ORIENT DISPLAY

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SPECIFICATION
FOR
LCD MODULE

MODULE NO: AFD1024600A0L-10.1N6NTM-R
VERSION NO.: V1.0

Customer's Approval:

	SIGNATURE	DATE
PREPARED BY		
CHECKED BY		
APPROVED BY		

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RECORD OF REVISION

Version	Revised Date	Page	Content
V1.0	2013/11/25	--	First Issued

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1. GENERAL DESCRIPTION

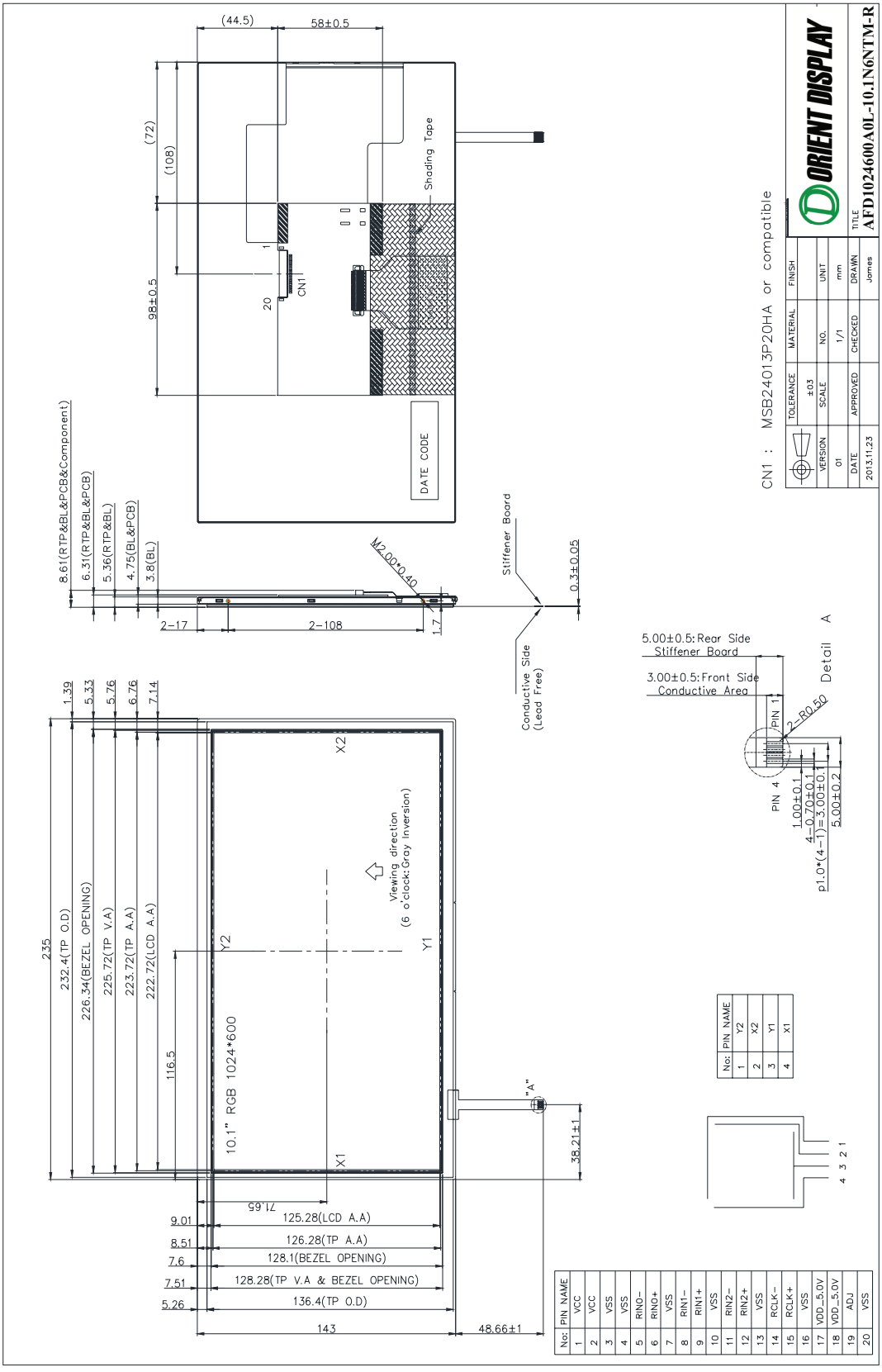
1.1 Description

The specifications is model AFD1024600A0L-10.1N6NTM-R is a color active matrix thin film transistor (TFT) liquid crystal display (LCD) that uses amorphous silicon TFT as a switching device. This model is composed of a TFT LCD panel, a driving circuit, a back light system and touch panel. This TFT LCD has a 10.1 (16:9) inch diagonally measured active display area with WSGA (1024 horizontal by 600 vertical pixels) resolution.

1.2 Features:

No.	Item	Specification	Unit
1	Panel Size	10.1”	Inch
2	Number of Pixels	1024 (W) x RGB x 600 (H)	Pixels
3	Active Area	222.72 (W) × 125.28 (H)	mm
4	Pixel Pitch	0.2175 (W) x 0.2088 (H)	mm
5	Outline Dimension	235 (W) × 143 (H) × 5.36 (T)	mm
6	Number of Colors	262K	- -
7	Display Mode	TN / Normally White / Transmissive	- -
8	Viewing Direction	12 o’clock (best view)	- -
		6 o’clock (gray inversion)	
9	Display Format	RGB vertical stripe	- -
10	Surface Treatment	Clear, Hard-Coating (3H)	- -
11	Contrast Ratio	500 (Typ.)	- -
12	Luminance (cd/m^2)	360 (typical)	cd/m2
13	Interface	LVDS 6 bit Interface	- -
14	Backlight	White LED	- -
15	Operation Temperature	-10 ~ 50	°C
16	Storage Temperature	-20 ~ 60	°C
17	Weight	TBD	g

2. MECHANICAL SPECIFICATION

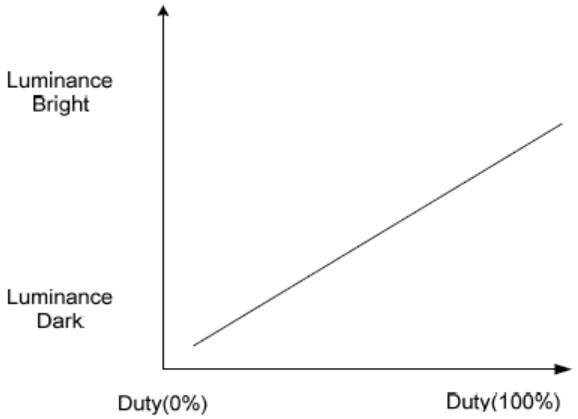


3. **PIN DESCRIPTION** (Connector Part No: MSB24013P20HA or equivalent)

