




TFT Module Specification

MODEL: 13-057VMLB4RG1-N

< ◇ > PRELIMINARY SPECIFICATION

< ◆ > APPROVAL SPECIFICATION

CUSTOMER
APPROVED BY
DATE:

DESIGNED	CHECKED	APPROVED
		

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RECORD OF REVISION

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TABLE OF CONTENTS

No.	Content	Page
	TFT Module Specification	1
	TABLE OF CONTENTS	3
1.	GENERAL DESCRIPTION	4
2.	MECHANICAL SPECIFICATION	5
3.	PIN DESCRIPTION	6
4.	ABSOLUTE MAXIMUM RATINGS	8
5.	BLOCK DIAGRAM	9
6.	RELATIONSHIP BETWEEN DISPLAYED COLOR AND INPUT	10
7.	ELECTRICAL CHARACTERISTICS	12
8.	TOUCH SCREEN PANEL SPECIFICATIONS	18
9.	OPTICAL CHARACTERISTICS	19
10.	RELIABILITY	22
11.	PRECAUTION RELATING PRODUCT HANDLING	27

1. GENERAL DESCRIPTION

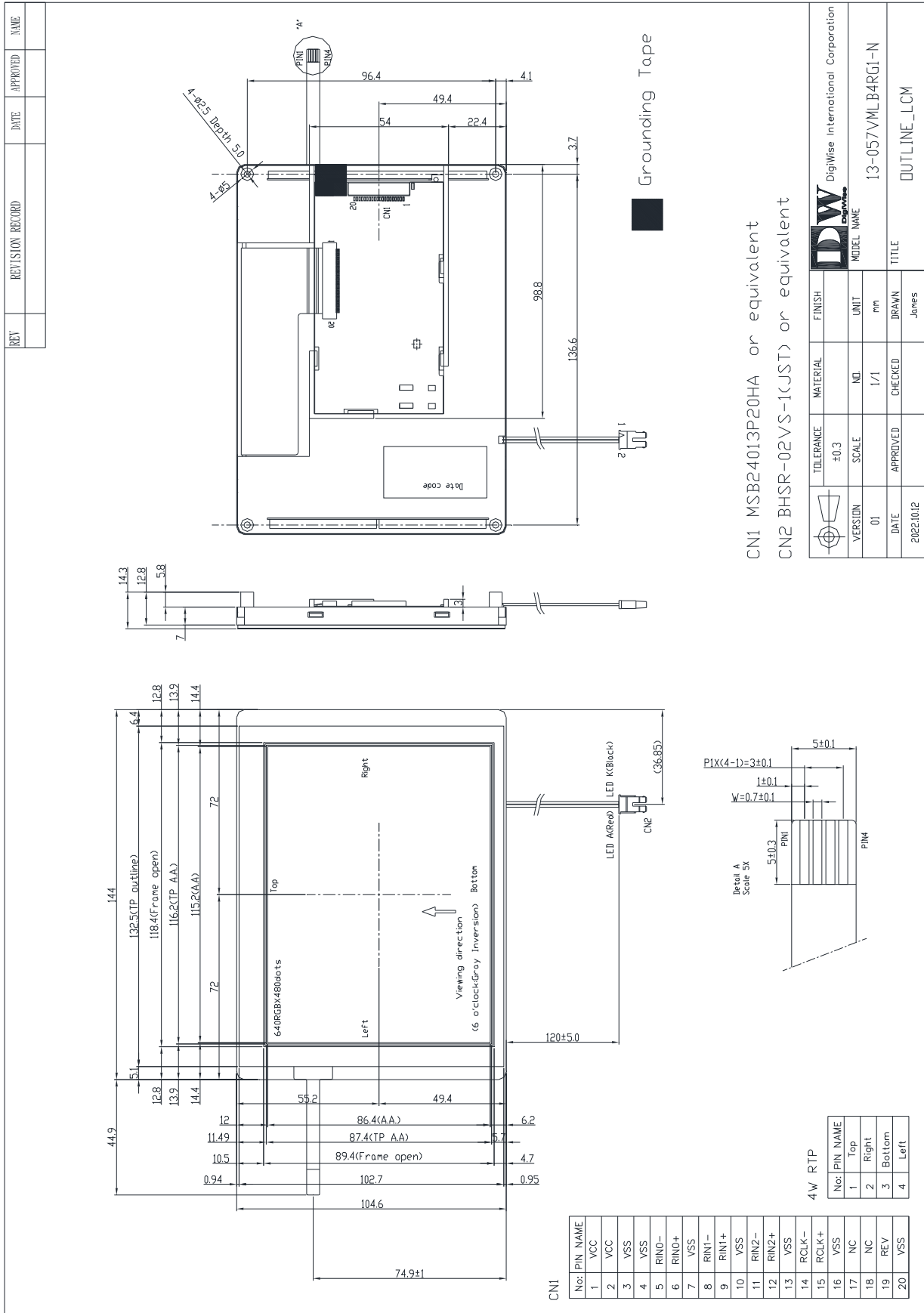
1.1 Description

The specification is model 13-057VMLB4RG1-N 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 backlight system and a Touch panel. This TFT LCD has a 5.7 (4:3) inch diagonally measured active display area with VGA (640 horizontal by 480 vertical pixels) resolution.

1.2 Features:

No.	Item	Specification	Unit
1	Panel Size	5.7"	Inch
2	Number of Pixels	640 (W) x RGB x 480 (H)	Pixels
3	Active Area	115.2 (W) x 86.4 (H)	mm
4	Pixel Pitch	0.1815 (W) x 0.1815 (H)	mm
5	Outline Dimension	144 (W) x 104.6 (H) x 14.3 (T)	mm
6	Number of Colors	262K	- -
7	Display Mode	TN / Normally White / Transmissive	- -
8	View Direction	6 o'clock (Gray Inversion)	
9	Display Format	RGB vertical stripe	- -
10	Surface Treatment	Anti-Glare	- -
11	Contrast Ratio	500 (Typ.)	- -
12	Luminance (cd/m ²)	1000 (Typ.)	cd/m ²
13	Interface	LVDS 6 bit Interface	- -
14	Backlight	White LED	- -
15	Operation Temperature	-20 ~ 70	°C
16	Storage Temperature	-30 ~ 80	°C
17	Weight	(195)	g
18	Burn in condition	0 defect, 2hrs 50°C	

