

DisplayModule



DM-ADTTR-024

0.6 cm (Type 0.23) Active Matrix Color OLED Panel Module

1. Overview / Application

OL23 BF is a 0.6 cm (0.23inch) diagonal, 640(RGB) × 400 dots active matrix color OLED (Organic Light Emitting Display) panel module based on single crystal silicon transistors. The module integrates panel driver and logic driver, and achieves smaller size, light in weight and high resolution.

(Potential applications: Head mounted displays, View finders, Small monitors etc.)

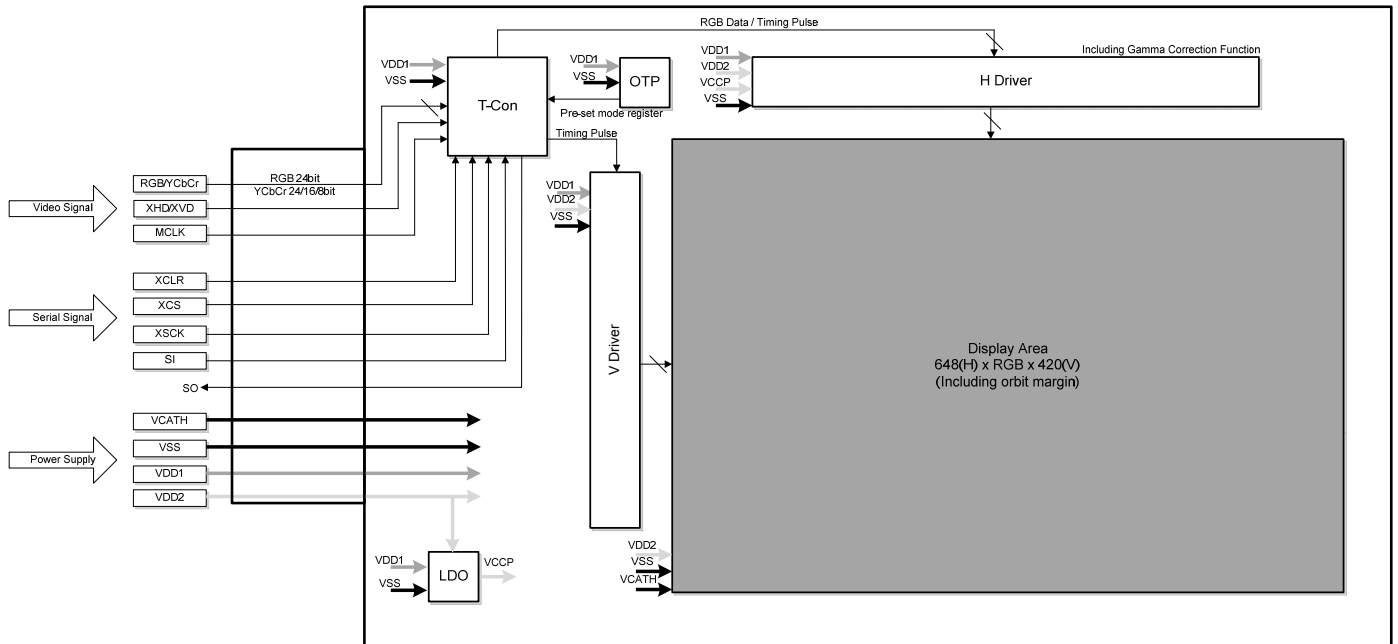
2. Features

- ◆ Small-size, high resolution 0.23 nHD+ display dots 640 (RGB) × 400 = 0.77M dots
 - ◆ Ultra high contrast
 - ◆ Wide color gamut
 - ◆ Fast response
 - ◆ Thin and light in weight
 - ◆ Power-saving (PS) mode
 - ◆ Scan direction selection, up or down and right or left.
 - ◆ Orbit supported
 - ◆ Input interface that supports parallel RGB 24-bit, YCbCr 24-bit and YCbCr 16-bit input
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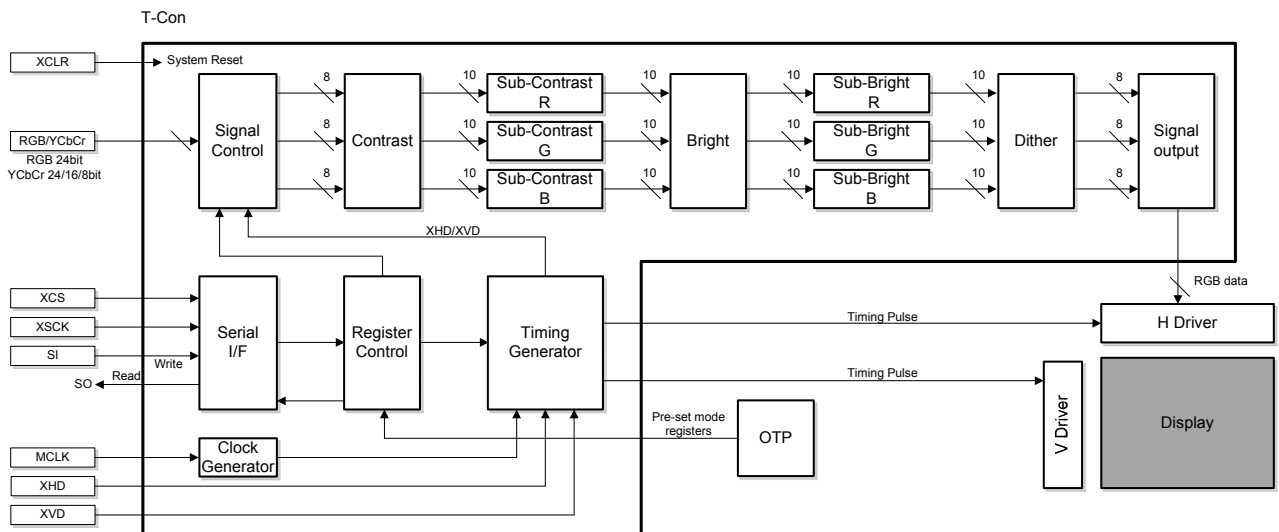
3. Module Structure

