



Semiconductor Inc.  
System IC SBU

## HV7141D

### CMOS IMAGE SENSOR

#### With 8-bit ADC

## DESCRIPTION

HV7141D is a highly integrated single chip CMOS color image sensor using Hynix 0.5um CMOS process developed for image application to realize high efficiency R/G/B photo sensor. The sensor has 812X612 pixels total, and 800X600 pixels effective. Each pixel is high photo sensitive, small size active pixel element that converts photons to analog voltage signal. The sensor has three on-chip 8 bit Digital to Analog Convert (DAC) and 812 comparators to digitize the pixel output. The three on-chip 8 bit DAC can be used for independent R/G/B gain control. Hynix proprietary on-chip CDS circuit can reduce Fixed Pattern Noise (FPN) dramatically. The whole 8 bit digital color raw data is directly available on the package pins and just few control signals are needed for whole chip control, so it is very ease to configure a system using the sensor.

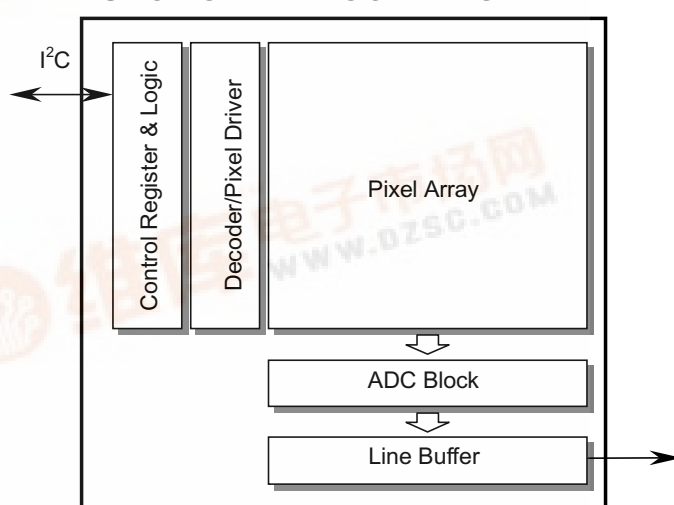
## FEATURES

- 800 x 600 pixels resolution
- 8um x 8um square pixels
- High efficiency R/G/B color photo sensors
- Integrated 8-bit ADC for direct digital output
- Low power 3.3V operation (5V tolerant I/O)
- Integrated pan control and window sizing
- Clock speed up to 20MHz
- Programmable frame rate and synchronous format
- Full function control through standard I<sup>2</sup>C bus
- Built-in AGC
- 48Pin CLCC
- Bayer RGB color pattern
- Anti-blooming circuit
- Flexible exposure time control
- Integrated on-chip timing and drive control
- 1/2" optical format

## TECHNICAL SPECIFICATION

|                                      |                   |
|--------------------------------------|-------------------|
| Total Pixel Array                    | 812x612           |
| Effective Pixel Array                | 802x602           |
| Fill factor                          | 30%               |
| Format                               | SVGA              |
| Sensitivity                          | 2500mV/lux·sec    |
| Supply voltage for analog            | 3.3V              |
| Supply voltage for digital           | 3.3V              |
| Supply voltage for 5V tolerant input | 5.0V              |
| Power Consumption                    | 100mW@10MHz       |
| Operating temperature                | 0~40 Centigrade   |
| Technology                           | 0.5um 2metal CMOS |

## FUNCTIONAL BLOCK DIAGRAM





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## ELECTRICAL CHARACTERISTICS

### Absolute Maximum Ratings

|                                     |   |       |   |       |
|-------------------------------------|---|-------|---|-------|
| ● Supply voltage(Analog, Digital)   | : | 3.0 V | ~ | 3.6 V |
| ● Voltage on any input pins         | : | 0 V   | ~ | 5.0 V |
| ● Operating Temperature(Centigrade) | : | 0     | ~ | 40    |
| ● Storage Temperature(Centigrade)   | : | -30   | ~ | 80    |

Note : Input pins are 5V tolerant. Stresses exceeding the absolute maximum ratings may induce failure.

### DC Operating Conditions

| Symbol          | Parameter                         | Units   | Min. | Max. | Load[pF] | Notes |
|-----------------|-----------------------------------|---------|------|------|----------|-------|
| V <sub>dd</sub> | Internal operation supply voltage | Volt    | 3.0  | 3.6  |          |       |
| V <sub>ih</sub> | Input voltage logic "1"           | Volt    | 2.0  | 5    | 6.5      |       |
| V <sub>il</sub> | Input voltage logic "0"           | Volt    | 0    | 0.8  | 6.5      |       |
| V <sub>oh</sub> | Output voltage logic "1"          | Volt    | 2.15 | 3.6  | 60       |       |
| V <sub>ol</sub> | Output voltage logic "0"          | Volt    | 0.4  | 0.4  | 60       |       |
| T <sub>a</sub>  | Ambient operating temperature     | Celsius | 0    | 40   |          |       |

### AC Operating Conditions

| Symbol | Parameter                        | Max Operation Frequency | Units | Notes |
|--------|----------------------------------|-------------------------|-------|-------|
| MCLK   | Main clock frequency             | 20                      | MHz   | 1     |
| SCK    | I <sup>2</sup> C clock frequency | 400                     | kHz   | 2     |

1. MCLK can be divided according to Clock Divide Register for internal clock.
2. SCK is driven by host processor. For the detail serial bus timing, refer to I<sup>2</sup>C Spec.

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## ELECTRO-OPTICAL CHARACTERISTICS

Color temperature of light source: 3200K / IR cut-off filter (CM-500S, 1mm thickness) is used. --- 8)

| Parameter                | Units        | Min. | Typical | Max. | Note |
|--------------------------|--------------|------|---------|------|------|
| Sensitivity              | mV / lux·sec | 1600 | 2500    |      | 1)   |
| Dark Signal              | mV/sec       |      | 5       | 100  | 2)   |
| Output Saturation Signal | mV           | 1200 | 1250    |      | 3)   |
| Dynamic Range            | dB           |      |         | 48   | 4)   |
| Output Signal Shading    | %            |      | 8       | 13   | 5)   |
| Dark Signal Shading      | mV/sec       |      | 3       | 300  | 6)   |
| Frame Rate               | fps          |      |         | 30   | 7)   |

Note:

- 1) Measured at 28lux illumination for exposure time 10 ms.
- 2) Measured at zero illumination for exposure time 50 ms. ( $T_{temp} = 40$  Centigrade)
- 3) Measured at  $V_{dd} = 3.3V$  and 100lux illumination for exposure time 50msec.
- 4) 48dB is limited by 8-bit ADC.
- 5) Variance of average value of 4x4 pixels response of each block over all equal blacks at 50% saturation level illumination for exposure time 10msec.
- 6) Range between  $V_{max}$  and  $V_{min}$  at zero illumination for exposure time 50msec, where  $V_{max}$  and  $V_{min}$  are the maximum and minimum values of each block's response, respectively.
- 7) Measured at MCLK 15MHz.  
Integration time must be set in order for effective window height not to exceed window height.  
It's because effective window height is directly proportional to integration time.
- 8) We recommend the IR cut-off filter with transmittance 50% at cut-off frequency 650nm for the real applications.

## Soldering

Infrared(IR) / Convection solder reflow condition

| Parameter              | Units   | Min. | Typical | Max. | Note |
|------------------------|---------|------|---------|------|------|
| Peak Temperature Range | Celsius | -    | 230     | 240  | 1)   |

Note:

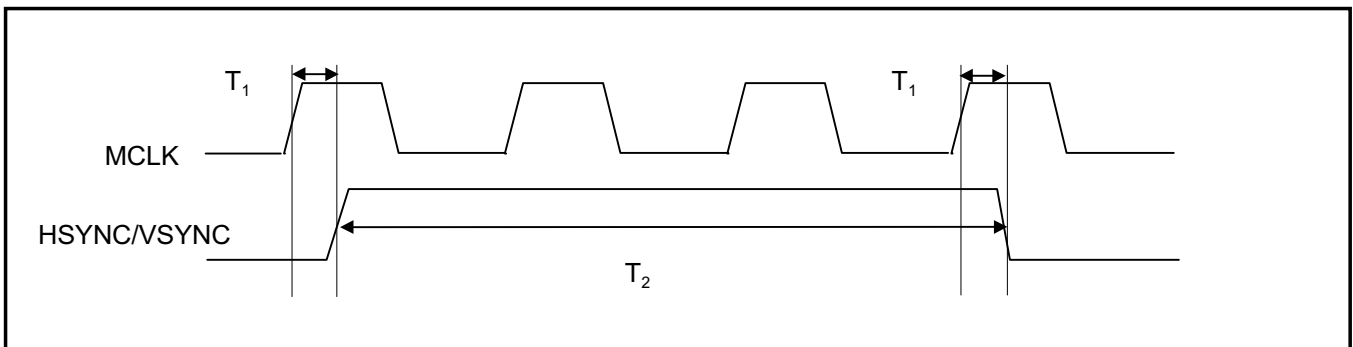
- 1) Time within 5 Celsius of actual peak temperature, 10sec

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## INPUT / OUTPUT AC CHARACTERISTICS

- All output timing delays are measured with output load 60[pF].
- Output delay include the internal clock path delay[6ns] and output driving delay that changes in respect to the output load, the operating environment, and a board design.
- Due to the variable valid time delay of the output, output signals may be latched in the negative edge of MCLK for the stable data transfer between the image sensor and a host for less than 15MHz operation.