2. MECHANICAL SPECIFICATION



3. PIN DESCRIPTION

3.1 TFT LCD Module

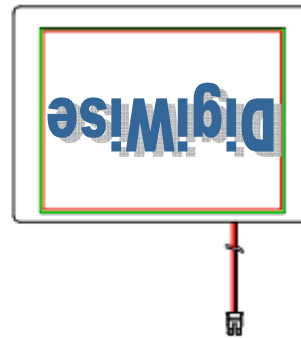
Pin No.	Symbol	I/O	Function	Note
1	VCC	P	Power Supply +3.3V	
2	VCC	P	Power Supply +3.3V	
3	GND	P	Ground	
4	GND	P	Ground	
5	RXIN0-	I	Negative LVDS differential data input	
6	RXIN0+	I	Positive LVDS differential data input	
7	GND	P	Ground	
8	RXIN1-	I	Negative LVDS differential data input	
9	RXIN1+	I	Positive LVDS differential data input	
10	GND	P	Ground	
11	RXIN2-	I	Negative LVDS differential data input	
12	RXIN2+	I	Positive LVDS differential data input	
13	GND	P	Ground	
14	CLK-	I	Negative LVDS differential clock input	
15	CLK+	I	Positive LVDS differential clock input	
16	GND	P	Ground	
17	NC	-	NO Connect	
18	NC	-	NO Connect	Note1
19	REV	I	Select horizontal and vertical scanning direction	Note2
20	GND	P	Ground	

Note:

1. NC Pin must be floating
- 2.



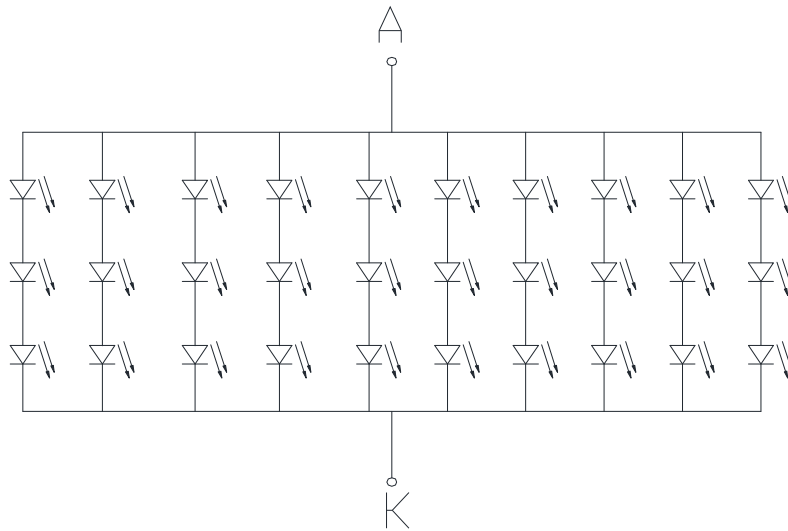
REV =L



REV =H

3.2 Backlight Unit

Pin No.	Symbol	Function	Remark
1	LEDA	Power Supply for LED backlight	RED
2	LEDK	GND for LED backlight	BLACK



4. ABSOLUTE MAXIMUM RATINGS

4.1 Electrical Absolute Rating

4.1.1 TFT LCD Module

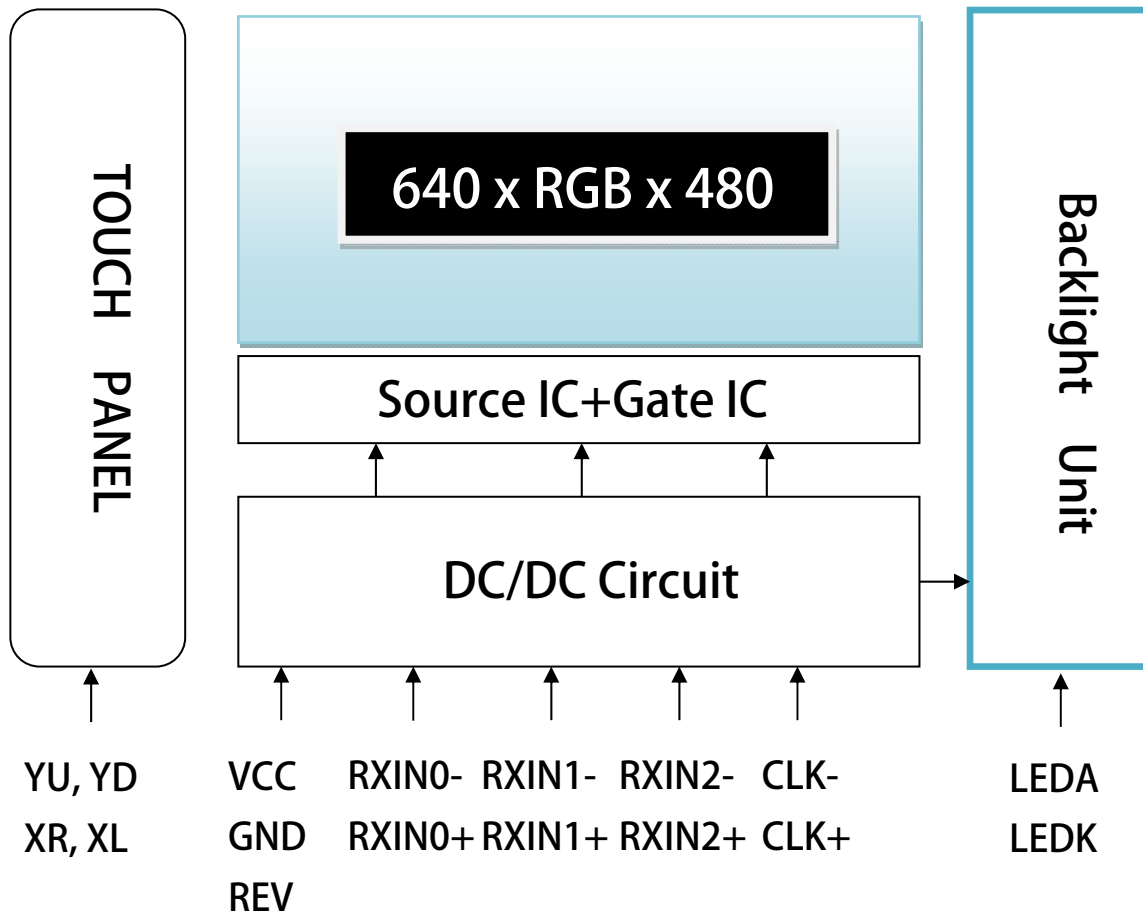
Item	Symbol	Values		Unit	Note
		Min	Max.		
Power supply voltage	VCC	-0.3	5.0	V	

4.1.2 Environment Absolute Rating

Item	Symbol	Values			Unit	Note
		Min	Typ	Max.		
Operating Temperature	Topa	-20		70	°C	Ambient temperature
Storage Temperature	Tstg	-30		80	°C	