Active matrix color OLED display with on-chip driver based on single crystal silicon transistors

4. System Block Diagram

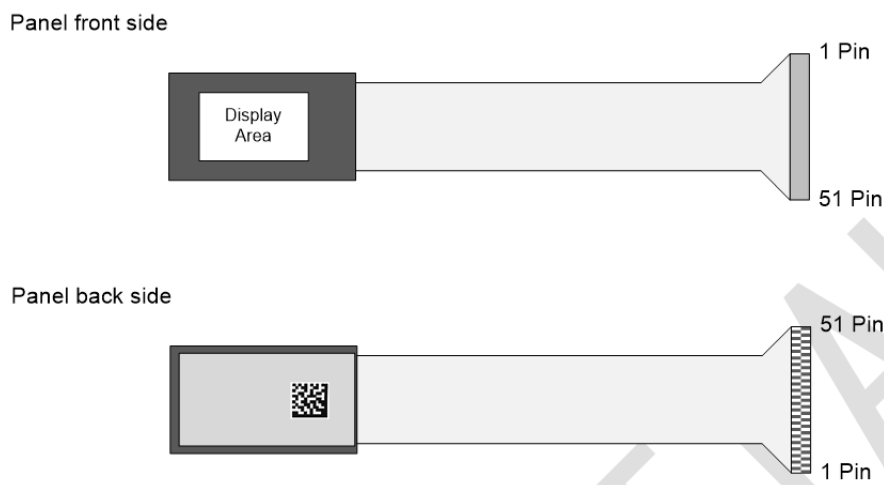


Details of T-Con Block



5. Pin Description

5.1. Pin Assignment



5.2. Pin Description

Pin No.	Symbol	Type	Pin Description	Equivalent circuit
1	VCATH	Power Supply	EL cathode power supply	
2	VCCP	Power supply	VCCP power supply	
3	VCAL	Output	Temperature sensor output voltage	*6
4	VG255	Output	Gamma top reference voltage (255)	*6
5	VG0	Output	Gamma bottom reference voltage (0)	*6
6	VOFS	Output	Gamma offset voltage	*6
7	VREF	Output	Gamma reference voltage	*6
8	VDD2	Power supply	10V power supply	
9	VSS	Power supply	GND	
10	VDD1	Power supply	1.8V power supply	
11	MCLK	Input	Master clock	*1
12	XHD	Input	Horizontal sync signal (negative polarity)	*1
13	XVD	Input	Vertical sync signal (negative polarity)	*1
14	VSS	Power supply	GND	
15	XCLR	Input	System reset (negative polarity)	*2
16	DATA7	Input	Video signal input (refer to 5.3.)	*1
17	DATA6	Input	Video signal input (refer to 5.3.)	*1
18	DATA5	Input	Video signal input (refer to 5.3.)	*1
19	DATA4	Input	Video signal input (refer to 5.3.)	*1
20	DATA3	Input	Video signal input (refer to 5.3.)	*1

