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Thin-Film-Transistor LCD Module
Model:GKSG156UNMLA0


Acceptance

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1. General Description and Features

GKSG156UNMLA0 is a TM (Transmissive) type color active matrix TFT (Thin Film Transistor) liquid crystal display (LCD) that uses amorphous silicon TFT as a switching device. This model is composed of a TFT-LCD module, a driver circuit and a back-light unit, which open cell is a transmissive type display operating in the normally black mode. It supports 1920 (W) x RGB x 1080 (H) FHD resolution and can display up to 16.7M colors (8bit). The following table described the features of **GKSG156UNMLA0**.

1.1 Features

- FHD Resolution (1920 x 1080)
- Display in 16.7M colors.
- LVDS Interface
- With Backlight LED Driver
- RoHS Compliance

1.2 LCD Module


Item	Specification	Unit
Screen Size	15.6 inches	Diagonal
Display Resolution	1920 (H) x 1080 (V)	Pixel
Dot Pitch	0.17925 x 0.17925	mm
Active Area	344.16 (H) x 193.59 (V)	mm
Outline Dimension	363.80 (H) x 216.14 (V) x 8.1 (T)	mm
Display Mode	Normally black/Transmissive	--
Pixel Arrangement	R,G,B Vertical stripe	--
Viewing Direction	All	--
Display Colors	16.7M	--
Input Interface	LVDS	--

2. Mechanical Information

Item	Min.	Typ.	Max.	Unit	Note	
Module Size	Horizontal (H)	363.3	363.8	364.3	mm	
	Vertical (V)	215.64	216.14	216.64	mm	
	Thickness (T)	--	8.1	--	mm	(1)
Weight	--	572	--	g	--	

Note (1) The thickness of LCM Side without PCB. Refer to the Outline Dimension Drawing as attached.

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3. Electrical Specifications

3.1 Absolute Max. Ratings

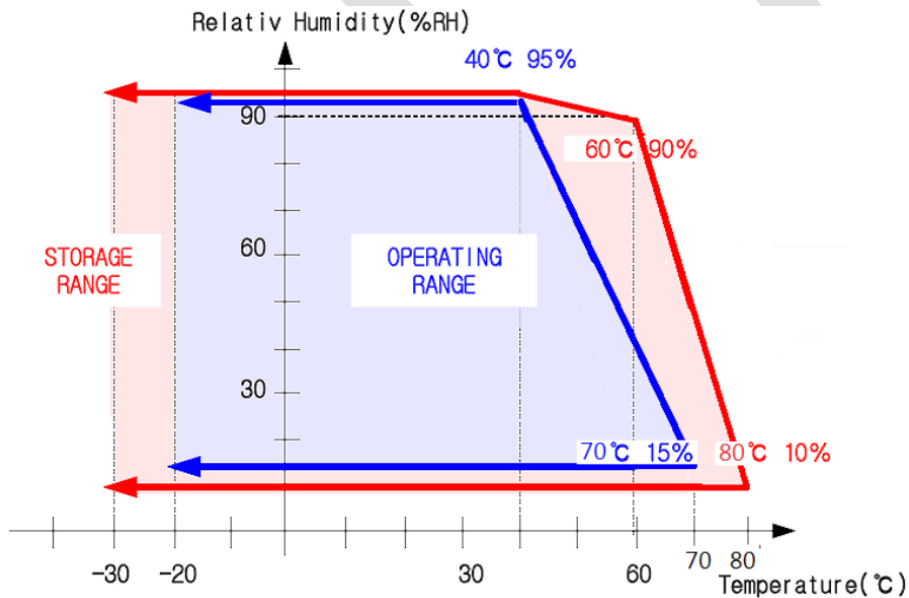
3.1.1 Absolute Ratings of Environment

If the operating condition exceeds the following absolute maximum ratings, the TFT LCD module may be damaged permanently.

(Ta=25±2°C, V_{SS}=GND=0)

Item	Symbol	Min.	Max.	Unit	Note
Storage temperature	T _{STG}	-30	85	°C	(1)
Operating temperature	T _{OPR}	-30	85	°C	(1,2,3)


Note (1) 90 % RH Max. (40 °C ≥ Ta). Maximum wet-bulb temperature at 39 °C or less. (Ta > 40 °C) No condensation.



Note (2) In case of below 0°, the response time of liquid crystal (LC) becomes slower and the color of panel becomes darker than normal one. Level of retardation depends on temperature, because of LC's character.

Note (3) Only operation is guaranteed at operating temperature. Contrast, response time, another display quality are evaluated at +25°C.

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3.1.2 Absolute Ratings of TFT-LCD Module

($V_{SS}=GND=0$)

Parameter	Symbol	Min.	Max.	Unit	Remark
LCD Drive Voltage (Logic)	V_{DD}	-0.3	16	V	

3.2 LCD Input Power Specifications

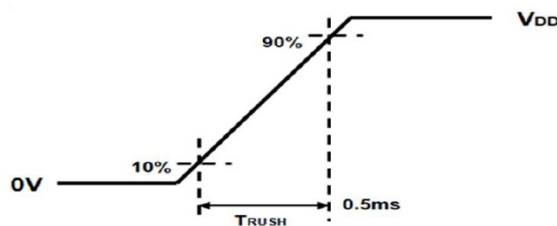
Parameter		Symbol	Min.	Typ.	Max.	Unit	Remark
LCD Drive Voltage (Logic)		V_{DD}	--	12	--	V	(1),(2)
Allowable Logic/LCD Drive Ripple Voltage		V_{VDD-RP}	--	--	200	mA	(1),(3)
Rush Current		I_{Rush}	--	--	1.5	A	(1),(4)
VDD Current	White Pattern	I_{DD}	--	--	1.86	A	(1),(3)
VDD Power	White Pattern	P_{DD}	--	--	21.02	W	
HPD Impedance		R_{HPD}	30K	--	--	ohm	(5)
HPD	High level voltage	V_{HPD}	2.25	--	2.75	V	(6)
	Low level voltage	V_{HPD}	0	--	0.4	V	(6)
LCD Self-Test (BIST)	High level voltage	V_{BIST}	3.0	--	3.6	V	(1)
	Low level voltage		0	--	0.6	V	

Note (1) All of the specifications are guaranteed under normal conditions. Normal conditions are defined as follow: Temperature: 25°C, Humidity: 55± 10%RH.


