SONY

ICX039BNB

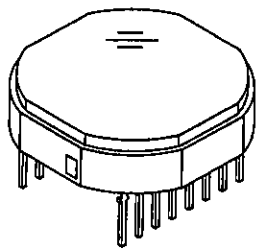
1/2 inch CCD Image Sensor for PAL Color Camera

Description

The ICX039BNB is an interline transfer CCD solid-state image sensor suitable for PAL 1/2 inch color video cameras. High resolution and high sensitivity are achieved through the adoption of Ye, Cy, Mg and G complementary color mosaic filters and HAD (Hole-Accumulation Diode) sensors.

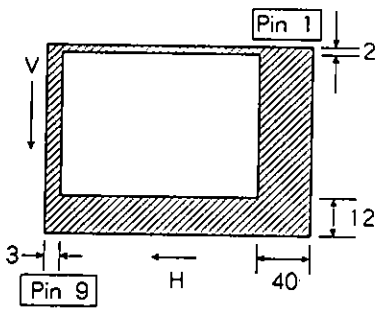
This chip features a field integration read out system, an electronic shutter with variable charge-storage time. Also, this outline is miniaturized by using original package.

16 pin DIP (Ceramic)



Features

- High resolution, high sensitivity (+6dB compare with ICX039AN) and low dark current
- Consecutive various speed shutter
  1/50s. (Typ.), 1/120s. to 1/10000s.
- Low smear
- High antiblooming
- Ye, Cy, Mg, G on chip type complementary color mosaic filter.
- Horizontal register 5V drive
- Horizontal register final stage 5V drive
- Reset gate 5V drive



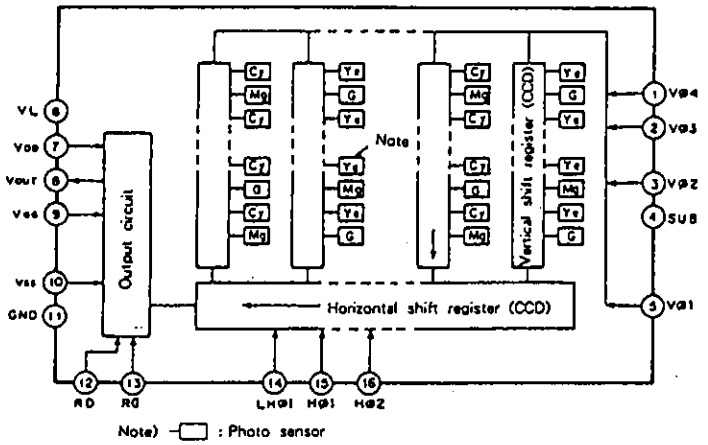
Optical black position (Top View)

Device Structure

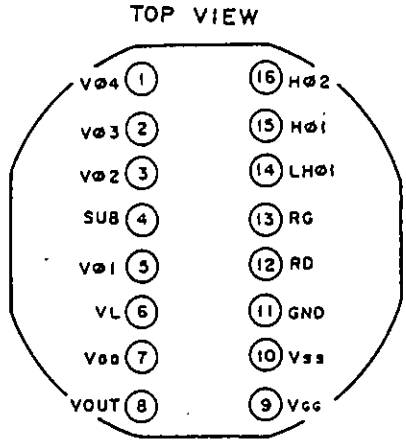
- Optical size 1/2 inch format
- Number of effective pixels 752 (H) × 582 (V) Approx. 440k pixels
- Number of total pixels 795 (H) × 596 (V) Approx. 470k pixels
- Interline transfer CCD image sensor
- Chip size 7.95mm (H) × 6.45mm (V)
- Unit cell size 8.6 µm (H) × 8.3 µm (V)
- Optical black Horizontal (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

E91766C71—PS

Block Diagram



Pin Configuration



Pin Description

No.	Symbol	Description	No.	Symbol	Description
1	$V\phi_4$	Vertical register transfer clock	9	V_{GG}	Output amplifier gate bias
2	$V\phi_3$	Vertical register transfer clock	10	Vss	Output amplifier source
3	$V\phi_2$	Vertical register transfer clock	11	GND	GND
4	SUB	Substrate (Overflow drain)	12	RD	Reset drain bias
5	$V\phi_1$	Vertical register transfer clock	13	RG	Reset gate clock
6	V_L	Protective transistor bias	14	$LH\phi_1$	Horizontal register final stage transfer clock
7	V_{DD}	Output amplifier drain supply	15	$H\phi_1$	Horizontal register transfer clock
8	V_{OUT}	Signal output	16	$H\phi_2$	Horizontal register transfer clock

Absolute Maximum Ratings

Item		Ratings	Unit	Remarks
Substrate voltage SUB-GND		–0.3 to +55	V	
Supply voltage	V_{DD}, V_{RD}, V_{OUT}, Vss–GND	–0.3 to +18	V	
	V_{DD}, V_{RD}, V_{OUT}, Vss–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	
	$V\phi_1$, $V\phi_2$, $V\phi_3$, $V\phi_4$–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	
$H\phi_1$, $H\phi_2$–$V\phi_4$		–17 to +17	V	
$LH\phi_1$, RG, V_{GG}–GND		–10 to +15	V	
$LH\phi_1$, RG, V_{GG}–SUB		–55 to +10	V	
V_L–SUB		–65 to +0.3	V	
Beside GND, SUB-V_L		–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

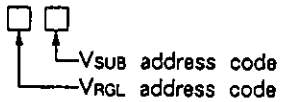
Item	Symbol	Min.	Typ.	Max.	Unit	Remarks
Output amplifier drain voltage	V_{DD}	14.55	15.0	15.45	V	
Reset drain voltage	V_{RD}	14.55	15.0	15.45	V	$V_{RD}=V_{DD}$
Output amplifier gate voltage	V_{GG}	1.75	2.0	2.25	V	
Output amplifier source	V_{SS}	Ground through 390Ω resistor				± 5%
Substrate voltage adjustment range	V_{SUB}	9.0		18.5	V	*2
Fluctuation range after substrate voltage adjustment	ΔV_{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	ΔV_{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}, Vss and SUB pins, while pins that are not tested are grounded.
2. Current to each pins when 20V is applied sequentially to Vφ1, Vφ2, Vφ3, Vφ4, Hφ1 and Hφ2, 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, LHφ1 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