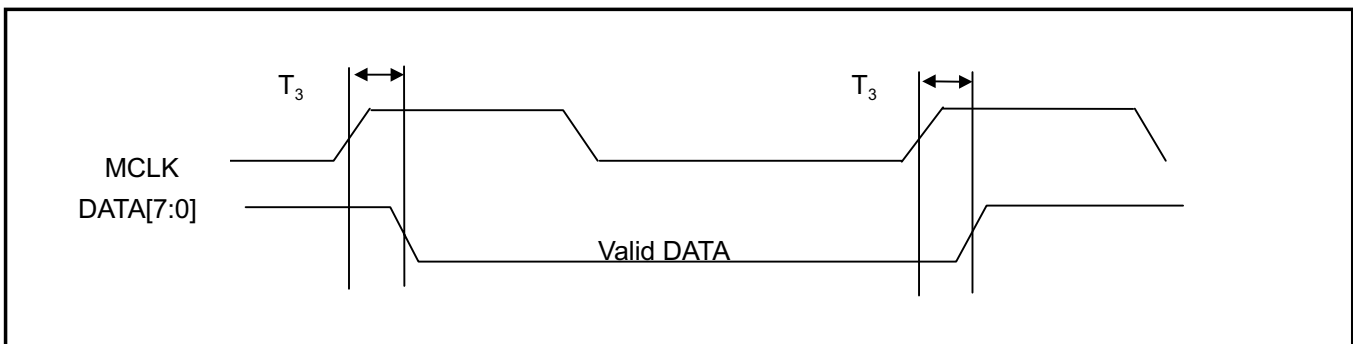
### MCLK to HSYNC/VSYNC Timing



$T_1$  : MCLK rising to HSYNC/VSYNC valid maximum time : 18ns [output load: 60pF]

$T_2$  : HSYNC/VSYNC valid time : minimum 1 Clock(subject to  $T_1$ ,  $T_2$  timing rule)

### MCLK to DATA Timing

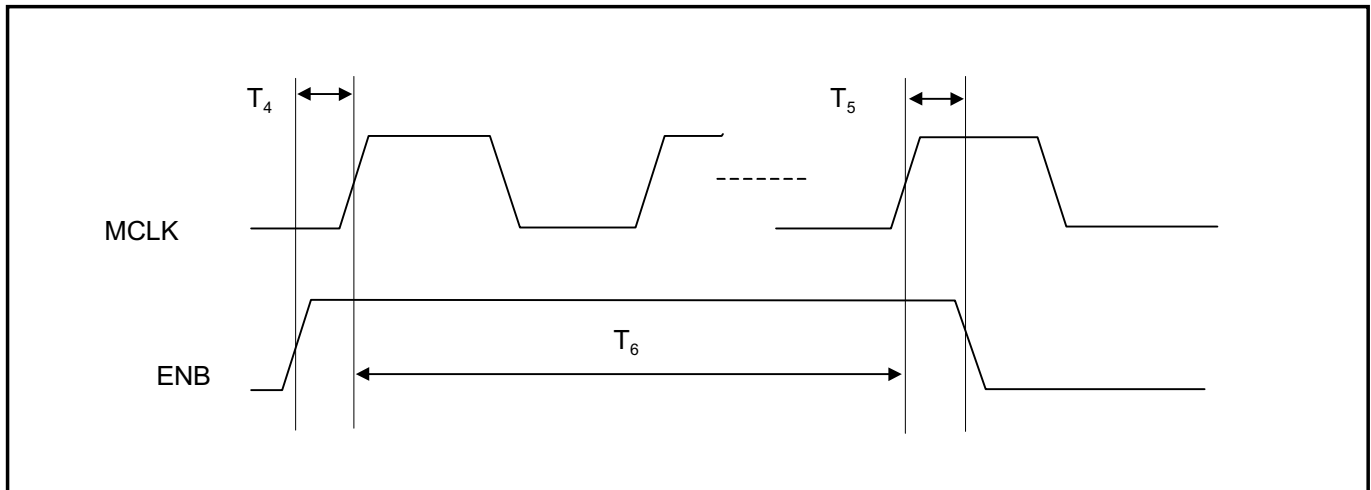


$T_3$  : MCLK rising to DATA Valid maximum Time : 18ns [output load: 60pF]

**Note)** HSYNC signal is high when valid data is on the DATA bus.

## INPUT / OUTPUT AC CHARACTERISTICS (Continue)

### ENB Timing



$T_4$  : ENB Setup Time : 5ns

$T_5$  : ENB Hold Time : 5ns

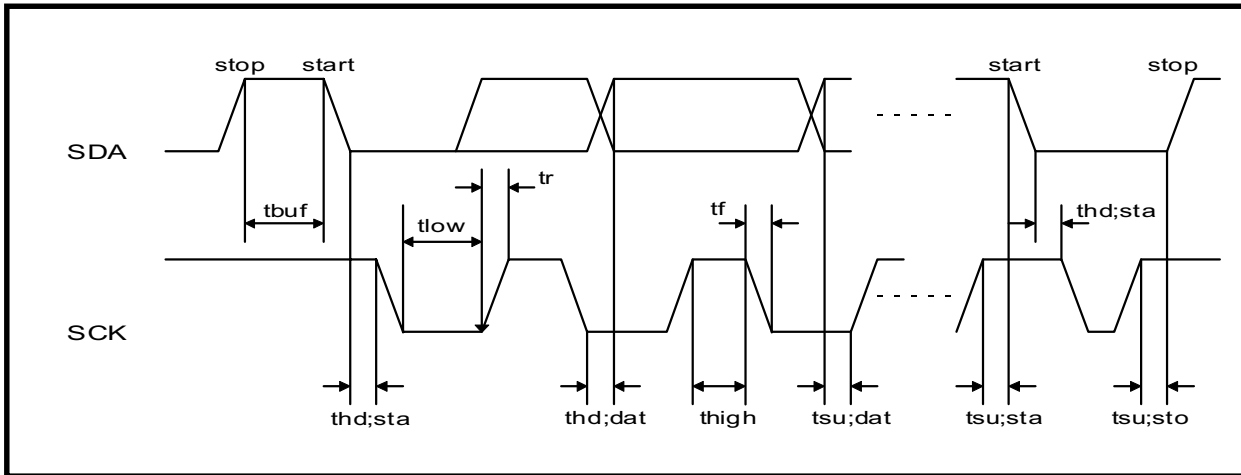
$T_6$  : ENB Valid Time : minimum 2 Clock

### RESET Timing

Must in Valid (active LOW) state at least 8MCLK periods

## INPUT / OUTPUT AC CHARACTERISTICS (Continue)

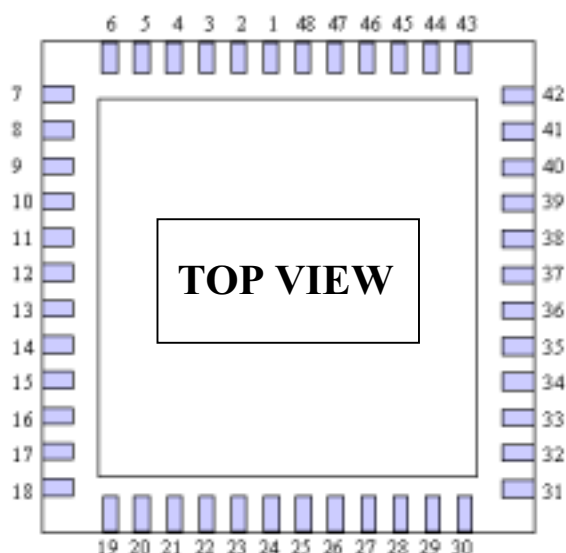
### I<sup>2</sup>C Bus (Programming Serial Bus) Timing