Pin No.	Symbol	I/O	Function	Remark
1	VCC	P	Power Supply Logic voltage +3.3V	
2	VCC	P	Power Supply Logic voltage +3.3V	
3	VSS	P	Ground	
4	VSS	P	Ground	
5	RIN0-	I	Negative LVDS differential data input	
6	RIN0+	I	Positive LVDS differential data input	
7	VSS	P	Ground	
8	RIN1-	I	Negative LVDS differential data input	
9	RIN1+	I	Positive LVDS differential data input	
10	VSS	P	Ground	
11	RIN2-	I	Negative LVDS differential data input	
12	RIN2+	I	Positive LVDS differential data input	
13	VSS	P	Ground	
14	RCLK-	I	Negative LVDS differential clock input	
15	RCLK+	I	Positive LVDS differential clock input	
16	VSS	P	Ground	
17	VDD_5V	P	Power Supply LED voltage +5V	
18	VDD_5V	P	Power Supply LED voltage +5V	
19	ADJ	I	Back-light Dimming control	
20	VSS	P	Ground	

Notes:

1) ADJ is brightness control Pin. The larger of the pulse duty is, the higher of the brightness.
2) ADJ signal is 0~3.3V.Operation frequency is 20KHz



3) VSS PIN must be grounding, cannot be floating.

4. ABSOLUTE MAXIMUM RATINGS

4.1 Electrical Absolute Rating

4.1.1 TFT LCD Module

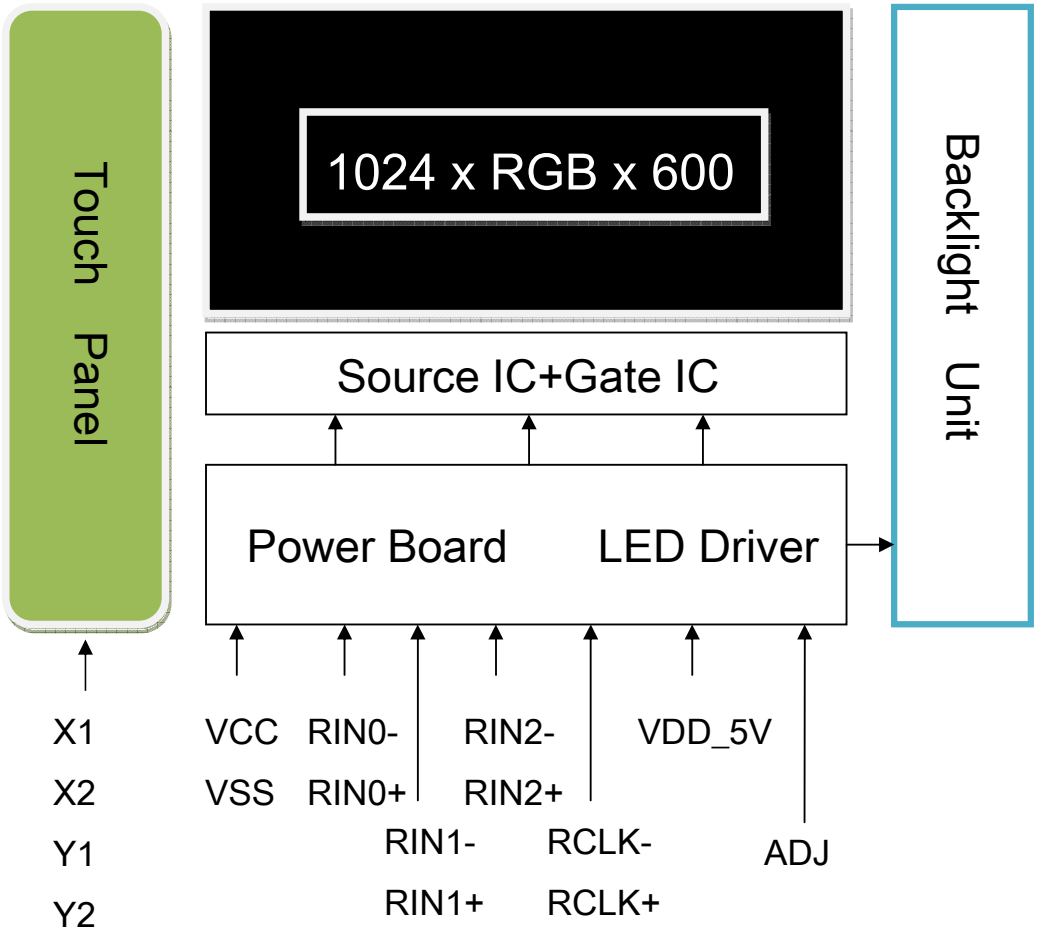
Item	Symbol	Values		Unit	Note
		Min	Max.		
Power supply voltage	VCC	-0.3	4.0	V	
Power supply voltage	VDD_5V	0	6.0	V	
Logic input voltage	VI	-0.3	VCC+0.3	V	

4.1.2 Environment Absolute Rating

Item	Symbol	Values			Unit	Note
		Min	Typ	Max.		
Operating Temperature	Topa	-10		50	°C	Ambient temperature
Storage Temperature	Tstg	-20		60	°C	