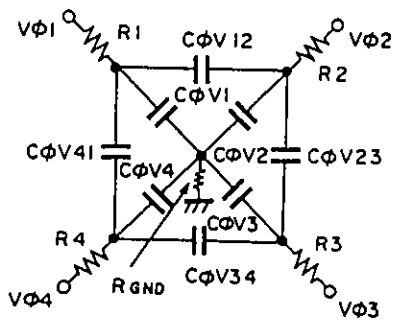
Item	Symbol	Min.	Typ.	Max.	Unit	Waveform diagram	Remarks
Read out clock voltage	V_{VT}	14.55	15.0	15.45	V	1	
Vertical transfer clock voltage	V_{VH1}, V_{VH2}	–0.05	0	0.05	V	2	$V_{VH}=(V_{VH1}+V_{VH2})/2$
	V_{VH3}, V_{VH4}	–0.2	0	0.05	V	2	
	V_{VL1}, V_{VL2}, V_{VL3}, V_{VL4}	–9.6	–9.0	–8.5	V	2	$V_{VL}=(V_{VL3}+V_{VL4})/2$
	$V\phi V$	8.3	9.0	9.65	V	2	$V\phi V=V_{VHn}-V_{VLn}$ (n=1 to 4)
	$\lvert V_{VH1}-V_{VH2}\rvert$			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	$V\phi_{LH}$	4.75	5.0	5.25	V	3	
	V_{HL}	–0.05	0	0.05	V	3	
Horizontal final stage transfer clock voltage	$V\phi_{LH}$	4.75	5.0	5.25	V	4	
	V_{LHL}	–0.05	0	0.05	V	4	
Reset gate clock voltage	$V\phi_{RG}$	4.5	5.0	5.5	V	5	*6
	$V_{RGLH}-V_{RGLL}$			0.8	V	5	Low level coupling
Substrate clock voltage	$V\phi_{SUB}$	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.

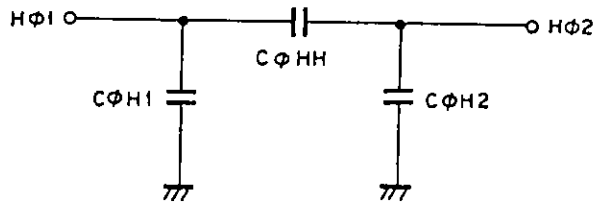
Item	Symbol	Min.	Typ.	Max.	Unit	Waveform diagram	Remarks
Reset gate clock voltage	V_{RGL}	–0.2	0	0.2	V	5	
	$V\phi_{RG}$	8.5	9.0	9.5	V	5	

Clock Equivalent Circuit Constant

Item	Symbol	Min.	Typ.	Max.	Unit	Remarks
Capacitance between vertical transfer clock and GND	$C\phi_{V1}$, $C\phi_{V3}$		1800		pF	
	$C\phi_{V2}$, $C\phi_{V4}$		2200		pF	
Capacitance between vertical transfer clocks	$C\phi_{V12}$, $C\phi_{V34}$		450		pF	
	$C\phi_{V23}$, $C\phi_{V41}$		270		pF	
Capacitance between horizontal transfer clock and GND	$C\phi_{H1}$, $C\phi_{H2}$		62		pF	
Capacitance between horizontal transfer clocks	$C\phi_{HH}$		47		pF	
Capacitance between horizontal final stage transfer clock and GND	$C\phi_{LH}$		8		pF	
Capacitance between reset gate clock and GND	$C\phi_{RG}$		8		pF	
Capacitance between substrate clock and GND	$C\phi_{SUB}$		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	



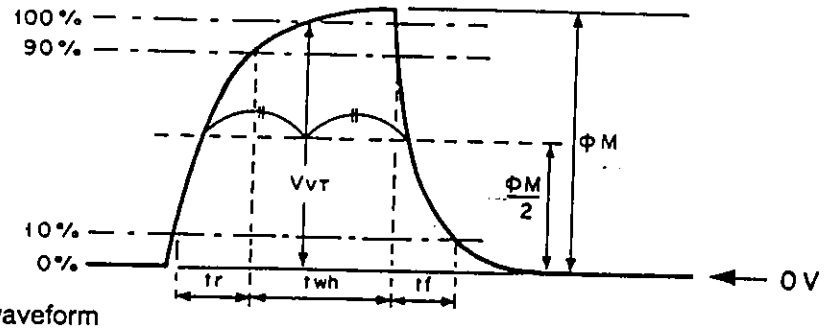
Vertical transfer clock equivalent circuit



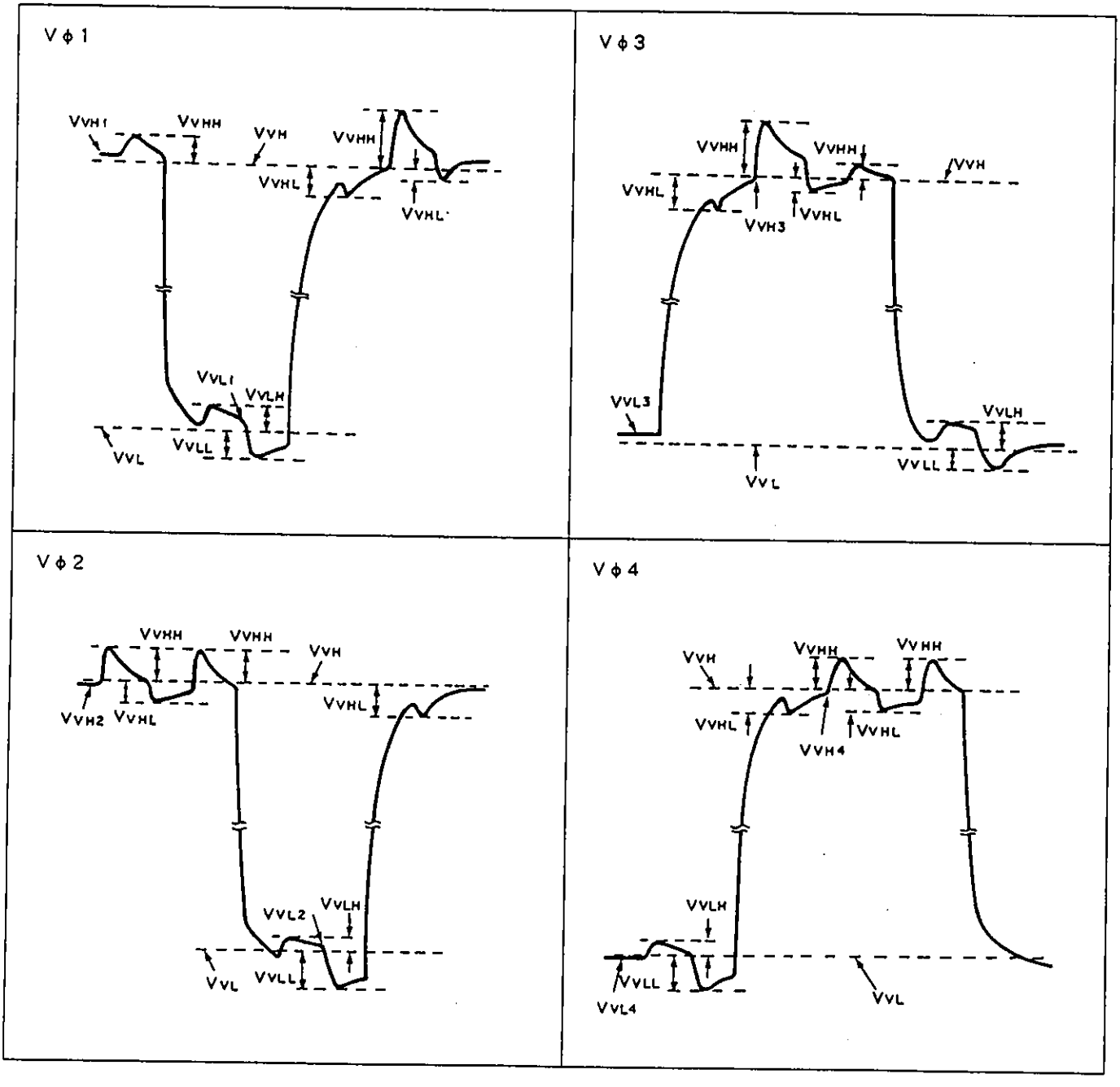
Horizontal transfer clock equivalent circuit