5. BLOCK DIAGRAM

5.1 TFT LCD Module



6. Relationship Between Displayed Color and Input

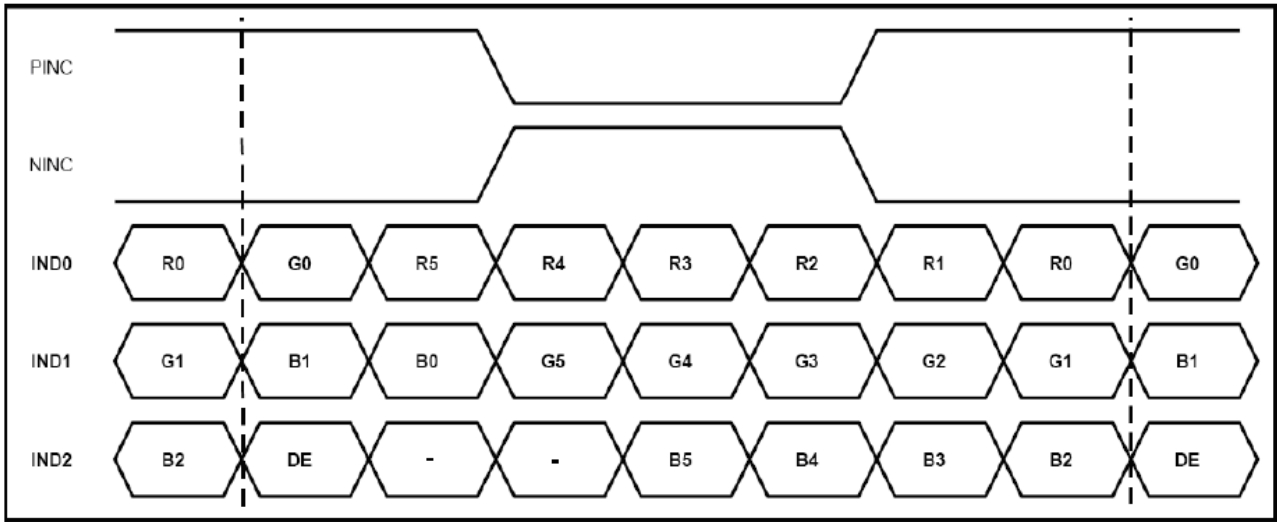
6.1 6 bit

	Color & Gray Scale	Data Signal																	
		R5	R4	R3	R2	R1	R0	G5	G4	G3	G2	G1	G0	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
	Red	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
	Green	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0
	Blue	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1
	Cyan	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1
	Magenta	1	1	1	1	1	1	0	0	0	0	0	0	1	1	1	1	1	1
	Yellow	1	1	1	1	1	1	1	1	1	1	1	1	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
Red	Black	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	1	0	0	0	0	0	0	0	0	0	0	0	0
	Red(2)	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
	Red(31)	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
	Red(62)	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	Red(63)	1	1	1	1	1	1	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
	Green(1)	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
	Green(2)	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
	Green(31)	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
	Green(62)	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0
	Green(63)	0	0	0	0	0	0	1	1	1	1	1	1	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
	Blue(1)	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	1	0
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
	Blue(31)	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
	Blue(62)	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0
	Blue(63)	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1

0 : Low level voltage, 1 :High level voltage

Each basic color can be displayed in 64 gray scales from 6 bit data signals. With the combination of total 18 bit data signals, the 262K-color display can be achieved on the screen.

6.2 Data Mapping



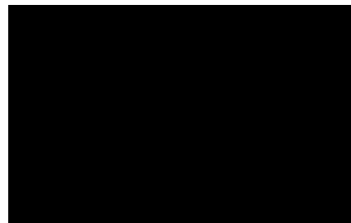
6bit LVDS input

7. ELECTRICAL CHARACTERISTICS

7.1 TFT LCD Module

Item	Symbol	Min.	Typ.	Max.	Unit	Remark
Power supply	VCC	3.0	3.3	3.6	V	
Input Voltage for logic	Differential Input High Threshold			+100	mV	
	Differential Input Low Threshold	VTL	-100		mV	
Power Supply current	ICC	-	150	200	mA	Note 1

Note 1: frame =60Hz, Ta=25°C, Display pattern: Black pattern



7.2 Backlight Unit

Item	Symbol	Value			Unit	Condition
		Min.	Typ.	Max.		
LED Voltage	VL	(8.6)	(9.3)	(10.5)	V	
LED Current	IF	-	200	-	mA	3S10P
Power Consumption	PBL	-	1.86	-	W	
LED Life Time (25°C)	-	(50000)	-	-	hr	(1)

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

7.3 INTERFACE SPECIFICATIONS

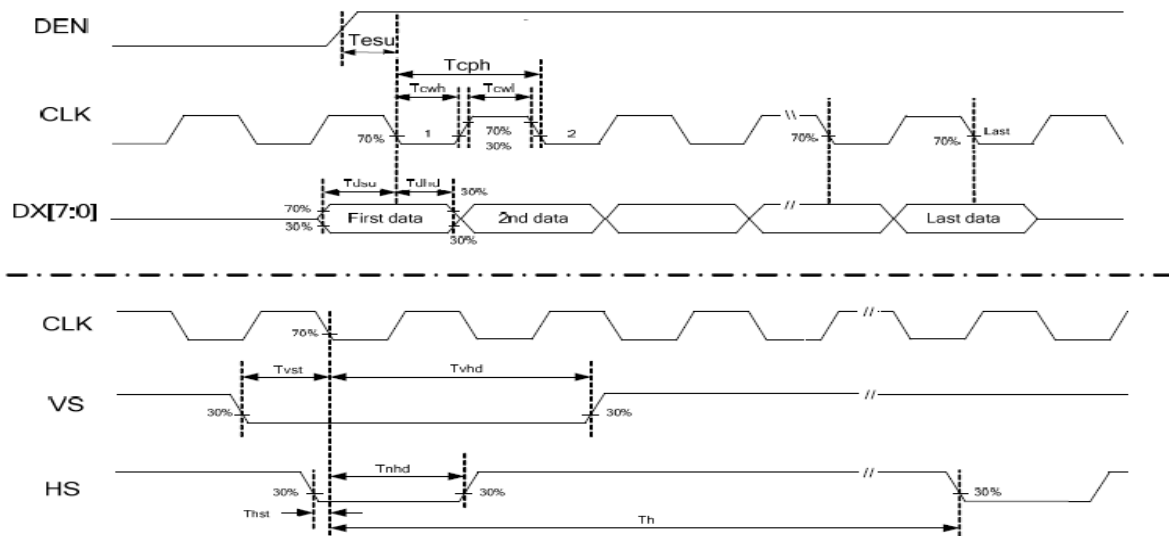
7.3.1 AC Timing characteristics

Parameter	Symbol	Min.	Typ.	Max.	Unit.	Note
CLK frequency	FCPH	22.66	25.175	27.69	MHZ	
CLK period	TCPH	36.11	39.7	44.13	ns	
CLK pulse duty	TCWH	40	50	60	%	
HS period	TH	750	800	850	TCPH	
HS pulse width	TWH	5	30	--	TCPH	
HS-first horizontal data time	THS	112	144	175	TCPH	
Display period	THA	--	640	--	TCPH	
HS setup time	THST	10	--	--	ns	
HS hold time	THHD	10	--	--	ns	
VS pulse width	TWV	1	3	5	TH	
First line data input time	TSTV	--	35	--	TH	
VS period	TV	515	525	535	TH	
VS setup time	TVST	10	--	--	ns	
VS hold time	TVHD	10	--	--	ns	

