SONY

Diagonal 6 mm (Type 1/3) CCD Image Sensor for PAL Color

Preliminary

ICX811AKA

Description

The ICX811AKA is an interline CCD image sensor suitable for PAL color video cameras with a diagonal 6 mm (Type 1/3) system.
This chip features a field period readout system and an electronic shutter with variable charge-storage time.
This chip is suitable for applications such as surveillance cameras.

Features

- ◆ High sensitivity
- ◆ High saturation signal
- ◆ High resolution, low dark current
- ◆ Excellent anti-blooming characteristics
- ◆ Ye, Cy, Mg, and G complementary color mosaic filters on chip
- ◆ Continuous variable-speed shutter function
- ◆ No voltage adjustments (Reset gate and substrate bias need no adjustment.)
- ◆ Reset gate: 3.3 V drive
- ◆ Horizontal register: 3.3 V drive

Package

16-pin DIP (Plastic)

Super **HAD CCD II** ™

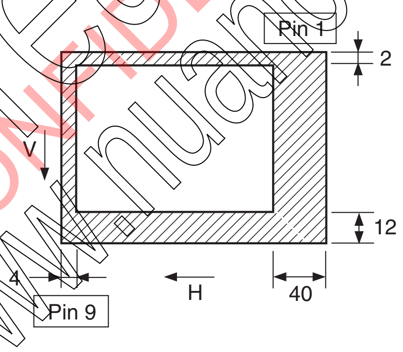
* "Super HAD CCD II" is a trademark of Sony Corporation. The "Super HAD CCD II" is a version of Sony's high performance CCD HAD (Hole-Accumulation Diode) sensor with realized sensitivity (typical) of 1000 mV or more per 1 μm^2 (Color: F5.6/BW: F8 in 1 s accumulation equivalent).

Device Structure

- Interline CCD image sensor
- Image size
  Diagonal 6 mm (Type 1/3)
- Number of effective pixels
  976 (H) × 582 (V) approx. 570 K pixels
- Total number of pixels
  1020 (H) × 596 (V) approx. 610 K pixels
- Chip size
  5.58 mm (H) × 4.67 mm (V)
- Unit cell size
  5.0 μm (H) × 6.25 μm (V)
- Optical black
  Horizontal (H) direction: Front 4 pixels, rear 40 pixels
  Vertical (V) direction : Front 12 pixels, rear 2 pixels
- Number of dummy bits
  Horizontal: 12
  Vertical : 1 (even fields only)
- Substrate material
  Silicon

Optical Black Position

(Top View)



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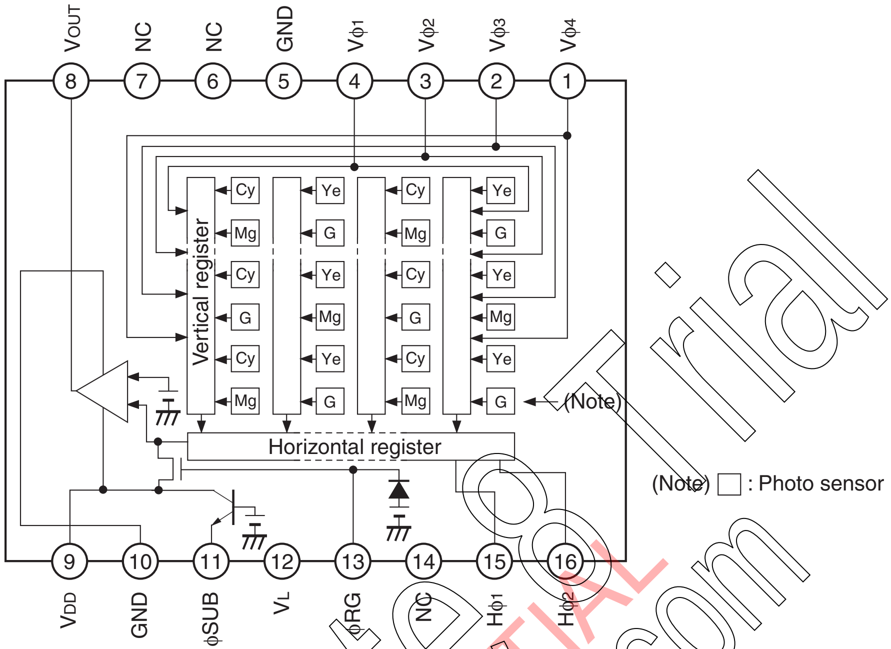
Block Diagram and Pin Configuration

(Top View)



Pin Description

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

Absolute Maximum Ratings

Item		Ratings	Unit	Remarks
Against ϕSUB	V_{DD}, V_{OUT}, ϕRG – ϕSUB	–39 to +12	V	
	$V\phi_1$, $V\phi_3$ – ϕSUB	–46 to +17	V	
	$V\phi_2$, $V\phi_4$, V_L – ϕSUB	–46 to +0.3	V	
	$H\phi_1$, $H\phi_2$, GND – ϕSUB	–39 to +0.3	V	
Against GND	V_{DD}, V_{OUT}, ϕRG – GND	–0.3 to +20	V	
	$V\phi_1$, $V\phi_2$, $V\phi_3$, $V\phi_4$ – GND	–10 to +17	V	
	$H\phi_1$, $H\phi_2$ – GND	–10 to +4.2	V	
Against V_L	$V\phi_1$, $V\phi_3$ – V_L	–0.3 to +25	V	
	$V\phi_2$, $V\phi_4$, $H\phi_1$, $H\phi_2$, GND – V_L	–0.3 to +13	V	
Between input clock pins	Potential difference between vertical clock input pins	to +13	V	*1
	$H\phi_1$ – $H\phi_2$	–5 to +5	V	
	$H\phi_1$, $H\phi_2$ – $V\phi_4$	–13 to +13	V	
Storage temperature		–30 to +80	°C	
Operating temperature		–10 to +60	°C	

*1 Operations are guaranteed up to 24 V when the width of the clock pulse is less than 10 µs, with a clock duty factor less than 0.1 %.

Bias Conditions

Item	Symbol	Min.	Typ.	Max.	Unit	Remarks
Supply voltage	V_{DD}	14.55	15.0	15.45	V	
Protective transistor bias	V_L		*1			
Substrate clock	ϕSUB		*2			
Reset gate clock	ϕRG		*2			

*1 For the V_L setting, use the V_{VL} voltage of the vertical clock waveform or the same voltage as the V_L power supply of the V driver.

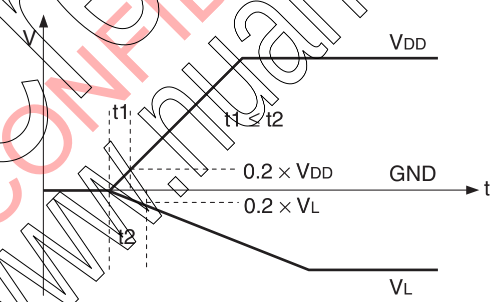
*2 Do not apply a DC bias to the substrate clock and reset gate clock pins, because a DC bias is generated internally.