Pin No.	Symbol	Type	Pin Description	Equivalent circuit
21	DATA2	Input	Video signal input (refer to 5.3.)	*1
22	DATA1	Input	Video signal input (refer to 5.3.)	*1
23	DATA0	Input	Video signal input (refer to 5.3.)	*1
24	DATA15	Input	Video signal input (refer to 5.3.)	*1
25	DATA14	Input	Video signal input (refer to 5.3.)	*1
26	DATA13	Input	Video signal input (refer to 5.3.)	*1
27	DATA12	Input	Video signal input (refer to 5.3.)	*1
28	DATA11	Input	Video signal input (refer to 5.3.)	*1
29	DATA10	Input	Video signal input (refer to 5.3.)	*1
30	DATA9	Input	Video signal input (refer to 5.3.)	*1
31	DATA8	Input	Video signal input (refer to 5.3.)	*1
32	DATA23	Input	Video signal input (refer to 5.3.)	*1
33	DATA22	Input	Video signal input (refer to 5.3.)	*1
34	DATA21	Input	Video signal input (refer to 5.3.)	*1
35	DATA20	Input	Video signal input (refer to 5.3.)	*1
36	DATA19	Input	Video signal input (refer to 5.3.)	*1
37	DATA18	Input	Video signal input (refer to 5.3.)	*1
38	DATA17	Input	Video signal input (refer to 5.3.)	*1
39	DATA16	Input	Video signal input (refer to 5.3.)	*1
40	TEST	Input	Test pin (connect to GND)	*3
41	XSCK	Input	Serial communication Serial clock (negative polarity)	*2
42	XCS	Input	Serial communication Chip select (negative polarity)	*2
43	SI	Input	Serial communication Data input	*2
44	SO	Output	Serial communication Data output	*7
45	TEST	Output	Test pin (no connect)	*4
46	TEST	Input	Test pin (connect to GND)	*5
47	VSS	Power supply	GND	
48	VDD1	Power supply	1.8V power supply	
49	VSS	Power supply	GND	
50	VDD2	Power supply	10V power supply	
51	VCCP	Power supply	VCCP power supply	*6

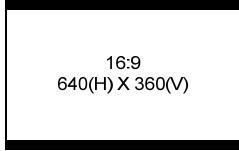
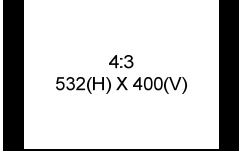
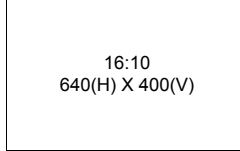
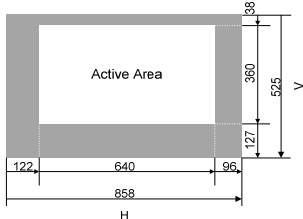
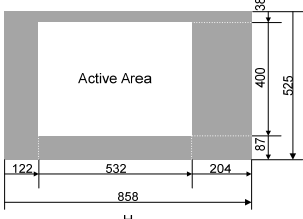
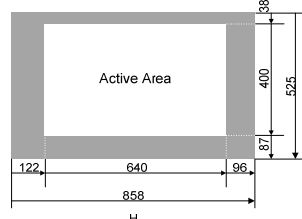
10.3. Input Signal Data Format

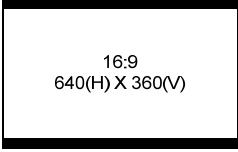
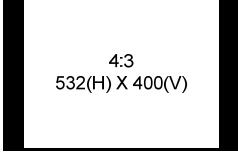
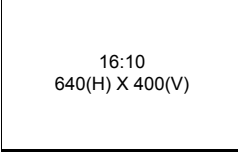
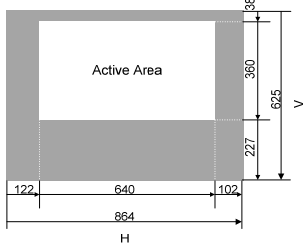
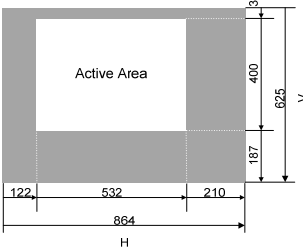
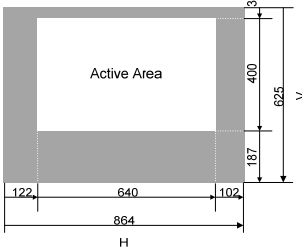
Set the panel timing registers appropriately for the input signal data format.

◆Register Settings

Address	Register name	Bits	Function
0x01h	FORMAT_SEL_H	2	Selection of input format (number of horizontal active pixels) 00: 640 (default) 10: 532
0x01h	FORMAT_SEL_V	2	Selection of input format (number of vertical active pixels) 00: 400 (default) 11: 360
0x2Dh 0x66h	H_ACT_U AZEN_D		Timing setting registers. Should be set appropriately for the input signal data format. Setting values are separately presented.