### I<sup>2</sup>C Bus Interface Timing

| Parameter                                                          | Symbol          | Min. | Max. | Unit |
|--------------------------------------------------------------------|-----------------|------|------|------|
| SCK clock frequency                                                | $f_{sck}$       | 0    | 400  | KHz  |
| Time that IIC bus must be free before a new transmission can start | $t_{buf}$       | 1.2  |      | us   |
| Hold time for a START                                              | $t_{hd};s_{ta}$ | 1.0  |      | us   |
| LOW period of SCK                                                  | $t_{low}$       | 1.2  |      | us   |
| HIGH period of SCK                                                 | $t_{high}$      | 1.0  |      | us   |
| Setup time for START                                               | $t_{su};s_{ta}$ | 1.2  |      | us   |
| Data hold time                                                     | $t_{hd};d_{at}$ | 1.3  |      | us   |
| Data setup time                                                    | $t_{su};d_{at}$ | 250  |      | ns   |
| Rise time of both SDA and SCK                                      | $t_r$           |      | 250  | ns   |
| Fall time of both SDA and SCK                                      | $t_f$           |      | 300  | ns   |
| Setup time for STOP                                                | $t_{su};s_{to}$ | 1.2  |      | us   |
| Capacitive load of each bus lines(SDA,SCK)                         | $C_b$           |      |      | pf   |

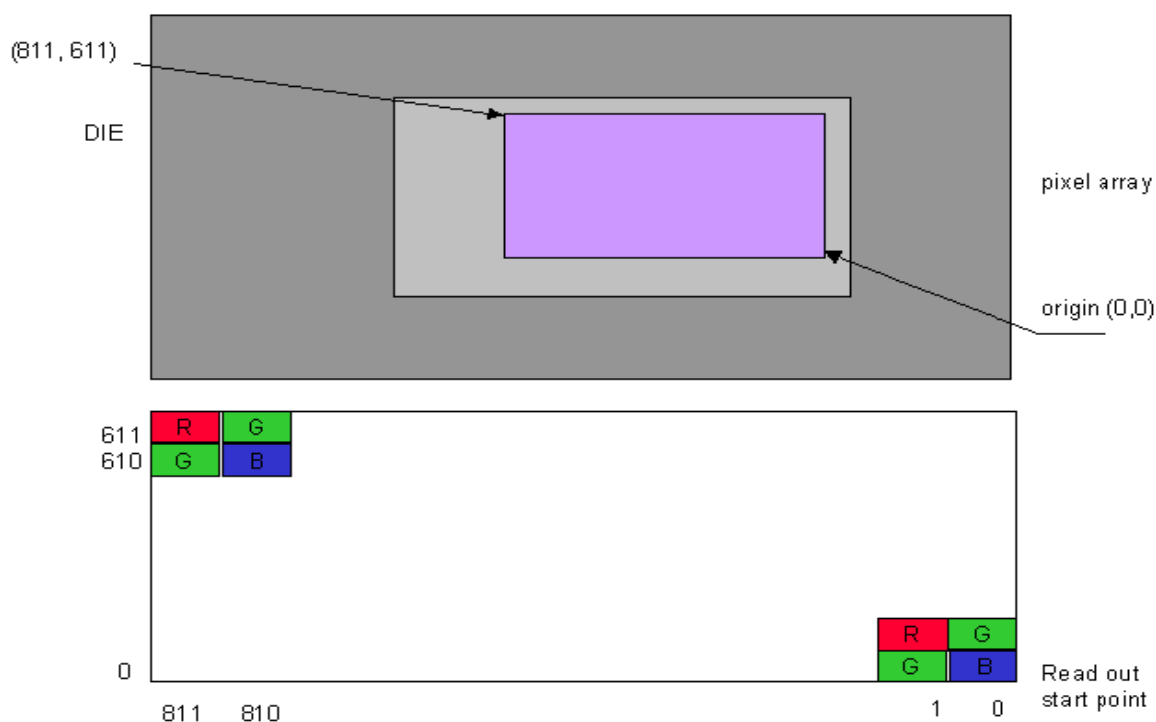
## PIN CONFIGURATION



| PIN NO. | NAME  | PIN NO. | NAME  |
|---------|-------|---------|-------|
| 1       | SCK   | 26      | DGND  |
| 2       | DGND  | 27      | DATA3 |
| 3       | ENB   | 28      | DATA2 |
| 4       | DGND  | 29      | DATA1 |
| 5       | MCLK  | 30      | DATA0 |
| 6       | VDD5  | 31      | DVDD  |
| 7       | AVDD  | 32      | DGND  |
| 8       | AGND  | 42      | DVDD  |
| 17      | AGND  | 43      | RESET |
| 18      | AVDD  | 44      | VSYNC |
| 21      | DGND  | 45      | HSYNC |
| 22      | DATA7 | 46      | DGND  |
| 23      | DATA6 | 47      | SDA   |
| 24      | DATA5 | 48      | DGND  |
| 25      | DATA4 |         |       |

Pin9~16, Pin19~20, Pin33~41 : No Connection

## COLOR PATTERN





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**PIN DESCRIPTION**

| PIN     | NAME           | I/O | DESCRIPTION                                                                                                                             |
|---------|----------------|-----|-----------------------------------------------------------------------------------------------------------------------------------------|
| 1       | SCK            | I   | I <sup>2</sup> C Clock ; I <sup>2</sup> C clock control from I <sup>2</sup> C master                                                    |
| 2       | DGND           | I   | Digital Ground                                                                                                                          |
| 3       | ENB            | I   | Sensor Enable Signal ; 'H' enable normal operation<br>'L' disable sensor                                                                |
| 4       | DGND           | I   | Digital Ground                                                                                                                          |
| 5       | MCLK           | I   | Master Clock (up to 20MHz)<br>; Global master clock for image sensor internal timing control                                            |
| 6       | VDD5           | I   | I/O bias voltage for 5V tolerant *1)                                                                                                    |
| 7       | AVDD           | I   | Analog Supply Voltage 3.3V                                                                                                              |
| 8       | AGND           | I   | Analog Ground                                                                                                                           |
| 9 ~ 16  | N.C            |     | No Connection                                                                                                                           |
| 17      | AGND           | I   | Analog Ground                                                                                                                           |
| 18      | AVDD           | I   | Analog Supply Voltage 3.3V                                                                                                              |
| 19, 20  | Reserved       |     | Reserved                                                                                                                                |
| 21      | DGND           | I   | Digital Ground                                                                                                                          |
| 22      | DATA7          | O   | Image Data bit 7                                                                                                                        |
| 23      | DATA6          | O   | Image Data bit 6                                                                                                                        |
| 24      | DATA5          | O   | Image Data bit 5                                                                                                                        |
| 25      | DATA4          | O   | Image Data bit 4                                                                                                                        |
| 26      | DGND           | I   | Digital Ground                                                                                                                          |
| 27      | DATA3          | O   | Image Data bit 3                                                                                                                        |
| 28      | DATA2          | O   | Image Data bit 2                                                                                                                        |
| 29      | DATA1          | O   | Image Data bit 1                                                                                                                        |
| 30      | DATA0          | O   | Image Data bit 0                                                                                                                        |
| 31      | DVDD           | I   | Digital Supply Voltage 3.3V                                                                                                             |
| 32      | DGND           | I   | Digital Ground                                                                                                                          |
| 33 ~ 41 | N.C            |     | No Connection                                                                                                                           |
| 42      | DVDD           | I   | Digital Supply Voltage 3.3V                                                                                                             |
| 43      | RESET          | I   | Hardware Reset Signal, Active Low                                                                                                       |
| 44      | VSYNC          | O   | Vertical synchronization signal / Frame start output<br>; Signal pulse at start of image data frame with programmable blanking duration |
| 45      | HSYNC / DVALID | O   | Horizontal synchronization signal / Data valid output<br>; Data valid when 'H' with programmable blanking duration                      |
| 46      | DGND           | I   | Digital Ground                                                                                                                          |
| 47      | SDA            | I/O | I <sup>2</sup> C Data ; I <sup>2</sup> C standard data I/O port                                                                         |
| 48      | DGND           | I   | Digital Ground                                                                                                                          |

\*1) Tie to DVDD for 3.3V operation / Tie to 5V for 5V tolerant operation

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## REGISTER DESCRIPTION

### MODE\_B

This is operating mode select register. Each bit's description is as below.

