SONY

ICX434AQ

Diagonal 5.68mm (Type 1/3.2) Frame Readout CCD Image Sensor with Square Pixel for Color Cameras

Description

The ICX434AQ is a diagonal 5.68mm (Type 1/3.2) interline CCD solid-state image sensor with a square pixel array and 2.02M effective pixels. Frame readout allows all pixels' signals to be output independently within approximately 1/7.5 second. Also, the adoption of high frame rate readout mode supports 30 frames per second which is four times the speed in frame readout mode. This chip features an electronic shutter with variable charge-storage time. Adoption of a design specially suited for frame readout ensures a saturation signal level equivalent to when using field readout. High resolution and high color reproductivity are achieved through the use of R, G, B primary color mosaic filters. Further, high sensitivity and low dark current are achieved through the adoption of Super HAD CCD technology.
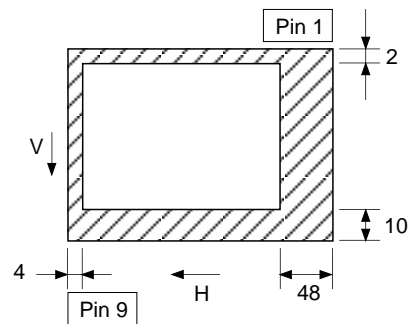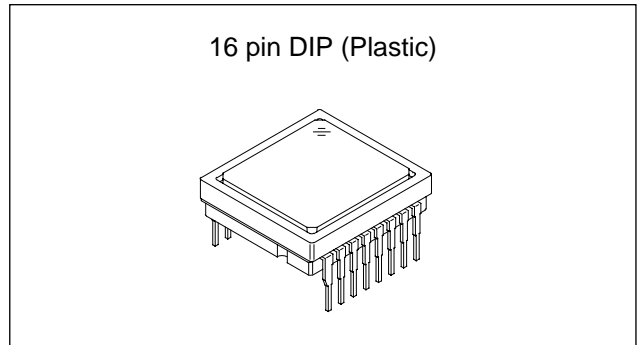
This chip is suitable for applications such as electronic still cameras, PC input cameras, etc.

Features

- Supports frame readout
- High horizontal and vertical resolution
- Supports high frame rate readout mode: 30 frames/s
- Square pixel
- Horizontal drive frequency: 18MHz
- No voltage adjustments (reset gate and substrate bias are not adjusted.)
- R, G, B primary color mosaic filters on chip
- High color reproductivity, high sensitivity, low smear
- Continuous variable-speed shutter
- Low dark current, excellent anti-blooming characteristics
- 16-pin high-precision plastic package (top/bottom dual surface reference possible)

16 pin DIP (Plastic)

Optical black position
(Top View)

Device Structure

- Interline CCD image sensor
- Image size: Diagonal 5.68mm (Type 1/3.2)
- Total number of pixels: 1688 (H) × 1248 (V) approx. 2.11M pixels
- Number of effective pixels: 1636 (H) × 1236 (V) approx. 2.02M pixels
- Number of active pixels: 1620 (H) × 1220 (V) approx. 1.98M pixels
- Chip size: 5.27mm (H) × 4.40mm (V)
- Unit cell size: 2.8μm (H) × 2.8μm (V)
- Optical black: Horizontal (H) direction: Front 4 pixels, rear 48 pixels
                                    Vertical (V) direction: Front 10 pixels, rear 2 pixels
- Number of dummy bits: Horizontal 28
                                    Vertical 1 (even fields only)
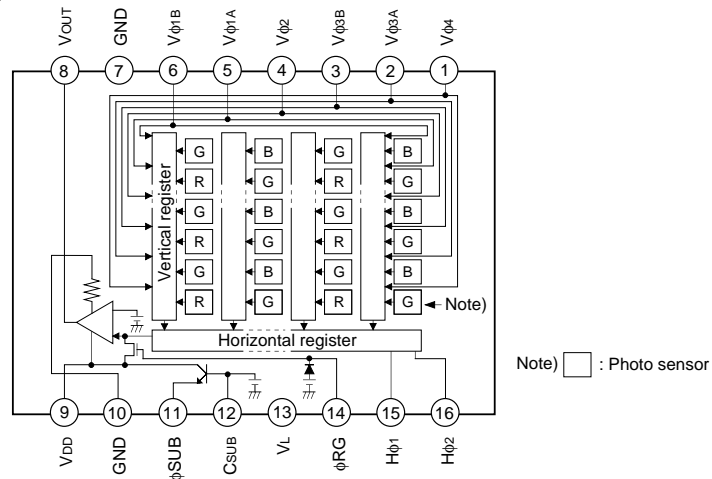- Substrate material: Silicon

Super **HAD CCD** ™

E01825

Block Diagram and Pin Configuration

(Top View)

Note) ☐ : Photo sensor

Pin Description

Pin No.	Symbol	Description	Pin No.	Symbol	Description
1	$V\phi_4$	Vertical register transfer clock	9	V_{DD}	Supply voltage
2	$V\phi_{3A}$	Vertical register transfer clock	10	GND	GND
3	$V\phi_{3B}$	Vertical register transfer clock	11	ϕSUB	Substrate clock
4	$V\phi_2$	Vertical register transfer clock	12	C_{SUB}	Substrate bias[*1]
5	$V\phi_{1A}$	Vertical register transfer clock	13	V_L	Protective transistor bias
6	$V\phi_{1B}$	Vertical register transfer clock	14	ϕRG	Reset gate clock
7	GND	GND	15	$H\phi_1$	Horizontal register transfer clock
8	V_{OUT}	Signal output	16	$H\phi_2$	Horizontal register transfer clock

[*1] DC bias is generated within the CCD, so that this pin should be grounded externally through a capacitance of 0.1µF.

Absolute Maximum Ratings

Item		Ratings	Unit	Remarks
Against ϕSUB	V_{DD}, V_{OUT}, ϕRG – ϕSUB	–40 to +12	V	
	$V\phi_{1A}$, $V\phi_{1B}$, $V\phi_{3A}$, $V\phi_{3B}$ – ϕSUB	–50 to +15	V	
	$V\phi_2$, $V\phi_4$, V_L – ϕSUB	–50 to +0.3	V	
	$H\phi_1$, $H\phi_2$, GND – ϕSUB	–40 to +0.3	V	
	C_{SUB} – ϕSUB	–25 to	V	
Against GND	V_{DD}, V_{OUT}, ϕRG, C_{SUB} – GND	–0.3 to +22	V	
	$V\phi_{1A}$, $V\phi_{1B}$, $V\phi_2$, $V\phi_{3A}$, $V\phi_{3B}$, $V\phi_4$ – GND	–10 to +18	V	
	$H\phi_1$, $H\phi_2$ – GND	–10 to +6.5	V	
Against V_L	$V\phi_{1A}$, $V\phi_{1B}$, $V\phi_{3A}$, $V\phi_{3B}$ – V_L	–0.3 to +28	V	
	$V\phi_2$, $V\phi_4$, $H\phi_1$, $H\phi_2$, GND – V_L	–0.3 to +15	V	
Between input clock pins	Voltage difference between vertical clock input pins	to +15	V	[*2]
	$H\phi_1$ – $H\phi_2$	–6.5 to +6.5	V	
	$H\phi_1$, $H\phi_2$ – $V\phi_4$	–10 to +16	V	
Storage temperature		–30 to +80	°C	
Guaranteed temperature of performance		–10 to +60	°C	
Operating temperature		–10 to +75	°C	

[*2] +24V (Max.) when clock width < 10µs, clock duty factor < 0.1%.

+16V (Max.) is guaranteed for turning on or off power supply.

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 V_L setting is the V_{VL} voltage of the vertical transfer clock waveform, or the same voltage as the V_L power supply for the V driver should be used.

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

DC Characteristics

Item	Symbol	Min.	Typ.	Max.	Unit	Remarks
Supply current	I_{DD}		6.5		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}	−8.0	−7.5	−7.0	V	2	$V_{VL} = (V_{VL3} + V_{VL4})/2$
	$V\phi V$	6.8	7.5	8.05	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}			0.5	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	$V\phi H$	3.0	3.3	3.6	V	3	
	V_{HL}	−0.05	0	0.05	V	3	
	V_{CR}	0.5	1.65		V	3	Cross-point voltage
Reset gate clock voltage	$V\phi RG$	3.0	3.3	3.6	V	4	
	$V_{RGLH} − V_{RGLL}$			0.4	V	4	Low-level coupling
	$V_{RGL} − V_{RGLm}$			0.5	V	4	Low-level coupling
Substrate clock voltage	$V\phi SUB$	21.5	22.5	23.5	V	5	