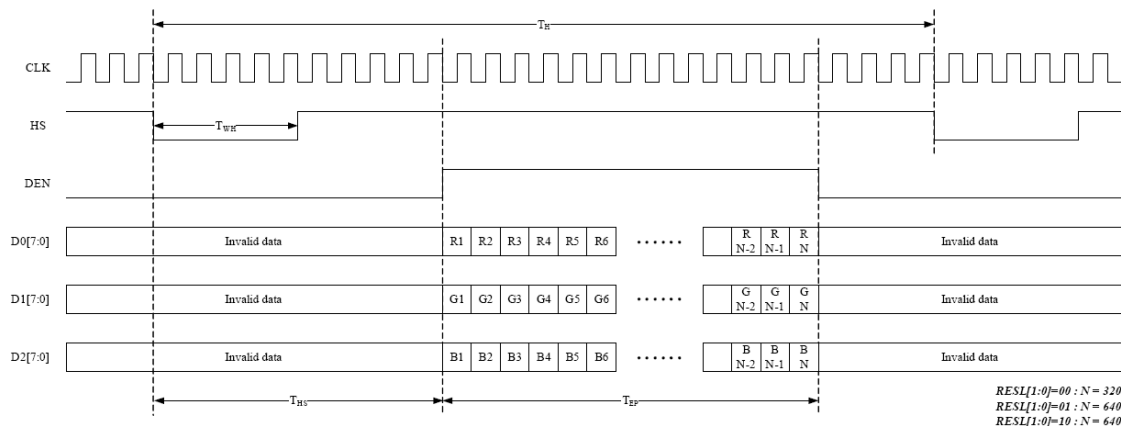
Note : When SYNC mode is used, 1st data start from 144th CLK after HS falling (when STHD[5:0]=00000)

Parameter	Symbol	Min.	Typ.	Max.	Unit.	Note
DEN Period	TDEN	--	800	--	TCPH	
DEN pulse width	TEP	--	640	--	TCPH	
DEN frame active time	TDEA	--	480	--	TDEN	
DEN frame blanking time	TDEB	--	45	--	TDEN	
DEN setup time	TESU	10	--	--	ns	