| Bit | Function                | Description                                                                                                                                                                                                                                                                                                           |
|-----|-------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0   | Integration time unit   | Integration time is controlled by register 25H, 26H<br>Integration time register value's unit will be changed by this bit setting, as line or pixel unit. Line mode is general, but under high light intensity Condition, or need of precise integration time control, pixel mode is used. Default is line mode.      |
| 1   | Shot mode               | Continuous frame mode : The sensor outputs the sensing data Consecutively. That is, sensor updates frame buffer data continuously after Reading out.<br>Single shot frame mode : Sensor stops updating frame buffer after only one frame data storing to catch just one picture frame.<br>Default is continuous mode. |
| 3   | HSYNC pin configuration | HSYNC only mode: HSYNC pin outputs the HSYNC signal only.<br>HSYNC & internal clock mode : HSYNC pin outputs 'Anding' signal of HSYNC signal and internal pixel clock. Use this mode to get pixel data and pixel clock both from the sensor<br>Default is HSYNC only mode                                             |
| 5,4 | Output data type        | Three output data types : data - reference, data only and reference only<br>For CDS(correlated double sampling), the sensor measured the reference and data respectively. To get rid of circuit noise, the sensor execute CDS. Default is data - reference (CDS).                                                     |

### MODE\_C

This is operating mode select register. Each bit's description is as below

| Bit | Function        | Description                                                                                                                           |
|-----|-----------------|---------------------------------------------------------------------------------------------------------------------------------------|
| 1   | Display Mode    | Color Mode : Color Output<br>Black & White Mode : Black & White Output<br>; In this mode pixel output is controlled by 'G' gain only. |
| 2   | Power Down Mode | Enable Analog Block Power Down<br>Disable Analog Block Power Down                                                                     |

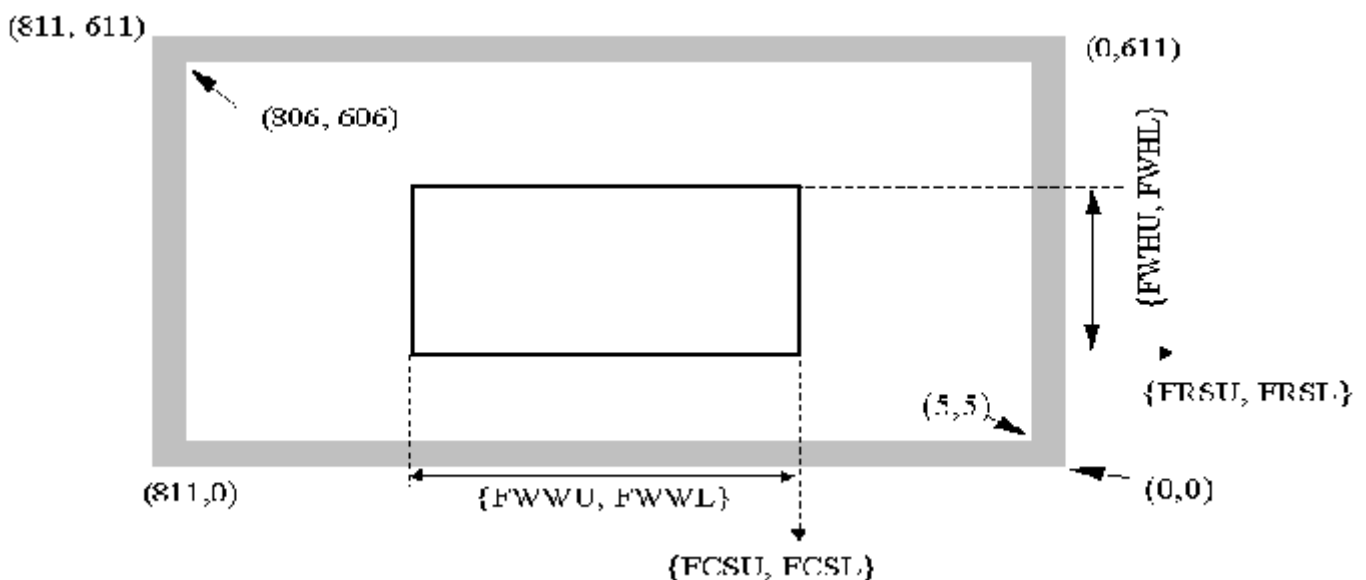
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## REGISTER DESCRIPTION (continue)

### FRAME REGISTER

The HV7141D can read any user specific window area within total effective window.

This is called panning function. For this function, 'row start', 'column start', 'width', 'height' can be programmed with four 4 registers, FRS(Frame Row Start), FCS(Frame Column Start), FWH(Frame Window Height), FWW(Frame Window Width). Panning window can be programmed as below.



**Note1)** Accessible pixel array size is 812X612

The edge of accessible pixel array may be commonly dedicated for just color interpolation.

In the case of a color image sensor the interpolation is needed to get all R,G,B color value for each pixel of a color image.

So, one more extra pixel line is needed at the edge of pixel array than what want to display.

That is, to make 800X600 effective window, 802X602 pixel array is necessary. You have to consider this interpolation line when you program the 'Frame register'. For example, If you want to get 300X250 image size, you have to program 302X252 to frame register.

**Note2)** You have to change the frame register value as below to get the full 800X600 window size.

|            |   |            |     |
|------------|---|------------|-----|
| FRSU, FRSL | 5 | FWHU, FWHL | 602 |
| FCSU, FCSL | 5 | FWWU, FWWL | 802 |



## CONTROL REGISTER DESCRIPTION (continue)

### CONTROL REGISTER

Control registers is divided into timing related register and adjust register.

### TIMING RELATED REGISTER

#### ● HSYNC blank register

The HSYNC blank register defines the active period of HSYNC output and the programming unit is pixel clock.

This low active signal defines boundary of each line. The pixel data output is valid while HSYNC is high. The value programmed to HSYNC blank register defines HSYNC low period under the 'full window size mode operation.(refer to timing diagram).

If the display window width is decreased by frame register's programming, the actual HSYNC blank register is increased as much as decreasing of window width automatically. (refer to timing diagram)

#### ● VSYNC blank register

The VSYNC blank register defines the active period of VSYNC output and the programming unit is line.

This high active signal defines boundary of each frame. Same as HSYNC, VSYNC register value also has a meaning under the full window size mode. That is, VSYNC blank register value means VSYNC high period under the full window size mode. According to variation of display window height by programming of frame register, VSYNC high active duration is also increased.

#### ● Integration time value register

Integration time value register defines integration time.

This is same as exposure time in a camera. So, at dark condition, long integration time is necessary.

The unit is changed by value of MODE\_B register's bit 0 as pixel or line.

#### ● Master clock divider register

This four bits register is used to divide external pixel clock frequency for internal use. The actual pixel operating frequency used in the sensor is same as external pixel frequency divided by divisor as below.

| Register value | Divisor | Register value | Divisor | Register value | Divisor |
|----------------|---------|----------------|---------|----------------|---------|
| 0              | 1       | 4              | 16      | 8              | 256     |
| 1              | 2       | 5              | 32      | 9              | 512     |
| 2              | 4       | 6              | 64      | 10             | 1024    |



|   |   |   |     |    |      |
|---|---|---|-----|----|------|
| 3 | 8 | 7 | 128 | 11 | 2048 |
|---|---|---|-----|----|------|

## REGISTER DESCRIPTION (continue)

### ADJUST REGISTER

Each chip has a little different photo-diode characteristics. So, some calibration of sensing circuit is needed to get the optimal performance. The adjust register is designed for this calibration purpose. There are three kinds of registers as below.

- **Reset level register**

The register controls the voltage level that is initially compared to pixel analog voltage, and the initial voltage level is called as "reference voltage level". Internal DAC analog voltage decrements from reference voltage level until the pixel analog voltage output is larger than DAC analog voltage. Appropriate reference voltage level varies from various factors, such as process variation, luminance, etc. If the register value is set to too large or too small value, vertical fixed pattern noise may be produced. Therefore this register value must be programmed to appropriate value in order to avoid FPN. For the automatic reset level control, please refer to Reset Level Statistics Register Section. High register value means high reference voltage and large digital output. Program value range is 0~63, User should refer to the "RESET LEVEL CONTROL" application notes for proper using this register.

- **RGB gain register**

There are three color gain registers for R, G, B pixels, respectively. These registers are used to amplify digital pixel output. If the gain register value is decreased, digital pixel output is increased. That is, under dark light condition the pixel output is not enough to get right image so that we must amplify the output value by decreasing gain value to get good image. These registers may be used for white balance and color effect with independent R,G,B color control. Program value range is 0~63. However, we recommend that the range should be 30~60 for capturing good image quality.