5. BLOCK DIAGRAM

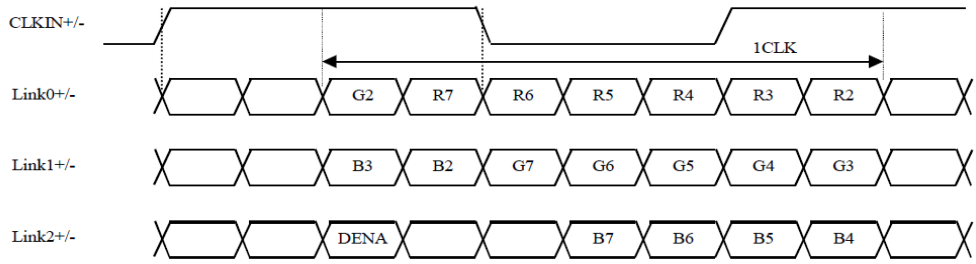
5.1 TFT LCD Module



6. Relationship Between Displayed Color and Input

6.1 6 bit

	Display	MSB LSB R5	R4	R3	R2	R1	R0	MSB LSB G5	G4	G3	G2	G1	G0	MSB LSB B5	B4	B3	B2	B1	B0	Gray scale level
Basic color	Black	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	-
	Blue	L	L	L	L	L	L	L	L	L	L	L	L	H	H	H	H	H	H	-
	Green	L	L	L	L	L	L	H	H	H	H	H	H	L	L	L	L	L	L	-
	Light Blue	L	L	L	L	L	L	H	H	H	H	H	H	H	H	H	H	H	H	-
	Red	H	H	H	H	H	H	L	L	L	L	L	L	L	L	L	L	L	L	-
	Purple	H	H	H	H	H	H	L	L	L	L	L	L	H	H	H	H	H	H	-
	Yellow	H	H	H	H	H	H	H	H	H	H	H	H	L	L	L	L	L	L	-
	White	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	-
Gray scale of Red	Black	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L0
	Dark ↑ ↓ Light	L	L	L	L	L	H	L	L	L	L	L	L	L	L	L	L	L	L	L1
		L	L	L	L	H	L	L	L	L	L	L	L	L	L	L	L	L	L	L2
		:						:						:						L3...L60
		H	H	H	H	L	H	L	L	L	L	L	L	L	L	L	L	L	L	L61
		H	H	H	H	H	L	L	L	L	L	L	L	L	L	L	L	L	L	L62
	Red	H	H	H	H	H	H	L	L	L	L	L	L	L	L	L	L	L	L	Red L63
Gray scale of Green	Black	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L0
	Dark ↑ ↓ Light	L	L	L	L	L	L	L	L	L	L	L	H	L	L	L	L	L	L	L1
		L	L	L	L	L	L	L	L	L	L	H	L	L	L	L	L	L	L	L2
		:						: :						: :						L3...L60
		L	L	L	L	L	L	H	H	H	H	L	H	L	L	L	L	L	L	L61
		L	L	L	L	L	L	H	H	H	H	H	L	L	L	L	L	L	L	L62
	Green	L	L	L	L	L	L	H	H	H	H	H	H	L	L	L	L	L	L	Green L63
Gray scale of Blue	Black	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L0
	Dark ↑ ↓ Light	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	L1
		L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	L	L2
		:						:						:						L3...L60
		L	L	L	L	L	L	L	L	L	L	L	L	H	H	H	H	L	H	L61
		L	L	L	L	L	L	L	L	L	L	L	L	H	H	H	H	H	L	L62
	Blue	L	L	L	L	L	L	L	L	L	L	L	L	H	H	H	H	H	H	Blue L63
Gray scale of White & Black	Black	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L0
	Dark ↑ ↓ Light	L	L	L	L	L	H	L	L	L	L	L	H	L	L	L	L	L	H	L1
		L	L	L	L	H	L	L	L	L	L	H	L	L	L	L	L	H	L	L2
		:						:						:						L3...L60
		H	H	H	H	L	H	H	H	H	H	L	H	H	H	H	H	L	H	L61
		H	H	H	H	H	L	H	H	H	H	H	L	H	H	H	H	H	L	L62
	White	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	White L63



7. ELECTRICAL CHARACTERISTICS

7.1 TFT LCD Module

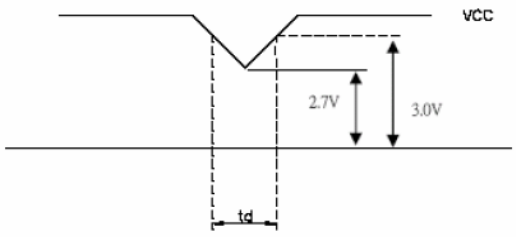
Item	Symbol	Values			Unit	Remark
		Min	Typ.	Max.		
Supply Voltage	VCC	3.0	3.3	3.6	V	
	VDD_5V	4.5	5.0	5.5	V	
	VRF	-	-	100	mV p-p	Ripple voltage
Differential Input High Threshold	VTH	-	-	+100	mV	Vcm=+1.2V
Differential Input Low Threshold	VTL	-100	-	-	mV	Vcm=+1.2V
Magnitude differential Input Voltage	[Vid]	100	-	600	mV	
Common Mode Voltage	Vcm	0.9	1.2	1.5	V	
Common Mode Voltage Offest	△Vcm	-	-	50	mV	Vcm=+1.2V
Supply Current	ICC	-	190	250	mA	VCC=3.3V
	IDD	-	(650)	(800)	mA	VDD_5V=5V
ADJ frequency		19K	20K	21K	Hz	
ADJ input voltage	VIH	3.0	-	3.3	V	
	VIL	0	-	0.3	V	
LED life time		30000	-	-	Hr	Note1

Note (1): The “LED life time” is defined as the module brightness decrease to 50% original brightness that the ambient temperature is 25℃ 60% RH.