Drive Clock Waveform Conditions

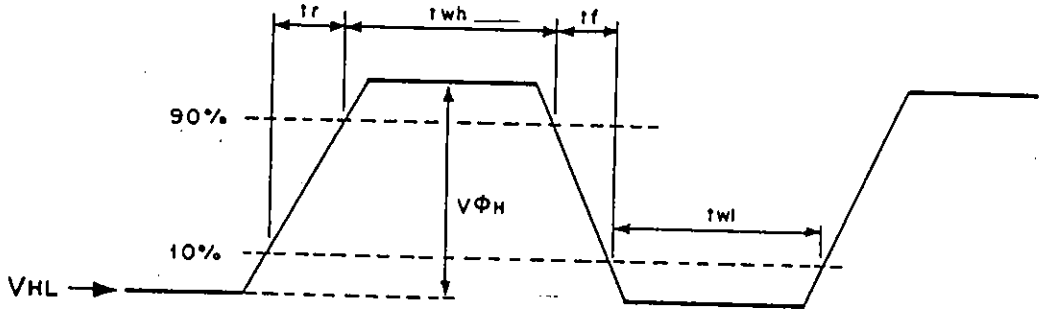
(1) Read out clock waveform



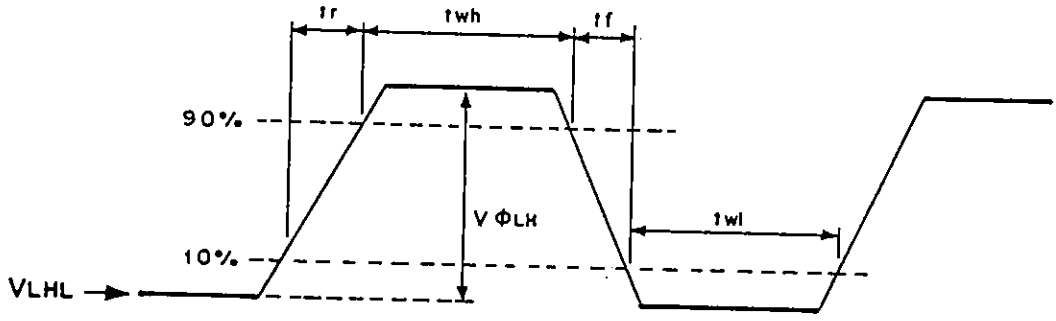
(2) Vertical transfer clock waveform



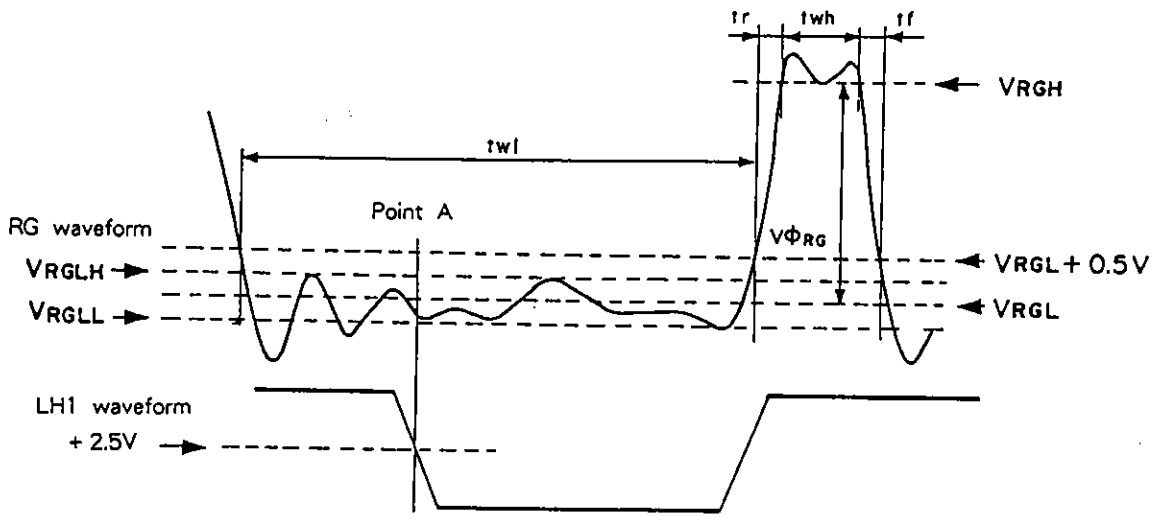
(3) Horizontal transfer clock waveform diagram



(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.