Note (2) All of the absolute maximum ratings specified in the table, if exceeded, may cause faulty operation or unrecoverable damage. It is recommended to follow the typical value.

Note (3) The specified V_{DD} current and power consumption are measured under the $V_{DD} = 3.3$ V, Frame rate = 60 Hz condition and White Pattern.

Note (4) The figures below is the measuring condition of V_{DD} . Rush current can be measured when T_{RUSH} is 0.5 ms.



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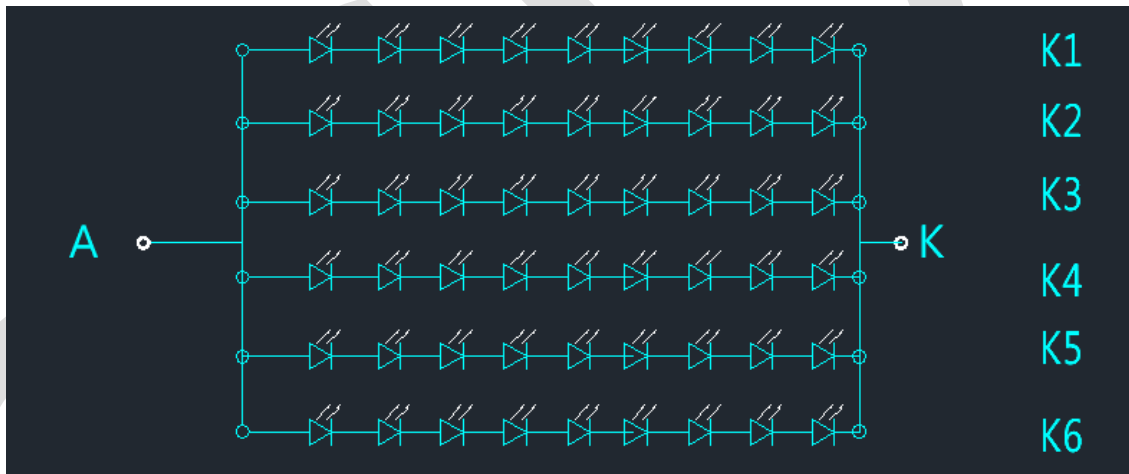
Note (5) The specified signals have equivalent impedances pull down to ground in the LCD module respectively. Customers should keep the input signal level requirement with the load of LCD module.

Note (6) When a source detects a low-going HPD pulse, it must be regarded as a HPD event. Thus, the source must read the link / sink status field or receiver capability field of the DPCD and take corrective action.


3.3 Backlight Unit Input Power Specifications

Parameter	Symbol	Min.	Typ.	Max.	Unit	Remark
Voltage of Backlight Unit	V_F	23.4	--	29.7	V	(1),(2)
Current of Backlight Unit	I_F	--	(540)	--	mA	90mA*6

Note (1) LEDs in 9 Series x 6 parallel type.

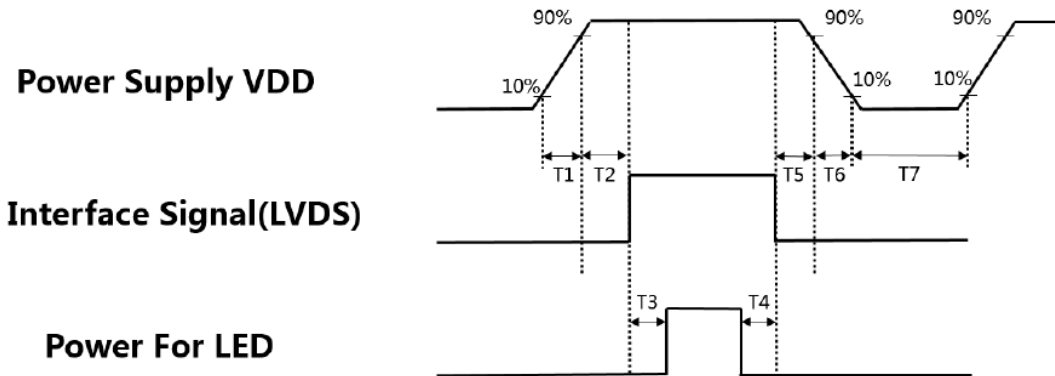


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3.4 Power ON/OFF Sequence

To prevent a latch-up or DC operation of the LCD module, the power on/off sequence shall be as shown in below



Parameter	Value			Units
	Min.	Typ.	Max.	
T1	0.1	-	8	(ms)
T2	120	-	-	(ms)
T3	300	-	-	(ms)
T4	300	-	-	(ms)
T5	0	-	50	(ms)
T6	0	-	10	(ms)
T7	500	-	-	(ms)

