

# 1/6-Inch SOC (Optional) VGA CMOS Digital Image Sensor Product Brief with ODS

**ST9V112-S Select (SOC0366)**
**ST9V112-G General (0366)**
**(Mfg part number GXMK12A [packaged] / Mfg part number WXUK12A [die])**

## Full Sensor Features

- Micron<sup>®</sup> DigitalClarity<sup>™</sup> CMOS Imaging technology
- Ultra-low power, low cost, progressive scan CMOS image sensor
- Superior low-light performance
- Filtered image downscaling to arbitrary size with smooth, continuous zoom and pan
- Fully automatic Xenon and LED-type flash support, fast exposure adaptation
- System-On-a-Chip (SOC)—Completely integrated camera system
- On-chip image flow processor (IFP) performs sophisticated processing:
  - Color recovery and correction
  - Sharpening
  - Gamma
  - Lens shading correction,
  - On-the-fly defect correction
- Automatic Features:
  - Auto exposure (AE)
  - Auto white balance (AWB)
  - Auto black reference (ABR)
  - Auto flicker avoidance
  - Auto color saturation
  - Auto defect identification and correction
- Multiple parameter contexts, easy/fast mode switching
- Camera control sequencer automates:
  - Snapshots
  - Snapshots with flash
  - Video clips
- ITU-R BT.656 (YCbCr), 565RGB, 555RGB, or 444RGB formats (progressive scan)
- Raw and processed Bayer formats
- Simple two-wire serial programming interface

## Applications

- Cellular phones
- PDAs
- Toys
- Other battery-powered products

**Table 1: Key Performance Parameters**

Parameter		Typical Value
Optical Format		1/6-inch (4:3)
Active Imager Size		2.30mm(H) x 1.73mm(V) 2.88mm Diagonal
Active Pixels		640H x 480V
Pixel Size		3.6µm x 3.6µm
Color Filter Array		RGB Bayer Pattern
Shutter type		Electronic Rolling Shutter (ERS)
Maximum Data Rate/ Master Clock		12 MPS–13.5 MPS/ 24 MHz–27 MHz
ADC Resolution		10-bit, on-chip
Responsivity		1.0V/lux-sec (550nm)
Dynamic Range		71dB
SNR <sub>MAX</sub>		44dB <sup>1</sup>
Supply Voltage	I/O Digital	1.7V–3.1V (VDD nominal)
	Core Digital	1.7V–1.9V or 2.5V–3.1V (1.8V or 2.8V nominal)
	Analog	2.5V–3.1V (2.8V nominal)
Power Consumption		76mW at 1.8V, 15 fps
Operating temperature		–30°C to +70°C
Frame Rate (VGA 640H x 480V)		30fps
Packaging		36-Ball ICSP, wafer or die 28-Pin PLCC
Maximum Integration Time		67 msec
<b>Order Configuration</b>		<b>-1</b> <b>-2</b>
STBY Current TYP/MAX <sup>2</sup>		<10µA/ 100µA                      <10µA/ 500µA

Notes: 1. Measured at 1.0 lux\*sec and 100% saturation.  
 2. Contact factory for actual ICC STBY distribution.

## General Description

SpecTek GXMK12A is a 1/6 inch CMOS Image Sensor with SOC. Built with Micron's exclusive DigitalClarity® technology these sensors feature exceptionally noise levels and excellent low light sensitivity. These sensors are capable of capturing color images at full resolution. This sensor achieves superior resolution—delivering CCD image quality (based on SNR and low-light sensitivity)—along with the advantages of the CMOS process, including low cost, low power, high performance, thermal stability, small form factor, and fast time-to-market.

The SpecTek GXMK12A sensor is available in two grades, S-Select and G-General.

The S-Select (-S) grade sensor is SpecTek's premium sensor offering with superior performance characteristics. This sensor is an excellent choice for Mobile Applications, Digital Still Cameras, PDAs, or other applications demanding value and performance.