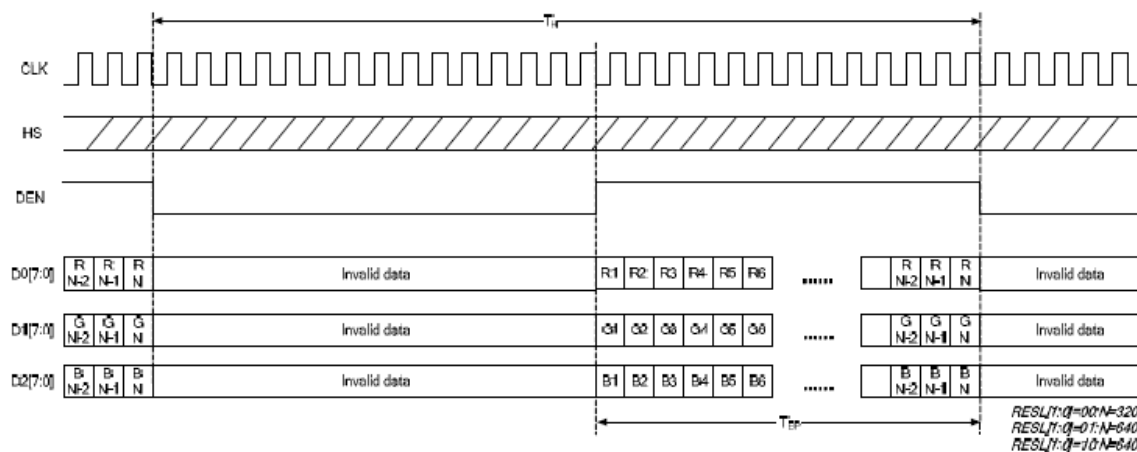
7.3.2 Clock and Data input waveforms



7.3.3 Parallel RGB SYNC Mode Horizontal Data Format



7.3.4 Parallel RGB DEN Mode Horizontal Data Format

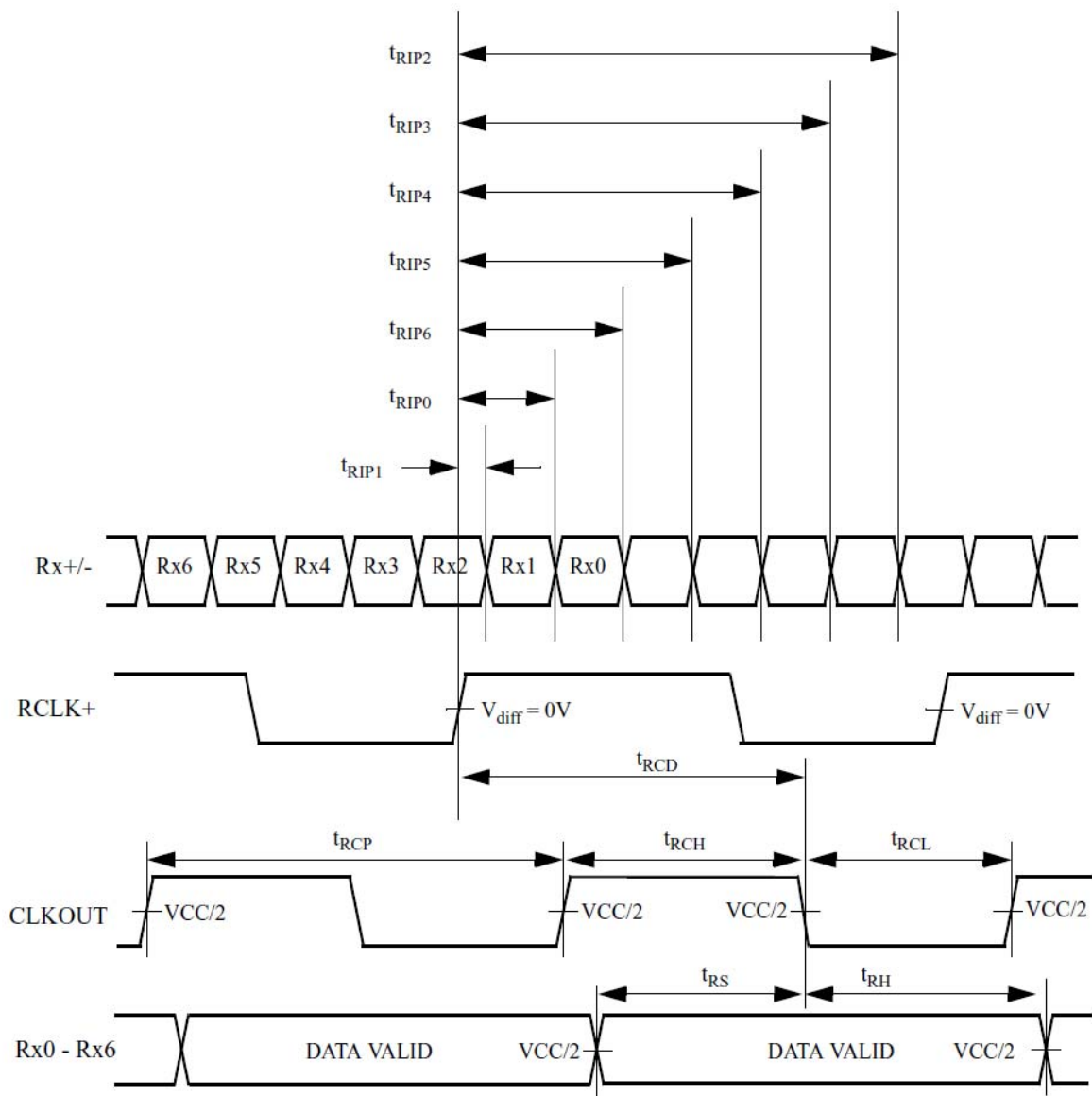
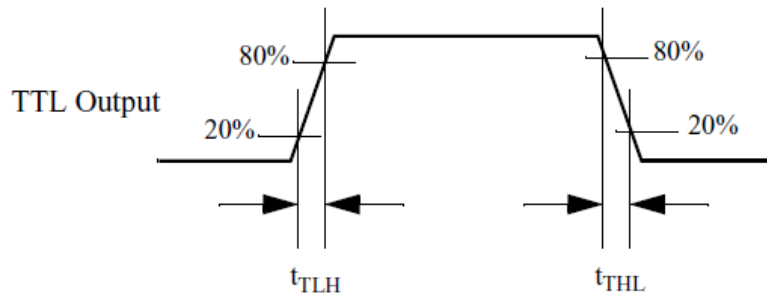


7.4 LVDS Switching Characteristics

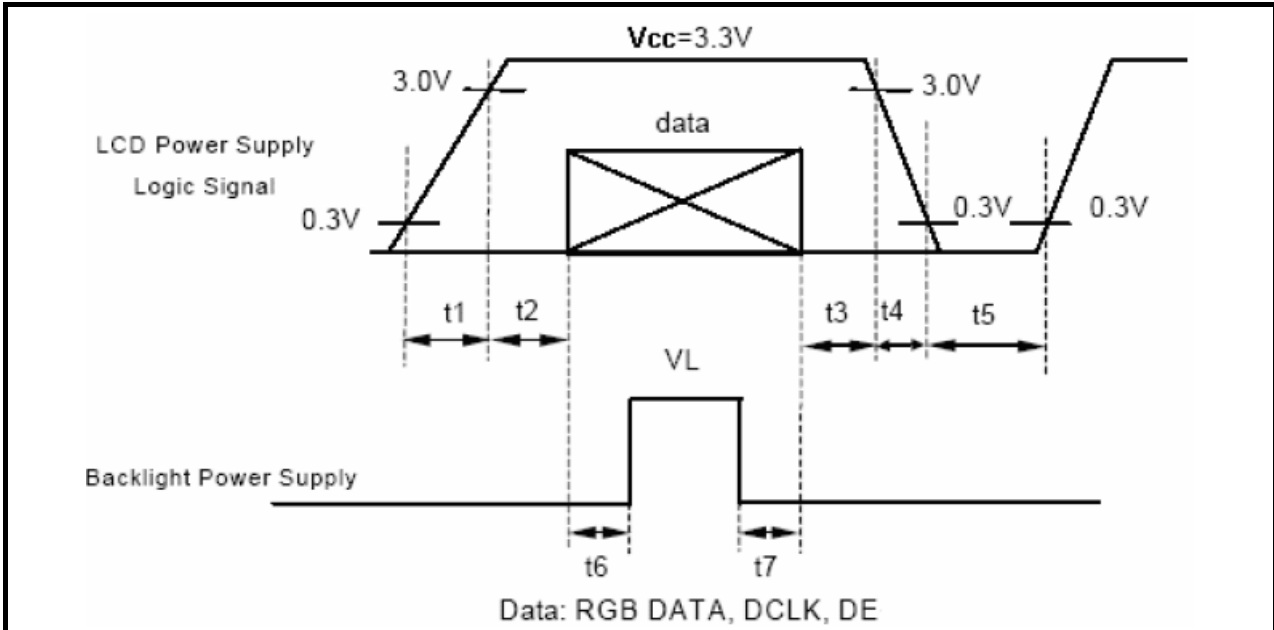
7.4.1 LVDS Timing Condition

Symbol	Parameter		Min.	Typ.	Max.	Unit	Note
tRCP	CLK OUT Period	VCC = 3.0 - 3.6V	11.76	T	50.0	ns	
		VCC = 2.5 - 3.6V	14.28	T	50.0	ns	
tRCH	CLK OUT High Time		-	4T/7	-	ns	
tRCL	CLK OUT Low Time		-	3T/7	-	ns	
tRCD	RCLK +/- to CLK OUT Delay		-	5T/7	-	ns	
tRS	TTL Data Setup to CLK OUT		0.35T-0.3	-	-	ns	
tRH	TTL Data Hold from CKL OUT		0.45T-1.6	-	-	ns	
tTLH	TTL Low to High Transition Time		-	2.0	3.0	ns	
tTHL	TTL High to Low Transition Time		-	1.8	3.0	ns	
tRIP1	Input Data Position0 (T = 11.76ns)		-0.4	0.0	0.4	ns	
tRIP0	Input Data Position1 (T = 11.76ns)		T/7-0.4	T/7	T/7+0.4	ns	
tRIP6	Input Data Position2 (T = 11.76ns)		2T/7-0.4	2T/7	2T/7+0.4	ns	
tRIP5	Input Data Position3 (T = 11.76ns)		3T/7-0.4	3T/7	3T/7+0.4	ns	
tRIP4	Input Data Position4 (T = 11.76ns)		4T/7-0.4	4T/7	4T/7+0.4	ns	
tRIP3	Input Data Position5 (T = 11.76ns)		5T/7-0.4	5T/7	5T/7+0.4	ns	
tRIP2	Input Data Position6 (T = 11.76ns)		6T/7-0.4	6T/7	6T/7+0.4	ns	
tRPLL	Phase Lock Loop Set				10.0	ms	