- **Pixel bias voltage register**

This register controls pixel reference level by controlling bias current of pixel output sensing load Transistor.

It controls pixel output level itself, compare with that reset level register adjust ADC circuit to calibrate reference level for data reading. Available program range is 0~7. The larger register value causes the higher bias current to decrease pixel output reference level.



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## REGISTER DESCRIPTION (continue)

### RESET LEVEL STATISTICS REGISTER

- **Low Reset Level Count[<5]**

This two-byte register has a value representing a eighth (1/8) of pixels that have reset value less than 5 during one frame time and is updated when VSYNC gets active.

With high reset level counter register it can be used as a parameter for external automatic reset level control logic that update the appropriate value in the reset level register to automatically compensate die to die overall reset level variation.

- **High Reset Level Count[ > 147]**

This two byte register has a value representing a eighth (1/8) of pixels that have reset value larger than 147 during one frame time and is updated when VSYNC gets active.

With low reset level counter register it can be used as a parameter for external automatic reset level control logic that update the appropriate value in the reset level (30H) register to automatically compensate die to die overall reset level variation.

### OFFSET REGISTER

- **Offset R register**

Specify the offset value for R pixels

- **Offset G register**

Specify the offset value for G pixels

- **Offset B register**

Specify the offset value for B pixels



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## REGISTER ADDRESS AND DEFAULT VALUE

| Group                                                                                                                                        | Symbol | Address                                                                                                                                        | Description                                                                                                                                                                                                                                                                                  |    |                              |                          |   |   |                              |   |   |                 |   |   |            |   |   |          |
|----------------------------------------------------------------------------------------------------------------------------------------------|--------|------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|------------------------------|--------------------------|---|---|------------------------------|---|---|-----------------|---|---|------------|---|---|----------|
| Mode-Registers                                                                                                                               | MODE_A | 00H                                                                                                                                            | Reserved                                                                                                                                                                                                                                                                                     |    |                              |                          |   |   |                              |   |   |                 |   |   |            |   |   |          |
|                                                                                                                                              | MODE_B | 01H                                                                                                                                            | Operating Mode Selection ( Default : 04H )                                                                                                                                                                                                                                                   |    |                              |                          |   |   |                              |   |   |                 |   |   |            |   |   |          |
|                                                                                                                                              |        |                                                                                                                                                | <table><tr><td>b0</td><td>0</td><td>Line Unit Integration</td></tr><tr><td></td><td>1</td><td>Pixel Unit Integration</td></tr></table>                                                                                                                                                       | b0 | 0                            | Line Unit Integration    |   | 1 | Pixel Unit Integration       |   |   |                 |   |   |            |   |   |          |
|                                                                                                                                              |        |                                                                                                                                                | b0                                                                                                                                                                                                                                                                                           | 0  | Line Unit Integration        |                          |   |   |                              |   |   |                 |   |   |            |   |   |          |
|                                                                                                                                              |        |                                                                                                                                                |                                                                                                                                                                                                                                                                                              | 1  | Pixel Unit Integration       |                          |   |   |                              |   |   |                 |   |   |            |   |   |          |
|                                                                                                                                              |        |                                                                                                                                                | <table><tr><td>b1</td><td>0</td><td>Continuous Frame</td></tr><tr><td></td><td>1</td><td>Single Shot Frame</td></tr></table>                                                                                                                                                                 | b1 | 0                            | Continuous Frame         |   | 1 | Single Shot Frame            |   |   |                 |   |   |            |   |   |          |
|                                                                                                                                              |        |                                                                                                                                                | b1                                                                                                                                                                                                                                                                                           | 0  | Continuous Frame             |                          |   |   |                              |   |   |                 |   |   |            |   |   |          |
|                                                                                                                                              |        |                                                                                                                                                |                                                                                                                                                                                                                                                                                              | 1  | Single Shot Frame            |                          |   |   |                              |   |   |                 |   |   |            |   |   |          |
|                                                                                                                                              |        |                                                                                                                                                | <table><tr><td>b2</td><td>0</td><td>Reserved</td></tr><tr><td></td><td>1</td><td>Windowed Image</td></tr></table>                                                                                                                                                                            | b2 | 0                            | Reserved                 |   | 1 | Windowed Image               |   |   |                 |   |   |            |   |   |          |
|                                                                                                                                              |        |                                                                                                                                                | b2                                                                                                                                                                                                                                                                                           | 0  | Reserved                     |                          |   |   |                              |   |   |                 |   |   |            |   |   |          |
|                                                                                                                                              |        |                                                                                                                                                |                                                                                                                                                                                                                                                                                              | 1  | Windowed Image               |                          |   |   |                              |   |   |                 |   |   |            |   |   |          |
|                                                                                                                                              |        |                                                                                                                                                | <table><tr><td>b3</td><td>0</td><td>HSYNC only</td></tr><tr><td></td><td>1</td><td>HSYNC &amp; Internal Clock</td></tr></table>                                                                                                                                                              | b3 | 0                            | HSYNC only               |   | 1 | HSYNC & Internal Clock       |   |   |                 |   |   |            |   |   |          |
|                                                                                                                                              |        |                                                                                                                                                | b3                                                                                                                                                                                                                                                                                           | 0  | HSYNC only                   |                          |   |   |                              |   |   |                 |   |   |            |   |   |          |
|                                                                                                                                              |        |                                                                                                                                                |                                                                                                                                                                                                                                                                                              | 1  | HSYNC & Internal Clock       |                          |   |   |                              |   |   |                 |   |   |            |   |   |          |
|                                                                                                                                              |        |                                                                                                                                                | <table><tr><td>b5</td><td>b4</td><td>Output Data Type</td></tr><tr><td>0</td><td>0</td><td>Data_Level - Reference_Level</td></tr><tr><td>0</td><td>1</td><td>Reference_Level</td></tr><tr><td>1</td><td>0</td><td>Data_Level</td></tr><tr><td>1</td><td>1</td><td>reserved</td></tr></table> | b5 | b4                           | Output Data Type         | 0 | 0 | Data_Level - Reference_Level | 0 | 1 | Reference_Level | 1 | 0 | Data_Level | 1 | 1 | reserved |
|                                                                                                                                              |        |                                                                                                                                                | b5                                                                                                                                                                                                                                                                                           | b4 | Output Data Type             |                          |   |   |                              |   |   |                 |   |   |            |   |   |          |
|                                                                                                                                              |        |                                                                                                                                                | 0                                                                                                                                                                                                                                                                                            | 0  | Data_Level - Reference_Level |                          |   |   |                              |   |   |                 |   |   |            |   |   |          |
|                                                                                                                                              |        |                                                                                                                                                | 0                                                                                                                                                                                                                                                                                            | 1  | Reference_Level              |                          |   |   |                              |   |   |                 |   |   |            |   |   |          |
|                                                                                                                                              |        |                                                                                                                                                | 1                                                                                                                                                                                                                                                                                            | 0  | Data_Level                   |                          |   |   |                              |   |   |                 |   |   |            |   |   |          |
|                                                                                                                                              |        |                                                                                                                                                | 1                                                                                                                                                                                                                                                                                            | 1  | reserved                     |                          |   |   |                              |   |   |                 |   |   |            |   |   |          |
|                                                                                                                                              |        |                                                                                                                                                | <table><tr><td>b7</td><td>b6</td><td>Operating Mode</td></tr><tr><td>0</td><td>0</td><td>Normal Mode</td></tr><tr><td>0</td><td>1</td><td>Reserved</td></tr><tr><td>1</td><td>0</td><td>Reserved</td></tr><tr><td>1</td><td>1</td><td>Reserved</td></tr></table>                             | b7 | b6                           | Operating Mode           | 0 | 0 | Normal Mode                  | 0 | 1 | Reserved        | 1 | 0 | Reserved   | 1 | 1 | Reserved |
|                                                                                                                                              |        |                                                                                                                                                | b7                                                                                                                                                                                                                                                                                           | b6 | Operating Mode               |                          |   |   |                              |   |   |                 |   |   |            |   |   |          |
|                                                                                                                                              | 0      | 0                                                                                                                                              | Normal Mode                                                                                                                                                                                                                                                                                  |    |                              |                          |   |   |                              |   |   |                 |   |   |            |   |   |          |
| 0                                                                                                                                            | 1      | Reserved                                                                                                                                       |                                                                                                                                                                                                                                                                                              |    |                              |                          |   |   |                              |   |   |                 |   |   |            |   |   |          |
| 1                                                                                                                                            | 0      | Reserved                                                                                                                                       |                                                                                                                                                                                                                                                                                              |    |                              |                          |   |   |                              |   |   |                 |   |   |            |   |   |          |
| 1                                                                                                                                            | 1      | Reserved                                                                                                                                       |                                                                                                                                                                                                                                                                                              |    |                              |                          |   |   |                              |   |   |                 |   |   |            |   |   |          |
| MODE_C                                                                                                                                       | 02H    | <table><tr><td>b0</td><td>0</td><td>8 bit mode</td><td rowspan="2">Default :00H</td></tr><tr><td></td><td>1</td><td>Reserved</td></tr></table> | b0                                                                                                                                                                                                                                                                                           | 0  | 8 bit mode                   | Default :00H             |   | 1 | Reserved                     |   |   |                 |   |   |            |   |   |          |
| b0                                                                                                                                           | 0      | 8 bit mode                                                                                                                                     | Default :00H                                                                                                                                                                                                                                                                                 |    |                              |                          |   |   |                              |   |   |                 |   |   |            |   |   |          |
|                                                                                                                                              | 1      | Reserved                                                                                                                                       |                                                                                                                                                                                                                                                                                              |    |                              |                          |   |   |                              |   |   |                 |   |   |            |   |   |          |
| <table><tr><td>b1</td><td>0</td><td>Color Output</td></tr><tr><td></td><td>1</td><td>Black &amp; White Output</td></tr></table>              | b1     | 0                                                                                                                                              | Color Output                                                                                                                                                                                                                                                                                 |    | 1                            | Black & White Output     |   |   |                              |   |   |                 |   |   |            |   |   |          |
| b1                                                                                                                                           | 0      | Color Output                                                                                                                                   |                                                                                                                                                                                                                                                                                              |    |                              |                          |   |   |                              |   |   |                 |   |   |            |   |   |          |
|                                                                                                                                              | 1      | Black & White Output                                                                                                                           |                                                                                                                                                                                                                                                                                              |    |                              |                          |   |   |                              |   |   |                 |   |   |            |   |   |          |
| <table><tr><td>b2</td><td>0</td><td>Disable Analog Power Down</td></tr><tr><td></td><td>1</td><td>Enable Analog Power Down</td></tr></table> | b2     | 0                                                                                                                                              | Disable Analog Power Down                                                                                                                                                                                                                                                                    |    | 1                            | Enable Analog Power Down |   |   |                              |   |   |                 |   |   |            |   |   |          |
| b2                                                                                                                                           | 0      | Disable Analog Power Down                                                                                                                      |                                                                                                                                                                                                                                                                                              |    |                              |                          |   |   |                              |   |   |                 |   |   |            |   |   |          |
|                                                                                                                                              | 1      | Enable Analog Power Down                                                                                                                       |                                                                                                                                                                                                                                                                                              |    |                              |                          |   |   |                              |   |   |                 |   |   |            |   |   |          |