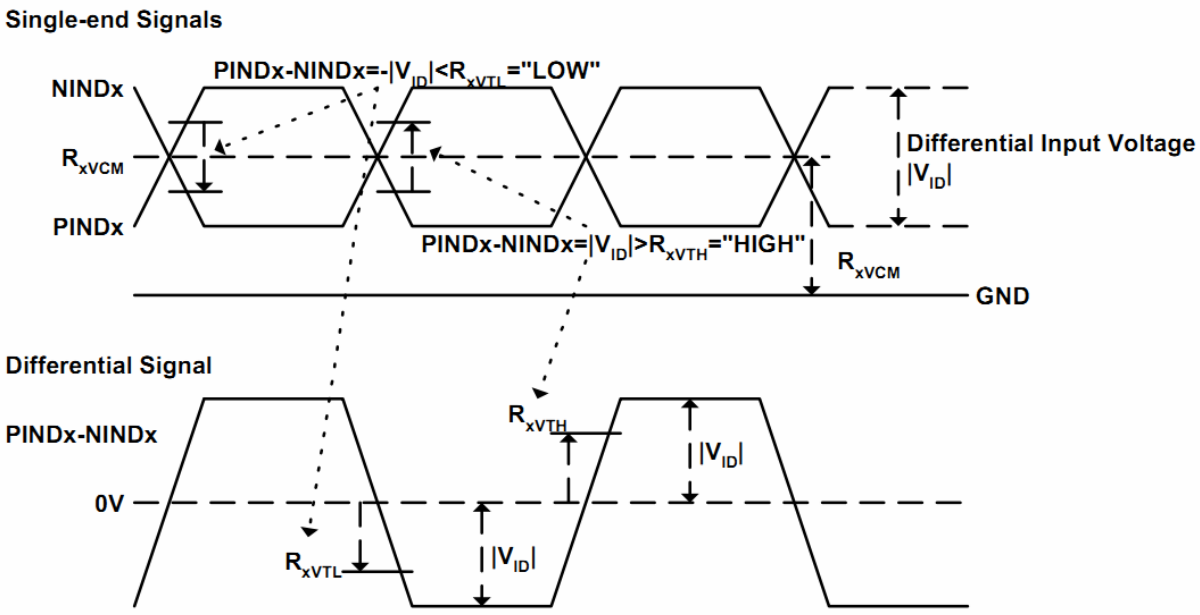
Note (2): VCC-dip condition

a. 2.7 V ≤VCC <3.0V, td ≤ 10 ms

b. VCC＞3.0V, VCC-dip condition should be the same with VCC-turn-on condition。



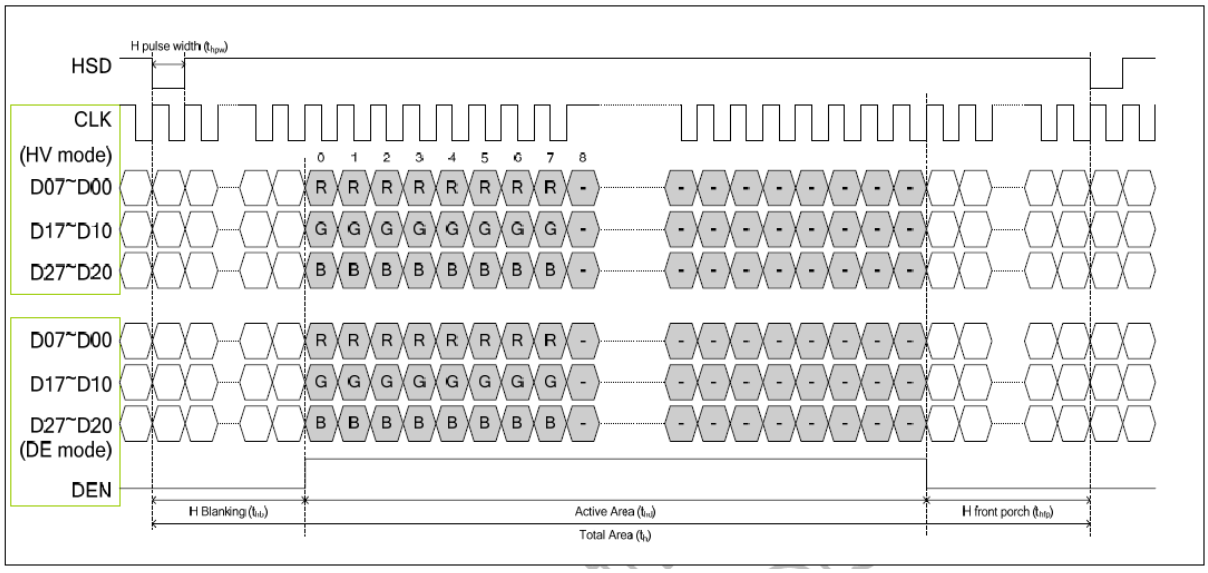
Note (3): The built-in LVDS receiver is compatible with (ANSI/TIA/TIA-644) standard.

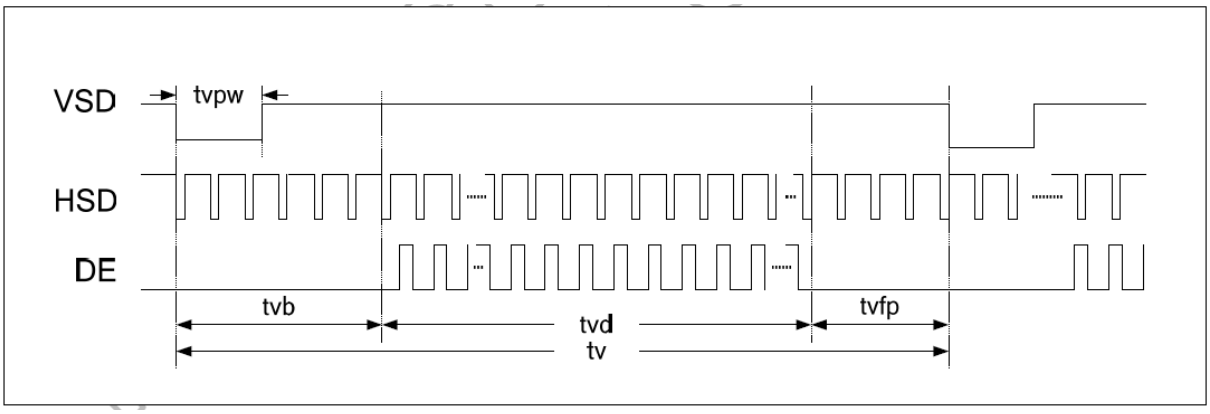


7.2 INTERFACE SPECIFICATIONS

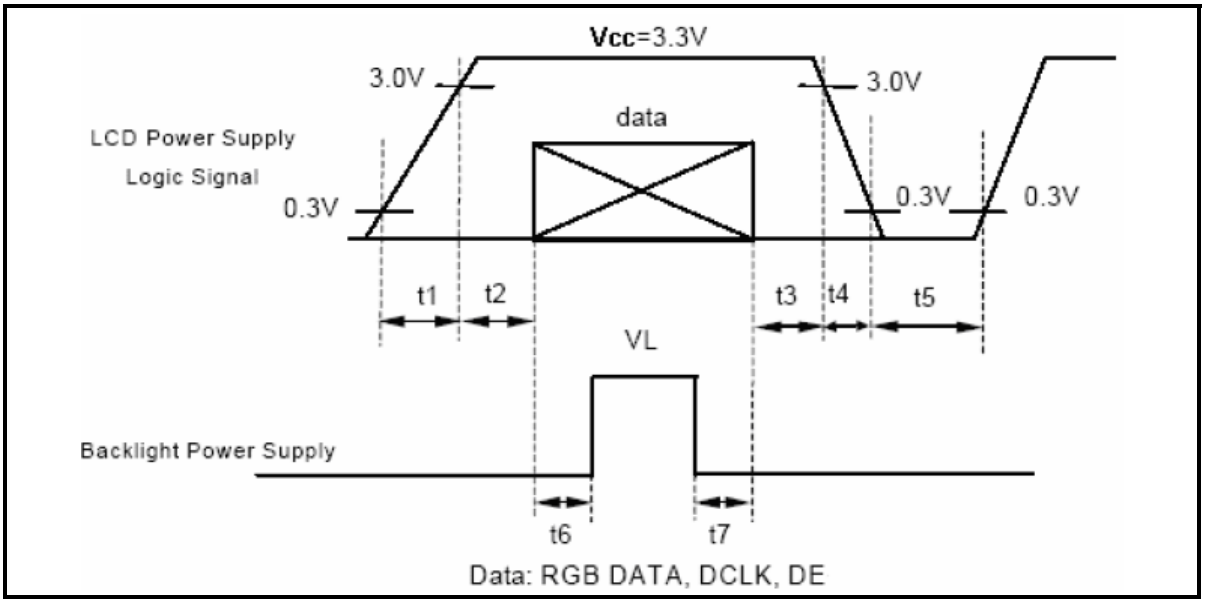
7.2.1 DE mode Input signal characteristics