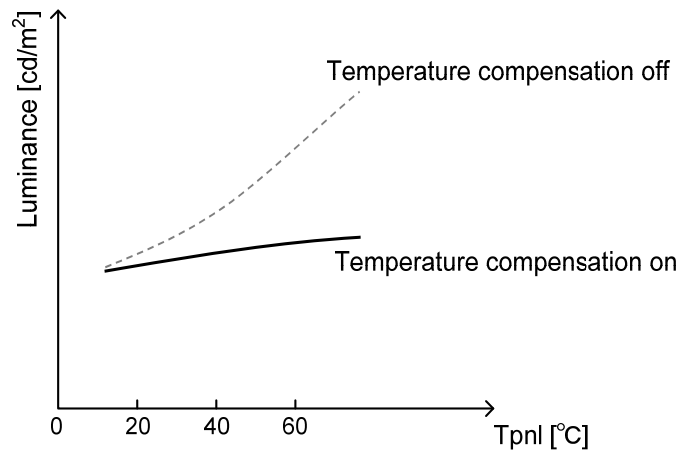
◆Panel Display Modes and Input Supported Formats

Panel Display Mode		①16:9 59.94Hz / 60Hz Frame Rate	②4:3 59.94Hz / 60Hz Frame Rate	③16:10 59.94Hz / 60Hz Frame Rate
				
Input Supported Format				
Active	H	640	532	640
	V	360	400	400
Total	H	858	858	858
	V	525	525	525
FP	H	96	204	96
	V	127	87	87
SYNC	H	64	64	64
	V	6	6	6
BP	H	58	58	58
	V	32	32	32
BP+SYNC	H	122	122	122
	V	38	38	38
fv	Hz	59.94 / 60	59.94 / 60	59.94 / 60
Th	μs	31.778 / 31.746	31.778 / 31.746	31.778 / 31.746
Clock	MHz	26.999 / 27.027	26.999 / 27.027	26.999 / 27.027

		④16:9 50Hz Frame Rate	⑤4:3 50Hz Frame Rate	⑥16:10 50Hz Frame Rate
Panel Display Mode				
Input Supported Format				
Active	H	640	532	640
	V	360	400	400
Total	H	864	864	864
	V	625	625	625
FP	H	102	210	102
	V	227	187	187
SYNC	H	64	64	64
	V	6	6	6
BP	H	58	58	58
	V	32	32	32
BP+SYNC	H	122	122	122
	V	38	38	38
fv	Hz	50	50	50
Th	μs	32.000	32.000	32.000
Clock	MHz	27.000	27.000	27.000

10.5. Luminance Temperature Compensation Function

In general, luminance of OLED depends on display panel temperature as show in below. This module integrates luminance compensation function against panel temperature variation. This function allows to sustain relatively constant luminance even if panel temperature changing as shown in below.



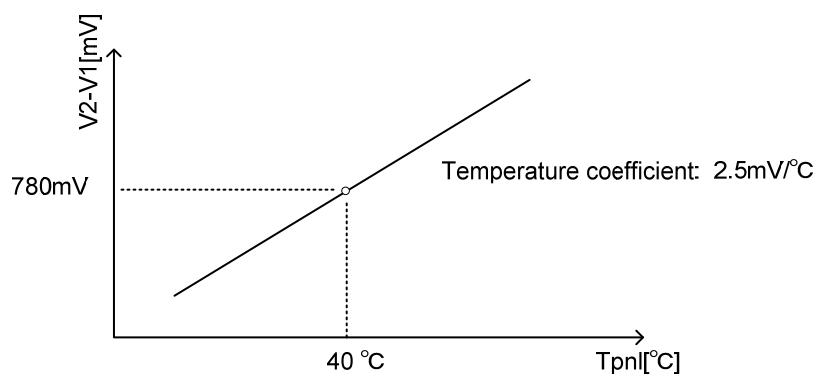
◆Register Settings

Address	Register name	Bits	Function
0x01h	VCAL_MON	1	Temperature sensor monitoring 0: Invalid (Default) 1: Valid
0x02h	CALSEL[1:0]	2	VCAL output selection 01: V1 output 10: V2 output

◆Method of Checking the Panel Temperature

The temperature sensor output voltage can be output from VCAL pin (#3).

Set the register VCAL_MON to 1: valid, set the register CALSEL as noted above, and read the V1 and V2 outputs. The temperature can be calculated by subtracting V1 from V2.



