DOCUMENT TITLE

Defect Criteria Definition

REVISION HISTORY

REV	ECN	CHANGE DATE	CHANGE DESCRIPTION
0	*2013-141*	*10-29-2013*	*Create a single document that defines defect criteria and test conditions that can be used both internally and externally.*
**00*	*2014-79*	*06-17-2014*	*Add reference to DSVGA and SXGA096 User Manual and add code 71 (Noise) to defect list (inadvertently deleted). *New DOC number assigned: previously I03-000005-XX*
01	*2014-120*	*09-17-2014*	*Added statement for inspection settings and clarified Code 14 particle code defect criteria*
02	*2014-154*	*11-20-2014*	*Changed Low Level Non Uniformity definition and added pictures*
A	*000159*	*10-28-2016*	*Removed allowable stuck-on sub pixels for SXGA and WUXGA and added Fiber-Plate defect chart and definitions to codes 10,14,and 50 – revision changing to follow new protocol – "A"*
B	*000177*	*11-30-2016*	*Added DSVGA*
C	*000263*	*07-17-2017*	*Changed acceptable stuck off criteria*
D	*001044*	*10-27-2020*	*Removed references to internal inspection codes and revised defect descriptions. Added 1000588 to Document List. Added Delamination, Die Chipping and Encap Overflow. Revised reject criteria for Thin Film Tear and Short Pixels. Formatted document so it is uniform. Added new display types to table, updated nominal luminance and removed obsolete display types from table. Revised defect images. Revised A,B and F criteria for all defect types.*
E	*001449*	*07-20-2023*	*Added pictures for Die placement not within fiducial(s.)*

1 PURPOSE AND SCOPE

The purpose of this document is to provide definition to what eMagin considers to be acceptable and non-acceptable product. This applies to all eMagin microdisplays.

2 RESPONSIBILITIES

All inspectors must be trained in understanding this procedure. Business Development is responsible for distributing this document to eMagin customers for reference. It is also published on our Customer Portal.

3 ACRONYMS AND DEFINITIONS

OLED	Organic Light Emitting Diode
DRK	Design Reference Kit

4 REFERENCE DOCUMENTS AND FORMS

1000588	Defect Codes List
User Manual	DSVGA User Manual
User Manual	SVGA Rev. 2 User Manual
User Manual	SVGA Rev. 3 User Manual
User Manual	SXGA096 User Manual
User Manual	SXGA120 User Manual
User Manual	VGA User Manual
User Manual	WUXGA User Manual
User Manual	2Kx2K User Manual

5 TOOLS / EQUIPMENT

Binocular Inspection 100X Zoom Microscope or better
eMagin DRK with Windows Interface Utility

6 ENVIRONMENTAL/TEST CONDITIONS

These tests are performed in a low light lab environment at ambient room temperature.

7 OPERATING CONDITIONS

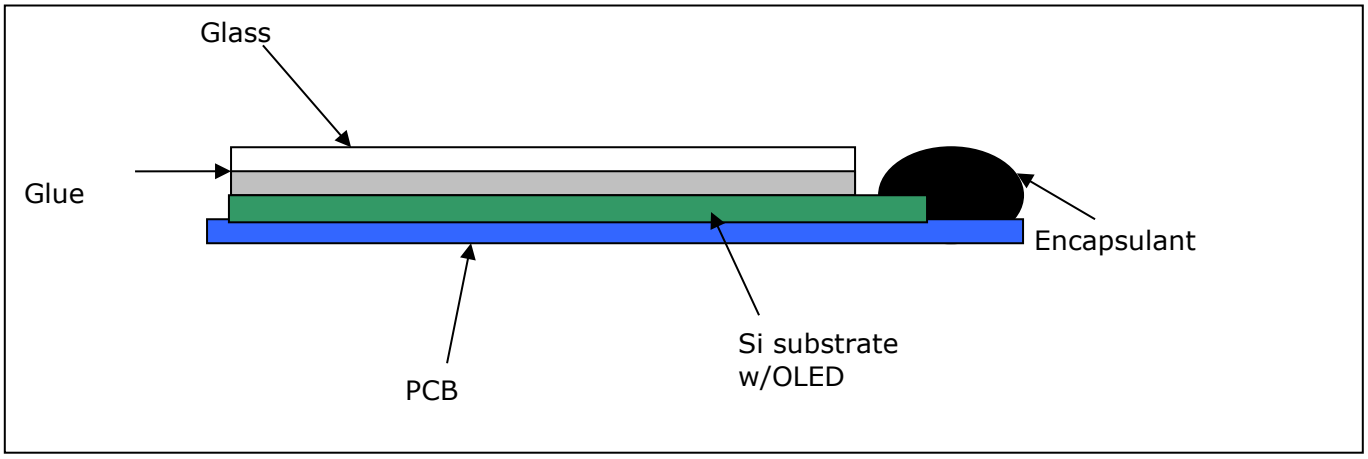
Recommended settings are defined and recorded in the appropriate product data sheets. Please refer to those for specific product information.

8 PRODUCT INSPECTION SETTINGS – MAGNIFICATION AND BRIGHTNESS

Product	Version	color	FULL SCREEN ACTIVE AREA*	FULL PCB	NOM LUM cd/m²
VGA	XL	WHITE	16X	9X	900
VGA	XL	GREEN	16X	9X	1500
VGA	XL	COLOR	16X	9X	150
DSVGA	XL	COLOR	13.4X	9.3X	150
DSVGA	XL	WHITE	13.4X	9.3X	900
DSVGA	XL	GREEN	13.4X	9.3X	1500
DSVGA	XLT	GREEN	13.4X	9.3X	5000
DSVGA	XLT	YELLOW	13.4X	9.3X	5000
SVGA+	STD	WHITE	13.4X	9X	500
SVGA+	STD	COLOR	13.4X	9X	100
SVGA+	XL	WHITE	13.4X	9X	900
SVGA+	XL	GREEN	13.4X	9X	1500
SVGA+	XL	YELLOW	13.4X	9X	1500
SVGA+	XL	COLOR	13.4X	9X	150
SXGA096	XL	COLOR	13.4X	9X	150
SXGA096	XLS	COLOR	13.4X	9X	750
SXGA096	XL	WHITE	13.4X	9X	700
SXGA096	XLT	GREEN	13.4X	9X	5000
SXGA120	XL	COLOR	9.8X	8X	150
SXGA120	XLS	COLOR	9.8X	8X	750
SXGA120	XL	GREEN	9.8X	8X	1500
SXGA120	XLT	GREEN	9.8X	8X	5000
WUXGA	XL	COLOR	9.3X	8X	150
WUXGA	XLS	COLOR	9.3X	8X	800
WUXGA	XLT	GREEN	9.3X	8X	5000
2Kx2K	ULT	COLOR	12X	8X	5000

*Note: Starting point for full screen view for large defects

9 DISPLAY DEFECT TYPES AND EXAMPLES



Functional Grade Definitions

Grade	Description
A	Functional parts that pass all eMagin criteria
B	Off Grade Parts – No black spot or functional defects (For testing or samples only)
F	Rejected part – Unsuitable for testing or samples

DOCUMENT TITLE

Defect Criteria Definition

Defect	A Part must meet criteria described below	B Part must meet criteria described below	F
NO DEFECT FOUND	No defects present in part	N/A	N/A
BLEMISH	One of the following criteria must be met: • Blemish affects < 3 sub-pixels • The blemish is not visible in transmitted light and can only be seen in reflected light • Blemish is outside of active area • For Fiber plates see fiber plate defect chart	Blemish affects ≥3 sub-pixels visible to naked eye when lit up with transmitted light illumination and in the active area of the display For fiber plates see fiber plate defect chart	N/A
FILTER	• One of the following criteria must be met: • Light donut acceptable (See sample image) • Center dot acceptable	One of the following criteria must be met: • Color filter problems (including torn filter causing bright sub-pixels) • Part does not meet standard for light donut or center spot (See sample image)	N/A
GLASS DEFECTS	• One of the following criteria must be met: Glass defect affects < 3 sub-pixels • Glass defect affects ≥ 3 sub-pixels that does not impede or distort OLED and cannot be seen in emissive mode • No crooked cut of glass plate edge • Small divot or chip on glass that will not propagate into the active area of the display (See images)	One of the following criteria must be met: • Glass defect ≥ 3 sub-pixels that impedes or distorts OLED and can be seen in emissive mode • Glass defect that creates a light pattern in a non-active area • Chips on glass edge or corners that can propagate into the active area of the display • Chips that run the entire thickness of the glass • Crooked cut of glass plate edge	N/A

DOCUMENT TITLE

Defect Criteria Definition

Defect	A Part must meet criteria described below	B Part must meet criteria described below	F
GLASS UNDERFILL	Glue coverage uniform for entire glass area	Glue coverage not uniform in active area	N/A
PARTICLE (Compact and well-defined defect – hard lines visible)	One of the following criteria must be met: • Particle affects <3 sub-pixels • Particle only visible with bright light illumination • Particle is outside of active area • **For Fiber plates see fiber plate defect chart**	One of the following criteria must be met: • Particle affects ≥3 sub-pixels visible to naked eye when lit up without bright light illumination in the active area of the display • **For fiber plates see fiber plate defect chart**	N/A
Dead Sub Pixel	REV2 ≤ 120 REV3 ≤ 120 SXGA - All types ≤ 310 VGA ≤ 90 WUXGA ≤ 690 DSVGA ≤ 120 In addition: No more than one sub pixel out per pixel and No touching sub pixels out in RGB order within row • For Fiber plates see fiber plate defect chart	REV2 > 120 REV3 > 120 SXGA - All types > 310 VGA > 90 WUXGA > 690 DSVGA > 120 In addition: 3 sub pixels out in a group - but not full pixel out; Two or more touching stuck-off sub pixels in RGB order (within row); **Or** Cluster type defect – see example • For Fiber plates see fiber plate defect chart	N/A

DOCUMENT TITLE

Defect Criteria Definition

Defect	A **Part must meet criteria described below**	B **Part must meet criteria described below**	F
PACKAGING	One of the following criteria must be met: • No encapsulant touching glass • Encapsulant on back of board does not interfere with connector • Encapsulant no higher than cover glass • No encapsulant beyond line formed by edge of glass lid • No open cracks in encapsulant • Die placement within fiducials • No component damage on carrier board • S/N label must lie flat and appear legible	One of the following criteria must be met: • Encapsulant material touching glass • Encapsulant interferes with connectors on back of board • Encapsulant higher than cover glass • Cracks in encapsulant • Die placement not within fiducials • S/N label is not flat or legible	N/A
MISALIGNMENT	NONE ALLOWED	Line or band visible along active area edges when in emissive mode	N/A