Clock Equivalent Circuit Constant

| Item	Symbol	Min.	Typ.	Max.	Unit	Remarks
Capacitance between vertical transfer clock and GND	CϕV1A, CϕV3A		680		pF	
	CϕV1B, CϕV3B		1500		pF	
	CϕV2, CϕV4		1500		pF	
Capacitance between vertical transfer clocks	CϕV1A2, CϕV3A4		100		pF	
	CϕV1B2, CϕV3B4		220		pF	
	CϕV23A, CϕV41A		30		pF	
	CϕV23B, CϕV41B		56		pF	
	CϕV1A3A		12		pF	
	CϕV1B3B		82		pF	
	CϕV1A3B, CϕV1B3A		39		pF	
	CϕV24		100		pF	
	CϕV1A1B, CϕV3A3B		30		pF	
Capacitance between horizontal transfer clock and GND	CϕH1		30		pF	
	CϕH2		30		pF	
Capacitance between horizontal transfer clocks	CϕHH		56		pF	
Capacitance between reset gate clock and GND	CϕRG		5		pF	
Capacitance between substrate clock and GND	CϕSUB		470		pF	
Vertical transfer clock series resistor	R_{1A}, R_{3A}		270		Ω	
	R_{1B}, R_{3B}		110		Ω	
	R_2, R_4		56		Ω	
Vertical transfer clock ground resistor	R_{GND}		10		Ω	
Horizontal transfer clock series resistor	RϕH		15		Ω	
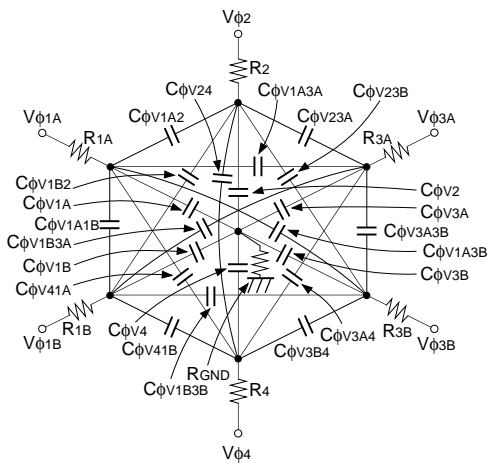
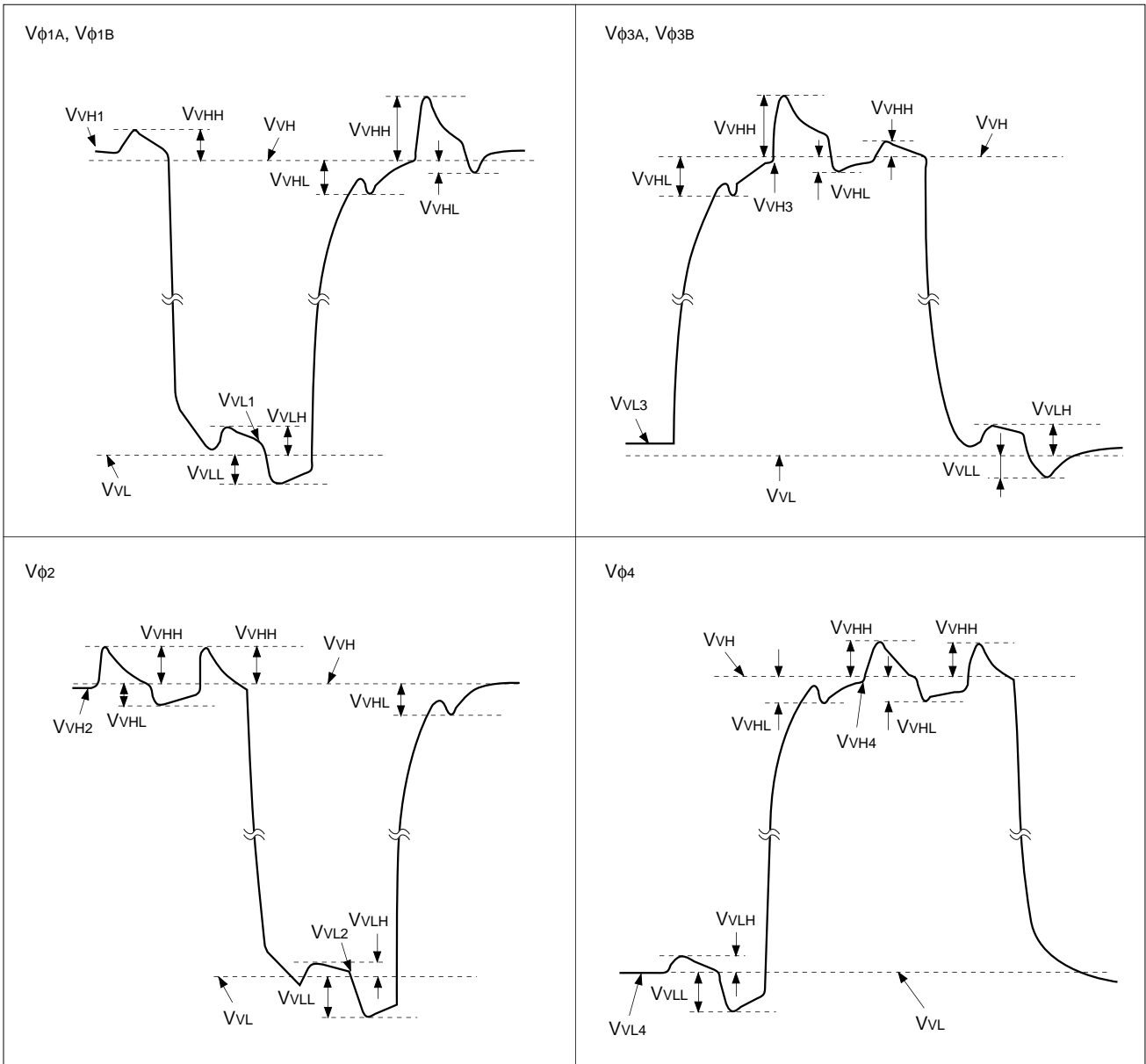**Vertical transfer clock equivalent circuit**

Horizontal transfer clock equivalent circuit

– 4 –
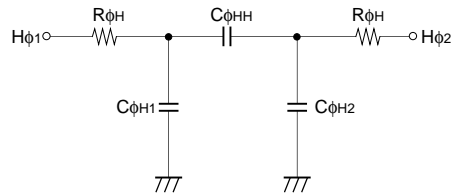
Drive Clock Waveform Conditions

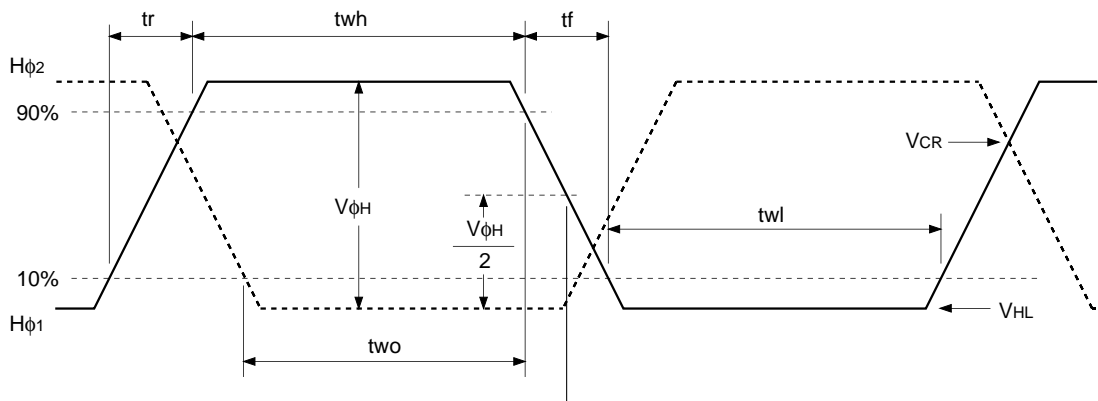### (1) Readout clock waveform
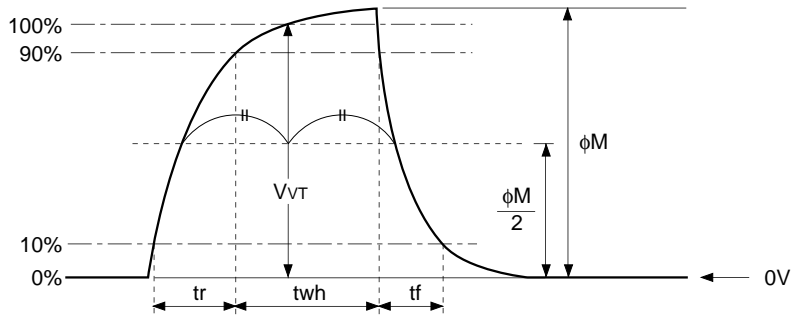
(2) Vertical transfer clock waveform

$V_{VH} = (V_{VH1} + V_{VH2})/2$
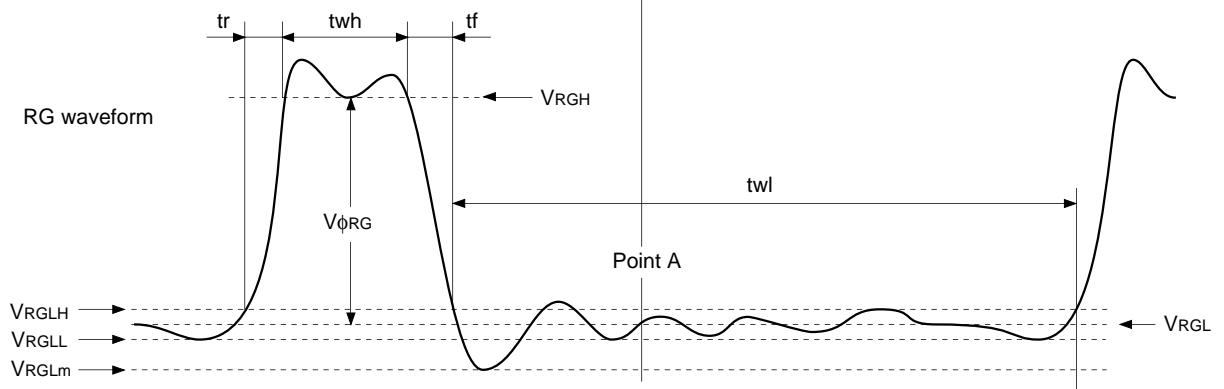
$V_{VL} = (V_{VL3} + V_{VL4})/2$

$V_{\phi V} = V_{VHn} - V_{VLn}$ (n = 1 to 4)

(3) Horizontal transfer clock waveform

Cross-point voltage for the Hϕ1 rising side of the horizontal transfer clocks Hϕ1 and Hϕ2 waveforms is V$_{CR}$.
The overlap period for twh and twl of horizontal transfer clocks Hϕ1 and Hϕ2 is two.

