$'s twl and horizontal final stage transfer clock $LH\phi$'s twh'

Operating Characteristics

(Ta=25 °C)

| Item | Symbol | Min. | Typ. | Max. | Unit | Test method | Remarks |
|----------------------|--------------|------|-------|-------|------|-------------|---------------|
| Sensitivity | S | 300 | 380 | | mV | 1 | |
| Saturation signal | Vsat | 600 | | | mV | 2 | Ta=60 °C |
| Smear | Sm | | 0.009 | 0.015 | % | 3 | |
| Video signal shading | SH | | | 20 | % | 4 | Zone 0, I |
| | | | | 25 | % | 4 | Zone 0 to II' |
| Dark signal | Vdt | | | 2 | mV | 5 | Ta=60 °C |
| Dark signal shading | Δ Vdt | | | 1 | mV | 6 | Ta=60 °C |
| Flicker | F | | | 2 | % | 7 | |
| Lag | Lag | | | 0.5 | % | 8 | |

Zone chart of Video signal shading

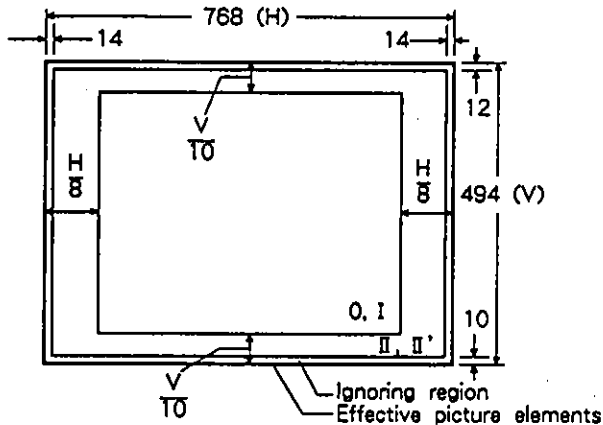


Image Sensor Characteristics Test Method

⊙ Test conditions

- ① Through the following tests the substrate voltage and reset gate clock voltage are set to the value displayed on the device, while the device drive conditions are at the typical value of the bias and clock voltage conditions.
- ② Through the following tests defects are excluded and, unless otherwise specified, the optical black level (Hence forth referred to as OB) is set as the reference, the values obtained at (A) point in the figure of the Drive Circuit are utilized.

◎ Definition of standard imaging conditions

- ① Standard imaging condition I: (As imaging device) Use a pattern box (luminance 706 cd/m², color temperature 3200K Halogen source) as a subject. (Pattern for evaluation is not applicable.) Use a testing standard lens with CM500S (t=1.0mm) as IR cut filter and image at F8. At this time, light intensity to sensor receiving surface is defined as standard sensitivity testing light intensity. Signal output average value in this condition is called V_A.
- ② Standard imaging condition II: Image a light source (color temperature of 3200K) which uniformity of brightness is within 2% at all angles. Use a testing standard lens with CM500S (t=1.0mm) as IR cut filter. The light intensity is adjusted to the value indicated in each testing item by lens diaphragm.

1. Sensitivity

Set to standard image condition I. After selecting the electronic shutter mode at a 1/250s. shutter speed, measure the signal (V_s) at the center of the screen and substitute in the following formula.

$$S = V_s \times \frac{250}{60}$$

2. Saturation signal

Set to standard imaging condition II. Adjust light intensity to 10 times that of signal output average value (V_A=200mV), then test signal output minimum value.

3. Smear

Set to standard imaging condition II. Adjust light intensity to 500 times that of signal output average value (V_A=200mV). Stop read out clock. When the charge drain executed by the electric shutter at the respective H blankings takes place, test the maximum value V_{sm} of signal output.

$$S_m = \frac{V_{sm}}{200} \times \frac{1}{500} \times \frac{1}{10} \times 100 (\%) (1/10V)$$

4. Video signal shading

Set to standard imaging condition II. Adjust light intensity to signal output average value (V_A=200mV) with lens diaphragm at F5.6 to F8. Then test maximum (V_{max}) and minimum (V_{min}) values of signal output.

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

5. Dark signal

Test signal output average value V_{dt} when the device ambient temperature is at 60 °C and light is obstructed with horizontal idle transfer level as reference.

