

**Display Elektronik GmbH**

**DATA SHEET**

**LCD MODULE**

**DEM 480272F TMH-PW-N  
(A-TOUCH)**

**4,3" TFT with Touch-Panel**

**Product Specification**

**Ver.: 4**

**03.05.2011**

Revise Records

Rev.	Date	Contents	Written	Approved
0	18.08.2010	Preliminary Specification	AJ	SC
1	26.10.2010	1. Modify description 3.2.2 "Current of Backlight" →"Current of One LED" 2. Add Max Current value of Backlight 3. Add Max Response time 4. Add IDD Current Value 5. Modify Pin define pin39→LEDK Pin40→LEDA	AJ	SC
2	30.11.2010	Add ROHS Compliance Description	AJ	SC
3	24.03.2011	Remove DE Timing Characteristics	AJ	SC
4	03.05.2011	1. Add logic voltage range of VIH,VIL 2. Add Black Tape	AJ	SC

Special Notes

Note1.	

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**1 General Description and Features**

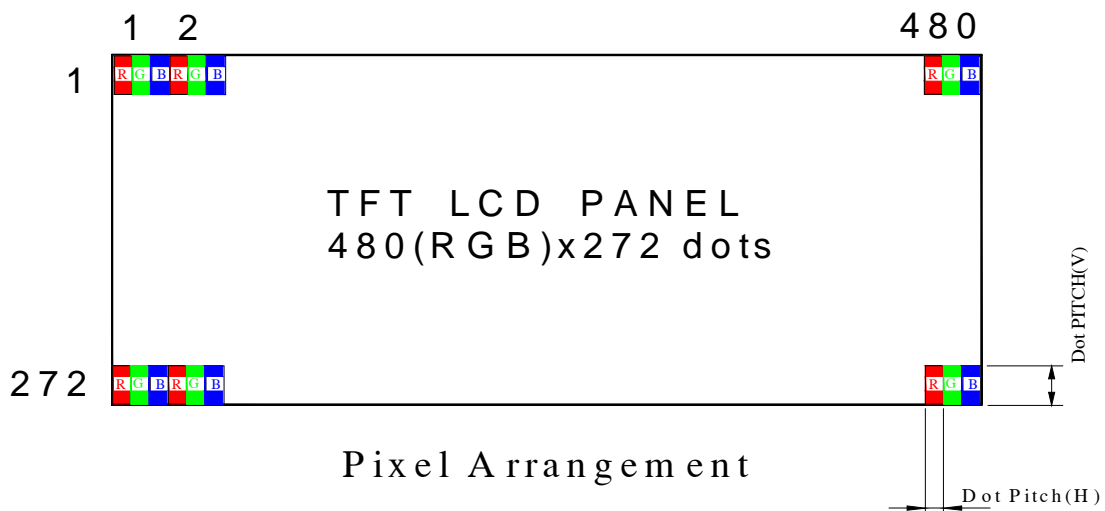
DEM 480272F TMH-PW-N(A-TOUCH) is a TM (Transmissive) type color active matrix TFT (Thin Film Transistor) liquid crystal display (LCD) that uses amorphous silicon TFT as a switching device. This model is composed of a TFT-LCD module, a driver circuit and a back-light unit and Touch panel. The resolution of a 4.3" contains 480(RGB)x272 dots and can display up to 16.7M colors. The following table described the features of DEM 480272F TMH-PW-N(A-TOUCH).

**1.1 Features**

- Transmissive and back-light with 7 LEDs are available.
- TN (Twisted Nematic) mode.
- 24bit RGB Interface
- 4-wire Touch panel
- ROHS Compliance

**1.2 LCD Module**

Item	Specification	Unit
Screen Size	4.3 inches	Diagonal
Display Resolution	480(H) x RGB x 272(V)	Dot
Pixel size	0.198 (H) x 0.198 (V)	mm
Active Area	95.040 (H) x 53.856 (V)	mm
Outline Dimension	105.5 (W) x 67.2 (H) x 5.05 (D)	mm
Display Mode	Normally white/Transmissive	--
Pixel Arrangement	RGB Vertical-Stripe	--
Surface Treatment	Anti-glare (AG)	--
Display Color	16.7M	--
Viewing Direction (Gray Inversion)	6 o'clock (Gray Inversion)	--
Input Interface	Digital 24-bits parallel RGB	--
Color Gamut (NTSC%)	NTSC 48%	--



**2 Mechanical Information**

Item		Min.	Typ.	Max.	Unit	Note
Module Size	Horizontal (H)	--	105.5	--	mm	--
	Vertical (V)	--	67.20	--	mm	(1)
	Thickness (T)	--	5.05	--	mm	(1)
Weight		--	(60)	--	g	--

Note (1) Not include FPC.

Refer to the Dimensional Outlines for further information.

**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<sub>SS</sub>=GND=0)

Item	Symbol	Min.	Max.	Unit	Note
Storage temperature	T <sub>STG</sub>	-30	80	°C	(1)
Operating temperature	T <sub>OPR</sub>	-20	70	°C	(1,2,3)

Note (1) 95 % 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.

**3.2 Electrical Absolute Rating**

3.2.1 TFT-LCD Module

(Ta=25±2°C, V<sub>SS</sub>=GND=0)

Item	Symbol	Value		Unit	Condition
		Min.	Max.		
Power supply voltage	DV <sub>DD</sub>	-0.3	4.5	V	

3.2.2 Backlight Unit

(Ta=25±2°C)

Item	Symbol	Min.	Max.	Unit	Note
Current of One LED	I <sub>LED</sub>	--	(25)	mA	(1)

Note (1) Permanent damage to the device may occur if maximum values are exceeded or reverse voltage is loaded. Functional operation should be restricted to the conditions described under normal operating conditions.