DC Characteristics

Item	Symbol	Min.	Typ.	Max.	Unit	Remarks
Supply current	I_{DD}		4	6	mA	

Power-on/off Sequence

(1) Power-on sequence
GND → V_{DD} (SUB), V_L → Clock ON



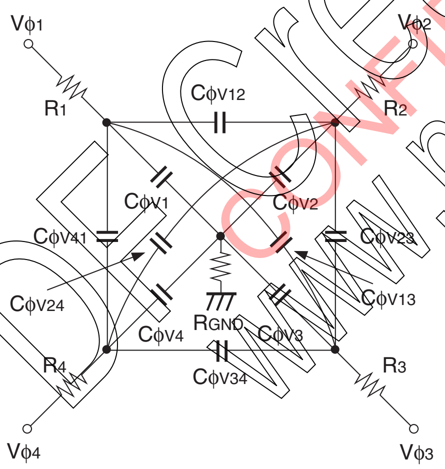
(2) Power-off sequence
Clock OFF → V_L, V_{DD} (SUB) → GND
(At power-off, use the power-on sequence with the time axis reversed.)

Clock Voltage Conditions

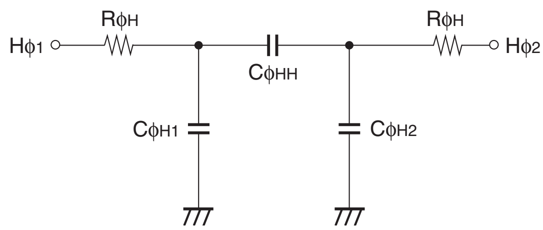
Item	Symbol	Min.	Typ.	Max.	Unit	Waveform diagram	Remarks
Readout clock voltage	V_{VT}	14.55	15.0	15.45	V	1	
Vertical transfer clock voltage	V_{VH1}, V_{VH2}	–0.05	0	0.05	V	2	$V_{VH} = (V_{VH1} + V_{VH2})/2$
	V_{VH3}, V_{VH4}	–0.2	0	0.05	V	2	
	V_{VL1}, V_{VL2}, V_{VL3}, V_{VL4}	–7.5	–7.0	–6.5	V	2	$V_{VL} = (V_{VL3} + V_{VL4})/2$
	$V_{\phi V}$	6.3	7.0	7.55	V	2	$V_{\phi V} = V_{VHn} - V_{VLn}$ (n = 1 to 4)
	$V_{VH3} - V_{VH}$	–0.25		0.1	V	2	
	$V_{VH4} - V_{VH}$	–0.25		0.1	V	2	
	V_{VHH}			0.3	V	2	High-level coupling
	V_{VHL}			0.3	V	2	High-level coupling
	V_{VLH}			0.3	V	2	Low-level coupling
	V_{VLL}			0.3	V	2	Low-level coupling
Horizontal transfer clock voltage	$V_{\phi H}$	3.0	3.3	3.6	V	3	
	V_{HL}	–0.05	0	0.05	V	3	
Reset gate clock voltage	$V_{\phi RG}$	3.0	3.3	3.6	V	4	Input through 0.1 µF capacitance
	$V_{RGLH} - V_{RGLL}$			0.4	V	4	Low-level coupling
	$V_{RGL} - V_{RGLm}$			0.5	V	4	Low-level coupling
Substrate clock voltage	$V_{\phi SUB}$	21.0	22.0	23.0	V	5	

Clock Equivalent Circuit Constants

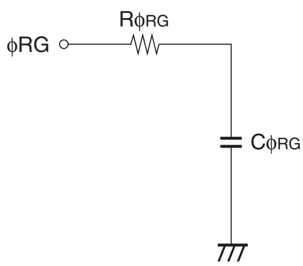
Item	Symbol	Min.	Typ.	Max.	Unit	Remarks
Capacitance between vertical transfer clock and GND	$C\phi_{V1}$, $C\phi_{V3}$		820		pF	
	$C\phi_{V2}$, $C\phi_{V4}$		680		pF	
Capacitance between vertical transfer clocks	$C\phi_{V12}$, $C\phi_{V34}$		820		pF	
	$C\phi_{V23}$, $C\phi_{V41}$		330		pF	
	$C\phi_{V13}$		120		pF	
	$C\phi_{V24}$		100		pF	
Capacitance between horizontal transfer clock and GND	$C\phi_{H1}$, $C\phi_{H2}$		56		pF	
Capacitance between horizontal transfer clocks	$C\phi_{HH}$		22		pF	
Capacitance between reset gate clock and GND	$C\phi_{RG}$		2p		F	
Capacitance between substrate clock and GND	$C\phi_{SUB}$		470		pF	
Vertical transfer clock series resistance	R_1, R_3		51		Ω	
	R_2, R_4		56		Ω	
Vertical transfer clock ground resistance	R_{GND}		68		Ω	
Horizontal transfer clock series resistance	$R\phi_H$		5.6		Ω	
Reset gate clock series resistance	$R\phi_{RG}$		39		Ω	



Vertical transfer clock equivalent circuit



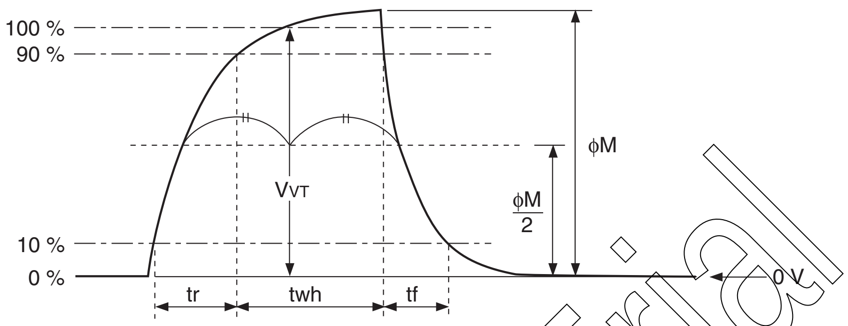
Horizontal transfer clock equivalent circuit