Signal	Parameter	Symbol	Min.	Typ.	Max.	Unit.	Note
DCLK	DCLK Frequency	fclk	40.8	51.2	67.2	MHz	
Horizontal	Horizontal display area	thd	-	1024	-	DCLK	
	HSD period time	th	1114	1344	1400	DCLK	
	HSD Blanking	thb+thfb	90	320	376	DCLK	
Vertical	Vertical display area	tvd	-	600	-	th	
	VSD period time	tv	-	635	-	th	
	VSD pulse width	tvb+tvfb	10	35	200	th	





7.3 Power On / Off Sequence



t1 ≤10ms : 1 sec≤ t5

50ms≤ t2 : 200ms ≤t6

0<t3 ≤50ms: 200ms≤ t7

0<t4 ≤10ms

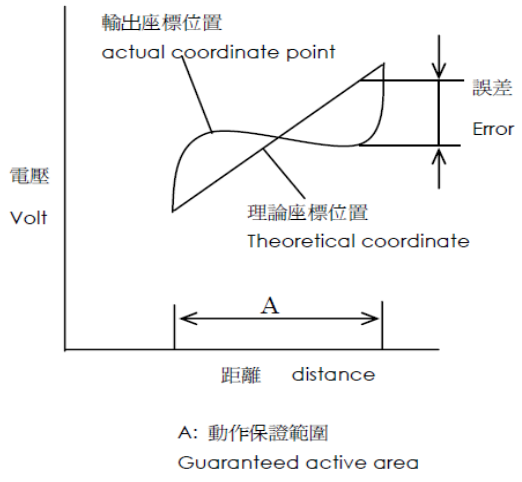
8. Touch Screen Panel Specifications

8.1 Main Feature

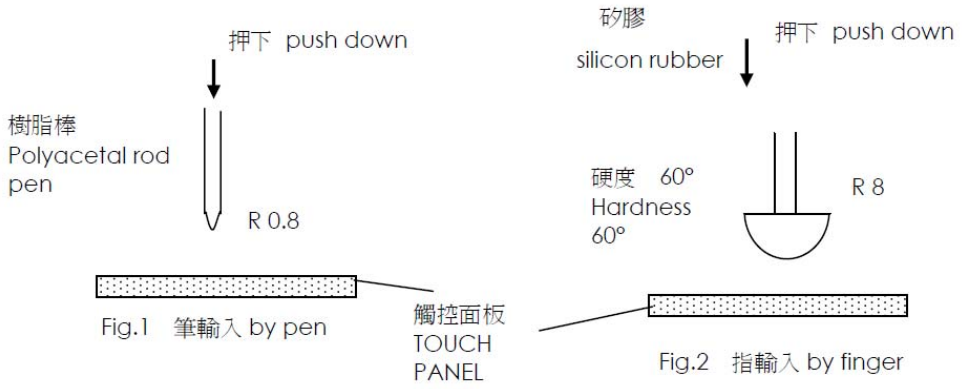
Item	Min.	Typ.	Max.	Unit	Note
Linearity	-1.5	-	1.5	%	Initial data
	-3.0	-	+3.0	%	After environmental &life test, Refer Note2
Terminal resistance	500	-	1650	Ω	X1~X2
	70	-	750	Ω	Y1~Y2
Insulation resistance	20	-	-	MΩ	DC 25V
Voltage		-	7.0	V	DC
Response time	-	-	10	ms	
Haze	-	3	-	%	JIS K-7105
FPC peeling strength	5	-	-	N	Peeling upward by 90°
Minimum Input force	-	-	80	gf	Test Area is 3mm inside of active area, but not on Dot-Spacer. Refer Note1
Notes life	100000			words	Refer Note3
Input life	1000000			times	Refer Note3

Note1: Measurement condition of minimum input force Resistance between X & Y axis must be equal or lower than 2kΩ (Ron ≤ 2kΩ)

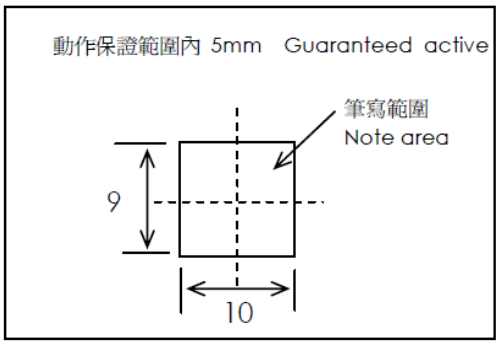
Note2: Measurement condition of Linearity Difference between actual voltage & Theoretical voltage is an error at any points. Linearity is the value max. Error voltage divided by voltage difference on active area inside 1mm.



Note3:



Notes area for pen notes life test is 10×9mm. Size of word is 7.5×6.75mm. Word is anyA.B.C….. word. Center of each word is changed at random on active area inside 5mm. Sharp of pen end : R 0.8 (Refer Fig.1)
Materials of pen : Polyacetal
Load : 250g
Speed : 60mm/s



Input life test condition(by finger)
By silicone rubber tapping at same point.
Sharp of rubber end : R8 Hardness 60°(Refer fig.2)
Load : 200g
Frequency : 5Hz

8.2 Pin Assignments and Definitions

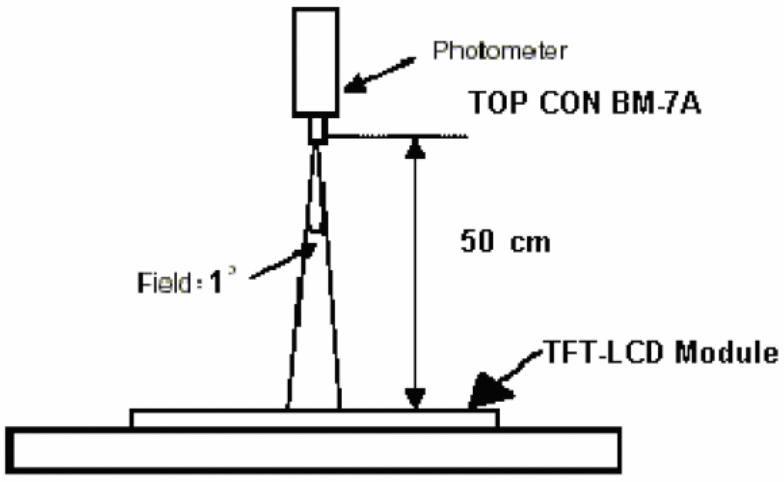
Item	Name	I/O	Unit
1	Y2	O	Touch Panel Up
2	X2	O	Touch Panel Right
3	Y1	O	Touch Panel Down
4	X1	O	Touch Panel Left