**4 Touch Screen Panel Specifications****4.1 Electrical Characteristics**

Item	Min.	Typ.	Max.	Unit	Note
Linearity	-1.5	-	1.5	%	Analog X and Y directions
Terminal resistance	(500)	-	(1300)	$\Omega$	X (Glass side)
	(100)	-	(540)	$\Omega$	Y (Film side)
Insulation resistance	20	-	-	M $\Omega$	DC 25V
Voltage	-	5.0	7.0	V	DC
Chattering	-	-	10	ms	100k $\Omega$ pull-up

**4.2 Mechanical & Reliability Characteristics**

Item	Min.	Typ.	Max.	Unit	Note
Activation force	60		100	g	
Durability-surface scratching	Write 100,000	-	-	characters	
Durability-surface pitting	1,000,000	-	-	touches	
Surface hardness	3	-	-	H	JIS K5400,ASTM D3363

**5 Electrical Characteristics**

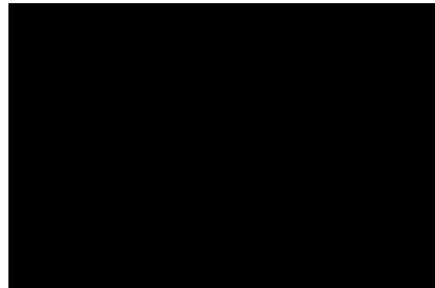
**5.1 TFT-LCD Module**

(Ta=25±2°C, V<sub>DD</sub> =3.3V)

Item	Symbol	Value			Unit	Condition	
		Min.	Typ.	Max.			
Power supply voltage	V <sub>DD</sub>	3.0	3.3	3.6	V		
Input Voltage for logic	H Level	V <sub>IH</sub>	0.7xV <sub>DD</sub>	-	V <sub>DD</sub>	V	
	L Level	V <sub>IL</sub>	0	-	0.3xV <sub>DD</sub>	V	
Digital Current	I <sub>DD</sub>	-	(13)	(15)	mA		

Note (1) The specified power consumption is under the conditions at V<sub>CC</sub>=3.3V , F<sub>V</sub>=60Hz, whereas a Power dissipation check pattern below is displayed.

Black Pattern / 0 Gray



Active Area

**5.2 Backlight Unit**

The back-light system is an edge-lighting type with white LED (Light Emitting Diode)s.

(Ta=25±2°C)

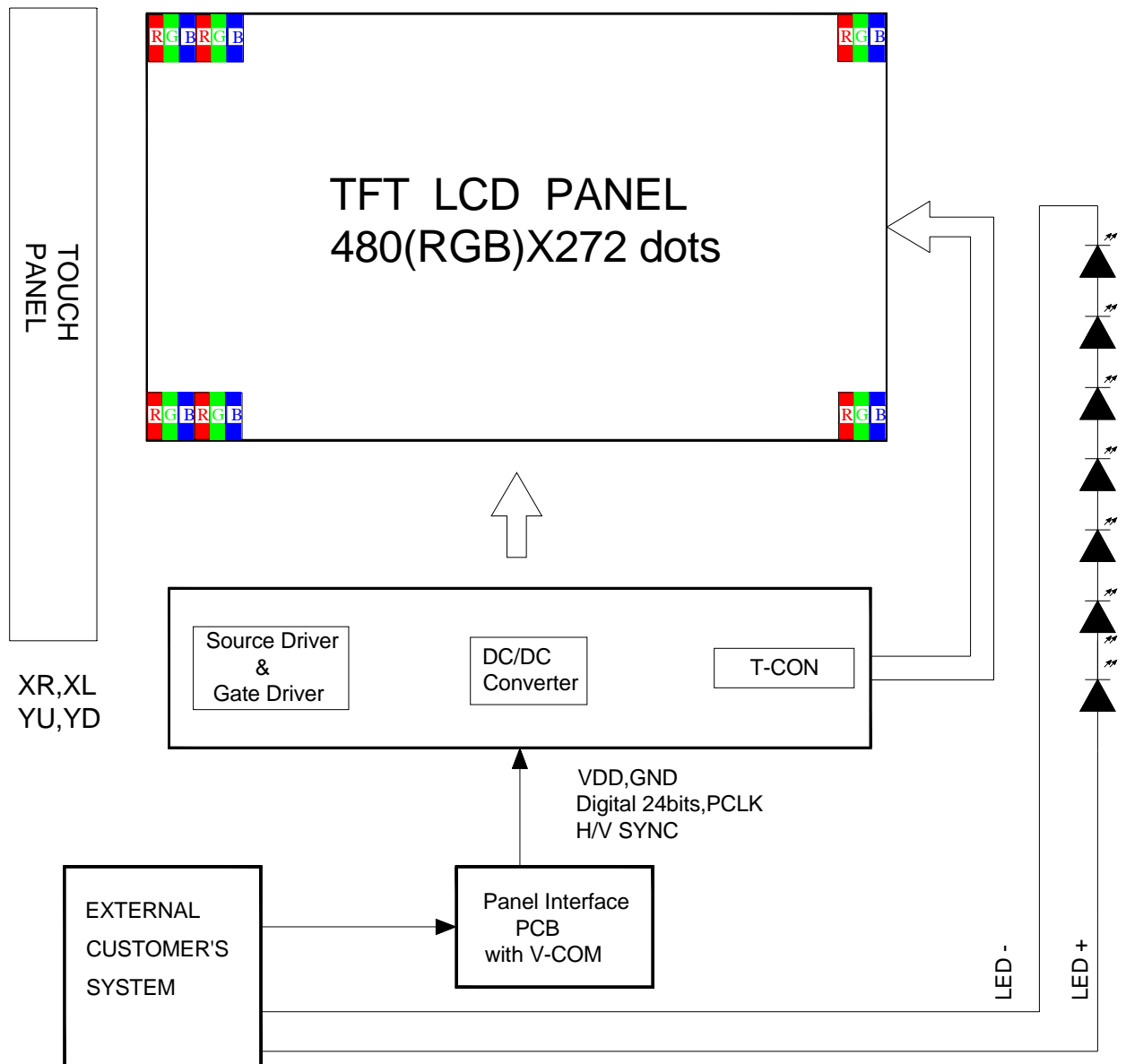
Item	Symbol	Value			Unit	Condition
		Min.	Typ.	Max.		
LED Voltage	V <sub>L</sub>	(20.3)	(22.4)	(23.8)	V	
LED Current	I <sub>f</sub>	-	20	25	mA	
Power Consumption	P <sub>LED</sub>	-	(448)	(595)	mW	(2)
LED Life Time (25°C)	-	(20000)	-	-	hr	(3)

Note (1) 7 LEDs serial type.