(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.

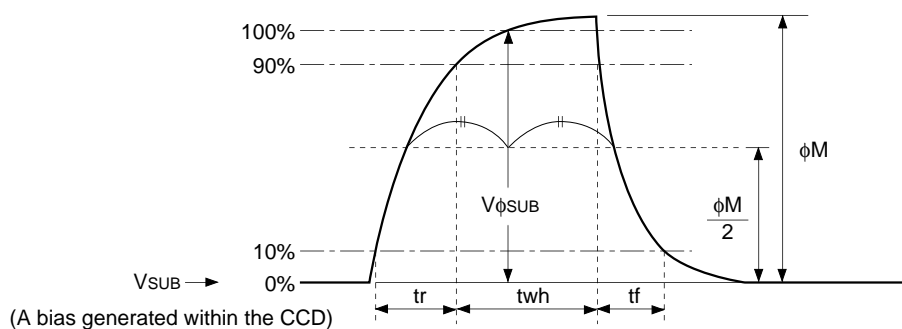In addition, V$_{RGL}$ is the average value of V$_{RGLH}$ and V$_{RGLL}$.

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

Assuming V$_{RGH}$ is the minimum value during the interval twh, 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 (Horizontal drive frequency:18MHz)

Item		Symbol	twh			twl			tr			tf			Unit	Remarks
			Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.		
Readout clock		Vт	1.36	1.56						0.5			0.5		µs	During readout
Vertical transfer clock		Vφ1A, Vφ1B, Vφ2, Vφ3A, Vφ3B, Vφ4							15					250	ns	When using CXD1267AN
Horizontal transfer clock	During imaging	Hφ1	14	19.5		14	19.5			8.5	14		8.5	14	ns	tf ≥ tr – 2ns
		Hφ2	14	19.5		14	19.5			8.5	14		8.5	14		
	During parallel-serial conversion	Hφ1		5.56						0.01			0.01		µs	
		Hφ2					5.56			0.01			0.01			
Reset gate clock		φRG	7	10			37			4			5		ns	
Substrate clock		φSUB	1.7	3.6							0.5			0.5	µs	During drain charge

Item	Symbol	two			Unit	Remarks
		Min.	Typ.	Max.		
Horizontal transfer clock	Hφ1, Hφ2	12	19.5		ns	

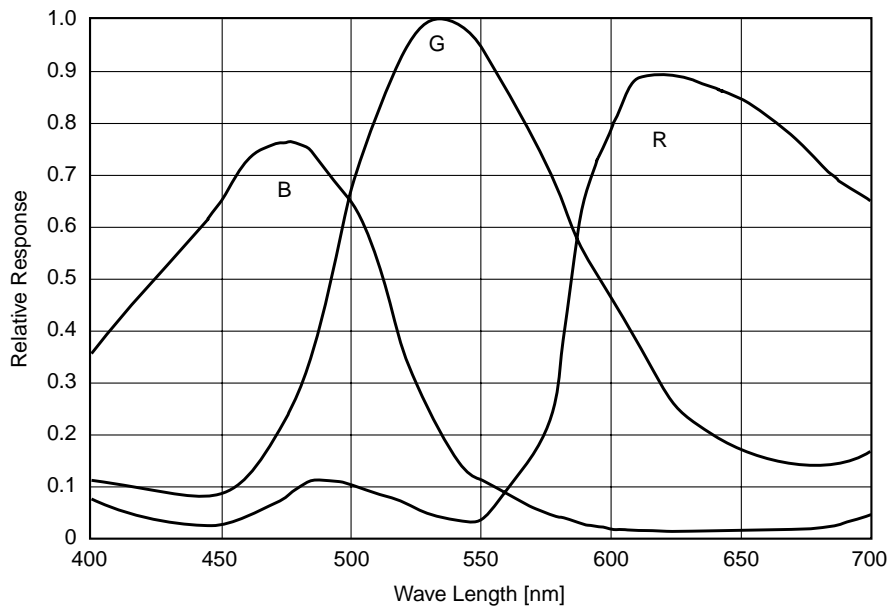## Spectral Sensitivity Characteristics (excludes lens characteristics and light source characteristics)


– 7 –

Image Sensor Characteristics (Ta = 25°C)

| Item		Symbol	Min.	Typ.	Max.	Unit	Measurement method	Remarks
G sensitivity		Sg	200	250		mV	1	1/30s accumulation
Sensitivity comparison	R	Rr	0.46		0.72		1	
	B	Rb	0.33		0.59		1	
Saturation signal		Vsat	420			mV	2	Ta = 60°C
Smear		Sm		−86	−76	dB	3	Frame readout mode*1
				−74	−64			High frame rate readout mode
Video signal shading		SHg			20	%	4	Zone 0 and I
					25	%	4	Zone 0 to II'
Dark signal		Vdt			8	mV	5	Ta = 60°C, 15 frame/s
Dark signal shading		ΔVdt			4	mV	6	Ta = 60°C, 15 frame/s,*2
Line crawl G		Lcg			3.8	%	7	
Line crawl R		Lcr			3.8	%	7	
Line crawl B		Lcb			3.8	%	7	
Lag		Lag			0.5	%	8	

*1 After closing the mechanical shutter, the smear can be reduced to below the detection limit by performing vertical register sweep operation.

*2 Excludes vertical dark signal shading caused by vertical register high-speed transfer.
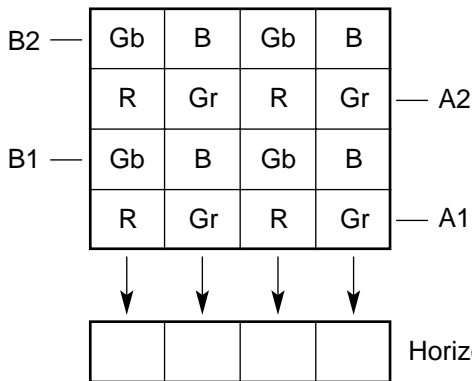
Zone Definition of Video Signal Shading
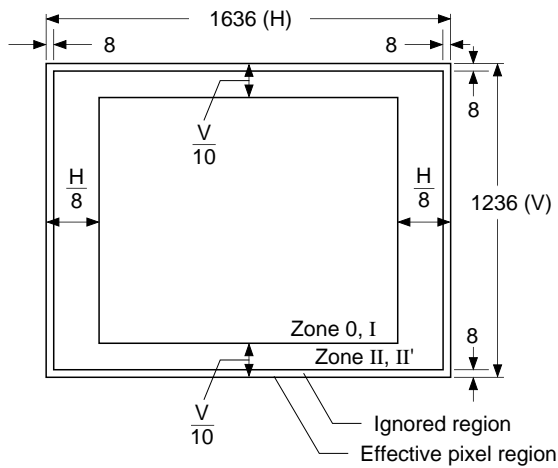
Measurement System
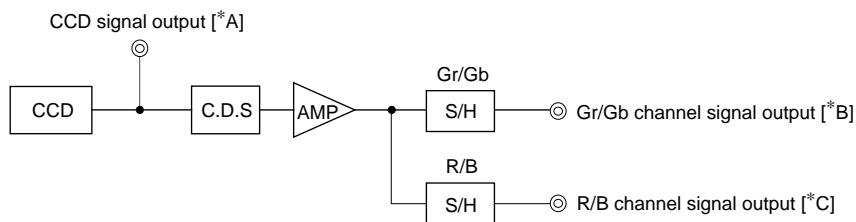
Note) Adjust the amplifier gain so that the gain between [*A] and [*B], and between [*A] and [*C] equals 1.

Image Sensor Characteristics Measurement Method

◎ **Color coding of this image sensor & Readout**

Gb	B	Gb	B
R	Gr	R	Gr
Gb	B	Gb	B
R	Gr	R	Gr

The primary color filters of this image sensor are arranged in the layout shown in the figure on the left (Bayer arrangement).
Gr and Gb denote the G signals on the same line as the R signal and the B signal, respectively.
For frame readout, the A1 and A2 lines are output as signals in the A field, and the B1 and B2 lines in the B field.

Color Coding Diagram

◎ **Readout modes**

The diagram below shows the output methods for the following two readout modes.