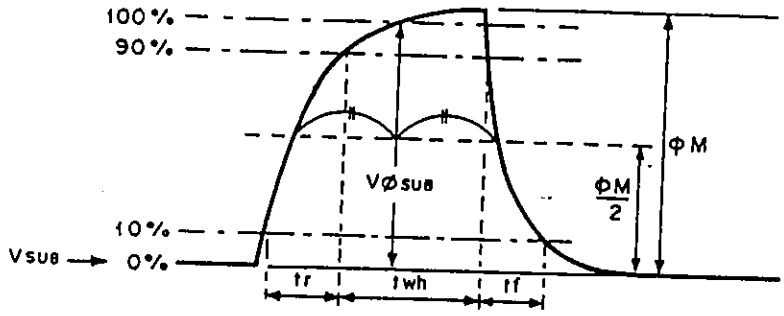
V_{RGL} is the mean value for V_{RGLH} and V_{RGLL}.

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

V_{RGH} is the minimum value for twh 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			0.5	µs	During charge drain.

*7. When vertical transfer clock driver CXD1250 is in use.
*8. tf ≧ tr–2 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

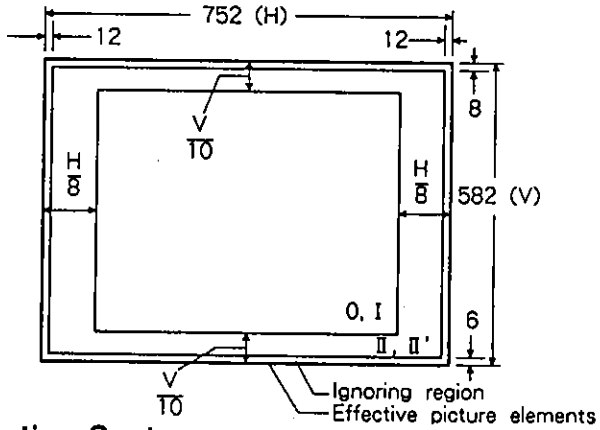
*9. "two" is the overlap period of horizontal transfer clocks $H\phi_1$ and $H\phi_2$'s twh and twl.
*10. "two" is the overlap period of horizontal transfer clock $H\phi_2$'s twl and horizontal final stage transfer clock $LH\phi$'s twh'.

Operating Characteristics

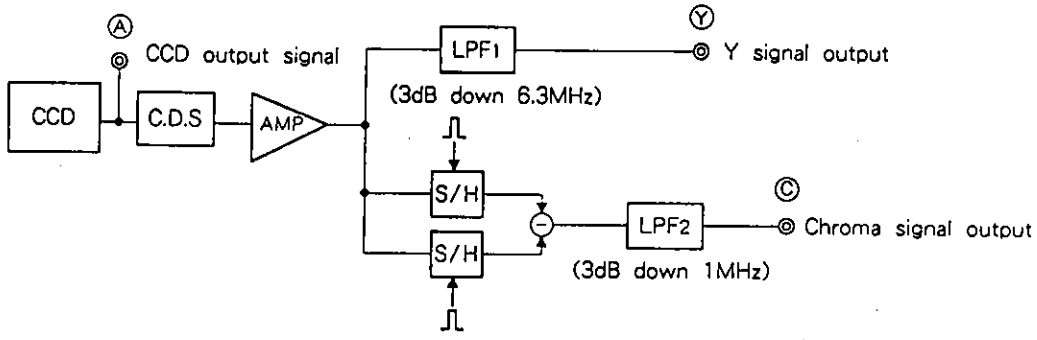
(Ta=25℃)

Item	Symbol	Min.	Typ.	Max.	Unit	Test method	Remarks
Sensitivity	S	320	420		mV	1	
Saturation signal	Ysat	540			mV	2	Ta=60℃
Smear	Sm		0.009	0.015	%	3	
Video signal shading	SHy			20	%	4	Zone 0, I
				25	%	4	Zone 0 to II'
Uniformity between signal channels	Δ Sr			10	%	5	
	Δ Sb			10	%	5	
Dark signal	Ydt			2	mV	6	Ta=60℃
Dark signal shading	Δ Ydt			1	mV	7	Ta=60℃
Flicker Y	Fy			2	%	8	
Flicker R–Y	Fcr			5	%	8	
Flicker B–Y	Fcb			5	%	8	
Horizontal stripes R	Lcr			3	%	9	
Horizontal stripes G	Lcg			3	%	9	
Horizontal stripes B	Lcb			3	%	9	
Horizontal stripes W	Lcw			3	%	9	
Lag	Lag			0.5	%	10	

Zone chart of Video signal shading



Testing System



Note) Adjust AMP amplifier so that total gains between Ⓐ and Ⓨ and between Ⓐ and Ⓒ equal 1.

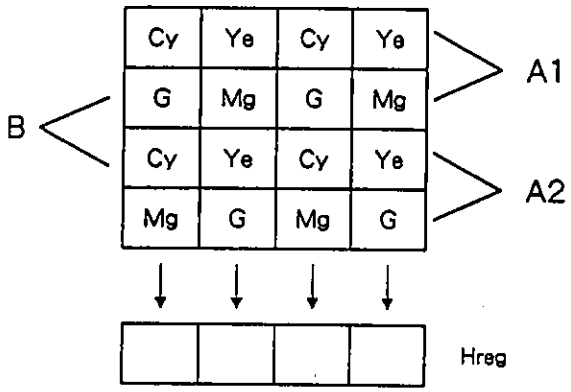
Image Sensor Characteristics Test Method

◎ 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 for the signal output which is taken as the Y signal output or the chroma signal output of the testing system.

◎ Color coding of CFA (Color Filter Array) & Composition of luminance (Y) and chrominance (C) signals



Color Coding Diagram

CFA of this image sensor is shown in the Figure. This complementary CFA is used with a "field integration mode", where all of the photosites are read out during each video field. Signals from two vertically adjacent photosites, such as line A1 or A2 for field A, are summed when the image charge is transferred into the vertical storage columns.
The read out line pairing is shifted down one line for field B. The sensor output signals through the horizontal register (H reg.) at line A1 are [G+Cy], [Mg+Ye], [G+Cy], [Mg+Ye].