(2) Where I<sub>f</sub> = 20mA, V<sub>L</sub> = 22.4V, P<sub>LED</sub> = V<sub>L</sub> × I<sub>f</sub>

(3)The environmental conducted under ambient air flow ,at Ta=25±2°C,60%RH±5%

6 Block Diagram





## 7 Input Terminal Pin Assignment

## 7.1 CN1 Pin Assignment (Reference Connector: Hirose Electric Co., LTD. Product No. FH12A-40S-0.5SH(55) Top contact type)

Pin No.	Symbol	I/O	Function	Remark
1	VSS	P	Ground	
2	VSS	P	Ground	
3	V <sub>DD</sub>	P	Logic power supply(+3.0~3.6V)	
4	V <sub>DD</sub>	P	Logic power supply(+3.0~3.6V)	
5	R0	I	Red Data Bit 0(LSB)	
6	R1	I	Red Data Bit 1	
7	R2	I	Red Data Bit 2	
8	R3	I	Red Data Bit 3	
9	R4	I	Red Data Bit 4	
10	R5	I	Red Data Bit 5	
11	R6	I	Red Data Bit 6	
12	R7	I	Red Data Bit 7(MSB)	
13	G0	I	Green Data Bit 0(LSB)	
14	G1	I	Green Data Bit 1	
15	G2	I	Green Data Bit 2	
16	G3	I	Green Data Bit 3	
17	G4	I	Green Data Bit 4	
18	G5	I	Green Data Bit 5	
19	G6	I	Green Data Bit 6	
20	G7	I	Green Data Bit 7(MSB)	
21	B0	I	Blue Data Bit 0 (LSB)	
22	B1	I	Blue Data Bit 1	
23	B2	I	Blue Data Bit 2	
24	B3	I	Blue Data Bit 3	
25	B4	I	Blue Data Bit 4	
26	B5	I	Blue Data Bit 5	
27	B6	I	Blue Data Bit 6	
28	B7	I	Blue Data Bit 7(MSB)	
29	VSS	P	Ground	
30	P <sub>CLK</sub>	I	Dot Data Clock	
31	DISP	I	Display on/off	
32	H <sub>SYNC</sub>	I	Horizontal Sync Input	(1)
33	V <sub>SYNC</sub>	I	Vertical Sync Input	(1)
34	NC	-	No Connect	
35	XR	O	Touch Right	
36	YD	O	Touch Bottom	
37	XL	O	Touch Left	
38	YU	O	Touch Top	
39	LEDK	P	Backlight Cathode	
40	LEDA	P	Backlight Anode	

Note: (1). Default Use SYNC MODE.

8 Optical Characteristics

The following items are measured under stable conditions. The optical characteristics should be measured in a dark room  
 Measuring equipment: BM-7A

(Ta=25±2°C , VDD =3.3V, If=20mA)

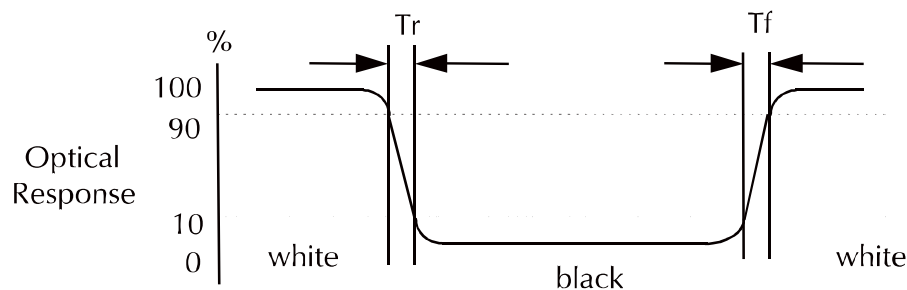
Item	Symbol	Condition	Min	Type	Max	Unit	Note	
Brightness	--	--	(350)	(400)	--	cd/m <sup>2</sup>	--	
Response time	T <sub>R</sub>	θ=0°	--	10	15	ms	--	
	T <sub>F</sub>		--	20	30	ms		
Contrast ratio	CR	At optimized viewing angle	(250)	(350)	--	--	--	
Color Chromaticity	Red	R <sub>X</sub>	θ=0° Normal Viewing Angle	(0.57)	(0.62)	(0.67)	--	--
		R <sub>Y</sub>		(0.29)	(0.34)	(0.39)		
	Green	G <sub>X</sub>		(0.29)	(0.34)	(0.39)	--	
		G <sub>Y</sub>		(0.52)	(0.57)	(0.62)		
	Blue	B <sub>X</sub>		(0.09)	(0.14)	(0.19)	--	
		B <sub>Y</sub>		(0.05)	(0.10)	(0.15)		
	White	W <sub>X</sub>		(0.27)	(0.32)	(0.37)	--	
		W <sub>Y</sub>		(0.29)	(0.34)	(0.39)		
Viewing Angle (6H)	Hor.	θ <sub>R</sub>	CR≥10	50	(65)	Degree	--	
		θ <sub>L</sub>		50	(65)			
	Ver.	θ <sub>U</sub>		40	(50)			
		θ <sub>D</sub>		50	(60)			

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-5A/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".