The General (-G) grade sensor is SpecTek's relaxed specification device. Still offering excellent performance characteristics, the General (-G) grade is a clear value choice. This sensor delivers great performance and is targeted at cost sensitive applications such as Toys, Security Cameras, Mobile devices, or other devices or general purpose applications requiring a high quality device at low cost.

The GXMK12A is a complete camera solution designed specifically to meet the low-power, low-cost demands of battery-powered products such as cellular phones, PDAs, and toys. It incorporates sophisticated camera functions on-chip and is programmable through a simple two-wire serial interface. This sensor perform sophisticated processing functions including color recovery, color correction, sharpening, programmable gamma correction, auto black reference, clamping, auto exposure, automatic 50Hz/60Hz flicker avoidance, lens shading correction, auto white balance, and on-the-fly defect identification and correction.

Additional features include day/night mode configurations; special camera effects such as sepia tone and solarization; and interpolation to arbitrary image size with continuous filtered zoom and pan. The device supports both Xenon and LED-type flash light sources in several snapshot modes.

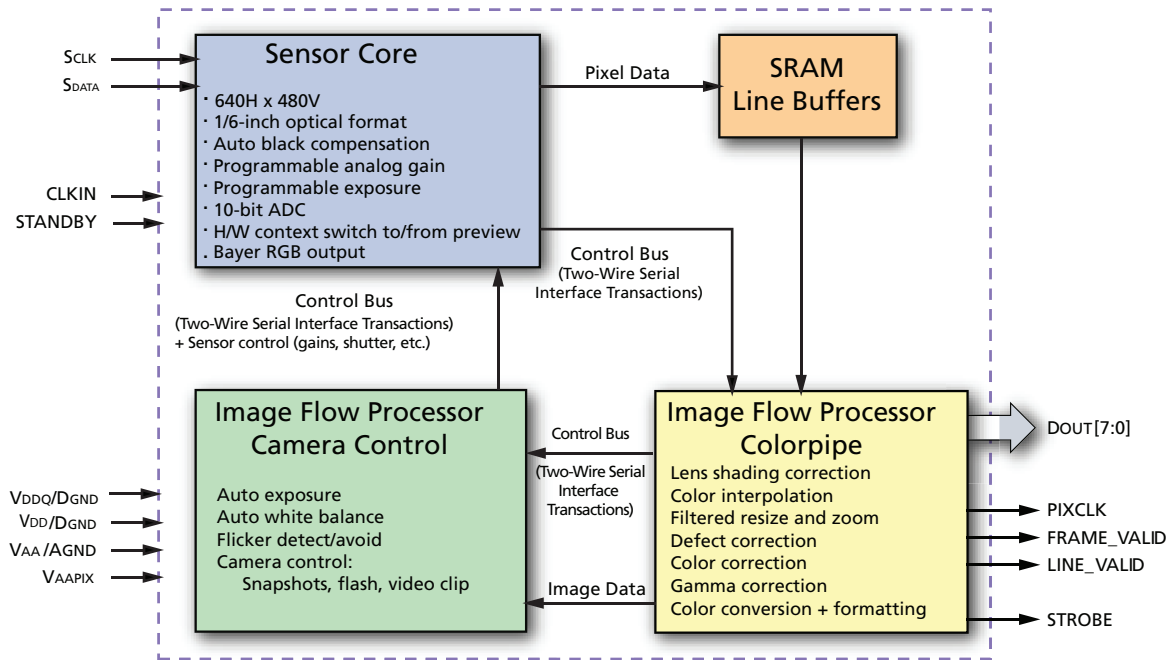
The GXMK12A can be programmed to output progressive-scan images up to 30 frames per second (fps). The image data can be output in any one of six 8-bit formats:

- ITU-R BT.656 (formerly CCIR656, progressive scan only) YCbCr
- 565RGB
- 555RGB
- 444RGB
- Raw Bayer
- Processed Bayer