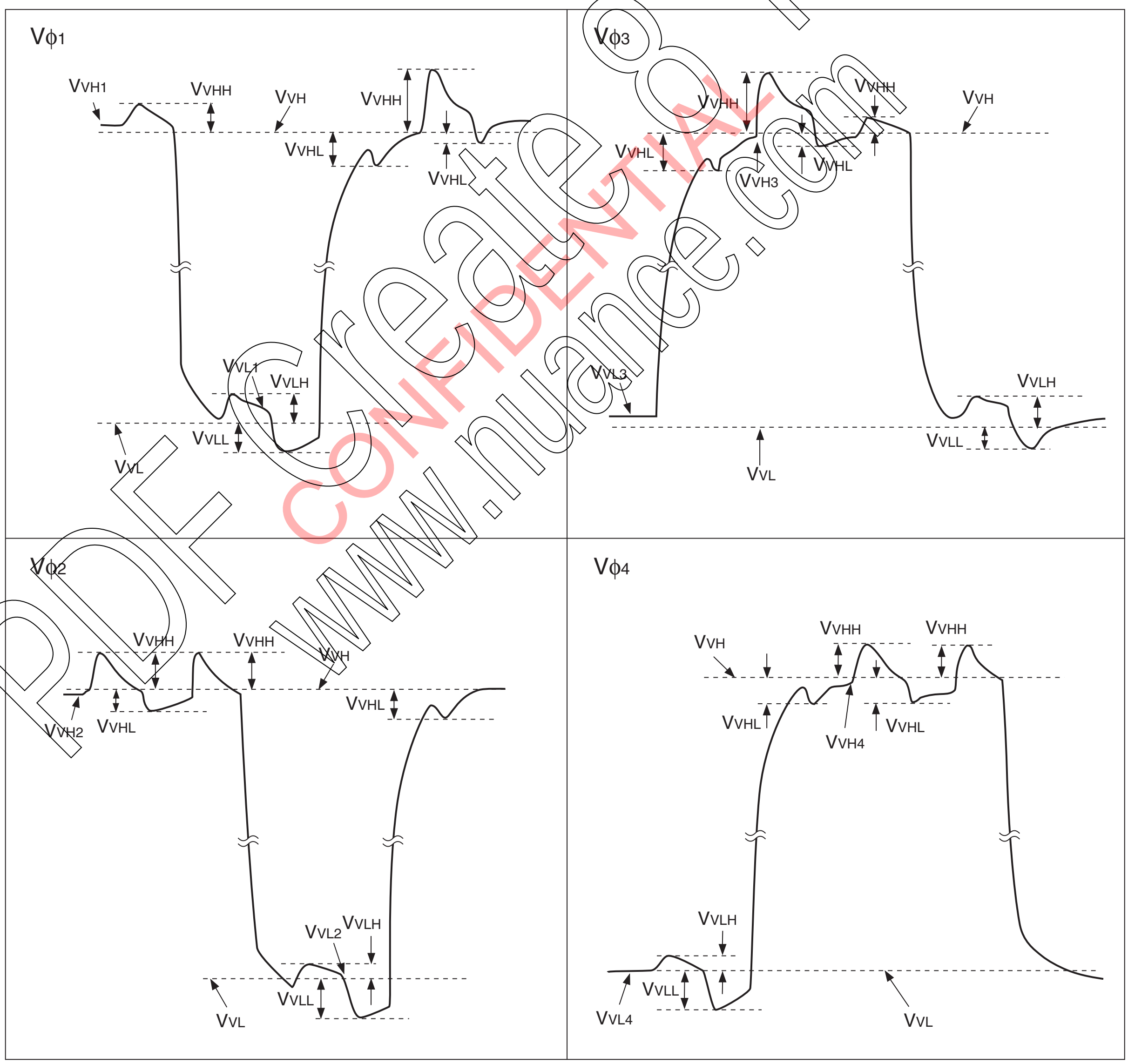
Reset gate clock equivalent circuit

Drive Clock Waveform Conditions

1. Readout clock waveform

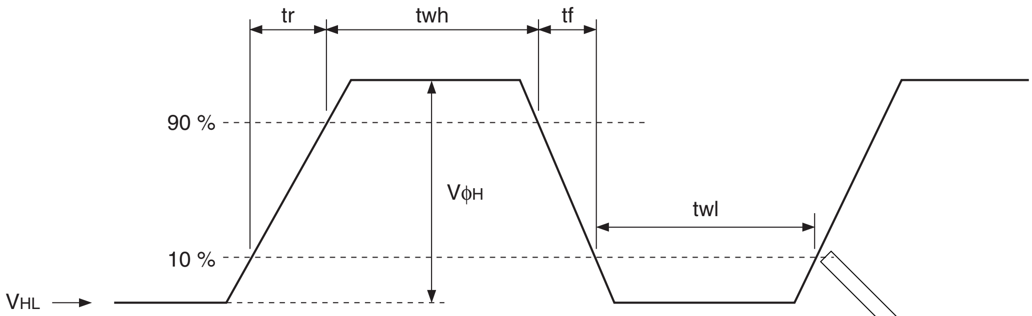


2. Vertical transfer clock waveform

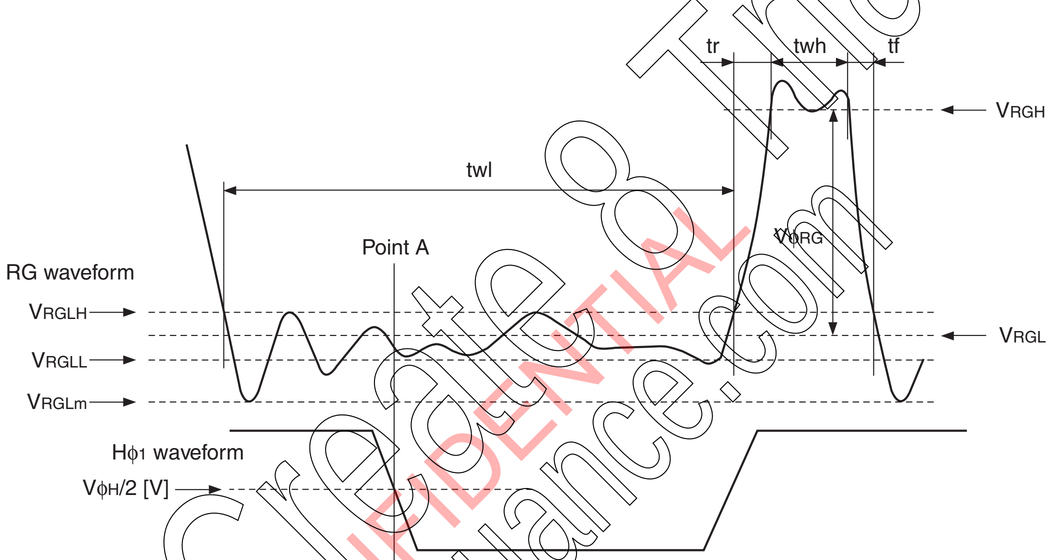


$V_{VH} = (V_{VH1} + V_{VH2})/2$
$V_{VL} = (V_{VL3} + V_{VL4})/2$
$V_{\phi V} = V_{VHn} - V_{VLn}$ (n = 1 to 4)

3. Horizontal transfer clock waveform



4. Reset gate clock waveform



V_{RGLH} is the maximum value and V_{RGLL} is the minimum value of thecoupling 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}.

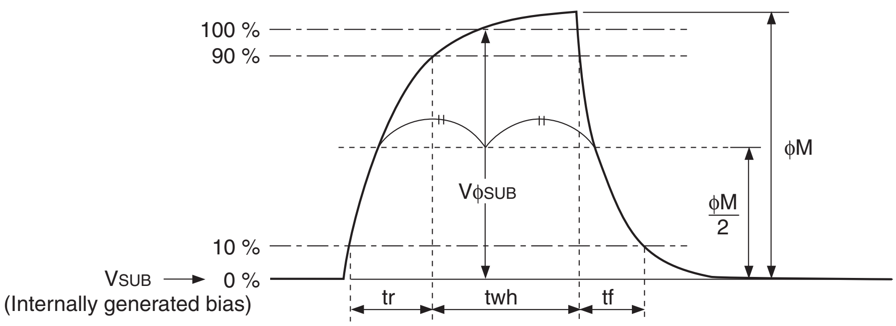
$V_{RGL} = (V_{RGLH} + V_{RGLL})/2$

V_{RGH} is the minimum value during the interval twh,

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

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

5. Substrate clock waveform



Clock Switching Characteristics

Item		Symbol	twh Min.	twh Typ.	twh Max.	twl Min.	twl Typ.	twl Max.	tr Min.	tr Typ.	tr Max.	tf Min.	tf Typ.	tf Max.	Unit	Remarks
Readout clock		V_T	2.3	2.5						0.2			0.2		µs	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 a video period	$H\phi_1$	14	19.5		14	19.5			8.5	14		8.5	14	ns	*2
		$H\phi_2$	14	19.5		14	19.5			8.5	14		8.5	14		
Reset gate clock		ϕRG	8	10			37			4			5		ns	
Substrate clock		ϕSUB	1.5	2.1							0.5			0.5	µs	When draining charge

*1 When vertical transfer clock driver CXD3400N is used.

*2 tf ≥ tr – 2 ns, and the cross-point voltage (V_{CR}) for the $H\phi_1$ rising side of the $H\phi_1$ and $H\phi_2$ waveforms must be at least $V\phi_H/2$ [V].

