



Technical Note

TN000104

CMV2000 & CMV4000

Defect Specification

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1 Introduction

This file details how outgoing inspection is done on CMV2000 and CMV4000 image sensors. Due to silicon impurities, manufacturing tolerances and other effects, defects are inherent to all CMOS image sensors. Therefore, **ams** does an outgoing inspection on 100 percent of devices, based on the test conditions and defect definitions in this document.

2 Part Numbers

This specification is valid for all of the production variants of the following sensors:

- CMV2000 v2
- CMV2000 v3
- CMV4000 v2
- CMV4000 v3

3 Test Setup and Conditions

3.1 Environment

The devices are tested at room temperature. The device under test (DUT) will be around 5°C to 10°C warmer depending on the test time.

3.2 Light Source

Figure 1:
Light Source Properties

Property	Description
Light Color	Monochrome DUT: Neutral white Color DUT: Red, Green and Blue
Illumination Levels	The light source is calibrated before test so that: Mono DUT: Sensor puts out about 50% of the signal swing at the exposure time for the gray image. Color: Sensor puts out about 50% of the signal swing for each color at the exposure time for the gray image. The light intensity does not change during the test, only exposure time. For dark images, the light source is powered off. The light is continuous, no PWM or pulsed.
Diffuser	Yes
F-number	f/16

3.3 DUT Settings

Figure 2:
DUT Settings

Property	Description
Exposure Time	T _{dark} = 10 T _{gray} = 3276 T _{saturation} = 13104

Property	Description
Gain Level	<u>v2:</u> PGA Gain = 0 ADC Gain = 32 <u>v3:</u> PGA Gain = 0 ADC Gain = 36
CLK_IN	48MHz
Output Data Rate	480Mbps per channel
Power Supplies	Typical datasheet values
Bit Depth	10-bit

3.4 Pixel Array

This specification is only applicable to the active pixels of the pixel array. There is a region of two pixels wide at all the edges of the sensor for which there are less strict definitions. These differences are clarified in the diagram below.

Figure 3:
CMV4000 Pixel Array

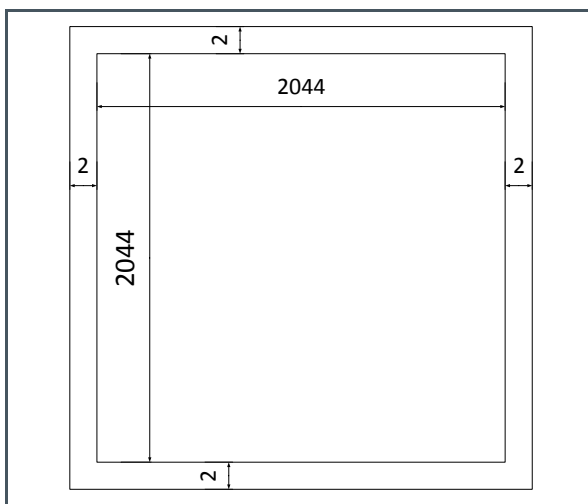
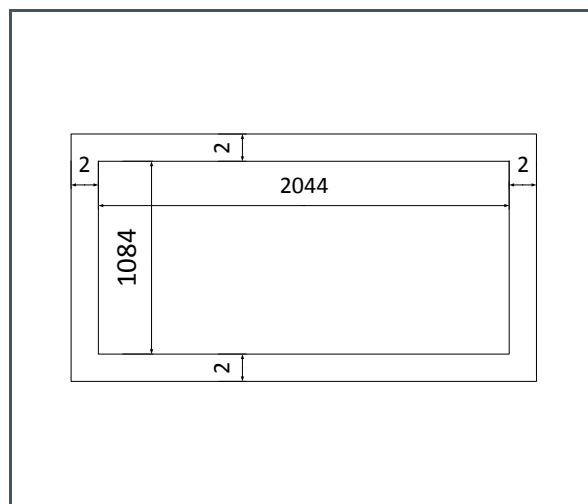


Figure 4:
CMV2000 Pixel Array



4 Definitions

4.1 Image Definitions

The table below explains the image levels used for testing and defect detection.

Figure 5:
Image Definitions

Image Level	Definition
Dark level	The average of one completely dark image with 10 line times exposure
Grey level	The average of one image with 3276 line times exposure
Saturation level	The level at which all pixels are saturated with 13104 line times exposure
Signal swing	Mean saturation level minus mean dark level

4.2 Defect Definitions

Figure 6:
Defect Definitions

Defect Name	Definition	Detail
Defect Pixel in Dark Image (1)	A pixel deviation >5% of the total swing	An image at dark level is taken. Any individual pixel in a tile of 64x64 pixels, which deviates more than +5% or -5% from the signal swing from the mean value of that tile is considered defect.
Defect Pixel in Grey Image (2)	A deviation >15% of the grey level for pixels more than 2 pixels away from the edge, and a deviation of >30% for pixels closer to the edge	An image is taken at grey level and from that the dark image is subtracted. Any individual pixel in a tile of 64x64 pixels, which deviates more than +15% (or -15%) from the mean value of that tile is considered defect. For pixels that are 2 pixels or less away from the edge, +30% or -30% is deviation is allowed.
Defect Pixel in Saturation Image (3)	<80% Swing	An image is taken at saturation level and from that the dark level is subtracted. Any individual pixel with a value <80% of the signal swing is considered defect.
Defect Pixel	Sum of (1), (2) and (3)	