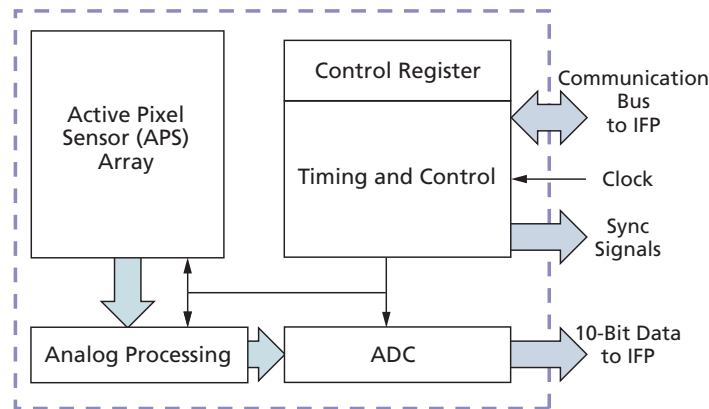
The FRAME\_VALID and LINE\_VALID signals are output on dedicated signals, along with a pixel clock that is synchronous with valid data.

**RoHS-Compliant:** This part meets internationally recognized Pb-free standards, including RoHS.

**Figure 1: Functional Block Diagram**

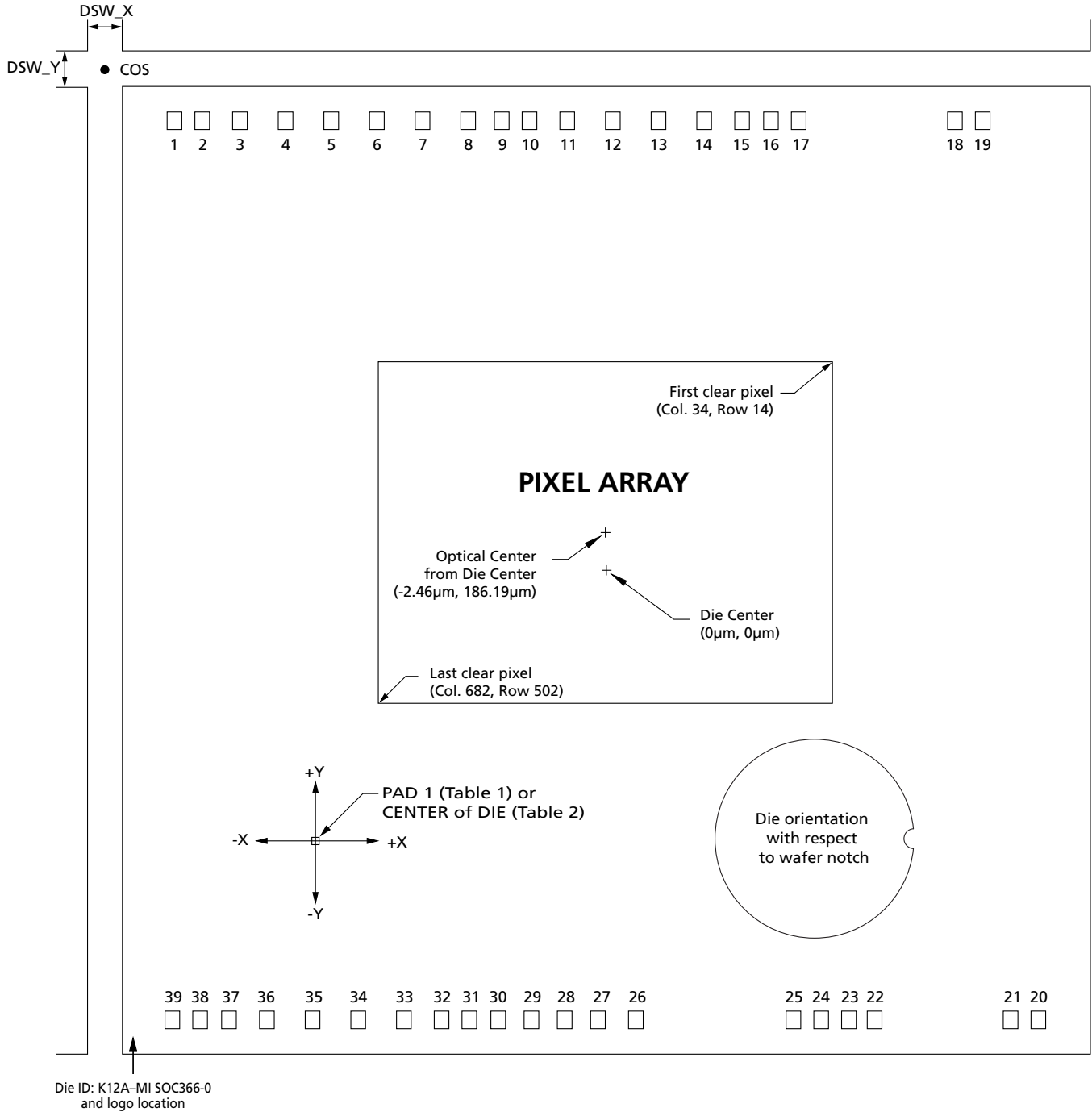


**Figure 2: Sensor Core Functional Block Diagram**



## Die Features

Figure 3: Die Outline (Top View)