Item	Symbol	two Min.	two Typ.	two Max.	Unit	Remarks
Horizontal transfer clock	$H\phi_1$, $H\phi_2$	12	19.5		ns	*3

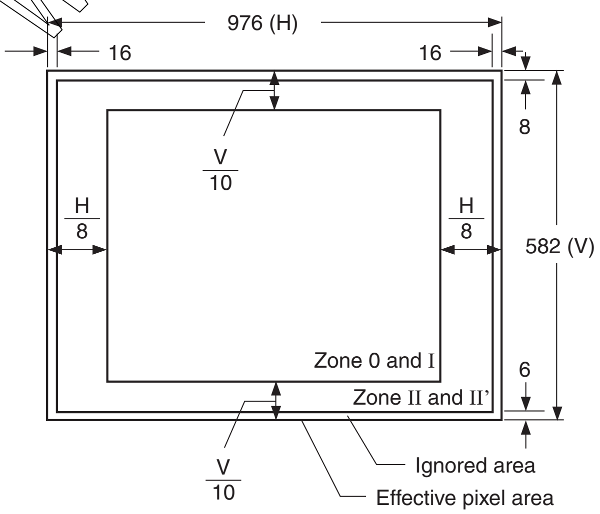
*3 "two" is the overlapped period with twh and twl of the horizontal transfer clocks $H\phi_1$ and $H\phi_2$.

Image Sensor Characteristics

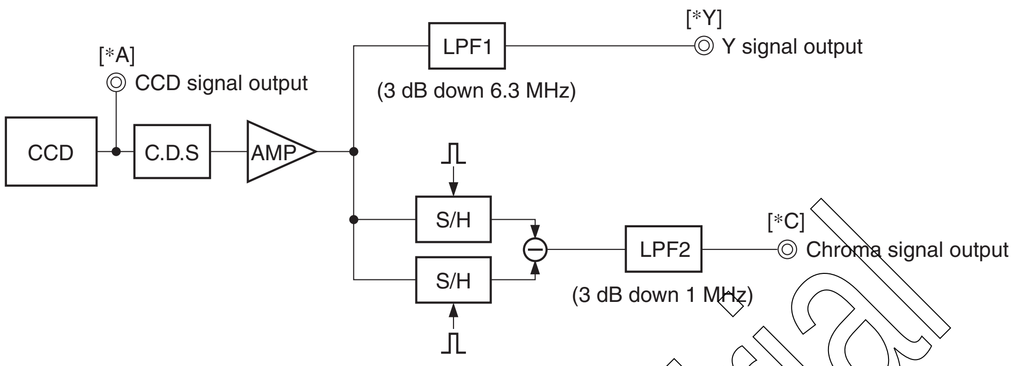
(Tj = 25 ℃)

Item	Symbol	Min.	Typ.	Max.	Unit	Measurement method	Remarks
Sensitivity	S	1880	2350		mV	1	
Sensitivity ratio	R_{MgG}	0.91		1.33		2	
	R_{YeCy}	1.19		1.52		2	
Saturation signal	Ysat	1400			mV	3	Tj = 60 ℃
Smear	Sm		–110	–100	dB	4	
Video signal shading	SHy			20	%	5	Zone 0 and zone I
				25	%	5	Zone 0, zone I, zone II and zone II’
Uniformity between video signal channels	ΔSr			10	%	6	
	ΔSb			10	%	6	
Dark signal	Ydt			2	mV	7	Tj = 60 ℃
Dark signal shading	ΔYdt			1	mV	8	Tj = 60 ℃
Flicker Y	Fy			2	%	9	
Flicker R–Y	Fcr			5	%	9	
Flicker B–Y	Fcb			5	%	9	
Line crawl R	Lcr			3	%	10	
Line crawl G	Lcg			3	%	10	
Line crawl B	Lcb			3	%	10	
Line crawl W	Lcw			3	%	10	
Lag	Lag			0.5	%	11	

Zone Definition of Video Signal Shading



Measurement System



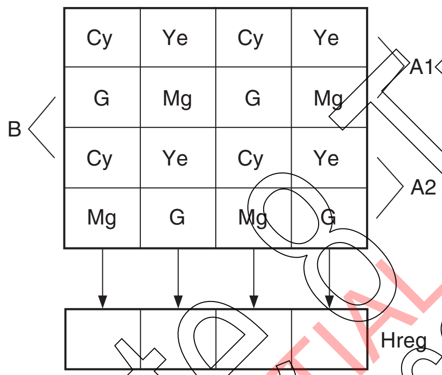
Note) Adjust the amplifier gain so that the gain between [*A] and [*Y], and between [*A] and [*C] equals 1.

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.
2. In the following measurements, spot pixels are excluded and, unless otherwise specified, the optical black (OB) level 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.

Color coding of this image sensor & Composition of luminance (Y) and chroma (color difference) signals



Color Coding Diagram

As shown in the figure above, fields are read out. The charge is mixed by pairs such as A1 and A2 in the A field (pairs such as B in the B field). As a result, the sequence of charges output as signals from the horizontal shift register (Hreg) is, for line A1, (G + Cy), (Mg + Ye), (G + Cy) and (Mg + Ye).

These signals are processed to form the Y signal and chroma (color difference) signal. The Y signal is formed by adding adjacent signals, and the chroma signal is formed by subtracting adjacent signals. In other words, the approximation:

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

is used for the Y signal, and the approximation:

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

is used for the chroma (color difference) signal. For line A2, the signals output from Hreg in sequence are

(Mg + Cy), (G + Ye), (Mg + Cy), (G + Ye)

The Y signal is formed from these signals as follows:

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

This is balanced since it is formed in the same way as for line A1.
Similarly, the chroma (color difference) signal is approximated as follows:

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

In other words, the chroma signal can be retrieved according to the sequence of lines from R – Y and –(B – Y) in alternation.
This is also true for the B field.

Definition of Standard Imaging Conditions

◆ Standard imaging condition I:
Use a pattern box (luminance: 706 cd/m^2, color temperature of 3200 K halogen source) as a subject. (Pattern for evaluation is not applicable.) Use a testing standard lens with CM500S (t = 1.0 mm) as an IR cut filter and image at F5.6. The luminous intensity to the sensor receiving surface at this point is defined as the standard sensitivity testing luminous intensity.

◆ Standard imaging condition II:
Image a light source (color temperature of 3200 K) with a uniformity of brightness within 2 % at all angles. Use a testing standard lens with CM500S (t = 1.0 mm) as an IR cut filter. The luminous intensity is adjusted to the value indicated in each testing item by the lens diaphragm.

1. Sensitivity
   Set the measurement condition to standard imaging condition I. After setting the electronic shutter mode with a shutter speed of 1/500 s, measure the Y signal (Ys) at the center of the screen, and substitute the value into the following formula.

   $$S = Ys \times (500/50)\ [mV]$$

2. Sensitivity ratio
   Set the measurement condition to standard imaging condition II. After adjusting the average value of the Y signal output to 200 mV, and then measure the Mg signal output (S_{Mg} [mV]) and G signal output (S_G [mV]), and Ye signal output (S_{Ye} [mV]) and Cy signal output (S_{Cy} [mV]) at the center of the screen with frame readout method. Substitute the values into the following formula.

   $$R_{MgG} = S_{Mg}/S_G$$
   $$R_{YeCy} = S_{Ye}/S_{Cy}$$

3. Saturation signal
   Set the measurement condition to standard imaging condition II. After adjusting the luminous intensity to 15 times the intensity with average value of the Y signal output, 200 mV, measure the minimum value of the Y signal.

