APPLICATION NOTE

GSPRINT4510 Micro Lens Shifted

Product Variance

INTRODUCTION

The purpose of this document is to give specifications for GSPRINT4510 micro lens shifted version (GSPRINT4510-AMS-R) image sensor and order information.

GSPRINT4510-AMS-R is a new, application tailored product variance supporting applications using large incoming light CRA (Chief Ray Angles), the micro lenses of all pixels are uniformly shifted away from pixel center in one direction, making the pixel sensitivity higher at a larger incoming light angle.

After GSPRINT4510-AMS-R enters mass production stage, this document will be added into GSPRINT4510 datasheet. Other GSPRINT4510 product variants will not be affected.

REVISION HISTORY

Version	Release date(MM/DD/YY)	Description
V 0.1	01/12/2023	First release.
V 0.2	05/16/2023	Update QE simulation result to measurement result Add improvement test result

REFERENCE DOCUMENT

GSPRINT4510 datasheet

CONTENTS

Micro lens Shift Configuration

The micro lenses are shifted uniformly vertically with same distance toward reference A3 pin. See below figure as indication.

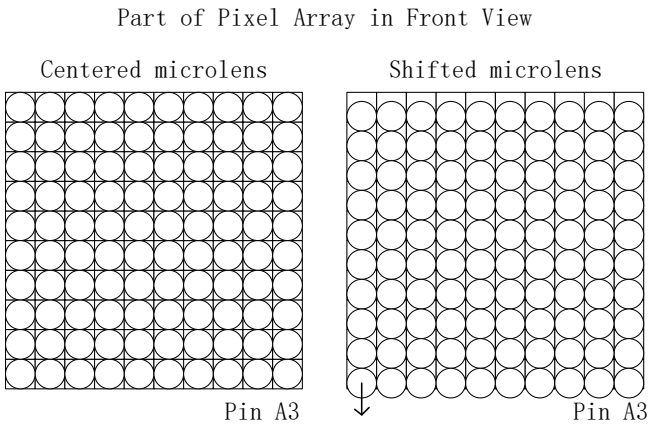


Figure 1 Shifted micro lens illustration

Gpixel expects only a change in the QE (Quantum Efficiency) specification. All other electro-electrical specifications of the sensor are expected not to change. Below QE measured with 405nm wavelength.

Note: both no micro lens version and shifted micro lens version QE are measured with cover glass removed.

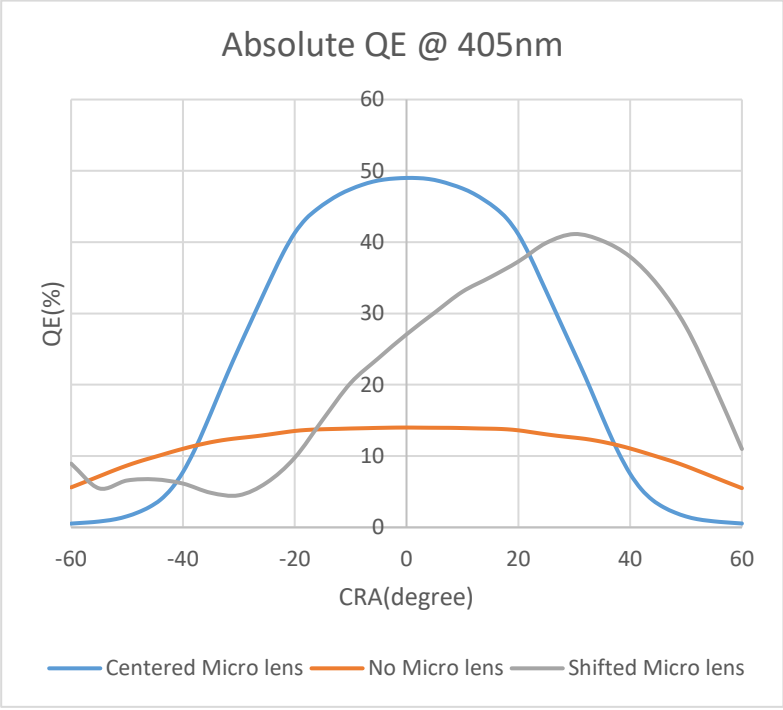


Figure 2 QE measurement result

The positive CRA are defined below.