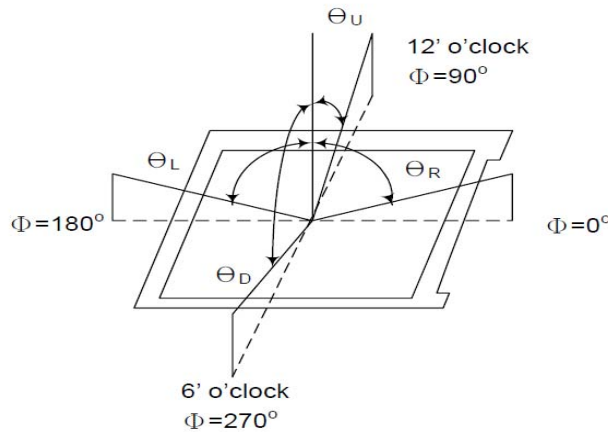


c. Definition of contrast ratio:

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

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

e. View Angle



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

Light Source of Back-Light Unit	LED Type
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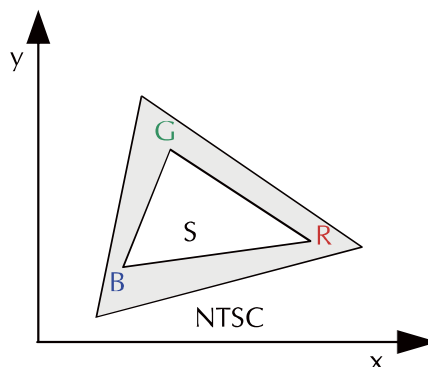
g. Definition of White Uniformity

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

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

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

$$\text{Color Gamut : NTSC(\%)} = ( \text{RGB Triangle Area} / \text{NTSC Triangle Area} ) \times 100$$



9 Basic Display Color and Gray Scale

	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(0)	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	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	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	1	0	0	0	0	0	0		
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:		
	Green(254)	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	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	0	1		
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:		
	Blue(127)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1		
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:		
	Blue(254)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0		
	Blue(255)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1		

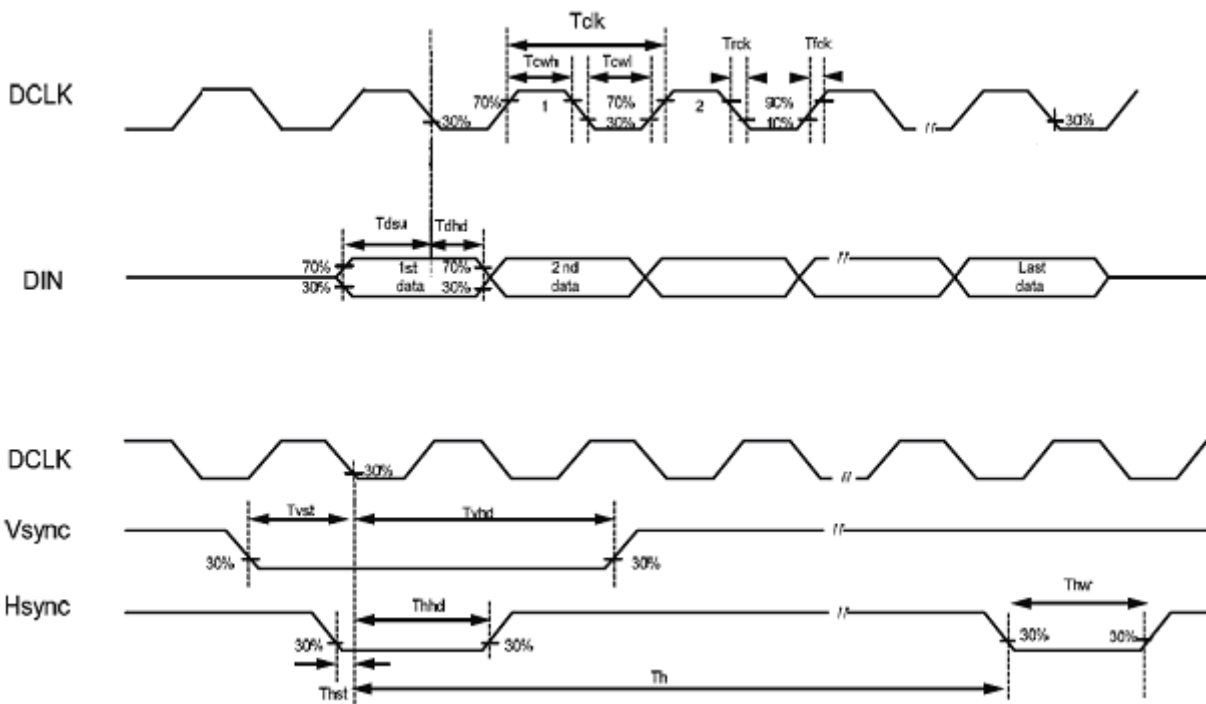
0 : Low level voltage, 1 :High level voltage

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 16,777,216-color display can be achieved on the screen.