4. Smear
   Set the measurement condition to standard imaging condition II. With the lens iris at F5.6 to F8, adjust the luminous intensity to 500 times the intensity with average value of the Y signal output, 200 mV. When the readout clock is stopped and the charge drain is executed by the electronic shutter at the respective H blanking, measure the maximum value (YSm [mV]) of the Y signal output, and substitute the value into the following formula.

   $$Sm = 20 \times \log\{(YSm/200) \times (1/500) \times (1/10)\}\ [dB] \quad \text{(1/10 V method conversion value)}$$

5. Video signal shading
   Set the measurement condition to standard imaging condition II. With the lens diaphragm at F5.6 to F8, adjust the luminous intensity so that the average value of the Y signal output is 200 mV.Then measure the maximum (Ymax [mV]) and minimum (Ymin [mV]) values of the Ysignal, and substitute the values into the following formula.

   $$SHy = (Ymax - Ymin)/200 \times 100\ [\%]$$

6. Uniformity between video signal channels
   Set the measurement condition to standard imaging condition II. After adjusting the average value of the Y signal output to 200 mV, measure the maximum (Crmax, Cbmax [mV]) and minimum (Crmin, Cbmin [mV]) values of the R – Y and B – Y channels of the chroma signal, and substitute the values into the following formula.

   $$\Delta Sr = |\ (Crmax - Crmin)/200\ | \times 100\ [\%]$$
   $$\Delta Sb = |\ (Cbmax - Cbmin)/200\ | \times 100\ [\%]$$

7. Dark signal
Measure the average value of the Y signal output (Ydt [mV]) based on the horizontal idle transfer level at the junction temperature of 60 °C placing the device in the light-obstructed state.

8. Dark signal shading
After measuring 7, measure the maximum (Ydmax [mV]) and minimum (Ydmin [mV]) values of the dark signal output, and substitute the values into the following formula.

$\Delta Ydt = Ydmax - Ydmin$ [mV]

9. Flicker
(1) Fy
Set the measurement condition to standard imaging condition II. After adjusting the average value of the Y signal output to 200 mV, measure the difference in the signal level between fields (ΔYf [mV]), and substitute the value into the following formula.

$Fy = (\Delta Yf/200) \times 100$ [%]

(2) Fcr, Fcb
Set the measurement condition to standard imaging condition II. After adjusting the average value of the Y signal output to 200 mV, insert an R or B filter, and measure both the difference in the signal level between fields of the chroma signal (ΔCr, ΔCb) as well as the average value of the chroma signal output (CAr, CAb). Substitute the values into the following formula.

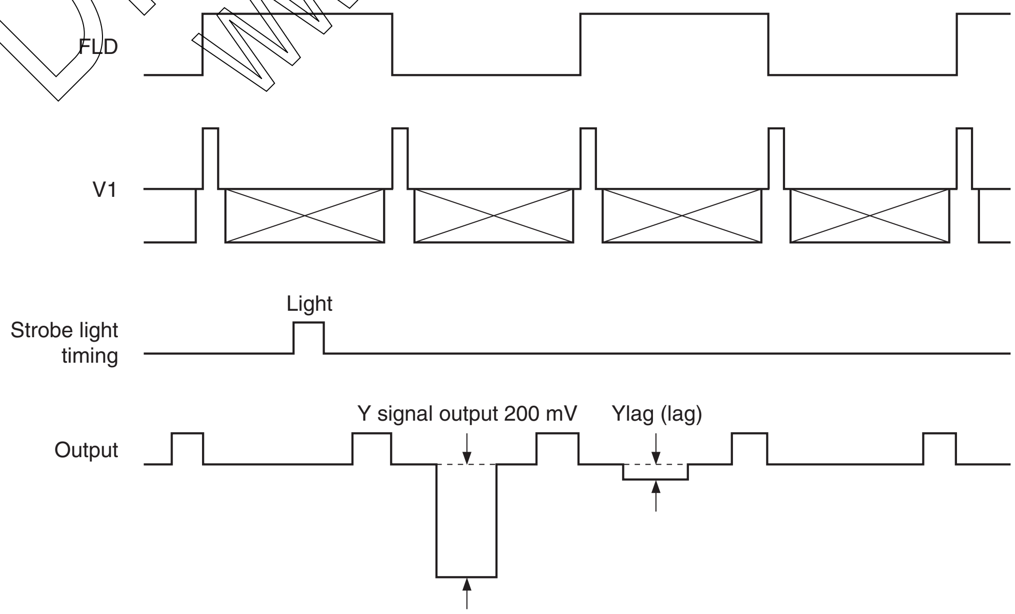
$Fci = (\Delta Ci/CAi) \times 100$ [%] (i = r, b)

10. Line crawl
Set the measurement condition to standard imaging condition II. After adjusting the average value of the Y signal output to 200 mV, insert a white subject and R, G, and B filters and measure the difference between Y signal lines for the same field (ΔYlw, ΔYlr, ΔYlg, ΔYlb [mV]). Substitute the values into the following formula.

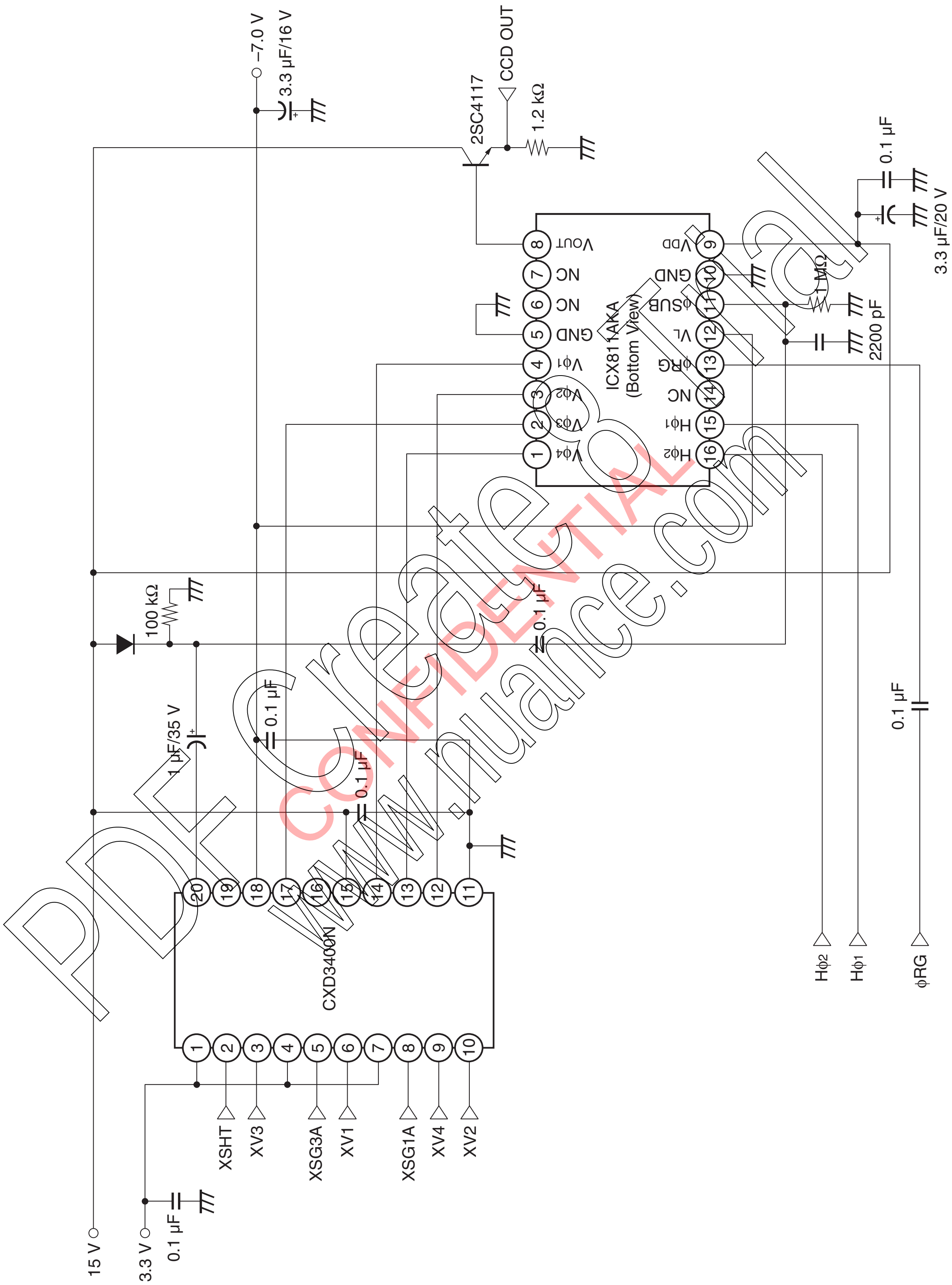
$Lci = (\Delta Yli/200) \times 100$ [%] (i = w, r, g, b)

