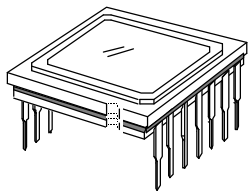
## INTRODUCTION

The S5F425NX03 is an interline transfer CCD area image sensor developed for NTSC 1/4 inch optical format video cameras, surveillance cameras, object detectors and image pattern recognizers. High sensitivity is achieved through the adoption of Ye, Cy, Mg and G complementary color mosaic filters, on-chip micro lenses and HAD (Hole Accumulated Diode) photosensors. This chip features a field integration read out system and an electronic shutter with variable charge storage time.

14Pin Cer - DIP



## FEATURES

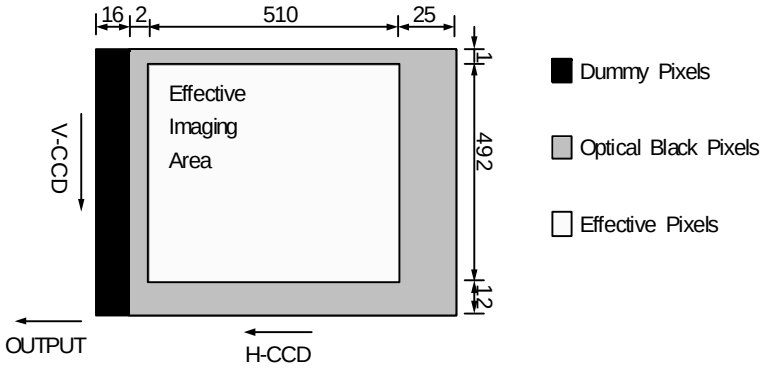
- High Sensitivity
- Optical Size 1/4 inch Format
- No adjust Substrate Bias
- Ye, Cy, Mg, G On-chip Complementary Color Mosaic Filter
- Low Dark Current
- Horizontal Register 3.3 to 5.0V Drive
- 14pin Ceramic DIP Package
- Field Integration Read Out System
- No DC Bias on Reset Gate

## ORDERING INFORMATION

| Device | Package | Operating |
|---|---|---|
| S5F425NX03-LDB0 | 14Pin Cer - DIP | -10 °C – +60 °C |

## STRUCTURE

- Number of Total Pixels: 537(H) × 505(V)
- Number of Effective Pixels: 510(H) × 492(V)
- Chip Size: 4.83mm(H) × 4.04mm(V)
- Unit Pixel Size: 7.15 μm(H) × 5.55 μm(V)
- Optical Blacks & Dummies: Refer to Figure Below
  Vertical 1 Line (Even Field Only)



## BLOCK DIAGRAM

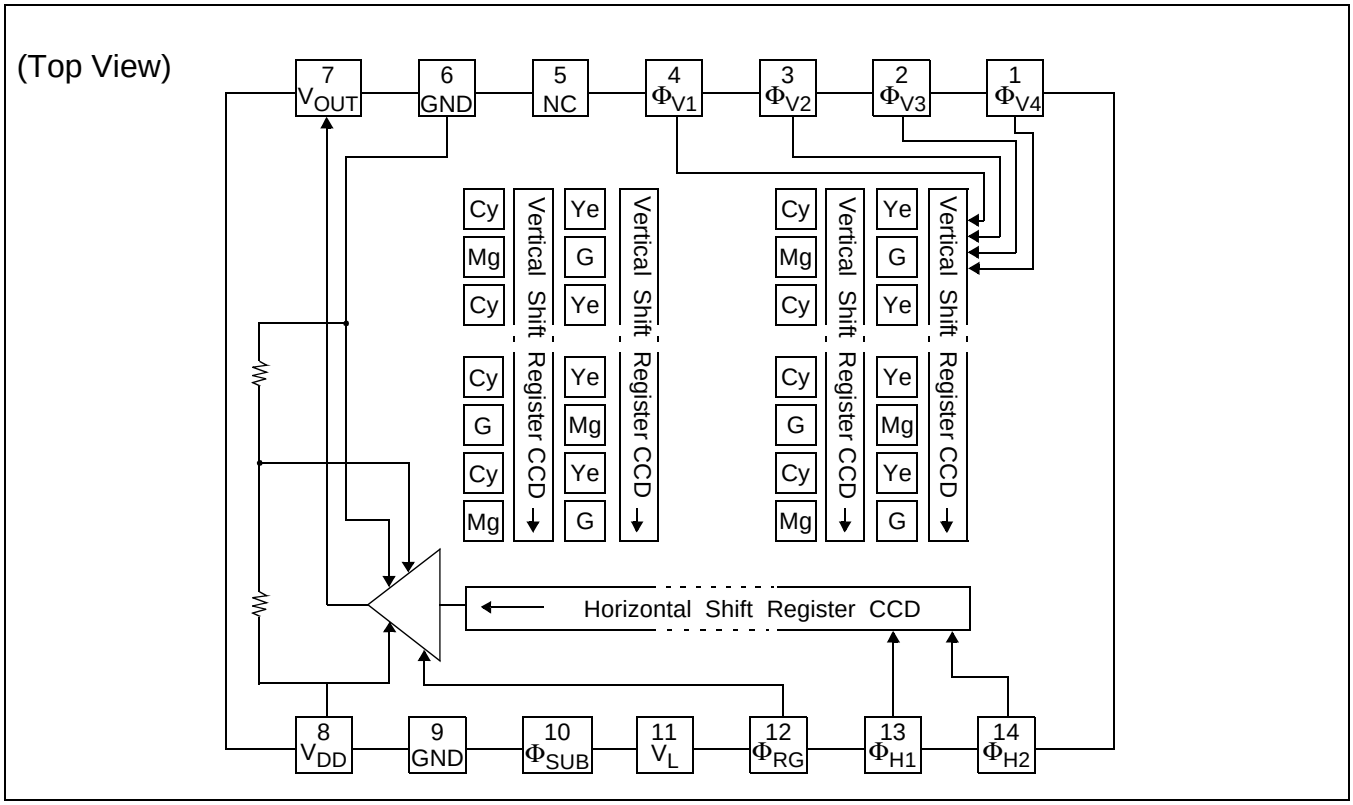



**Figure 1. Block Diagram**

## PIN DESCRIPTION

**Table 1. Pin Description**

| Pin | Symbol | Description | Pin | Symbol | Description |
|---|---|---|---|---|---|
| 1 | $\Phi_{V4}$ | Vertical register transfer clock | 8 | $V_{DD}$ | Output stage drain bias |
| 2 | $\Phi_{V3}$ | Vertical register transfer clock | 9 | GND | GND |
| 3 | $\Phi_{V2}$ | Vertical register transfer clock | 10 | $\Phi_{SUB}$ | Substrate clock |
| 4 | $\Phi_{V1}$ | Vertical register transfer clock | 11 | $V_L$ | Protection transistor bias |
| 5 | NC | No connection | 12 | $\Phi_{RG}$ | Reset gate clock |
| 6 | GND | Ground | 13 | $\Phi_{H1}$ | Horizontal register transfer clock |
| 7 | $V_{OUT}$ | Signal output | 14 | $\Phi_{H2}$ | Horizontal register transfer clock |