7.4.2 LVDS AC Timing



7.5 Power On / Off Sequence



$t_1 \leq 10\text{ms} : 1 \text{ sec} \leq t_5$
 $50\text{ms} \leq t_2 : 200\text{ms} \leq t_6$
 $0 < t_3 \leq 50\text{ms} : 200\text{ms} \leq t_7$
 $0 < t_4 \leq 10\text{ms}$

8. TOUCH SCREEN PANEL SPECIFICATIONS

8.1 Main Feature

Item	Min.	Typ.	Max.	Unit	Note
Linearity	-1.5	-	1.5	%	Initial data
	-2.0	-	+2.0	%	After environmental & life test
Terminal resistance	200	-	900	Ω	XR~XL
	200	-	900	Ω	YU~YD
Insulation resistance	20	-	-	M Ω	DC 25V
Voltage	-	5	-	V	DC
Response time	-	-	10	ms	
Haze	-	8	-	%	ASTM D 1003
Minimum Input force	60	-	100	gf	Test Area is 3mm inside of active area, but not on Dot-Spacer.
Notes life	100000			words	
Input life	1000000			times	

8.2 Pin Assignments and Definitions

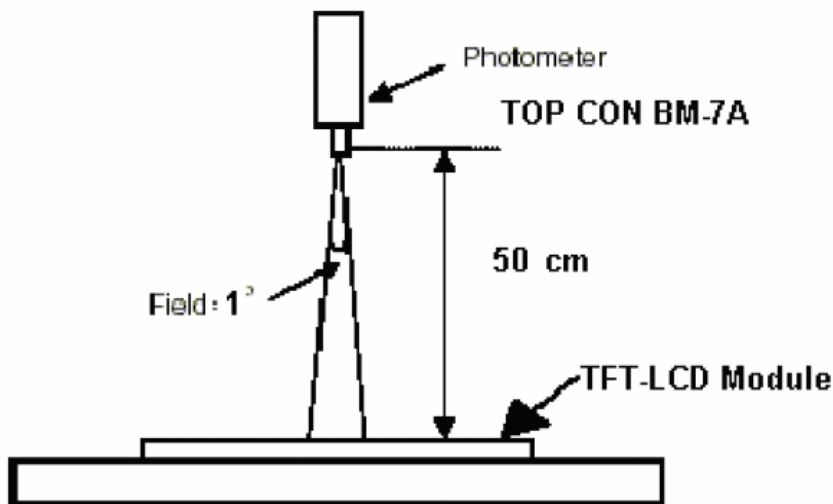
Item	Name	I/O	Unit
1	YU	O	Touch Panel Up
2	XR	O	Touch Panel Right
3	YD	O	Touch Panel Down
4	XL	O	Touch Panel Left

9. OPTICAL CHARACTERISTICS

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
Brightness	--	Note1, Note 3, ($\theta = 0^\circ$; Normal Viewing Angle)	850	1000	1150	cd/m ²
Uniformity	B-uni		70	75	-	%
Contrast Ratio	CR		400	500	--	--
Response Time	Tr		--	15	20	ms
	Tf	--	25	35	ms	
Color Chromaticity	White	Wx	0.280	0.310	0.340	--
		Wy	0.320	0.350	0.380	--
View angle	Horizontal	$\theta x+$	55	65	--	
		$\theta x-$	55	65	--	
	Vertical	$\theta Y+$	40	50	--	
		$\theta Y-$	55	65	--	

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 $25^\circ\text{C} \pm 2^\circ\text{C}$. The measurement method is shown in Note1.

Note 1: The method of optical measurement:

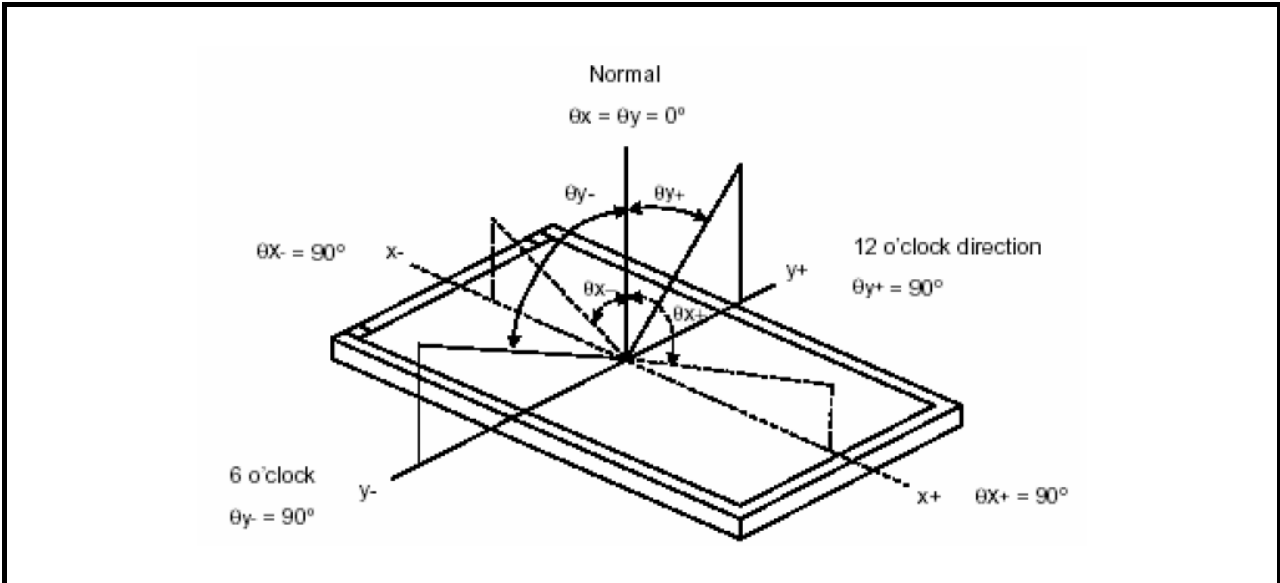


Note 2: Measured at the center area of the panel and at the viewing angle of the $\theta x = \theta y = 0^\circ$