Frame readout mode		High frame rate readout mode
1st field	2nd field	
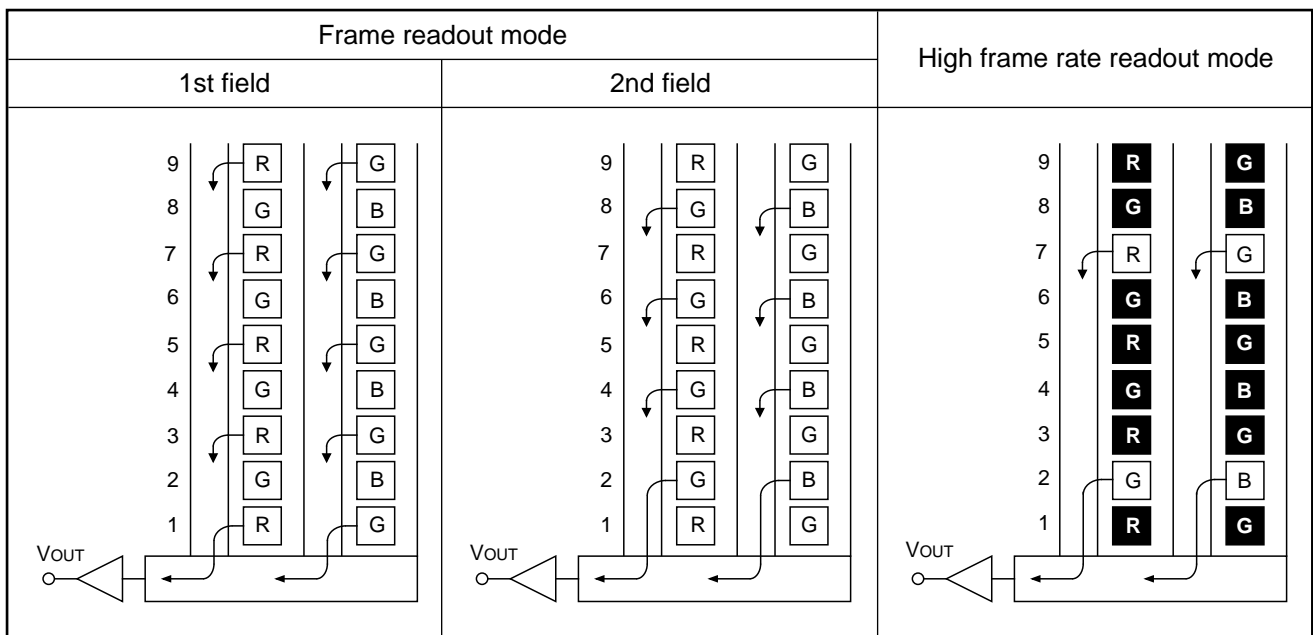
Note) Blacked out portions in the diagram indicate pixels which are not read out.
Output starts from the line 2 in high frame rate readout mode

1. Frame readout mode
   In this mode, all pixel signals are divided into two fields and output.
   All pixel signals are read out independently, making this mode suitable for high resolution image capturing.

2. High frame rate readout mode
   All effective area signals are output in 1/4 the period for frame readout mode by reading out two lines for every eight lines. The number of output lines is 309 lines.
   This readout mode emphasizes processing speed over vertical resolution.

◎ **Measurement conditions**

1) In the following measurements, the device drive conditions are at the typical values of the bias and clock voltage conditions, and the frame readout mode is used.

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 the Gr/Gb channel signal output or the R/B channel signal output of the measurement system.

◎ **Definition of standard imaging conditions**

1) Standard imaging condition I:
Use a pattern box (luminance: 706cd/m^2, color temperature of 3200K halogen source) as a subject. (Pattern for evaluation is not applicable.) Use a testing standard lens with CM500S (t = 1.0mm) 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.

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

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 (exit pupil distance –33mm) with CM500S (t = 1.0mm) as an IR cut filter. The luminous intensity is adjusted to the value indicated in each testing item by the lens diaphragm.

1. G sensitivity, sensitivity comparison
Set to standard imaging condition I. After selecting the electronic shutter mode with a shutter speed of 1/100s, measure the signal outputs (V_{Gr}, V_{Gb}, V_R and V_B) at the center of each Gr, Gb, R and B channel screen, and substitute the values into the following formulas.

$V_G = (V_{Gr} + V_{Gb})/2$
$Sg = V_G \times 100/30$ [mV]
$Rr = V_R/V_G$
$Rb = V_B/V_G$

2. Saturation signal
Set to standard imaging condition II. After adjusting the luminous intensity to 20 times the intensity with the average value of the Gr signal output, 150mV, measure the minimum values of the Gr, Gb, R and B signal outputs.

3. Smear
Set to standard imaging condition II. With the lens diaphragm at F5.6 to F8, first adjust the average value of the Gr signal output to 150mV. Measure the average values of the Gr signal output, Gb signal output, R signal output and B signal output (Gra, Gba, Ra, Ba), and then adjust the luminous intensity to 500 times the intensity with the average value of the Gr signal output, 150mV. After the readout clock is stopped and the charge drain is executed by the electronic shutter at the respective H blankings, measure the maximum value (V_{sm} [mV]) independent of the Gr, Gb, R and B signal outputs, and substitute the values into the following formula.

$$Sm = 20 \times \log \left(Vsm \div \frac{Gra + Gba + Ra + Ba}{4} \times \frac{1}{500} \times \frac{1}{10} \right) \text{ [dB] (1/10V method conversion value)}$$

– 10 –

4. 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 Gr signal output is 150mV. Then measure the maximum (Grmax [mV]) and minimum (Grmin [mV]) values of the Gr signal output and substitute the values into the following formula.

$$SHg = (Grmax - Grmin)/150 \times 100 \ [\%]$$

5. 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.

6. Dark signal shading

After measuring 5, measure the maximum (Vdmax [mV]) and minimum (Vdmin [mV]) values of the dark signal output and substitute the values into the following formula.

$$\Delta Vdt = Vdmax - Vdmin \ [mV]$$

7. Line crawl

Set to standard imaging condition II. Adjusting the luminous intensity so that the average value of the Gr signal output is 150mV, and then insert R, G and B filters and measure the difference between G signal lines (ΔGlr, ΔGlg, ΔGlb [mV]) as well as the average value of the G signal output (Gar, Gag, Gab). Substitute the values into the following formula.

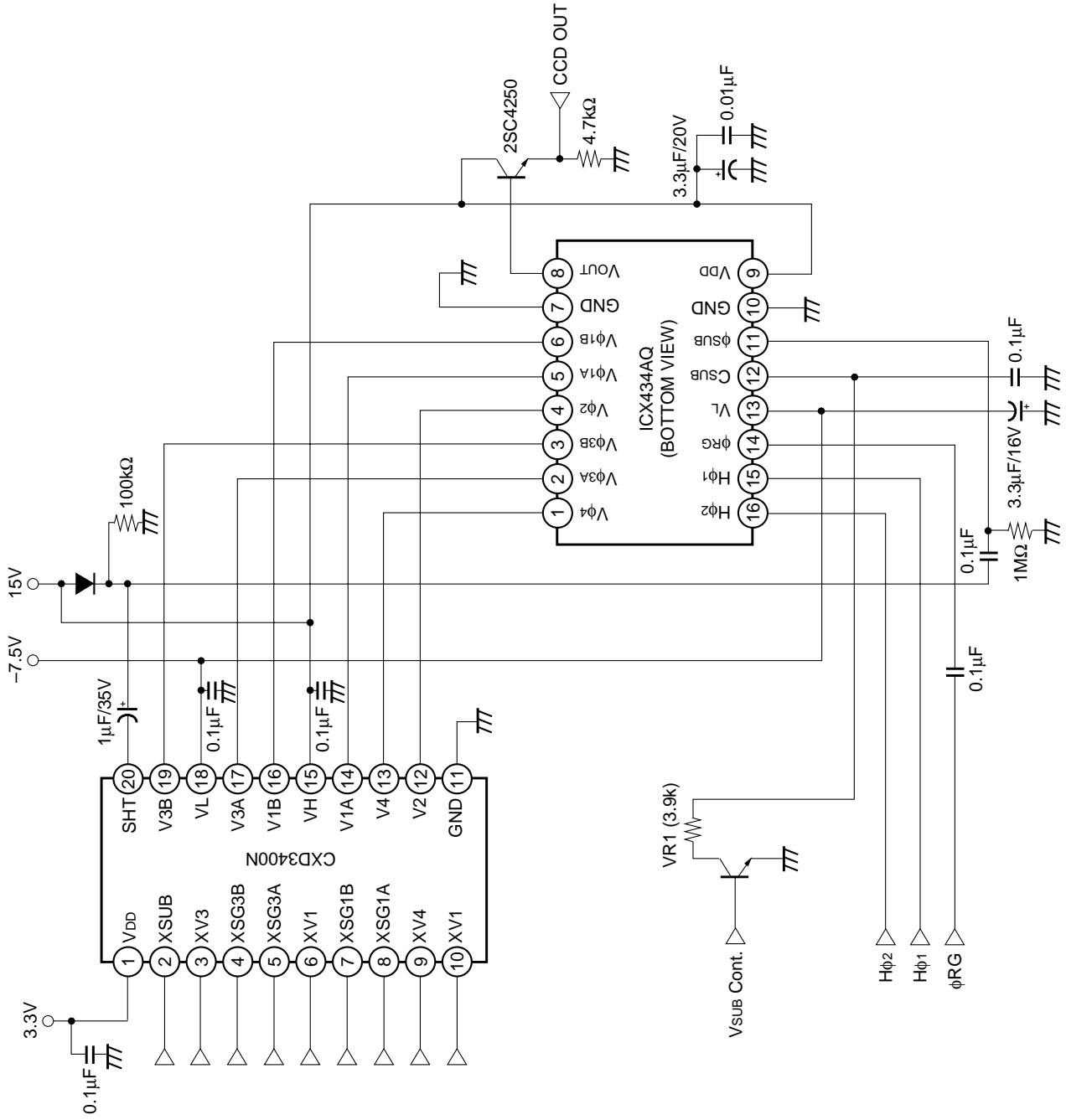$$Lci = \Delta Gli/Gai \times 100 \ [\%] \ (i = r, g, b)$$