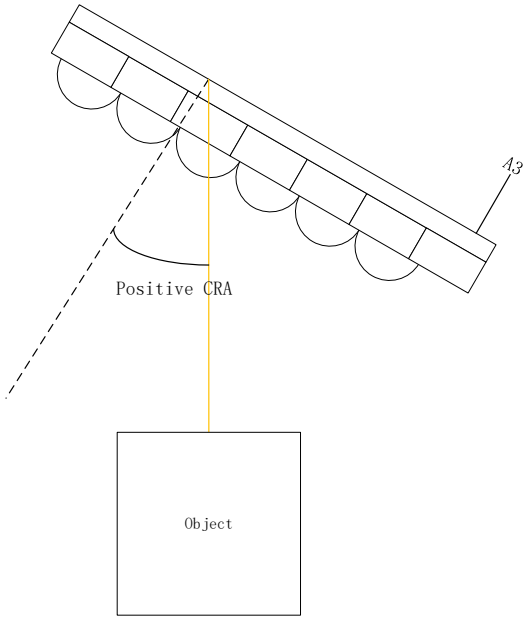


Figure 3 Positive CRA definition (sensor side view)

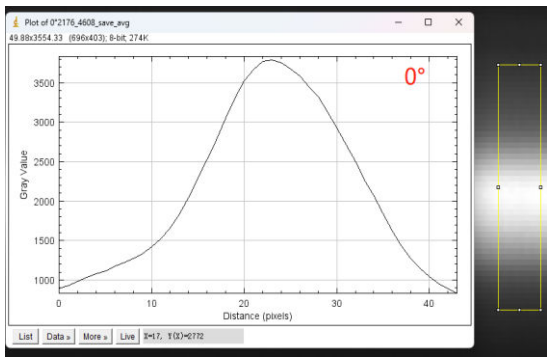
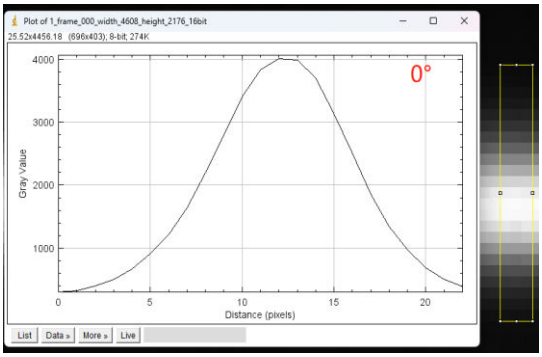
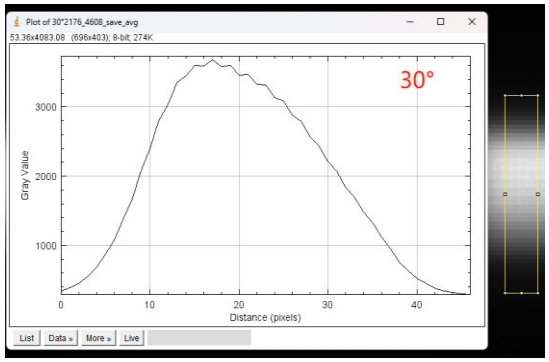
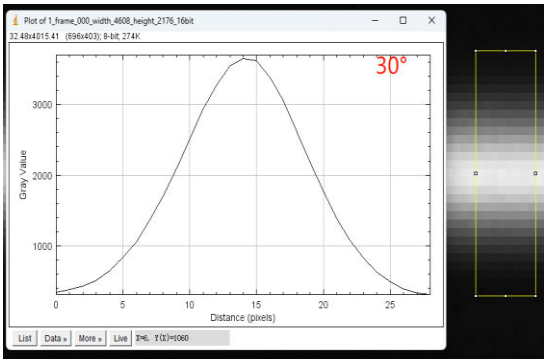
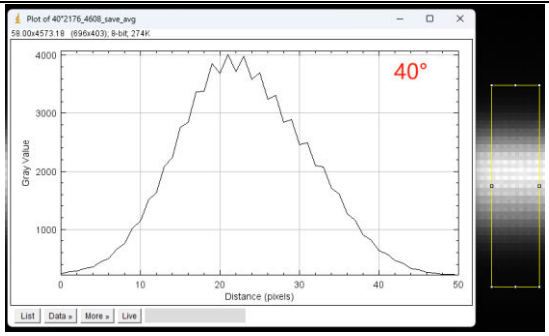
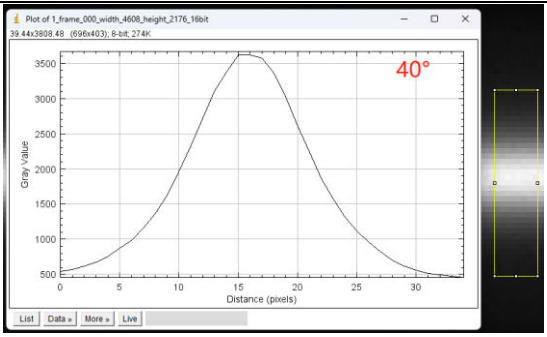
The micro lens shifted version GSPRINT4510 comes with a taped-on glass lid which can be easily removed.