9. OPTICAL CHARACTERISTICS

Item		Symbol	Condition	Min.	Typ.	Max.	Unit
Brightness		--	Note1, Note 3, ($\theta = 0^\circ$, Normal Viewing Angle)	280	360	--	cd/m2
Uniformity		B-uni		70	75	-	%
Contrast Ratio		CR		400	500	--	--
Response Time		Tr		--	5	7	ms
		Tf		--	20	28	ms
Color Chromaticity	White	Wx		0.260	0.310	0.360	--
		Wy		0.280	0.330	0.380	--
View angle	Horizontal	θ x+	Center CR≥10	60	70	--	
		θ x-		60	70	--	
	Vertical	θ Y+		40	50	--	
		θ Y-		50	60	--	
Image sticking		tis	2 hours	--	--	2	Sec

Note：The following optical specifications shall be measured in a darkroom or equivalent state(ambient luminance ≤1 lux, and at room temperature). The operation temperature is 25°C±2°C. The measurement method is shown in Note1.

Note1: The method of optical measurement:

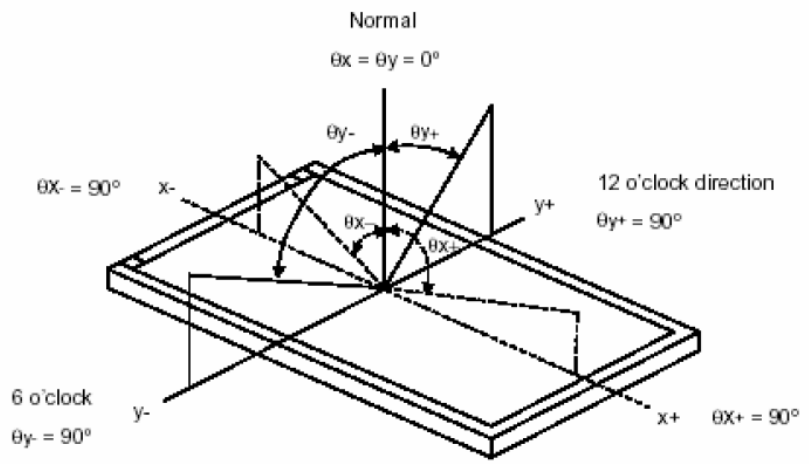


Note2: Measured at the center area of the panel and at the viewing angle of the θ x= θ y =0°

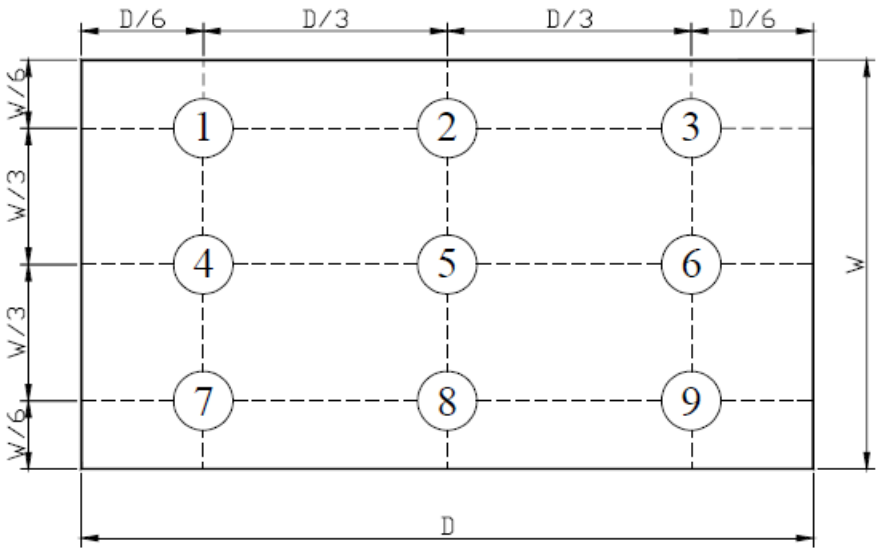
Note3: Definition of Contrast Ratio (CR):

CR = Luminance with all pixels in white state ÷ Luminance with all pixels in Black state

Note4: Definition of Viewing Angle:

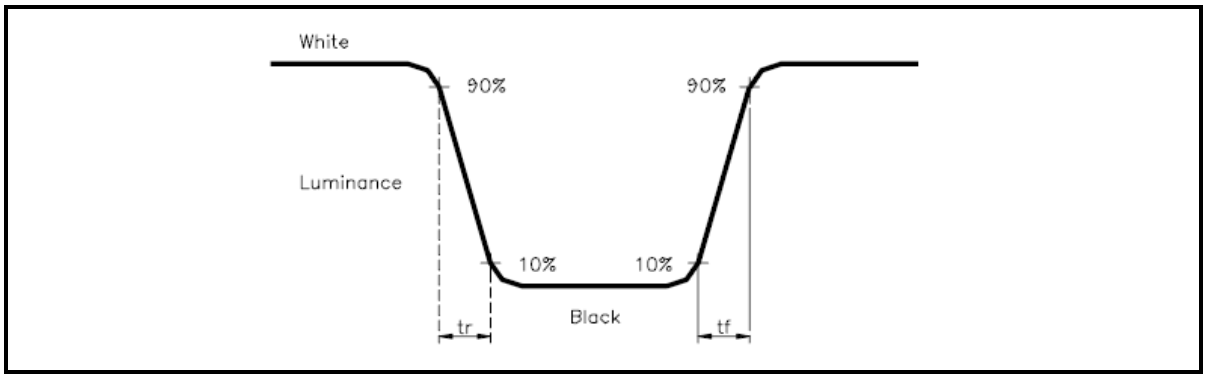


Note 5: Definition of Brightness Uniformity (B-uni):