8. Lag

Adjust the Gr signal output value generated by strobe light to 150mV. After setting the strobe light so that it strobes with the following timing, measure the residual signal (Vlag). Substitute the value into the following formula.
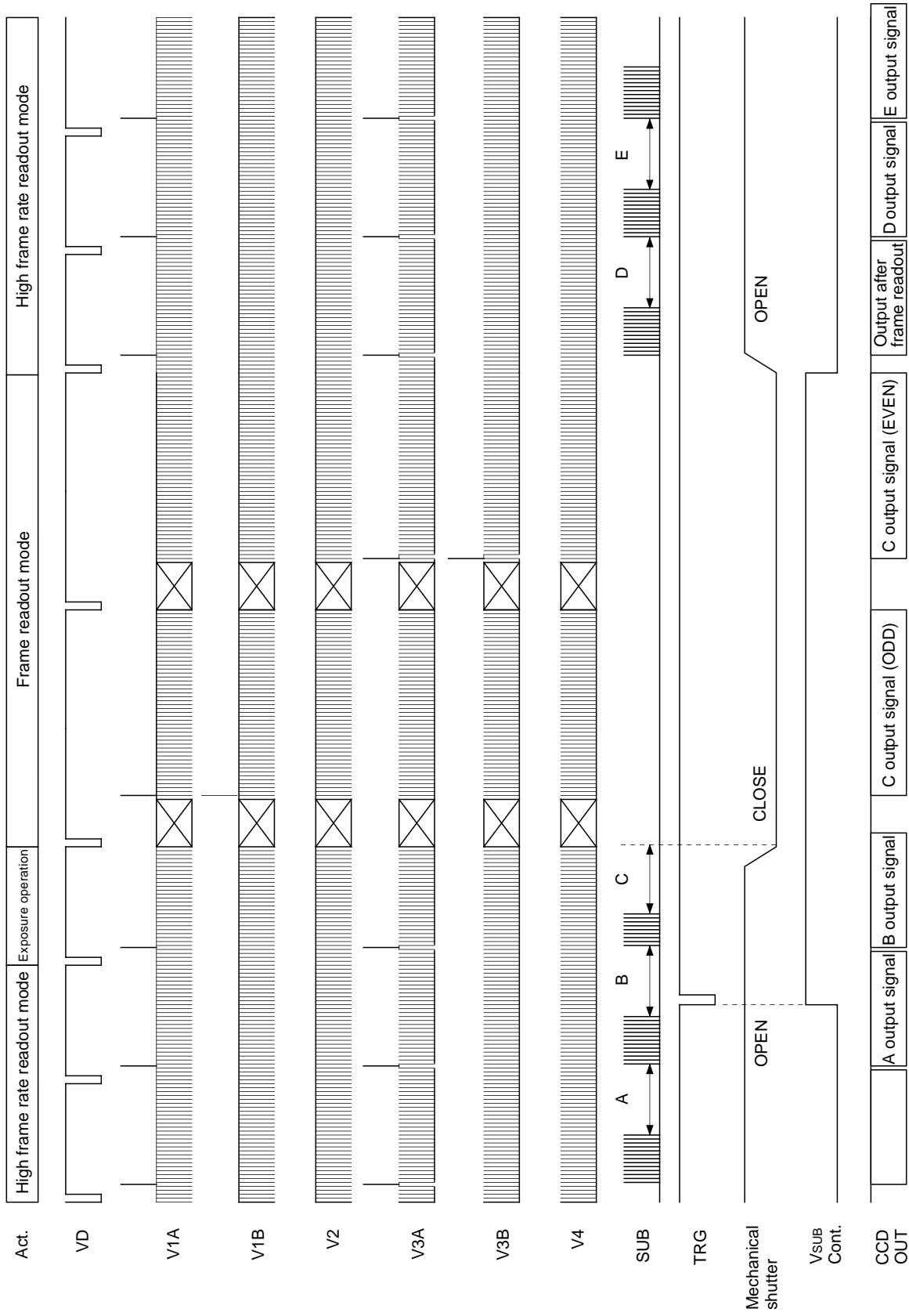
$$Lag = (Vlag/150) \times 100 \ [\%]$$
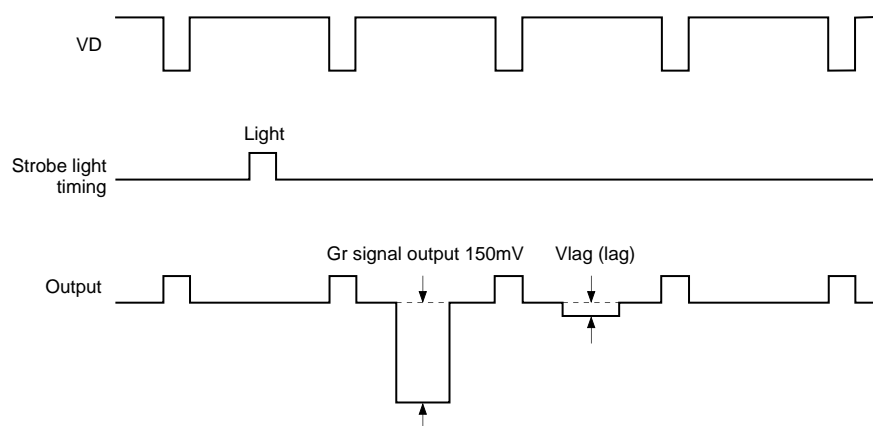
Drive Circuit

Drive Timing Chart (Vertical Sequence) High Frame Rate Readout Mode → Frame Readout Mode/Electronic Shutter

Note) The B output signal contains a blooming component and should therefore not be used.

Drive Timing Chart (Vertical Sync) Frame Readout Mode
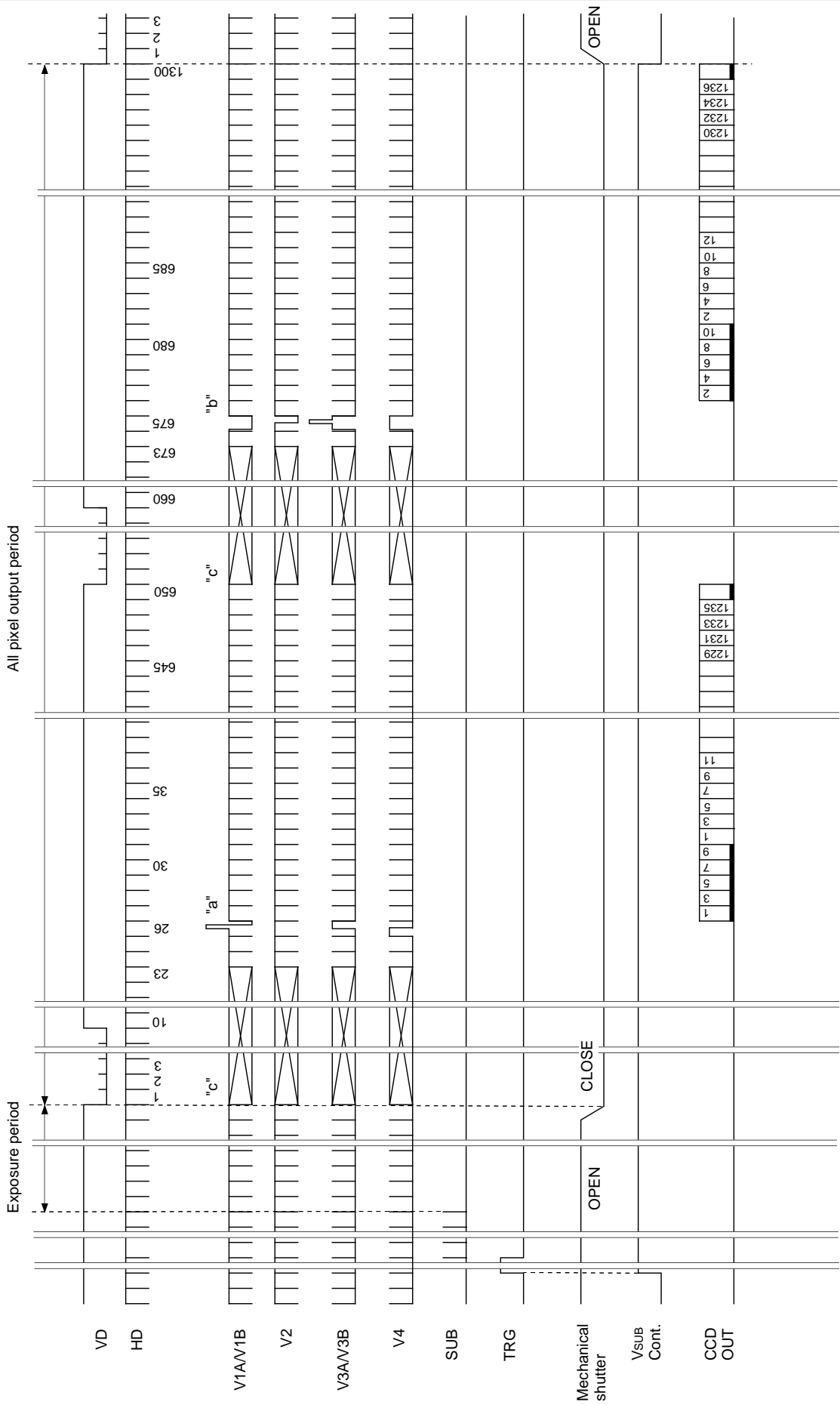
Exposure period