10 AC Timing

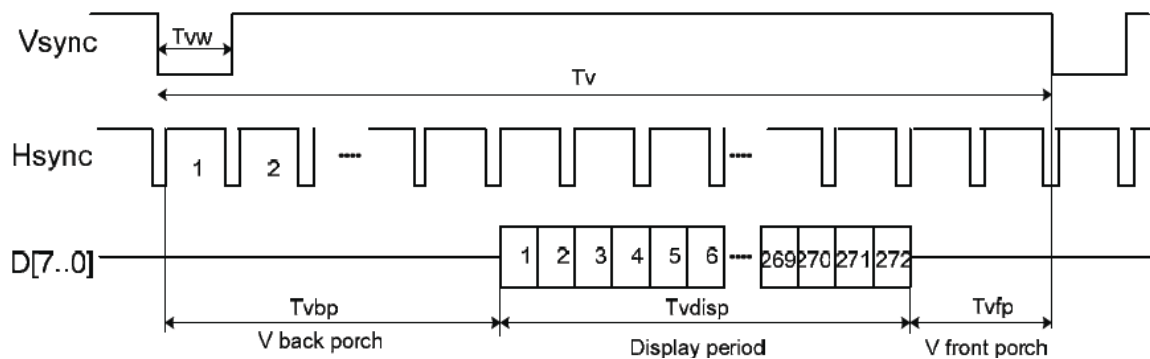
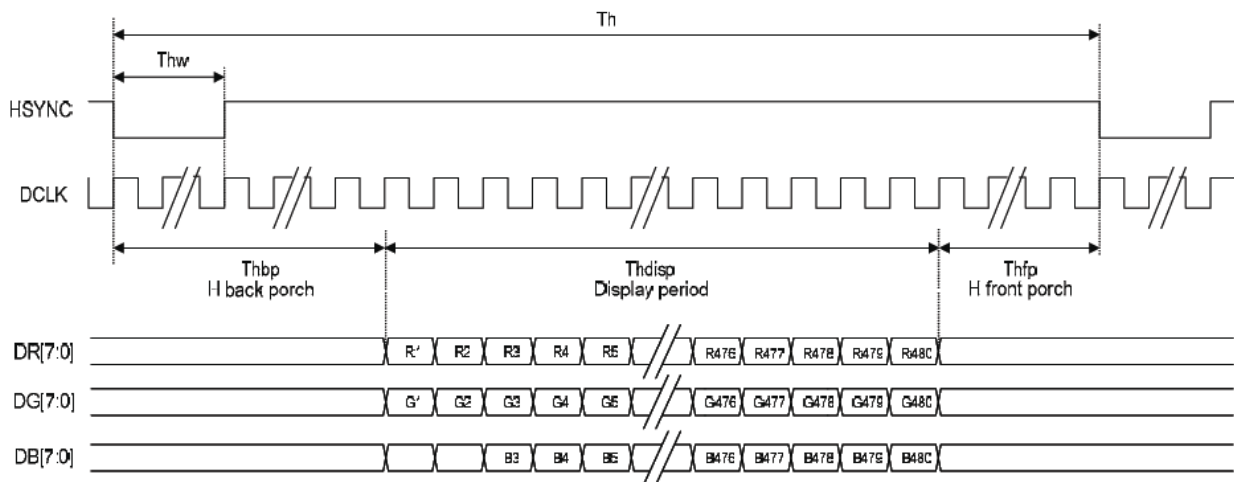
10.1 AC Characteristics

Parameter	Symbol	Min	Typ	Max	Unit
CLK pulse duty	Tcw	40	50	60	%
Hsync width	Thw	1.0	-	-	DCLK
Hsync period	Th	55	60	65	us
Vsync setup time	Tvst	12	-	-	ns
Vsync hold time	Tvhd	12	-	-	ns
Hsync setup time	Thst	12	-	-	ns
Hsync hold time	Thhd	12	-	-	ns
Data set-up time	Tdsu	12	-	-	ns
Data hold time	Tdhd	12	-	-	ns



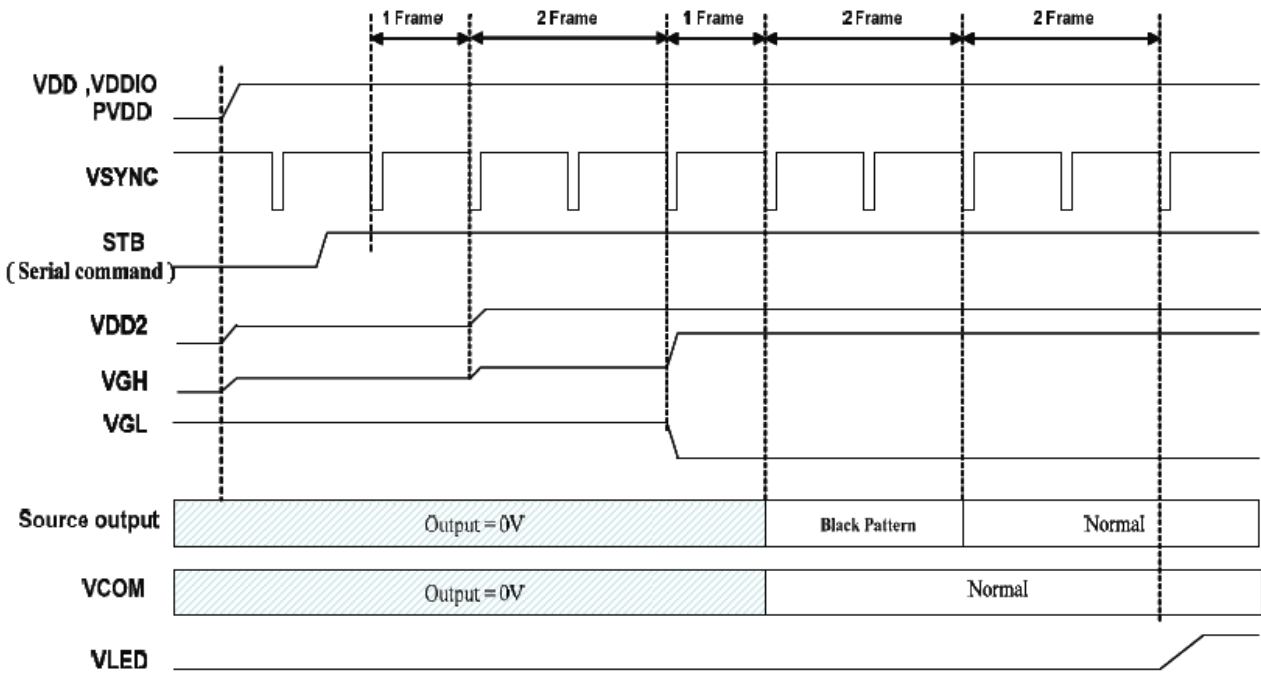
10.2 Parallel RGB Input Timing Table (SYNC MODE)