DOCUMENT TITLE

Defect Criteria Definition

Defect	A Part must meet criteria described below	B Part must meet criteria described below	F
THIN FILM TEAR	Tear(s) < ¼ length of a side of the display or the sum of individual tears < ¼ length	Tear(s) > ¼ length of the encapsulant side of display or the sum of individual tears < ¼ length	Tears affect the black frame or exposes metal
BUBBLE	One of the following criteria must be met: • Bubble(s) affecting < 3 sub-pixels • Bubble(s) not visible when display is actively driven or outside of active area	• Bubble(s) affects ≥ 3 sub-pixels **OR** bubble is visible when display is actively driven	N/A
MP NO GLASS	(eMagin Use Only)	(eMagin Use Only)	(eMagin Use Only)
DELAMINATION	NONE ALLOWED	NONE ALLOWED	Any delamination of the glass from the die
DIE CHIPPING	NONE ALLOWED	NONE ALLOWED	Die shows signs of impact or is fractured.
ENCAPSULATION OVERFLOW	NONE ALLOWED	NONE ALLOWED	Encapsulation is touching the glass or has flowed to edges of the PCB.
MP Edge Bead Removal	(eMagin Use Only)	(eMagin Use Only)	(eMagin Use Only)
MP Missing CF	(eMagin Use Only)	(eMagin Use Only)	(eMagin Use Only)

Defect	A Part must meet criteria described below	B Part must meet criteria described below	F
BLACK SPOT	NONE ALLOWED	NONE ALLOWED	Black spots of any size or location
BLACK SPOT LINE	NONE ALLOWED	NONE ALLOWED	Large black spot that runs across the active area
STUCK ON SUB-PIXEL	NONE ALLOWED	NONE ALLOWED	One or more stuck-ons are apparent
STUCK ON ROW	NONE ALLOWED	NONE ALLOWED	One or more stuck-on rows are apparent
STUCK ON COLUMN	NONE ALLOWED	NONE ALLOWED	
STUCK OFF COLUMN	NONE ALLOWED	NONE ALLOWED	
FUNCTIONAL	NONE ALLOWED	NONE ALLOWED	One of the following criteria must be met: • Lights up, but no video images (composite or SVGA)Intermittent image: image dies or does not stay on • Black level too bright • Loose connector: display does not firmly fit into electrical socket • Image does not rotate • Missing colors: red, green, blue • Wavy grid • Flickering light • Serial port failure • No grey scale to sub-pixel • Fewer than 8 grey shades

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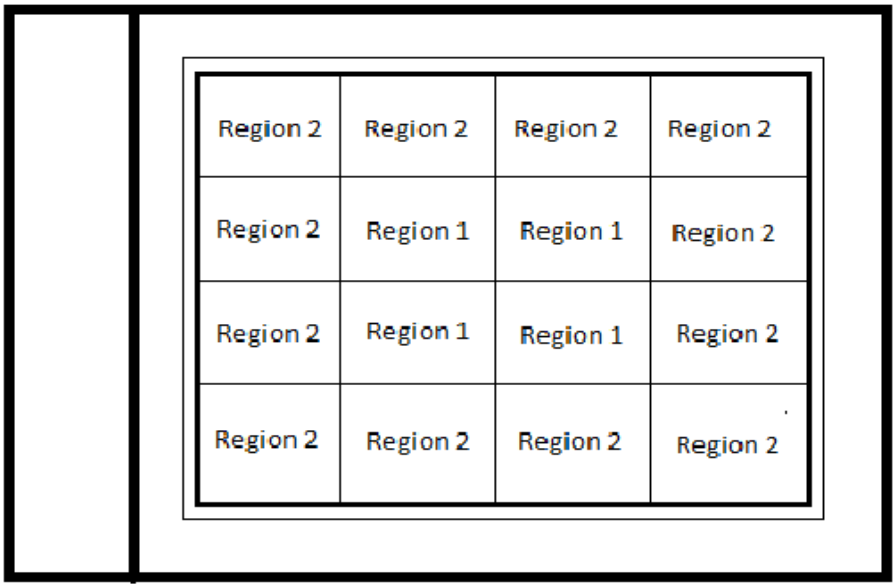
Defect Criteria Definition

Defect	A Part must meet criteria described below	B Part must meet criteria described below	F
SHORT PIXELS	NONE ALLOWED	NONE ALLOWED	Lit pixel area <100% of electrode area. Will affect all sub-pixels in a display in a uniform fashion
NON-UNIFORMITY	NONE ALLOWED	NONE ALLOWED	Inconsistencies in luminance or color that affects large areas of the display when lit (See example images)
NO LIGHT	NONE ALLOWED	NONE ALLOWED	Display does not light
STUCK OFF ROW	NONE ALLOWED	NONE ALLOWED	At least 1 entire row of pixels is out
EEPROM/PCB ISSUE	NONE ALLOWED	NONE ALLOWED	Functional failure related to the EEPROM or PCB
START UP FLASH	NONE ALLOWED	Brief flash at power on before stable image is displayed	N/A
IMAGE NOISE	Image must be stable and show no systematic or random noise when looking a at a flat field mid-gray image.	NONE ALLOWED	NOISE EXISTS
LOW LUMINANCE NON-UNIFORMITY	NONE ALLOWED	Non-Uniformity exists at low brightness setting (< 100 cd/m²)	N/A
MP CIE	eMagin use only	eMagin use only	eMagin use only

Fiber Plate Defect Chart



16 Sections of slide show dividing display active area

A Part definition (Fiber Plates)

Region 1
≤ 2 Individual defects ranging in size from 2 to 3 subpixels, particle touching 3 sub pixels or total blockage of 2 to 3 subpixels.

Region 2
≤ 2 Individual defects ranging in size from 2 to 3 subpixels, particle touching 3 sub pixels or total blockage of 2 to 3 subpixels.

Plus
≤ 2 Individual defects ranging from (size or touching) 4 to 9 subpixels

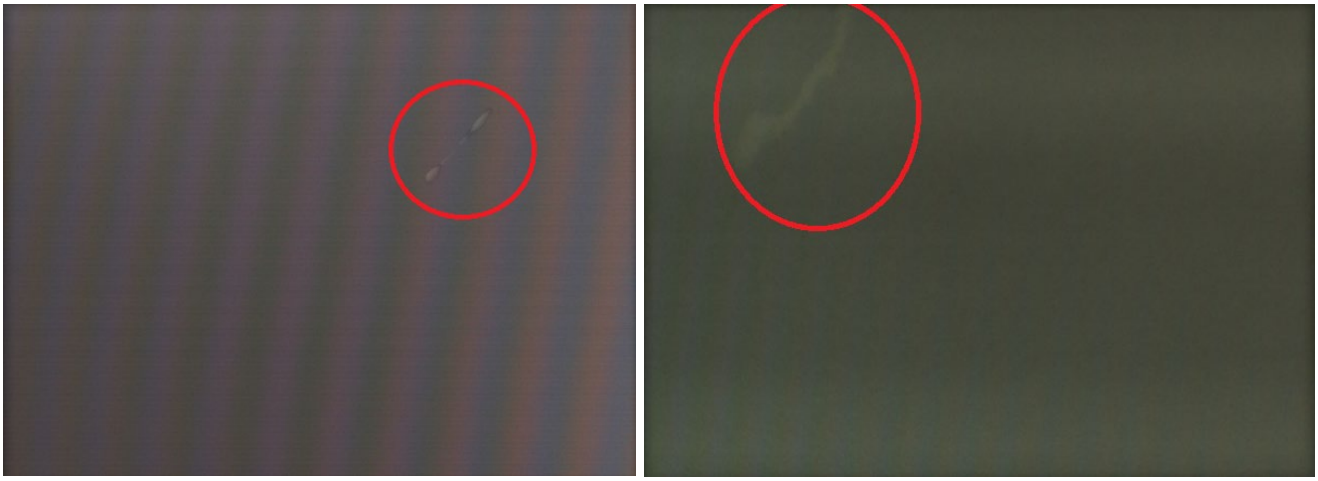
Plus
≤ 1 Individual defects ranging from (size or touching) 10 to 15 subpixels

B Part definition (Fiber Plates)

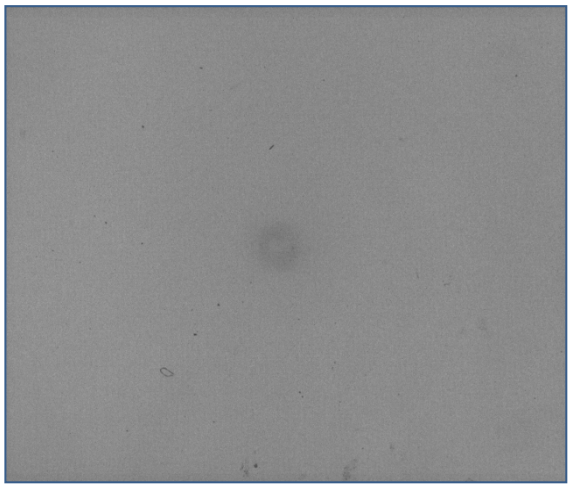
Defects greater than the (A part definition) criteria.

DEFECT PHOTO REFERENCES:

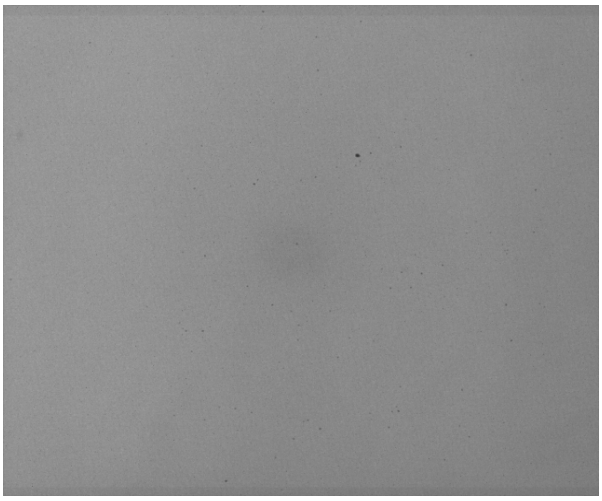
Blemish:



Filter:

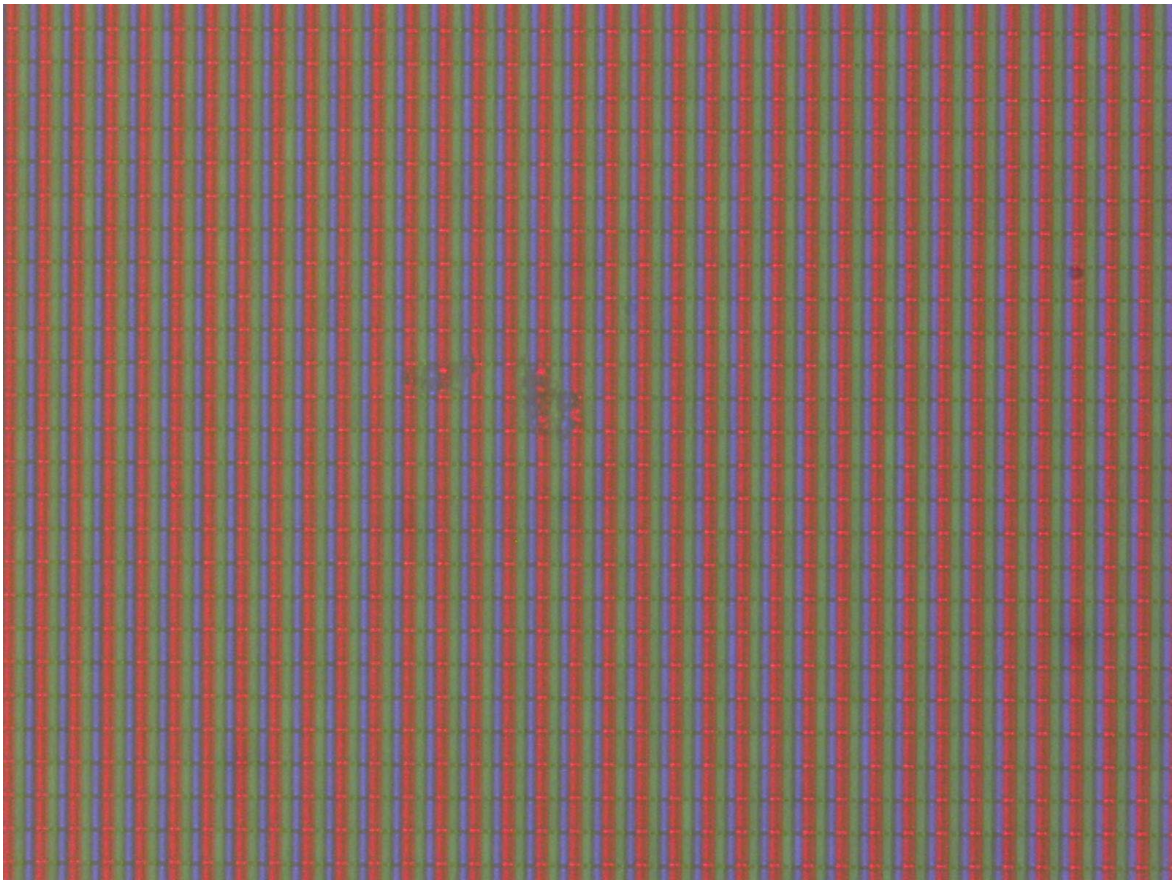


Reject



Accept

Filter continued:



Example of color filter non-uniformity = Reject

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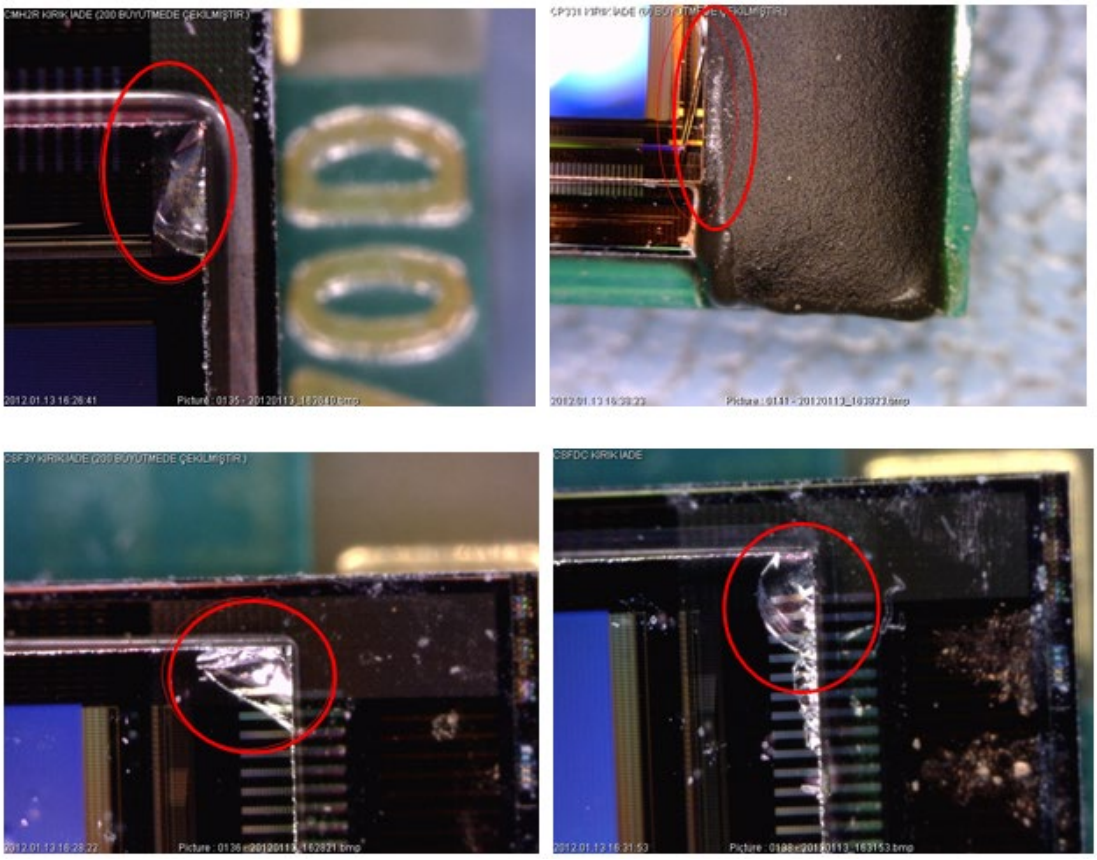
Defect Criteria Definition

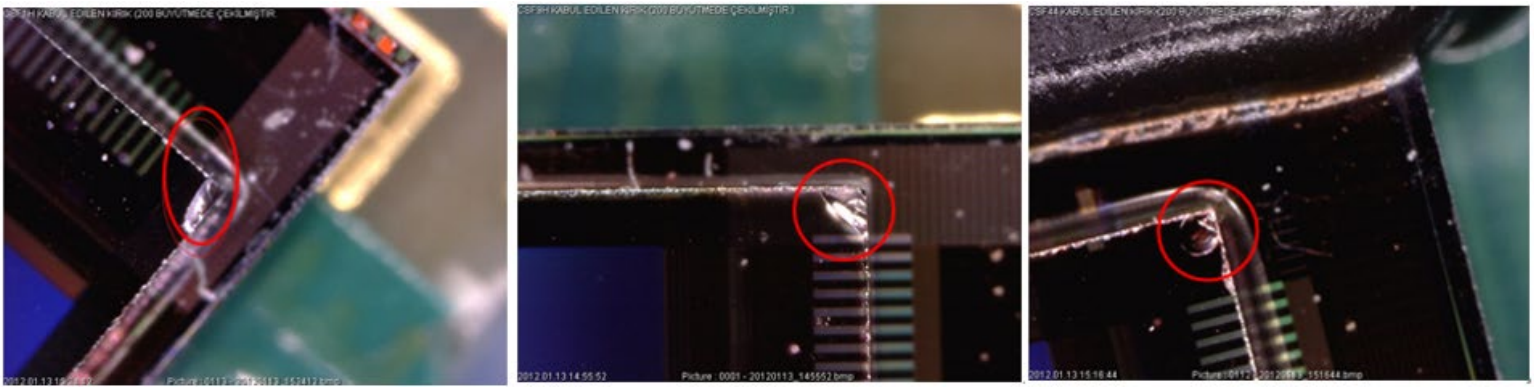
Glass Defects:



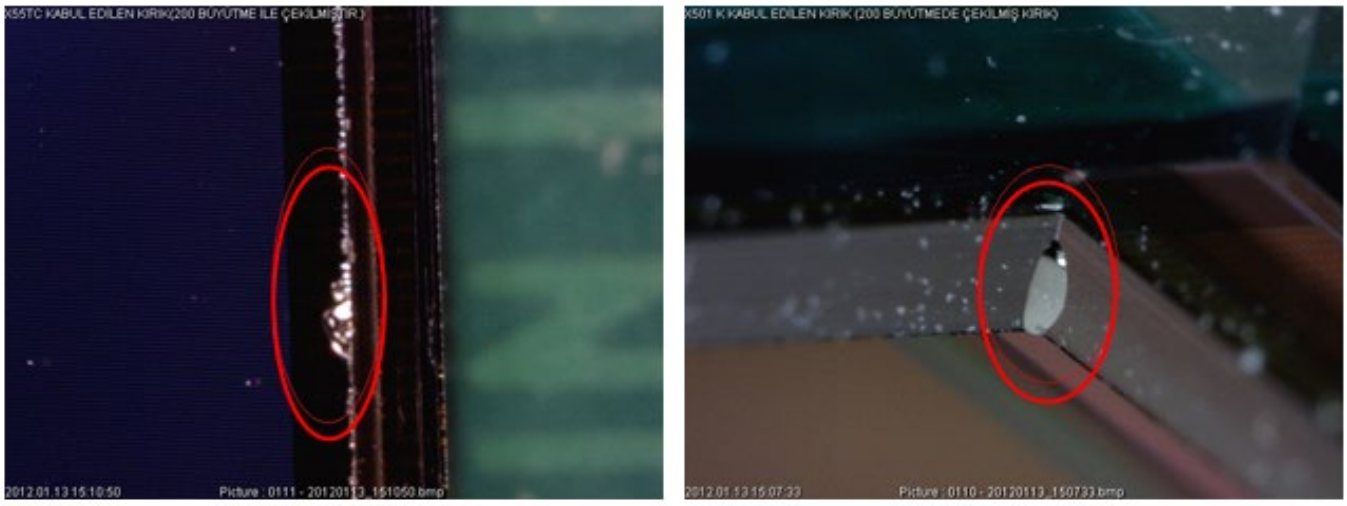
Edge / Corner glass chip defect = Reject

Edge / Corner glass chip defect = Reject

Glass Defects continued:

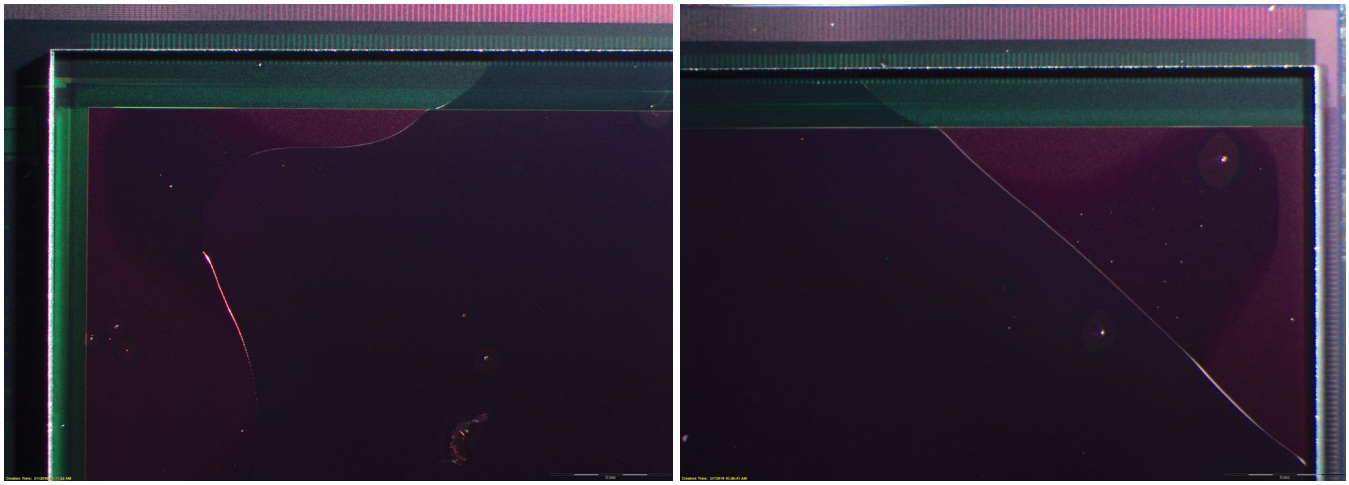


Edge / Corner glass chip defect = Accept

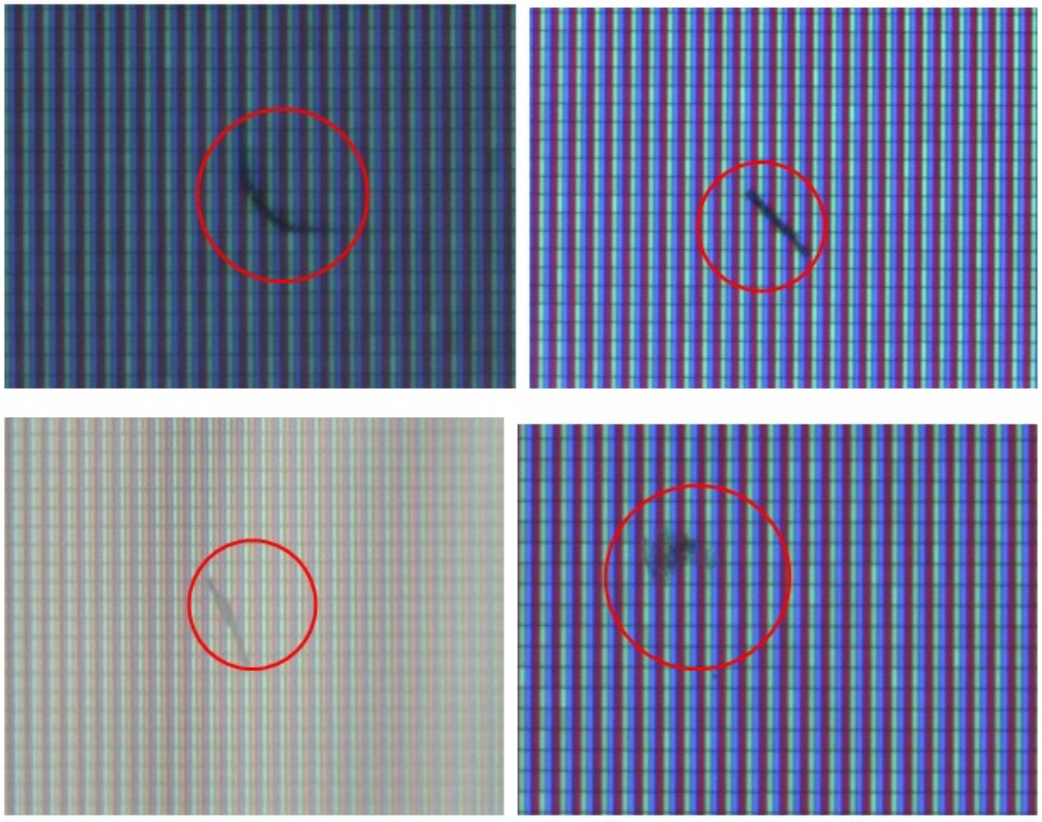


Edge / Corner glass chip defect = Accept

Glass Underfill:

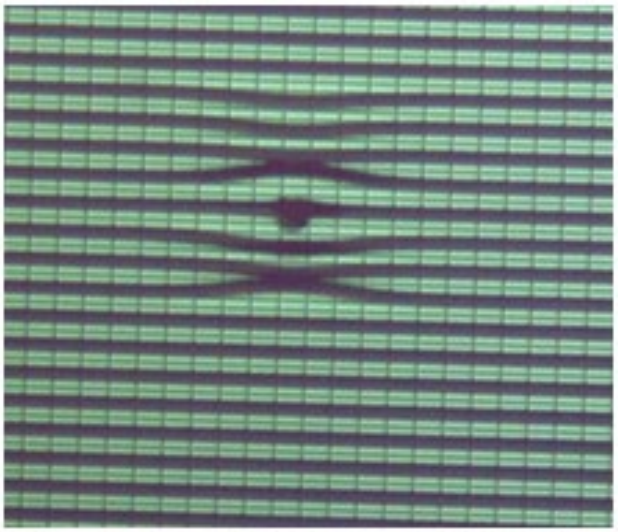


Particle:

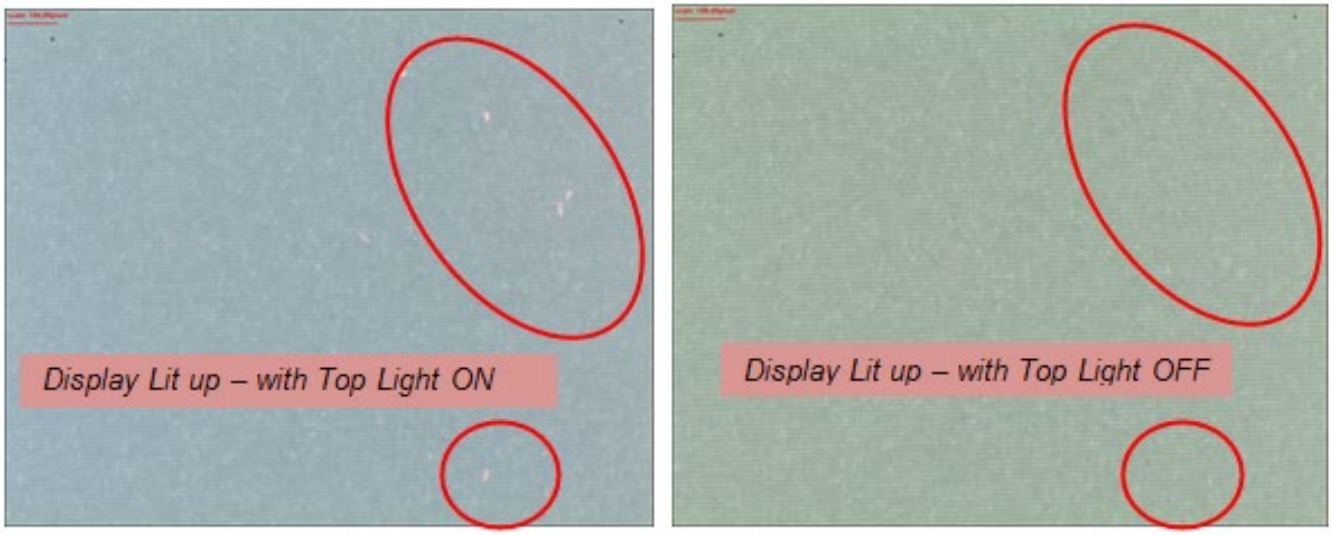


Example of a Particle = Reject

Particle continued:

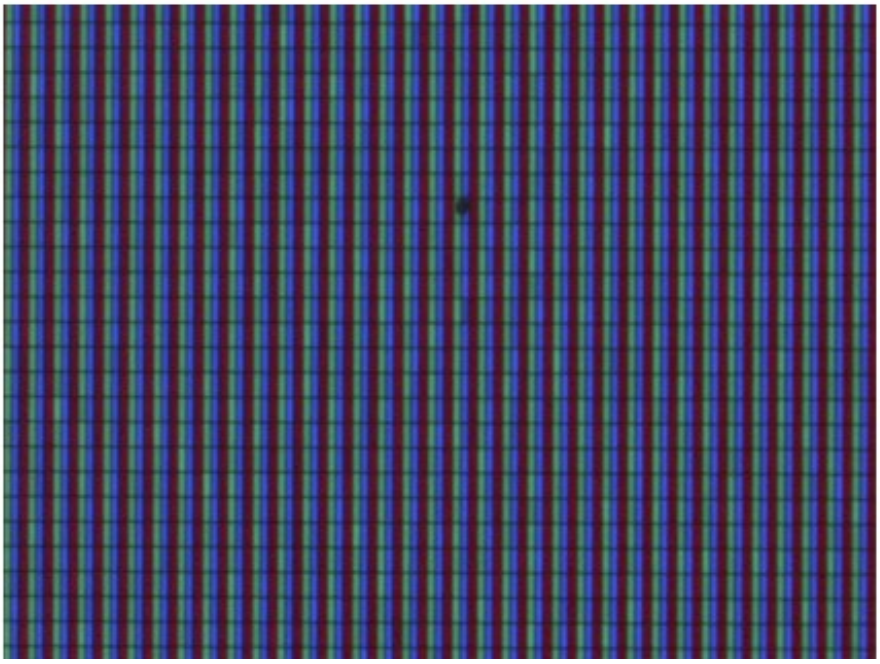


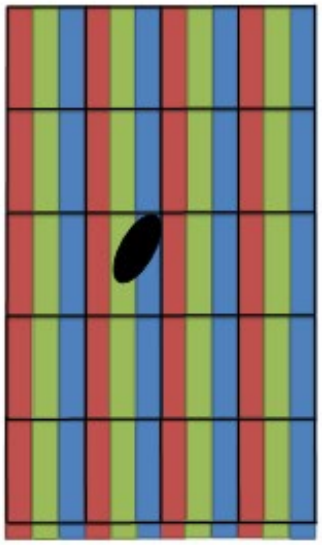
Example of particle causing filter problem = Reject