All pixel output period

VD

HD

V1A/V1B

V2

V3A/V3B

V4

SUB

TRG

Mechanical shutter

Vsub Cont.

CCD OUT

OPEN

CLOSE

OPEN

"a"

"b"

"c"

Drive Timing Chart (Vertical Sync) Frame Readout Mode

Drive Timing Chart (Vertical Sync) Frame Readout Mode

"c" Enlarged

Drive Timing Chart (Vertical Sync) High Frame Rate Readout Mode

VD
HD
V1A
V1B
V2
V3A
V3B
V4
CCD
OUT

"p"

320
325
1
2
3
4
5
10
15
18
20

1218
1223
1226
1231
1234

4
6
2
7
10
15
18
23
26
31
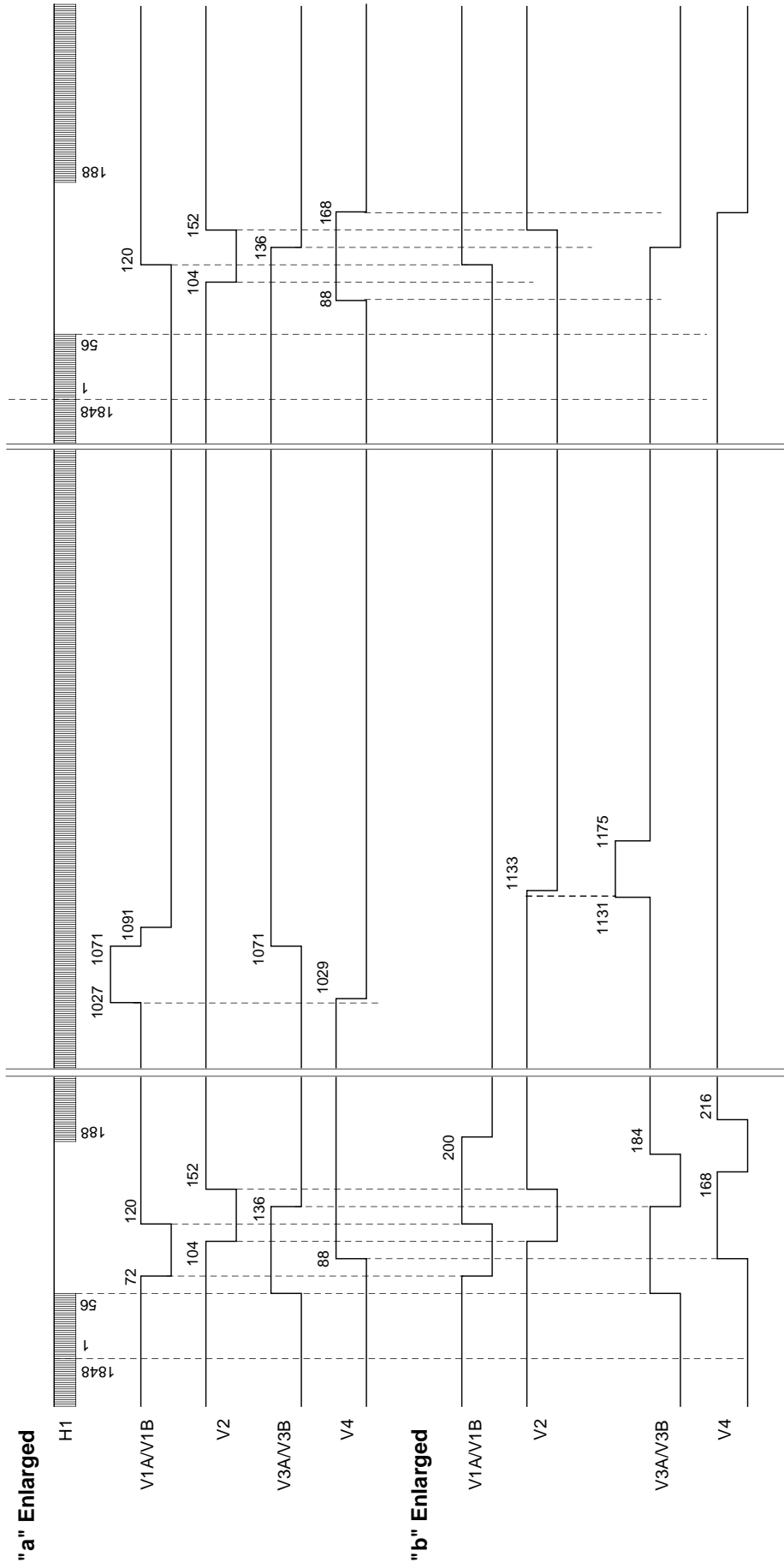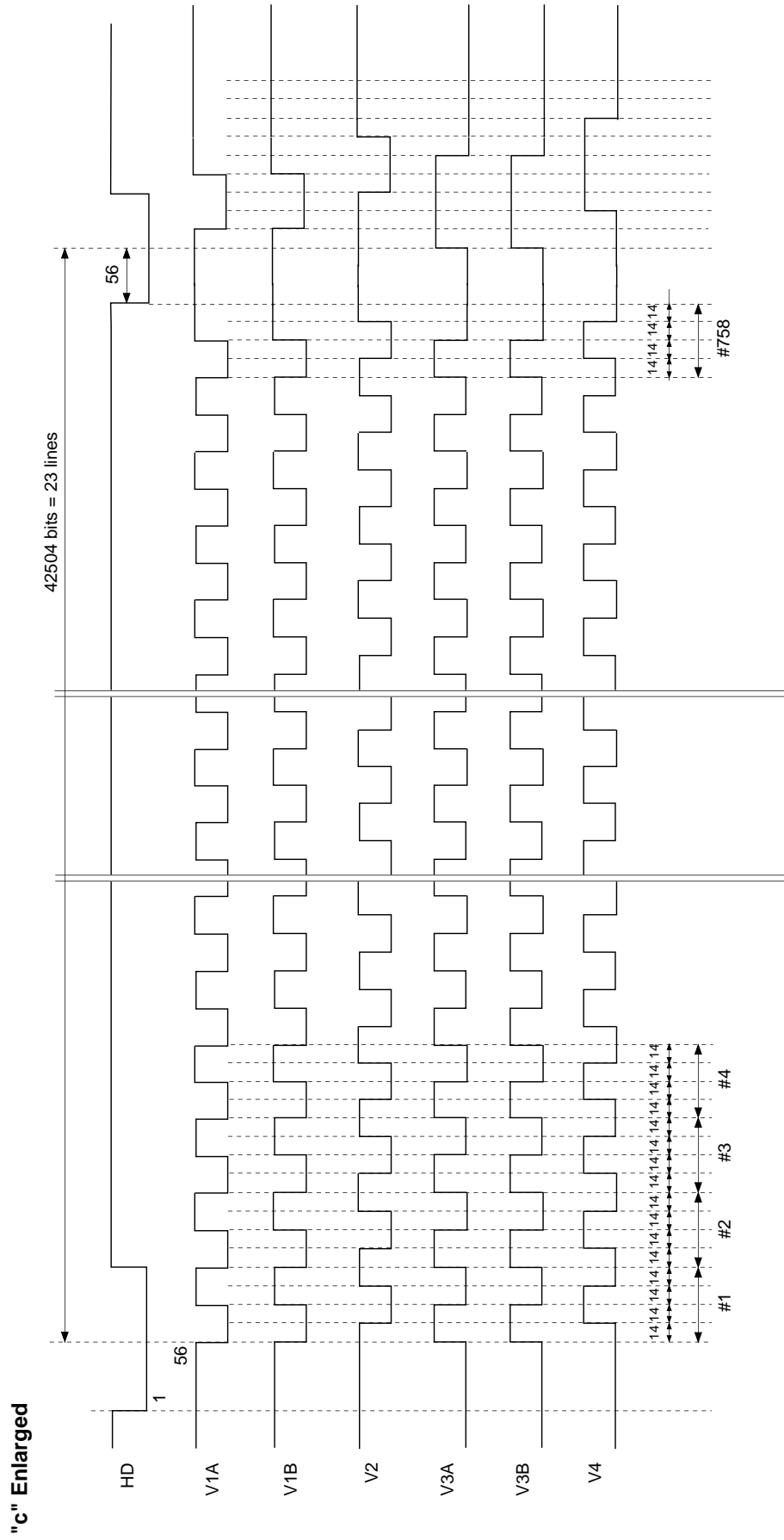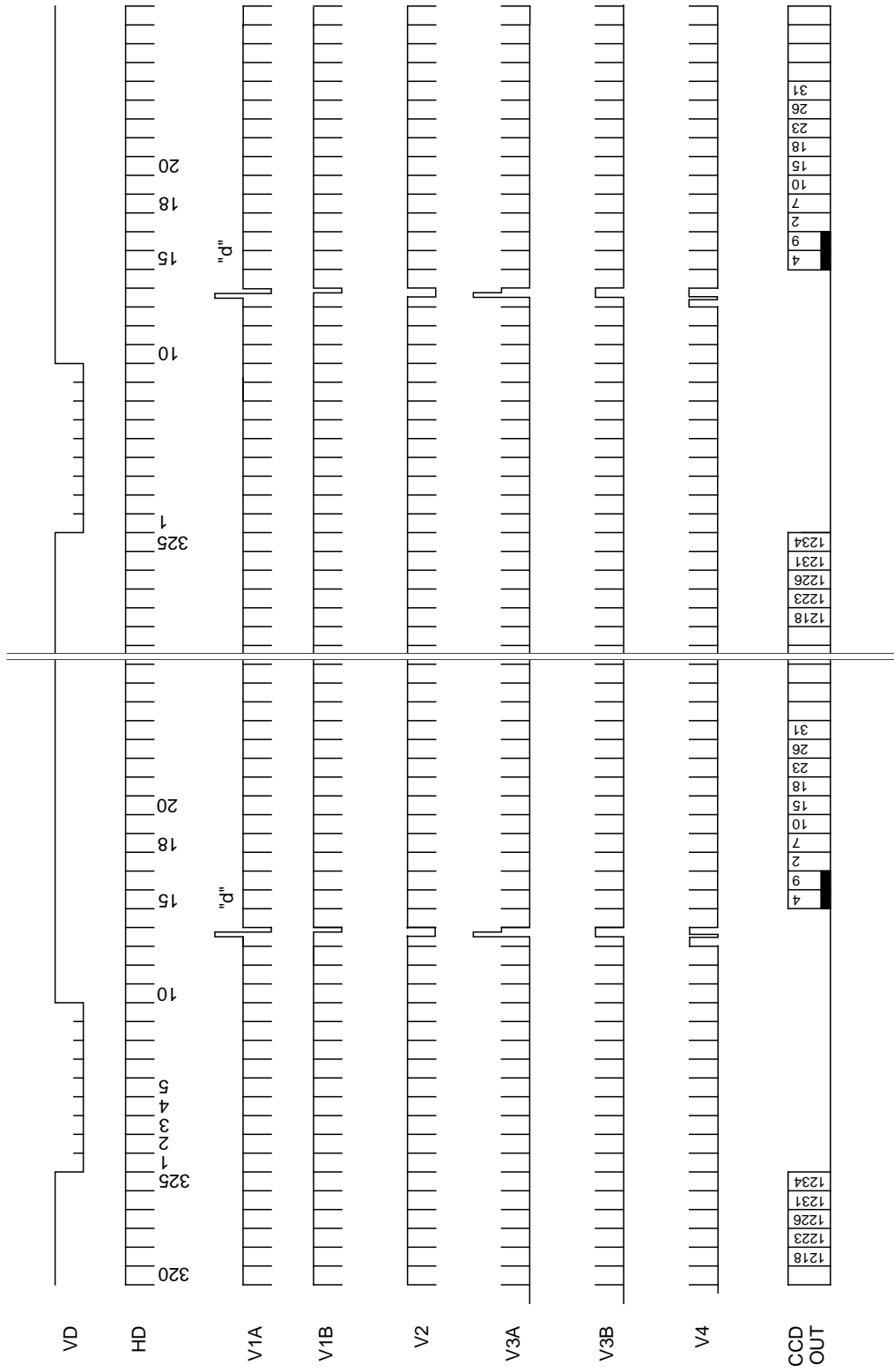
Drive Timing Chart (Vertical Sync) High Frame Rate Readout Mode