These signals are processed in order to compose Y and C signals. By adding the two adjacent signals at line A1, Y signal is formed as follows:

$$Y = \{(G+Cy)+(Mg+Ye)\} \times 1/2$$
$$= 1/2\{2B+3G+2R\}$$

C signal is composed by subtracting the two adjacent signals at line A1.

$$R-Y = \{(Mg+Ye)-(G+Cy)\}$$
$$= \{2R-G\}$$

Next, the signals through H reg. at line A2 are

[Mg+Cy], [G+Ye], [Mg+Cy], [G+Ye]

Similarly, Y and C signals are composed at line A2.

$$Y = \{(G+Ye)+(Mg+Cy)\} \times 1/2$$
$$= 1/2\{2B+3G+2R\}$$
$$-(B-Y) = \{(G+Ye)-(Mg+Cy)\}$$
$$= -\{2B-G\}$$

Accordingly, Y signal is balanced in relation to the scanning lines, and C signal takes the form of R–Y and –(B–Y) on alternate lines.
It is the same for B field.

◎ 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 F5.6. At this time, light intensity to sensor receiving surface is defined as standard sensitivity testing light intensity.

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 Y signal (Ys) at the center of the screen and substitute in the following formula.

   $$S = Ys \times \frac{250}{50} \text{ (mV)}$$

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

3. Smear
   Set to standard imaging condition II. Adjust light intensity to 500 times that of Y signal output average value (Y_A=200mV). Stop read out clock. When the charge drain executed by the electronic shutter at the respective H blankings takes place, test the maximum value YSm of Y signal output.

   $$Sm = \frac{YSm}{200} \times \frac{1}{500} \times \frac{1}{10} \times 100 \text{ (\%) (1/10V)}$$

4. Video signal shading
   Set to standard imaging condition II. Adjust light intensity to Y signal output average value (Y_A=200mV) with lens diaphragm at F5.6 to F8. Then test maximum (Ymax) and minimum (Ymin) values of Y signal.

   $$SHy = (Ymax - Ymin) / 200 \times 100 \text{ (\%)}$$

5. Video signal between channels uniformity
   Set to standard imaging condition II. Adjust light intensity to Y signal output average value (Y_A=200mV). Then test maximum (Crmax, Cbmax) and minimum (Crmin, Cbmin) values of chroma signals from R–Y and B–Y channels.

   $$\Delta Sr = |(Crmax - Crmin) / 200| \times 100 \text{ (\%)}$$
   $$\Delta Sb = |(Cbmax - Cbmin) / 200| \times 100 \text{ (\%)}$$

6. Dark signal
   Test Y signal output average value Ydt when the device ambient temperature is at 60 °C and light is obstructed with horizontal idle transfer level as reference.

7. Dark signal shading
Following 6, test maximum (Ydmax) and minimum (Ydmin) values of dark signal output.

Δ Ydt=Ydmax–Ydmin (mV)

8. Flicker
① Fy
Set to standard imaging condition II. Adjust light intensity to Y signal output average value (Y_A=200mV). Then test the Y signal difference (Δ Yf) between even field and odd field.

Fy= (Δ Yf/200) × 100 (%)

② Fcr, Fcb
Set to standard imaging condition II. Adjust light intensity to Y signal output average value (Y_A=200mV). Then insert R or B filter, and test the C signal difference (Δ Cr, Δ Cb) between even field and odd field and the C signal output average value (CAr, CAb).

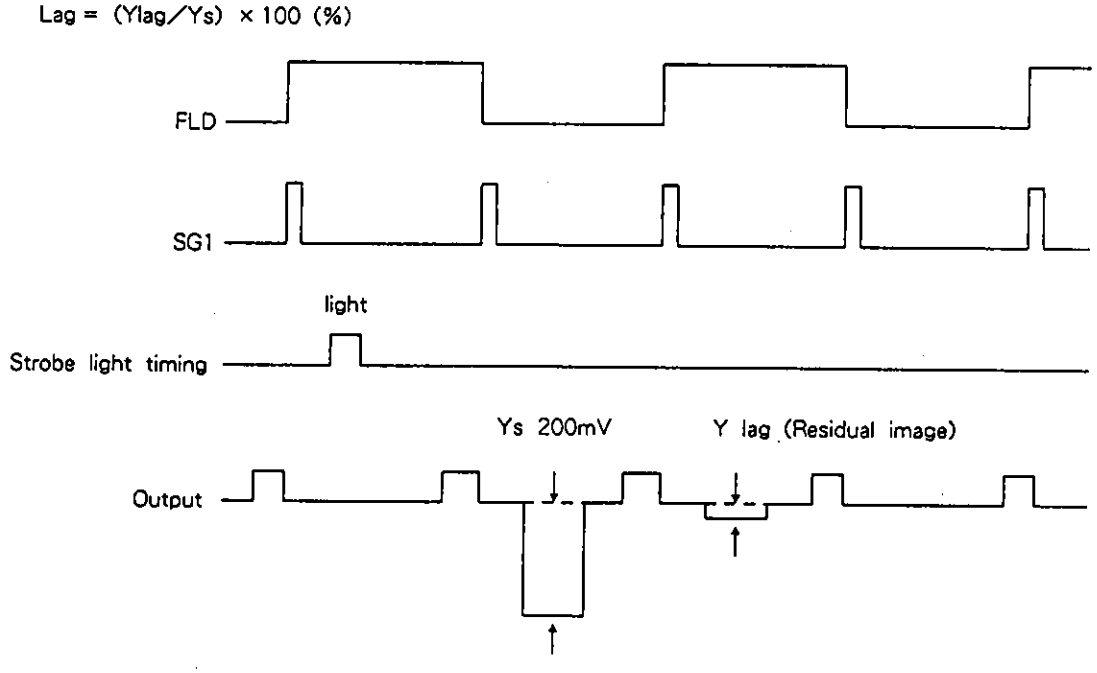
Fci= (Δ Ci/CAi) × 100 (%) (i=r, b)

9. Lateral stripe
Set to standard imaging condition II. Adjust light intensity to Y signal output average value (Y_A=200mV). Then insert R, G and B filters respectively, and test the signal difference (Δ Yiw, Δ Yir, Δ Yig, Δ Yib) between Y signal lines of the same field.