6. Dark signal shading

Following 5, test maximum (V_{dmax}) and minimum (V_{dmin}) values of dark signal output.

$$\Delta V_{dt} = V_{dmax} - V_{dmin}$$

7. Flicker

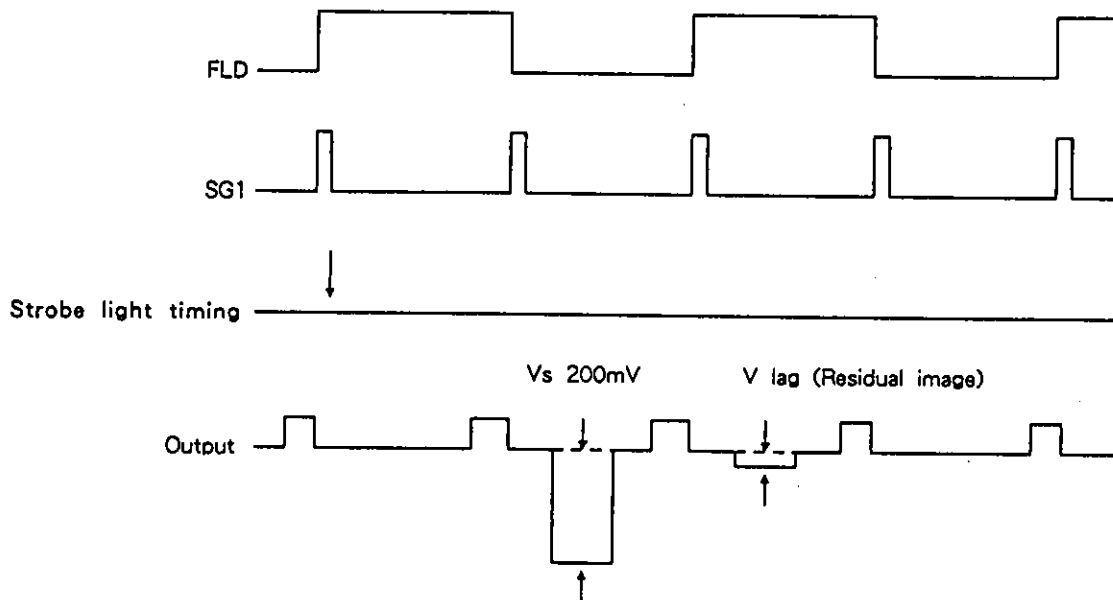
Set to standard imaging condition II. Adjust light intensity to signal output average value ($V_A=200\text{mV}$). Then test the signal output difference (ΔV_f) between even field and odd field.

$$F = (\Delta V_f / 200) \times 100 (\%)$$

8. Residual image

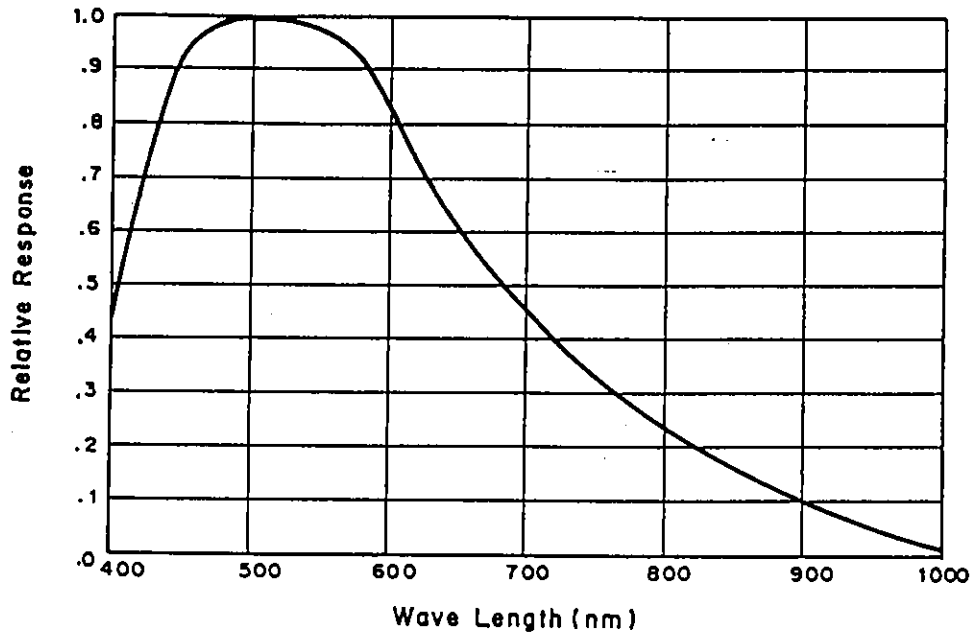
Adjust signal output value (V_s) by strobe light to 200mV . Then light a stroboscopic tube with the following timing and test the residual image (V_{lag}).