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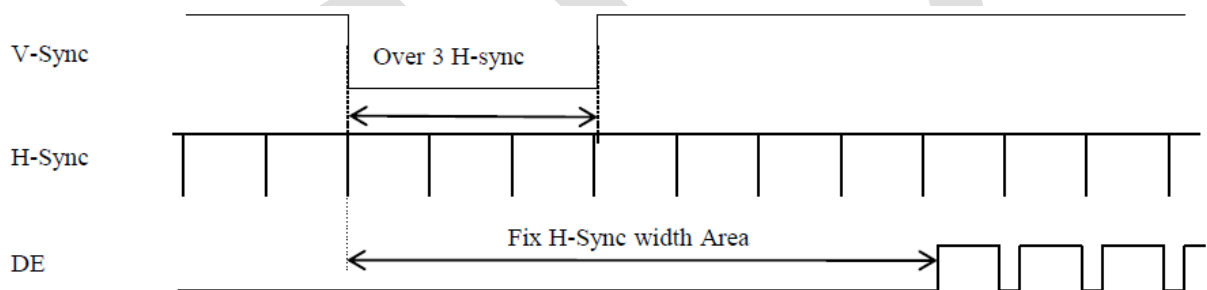
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3.5 Digital Timing < by the DE only. >

Parameter	Symbol	Min.	Typ.	Max.	Unit.
DCLK frequency	$1/T_C$	151.6	152.84	154.04	MHz
Horizontal display area	T_{HD}	--	1920	--	DCLK
One line Scanning Period	T_H	2240	2250	2260	DCLK
Vertical display area	T_{VD}	--	1080	--	H
Frame Period	T_H	1128	1132	1136	Lines
		--	60	--	Hz

3.6 Singal timing waveforms of interface signal

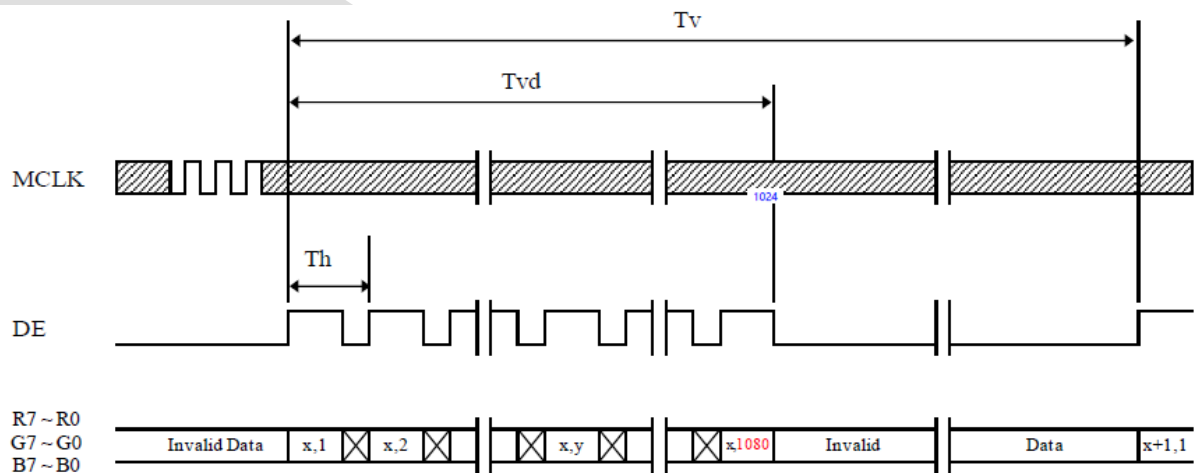
3.6.1 Sync Timing Waveforms



Note (1) Need over 3 H-sync during V-Sync Low

Note (2) Fix H-Sync width from V-Sync falling edge to first rising edge

3.6.2 Vertical Timing Waveforms



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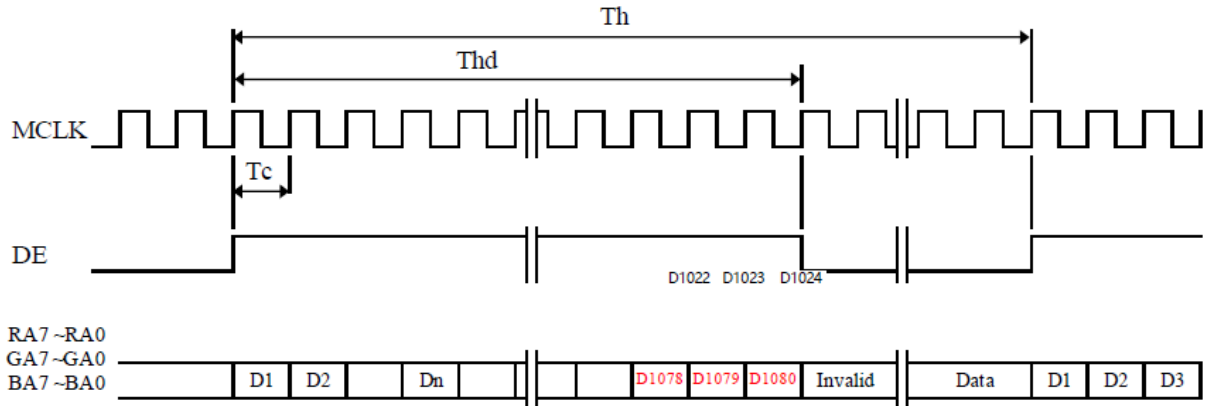
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3.6.3 Horizontal Timing Waveforms



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4. Optical Characteristics

4.1 Optical characteristics of the LCD

The following items are measured under stable conditions. The optical characteristics should be measured in a dark room or equivalent state with the methods.