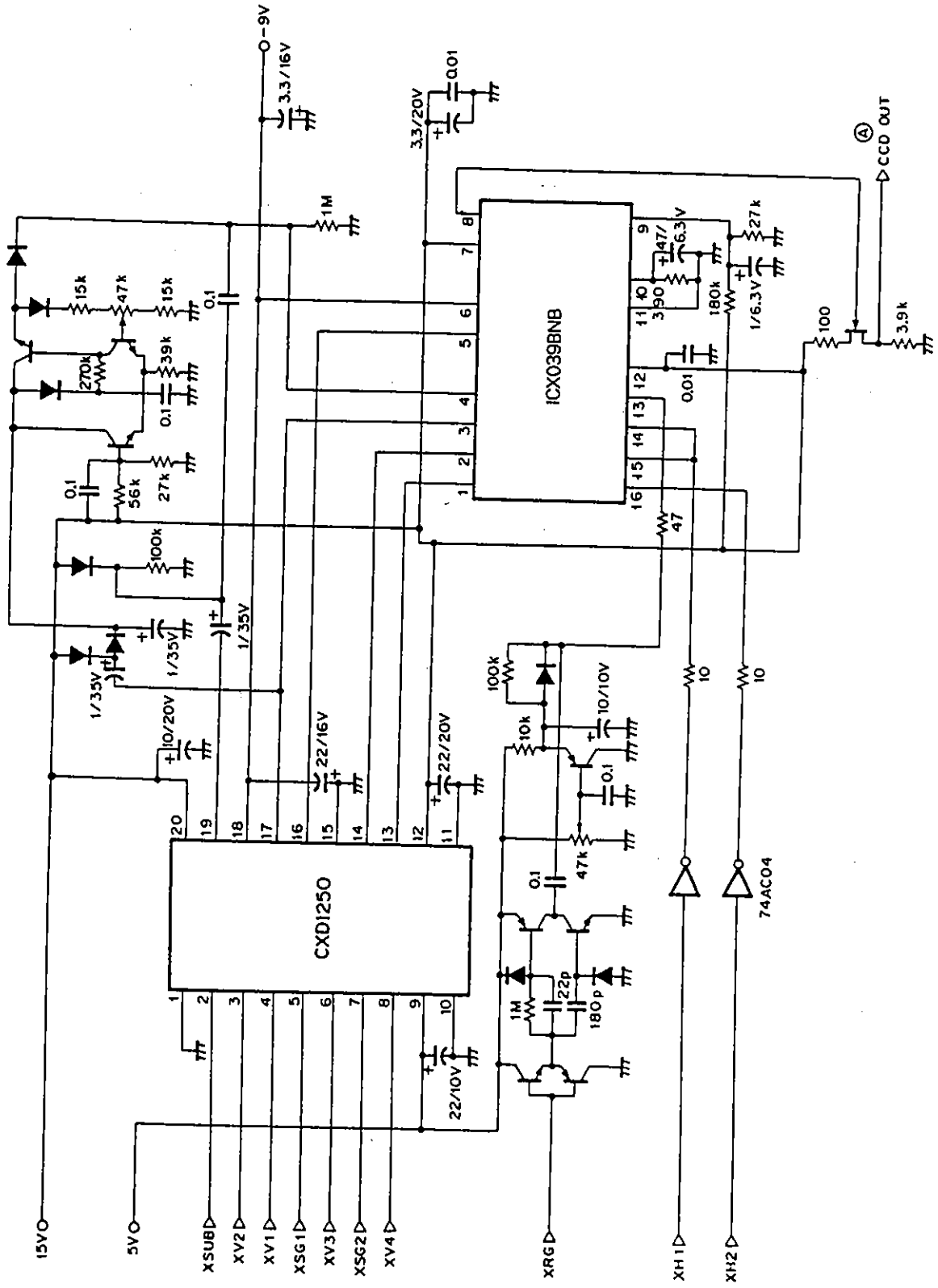
Lci= (Δ Yli/200) × 100 (%) (i=w, r, g, b)

10. Residual image
Adjust Y signal output value (Ys) by strobe light to 200mV. Then light a stroboscopic tube with the following timing and test the residual image (Ylag).

Lag = (Ylag/Ys) × 100 (%)