## ABSOLUTE MAXIMUM RATINGS (NOTE)

**Table 2. Absolute Maximum Ratings**

| Characteristics | Symbols | Min. | Max. | Unit |
|---|---|---|---|---|
| Substrate voltage | SUB - GND | -0.3 | 40 | V |
| | $V_{DD}$, $V_{OUT}$ - SUB | -40 | 10 | V |
| Vertical clock input voltage | $\Phi_{V1}$, $\Phi_{V3}$, - GND | -0.3 | 30 | V |
| | $\Phi_{V2}$, $\Phi_{V4}$ - GND | -0.3 | 17 | V |
| | $\Phi_{V1}$, $\Phi_{V3}$, - $V_L$ | -0.3 | 30 | V |
| | $\Phi_{V2}$, $\Phi_{V4}$ - $V_L$ | -0.3 | 17 | V |
| | $\Phi_{V1}$, $\Phi_{V2}$, $\Phi_{V3}$, $\Phi_{V4}$ - SUB | -40 | 10 | V |
| Horizontal clock input voltage | $\Phi_{H1}$, $\Phi_{H2}$ - $V_L$ | -0.3 | 7 | V |
| | $\Phi_{H1}$, $\Phi_{H2}$ - SUB | -30 | 7 | V |
| Voltage difference between vertical and horizontal clock input pins | $\Phi_{V1}$, $\Phi_{V2}$, $\Phi_{V3}$, $\Phi_{V4}$ | | 15 | V |
| | $\Phi_{H1}$, $\Phi_{H2}$ | | 16 | V |
| | $\Phi_{H1}$, $\Phi_{H2}$ - $\Phi_{V4}$ | -17 | 16 | V |
| Output clock input voltage | $\Phi_{RG}$ - GND | -0.3 | 16 | V |
| | $\Phi_{RG}$ - SUB | -40 | 16 | V |
| Protection circuit bias voltage | $V_L$ - SUB | -40 | 10 | V |
| Operating temperature | $T_{OP}$ | -10 | 60 | °C |
| Storage temperature | $T_{STG}$ | -30 | 80 | °C |

**NOTE:** The device can be destroyed, if the applied voltage or temperature is higher than the absolute maximum rating voltage or temperature.

## DC CHARACTERISTICS

**Table 3. DC Characteristics**

| Item | Symbol | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|
| Output stage drain bias | $V_{DD}$ | 14.55 | 15.0 | 15.45 | V |
| Protection circuit bias voltage | $V_L$ | The lowest vertical clock level | | | |
| Output stage drain current | $I_{DD}$ | | 5 | | mA |

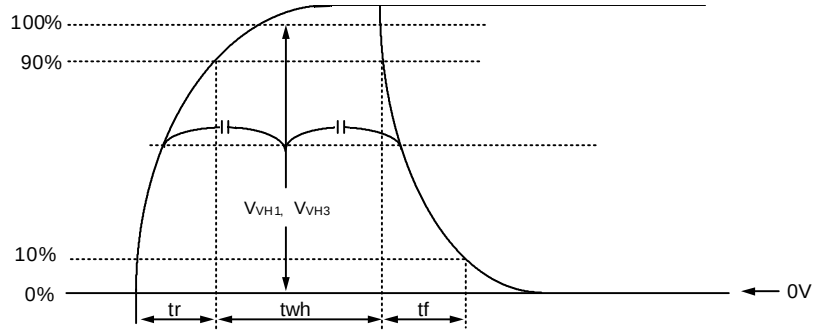
## CLOCK VOLTAGE CONDITIONS

**Table 4. Clock Voltage Conditions**

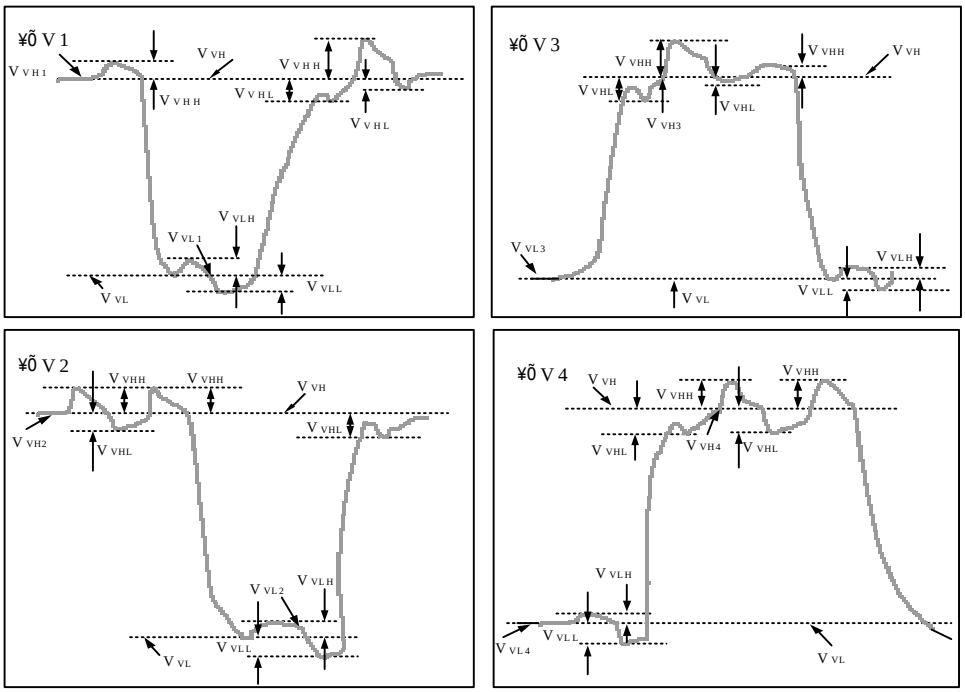
| Item | Symbol | Min. | Typ. | Max. | Unit | Remark |
|---|---|---|---|---|---|---|
| Read-out clock voltage | $V_{VH1}$, $V_{VH3}$ | 14.55 | 15.0 | 15.45 | V | High level |
| Vertical transfer clock voltage | $V_{VM1}$ ~ $V_{VM4}$ | -0.2 | 0.0 | 0.2 | V | Middle |
| | $V_{VL1}$ ~ $V_{VL4}$ | -8.0 | -7.5 | -7.0 | V | Low |
| Horizontal transfer clock voltage | $V_{HH1}$, $V_{HH2}$ | 3.0 | 5.0 | 5.25 | V | High |
| | $V_{HL1}$, $V_{HL2}$ | -0.05 | 0.0 | 0.05 | V | Low |
| Charge reset clock voltage | $V_{RGH}$ | 4.75 | 5.0 | 5.25 | V | High |
| | $V_{RGL}$ | -0.2 | 0.0 | 0.2 | V | Low |
| Substrate clock voltage | $V_{\Phi SUB}$ | 21.5 | 22.5 | 23.5 | V | Shutter |

## DRIVE CLOCK WAVEFORM CONDITIONS

### Read Out Clock Waveform




### Vertical Transfer Clock Waveform




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

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

$V_{¥õV} = V_{VHn} - V_{VLn}$ (n=1~4)

