1/4-Inch 2-Megapixel SOC CMOS Digital Image Sensor Product Brief with ODS

ST9D112-S Select (SOC2020)
ST9D112-G General (SOC2020)
(Mfg part number GXMK15A [package] / Mfg part number WXMK15A [die])

Full Sensor Features

- Internal master clock generated by on-chip phase-locked loop oscillator (PLL)
- Electronic rolling shutter (ERS), progressive scan
- Integrated image flow processor (IFP) for single-die camera module
- Arbitrary image decimation with anti-aliasing
- Integrated real-time JPEG encoder
- Integrated microcontroller for flexibility
- Selectable output data format: ITU-R BT.601 (YCbCr), 565RGB, 555RGB, 444RGB, processed Bayer, RAW8, and RAW 10-bit
- Output FIFO for data rate equalization
- Programmable I/O slew rate
- Flexible support for external auto focus, optical zoom, and mechanical shutter
- DigitalClarity™ CMOS Imaging Technology
- Superior low-light performance
- Low-power, low-cost
- Automatic image correction and enhancement, including lens shading correction
- Two-wire serial interface providing access to registers and microcontroller memory
- Xenon and LED flash support with fast exposure adaptation

Applications

- Cellular phones
- PC cameras
- PDAs
- Toys
- Security cameras

Table 1: Key Performance Parameters

Parameter		Typical Value	
Optical format		1/4-inch (4:3)	
Full resolution		1,600 x 1,200 pixels (UXGA)	
Pixel size		2.2µm x 2.2µm	
Color filter array		RGB Bayer pattern	
Active pixel array area		3.56mm x 2.68mm	
Shutter type		Electronic Rolling Shutter (ERS) with Global Reset	
Maximum data rate/ master clock		80 MB/s 6 MHz to 80 MHz	
ADC resolution		10-bit, on-die	
Responsivity		0.53 V/lux-sec (preliminary)	
Dynamic range		59.5dB (preliminary)	
SNR_{MAX}		37.7dB (preliminary)	
Supply voltage	Analog	2.5V–3.1V	
	Digital	1.7V–1.95V	
	I/O	1.7V–1.95V or 2.5V–3.1V	
	PLL	2.5V–3.1V	
	AF	1.7V–3.1V	
Power consumption		245mW at 15 fps, full resolution	
		230mW at 30 fps, video mode 168mW at 24 fps, preview mode	
		10µW, standby/shutdown	
Operating temperature		-30°C to +70°C (at junction)	
Chief ray angle	A	Not available	
	B	Linear 2µ micro lens shift (L2)	
Maximum frame rate		15 fps at full resolution, 45 fps in preview mode, 30 fps in video mode	
Package		Bare die, 11.43SQ. 48Ld PLCC	
Order Configuration		**-S (Select)**	**-G (General)**
STBY current TYP/MAX*		<10µA/100µA	<10µA/500µA

Note: Contact factory for actual ICC STBY distribution.

General Description

SpecTek GXMK15A is a 2-Megapixel 1/4-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 2-Megapixel 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 GXMK15A 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, PC 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 GXMK15A 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.

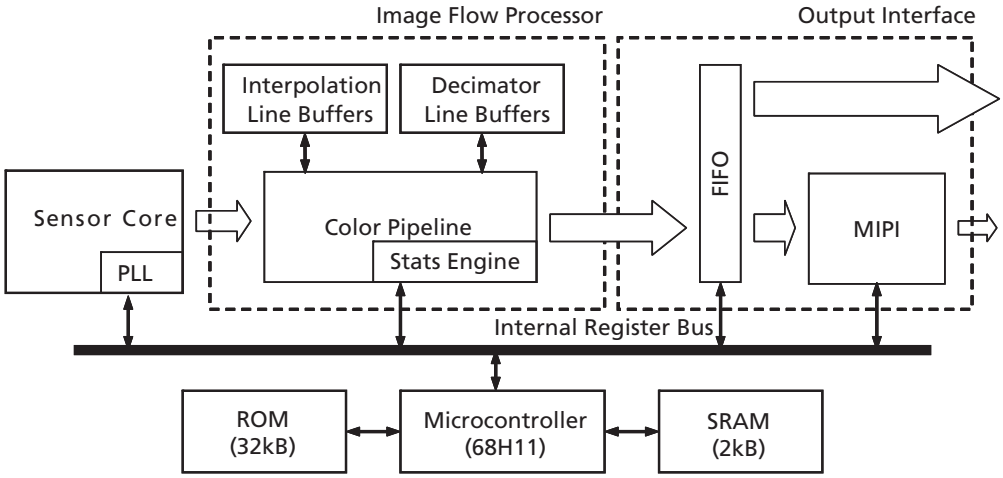
The GXMK15A can be programmed to output progressive-scan images up to 30 frames per second (fps). The image data can be output in any one of six 8-bit formats:

- 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



Note: For optimal performance, all power supply pads must be used.