11. Optical Characteristics

11.1. Optical Characteristics

Item		Symbol	Measurement Method	Min.	Typ.	Max.	Unit
Luminance	Mode 1	L1	1	240	300	360	cd/m ²
	Mode 2	L2	1	425	500	575	cd/m ²
	Mode 0	L0	1	680	800	920	cd/m ²
	Mode 3	L3	1	1275	1500	1725	cd/m ²
	Mode 4	L4	1	1600	2000	2400	cd/m ²
Contrast		CR	1	10,000	—	—	
Chromaticity	W (L0, L2 & L3)	x	1	0.298	0.310	0.322	CIE
		y	1	0.308	0.320	0.332	CIE
	W (L1 & L4)	x	1	0.290	0.310	0.330	CIE
		y	1	0.300	0.320	0.340	CIE
	R	x	1	0.630	0.650	0.670	CIE
		y	1	0.310	0.330	0.350	CIE
	G	x	1	0.240	0.260	0.280	CIE
		y	1	0.520	0.540	0.560	CIE
	B	x	1	0.130	0.150	0.170	CIE
		y	1	0.050	0.070	0.090	CIE

Drive conditions:

OTPDG_REGDIS=0, OTCALDAC_REGDIS=0,

LUMINANCE=1(Mode1), 2 (Mode 2), 0 (Mode 0), 3 (Mode 3), 4(Mode4)

11.2. Measurement System • Measurement Method 1

The luminance and chromaticity are measured in Measurement System A shown below.

Measurement temperature: T_{pnl} = 40°C

Measurement point: One point on the screen center

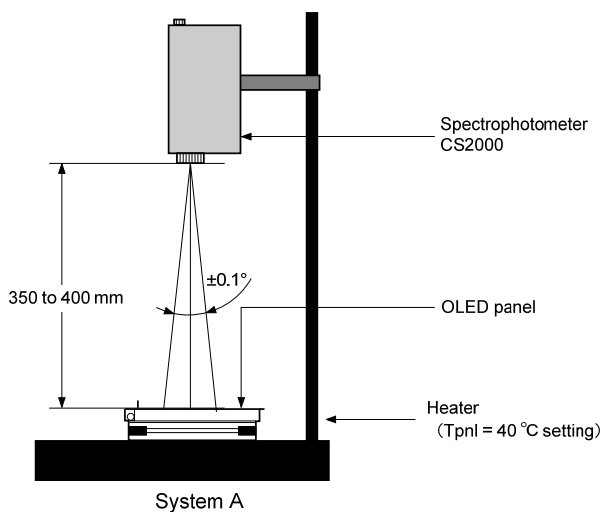
All white display: All RGB signal data is set to High.

All black display: All RGB signal data is set to Low.

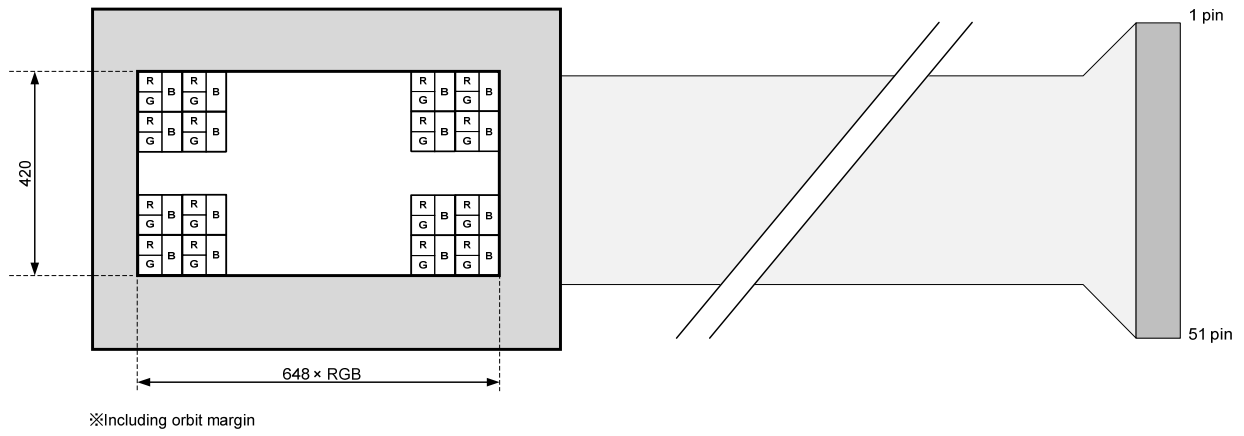
Luminance and chromaticity: Measure the luminance and chromaticity in all white display in Measurement System A.

Contrast: Measure the luminance in all white display (@ Mode0: 800cd/m²) and all black display in Measurement System A, and substitute them into the formula below.

Contrast = Luminance in all white display/Luminance in all black display



12. Pixel Alignment



13. Picture Quality Specification

13.1. Dot and Pixel defect specification

Dot and Pixel defect specification is summarized in below. Definition of each defect is listed in following section.