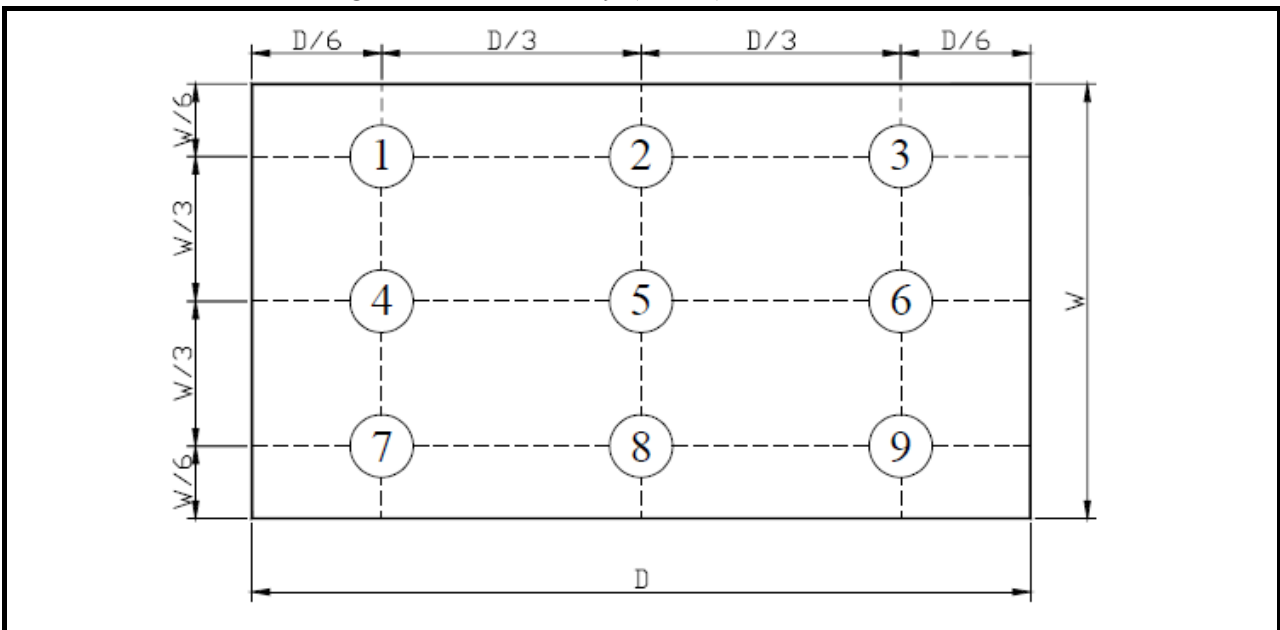
Note 3: Definition of Contrast Ratio (CR):

CR = Luminance with all pixels in white state \div Luminance with all pixels in Black state

Note 4: Definition of Viewing Angle:



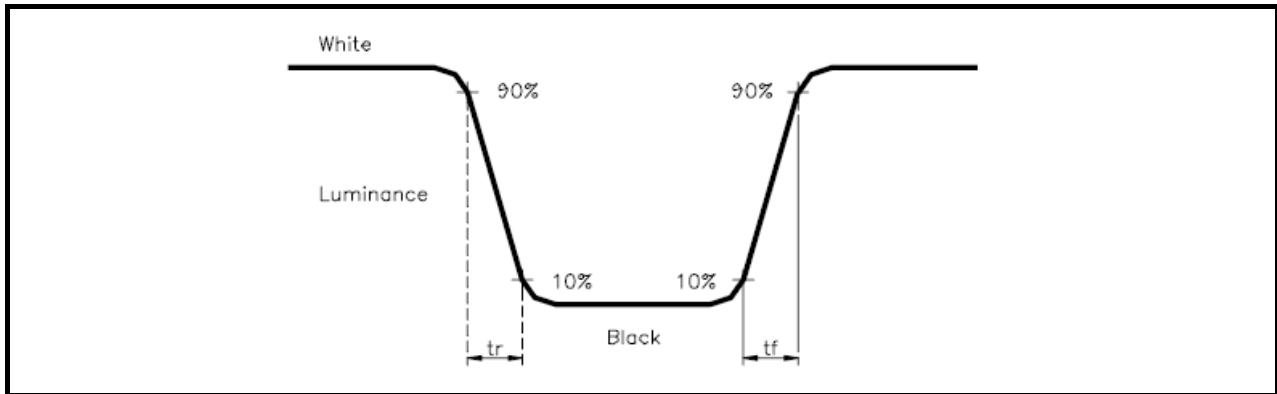
Note 5: Definition of Brightness Uniformity (B-uni):



$$B\text{-uni} = (\text{Minimum luminance of 9 points} \div \text{Maximum luminance of 9 points}) \times 100\%$$

Note 6: Definition of Response Time:

The Response Time is set initially by defining the “Rising Time (T_r)” and the “Falling Time (T_f)” respectively. T_r and T_f are defined as following figure



Note 7: Definition of Chromaticity:

The color coordinates (W_x, W_y), (R_x, R_y), (G_x, G_y), and (B_x, B_y) are obtained with all pixels in the viewing field at white, red, green, and blue states, respectively.

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	80°C, 120 hrs
2	Low Temperature Storage	-30°C, 120 hrs
3	High Temperature Operating	70°C, 120 hrs
4	Low Temperature Operating	-20°C, 120 hrs
5	High Temperature/Humidity Non-Operating	60°C, 90%RH, 120 hrs
6	Temperature Shock Non-Operating	-30°C ←→ 80°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	Electro-static Discharge Non-Operating	150pF,330Ω Air:± 12KV;Contact: ±6KV 10 times/point;4 points/panel face