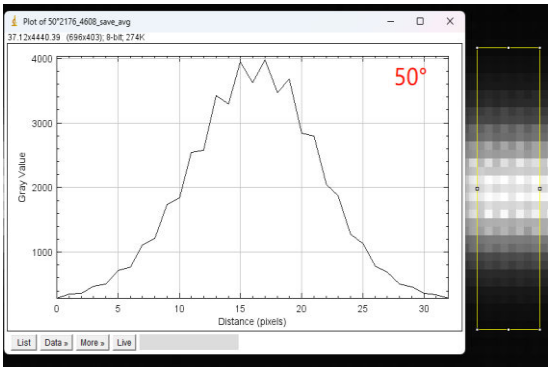
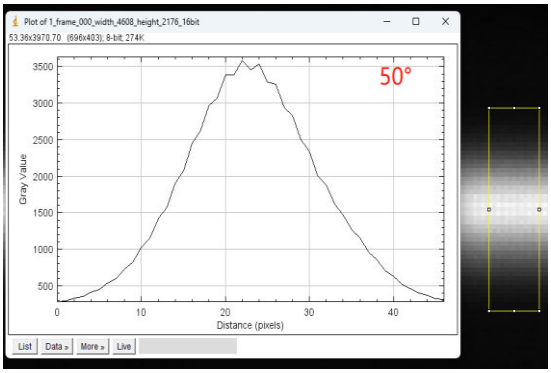
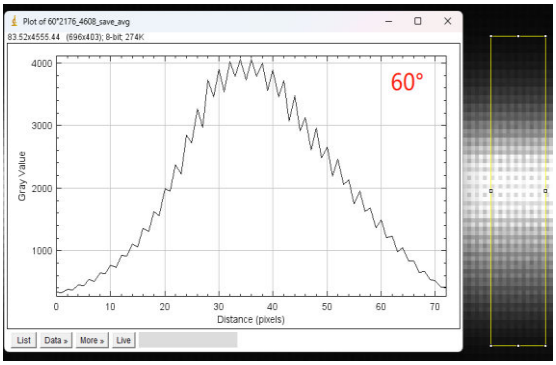
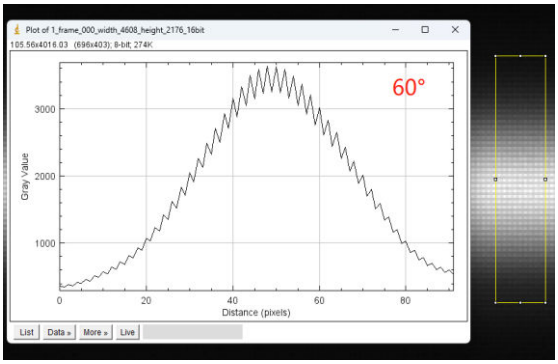
GSPRINT4510-AMS-R is offered in two speed variance where the high speed version support 8bit 144 pairs LVDS run at 1920fps, and normal speed version support 8bit 72 pairs LVDS run at 999fps.

Evaluation Result

Line laser is directly shine on cover glass removed GSPRINT4510-AMS-R(shifted micro lens) and GSPRINT4510-AM-R(centered micro lens) sensor's image plane. Following result is to demonstrate improvement of odd even row difference at large angle light, in comparison with centered micro lens version.

Note: Exposure time is adjust per image to ensure same signal level.

CRA	Centered micro lens GSPRINT4510-AM-R	Shifted micro lens GSPRINT4510-AMS-R
0 degree		
30 degree		
40 degree		

50 degree		
60 degree		

The test show significant odd even improvement from 30 degree to 50 degree of shifted micro lens version. And due to QE increase, the shifted micro lens version is more sensitive compare to no micro lens version.

Blemish Specification

Testing Configuration

Sensor outgoing test guarantee the sensor performance with selected modes & gain based on sensor variance as listed in Table 1.

Table 1 Sensor configuration

Sensor variance (Based on Marking code)	Test Configuration	Channels	PGA gain
GSPRINT4510-AMS-R H	8bit Normal mode	144ch	Gain 2 (1.6x)
GSPRINT4510-AMS-R	8bit Normal mode	72ch	Gain 2 (1.6x)

GSPRINT4510 sensor's defect limits apply to area of 4608 x 2176 effective pixel array as shown in Figure 1.