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**HV7141D**  
**CMOS IMAGE SENSOR**  
**With 8-bit ADC**

## REGISTER ADDRESS AND DEFAULT VALUE ( continue )

| Group                           | Symbol   | Address | Description                                  | Default      |       |
|---------------------------------|----------|---------|----------------------------------------------|--------------|-------|
| Frame-Registers                 | FRSU     | 10H     | Row Start Address (Upper byte )              | 00H          | [5]   |
|                                 | FRSL     | 11H     | Row Start Address ( Lower byte )             | 05H          |       |
|                                 | FCSU     | 12H     | Column start Address ( Upper byte )          | 00H          | [5]   |
|                                 | FCSL     | 13H     | Column start Address ( Lower byte )          | 05H          |       |
|                                 | FWHU     | 14H     | Window Height ( Upper byte )                 | 02H          | [602] |
|                                 | FWHL     | 15H     | Window Height ( Lower byte )                 | 5aH          |       |
|                                 | FWWU     | 16H     | Window Width ( Upper byte )                  | 03H          | [802] |
|                                 | FWWL     | 17H     | Window Width ( Lower byte )                  | 22H          |       |
| Timing-Register                 | THBU     | 20H     | HSYNC Blanking Duration value ( Upper byte ) | Default :00H |       |
|                                 | THBL     | 21H     | HSYNC Blanking Duration value ( Lower byte ) | 03H          |       |
|                                 | TVBU     | 22H     | VSYNC Blanking Duration value ( Upper byte ) | 00H          |       |
|                                 | TVBL     | 23H     | VSYNC Blanking Duration value ( Lower byte ) | 03H          |       |
|                                 | TITU     | 25H     | Integration Time value ( Upper byte )        | 00H          |       |
|                                 | TITM     | 26H     | Integration Time value ( Middle byte )       | 01H          |       |
|                                 | TITL     | 27H     | Integration Time value ( Lower byte )        | F4H          |       |
|                                 | TMCD     | 28H     | Master Clock Divider                         | 00H          |       |
| Adjust-Register                 | ARLV     | 30H     | Reset Level Value                            | 28H          |       |
|                                 | ARCG     | 31H     | Red Color Gain                               | 28H          |       |
|                                 | AGCG     | 32H     | Green Color Gain                             | 28H          |       |
|                                 | ABCG     | 33H     | Blue Color Gain                              | 28H          |       |
|                                 | APBV     | 34H     | Pixel Bias Voltage Control                   | 02H          |       |
| Offset Register                 | OFSR     | 50H     | R Offset Register (Test purpose Only)        | 00H          |       |
|                                 | OFSG     | 51H     | G offset Register (Test purpose Only)        | 00H          |       |
|                                 | OFSB     | 52H     | B offset Register (Test purpose Only)        | 00H          |       |
| Reset Level Statistics Register | LoREfNOH | 57H     | Low Reset Level Counter [<3] (Upper byte)    | (Read Only)  |       |
|                                 | LoREfNOL | 58H     | Low Reset Level Counter [<3] (Lower byte)    | (Read Only)  |       |
|                                 | HiRefNOH | 59H     | High Reset Level Counter [>147] (Upper byte) | (Read Only)  |       |
|                                 | HiRefNOL | 5AH     | High Reset Level Counter [>147] (Lower byte) | (Read Only)  |       |

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## PROGRAMMING SEQUENCE FOR CMOS IMAGE SENSOR

### ● Single Register Byte Programming

|    |     |    |     |    |             |    |    |
|----|-----|----|-----|----|-------------|----|----|
| S  | 22H | A  | 01H | A  | mode inform | A  | P  |
| *1 | *2  | *3 | *4  | *5 | *6          | *7 | *8 |

⇒ Set "Operating Mode" register into Window mode

- \*1. Drive: I<sup>2</sup>C start condition
- \*2. Drive: 22H(001\_0001 + 0) [device address + R/W bit]
- \*3. Read: acknowledge from sensor
- \*4. Drive: 01H [sub-address]
- \*5. Read: acknowledge from sensor
- \*6. Drive: 04H [mode information]
- \*7. Read: acknowledge from sensor
- \*8. Drive: I<sup>2</sup>C stop condition

### ● Multiple Register Byte Programming using Auto increment Mode

|    |     |    |     |    |     |    |     |    |     |
|----|-----|----|-----|----|-----|----|-----|----|-----|
| S  | 22H | A  | 01H | A  | 02H | A  | 65H | A  | P   |
| *1 | *2  | *3 | *4  | *5 | *6  | *7 | *8  | *9 | *10 |

⇒ You can program multiple configuration registers with single I<sup>2</sup>C bus cycle.