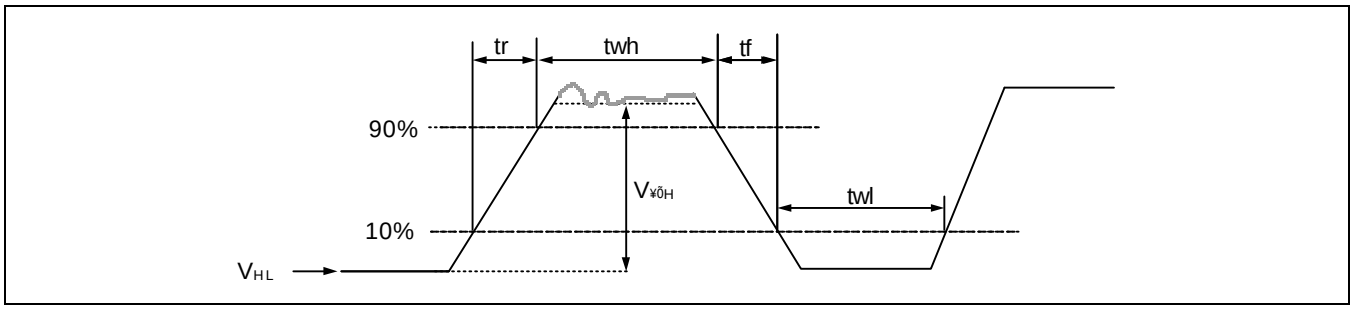
$V_{VHH} = V_{VH} + 0.3V$

$V_{VHL} = V_{VH} - 0.3V$

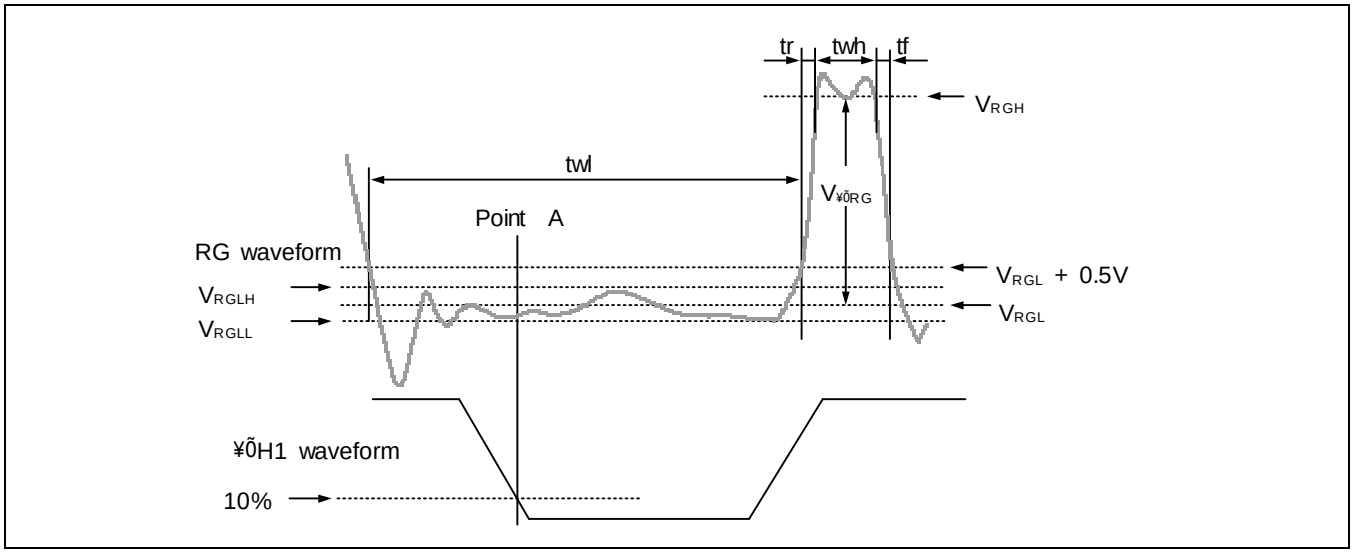
$V_{VLH} = V_{VL} + 0.3V$

$V_{VLL} = V_{VL} - 0.3V$

**Horizontal Transfer Clock Waveform Diagram**



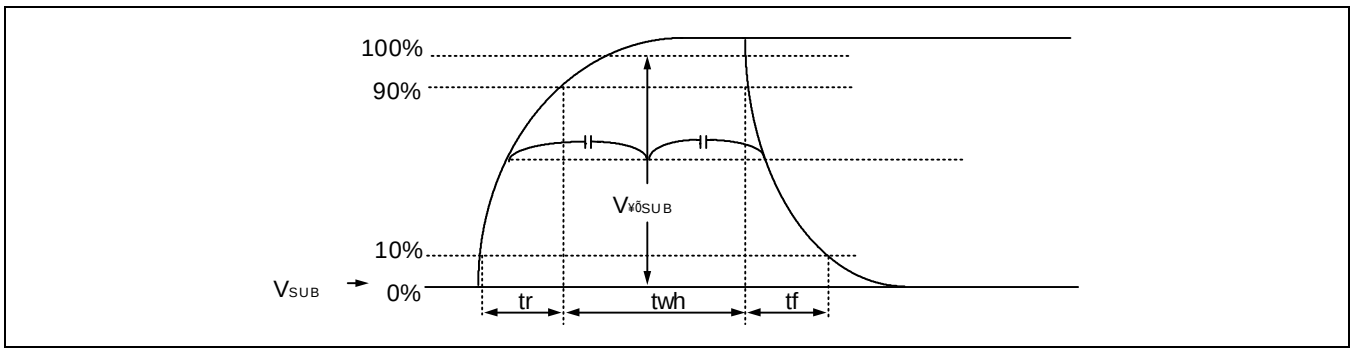

**Reset Gate Clock Waveform Diagram**




$V_{RGLH}$ is the maximum value and $V_{RGLL}$ is the minimum value of the coupling waveform in the period from Point A in the diagram about to $R_G$ rise

$V_{RGL} = (V_{RGLH} + V_{RGLL})/2$, $V_{FRG} = V_{RGH} - V_{RGL}$

**Substrate Clock Waveform**






SAMSUNG ELECTRONICS

## CLOCK EQUIVALENT CIRCUIT CONSTANT

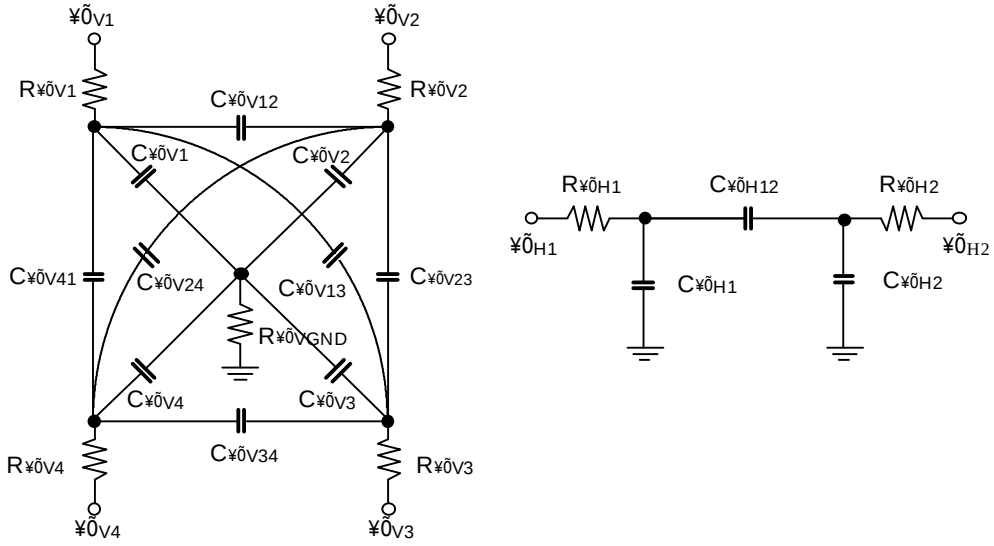
**Table 5. Clock Equivalent Circuit Constant**

| Item | Symbol | twh | | | twl | | | tr | | | tf | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | Min. | Typ. | Max. | Min. | Typ. | Max. | Min. | Typ. | Max. | |
| Read-out clock | $\Phi_{VH}$ | | 2.5 | | | | | | 0.5 | | | 0.5 | | µs |
| Vertical clock | $\Phi_{V1}$, $\Phi_{V2}$ $\Phi_{V3}$, $\Phi_{V4}$ | | | | | | | | | | 15 | | 250 | ns |
| Horizontal clock | $\Phi_{H1}$ | 41 | 46 | | 41 | 46 | | | 6.5 | 9.5 | | 6.5 | 9.5 | ns |
| | $\Phi_{H2}$ | 41 | 46 | | 41 | 46 | | | 6.5 | 9.5 | | 6.5 | 9.5 | ns |
| Reset clock | $\Phi_{RG}$ | 11 | 15 | | 75 | 79 | | | 6.5 | | | 4.5 | | ns |
| Substrate clock | $\Phi_{SUB}$ | 1.5 | 2.0 | | | | | | | 0.5 | | | 0.5 | µs |