	Inspection condition			Maximum acceptable number of defect			Minimum acceptable distance between defects	Reference
	Luminance 100%	Defect size	Criteria of Luminance Level	Zone A	Zone B	Total		
Bright Spot	Green Raster Red Raster Blue Raster (White 300cd/m ²)	1 dot	Green : $L \geq 20\%$ Red : $L \geq 25\%$ Blue : $L \geq 80\%$	0	0	0	N/A	13.1.1
		1 dot	Green : $20\% > L \geq 11\%$ Red : $25\% > L \geq 11\%$ Blue : $80\% > L \geq 50\%$	2	4	4	“Horizontal 2 pixels” or “Vertical 2 pixels”	13.1.1
		1 dot	Green : $11\% > L$ Red : $11\% > L$ Blue : $50\% > L$	Ignored	Ignored	Ignored	N/A	13.1.1
Too-Bright Spot	Green Raster Red Raster Blue Raster (White 800cd/m ²)	1 dot	Green : $L \geq 200\%$ Red : $L \geq 200\%$ Blue : $L \geq 300\%$	0	0	0	N/A	13.1.2
		1 dot	Green : $200\% > L$ Red : $200\% > L$ Blue : $300\% > L$	Ignored	Ignored	Ignored	N/A	13.1.2
Dark Spot	White raster 300cd/m ²	$S \geq 2 \times 1$ pixel	White : $10\% \geq L$	0	0	0	N/A	13.1.3
			White : $L > 10\%$	Ignored	Ignored	Ignored	N/A	13.1.3
		2×1 pixel $> S$ $S \geq 1 \times 1$ pixel	White : $10\% \geq L$	3	6	6	“Horizontal 2 pixels” or “Vertical 2 pixels”	13.1.3
			White : $L > 10\%$	Ignored	Ignored	Ignored	N/A	13.1.3
		1×1 pixel $> S$	-	Ignored	Ignored	Ignored	N/A	13.1.3

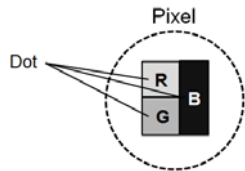
(T_{pn} = 40 °C)

L : monochromatic raster luminance

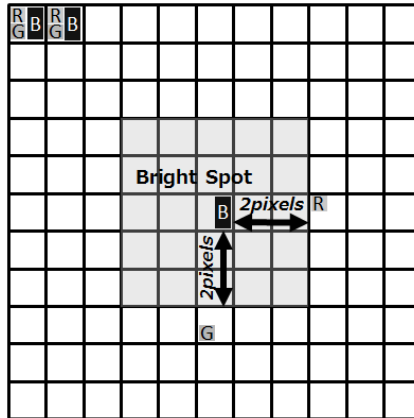
S : Dark spot size

13.1.1 Definition of Bright Spot defect

Suspected bright spot is inspected on Black raster display. Criteria to judge as defect or not should be comparison with Luminance level on Red or Green or Blue raster display, according to which dot is suspected. 1 Dot is unit of the Bright dot defect. Please refer definition for Dot and Pixel. Minimum acceptable distance between defects is defined as following.



Definition of Pixel and Dot



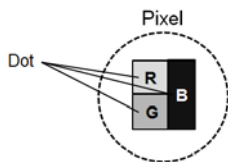
Minimum acceptable distance between defects

13.1.2 Definition of Too-Bright Spot defect

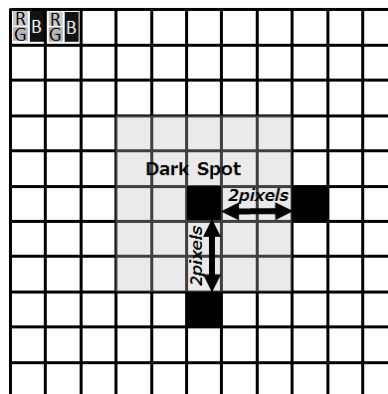
Suspected too-bright spot defect is too-much brighter dot other than normal luminance. Criteria to judge as defect or not should be comparison with Luminance level on Red or Green or Blue raster display, according to which dot is suspected.

13.1.3 Definition of Dark Spot defect

Suspected dark spot is inspected White raster display. Criteria to judge as defect or not should be comparison with Luminance level on White raster. 1 pixel consists of 3 Dots. 1 Pixel is unit of the dark spot defect. And, minimum acceptable distance between defects is defined as following.