$$\text{Lag} = (V_{\text{lag}} / V_s) \times 100 (\%)$$

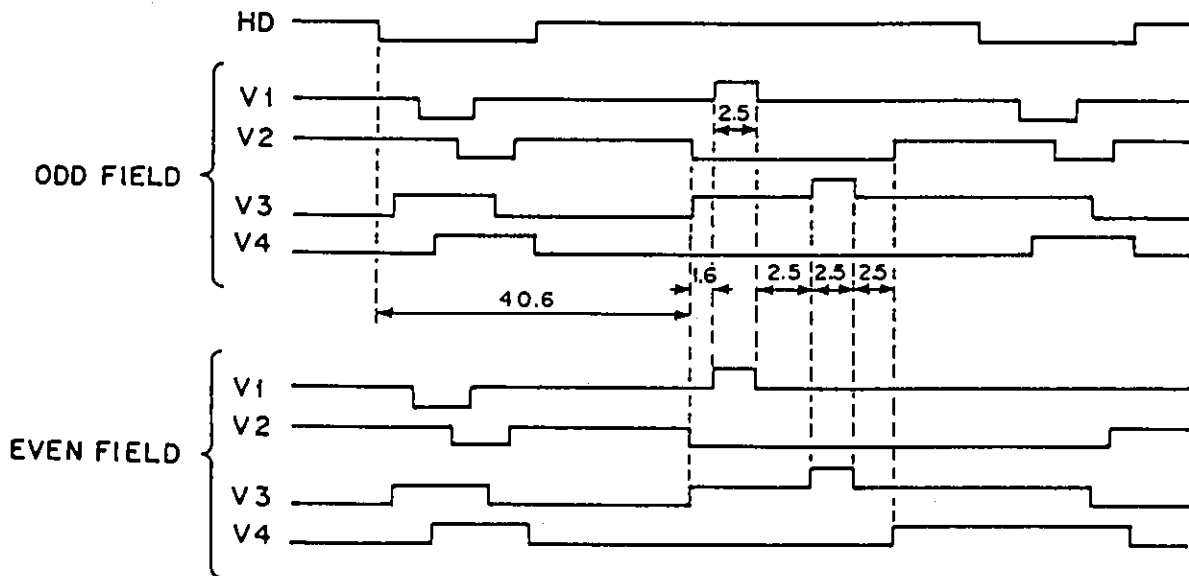


Spectral Sensitivity Characteristics

(Excluding light source characteristics, including lens characteristics)