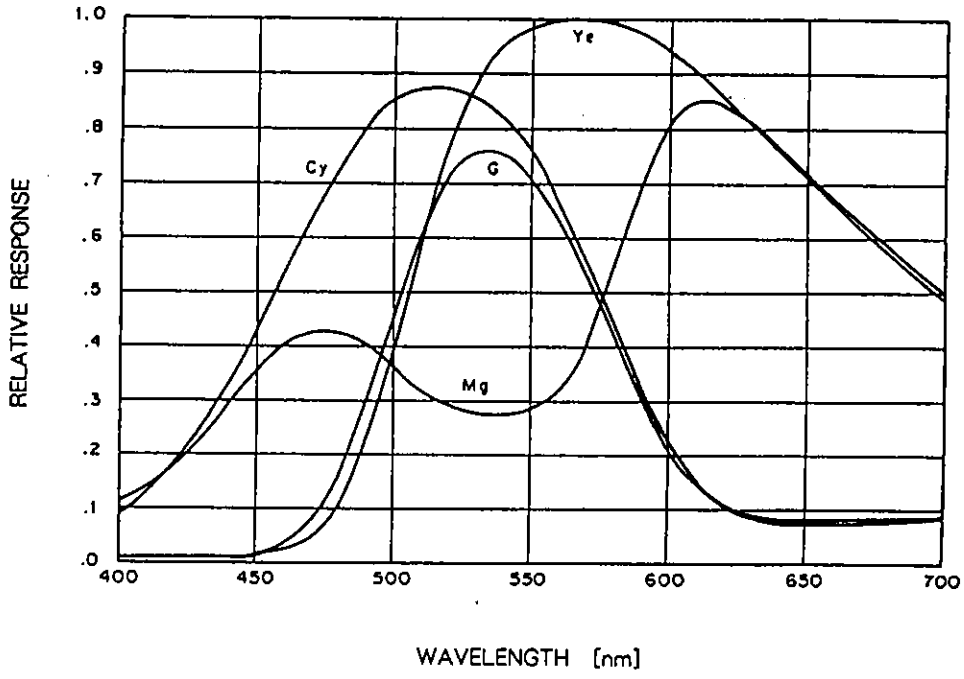


Drive Circuit

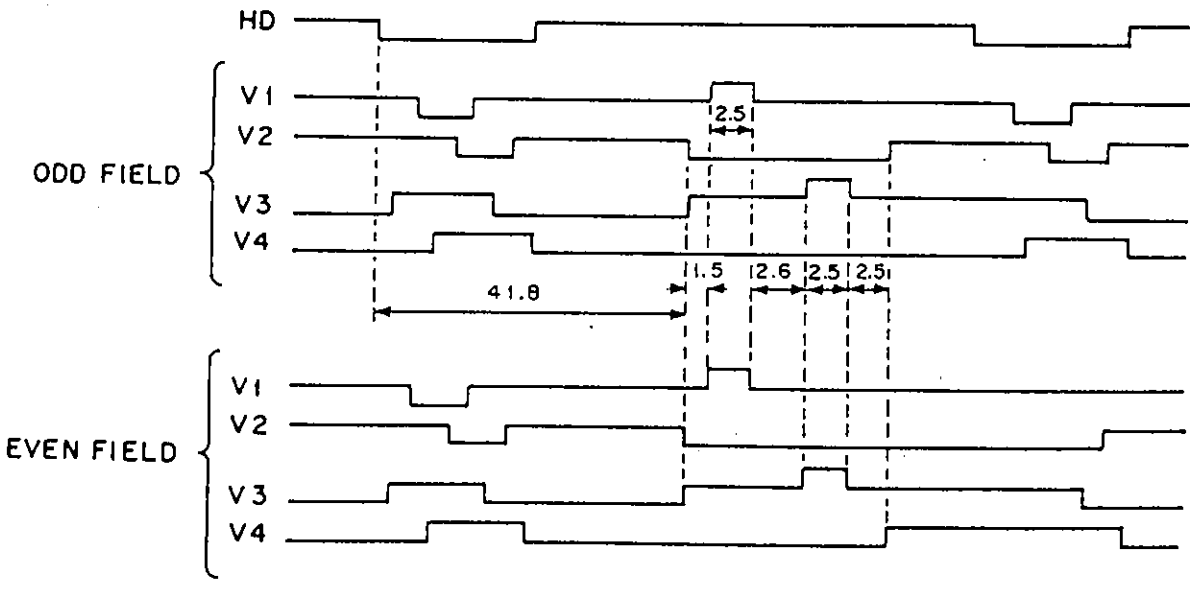


Spectral Sensitivity Characteristics

(Excluding light source characteristics, including lens characteristics)