"d" Enlarged
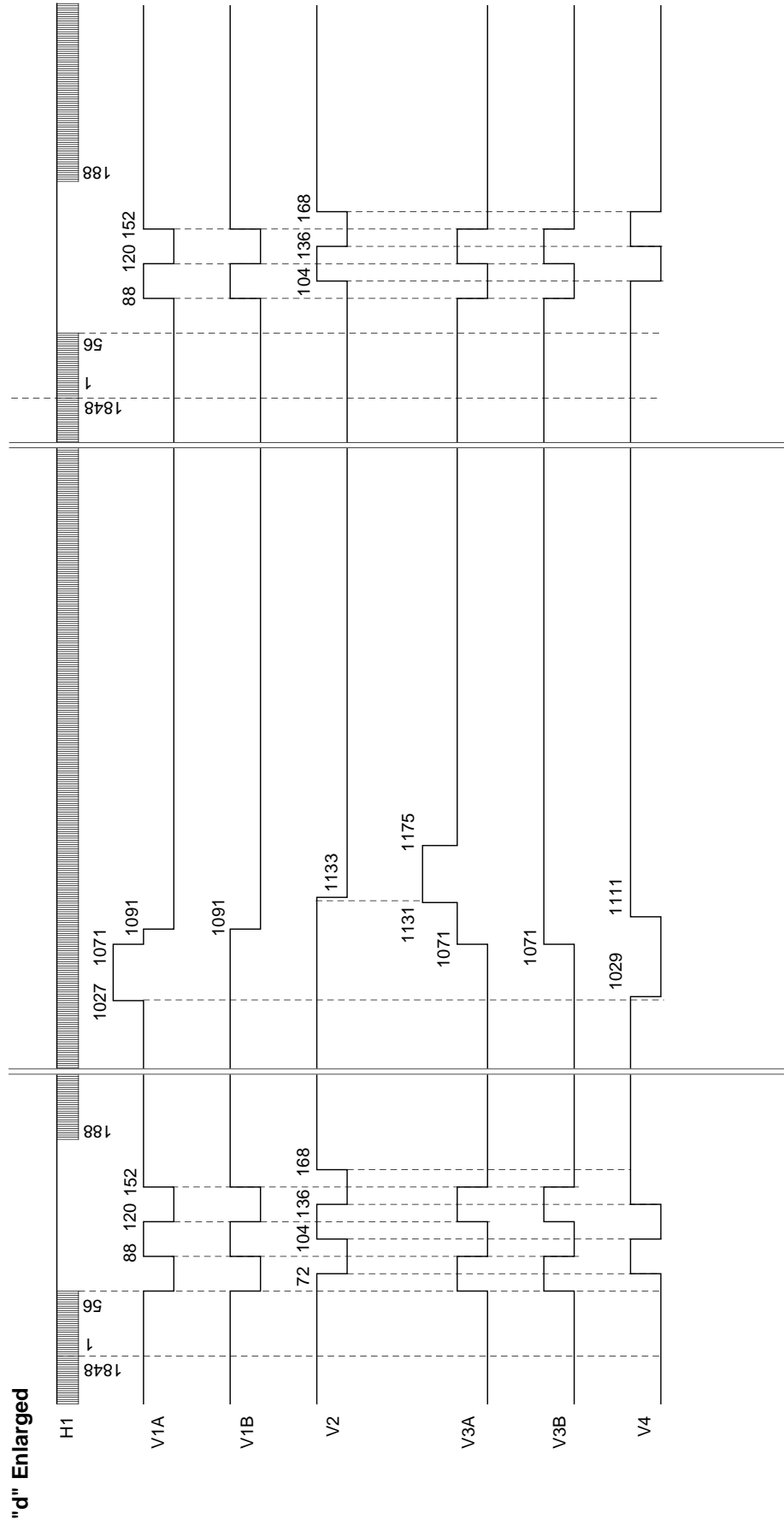
Drive Timing Chart (Horizontal Sync) Frame Readout Mode
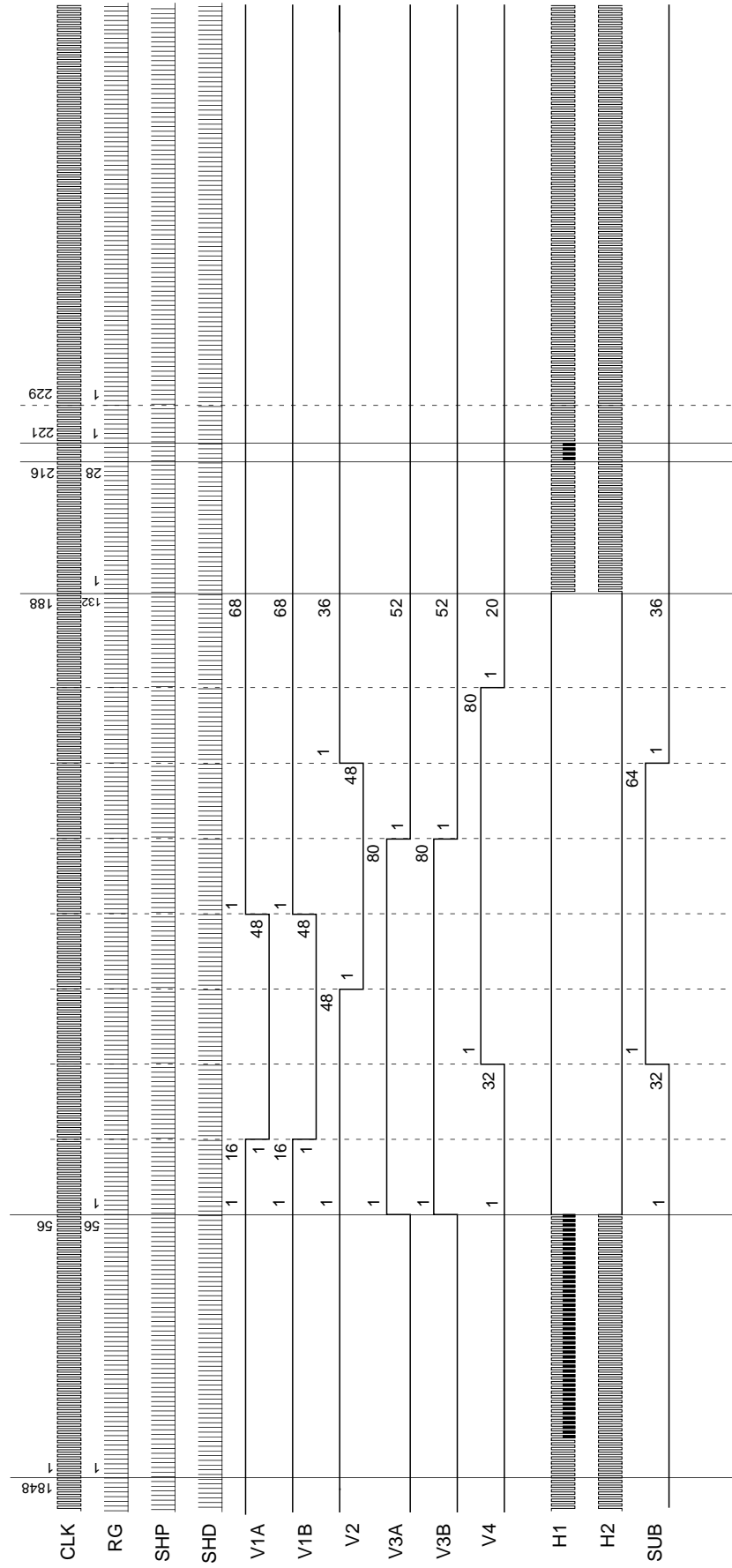
Drive Timing Chart (Horizontal Sync) High Frame Rate Readout Mode
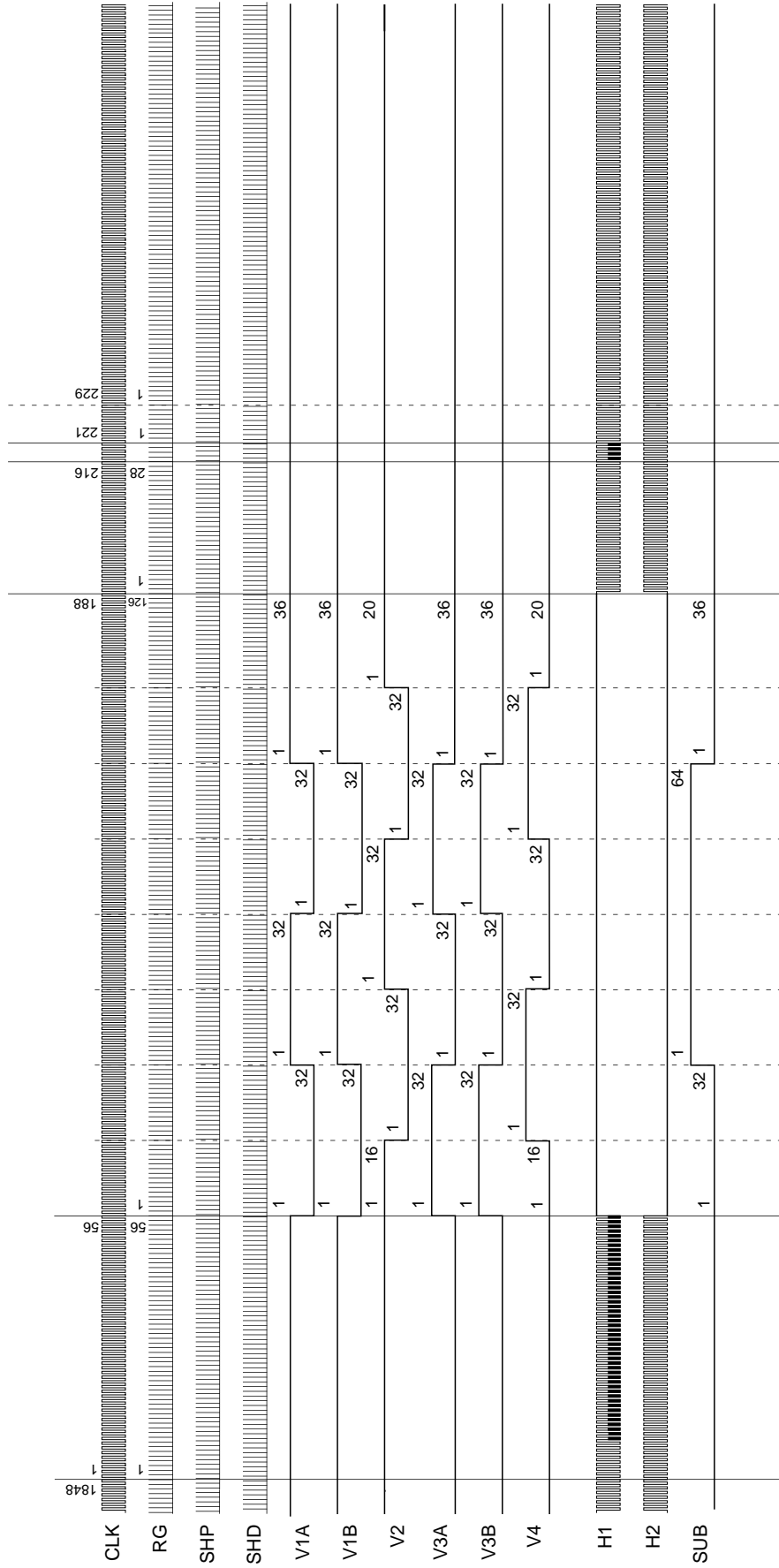
Notes on Handling