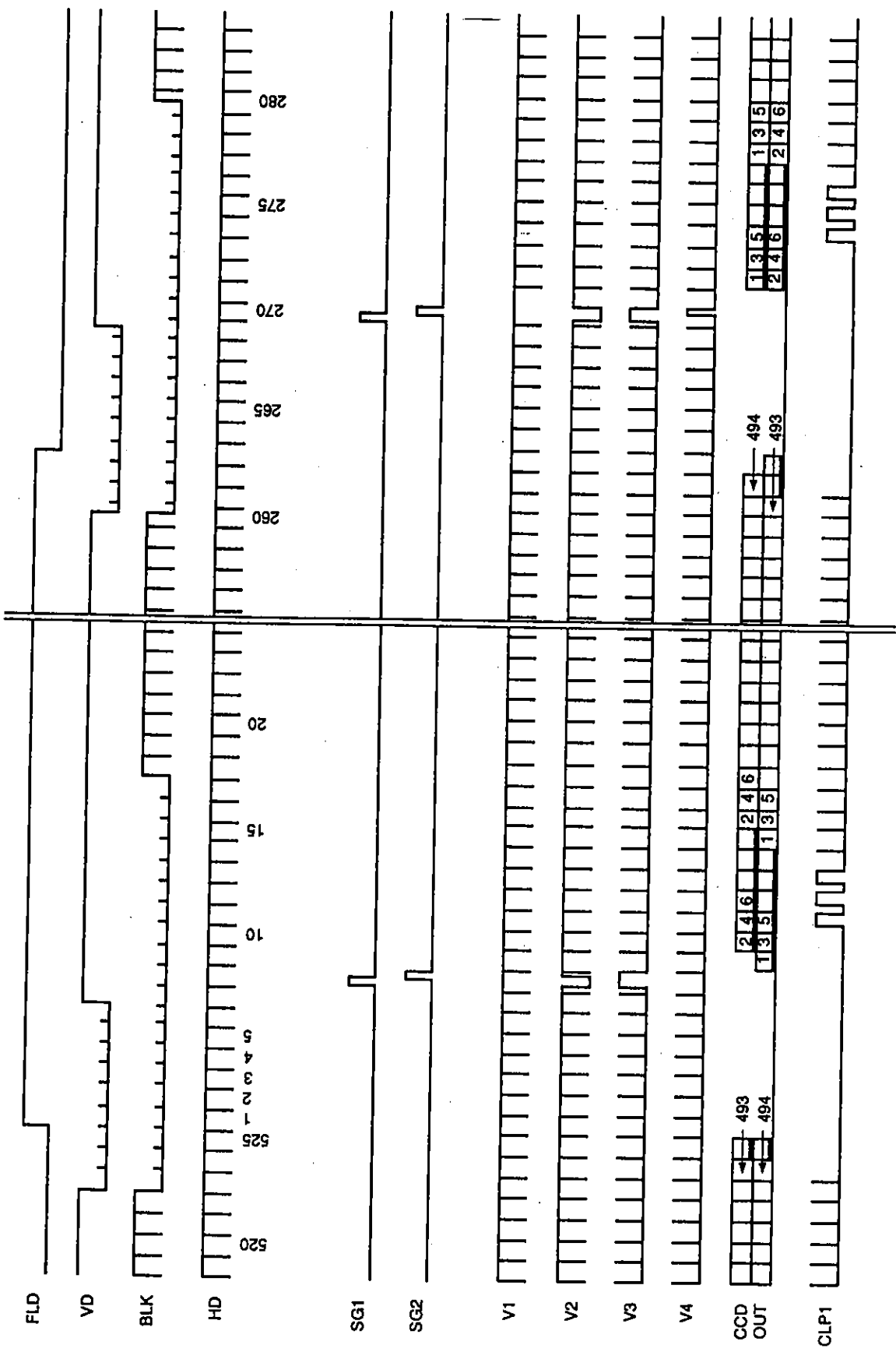


Using read out clock timing chart



Unit : μs

Drive Timing Chart (Vertical 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 grounded 30W soldering iron and solder each pin in less than 2 seconds. For repairs and remount, cool sufficiently.
- c) To dismount an imaging device 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 to ground.