Measuring equipment: BM-7A

Item	Symbol	Condition	Min	Type	Max	Unit	Note
Brightness	B		900	1,000	--	cd/m ²	
Response time	T _r + T _f	θ=0°	--	25	35	ms	
Contrast ratio	CR	At optimized viewing angle	1,000	1,500	--	--	
Color Chromaticity (CIE 1931)	White	W _x	(0.25)	(0.3)	(0.35)	--	BM-7A
		W _y	(0.34)	(0.39)	(0.44)		
	Red	R _x	(0.60)	(0.65)	(0.70)	--	
		R _y	(0.29)	(0.34)	(0.39)		
	Green	G _x	(0.26)	(0.31)	(0.36)	--	
		G _y	(0.59)	(0.64)	(0.69)		
	Blue	B _x	(0.07)	(0.12)	(0.17)	--	
		B _y	(0.06)	(0.11)	(0.16)		
NTSC	--	--	65	70	--	%	
Luminance Uniformity (9 Points)	ΔL	--	70	--	--	%	
Viewing Angle	Hor.	θ _R	80	85	--	Degree	
		θ _L	80	85	--		
	Ver.	θ _U	80	85	--		
		θ _D	80	85	--		
LED Life Time	--	--	50000	--	--	hr	

a. Test equipment setup

After stabilizing and leaving the panel alone shall be warmed up for the stable operation of LCM, the measurement should be executed. Measurement should be executed in a stable, windless, and dark room. Optical specifications are measured by Topcon BM-7(fast) with a viewing angle of 2° at a distance of 50cm and normal direction.

b. Definition of response time: Tr and Tf

The response time is defined as the following figure and shall be measured by switching the input signal for "black" and "white".

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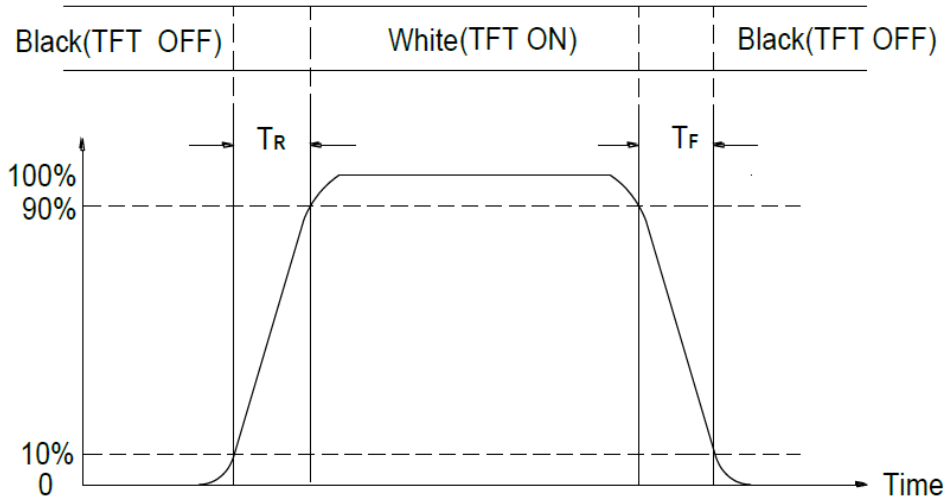
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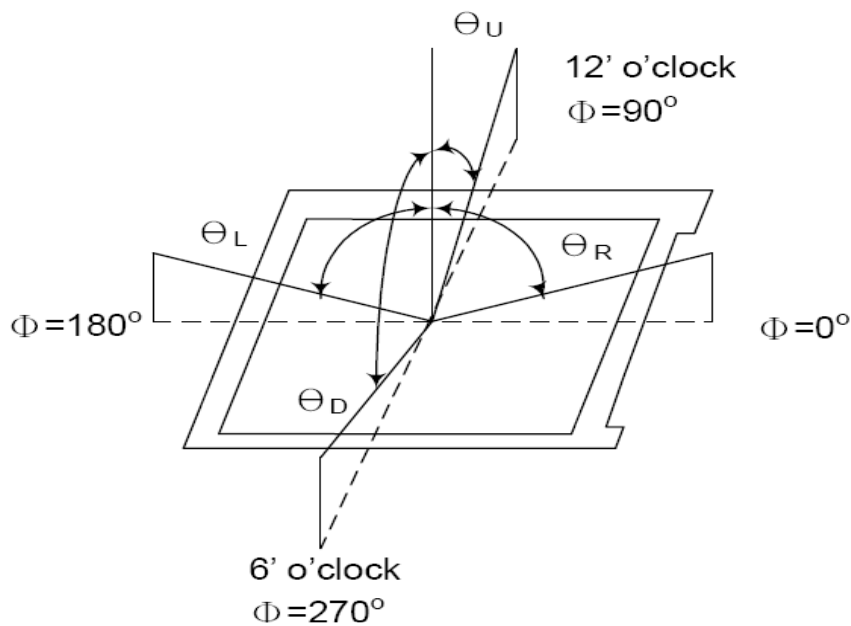


c. Definition of contrast ratio:


$$\text{Contrast Ratio (CR)} = \frac{\text{Brightness measured when LCD is at "white state"}}{\text{Brightness measured when LCD is at "black state"}}$$

d. Measured at the center area of the panel when all the input terminals of LCD panel are electrically opened.

e. Definition of Viewing Angle



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f. Definition of Luminance of White: Luminance of white at the center points

Light Source of Back-Light Unit	LED Type ; PWM_LED : Duty 100 %
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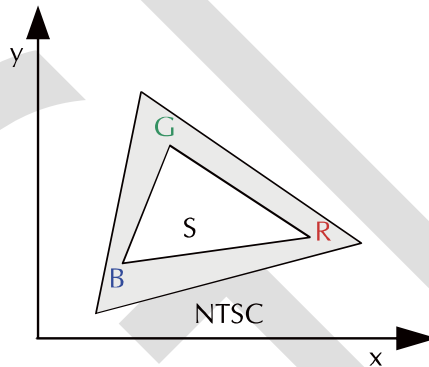
g. Definition of White Uniformity

$$\text{White Uniformity} = \frac{\text{Min. luminance of white among 9-points}}{\text{Max. luminance of white among 9-points}} \times 100\%$$


h. The definition of Color Gamut -Color Chromaticity CIE 1931

Color coordinate of white & red, green, blue at center point.