**Figure 4: K12A Die Orientation in Reconstructed Wafer**

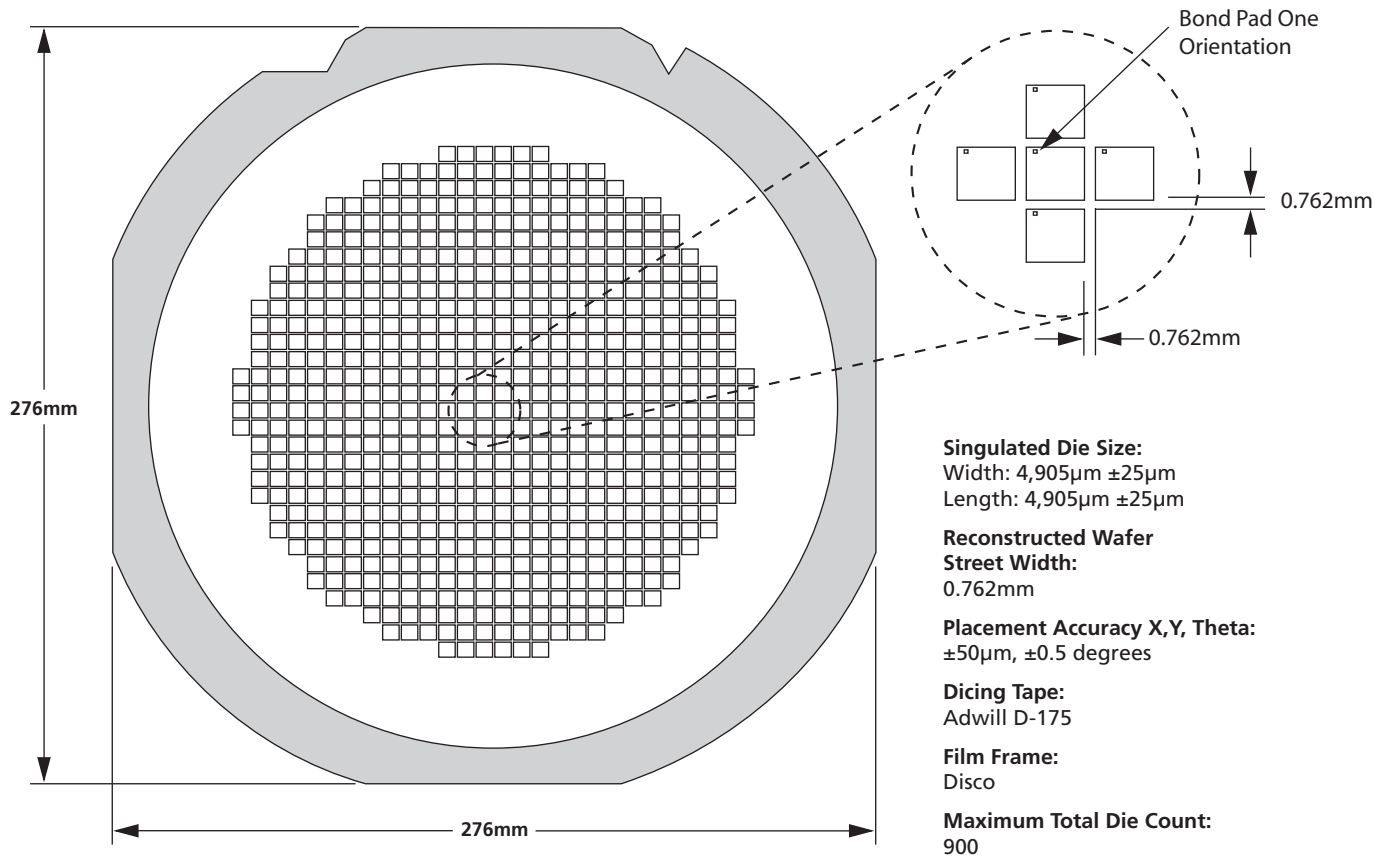
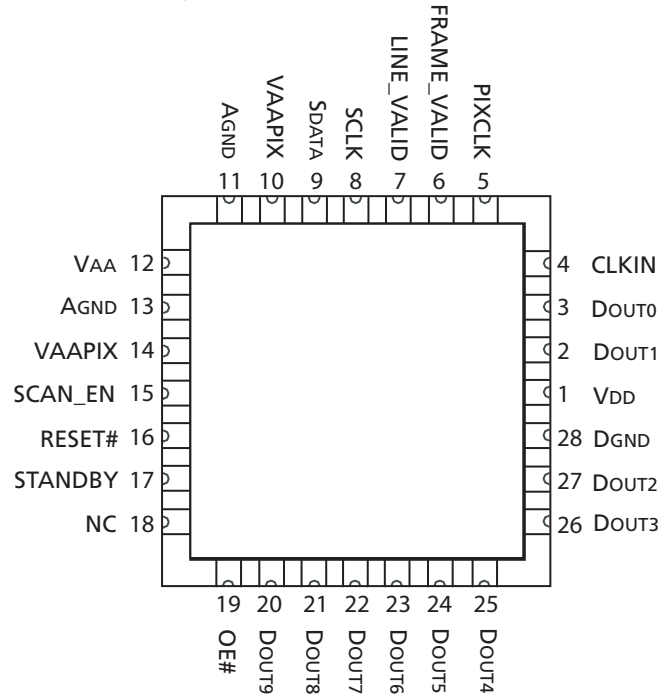