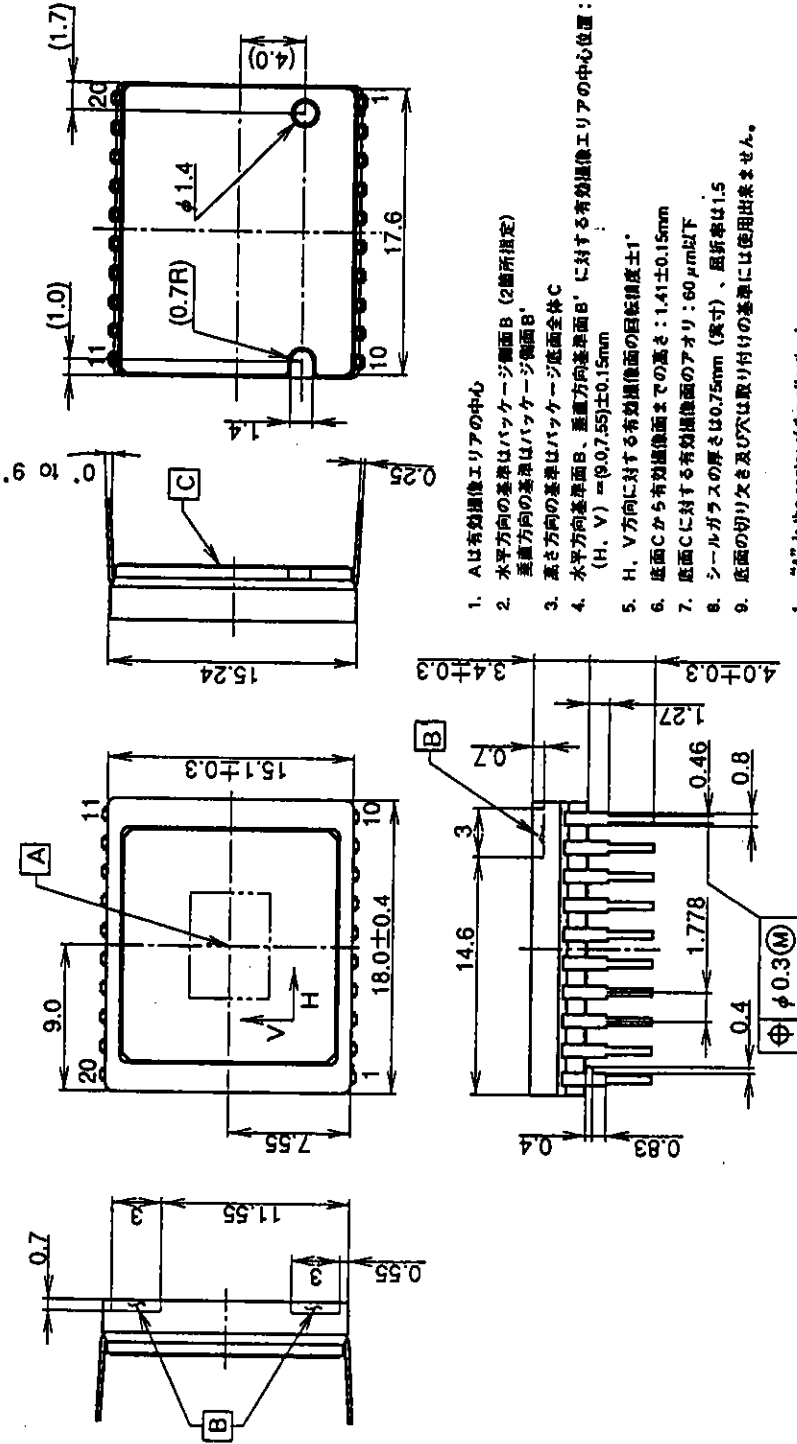
3) Dust and dirt protection

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 operation as required, and use them.

- a) Operate in clean environments (around class 1000 will be appropriate).
 - 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 blow. (For dirt stuck through static electricity ionized air is recommended.)
 - c) Clean with a cotton bud and ethyl alcohol if the glass surface is 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 temperatures or humidity will affect the characteristics. Accordingly avoid storage or usage in such conditions.
- 6) CCD image sensor are precise optical equipment that should not be subject to too much mechanical shocks.

Package Outline Unit: mm

20pin DIP (600mil)



1. Aは有効撮像エリアの中心
2. 水平方向の基準はパッケージ側面B (2箇所指定)
3. 垂直方向の基準はパッケージ側面B'
4. 高さ方向の基準はパッケージ底面全体C
5. 水平方向基準面B、垂直方向基準面B' に対する有効撮像エリアの中心位置:
(H, V) = (9.0, 7.55) ± 0.15mm
6. H, V方向に対する有効撮像面の回転傾度 ± 1°
7. 底面Cから有効撮像面までの高さ: 1.41 ± 0.15mm
8. 底面Cに対する有効撮像面のアオリ: 60 μm以下
9. シールガラスの厚さは0.75mm (実寸)、屈折率は1.5
10. 底面の切り欠き及び穴は取り付けの基準には使用出来ません。

1. "A" is the center of the effective image area.
2. The two points "B" of the package are the horizontal reference.
3. The point "B'" of the package is the vertical reference.
4. The bottom "C" of the package is the height reference.
5. The center of the effective image area, relative to "B" and "B'" is
(H, V) = (9.0, 7.55) ± 0.15mm.
6. The rotation angle of the effective image area relative to H and V is ± 1°.
7. The height from the bottom "C" to the effective image area is 1.41 ± 0.15mm.
8. The tilt of the effective image area relative to the bottom "C" is less than 60 μm.
9. The thickness of the cover glass is 0.75mm, and the refractive index is 1.5.
10. The notch and the hole on the bottom must not be used for reference of fixing.

PACKAGE STRUCTURE

| | |
|------------------|-------------|
| PACKAGE MATERIAL | Cer-DIP |
| LEAD TREATMENT | TIN PLATING |
| LEAD MATERIAL | 42ALLOY |
| PACKAGE WEIGHT | 2.6g |