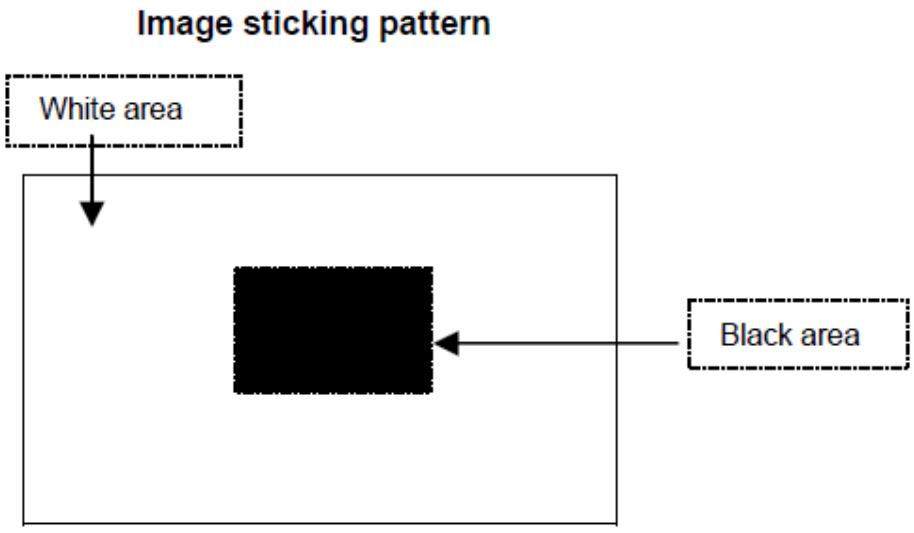
B-uni ＝(Minimum luminance of 9 points÷Maximum luminance of 9points)X100%

Note6: Definition of Response Time:
The Response Time is set initially by defining the “Rising Time (Tr)” and the “Falling Time (Tf)” respectively. Tr and Tf are defined as following figure



Note 7: Definition of Chromaticity:
The color coordinates (Wx,Wy),(Rx,Ry),(Gx,Gy),and (Bx,By) are obtained with all pixels in the viewing field at white, red, green, and blue states, respectively.

Note 8: Definition of Image sticking (tis):
Continuously display the test pattern shown in the figure below for 2 hours. Then display a completely white screen. The previous image shall not persist more than 2 sec at 25 ˚C



10. RELIABILITY

10.1 Test Condition

10.1.1 Temperature and Humidity(Ambient Temperature)

Temperature : 25 ± 5°C

Humidity : 65 ± 5%

10.1.2 Operation

Unless specified otherwise, test will be conducted under function state.

10.1.3 Container

Unless specified otherwise, vibration test will be conducted to the product itself without putting it in a container.

10.1.4 Test Frequency

In case of related to deterioration such as shock test. It will be conducted only once.

10.2 TESTS

No.	ITEM	CONDITION CRITERION
1	High Temperature Storage	60°C, 120 hrs
2	Low Temperature Storage	-20°C, 120 hrs
3	High Temperature Operating	50°C, 120 hrs
4	Low Temperature Operating	-10°C, 120 hrs
5	High Temperature/Humidity Non-Operating	50°C, 90%RH, 120 hrs
6	Temperature Shock Non-Operating	-20°C ←→ 60°C (0.5hr each), 25 cycles
7	Vibration Test Non-Operating	Frequency:0 ~ 55 Hz Amplitude:1.5 mm Sweep Time:11min Test Period:6 Cycles for each Direction of X,Y,Z
8	Electrostatic discharge voltage (human body model)	TA = +25 °C conforming to JESD22-A114 CLASS:2, Maximum:2000V

Note1: The test sample have recovery time for 24 hours at room temperature before the function check. In the standard conditions, there is no any touch panel function NG issue occurred.

10.3 JUDGMENT STANDARD

The judgment of the above test should be made as follow:

Pass: Normal display image with no obvious non-uniformity and no line defect. Partial transformation of the module parts should be ignored.

Fail: No display image, obvious non-uniformity, or line defects.

10.4 INCOMING INSPECTION STANDARDS

<table>
<tr><th>No.</th><th>Parameter</th><th>Criteria</th></tr>
<tr><td rowspan="5">1</td><td rowspan="5">Operating</td><td>Display function: No Display malfunction (Major)</td></tr>
<tr><td>Contrast ratio (Black, White):
Does not meet specified range in the spec. (Major) (Note:3)</td></tr>
<tr><td>Line Defect: No obvious Vertical and Horizontal line defect in bright, dark and colored. (Major) (Note:1)</td></tr>
<tr><td>Point Defect : Active area ≤ 5 dots (Minor) (Note:1)
<table>
<tr><th rowspan="2">Item</th><th>Acceptable number</th><th rowspan="2">Total</th></tr>
<tr><th>Active Area</th></tr>
<tr><td>Bright</td><td>2</td><td rowspan="2">5</td></tr>
<tr><td>Dark</td><td>4</td></tr>
</table></td></tr>
<tr><td>Non-uniformity: Visible through 5%ND filter. (Minor)
Foreign material in Black or White spots shape (W>1/4L)
<table>
<tr><th>Zone / Dimension</th><th>Acceptable number</th><th>Class Of Defects</th><th>AQL Level</th></tr>
<tr><td>D> 0.5</td><td>0</td><td rowspan="3">Minor</td><td rowspan="3">1.5</td></tr>
<tr><td>0.3 < D ≤ 0.5</td><td>5</td></tr>
<tr><td>D ≤ 0.3</td><td>*</td></tr>
</table>
D = (Long + Short) / 2 ＊ : Disregard
Foreign Material in Line or spiral shape (W≤1/4L) (Note: 4)
<table>
<tr><th>L (mm) / Zone W(mm)</th><th>Acceptable number</th><th>Class Of Defects</th><th>AQL Level</th></tr>
<tr><td>L >5</td><td>W>0.1</td><td>0</td><td rowspan="3">Minor</td><td rowspan="3">1.5</td></tr>
<tr><td>0.5 < L ≤ 5</td><td>0.03 < W≤0.1</td><td>5</td></tr>
<tr><td>L ≤0.5</td><td>W≤0.03</td><td>*</td></tr>
</table>
L : Length W : Width ＊ : Disregard</td></tr>
<tr><td rowspan="3">2</td><td rowspan="3">External Inspection (non-operating)</td><td>Dimension: Outline (Major)
Bezel appearance: uneven (Minor)
Scratch on the polarize: (Note:2)
<table>
<tr><th>L (mm) / Zone W(mm)</th><th>Acceptable number</th><th>Class Of Defects</th><th>AQL Level</th></tr>
<tr><td>--</td><td>W>0.1</td><td>0</td><td rowspan="2">Minor</td><td rowspan="2">1.5</td></tr>
<tr><td>L ≤ 3</td><td>W≤0.1</td><td>3</td></tr>
</table>
L : Length W : Width ＊ : Disregard</td></tr>
<tr><td>Dent or bubble on the polarize (Note:2)
<table>
<tr><th>Zone / Dimension</th><th>Acceptable number</th><th>Class Of Defects</th><th>AQL Level</th></tr>
<tr><td>D≤0.3</td><td>*</td><td rowspan="2">Minor</td><td rowspan="2">1.5</td></tr>
<tr><td>D≤0.5</td><td>3</td></tr>
</table>
D = (Long + Short) / 2 ＊ : Disregard</td></tr>
</table>

Class of defects	**Major**	AQL 0.65%	**Definition** It is a defect that is likely to result in failure or to reduce materially the usability of the product for the intended function.
	Minor	AQL 1.5%	It is a defect that will not result in functioning problem with deviation classified.