Figure 5: 28-Pin LCC Pinout Diagram



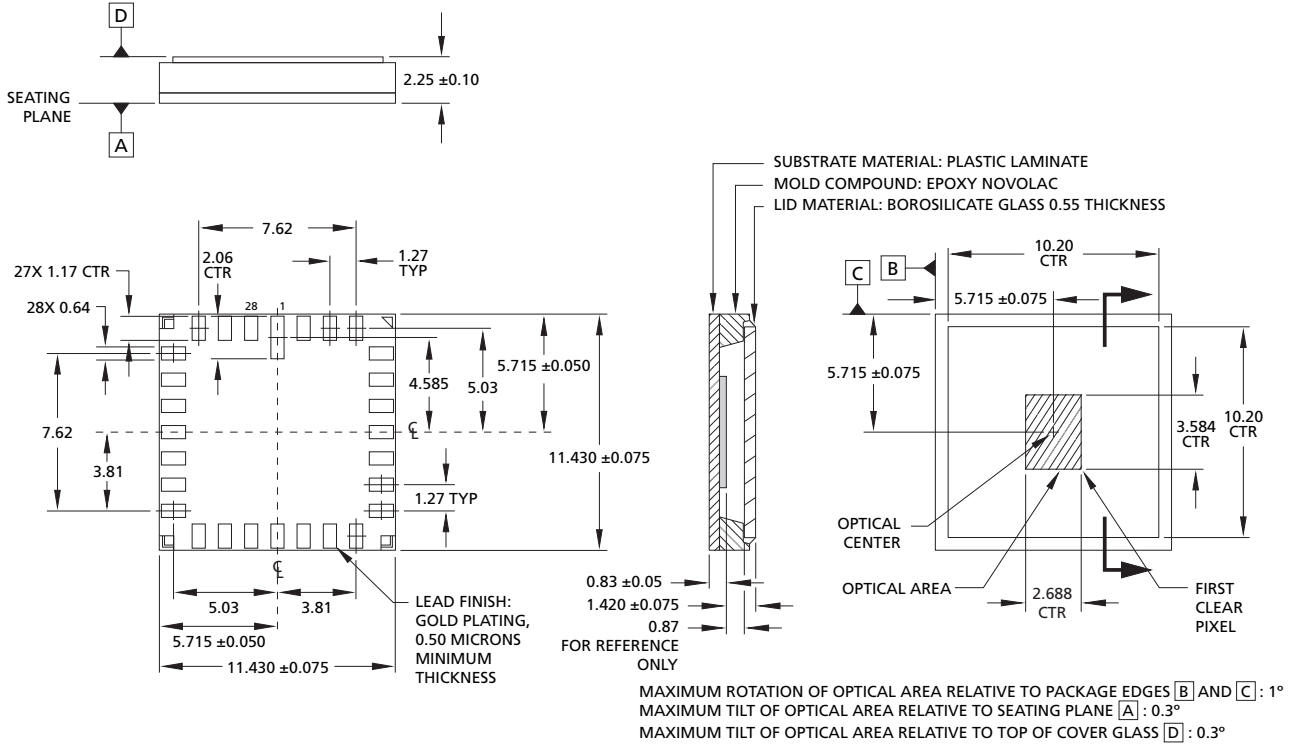
**Table 2: ST9V112 Signal Descriptions**

Die Pad Number	Name	Type	Description
15	CLKIN	Input	Master clock in sensor.
29	RESET#	Input	Active LOW: RESET <sup>1</sup> .
37	SADDR	Input	Two-Wire Serial Interface Device ID selection 1:0xBA, 0:0x90.
27	TEST_ENABLE (SCAN_ENABLE)	Input	Tie to DGND for normal operation. (Manufacturing use only.)
30	SCLK	Input	Two-Wire Serial Interface Clock.
28	STANDBY	Input	Multifunctional signal to control device addressing, power-down, and state functions (covering output enable function).
26	SDATA	Input/Output	Two-Wire Serial Interface Data I/O.
3–8, 11, 12	DOUT[7:0]	Output	Pixel Data Output bit 0, DOUT[7] (most significant bit (MSB)), DOUT[0] (least significant bit (LSB)).
36	DOUT_LSB0	Output	Sensor bypass mode output 0—typically left unconnected for normal SOC operation.
35	DOUT_LSB1	Output	Sensor bypass mode output 1—typically left unconnected for normal SOC operation.
13	FRAME_VALID	Output	Active HIGH: FRAME_VALID; indicates active frame.
14	LINE_VALID	Output	Active HIGH: LINE_VALID, DATA_VALID; indicates active pixel.
34	PIXCLK	Output	Pixel clock output.
33	STROBE	Output	Active HIGH: STROBE (Xenon) or turn on (LED) flash.
23	AGND	Supply	Analog ground.
1, 9, 16, 20, 31, 38	DGND	Supply	Core digital ground.
24, 25	VAA	Supply	Analog power: 2.5V–3.1V (2.8V nominal).
22	VAAPIX	Supply	Pixel array analog power supply: 2.5V–3.1V (2.8V nominal).
2, 17, 21, 39	VDD	Supply	Core digital power: 1.7V–1.9V or 2.5V–3.1V (1.8V or 2.8V nominal).
10, 32	VDDQ	Supply	I/O digital power: 1.7V–3.1V (VDD nominal).
18, 19	NC	–	No connect.