11. Lag
Adjust the Y signal output value generated by strobe light to 200 mV. After setting the strobe light so that it strobes with the following timing, measure the residual signal level (Ylag), and substitute the value into the following formula.

$Lag = (Ylag/200) \times 100$ [%]



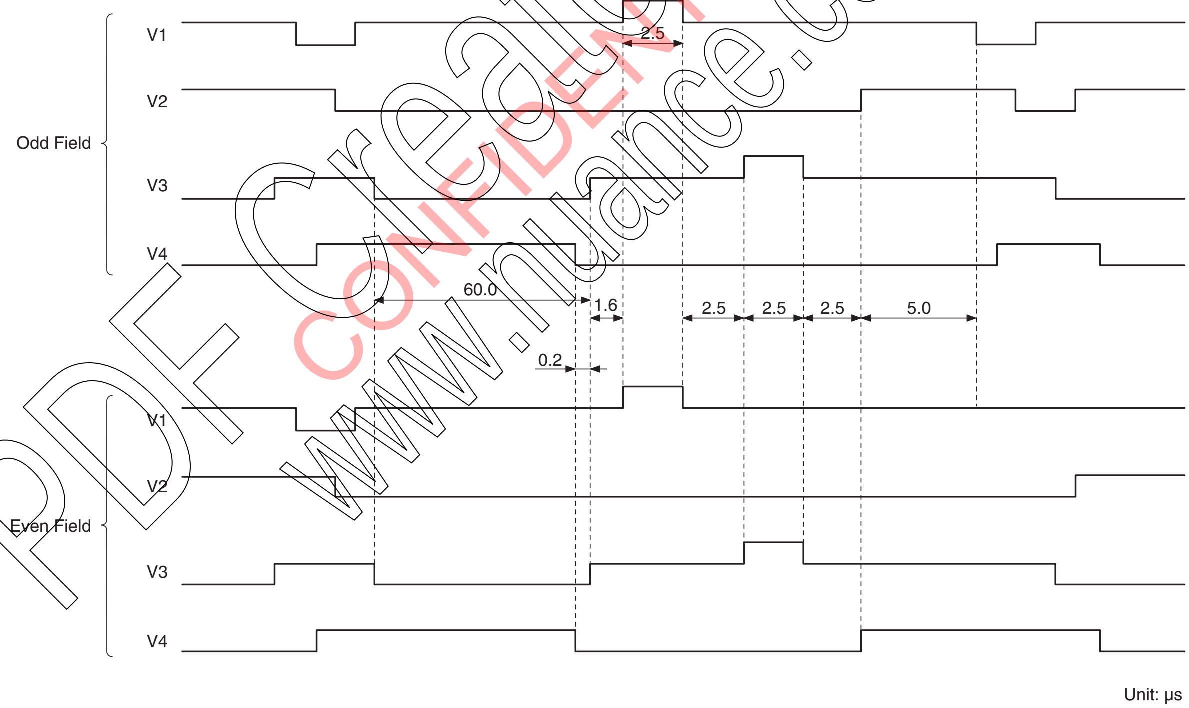
Drive Circuit



Spectral Sensitivity Characteristics

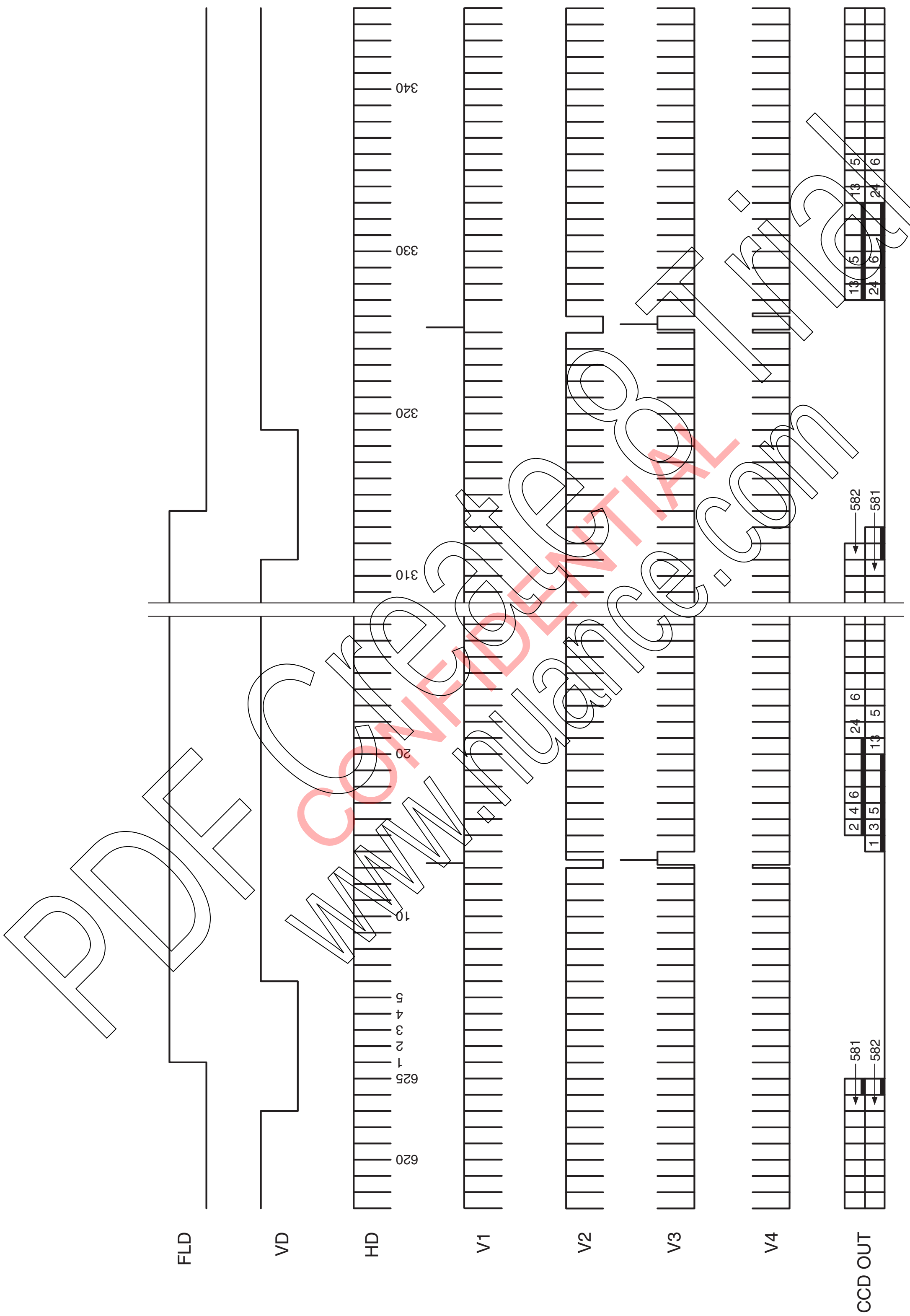
(includes lens characteristics and excludes light source characteristics)