## EQUIVALENT CIRCUIT PARAMETERS

**Table 6. Equivalent Circuit Parameters**

| Item | Symbol | Typ. | Unit | Remark |
|---|---|---|---|---|
| Capacitance between vertical transfer clock and GND | $C_{\Phi V1}$, $C_{\Phi V3}$ | 680 | pF | |
| | $C_{\Phi V2}$, $C_{\Phi V4}$ | 820 | pF | |
| Capacitance between vertical transfer clocks | $C_{\Phi V12}$, $C_{\Phi V34}$ | 180 | pF | |
| | $C_{\Phi V23}$, $C_{\Phi V41}$ | 180 | pF | |
| | $C_{\Phi V13}$ | 60 | pF | |
| | $C_{\Phi V24}$ | 60 | pF | |
| Capacitance between horizontal transfer clock and GND | $C_{\Phi H1}$, $C_{\Phi H2}$ | 30 | pF | |
| Capacitance between horizontal transfer clocks | $C_{\Phi H12}$ | 30 | pF | |
| Capacitance between substrate clock and GND | $C_{\Phi SUB}$ | 180 | pF | |
| Vertical transfer clock serial resistor | $R_{\Phi V1}$ ~ $R_{\Phi V4}$ | 40 | Ω | |
| Vertical transfer clock ground resistor | $R_{\Phi VGND}$ | 15 | Ω | |
| Horizontal transfer clock serial resistor | $R_{\Phi H1}$, $R_{\Phi H2}$ | 10 | Ω | |
| Reset gate clock serial resistor | $R_{\Phi RG}$ | 100 | Ω | |






SAMSUNG ELECTRONICS

## OPERATING CHARACTERISTICS

Device Temperature = 25 °C

**Table 7. Operating Characteristics**

| Item | Symbol | Min. | Typ. | Max. | Unit | Remark |
|---|---|---|---|---|---|---|
| Sensitivity | S | 45 | 50 | | mV/lux | 1 |
| Saturation signal | $Y_{SAT}$ | 800 | | | mV | 2 |
| Smear | SM | | 0.007 | 0.01 | % | 3 |
| Blooming margin | BM | 1,000 | | | times | 4 |
| Uniformity | U | | | 20 | % | 5 |
| Dark signal (NOTE) | D | | | 2 | mV | 6 |
| Dark shading (NOTE) | ΔD | | | 2 | mV | 7 |
| Image lag | $Y_{LAG}$ | | | 0.5 | % | 8 |
| Flicker Y | $F_Y$ | | | 2 | % | 9 |
| Flicker red, blue | $F_{CR}$, $F_{CB}$ | | | 5 | % | 10 |
| Color uniformity | $D_{SR}$, $D_{SB}$ | | | 10 | % | 11 |
| Line stripe W, R, G, B | $L_{CW}$, $L_{CR}$, $L_{CG}$, $L_{CB}$ | | | 3 | % | 12 |

**NOTE:** Test Temperature = 60 °C

## TESTING SYSTEM

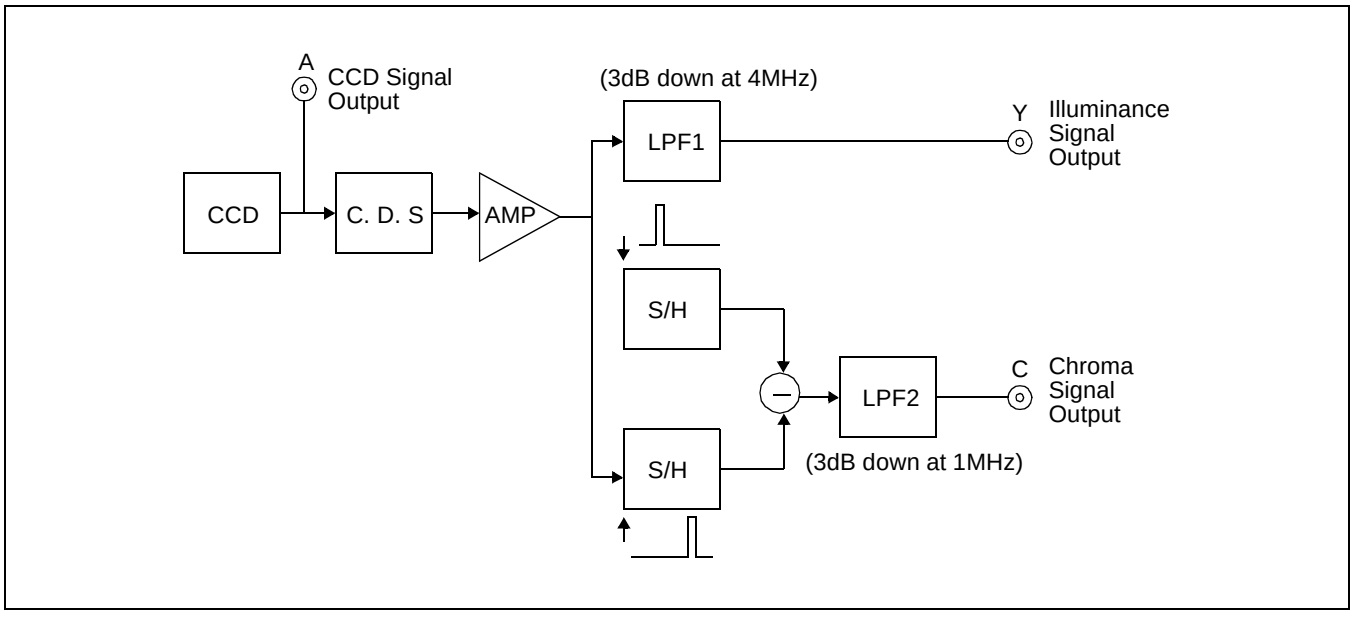



**Figure 2. Testing System**

## TEST CONDITION

1. Use a light source with color temperature of 3,200K hallogen lamp and CM-500S for IR cut filter.
   The light source is adjusted in accordance with the average value of Y signals indicated in each item.

## COLOR FILTER ARRAY

The color filter array of this image sensor is shown in the right figure. this complementary mosaic CFA is used with the operation of field integration mode, where all of the photosensors are read out during each video field. The signals from two vertically-adjacent photosensor lines, such as line couple A1 or A2 for field A are summed when the signal charges are transferred into the vertical transfer CCD column. The read out line pairing is shifted down by one line for field B.

The sensor output signals through the horizontal register (H-CCD) 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

$$Y = \frac{1}{2}[(G + Cy) + (Mg + Ye)] = \frac{1}{2}(2B + 3G + 2R)$$

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

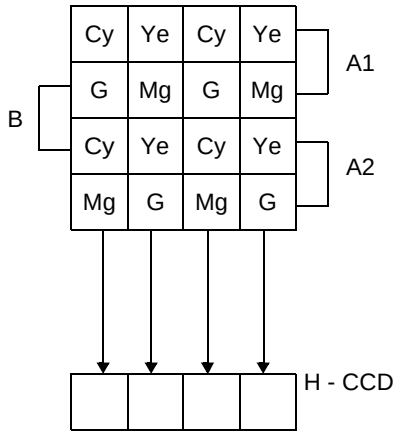



**Figure 3. Color Filter Array**

$$R-Y = [(Mg + Ye) - (G + Cy)] = (2R - G)$$

Next, the signals through H-CCD at line A2 are [Mg+Cy], [G+Ye], [Mg+Cy], [G+Ye]. Simmilary, Y and C signals are composed at line A2 as follows

$$Y = \frac{1}{2}[(G + Ye) + (Mg + Cy)] = \frac{1}{2}(2B + 3G + 2R)$$

$$-(B - Y) = [(G + Ye) - (Mg + Cy)] = -(2B - G)$$

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

## TEST METHODS

1. Measure the light intensities (L) when the averaged illuminance output value (Y) is the standard illuminance output value, 150mV ($Y_A$) and when half of 150mV (1/2 $Y_A$).

$$S = \frac{Y_A - \frac{1}{2}Y_A}{L_{Y_A} - L_{\frac{1}{2}Y_A}}$$

2. Adjust the light intensity to 15 times of the value with which Y is $Y_A$, then measure the averaged illuminance output value (Y = $Y_{SAT}$).