Signal	Parameter	Symbol	Min.	Typ.	Max.	Unit.	Remark
DCLK	DCLK frequency	Fclk	5	9	12	MHz	
	DCLK period	Tclk	83	110	200	ns	
Hsync	Period Time	Th	490	531	605	DCLK	
	Display Period	Thdisp	-	480	-	DCLK	
	Back Porch	Thbp	8	43	-	DCLK	
	Front Porch	Thfp	2	8	-	DCLK	
	Pulse Width	Thw	1	-	-	DCLK	
Vsync	Period Time	Tv	275	288	335	H	
	Display Period	Tvdisp	-	272	-	H	
	Back Porch	Tvbp	2	12	-	H	
	Front Porch	Tvfp	1	4	-	H	
	Pulse Width	Tvw	1	10	-	H	

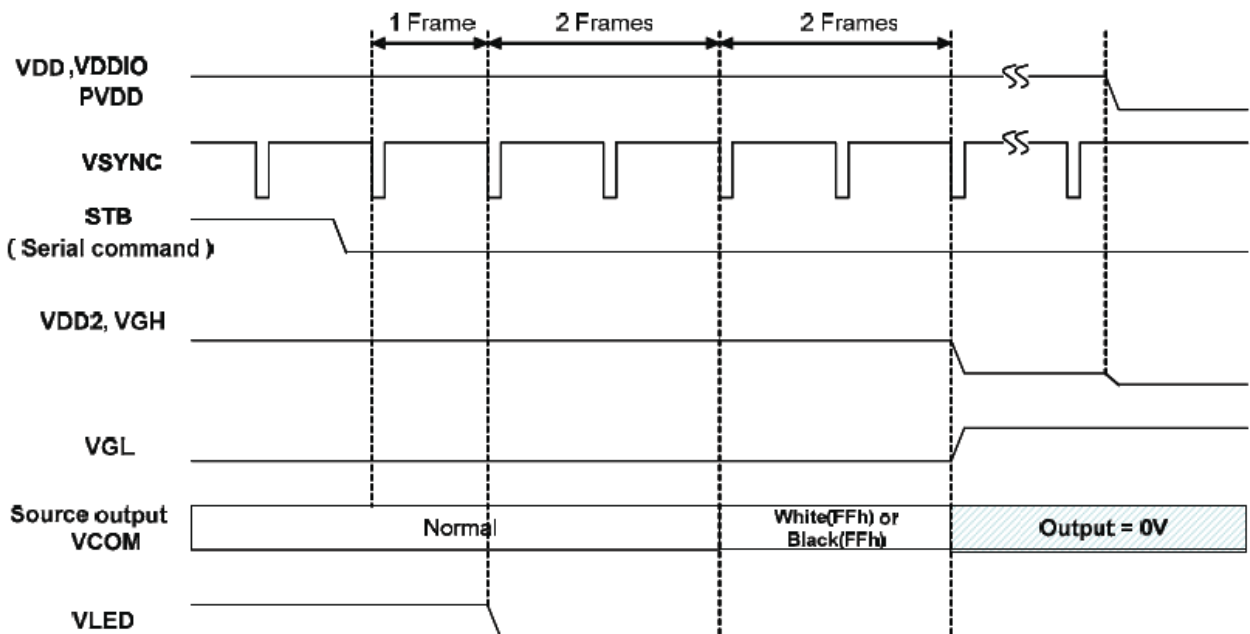


10.3 POWER ON/OFF SEQUENCE

10.3.1 Power ON Sequence



10.3.2 Power OFF Sequence



**11 Test**

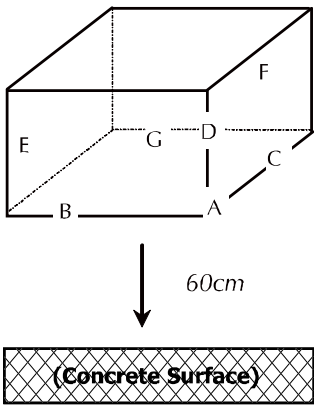
No change on display and in operation under the following test condition.

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

Temperature: 20±5°C.