Figure 2: Sensor Core Functional Block Diagram

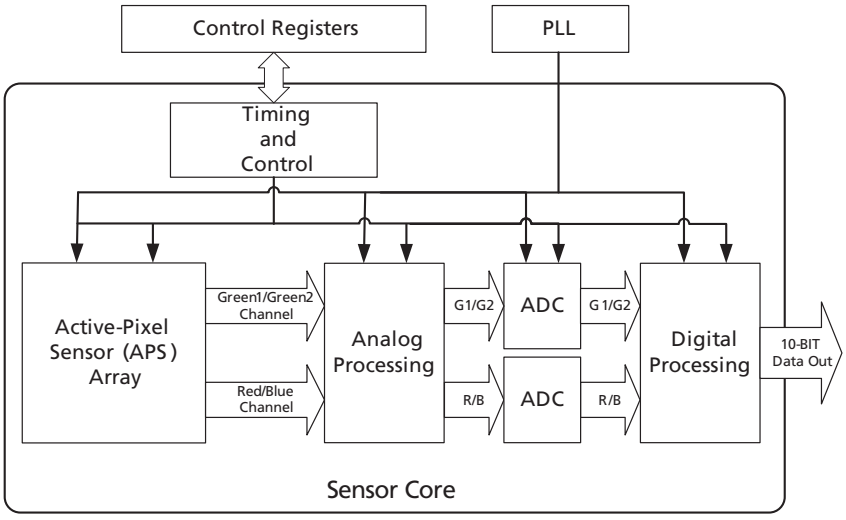
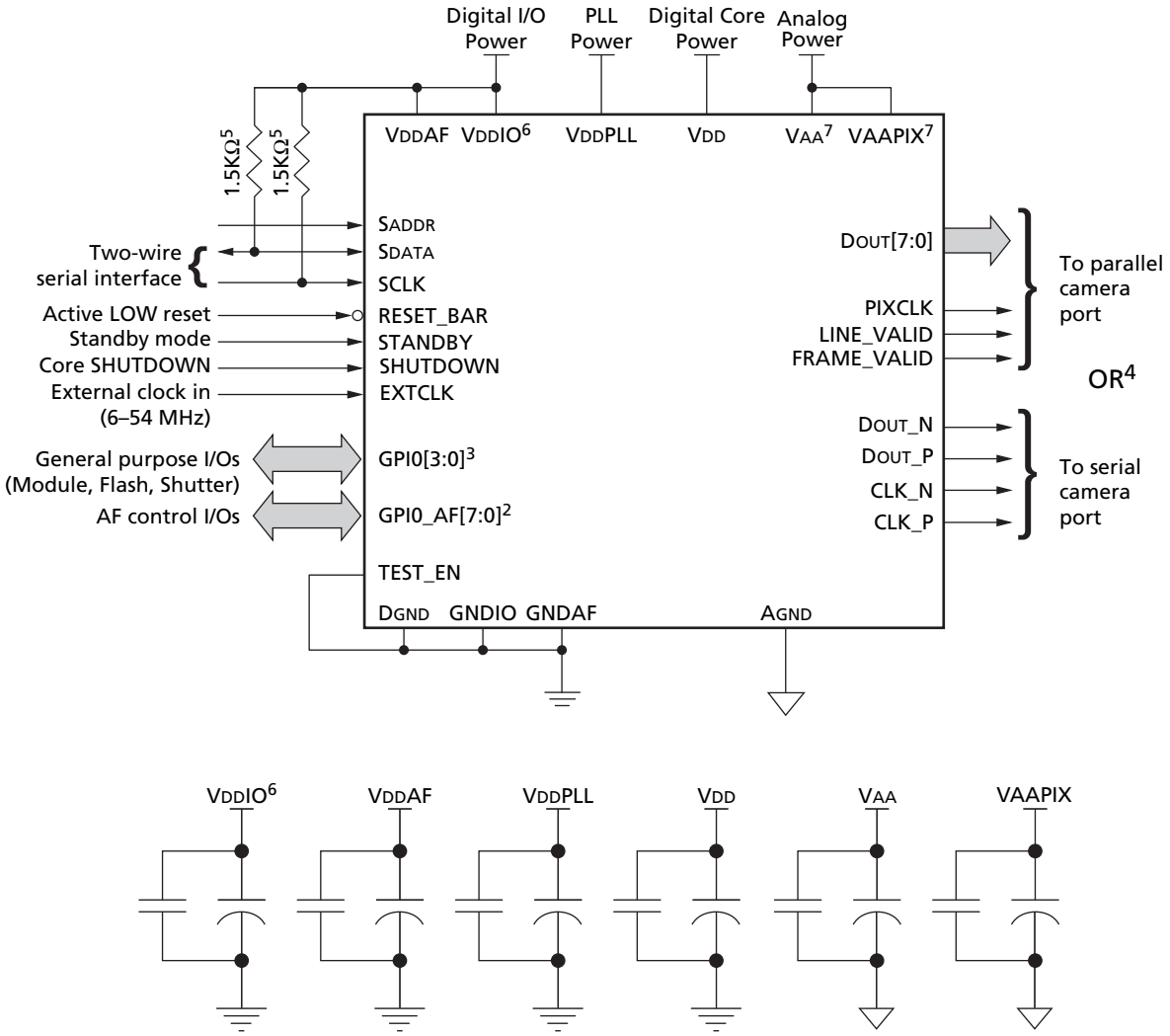