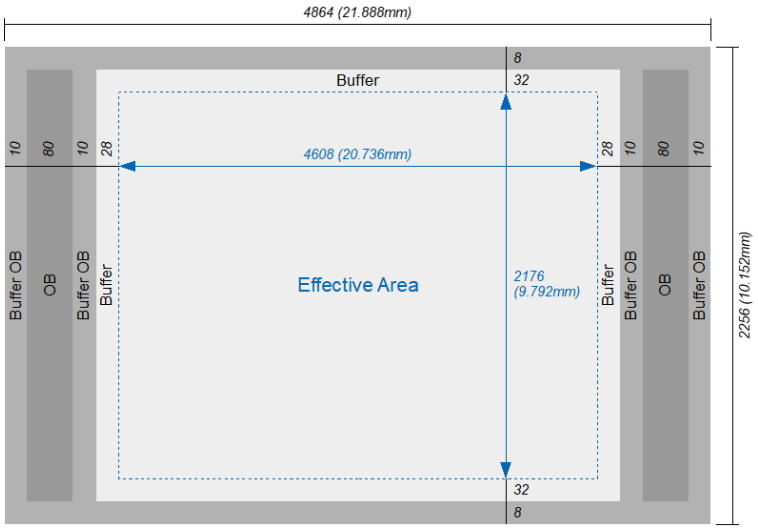


Figure1 GSPRINT4510 defects controlled region

Test Images

Test images as listed in Table 2 are grabbed with GSPRINT4510-AMS-R device level tester at room temperature, under the illumination of a light source with a uniformity > 98% across the image area. These images are saved with default pixel shift operation and used for defect definitions. No image correction algorithm is applied.

Table 2 Test image Definition

Test Images	Description
Dark	2 images grabbed at shortest integration time in dark environment; per pixel average is performed on these images to form the test image.
Grey	2 images grabbed at a typical integration time (T) to reach half-saturation in light environment; per pixel average is performed on these images to form the test image.
Saturation	2 images grabbed at an integration time of 2xT in light environment; per pixel average is performed on these images to form the test image.

Defect Definitions

Table 3 below describes the definition of defects.

Table 3 Defect definitions

Defect Name	Description
Bad pixel in Dark image	Any pixel deviates more than +/-5% of the full swing(1) from the mean value of the Dark image.
Bad pixel in Grey image	Any pixel deviates more than +/-20% from the mean value of the Grey image.
Bad pixel in Saturation image	Any pixel deviates more than -20% from the mean value of the Saturation image.
Total defect pixels	The total number of non-overlapping bad pixels in Dark, Grey and Saturation image.
Cluster	Horizontal and vertical consecutive defect pixels are considered as a cluster.
Cluster (N)	Any cluster with size of N defect pixels is considered as cluster (N). For color sensors, the rule is applied within each color plane.
Defect Row/Column	Any row/column with its mean value deviating more than +/-3% of the full swing from the mean value of the Dark image. Any row/column with its mean value deviating more than +/-5% from the mean value of the Grey image. Any row/column with its mean value deviating more than -5% from the mean value of the Saturation image. Or a row/column with more than 100 defect pixels.

(1) Swing is equal to the difference between the mean value of the Saturation image and the mean value of the Dark image.

Defect Limits

Maximum allowed defect numbers are indicated below.

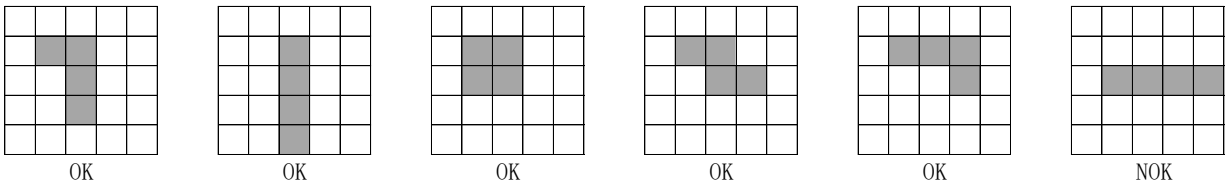
Table 1 Defect limits

Item	Grade 1	Grade 2
Maximum # of defect pixels	200	400
Acceptable cluster size	-	2-4 (1)
Maximum # of Cluster	-	12
Maximum # of defect row and column	0	0

(1) Cluster with 4 consecutive defect pixels in a row is not allowed in Grade 2.

(2) All Defect limits are guaranteed at room temperature.

Example of allowed and not allowed cluster in Grade 2



** OK is allowed, NOK is not allowed.

Product Ordering Information

For ordering information, please see below table for details.

Part Number	Blemish Grade	Description	Marking Code
GSPRINT4510-AVM-NUS-AR1	Grade 1	Monochrome, microlens shifted, taped D263T glass without ARC, 454 pin μPGA, Normal speed version, 999fps @ 8-bit 72 channels	GSPRINT4510-AMS-R
GSPRINT4510-AVM-NUS-AR2	Grade 2		
GSPRINT4510-AVM-HUS-AR1	Grade 1	Monochrome, microlens shifted, taped D263T glass without ARC, 454 pin μPGA, High speed version, 1920fps @ 8-bit 144 channels	GSPRINT4510-AMS-R H
GSPRINT4510-AVM-HUS-AR2	Grade 2		

Notes:

1. Marking code is located at the center of bottom side of ceramic package.
2. Change last digit of part number to E for ordering engineering sample. Engineering sample has same E/O specs as graded sensor but failed in blemish limit.