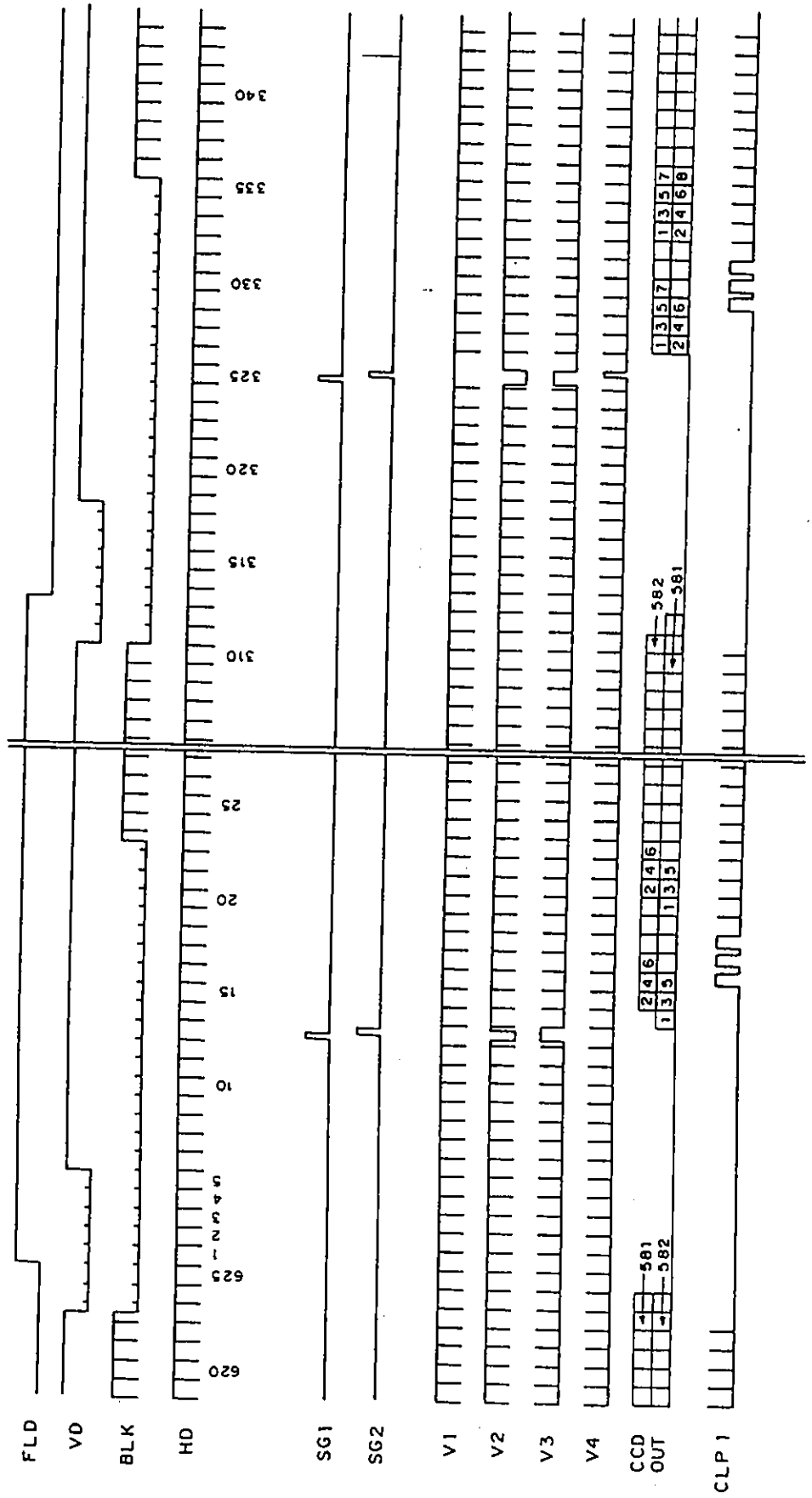


Using read out clock timing chart

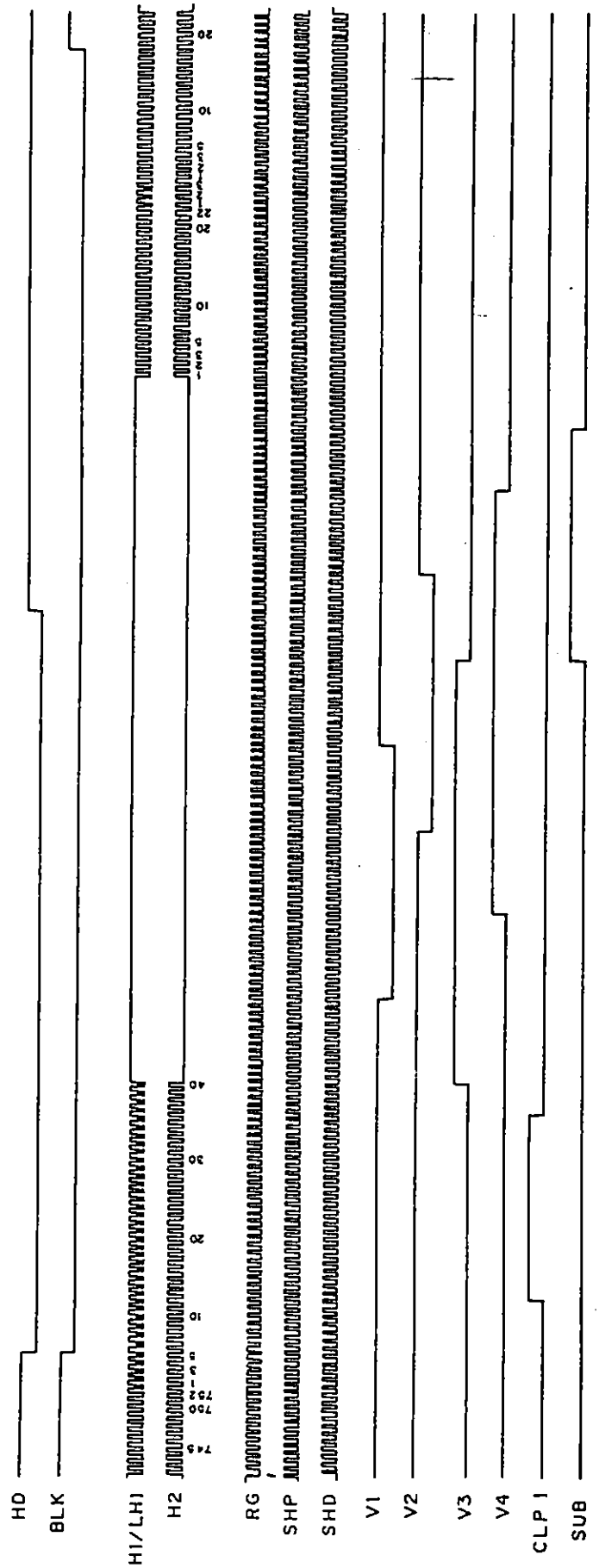


Unit : μs

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 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 no to scratch the glass.
d) Keep in 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.

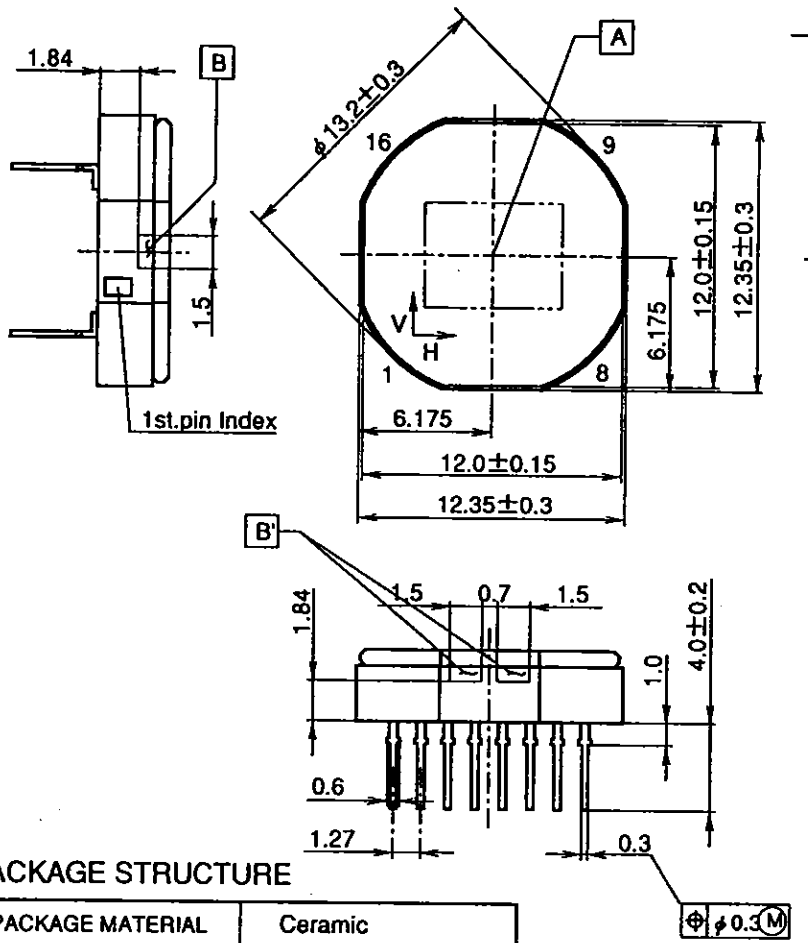
4) Do not expose to strong light (sun rays) for long periods, color filters are discolored.
For continuous using under cruel condition exceeding the normal using condition, consult our company.

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

16pin DIP(300mil)



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
   垂直方向の基準はパッケージ側面B'
3. 高さ方向の基準はパッケージ底面C
4. パッケージ中心*に対する有効撮像エリアの中心位置度公差±0.15mm
5. H、V方向に対する有効撮像面の回転精度：±1°
6. 底面Cから有効撮像面までの高さ：1.41±0.15mm
7. 底面Cに対する有効撮像面のアオリ：60μm以下
8. シールガラスの厚さは0.75mm（実寸）、屈折率は1.5

*パッケージ中心：パッケージ側面B、B'にそれぞれ対向し合う2組の端面により得られる中心点

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)±0.15mm.
5. The rotation angle of the effective image area relative to H and V is ±1°.
6. The height from the bottom "C" to the effective image area is 1.41±0.15mm.
7. The tilt of the effective image area relative to the bottom "C" is less than 60 μm.
8. The thickness of the cover glass is 0.75mm, 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	42ALLOY
PACKAGE WEIGHT	0.9g