Figure 3: Typical Configuration (Connection)



It is recommended that 0.1µF and 1µF decoupling capacitors for each power supply are mounted as close as possible to the pad. Actual values and results may vary depending on layout and design considerations.

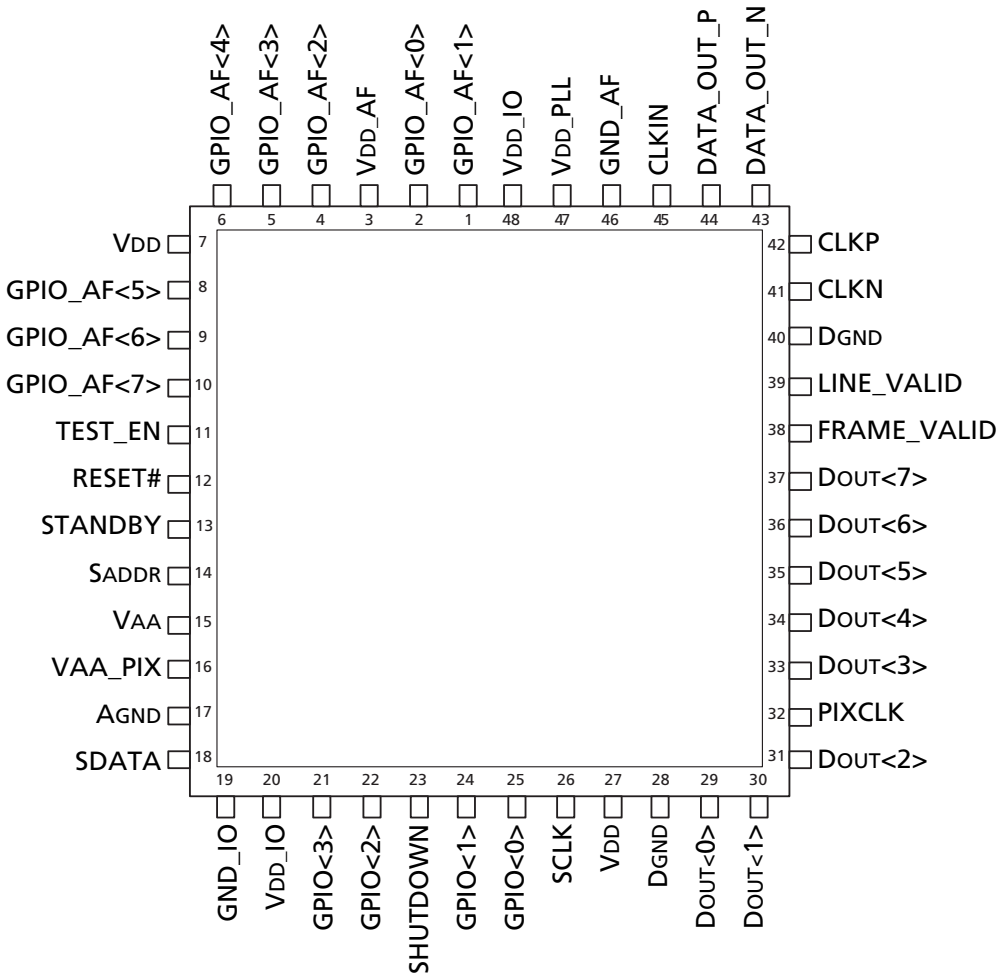
Notes:
1. Typical Connection shows only one scenario out of multiple possible variations for this sensor.
2. If auto focus is not required the following pads can be left floating: VDDAF, GNDAF, and GPIO_AF.
3. The GPIO pads can serve multiple features that can be reconfigured. The function and direction will vary by applications.
4. Only one of the output modes (serial or parallel) can be used at any time.
5. 1.5kΩ resistor value is recommended for the two-wire serial interface RPULL-UP, however, greater value may be used for slower transmission speed.
6. All inputs must be configured in VDDIO.
7. VAA and VAAPIX must be tied together.