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 sensors.
   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 30W
      soldering iron with a ground wire 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) Installing (attaching)
   a) Remain within the following limits when applying a static load to the package. Do not apply any load more
      than 0.7mm inside the outer perimeter of the glass portion, and do not apply any load or impact to limited

Cover glass

Plastic package

50N   50N   1.2Nm

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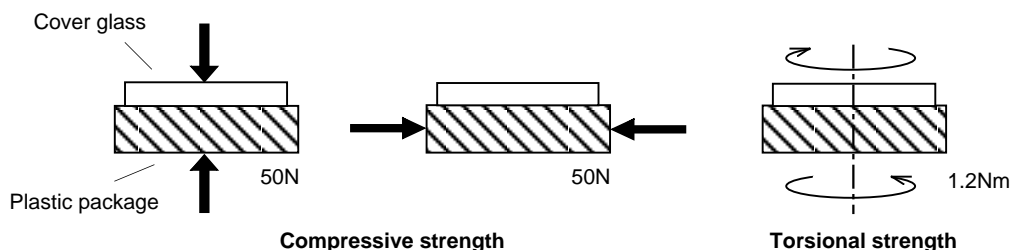
   b) If a load is applied to the entire surface by a hard component, bending stress may be generated and the
      package may fracture, etc., depending on the flatness of the bottom of the package. Therefore, for
      installation, use either an elastic load, such as a spring plate, or an adhesive.

– 21 –

c) 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 other locations as a precaution.

d) 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.

e) If the leads are bent repeatedly and metal, etc., clash or rub against the package, the dust may be generated by the fragments of resin.

f) Acrylate anaerobic adhesives are generally used to attach CCD image sensors. In addition, cyano-acrylate instantaneous adhesives are sometimes used jointly with acrylate anaerobic adhesives. (reference)

5) Others

a) Do not expose to strong light (sun rays) for long periods, as color filters will be discolored. When high luminous objects are imaged with the exposure level controlled by the electronic iris, the luminance of the image-plane may become excessive and discoloring of the color filter will possibly be accelerated. In such a case, it is advisable that taking-lens with the automatic-iris and closing of the shutter during the power-off mode should be properly arranged. For continuous using under cruel condition exceeding the normal using condition, consult our company.

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

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

Package Outline   Unit: mm

16 pin DIP (450mil)

2-R0.5

(For the first pin only)

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-C2.2-01(E)