Note1:

(a)Bright point defect is defined as point defect of R,G,B with area >1/2 pixel respectively

(b)Dark point defect is defined as visible in full white pattern.

(c)Definition of distribution of point defect is as follows:

-minimum separation between dark point defects should be larger than 5mm.

-minimum separation between bright point defects should be larger than 5mm.

(d)Definition of joined bright point defect and joined dark point defect are as follows:

-Two or more joined bright point defects must be nil.

-Three joined dark point defects must be nil.

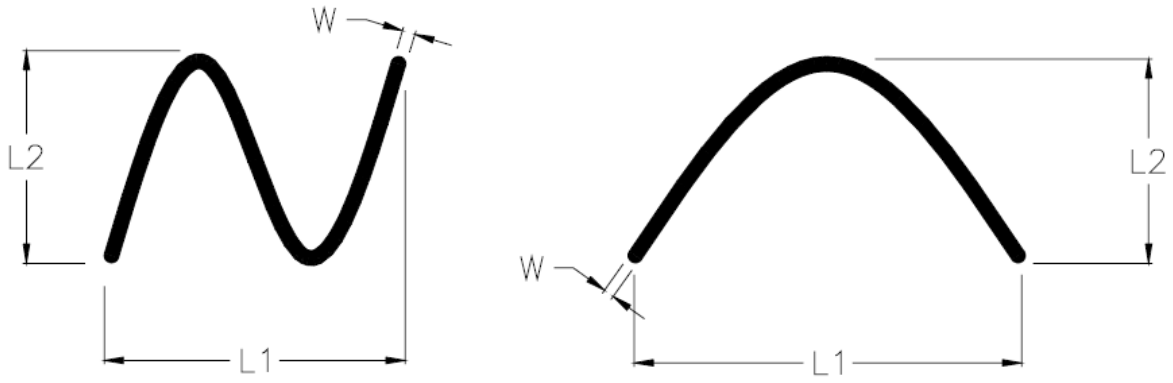
-Coupling of one dark and one bright point in junction is counted as one dark and bright spot with 1 pair maximum.

-Two Joined dark point is counted as two dark points with 2 pair maximum.

Note2: The external inspection should be conducted at the distance 30± 5cm between the eyes of inspector and the panel.

Note3: Luminance measurement for contrast ratio is at the distance 50± 5cm between the detective head and the panel with ambient luminance less than 1 lux. Contrast ratio is obtained at optimum view angle.

Note4: W-Width in mm , L-length of Max.(L1,L2) in mm.



10.5 Sampling Condition

Unless otherwise agree in written, the sampling inspection shall be applied to the incoming inspection of customer.

Lot size: Quantity of shipment lot per model.

Sampling type: normal inspection, single sampling

Sampling table: MIL-STD-105E

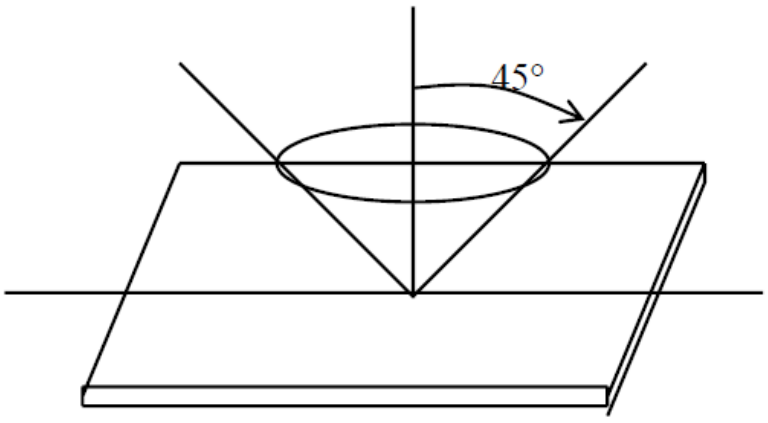
Inspection level: Level II

10.6 Inspection conditions

The LCD shall be inspected under 40W white fluorescent light.

$\theta \leq 45^{\circ}$ inspection under non-operating condition.

$\theta \leq 5^{\circ}$ inspection under operating condition



11. PRECAUTION RELATING PRODUCT HANDLING

11.1 SAFETY

11.1.1 **If the LCD panel breaks , be careful not to get the liquid crystal to touch your skin.**

11.1.2 **If the liquid crystal touches your skin or clothes , please wash it off immediately by using soap and water.**

11.2 HANDLING

11.2.1 **Avoid any strong mechanical shock which can break the glass.**

11.2.2 **Avoid static electricity which can damage the CMOS LSI—When working with the module, be sure to ground your body and any electrical equipment you may be using.**

11.2.3 **Do not remove the panel or frame from the module.**

11.2.4 **The polarizing plate of the display is very fragile. So , please handle it very carefully, Do not touch, push or rub the exposed polarizing with anything harder than an HB pencil lead (glass , tweezers , etc.)**

11.2.5 **Do not wipe the polarizing plate with a dry cloth, as it may easily scratch the surface of plate.**

11.2.6 **Do not touch the display area with bare hands , this will stain the display area.**

11.2.7 **Do not use ketonics solvent & aromatic solvent. Use with a soft cloth soaked with a cleaning naphtha solvent.**

11.2.8 **To control temperature and time of soldering is 280 ± 10°C and 3-5 sec.**

11.2.9 **To avoid liquid (include organic solvent) stained on LCM.**

11.3 STORAGE

11.3.1 **Store the panel or module in a dark place where the temperature is 25°C ± 5°C and the humidity is below 65% RH.**

11.3.2 **Do not place the module near organics solvents or corrosive gases.**

11.3.3 **Do not crush, shake, or jolt the module.**