ST9D112 Signal Description

Table 2: ST9D112 Signal Description

Die Pad Number	Name	Type	Description
23	SHUTDOWN	Input	Power down VDD, active HIGH.
11	TEST_EN	Input	Reserved for factory test. Tie to digital ground during normal operation (can leave floating if not used).
13	STANDBY	Input	Controls sensor standby mode, active HIGH.
26	SCLK	Input	Two-wire serial interface clock.
14	SADDR	Input	Selects device address for the two-wire serial interface. The address is 0x78 when SADDR is tied LOW, 0x7A if tied HIGH.
12	RESET#	Input	Master reset signal, active LOW.
45	CLKIN	Input	Master clock signal (can either drive the on-chip PLL or bypass it).
21, 22, 24, 25	GPIO[3:0]	I/O	General purpose digital I/O, could be configured for FLASH/SHUTTER/ DOUT_LSB0/DOUT_LSB1/MODULE_ID/OE_BAR/TRIGGER.
18	SDATA	I/O	Two-wire serial interface data.
1, 2, 4–6, 8–10	GPIO_AF[7:0]	I/O	General purpose digital I/O. Used for auto focus function (can leave floating if not used).
29–31, 33–37	DOUT[7:0]	Output	Eight-bit image data output or most significant bits (MSB) of 10-bit sensor bypass mode.
43	DATA_OUT_N	Output	Differential MIPI data (sub-LVDS, negative) (must leave floating if not used).
44	DATA_OUT_P	Output	Differential MIPI data (sub-LVDS, positive) (must leave floating if not used).
41	CLKN	Output	Differential CCP (sub-LVDS) serial clock/strobe (negative).
42	CLKP	Output	Differential CCP (sub-LVDS) serial clock/strobe (positive).
32	PIXCLK	Output	Pixel clock. Used for sampling DOUT, FRAME_VALID, and LINE_VALID.
39	LINE_VALID	Output	Identifies lines in the active image.
38	FRAME_VALID	Output	Identifies rows in the active image.
7, 27	VDD	Supply	Digital power (1.8V).
16	VAA_PIX	Supply	Pixel array power (2.8V).
15	VAA	Supply	Analog power (2.8V).
47	VDD_PLL	Supply	PLL power (2.8V).
20, 48	VDD_IO	Supply	I/O power supply (1.7–1.95V or 2.5–3.1V).
19	GND_IO	Supply	I/O ground.
28, 40	DGND	Supply	Digital, I/O, and PLL ground.
17	AGND	Supply	Analog ground.
3	VDD_AF	Supply	I/O power supply for GPIO_AF[7:0] pads (can leave floating if not used).
46	GND_AF	Supply	IO ground for GPIO_AF[7:0].