Color Gamut : NTSC(%) = (RGB Triangle Area / NTSC Triangle Area) x 100



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5. I/O Terminal

5.1 LCM Pin Assignment (40Pin) (connector part No: LV03040-13100 or equivalent.)

Pin No.	Symbol	Function	Remark
1	LVDS_Even_RX3+	Positive LVDS differential data 3 input (Even data)	
2	LVDS_Even_RX3-	Negative LVDS differential data 3 input (Even data)	
3	LVDS_Even_RXCLK+	Positive LVDS differential clock input (Even data)	
4	LVDS_Even_RXCLK-	Negative LVDS differential clock input (Even data)	
5	LVDS_Even_RX2+	Positive LVDS differential data 1 input (Even data)	
6	LVDS_Even_RX2-	Negative LVDS differential data 1 input (Even data)	
7	GND	Ground	
8	LVDS_Even_RX1+	Positive LVDS differential data 1 input (Even data)	
9	LVDS_Even_RX1-	Negative LVDS differential data 1 input (Even data)	
10	LVDS_Even_RX0+	Positive LVDS differential data 0 input (Even data)	
11	LVDS_Even_RX0-	Negative LVDS differential data 0 input (Even data)	
12	LVDS_Odd_RX3+	Positive LVDS differential data 3 input (Odd data)	
13	LVDS_Odd_RX3-	Negative LVDS differential data 3 input (Odd data)	
14	GND	Ground	
15	LVDS_Odd_RXCLK+	Positive LVDS differential clock input (Odd data)	
16	LVDS_Odd_RXCLK-	Negative LVDS differential clock input (Odd data)	
17	GND	Ground	
18	LVDS_Odd_RX2+	Positive LVDS differential data 2 input (Odd data)	
19	LVDS_Odd_RX2-	Negative LVDS differential data 2 input (Odd data)	
20	LVDS_Odd_RX1+	Positive LVDS differential data 1 input (Odd data)	
21	LVDS_Odd_RX1-	Negative LVDS differential data 1 input (Odd data)	
22	LVDS_Odd_RX0+	Positive LVDS differential data 0 input (Odd data)	
23	LVDS_Odd_RX0-	Negative LVDS differential data 0 input (Odd data)	
24	GND	Ground	
25	NC	SDA for SGD use, this pin should be open	
26	NC	SCL for SGD use, this pin should be open	
27	NC	MTP for SGD use, this pin should be open	
28	LCD_VDD	Power Supply Input Voltage (+3.3V)	

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29	LCD_VDD	Power Supply Input Voltage (+3.3V)	
30	LCD_VDD	Power Supply Input Voltage (+3.3V)	
31	NC	SDA for SGD use, this pin should be open	
32	NC	SCL for SGD use, this pin should be open	
33	GND	Ground	
34	STBYB	Deep standby mode setting pin.	
35	RSTB	Device Reset for LCD driver IC, Low active	
36	GND	Ground	
37	NC	SDA for SGD use, this pin should be open	
38	NC	SCL for SGD use, this pin should be open	
39	NC	SDA for SGD use, this pin should be open	
40	NC	SCL for SGD use, this pin should be open	

5.2 BL Pin Assignment (2Pin) (connector part No:JST BHSR-02VS-1 or equivalent.)

Pin No.	Symbol	Function	Remark
1	LED K	Backlight Cathode	
2	LED A	Backlight Anode	

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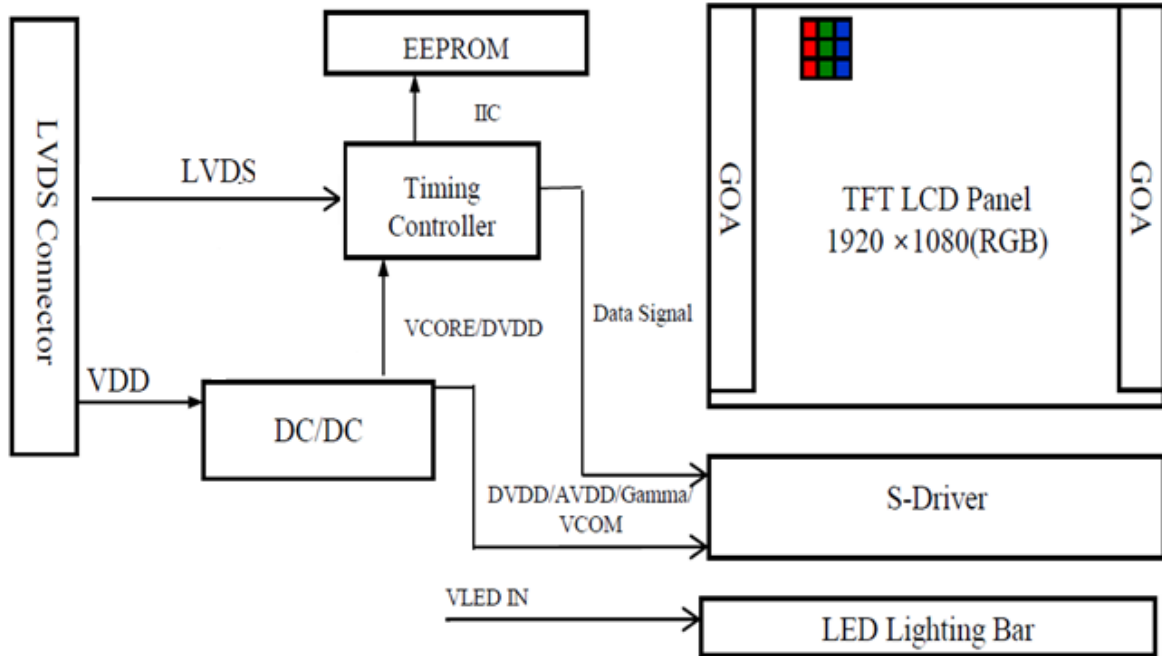
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5.3 Block Diagram