⇒ Set "Row Start Address" register as 265H

- \*1. Drive: I<sup>2</sup>C start condition
- \*2. Drive: 22H(001\_0001 + 0) [device address + R/W bit]
- \*3. Read: acknowledge from sensor
- \*4. Drive: 01H [sub-address]
- \*5. Read: acknowledge from sensor
- \*6. Drive: 02H [row start address upper byte]
- \*7. Read: acknowledge from sensor
- \*8. Drive: 65H [row start address lower byte]
- \*9. Read: acknowledge from sensor
- \*10. Drive : I<sup>2</sup>C stop condition



## PROGRAMMING SEQUENCE FOR CMOS IMAGE SENSOR ( continue )

- **Reading Register Value**

|    |     |    |     |    |    |     |    |           |     |   |
|----|-----|----|-----|----|----|-----|----|-----------|-----|---|
| S  | 22H | A  | 01H | A  | S  | 23H | A  | Read Data | A   | P |
| *1 | *2  | *3 | *4  | *5 | *6 | *7  | *8 | *9        | *10 |   |

⇒ Single Read or Auto-Increment Read

⇒ Set "Reset Level Value" register

\*1. Drive: I<sup>2</sup>C start condition

\*2. Drive: 22H(001\_0001 + 0) [device address + R/W bit(be careful. R/W=0)]

\*3. Read: acknowledge from sensor

\*4. Drive: 01H [sub-address]

\*5. Read: acknowledge from sensor

\*6. Drive: I<sup>2</sup>C start condition

\*7. Drive: 23H(001\_0001 + 1) [device address + R/W bit(be careful. R/W=1)]

\*8. Read: acknowledge from sensor

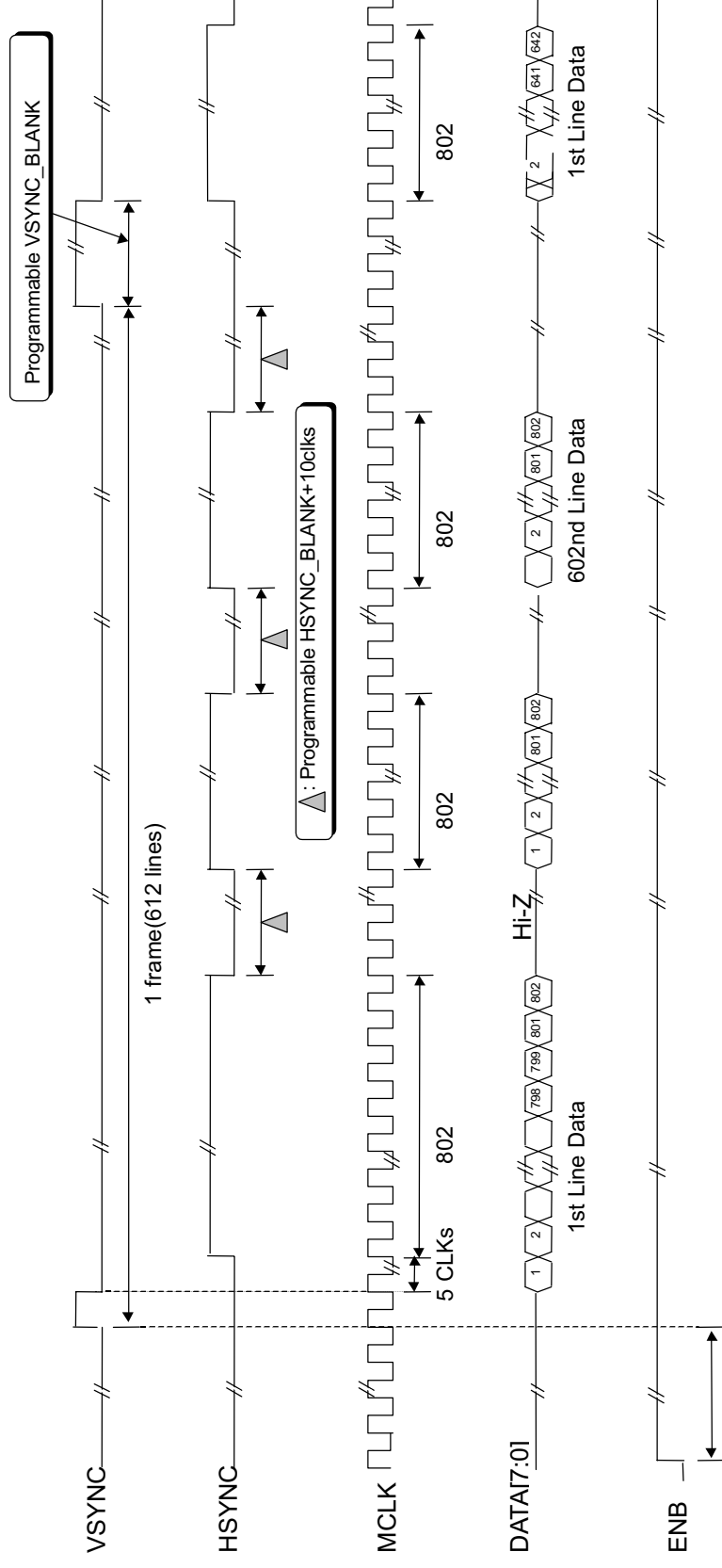
\*9. Read: Read Data from sensor

\*10. Drive: acknowledge to sensor(if there is no more read data Ack=1, else Ack=0)

\*11. Drive : I<sup>2</sup>C stop condition

## TIMING DIAGRAM

### 1. Synchronous Readout Mode @ Full sized image (802x602)

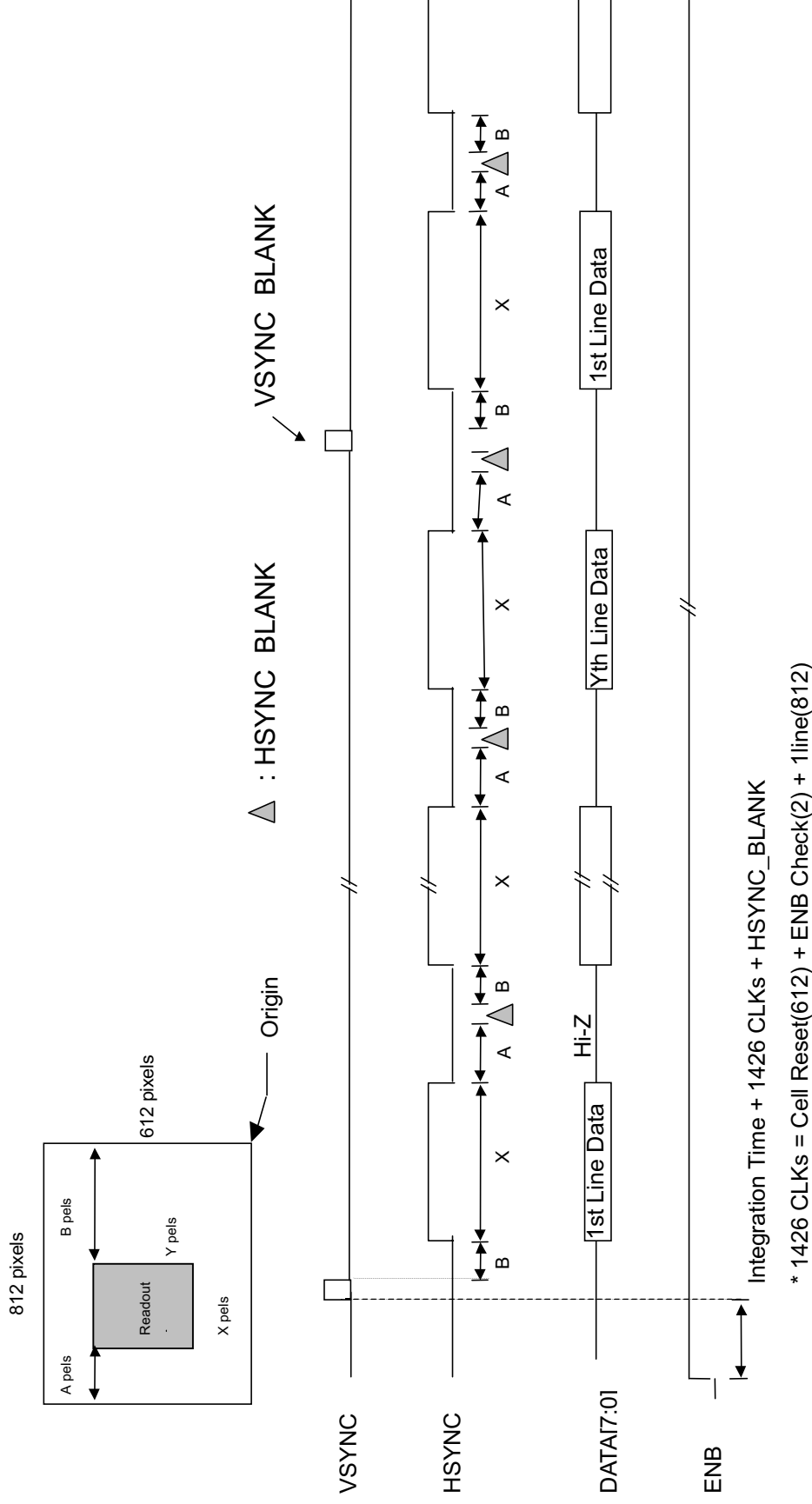


Integration Time + 1426 CLKs + HSYNC\_BLANK

\* 1426 CLKs = Cell Reset(612) + ENB Check(2) + 1line(812)