Figure 4: 48-Pin PLCC Pinout Diagram



Die Features

Figure 5: Die Outline (Top View)

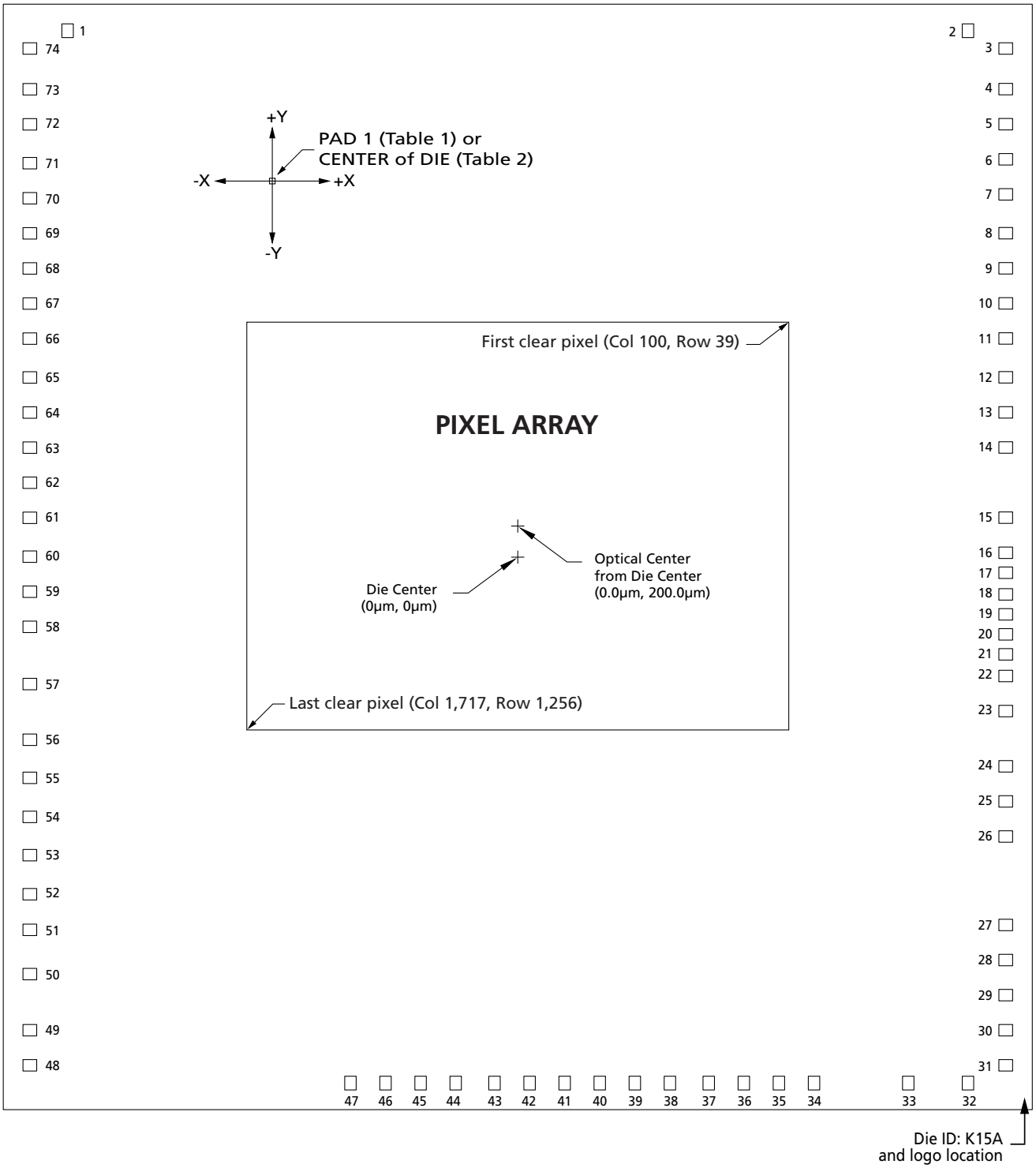
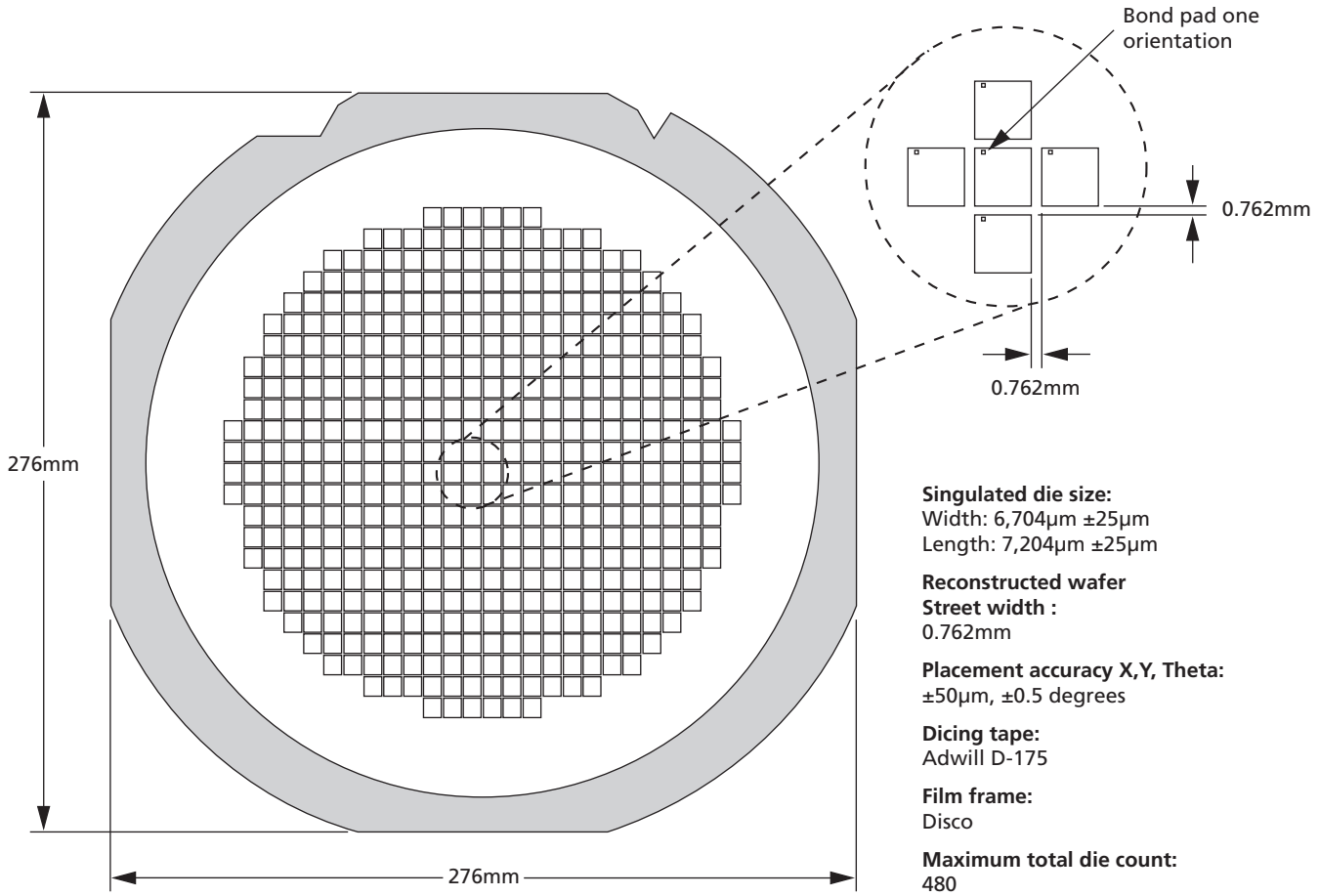