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

No.	Parameter	Criteria																			
1	Operating	Display function: No Display malfunction (Major)																			
		Contrast ratio (Black, White): Does not meet specified range in the spec. (Major) (Note:3)																			
		Line Defect: No obvious Vertical and Horizontal line defect in bright, dark and colored. (Major) (Note:1)																			
		Dot Defect : Active area ≤ 0 dots (Minor) (Note:1)																			
		<table border="1"> <thead> <tr> <th rowspan="2">Item</th> <th>Acceptable number</th> <th rowspan="2">Total</th> </tr> <tr> <th>Active Area</th> </tr> </thead> <tbody> <tr> <td>Bright</td> <td>0</td> <td rowspan="2">0</td> </tr> <tr> <td>Dark</td> <td>0</td> </tr> </tbody> </table>	Item	Acceptable number	Total	Active Area	Bright	0	0	Dark	0										
Item	Acceptable number	Total																			
	Active Area																				
Bright	0	0																			
Dark	0																				
2	External Inspection (non-operating)	Non-uniformity: Visible through 5%ND filter. (Minor)																			
		Foreign material in Black or White spots shape ($W > 1/4L$)																			
		<table border="1"> <thead> <tr> <th>Zone</th> <th>Acceptable number</th> <th>Class Of Defects</th> <th>AQL Level</th> </tr> </thead> <tbody> <tr> <td>Dimension</td> <td></td> <td></td> <td></td> </tr> <tr> <td>$D > 0.5$</td> <td>0</td> <td rowspan="3">Minor</td> <td rowspan="3">1.5</td> </tr> <tr> <td>$0.3 < D \leq 0.5$</td> <td>0</td> </tr> <tr> <td>$D \leq 0.3$</td> <td>*</td> </tr> </tbody> </table> <p>D = (Long + Short) / 2 * : Disregard</p>	Zone	Acceptable number	Class Of Defects	AQL Level	Dimension				$D > 0.5$	0	Minor	1.5	$0.3 < D \leq 0.5$	0	$D \leq 0.3$	*			
		Zone	Acceptable number	Class Of Defects	AQL Level																
		Dimension																			
$D > 0.5$	0	Minor	1.5																		
$0.3 < D \leq 0.5$	0																				
$D \leq 0.3$	*																				
Foreign Material in Line or spiral shape ($W \leq 1/4L$) (Note: 4)																					
<table border="1"> <thead> <tr> <th>L (mm)</th> <th>Zone</th> <th>Acceptable number</th> <th>Class Of Defects</th> <th>AQL Level</th> </tr> </thead> <tbody> <tr> <td></td> <td>W(mm)</td> <td></td> <td></td> <td></td> </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>$0.5 < L \leq 5$</td> <td>$0.03 < W \leq 0.1$</td> <td>0</td> </tr> <tr> <td>$L \leq 0.5$</td> <td>$W \leq 0.03$</td> <td>*</td> </tr> </tbody> </table> <p>L : Length W : Width * : Disregard</p>	L (mm)	Zone	Acceptable number	Class Of Defects	AQL Level		W(mm)				$L > 5$	$W > 0.1$	0	Minor	1.5	$0.5 < L \leq 5$	$0.03 < W \leq 0.1$	0	$L \leq 0.5$	$W \leq 0.03$	*
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2	External Inspection (non-operating)	Dimension: Outline (Major)																			
		Bezel appearance: uneven (Minor)																			
		Scratch on the polarize: (Note:2)																			
		<table border="1"> <thead> <tr> <th>L (mm)</th> <th>Zone</th> <th>Acceptable number</th> <th>Class Of Defects</th> <th>AQL Level</th> </tr> </thead> <tbody> <tr> <td></td> <td>W(mm)</td> <td></td> <td></td> <td></td> </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>$L \leq 3$</td> <td>$W \leq 0.1$</td> <td>3</td> </tr> </tbody> </table> <p>L : Length W : Width * : Disregard</p>	L (mm)	Zone	Acceptable number	Class Of Defects	AQL Level		W(mm)				--	$W > 0.1$	0	Minor	1.5	$L \leq 3$	$W \leq 0.1$	3	
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Class of defects			Definition
	Major	AQL 0.65%	
Minor	AQL 1.5%		It is a defect that will not result in functioning problem with deviation classified.

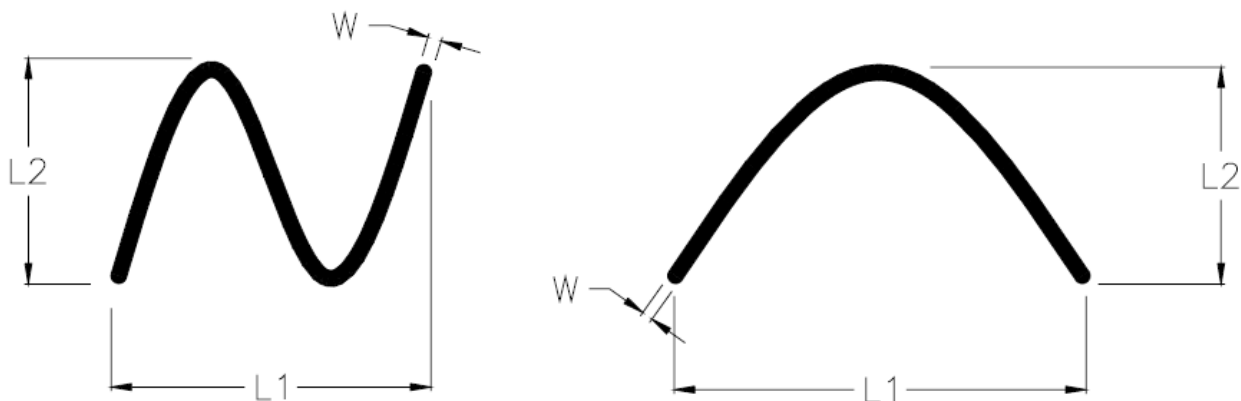
Note1:

- (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 ± 5 cm between the eyes of inspector and the panel.

Note3: Luminance measurement for contrast ratio is at the distance 50 ± 5 cm 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

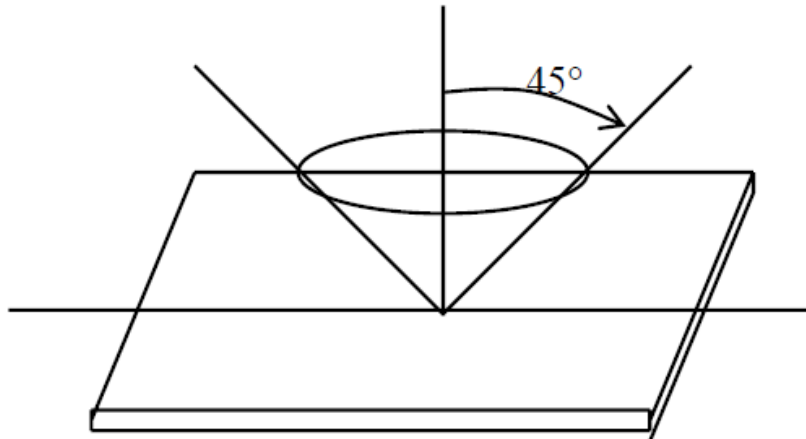
Inspection level: Level II

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 $280 \pm 10^{\circ}\text{C}$ 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 $25^{\circ}\text{C} \pm 5^{\circ}\text{C}$ 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.