Sensor Readout Clock Timing Chart



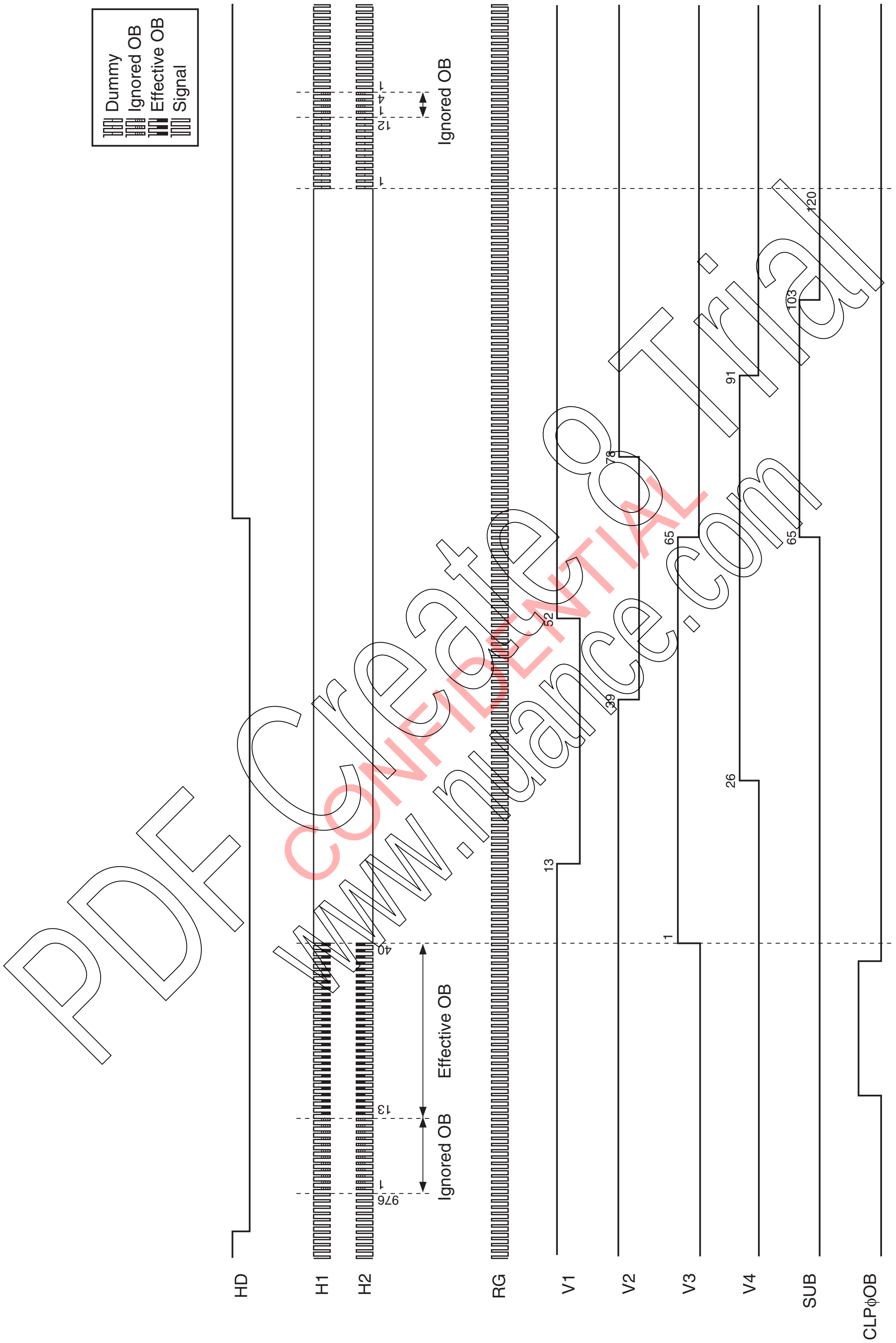
Drive Timing Chart

Vertical Sync



* During the vertical optical black period and vertical dummy bit signal output period, alias signal may occur such as smear and blooming.
If either of the above periods is to be used for image or other processing, consult your Sony representative in advance.

Horizontal Sync



* OB clamp pulse CLPϕOB are reference examples that do not take into account the system delay or other factors.
* Clamp CLPϕOB pulses in an effective OB.

Notes On Handling

1. Static charge prevention

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

(1) Either handle bare handed or use non-chargeable gloves, clothes or material.
Also use conductive shoes.

(2) Use a wrist strap when handling directly.

(3) Install grounded conductive mats on the floor and working table to prevent the generation of static electricity.

(4) Ionized air is recommended for discharge when handling image sensors.

(5) For the shipment of mounted boards, use boxes treated for the prevention of static charges.

2. Soldering

(1) Make sure the temperature of the upper surface of the seal glass resin adhesive portion of the package does not exceed 80 °C.

(2) Solder dipping in a mounting furnace causes damage to the glass and other defects.
Use a 30 W soldering iron with a ground wire and solder each pin in 2 seconds or less.
For repairs and remount, cool sufficiently.

(3) To dismount an image sensor, do not use solder suction equipment. When using a desoldering tool, use a zero-cross ON/OFF type for the temperature control system and ground the controller.

3. Protection from dust and dirt

Image sensors are packed and delivered with care taken to protect the element glass surfaces from harmful dust and dirt. Clean glass surfaces with the following operations as required before use.

(1) Perform all lens assembly and other work in a clean environment (class 1000 or less).

(2) Do not touch the glass surface with hand and make any object contact with it.
If dust or other is stuck to a glass surface, blow it off with an air blower.
(For dust stuck through static electricity, ionized air is recommended.)

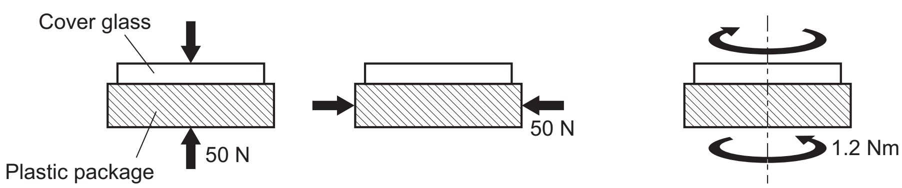
(3) Clean with a cotton swab with ethyl alcohol if grease stained. Be careful not to scratch the glass.

(4) Keep in a dedicated case to protect from dust and dirt. To prevent dew condensation, preheat or precool when moving to a room with great temperature differences.