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6. Displayed Color and Input Data

	Color & Gray Scale	Data Signal																							
		R7	R6	R5	R4	R3	R2	R1	R0	G7	G6	G5	G4	G3	G2	G1	G0	B7	B6	B5	B4	B3	B2	B1	B0
Basic Color	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	Red	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	Green	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	
	Blue	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	
	Cyan	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
	Magenta	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	
	Yellow	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	
	White	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Red	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	Red(1)	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	Red(2)	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:		
	Red(127)	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	
	Red(254)	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	Red(255)	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Green	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	Green(1)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0		
	Green(2)	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0		
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:		
	Green(127)	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0	0		
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:		
	Green(254)	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0	0	0		
	Green(255)	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0		
Blue	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	Blue(1)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1		
	Blue(2)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0		
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:		
	Blue(127)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1		
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:		
	Blue(254)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0		
	Blue(255)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1		

0 : Low level voltage, 1 :High level voltage

Each basic color can be displayed in 256 gray scales from 8 bit data signals. With the combination of total 24 bit data signals, the 16.7M color display can be achieved on the screen.

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7. Reliability Condition

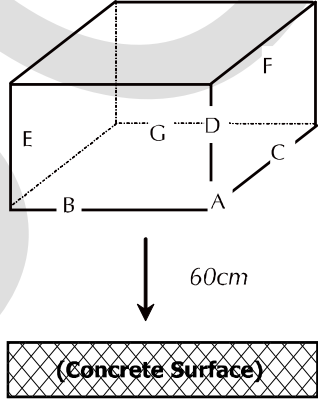
No change on display and in operation under the following test condition.

Condition: Unless otherwise specified, tests will be conducted under the following condition.

Temperature: $20 \pm 5^\circ\text{C}$.

Humidity: $65 \pm 5\% \text{RH}$.

Tests will be not conducted under functioning state.

No.	Parameter	Condition	Notes
1	High Temperature Operating	85°C , 240hrs (Operation state).	
2	Low Temperature Operating	-30°C , 240hrs (Operation state).	1
3	High Temperature Storage	85°C , 240hrs	2
4	Low Temperature Storage	-30°C , 240hrs	1,2
5	High Temperature and High Humidity Operation Test	60°C , 90%RH, 240hrs	1,2
6	Thermal Shock Non-operation	-30°C to 80°C , Duration at 30 min, 200cycles	1,2
7	Vibration Test Non-operation	Total fixed amplitude: 1.5mm. Vibration Frequency: 10~55Hz. One cycle 60 seconds to 3 directions of X, Y, Z each 15 minutes.	3
8	Drop Test	To be measured after dropping from 60cm high on the concrete surface in packing state.  <p style="margin-left: 20px;"><i>Dropping method corner dropping:</i></p> <p style="margin-left: 20px;"><i>A corner: Once edge dropping.</i></p> <p style="margin-left: 20px;"><i>B, C, D edge: Once face dropping.</i></p> <p style="margin-left: 20px;"><i>E, F, G face: Once.</i></p>	

- Notes:
1. No dew condensation to be observed.
 2. The function test shall be conducted after 4 hours storage at the normal temperature and humidity after removed from the test chamber.
 3. Vibration test will be conducted to the product itself without putting I in a container.

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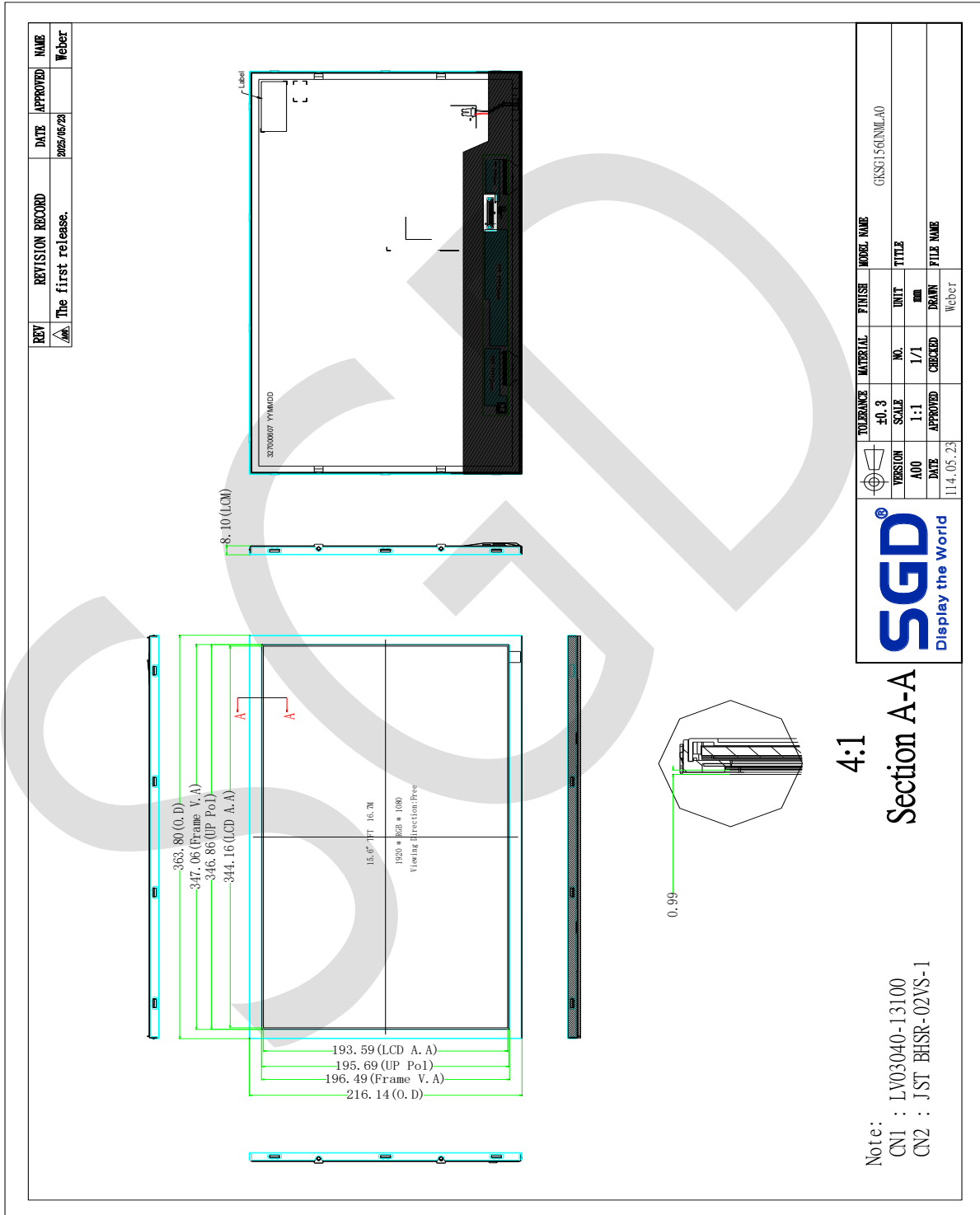
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8. Dimensional Outlines