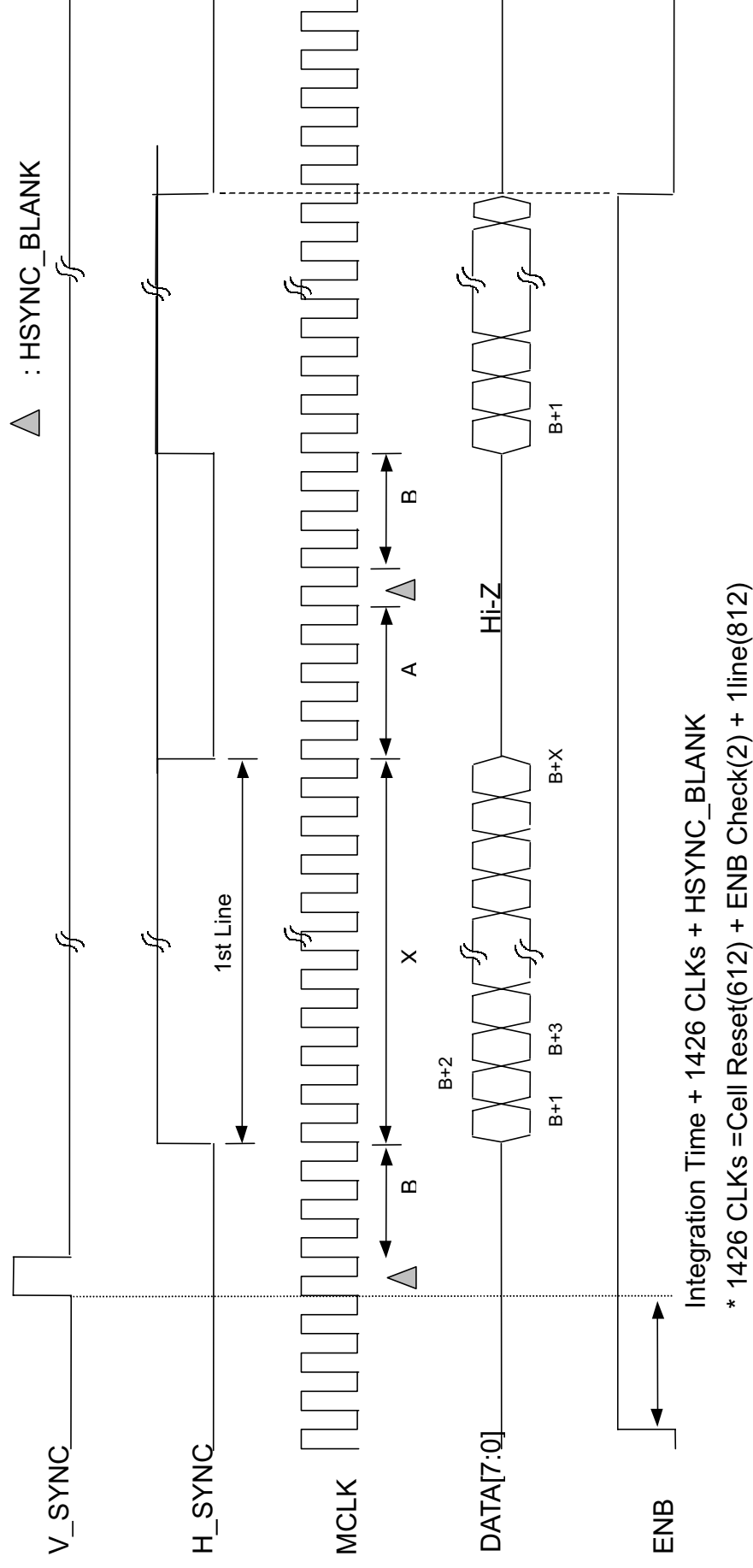
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## 2. Synchronous Readout Mode @ Windowed image ( X \* Y pixels )



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## 2. Synchronous Readout Mode @ Windowed image ( X \* Y pixels ) – Continued



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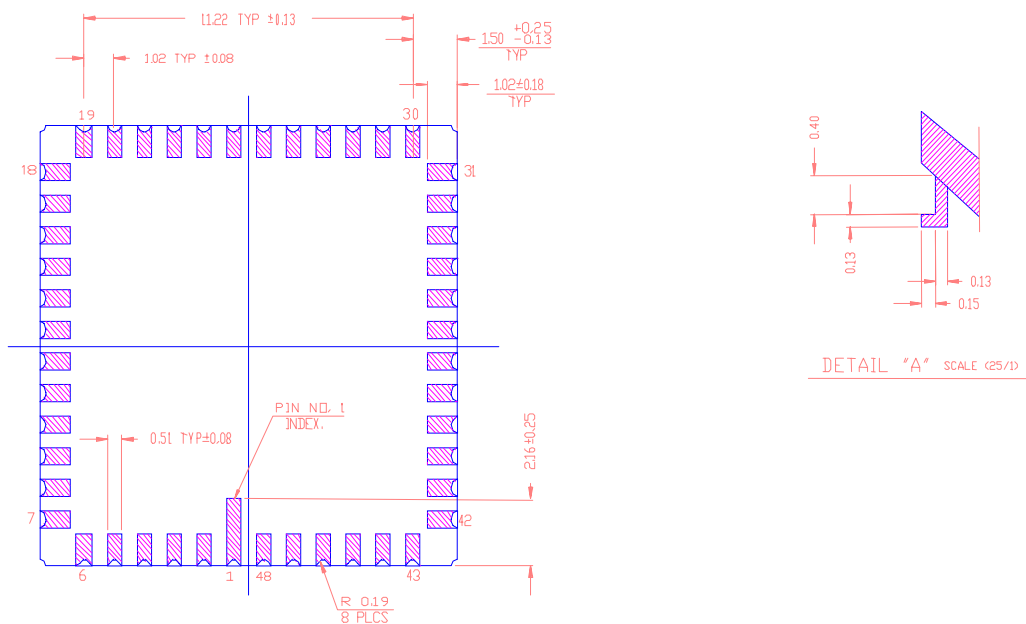
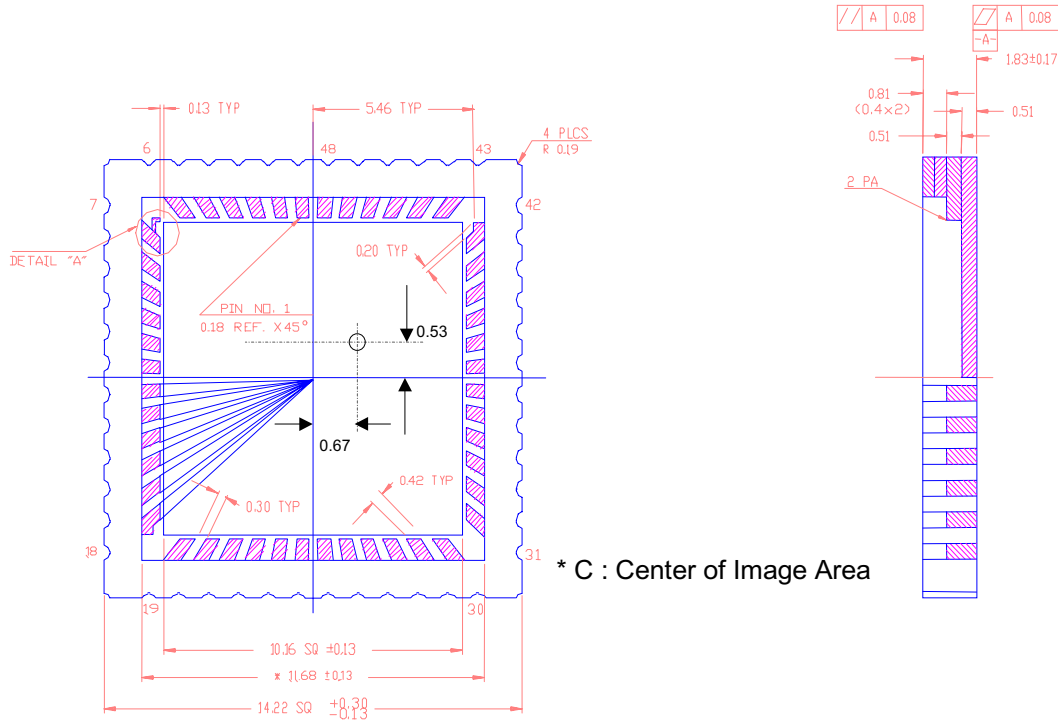
# HV7141D

## CMOS IMAGE SENSOR

### With 8-bit ADC

#### PACKAGE DISMENSION (48 PIN CLCC)

UNIT: mm



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**HV7141D**  
**CMOS IMAGE SENSOR**  
**With 8-bit ADC**

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## MEMO

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