(5) When a protective tape is applied before shipping, remove the tape applied for electrostatic protection just before use. Do not reuse the tape.

4. Installing (attaching)

(1) Remain within the following limits when applying a static load to the package. Do not apply any load more than 0.7 mm inside the outer perimeter of the glass portion, and do not apply any load or impact to limited portions. (This may cause cracks in the package.)



Compressive strength **Torsional torque**

(2) If a load is applied to the entire surface by a hard component, bending stress may be generated and the package may fracture, etc., depending on the flatness of the bottom of the package. Therefore, for installation, use either an elastic load, such as a spring plate, or an adhesive.

(3) The adhesive may cause the marking on the rear surface to disappear, especially in case the regulated voltage value is indicated on the rear surface. Therefore, the adhesive should not be applied to this area, and indicated values should be transferred to the other locations as a precaution.

(4) The notch of the package is used for directional index, and that can not be used for reference of fixing.
In addition, the cover glass and seal resin may overlap with the notch of the package.

(5) If the leads are bent repeatedly or metal, etc., clash or rub against the package surface, the package may chip or fragment and generate dust.

(6) Acrylate anaerobic adhesives are generally used to attach this product. In addition, cyanoacrylate instantaneous adhesives are sometimes used jointly with acrylate anaerobic adhesives to hold the product in place until the adhesive completely hardens. (reference)

(7) Note that the sensor may be damaged when using ultraviolet ray and infrared ray on mounting it.

5. Others

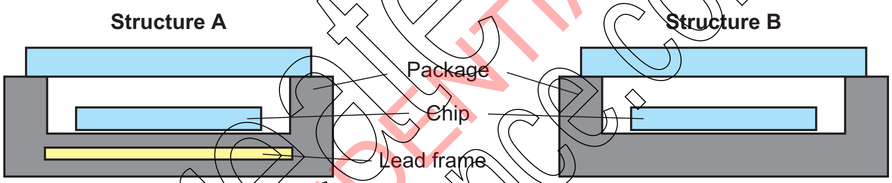
(1) Do not expose to strong light (sun rays) for long periods, as the color filters of color devices will be discolored.

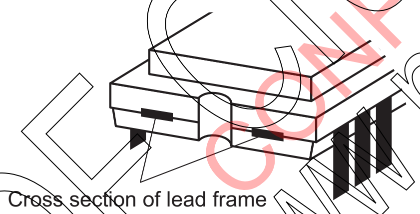
(2) Exposure to high temperature or humidity will affect the characteristics. Accordingly avoid storage or use in such conditions.

(3) Brown stains may be seen on the bottom or side of the package. But this does not affect the characteristics.

(4) This product is precision optical parts, so care should be taken not to apply excessive mechanical shocks or force.

(5) This package has 2 kinds of internal structure. However, their package outline, optical size, and strength are the same.



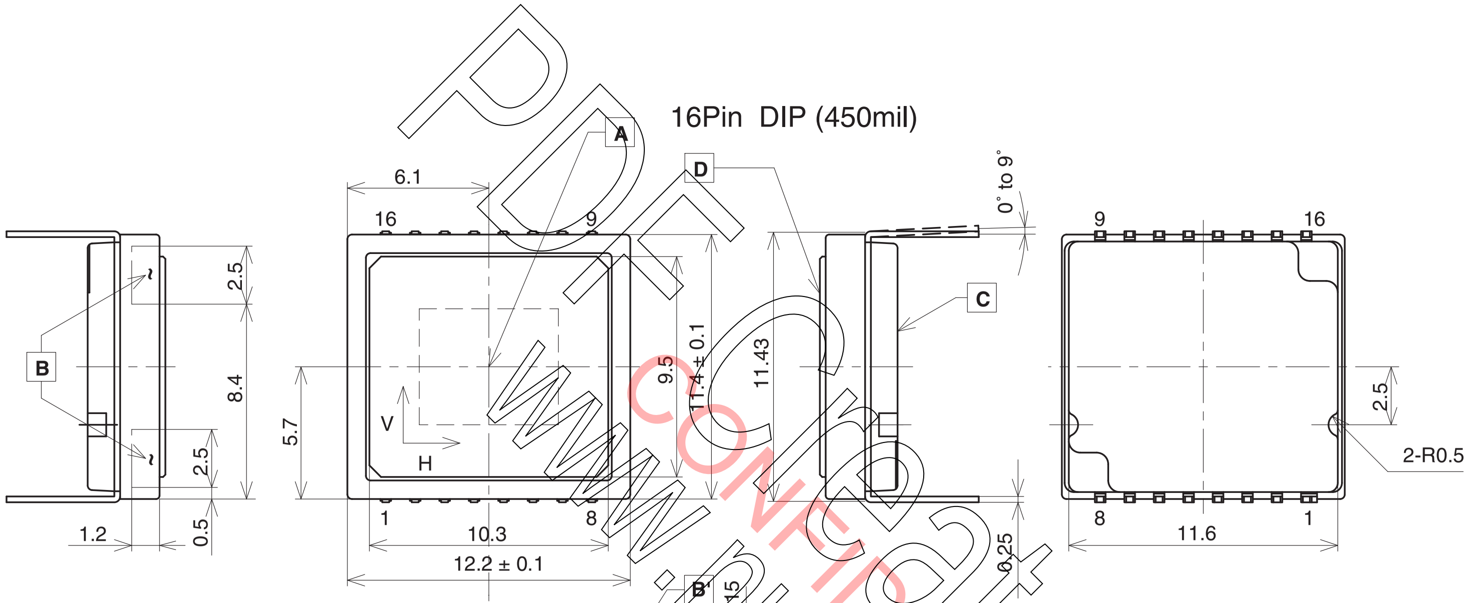


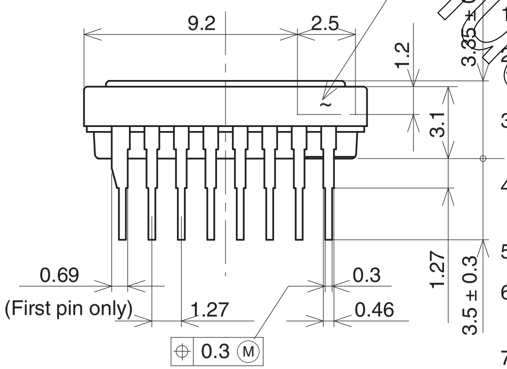
The cross section of lead frame can be seen on the side of the package for structure A.

Package Outline

(Unit: mm)

16Pin DIP (450mil)





1. "A" is the center of the effective image area.
2. The two points "B" of the package are the horizontal reference.
   The point "B'" of the package is the vertical reference.
3. The bottom "C" of the package, and the top of the cover glass "D" are the height reference.
4. The center of the effective image area relative to "B" and "B'" is (H, V) = (6.1, 5.7) ± 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 ± 0.10mm.
   The height from the top of the cover glass "D" to the effective image area is 1.94 ± 0.15mm.
7. The tilt of the effective image area relative to the bottom "C" is less than 50μm.
   The tilt of the effective image area relative to the top "D" of the cover glass is less than 50μm.-
8. The thickness of the cover glass is 0.75mm, and the refractive index is 1.5.
9. The notches on the bottom of the package are used only for directional index, they must not be used for reference of fixing.

PACKAGE STRUCTURE

PACKAGE MATERIAL	Plastic
LEAD TREATMENT	GOLD PLATING
LEAD MATERIAL	42 ALLOY
PACKAGE MASS	0.90g
DRAWING NUMBER	AS-C2-2-03(E)