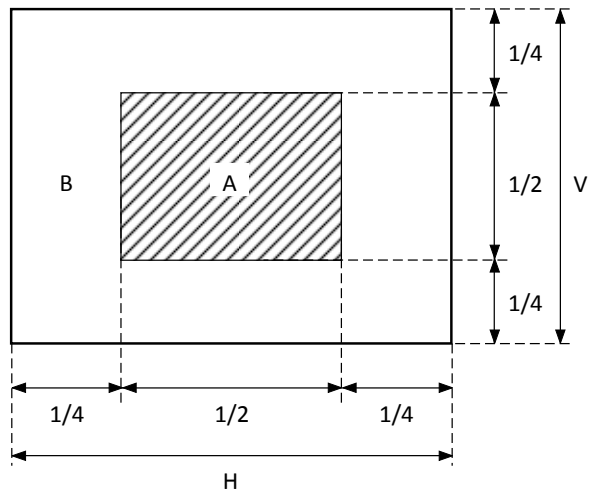
Definition of Pixel and Dot



Minimum acceptable distance between defects

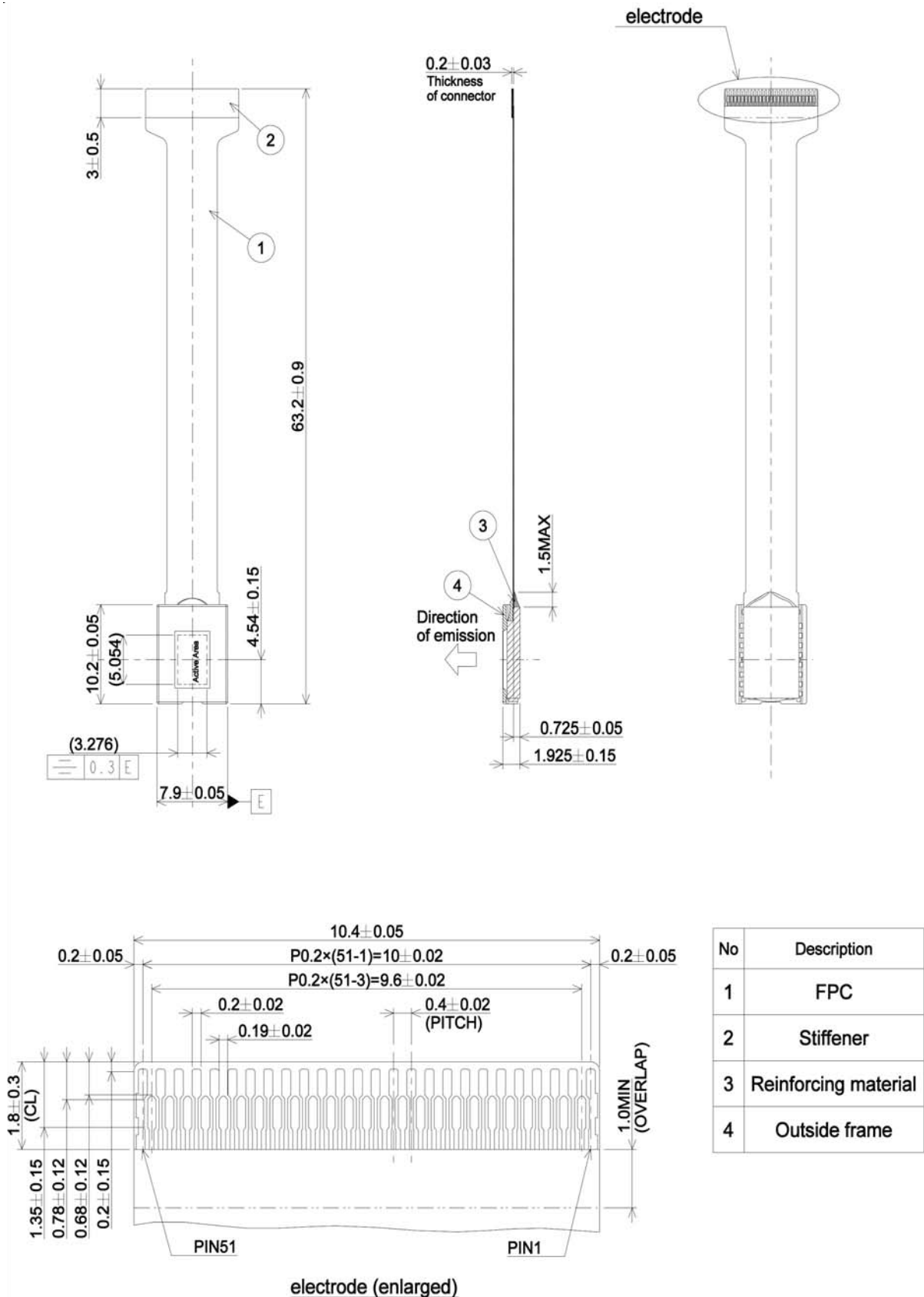
13.1.4 Definition of Zone A and B

Zone A and Zone B are defined as shown in below.