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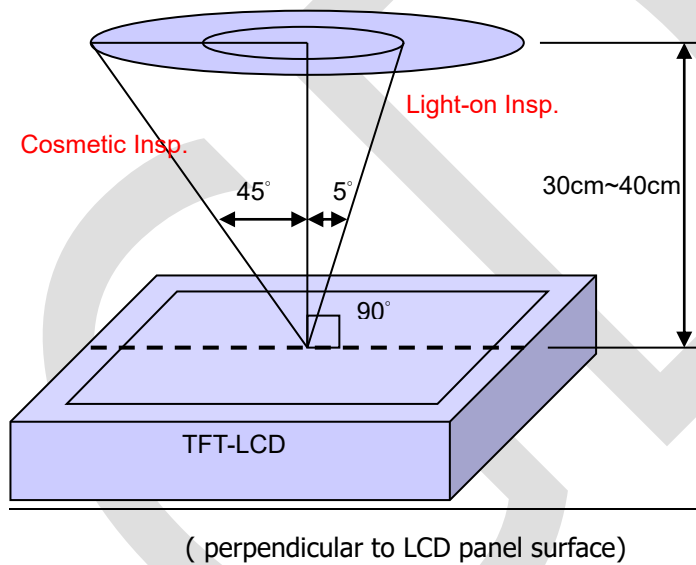
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9. Incoming Inspection Standards

9.1 Inspection and Environment Conditions

9.1.1 Inspection Conditions:

- (1) Inspection Distance: 35 cm±5cm
- (2) View Angle : Light-on Inspection Angle : ±5°
Cosmetic Inspection Angle : ±45°



9.1.2 Environment Conditions:


Ambient Temperature		23°C ±5°C
Ambient Humidity		55±10%RH
Ambient Illumination	Cosmetic Inspection	more than 600 Lux
	Functional Inspection	300~500 Lux

9.1.3 Sampling Conditions:

- (1) Lot Size: Quantity of shipment lot per model
- (2) Sampling Method:

Sampling Plan		MIL-STD-105E
		Normal Inspection, Single Sampling
		Level II
AQL	Major Defect	1.0%
	Minor Defect	1.5%

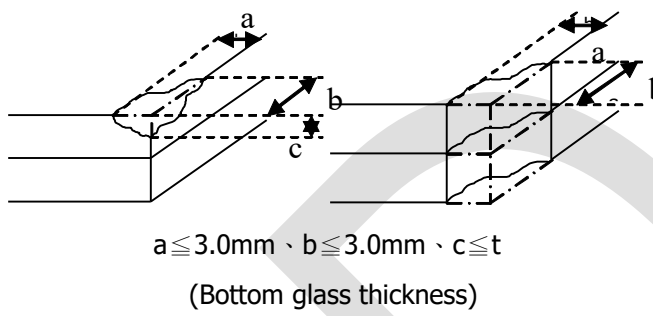
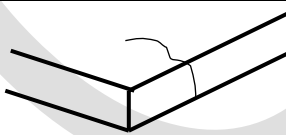
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(3) The classification of Major(MA) and Minor(MI) defects is shown as 3. Inspection Criteria.

9.1.4 Inspection Criteria

9.1.4.1 Cosmetic Inspection (Panel):

Item	Judgment Criteria	Classification
Chipping on Panel	 <p style="text-align: center;">$a \leq 3.0\text{mm} \cdot b \leq 3.0\text{mm} \cdot c \leq t$ (Bottom glass thickness)</p>	MA
Scratch on Panel *Note-2	<p style="text-align: center;">1.BM: Ignored 2.Pixel area :</p> <p style="text-align: center;">$W \leq 0.05\text{mm}$ or $L < 5\text{mm}$: Ignored $0.05\text{mm} < W \leq 0.1\text{mm}$ and $L \leq 5\text{mm}$: $N \leq 5$ $W > 0.1\text{mm}$ or $L > 5\text{mm}$: Not allowed</p>	MI
Bubble or Dent on Panel *Note-3	<p style="text-align: center;">1.BM: Ignored 2.Pixel area :</p> <p style="text-align: center;">$D \leq 0.2\text{mm}$: Ignored $0.2\text{mm} < D \leq 0.3\text{mm}$: $N \leq 5$ $D > 0.3\text{mm}$: Not allowed</p>	MI
Panel Crack	 <p style="text-align: center;">Not Allowed crack</p>	MA
Bezel Deformation	Obvious deformation is not allowed.	MI
Bezel Oxidation	Not allowed if it rusts continuously over 1 cm. (It is out of warranty with rusted tin plate)	MI
Bezel Scratch	$L \leq 20\text{mm}$, $W \leq 0.2$, $N \leq 3$	MI
Metal Squash Dent /Flange (Front Side)	$D(W) \leq 1, L \leq 3, N \leq 3$;	MI
B/L High Voltage Wire Denudation	Not allowed	MA