3. Adjust the light intensity to 500 times of the value with which Y is $Y_A$, then remove the read-out clock and drain the signal in photosensors by the electronic shutter operation in all the respective horizontal blanking times with the other clocks unchanged. Measure the maximum illuminance output value ($Y_{SM}$).

$$SM = \frac{Y_{SM}}{Y_A} \times \frac{1}{500} \times \frac{1}{10} \times 100(\%)$$

4. Adjust the light intensity to 1,000 times of the value with which Y is $Y_A$, then inspect whether there is blooming phenomenon or not.

5. Measure the maximum and minimum illuminance output value ($Y_{MAX}$, $Y_{MIN}$) when the light intensity is adjusted to make Y to be $Y_A$.

$$U = \frac{Y_{MAX} - Y_{MIN}}{Y_A} \times 100(\%)$$

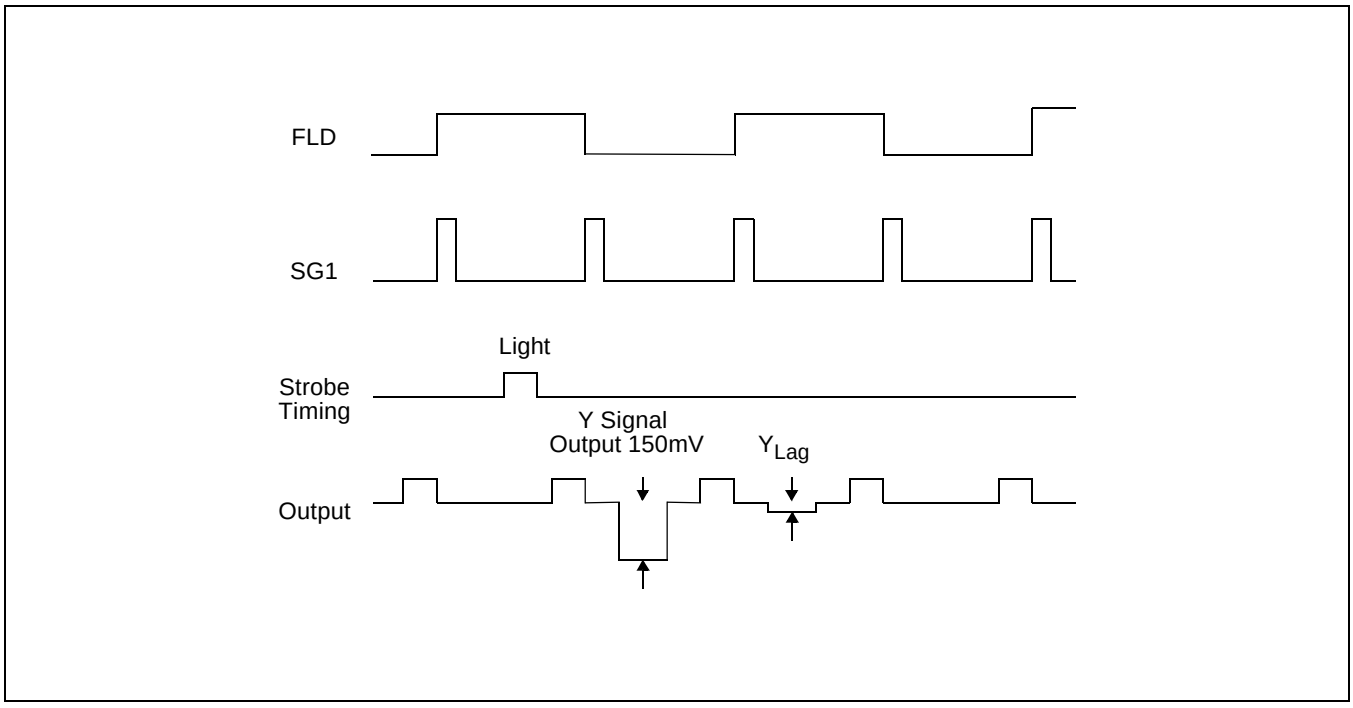
6. Measure $Y_D$ with the horizontal idling time transfer level as reference, when the device ambient temperature is 60 °C and all of the light sources are shielded.

7. Follow test method 6, measure the maximum ($D_{MAX}$) and minimum illuminance output ($D_{MIN}$).

$$\Delta D = D_{MAX} - D_{MIN}$$

8. Adjust the light intensity of Y signal output value by strobe light to 150mV ($Y_A$), calculate by below formula with measuring the image lag signal which is qenerated by below timing diagram.

$$Y_{LAG} = (Y_{lag}/150) \times 100(\%)$$



9. Adjust the light intensity of Y signal average value to 150mV ($Y_A$), calculate by below formula with measuring the signal differences ($\Delta Y_f$ [mV]) between fields.

$$F_Y = (\Delta Y_f / Y_A) \times 100(\%)$$

10. Adjust the light intensity to make Y = $Y_A$ using red (R) and blue (B) optical filters respectively, measure the differences ($\Delta C_R$, $\Delta C_B$) between the chroma signal values in even and odd fields and the averaged chroma signal values ($C_R$, $C_B$).

$$F_{C_i} = \frac{\Delta C_i}{C_i} \times 100(\%)$$

, where i = R, B

11. Adjust the light intensity to make Y = $Y_A$ using red (R) and blue (B) optical filters respectively, measure the minimum ($C_{R,MIN}$ and $C_{B,MIN}$) and maximum ($C_{R,MAX}$ and $C_{B,MAX}$) chroma signal values.

$$DS_i = \frac{C_{i,MAX} - C_{i,MIN}}{Y_i} \times 100(\%)$$

, where i = R, B

12. Adjust the light intensity to make Y = 150mV($Y_L$) using white (no filter, W), red (R), green (G) and blue (B) optical filters respectively, measure the illuminance signal difference values ($\Delta Y_{LW}$, $\Delta Y_{LR}$, $\Delta Y_{LG}$, $\Delta Y_{LB}$) between illuminance signal lines of the same field.