Example of clear particle = Accept

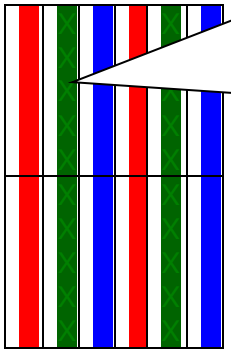
Particle continued:

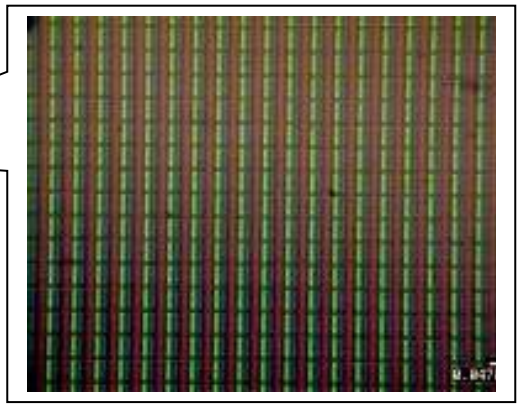




Example of particle smaller than 2 sub-pixels = Accept

Dead Sub-pixels:





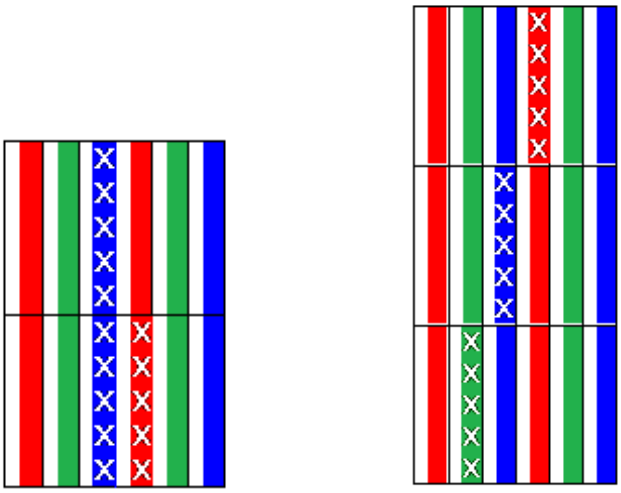
Example of 4 good RGB pixels Sample of Display at sub-pixels level

Dead Sub Pixels continued:

Example of 1 good pixel

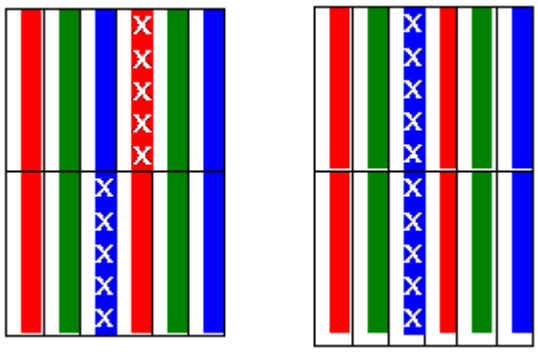
Example of 3 out/off sub-pixels = 1 pixel out

Example of a 2 sub-pixel out/off = Reject

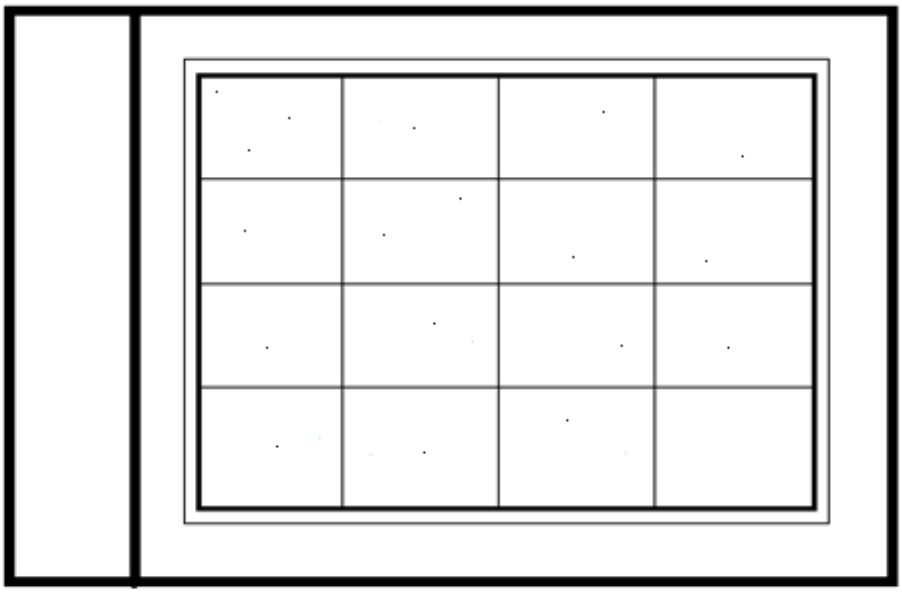


Example of 3 adjacent sub-pixels from different pixels out/off = Reject

Dead Sub Pixels continued:



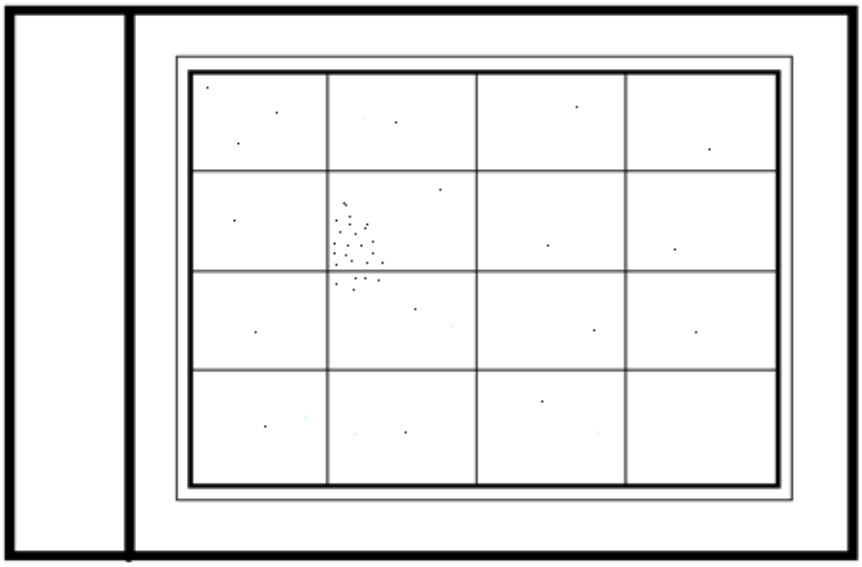
Example of 2 adjacent-diagonal sub-pixels and 2 top-bottom sub-pixels from 2 different pixel
OUT/OFF =Acceptable



16 Sections of slide show dividing display active area

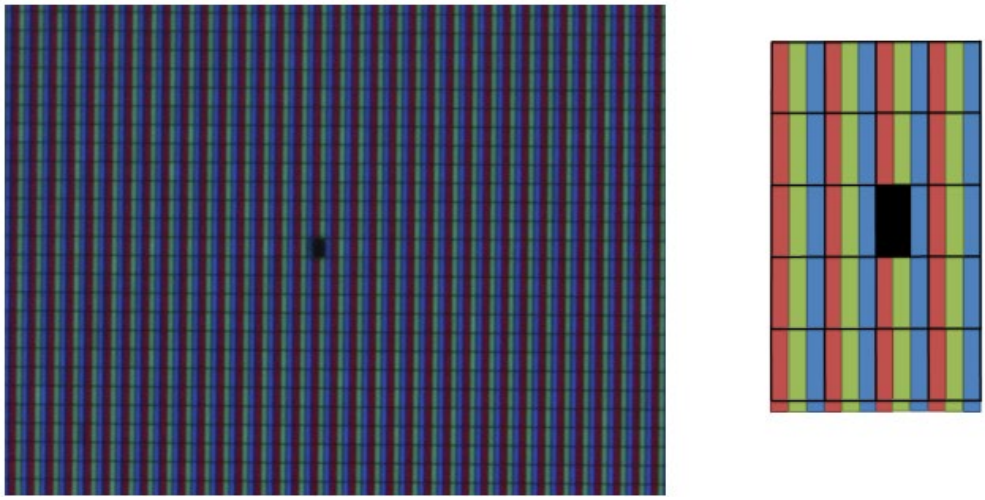
Example of passing stuck offs = Pass

Dead Sub Pixels continued:



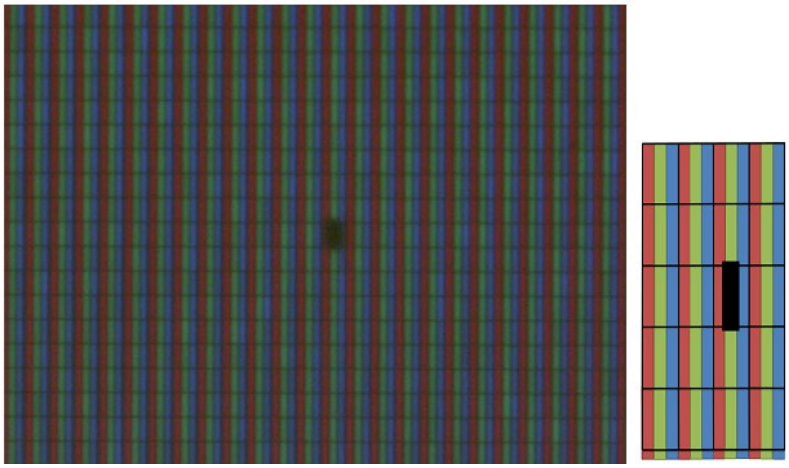
16 Sections of slide show dividing display active area

Example of cluster of stuck offs = Fail



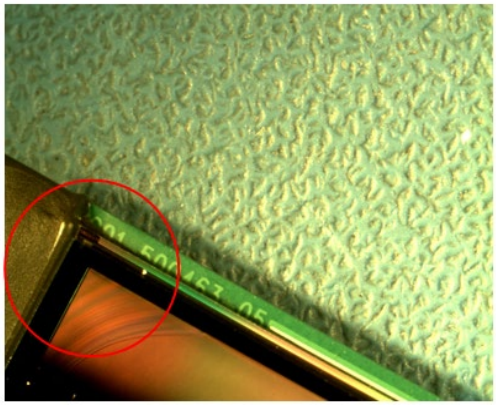
Example of 2 adjacent sub-pixels pixels OUT/OFF with Green and Red Background = Reject

Dead Sub Pixels continued:

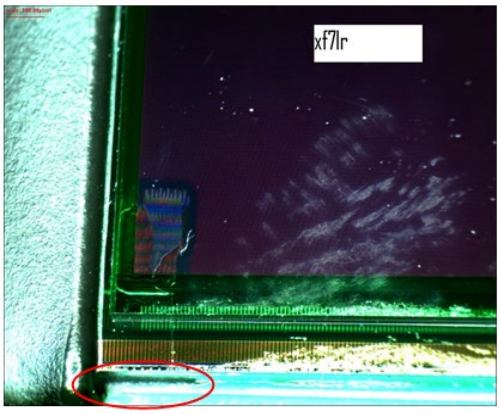


Example of zapped stuck off sub-pixel not fully blocking adjacent sub-pixel = Accept

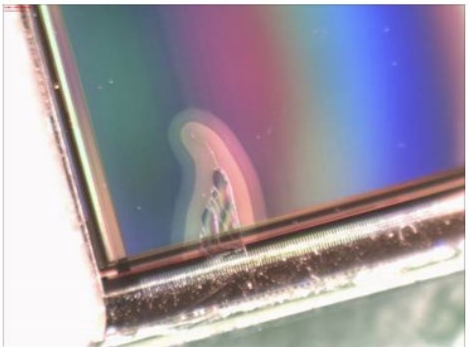
Packaging:



Damming material touching side of glass = Reject

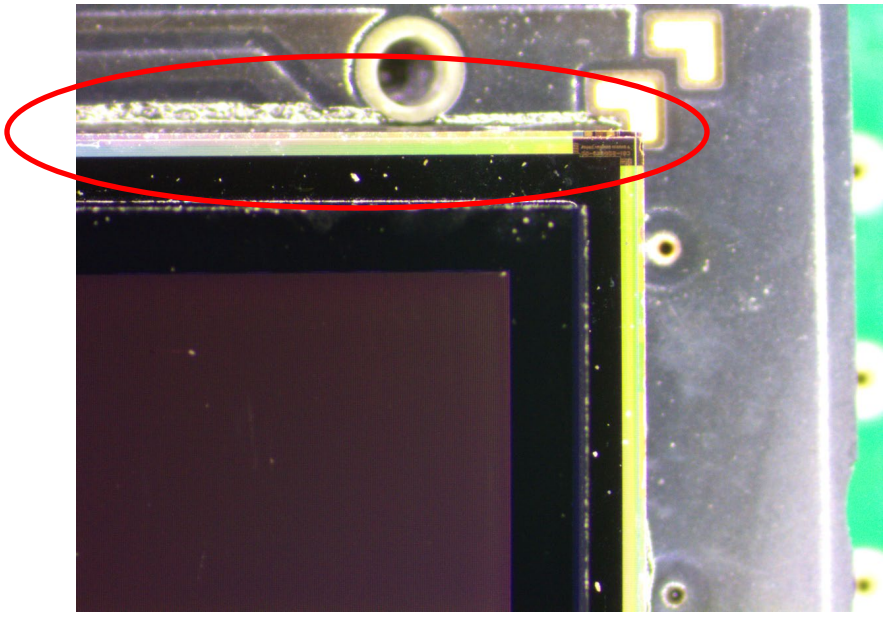


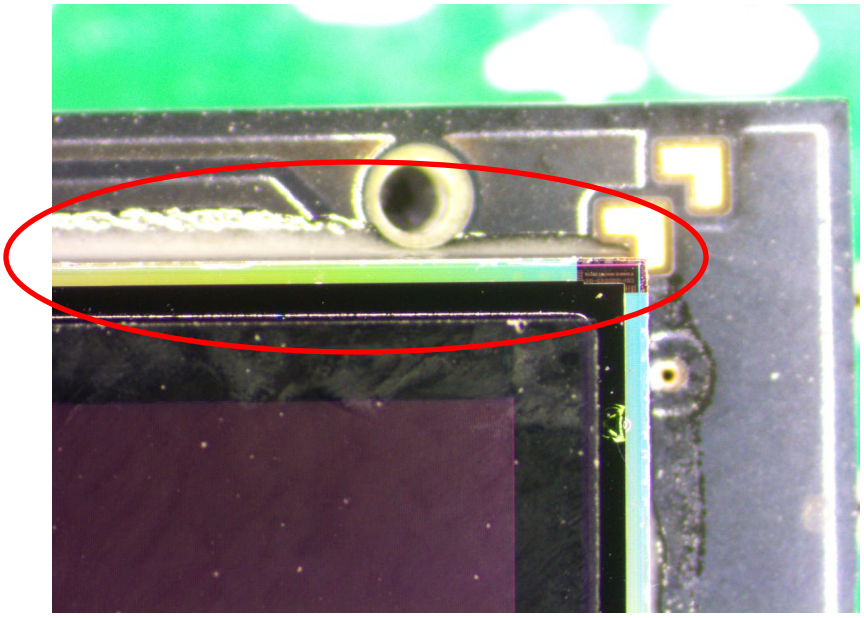
Encap material cracking silicon die = Reject



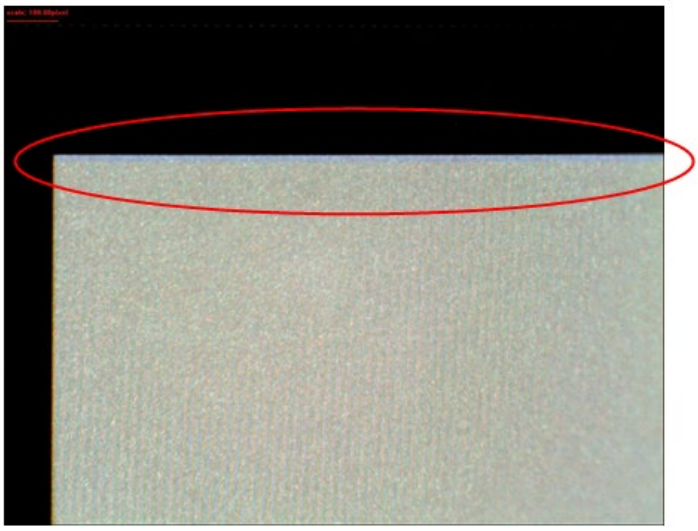
Cracked die = Reject

Die placement not within fiducial(s.):

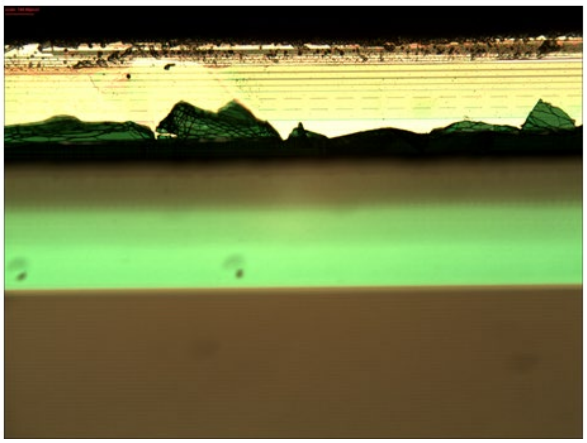


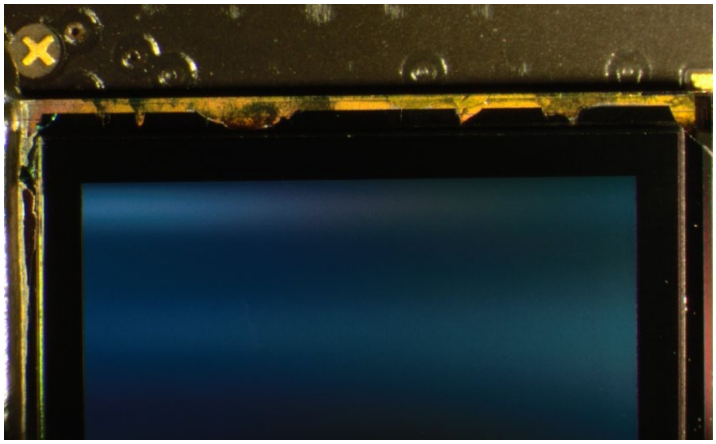


Misalignment:

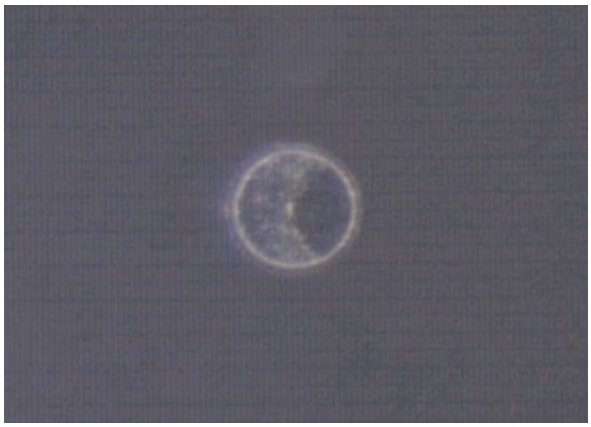


Thin Film Tear:

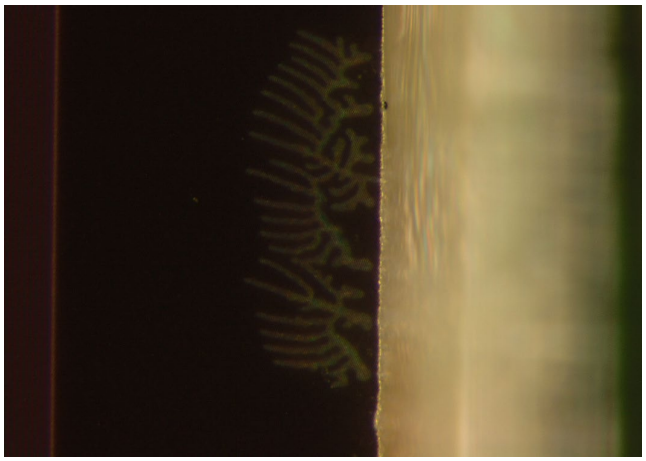


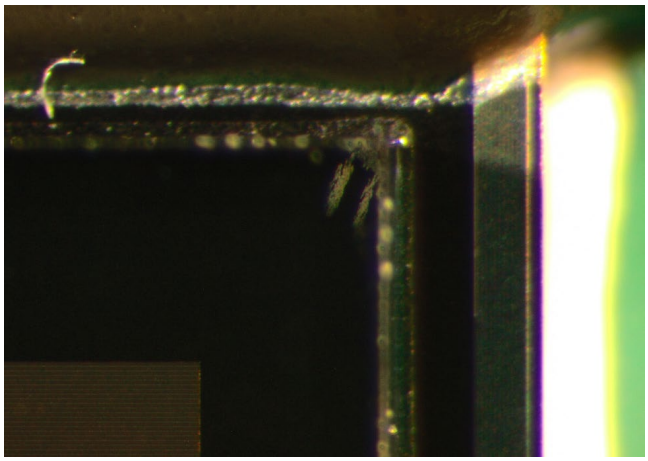


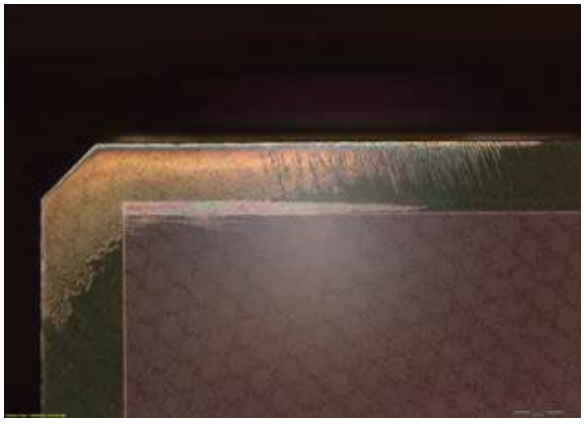
Bubble:



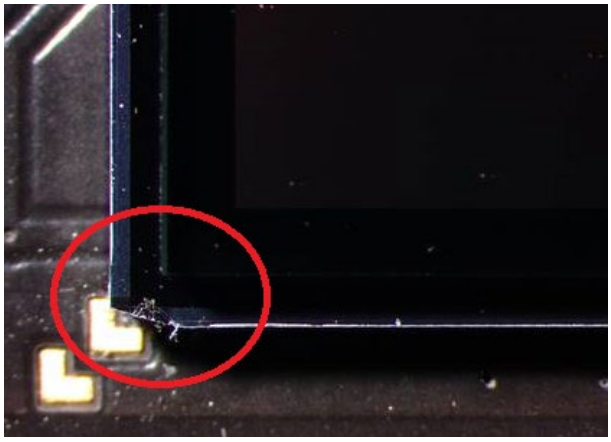
Delamination:

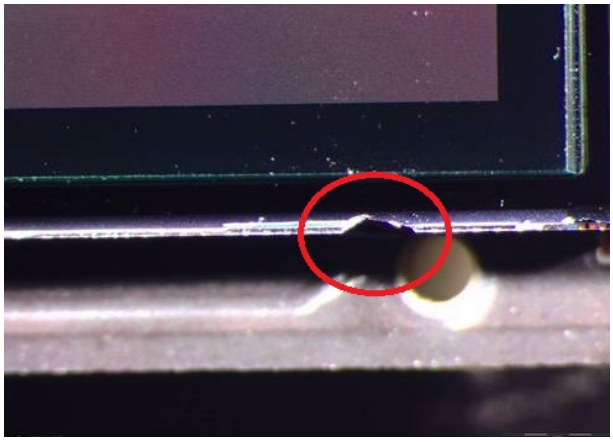




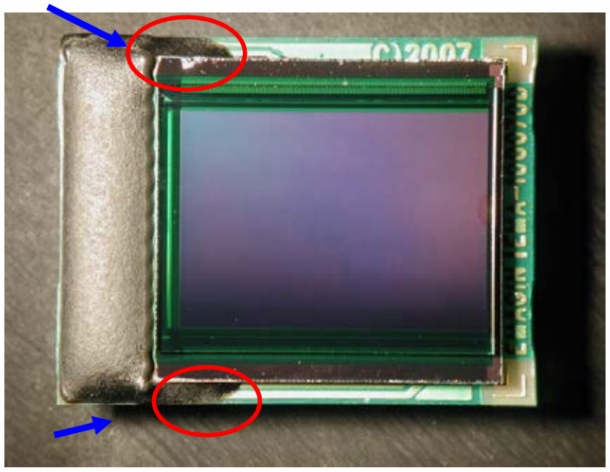


Die Chipping:

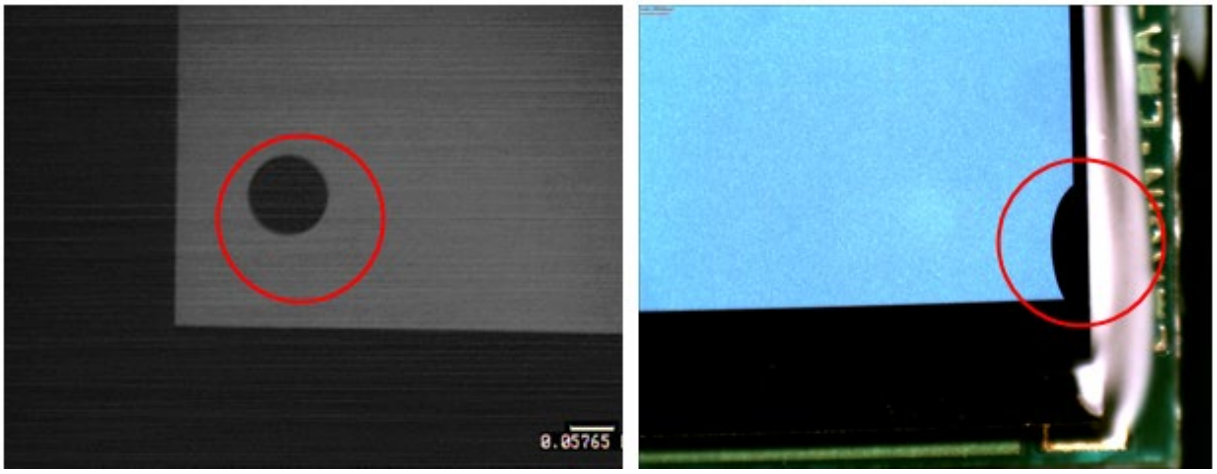




Encapsulation Overflow:

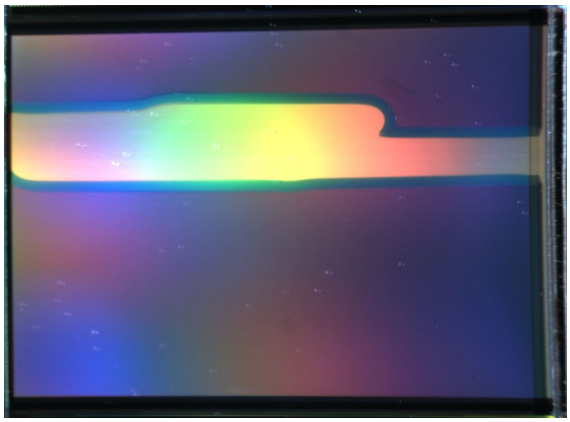


Black Spot:

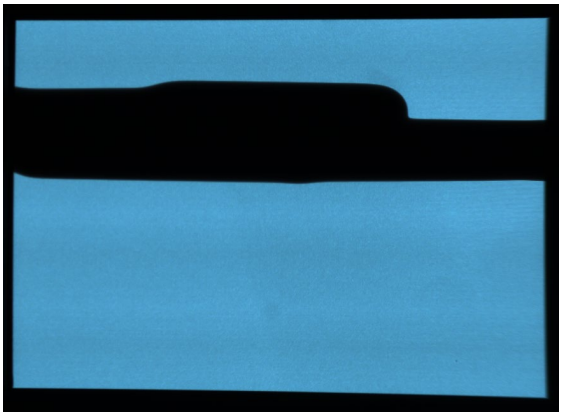


Example of black spot and edge black spot = Reject

Black Spot Line:

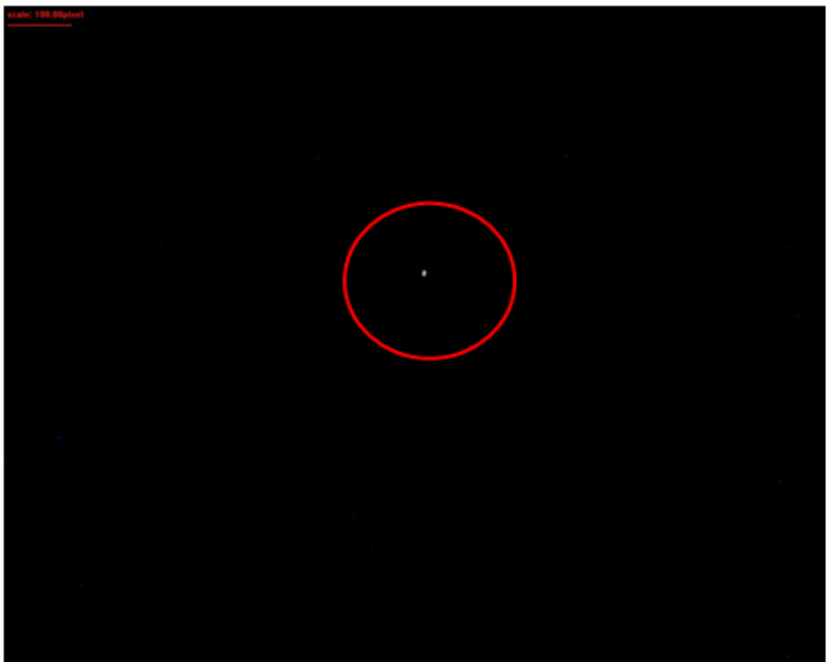


Black Spot Line-Unlit



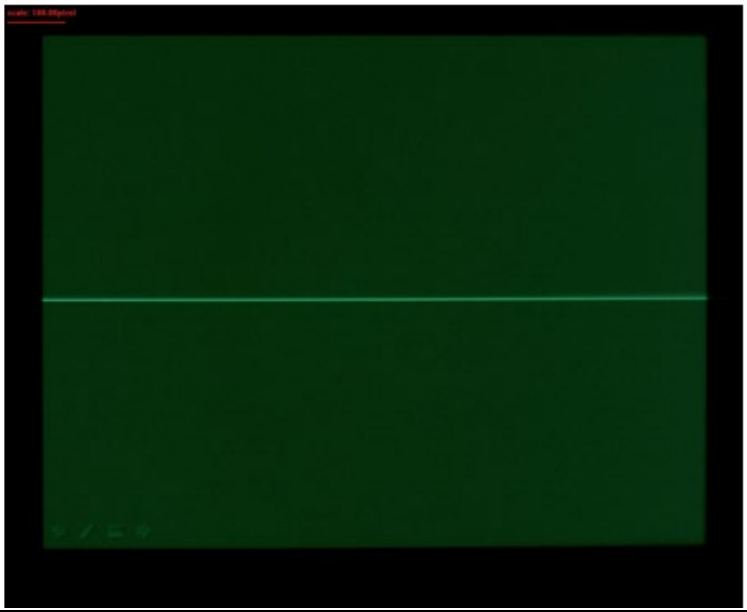
Black Spot Line - Lit

Stuck on Pixel:



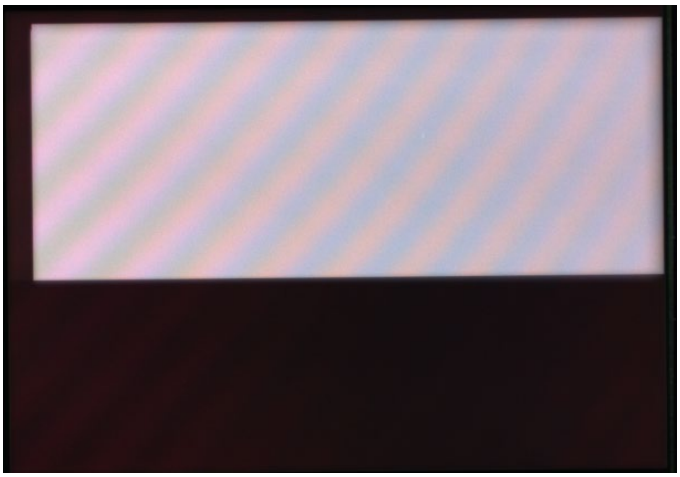
Example of stuck-on sub-pixel = Reject

Stuck-on Row:

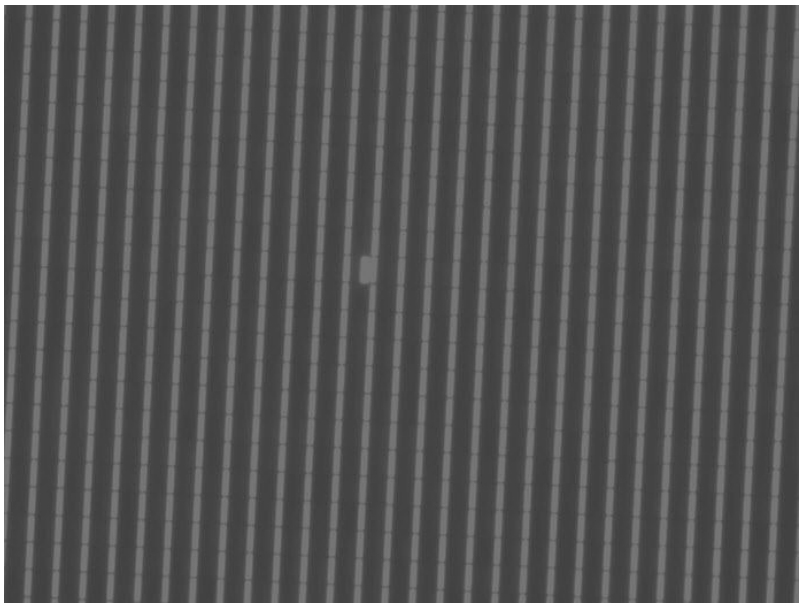


Stuck-off column:


Functional:

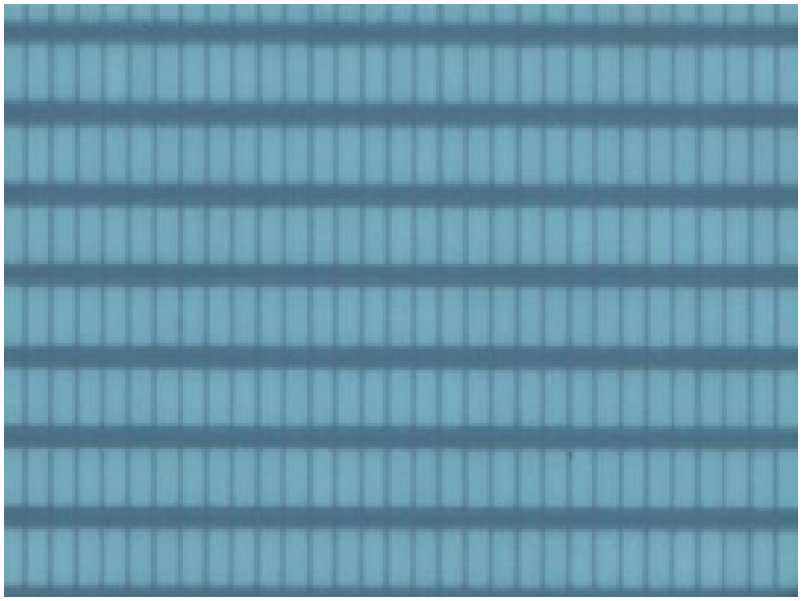



Functional continued:

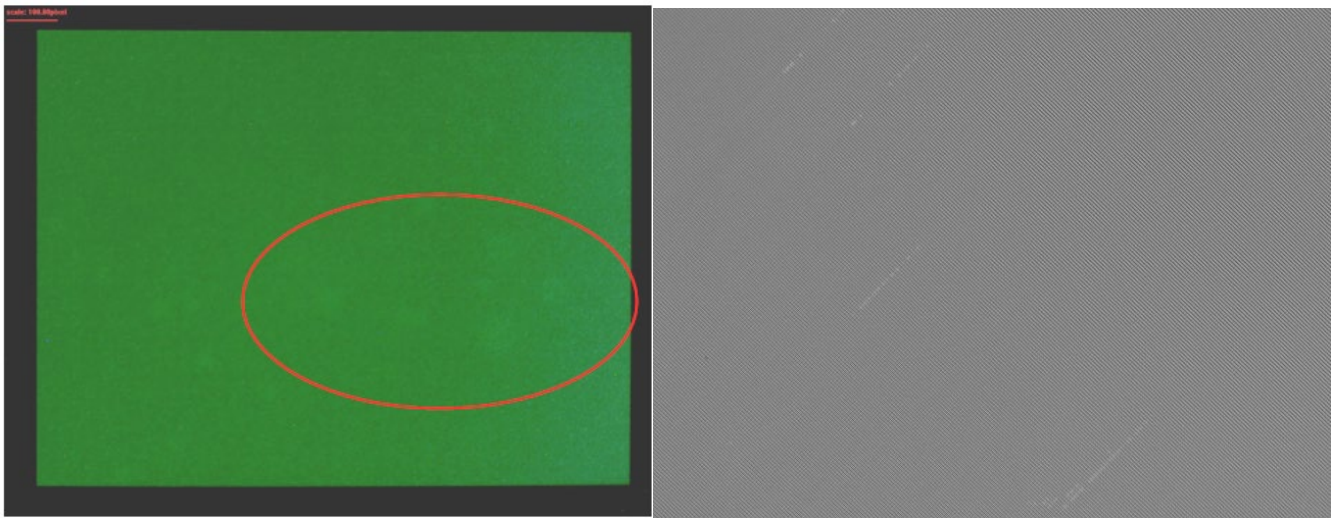


Example of two sub-pixels shorted together

Short Pixels:



Uniformity:



Example of uniformity = Rejects

Stuck-off Row:

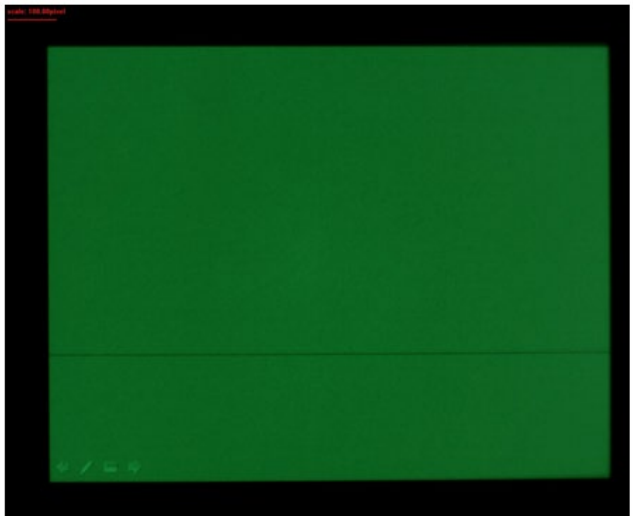
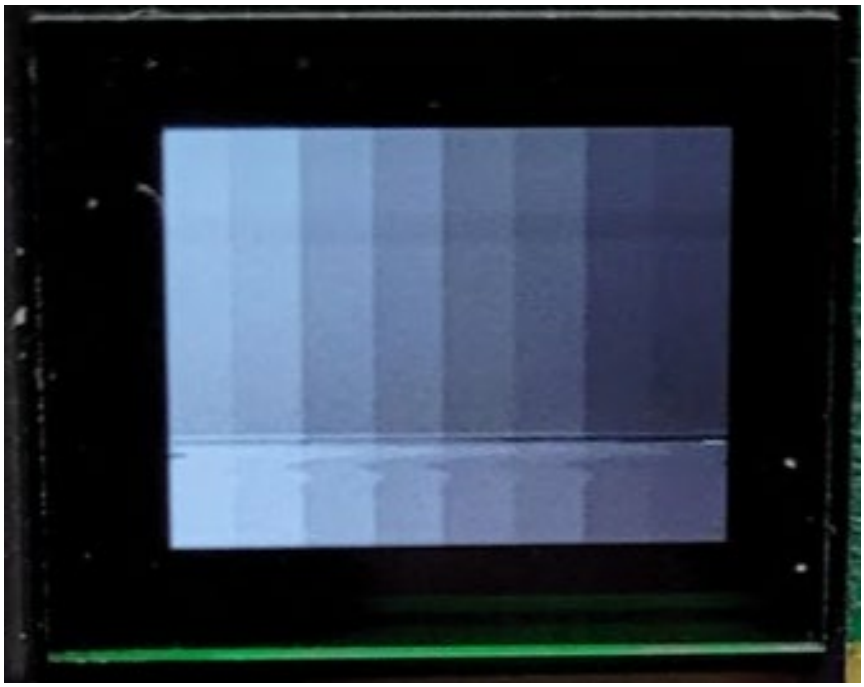
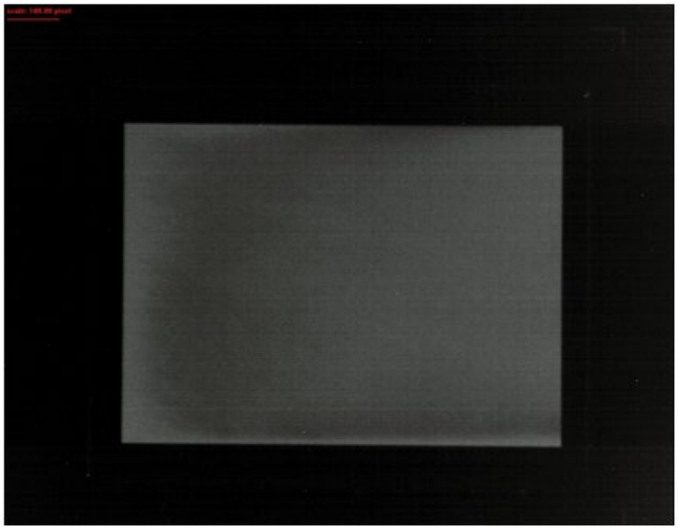


Image Noise:



Low Luminance Non-Uniformity:



Low Luminance Non-Uniformity:

Example of LLNU = Reject