Defect Name	Definition	Detail
Defect Column in Grey Image	A deviation of >5% of the grey level for columns more than 2 pixels away from the edge, and >10% deviation for columns closer to the edge	An image is taken at grey level and from that the dark image is subtracted. Any column in a tile of 64*1088 (for CMV2000) or 64*2048 (for CMV4000) pixels, which deviates more than +5% (or -5%) from the mean value of that tile is considered defect. For columns that are 2 pixels or less away from the edge, +10% and -10% deviation is allowed.
Defect Row in Grey Image	A deviation of >5% of the grey level for rows more than 2 pixels away from the edge, and a >10% deviation for rows closer to the edge	An image is taken at grey level and from that the dark image is subtracted. Any row in a tile of 64*2048 pixels, which deviates more than +5% (or -5%) from the mean value of that tile is considered defect. For rows that are 2 pixels or less away from the edge, +10% or -10% deviation is allowed.
Defect Column	>100 defect pixels	A column is defect when it has >100 defect pixels
Defect Row	>100 defect pixels	A row is defect when it has >100 defect pixels
FPN	FPN < 1%rms in the dark image	The standard deviation of the dark image is measured per tiles of 64*64 pixels and compared to the signal swing. Defect pixels are not taken into account.
PRNU	PRNU < 5%rms in the grey image	The standard deviation of the grey image is measured per tiles of 64*64 pixels and compared to the signal swing. Defect pixels are not taken into account.

5 Defect Limits

The table below indicates the actual defect limits used during device testing.

Figure 7:
Defect Limits

Name	CMV2000	CMV4000	Comment
Defect Columns	0	0	No defect columns allowed
Defect Rows	0	0	No defect rows allowed
Defect Pixels	100	200	Maximum amount of defect pixels allowed
Clusters (Size 1 pixel)	0	0	(1) and (2)
Clusters (Size 2 pixel)	0	0	No clusters allowed
Clusters (Size 3 pixel)	0	0	No clusters allowed
Clusters (Size 4 pixel)	0	0	No clusters allowed
Clusters (Size 5 pixel)	0	0	No clusters allowed
Clusters (Size 6 pixel)	0	0	No clusters allowed
Clusters (Size 7 pixel)	0	0	No clusters allowed
Clusters (Size 8 pixel)	0	0	No clusters allowed
Clusters (Size 9 pixel)	0	0	No clusters allowed
Clusters (Size 10 or more pixels)	0	0	No clusters allowed



Information

(1) For monochrome devices, defect pixels that are adjacent (horizontal, vertical or diagonal) are considered a cluster.

(2) For color devices, defect pixels of the same color that are adjacent (horizontal, vertical or diagonal) are considered a cluster.

Example 1: A defect red pixel next to a defect green pixel is not considered as a cluster

Example 2: A defect red pixel next to a good green pixel, next to a defect red pixel is considered a cluster.

**Information**

Green is split up in two color planes (green1 and green2). This means that if two defect green pixels are detected in a Bayer pattern kernel, they are not considered a cluster because they can be considered single defect pixels (unless they fall under (2) in their respective color planes).

6 Removable Glass Devices

Devices with removable cover glass are using tape to secure the glass to the package. The tape is attached at the edges of the window, so it does not obstruct the optical path. The same protective tape as on fixed glass devices is also placed on top of the window. The glass on removable glass devices is only there as protection of the silicon and bond wires and is not subject to defect claims.

The tape is not a hermetic seal of the sensor cavity. This means air, moisture and particles can enter the sensor cavity, and special handling of these devices is required. Because the glass is not fully secured to the ceramic, physical handling of the devices should be limited to avoid scratching between the glass and the ceramic package, which includes particles.

Removable glass devices are tested following the same specifications as fixed glass devices. This ensures the same quality at outgoing inspection. Because of the non-hermetic seal and the possibility of friction between the glass and the ceramic package, particles can be introduced during shipping or when opening the packaging or when handling the devices afterwards. As **ams** has no control over these stages, we limit the defect claims of removable glass devices in the following manner.

Non-claimable defects:

- Glass or coating defects, e.g. stains, scratches or digs
- Physical and optical defects after glass lid has been removed
- Particles and stains before the glass lid has been removed

As the glass is only there as a protection and not for the final application, claims on stains, scratches or digs on the glass or coating are not accepted by **ams**.

When the taped glass is removed, the sensor is very sensitive to damage. Particles, dirt, moisture or electrical and physical damage can therefore happen. Defects (optical and physical) cannot be claimed after the glass lid has been removed. Therefore, **ams** recommends to perform a full incoming inspection with the glass still attached in a clean room environment.

Particles on the silicon or glass can be cleaned at the customer's own risk after removing the glass. As the sensors are tested at **ams** with the glass attached following the same test specification as fixed glass devices, particles seen at the customer side should be cleanable.

Application Note AN000589 contains general guidelines on handling windowless image sensors.

7 Revision Information

Changes from previous version to current revision v1-00	Page
Initial version, update from CMOSIS document v14	all

- Page and figure numbers for the previous version may differ from page and figure numbers in the current revision.
- Correction of typographical errors is not explicitly mentioned.

8 Legal Information

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