Note: A proper test sequence requires an active CLKIN signal after the RESET# signal has been driven low. For more details about the reset sequence, refer to the GXMK12A Developer Guide.

## Package Dimensions

Figure 6: 28-Pin PLCC Package Outline Drawing



## Outgoing Defect Specifications (ODS)

Note: Outside the temperature range is not recommended or warranted.

### Conditions for Image Test A

- Full resolution images (4 frames) are captured at 15 fps in SOC bypass mode (raw Bayer format) in dark condition, without a lens system. Frames are averaged for analysis.
- Sensor analog gain is 8X for all color planes and digital gain is 1X (unity).
- The sensor is operated at maximum external clock frequency.

### Conditions for Image Test B

- Full resolution images (4 frames) are captured at 15 fps in SOC bypass mode (raw Bayer format) with light signal equivalent to 50 percent of sensor full-scale output, without a lens system. Frames are averaged for analysis.
- Sensor analog gain is 1X for all color planes and digital gain is 1X (unity).
- The sensor is operated at maximum external clock frequency.

### Conditions for Image Test C

- Full resolution images (4 frames) are captured at 5 fps in SOC YCbCr mode in 1 lux incident light, without a lens system. Frames are averaged for analysis.
- Sensor analog gain is 16X for blue color plane and all digital gains are unity. ADC-reference and gamma are set to default conditions.
- The sensor is operated at maximum external clock frequency.

## Defect Definitions in SOC Bypass Mode

Defect definitions in the bypass mode (with no defect correction) are defined in this section.

Operating condition:  $T_j = 55^\circ\text{C}$

#### Definition 1: Hot Pixel Defect

A hot pixel is defined as any single pixel that is greater than 50 percent of the sensor full-scale output when the sensor is operated as in image test A.

#### Definition 2: Bright Pixel Defect

Within a color plane, each pixel is compared to the mean of the neighboring 11 x 11 pixels. If the pixel value is 20 percent or more above the mean, it is considered a bright pixel defect when the sensor is operated as in image test B.

#### Definition 3: Dark Pixel Defect

Within a color plane, each pixel is compared to the mean of the neighboring 11 x 11 pixels. If the pixel value is 20 percent or more below the mean, it is considered a dark pixel defect when the sensor is operated as in image test B.

#### Definition 4: Bright Cluster

Using definition 2 results, the defects within each color plane are examined. If any 2<sup>1</sup> or more adjacent pixels that are considered bright pixel defects are detected, they are then defined as a bright cluster.

#### Definition 5: Dark Cluster

Using definition 3 results, the defects within a color plane are examined. If any 2<sup>1</sup> or more adjacent pixels that are considered dark pixel defects are detected, they are then defined as a dark cluster.

## Defect Definitions in SOC YCbCr Mode

Defect definitions in the SOC YCbCr mode (with defect correction enabled) are defined in this section.

Operating condition:  $T_j = 55^\circ\text{C}$

### Definition 6: Bright Pixel Defect

Within each RGB color plane, each pixel is compared to the mean of the neighboring 11 x 11 pixels. If the pixel value is 50 percent or more above the mean, it is considered a bright pixel defect when the sensor is operated as in image test C.