20. Module Outline (Nagasaki 200mm wafer)

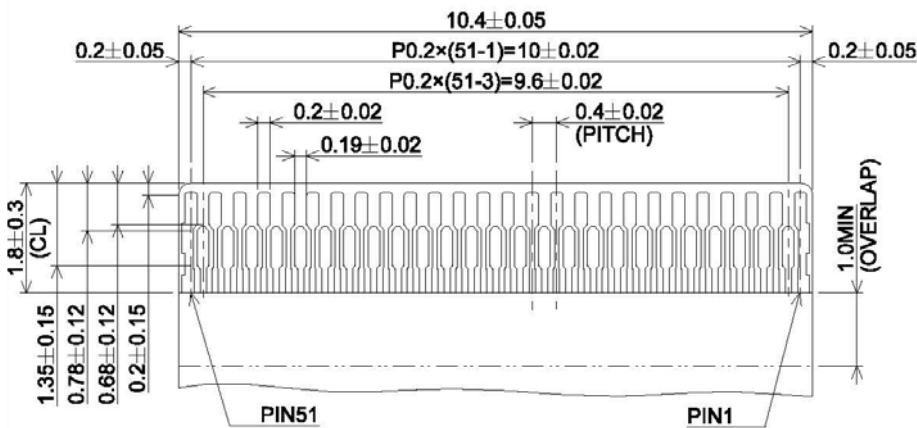
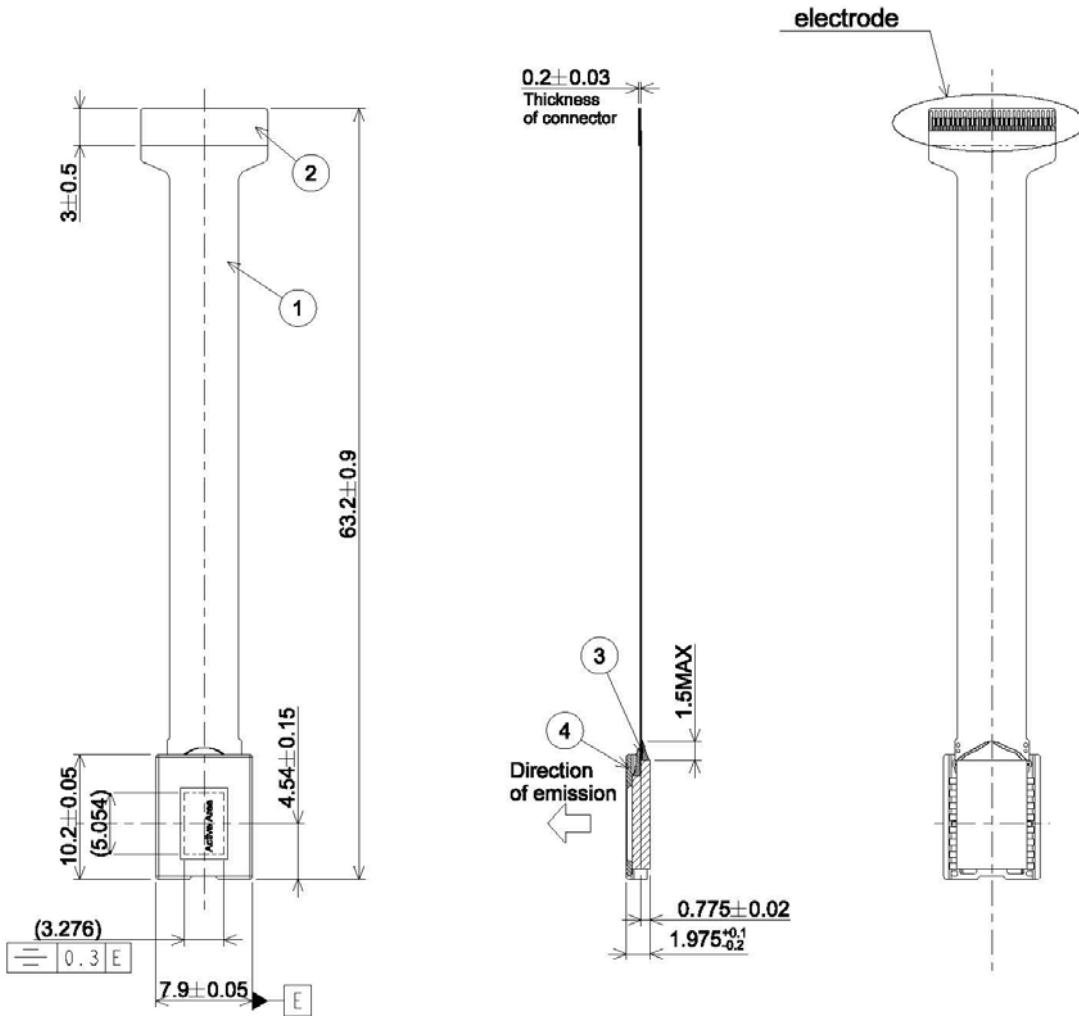
(Unit: mm)



No	Description
1	FPC
2	Stiffener
3	Reinforcing material
4	Outside frame

Package Outline (Kumamoto 300mm wafer)

(Unit: mm)



electrode (enlarged)

No	Description
1	FPC
2	Stiffener
3	Reinforcing material
4	Outside frame