$$L_{c_i} = \frac{\Delta Y_{L_i}}{Y_L} \times 100(\%)$$

, where i = W, R, G, B

## SPECTRAL RESPONSE CHARACTERISTICS

Excluding Light Source Characteristics

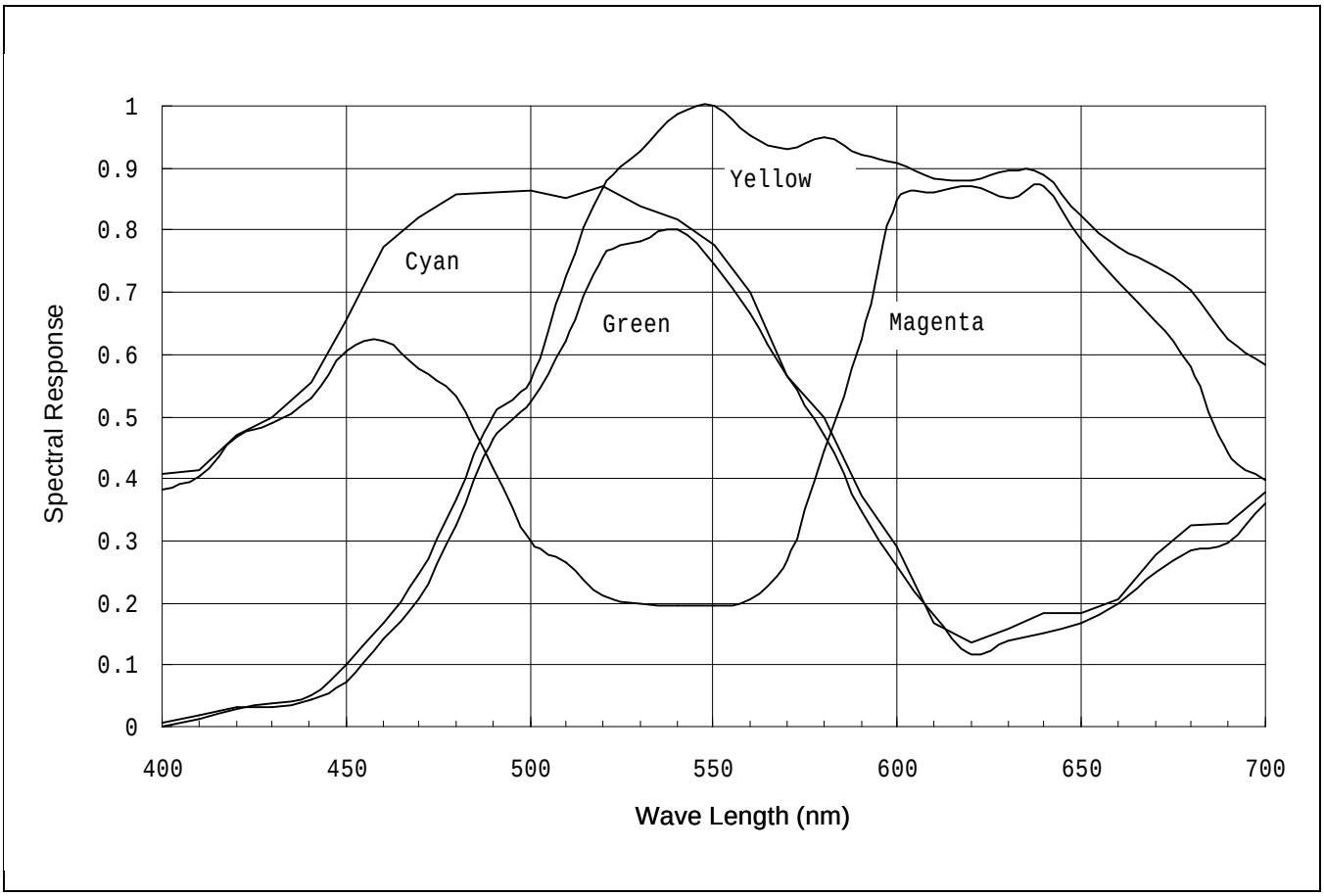



**Figure 4. Spectral Response Characteristics**

## APPLICATION CIRCUITS

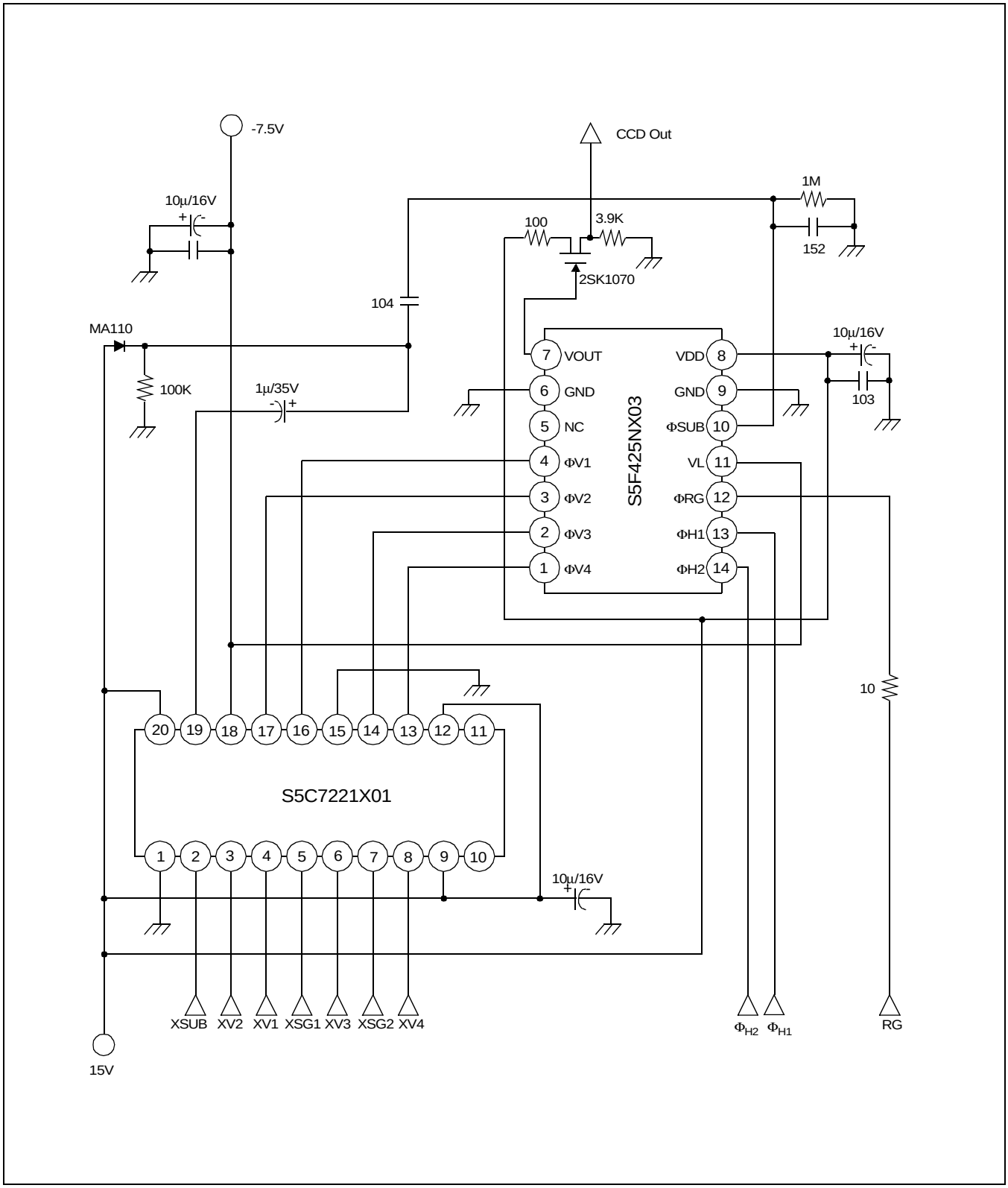



**Figure 5. Application Circuits**

## READ-OUT CLOCK TIMING CHART

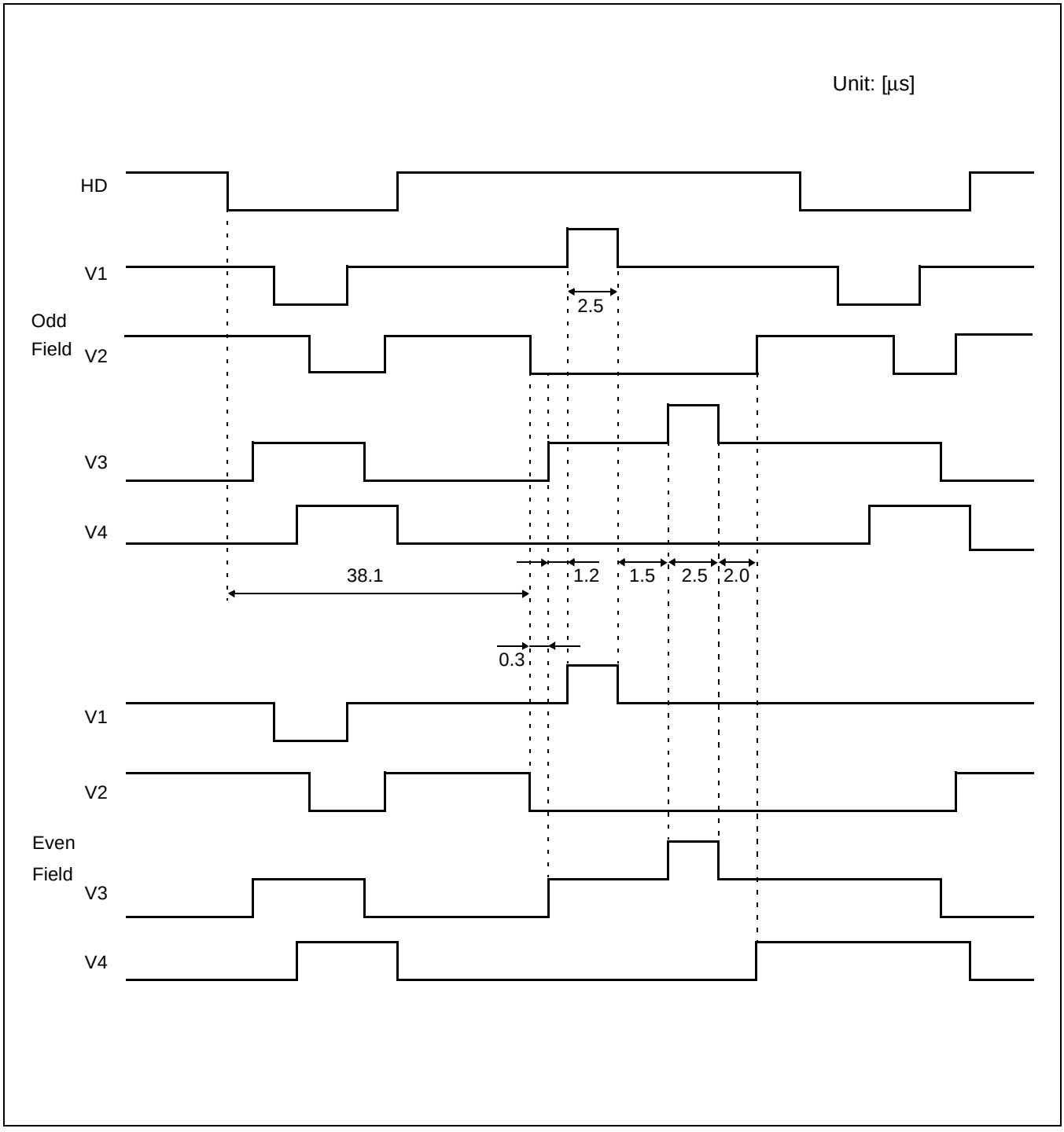



**Figure 6. Read-out Clock Timing Chart**

## CLOCK TIMING CHART (VERTICAL SYNC.)

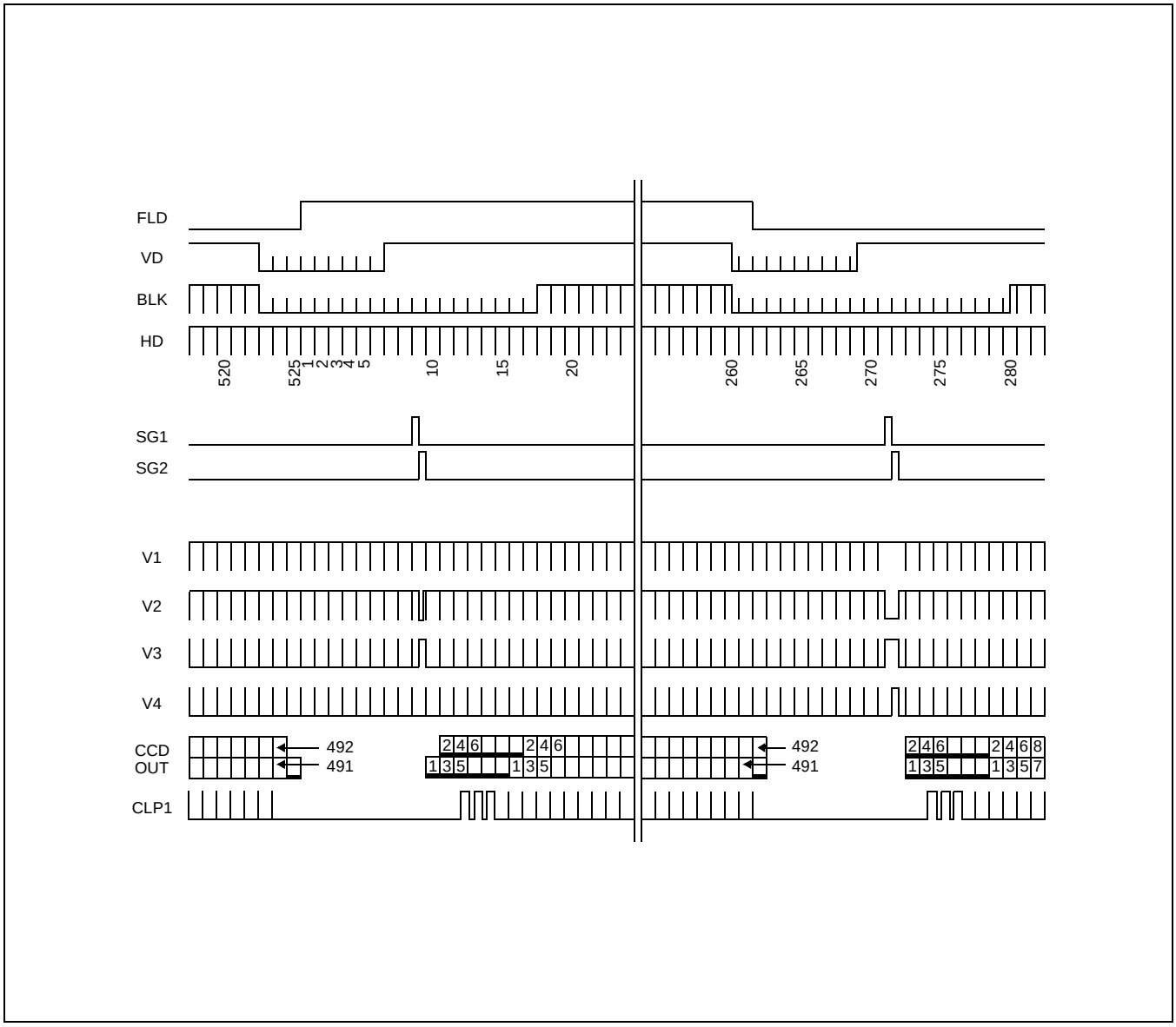



**Figure 7. Clock Timing Chart (Vertical Sync.)**

## CLOCK TIMING CHART (HORIZONTAL SYNC.)

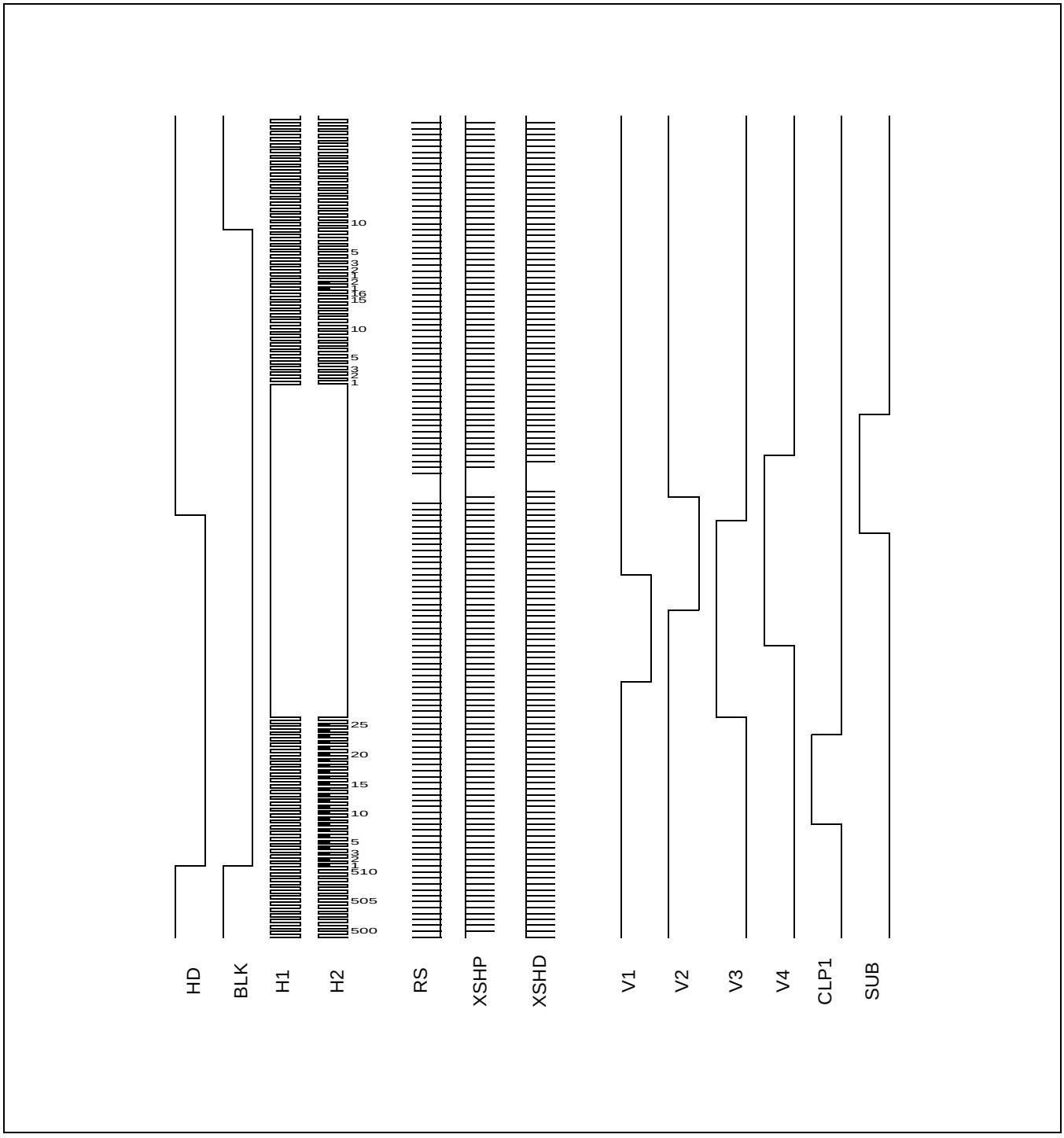
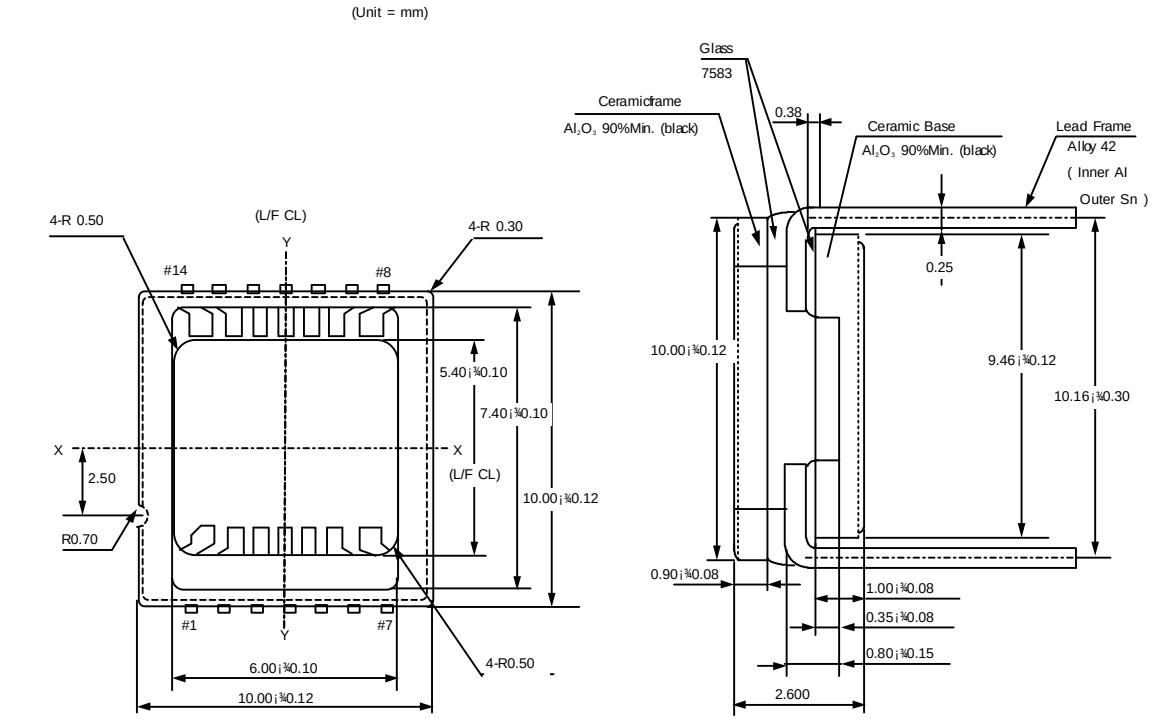



**Figure 8. Clock Timing Chart (Horizontal Sync.)**

## PACKAGE DIMENSIONS




NOTES:

1. Max. Leakage by Hellium Detector :$10^{-8}$atm. cc/sec at $10^{-5}$ mmHg
2. Resistance Between Leads :Above $10^{10}$0HM at 25¡É, 60% R>H
3. Insulation Resistance :Electrical leakage shall not exceed 5 nano AMP at 100V D.C
4. Ceamic Material :Min. 90% $al_2O_3$ (black)
5. Lead Frame