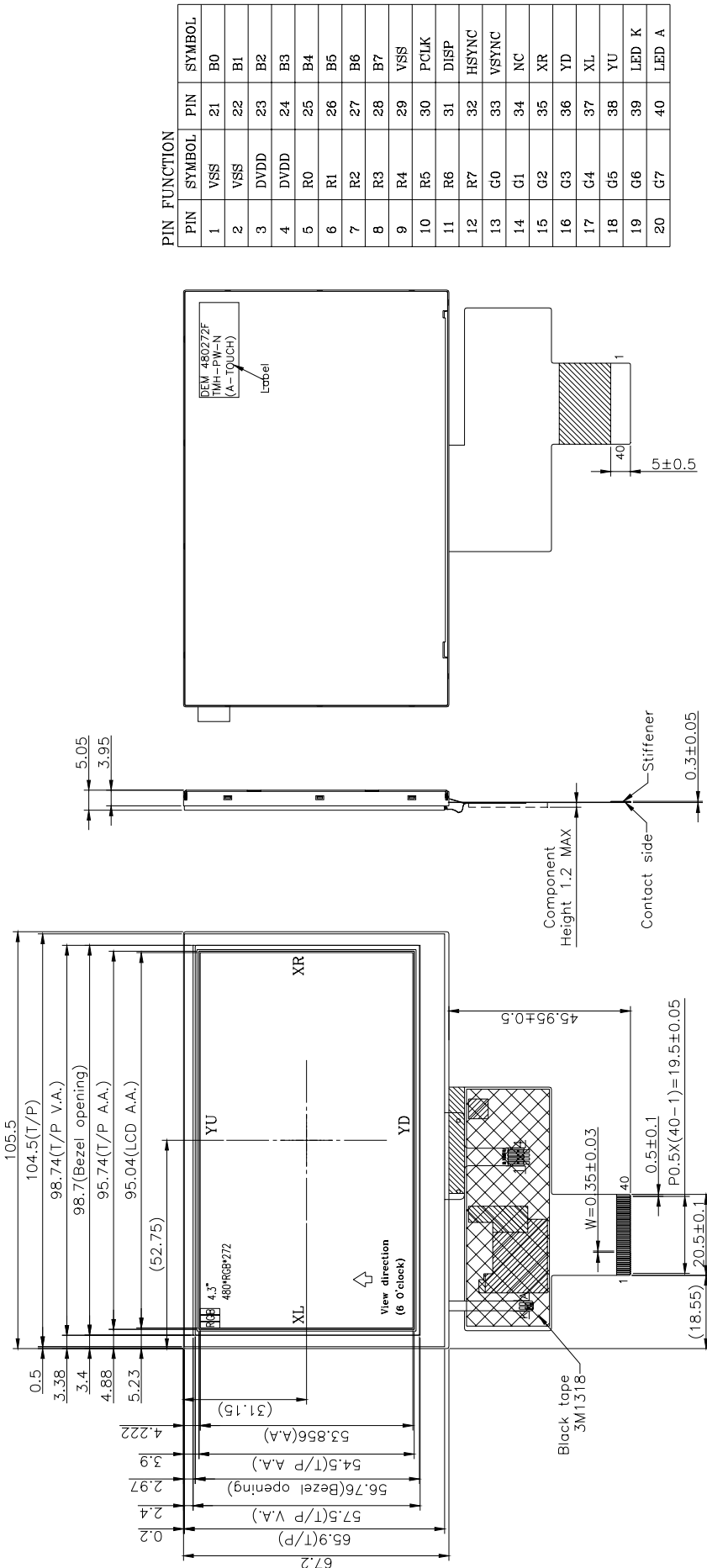
Humidity: 65±5%RH.

Tests will be not conducted under functioning state.

No.	Parameter	Condition	Notes
1	High Temperature Operating	70°C±2°C, 240hrs (Operation state).	
2	Low Temperature Operating	-20°C±2°C, 240hrs (Operation state).	1
3	High Temperature Storage	80°C±2°C, 240hrs.	2
4	Low Temperature Storage	-30°C±2°C, 240hrs.	1,2
5	High Temperature and High Humidity Operation Test	60°C±2°C, 90%, 240hrs	1,2
6	Vibration Test	Total fixed amplitude: 1.5mm. Vibration Frequency: 10~55Hz. One cycle 60 seconds to 3 direction of X, Y, Z each 15 minutes.	3
7.	Drop Test	To be measured after dropping from 60cm high on the concrete surface in packing state.  <i>Dropping method corner dropping:</i> <i>A corner: Once edge dropping.</i> <i>B, C, D edge: Once face dropping.</i> <i>E, F, G face: Once.</i>	



12 Dimensional outlines



PIN FUNCTION		PIN SYMBOL	
1	VSS	21	B0
2	VSS	22	B1
3	DVDD	23	B2
4	DVDD	24	B3
5	R0	25	B4
6	R1	26	B5
7	R2	27	B6
8	R3	28	B7
9	R4	29	VSS
10	R5	30	FCLK
11	R6	31	DISP
12	R7	32	HSYNC
13	G0	33	VSYNC
14	G1	34	NC
15	G2	35	XR
16	G3	36	YD
17	G4	37	XL
18	G5	38	YU
19	G6	39	LED K
20	G7	40	LED A

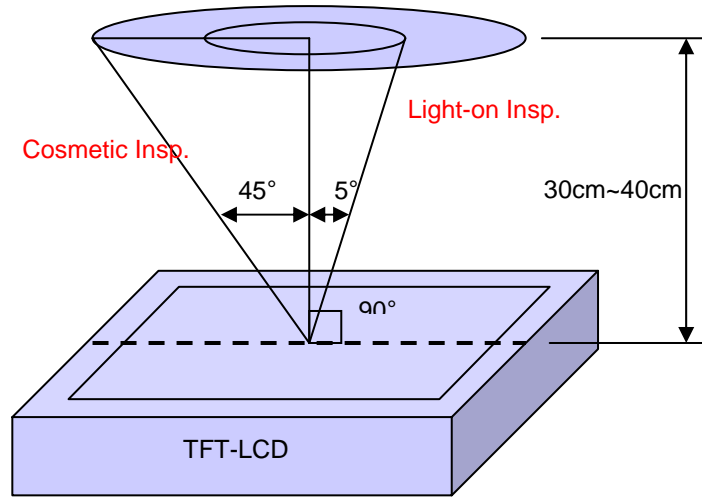
**13 Incoming Inspection Standards**

**13.1 Inspection and Environment Conditions**

13.1.1 Inspection Conditions:

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

Cosmetic Inspection Angle : ±45°



( perpendicular to LCD panel surface)

13.1.2 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

13.1.3 Sampling Conditions:

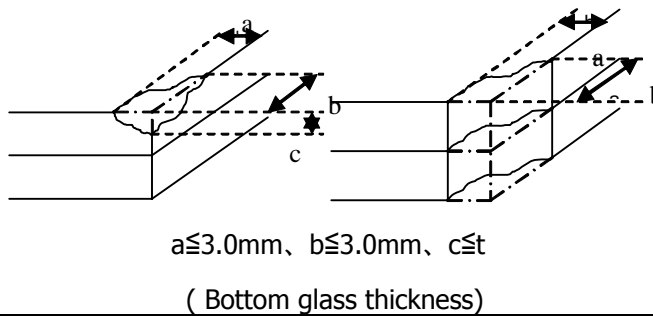
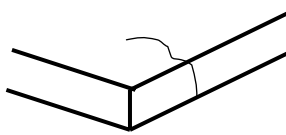
- (1) Lot Size: Quantity of shipment lot per model
- (2) Sampling Method:

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

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

13.1.4 Inspection Criteria

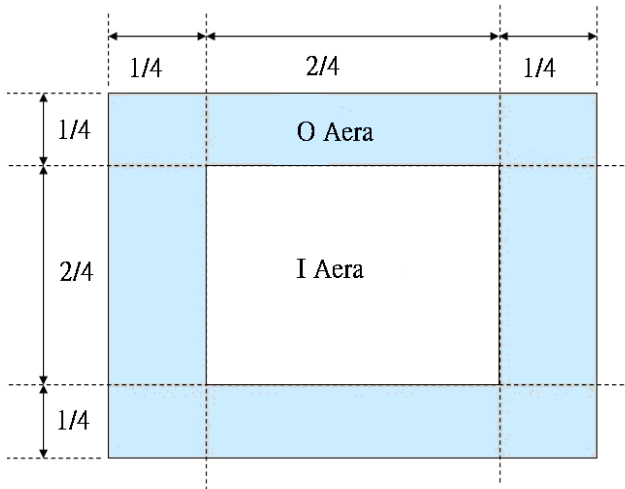
13.1.4.1 Cosmetic Inspection(Panel):

Item	Judgment Criteria	Classification
Chipping on Panel	 <p><math>a \leq 3.0\text{mm}</math>, <math>b \leq 3.0\text{mm}</math>, <math>c \leq t</math> ( Bottom glass thickness)</p>	MA
Scratch on Panel *Note-2	<p><math>W \leq 0.05\text{mm}</math> or <math>L &lt; 5\text{mm}</math>: Ignored</p> <p><math>0.05\text{mm} &lt; W \leq 0.1\text{mm}</math> and <math>L \leq 5\text{mm}</math>: <math>N \leq 5</math></p> <p><math>W &gt; 0.1\text{mm}</math> or <math>L &gt; 5\text{mm}</math>: Not allowed</p>	MI
Bubble or Dent on Panel *Note-3	<p><math>D \leq 0.2\text{mm}</math>: Ignored</p> <p><math>0.2\text{mm} &lt; D \leq 0.3\text{mm}</math>: <math>N \leq 5</math></p> <p><math>D &gt; 0.3\text{mm}</math>: Not allowed</p>	MI
Panel Crack	 <p>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	$L \geq 20\text{mm}$ , $W \geq 0.2$ , $N \geq 3$	MI
Metal Squash Dent /Flange(Front Side)	$D(W) \geq 1$ , $L \geq 3$ , $N \geq 3$ ;	MI
B/L High Voltage Wire Denudation	Not allowed	MA
Polarizer flaw or leak out resin	Defect is defined as the active area.	MI
Outline Dimension	Must in Spec, refer to related product spec.	MI

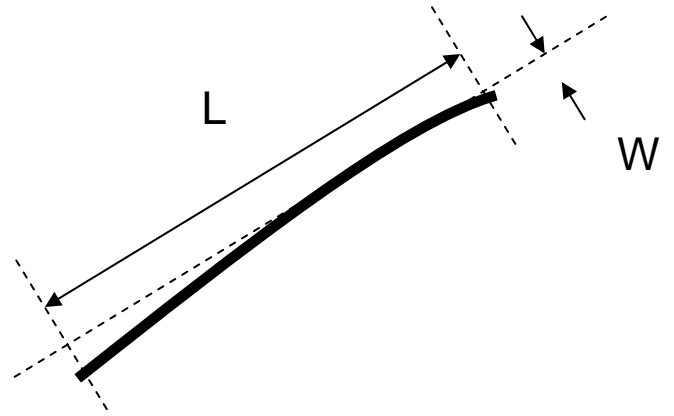
13.1.4.2 Functional Inspection:

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 5mm	
		Distance between Bright and Dark dot	L 5mm	
		Distance between Dark dot	L 5mm	
(1) It is defined as Point Defect if defect area > 0.5dot (2) It is ignored if defect area ≤ 0.5dot (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	D ≤ 0.2mm: Ignored 0.2mm < D ≤ 0.5mm: N ≤ 8 D > 0.5mm: Not allowed			MI
Foreign Material in line or spiral shape *Note-4	W ≤ 0.05mm or L ≤ 5mm: Ignored 0.05mm < W ≤ 0.2mm and L 1.0mm ≤ 5mm: N ≤ 8 W > 0.2mm or L > 5mm: Not allowed			MI
Display Function Abnormal	No Malfunction can be allowed			MA

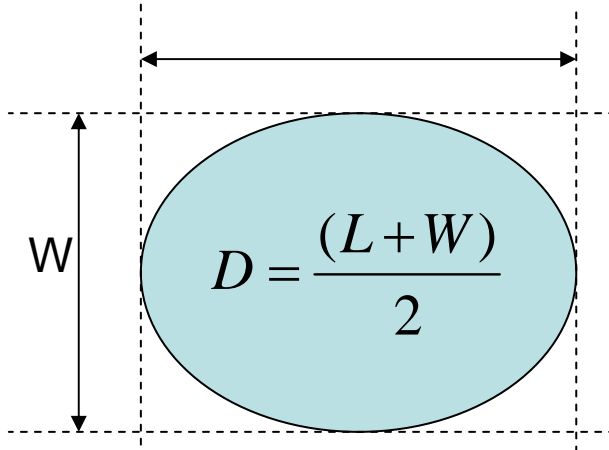
Note-1 : I/O Area Definition



Note-2 : Polarizer Scratch



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



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