Figure 6: K15A Die Orientation in Reconstructed Wafer



Singulated die size:
Width: 6,704µm ±25µm
Length: 7,204µm ±25µm

Reconstructed wafer
Street width :
0.762mm

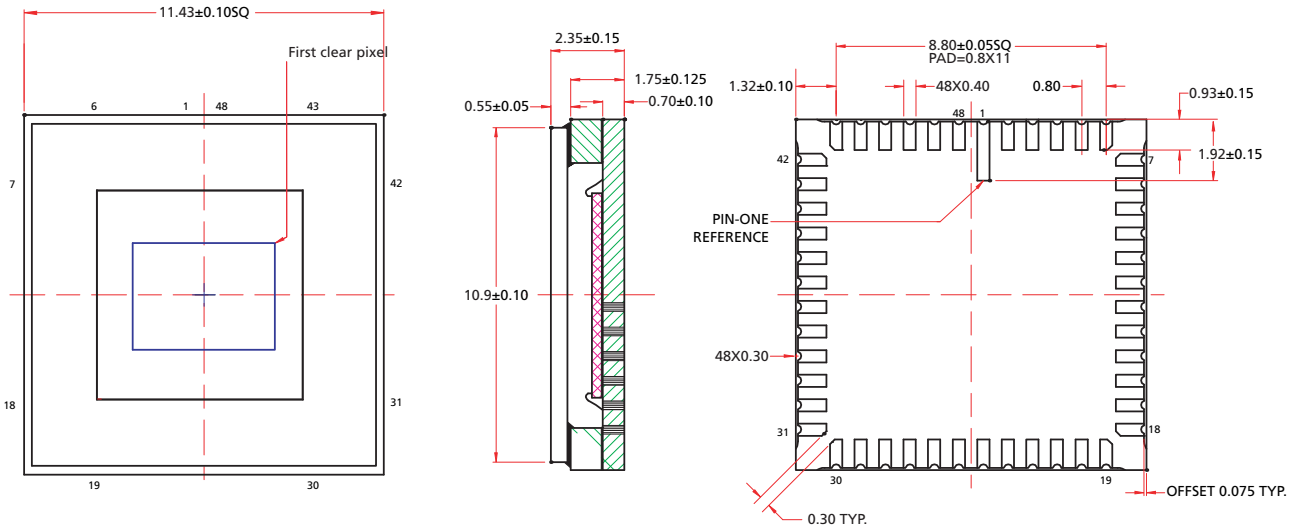
Placement accuracy X,Y, Theta:
±50µm, ±0.5 degrees

Dicing tape:
Adwill D-175

Film frame:
Disco

Maximum total die count:
480

Figure 7: 48-Pin PLCC Package Outline Drawing



NOTE: OPTICAL CENTER POSITION RELATIVE TO THE PACKAGE CENTER = ±0.10 (X,Y)

TOP VIEW

BOTTOM VIEW

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 with PLL bypassed.

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 with PLL bypassed.

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 with PLL bypassed.

Defect Definitions in SOC Bypass Mode

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

Operating condition: $T_J = 55°C$

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 2^1 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 2^1 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°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 2^1 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 2^1 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	ST9D112–Select 3	ST9D112–General 4

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 8. 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 8 are analyzed.

For definitions 6–10, each of the R, G, and B color planes are analyzed separately.

Figure 8: Raw Pixel Output

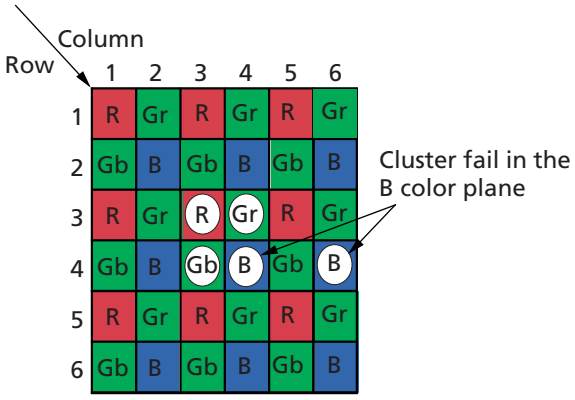
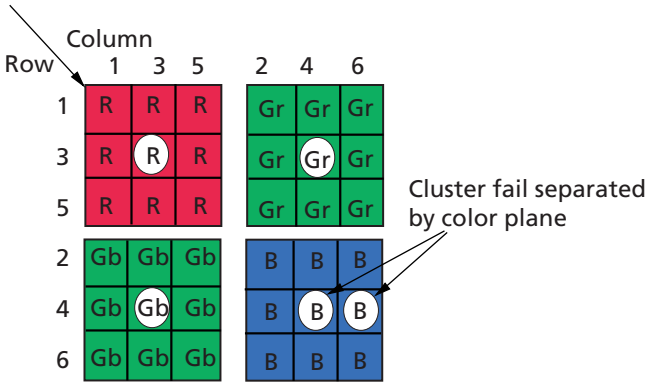


Figure 9: Raw Pixel Output Separated by Color Plane



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Revision History

Rev C 11/07

- Incorporated ODS (Outgoing Defect Specification) information.

Rev B. 10/07

- Added Figure 7: 48 Pin PLCC Package Outline Drawing on page 7.

Rev A. 02/07

- SpecTek Initial Release