   - Coplanarity :0.25 Max. (after L/F attach)
   - Planarity :0.076/mm, -0.102/mm
   - Al clad
     . Thickness :5um to 10um (for stamp)
     . Thickness :2.5um to 12.7um (for etch)
     . Coverage :Min. 0.762mm from lead tip
   - Sn thickness :4um to 20um
6. Flatness
   - DIE attach pad :Max. 0.051mm
   - LID seal area :Max. 0.051mm
7. Other :In according to semi standards.

**Figure 9. Package Dimensions**

## HANDLING INSTRUCTIONS

- Static Charge Prevention

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

  — Use non chargeable gloves, clothes or material. Also use conductive shoes.
  — When handling directly, use an earth band.
  — Install a conductive mat on the floor or working table to prevent generation of static electricity.
  — Ionized air is recommended for discharging when handling CCD image sensor.
  — For the shipment of mounted substrates, use boxes treated for the prevention of static charges.

- Soldering
  — Make sure the package temperature does not exceed 80 °C.
  — 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.
  — To dismount an imaging device, do not use a solder suction equipment. When using an electronic disoldering tool, use a thermal controller of the zero cross on/off type and connect to ground.

- Dust and Dirt Protection
  — Operate in the clean environments (around class 1000 will be appropriate).
  — Do not either touch glass plates by hand or have object come in contact with glass surface. Should dirt stick to a glass surface blow it off with an air blow (for dirt stuck through static electricity ionized air is recommended).
  — Clean with a cotton bud and ethyl alcohol if the glass surface is grease stained. Be careful not to scratch the glass.
  — 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.
  — When a protective tape is applied before shipping, just before use remove the tape applied electrostatic protection. Do not reuse the tape.

- Do not expose to strong light (sun rays) for long period, color filter are discolored.

- Exposure to high temperature or humidity will affect the characteristics. accordingly avoid storage or usage in such conditions.

- CCD image sensors are precise optical equipment that should not be subject to mechanical shocks.