### Definition 7: Dark Pixel Defect

Within each RGB color plane, each pixel is compared to the mean of the neighboring 11 x 11 pixels. If the pixel value is 50 percent or more below the mean, it is considered a dark pixel defect when the sensor is operated as in image test C.

### Definition 8: Bright Cluster

Using definition 6 results, the defects within each RGB color plane are examined. If any 2<sup>1</sup> or more adjacent pixels that are considered bright pixel defects are detected, they are then defined as a bright cluster.

### Definition 9: Dark Cluster

Using definition 10 results, the defects within each RGB color plane are examined. If any 2<sup>1</sup> or more adjacent pixels that are considered dark pixel defects are detected, they are then defined as a dark cluster.

### Definition 10: Row/Column Defect

Within an image each row/column is compared with its adjacent row/column. If the value of a row/column is different from its adjacent row/column by 8 percent, that row/column is defined as a row/column defect when the sensor is operated as in image test C.

Note: 1. The cluster size will vary depending upon grade, see table below.

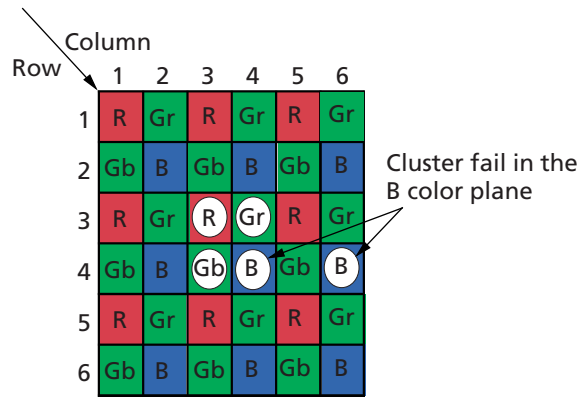
Cluster Size, Adjacent Pixel Defects		
Cluster Definition Bright or Dark Cluster	ST9V112-Select	ST9V112-General
	2	2

## Cluster Defects

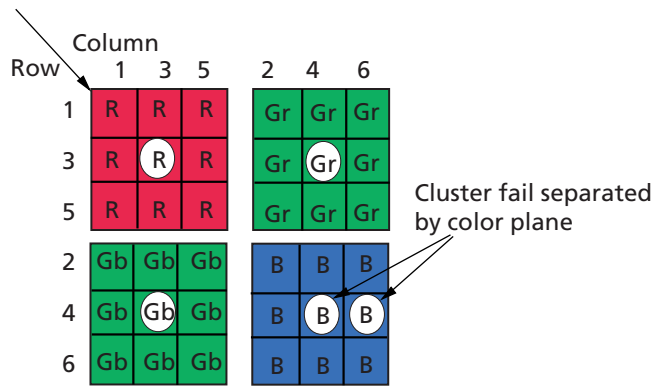
Clusters are analyzed by looking at one particular pixel and its surrounding 8 adjacent pixels within the same color plane, as seen in Figure 7. For example, if the center pixel is a dark pixel and any of its surrounding 8 pixels within the same color plane are dark pixels, then it is defined as a dark cluster.

For definitions 1–5, each of R, Gr, Gb, and B color planes shown in Figure 7 are analyzed. For definitions 6–10, each of the R, G, and B color planes are analyzed separately.

**Figure 7: Raw Pixel Output**



**Figure 8: Raw Pixel Output Separated by Color Plane**





# 1/6-Inch SOC Optional VGA CMOS Digital Image Sensor Revision History

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## Revision History

Rev B.....	11/07
<ul style="list-style-type: none"><li>• Incorporated ODS (Outgoing Defect Specification) information on pages 9–11.</li></ul>	
Rev A.....	10/06
<ul style="list-style-type: none"><li>• SpecTek Initial Release.</li></ul>	