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Polarizer flaw or leak out resin	Defect is not allowed in the active area.	MI
Outline Dimension	Must in Spec, refer to related product spec.	MI

9.1.4.2 Functional Inspection:

Item	Judgment Criteria			Classification
	Area (Note1)	I	O	
Point Defect	Bright dot	Random	2	
		2 dots adjacent	0	0
		3 dots adjacent or more	0	0
	Dark dot	Random	3	
		2 dots adjacent	0	
		3 dots adjacent or more	0	0
	Total Dot Defect		5	
	Distance	Distance between Bright and Bright dot	$L \geq 5\text{mm}$	
		Distance between Bright and Dark dot	$L \geq 5\text{mm}$	
		Distance between Dark dot	$L \geq 5\text{mm}$	
(1) It is defined as Point Defect if defect area $> 0.5\text{dot}$ (2) It is ignored if defect area $\leq 0.5\text{dot}$ (3) Weak point defect will be defined as Bright Dot if it can be observed through ND filter 5% (Full Screen Black Inspection)				
Line Defect	Obvious vertical or horizontal line defect is not allowed.			MA
Mura	Not allowed if it can be observed through ND Filter 5 %			MI
Foreign Material in spot shape *Note-3	Visible under : ND5% $D \leq 0.2\text{mm}$: Ignored $0.2\text{mm} < D \leq 0.5\text{mm}$: $N \leq 8$ $D > 0.5\text{mm}$: Not allowed			MI
Foreign Material in line or spiral shape *Note-4	Visible under : ND5% $W \leq 0.05\text{mm}$ or $L \leq 5\text{mm}$: Ignored $0.05\text{mm} < W \leq 0.2\text{mm}$ and $L 1.0\text{mm} \leq 5\text{mm}$: $N \leq 8$ $W > 0.2\text{mm}$ or $L > 5\text{mm}$: Not allowed			MI
Abnormal Display	Abnormal Display is not allowed			MA

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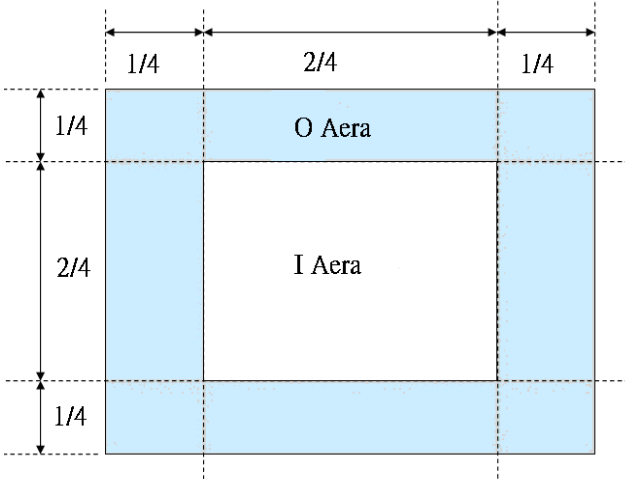
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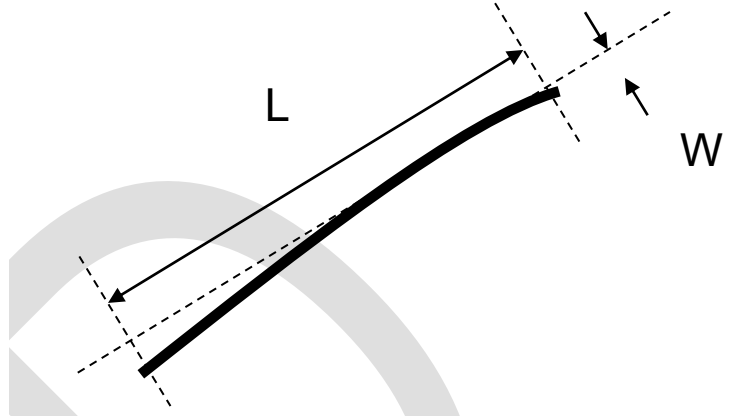
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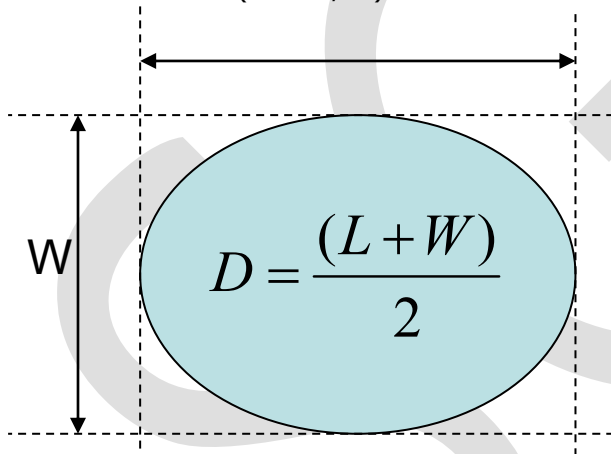
Note-1 : I/O Area Definition



Note-2 : Polarizer Scratch



Note-3 : Spot Foreign Material
($W \geq L / 4$)



Note-4 : Line or Spiral Foreign Material
($W < L / 4$)

