US Micro Products
ENGINEERED DISPLAY SOLUTIONS

TFT SPECIFICATION

Part Number	USMP-T104-102076NDU-A0
Size	10.4"
Resolution	1024 x 768
Brightness	1200 cd/m²
Contrast	800:1
Viewing Angle	75/75/60/70
Operating Temp.	-20 ~ 70°C

FOR ADDITIONAL INFORMATION
PLEASE CONTACT:
engineering@usmicroproducts.com

Issue Date	Approved by (customer use)	Checked by	Prepared by

(800) 741-7755
www.usmicroproducts.com

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2. RECORD OF REVISION

ATE	SHEET No.	SUMMARY

3. GENERAL DATA

3.1 DISPLAY FEATURES

This module is a 10.4” XGA format amorphous silicon TFT. The pixel format is vertical stripe and sub pixels are arranged as R(red), G(green), B(blue) sequentially. This display is RoHS compliant, and COG (chip on glass) technology and LED backlight are applied on this display.

Part Name	USMP-T104-102076NDU-A0
Module Dimensions	235.0(W) mm x 180.2(H) mm x 9.5(D) mm
LCD Active Area	211.2(W) mm x 158.4(H) mm
Pixel Pitch	0.20625(W) mm x 0.20625(H) mm
Resolution	1024 x 3(RGB)(W) x 768(H) Dots
Color Pixel Arrangement	R, G, B Vertical Stripe
LCD Type	Transmissive Color TFT; Normally White
Display Type	Active Matrix
Number of Colors	262K (6-bit) / 16.7M (8-bit RGB)
Backlight	Light Emitting Diode (LED)
Weight	370g
Interface	LVDS; 20 pins
Power Supply Voltage	3.3V for LCD; 30V for Backlight
Power Consumption	0.594W for LCD; 6W for Backlight
Viewing Direction	12 O’clock (without image inversion and least brightness change) 6 O’clock (contrast peak located at)

4. ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Min.	Max.	Unit	Remarks
Supply Voltage	V_{DD}	-0.3	3.96	V	-
Input Voltage of Logic	V_I	-0.3	V_{DD}+0.3	V	Note 1
Operating Temperature	T_{op}	-20	70	°C	Note 2
Storage Temperature	T_{st}	-30	80	°C	Note 2
LED Forward Current	I_F	-	150	mA	-

Note 1: The rating is defined for the signal voltages of the interface such as CLK and pixel data pairs.

Note 2: The maximum rating is defined as above based on the chamber temperature, which might be different from ambient temperature after assembling the panel into the application. Moreover, some temperature-related phenomenon as below needed to be noticed:

- Background color, contrast and response time would be different in temperatures other than 25°C.
- Operating under high temperature will shorten LED lifetime.

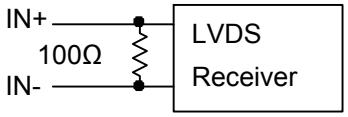
5. ELECTRICAL CHARACTERISTICS

5.1 LCD CHARACTERISTICS

$T_a = 25\ ^{\circ}C,\ \text{Vss} = 0\text{V}$

Item	Symbol	Condition	Min.	Typ.	Max.	Unit	Remarks
Power Supply Voltage	V_{DD}	-	3.0	3.3	3.6	V	-
Differential Input Voltage for LVDS Receiver Threshold	V_I	"H" level	-	-	+100	mV	Note 1
		"L" level	-100	-	-		
Power Supply Current	I_{DD}	V_{DD}-V_{SS} =3.3V	-	180	250	mA	Note 2
Frame Frequency	f_{Frame}	-	-	60	66	Hz	Note 3
CLK Frequency	f_{CLK}	-	-	65	71.5	MHz	

Note 1: VCM 1.2V is common mode voltage of LVDS transmitter and receiver. The input terminal of LVDS receiver is terminated with 100Ω.



Note 2: An all black check pattern is used when measuring I_{DD}. f_{Frame} is set to 60Hz. Moreover, 1.0A fuse is applied in the module for I_{DD}. For display activation and protection purpose, power supply is recommended larger than 2.5A to start the display and break fuse once any short circuit occurred.

Note 3: Please refer to Page 9-6/10 typ. value for the horizontal and vertical timing.

5.2 BACKLIGHT CHARACTERISTICS

$T_a = 25\ ^\circ C$

Item	Symbol	Condition	Min.	Typ.	Max.	Unit	Remarks
LED Input Voltage	V_{LED}	I_{LED}=50mA	-	30	34	V	Note 1
LED Forward Current (per serial)	I_{LED}	-	-	50	55	mA	
LED Lifetime	-	I_{LED}=50mA	-	70K	-	hrs	Note 2

Note 1: Fig. 5.1 shows the LED backlight circuit.

Note 2: The estimated lifetime is specified as the time to reduce 50% brightness by applying 50 mA at 25°C.

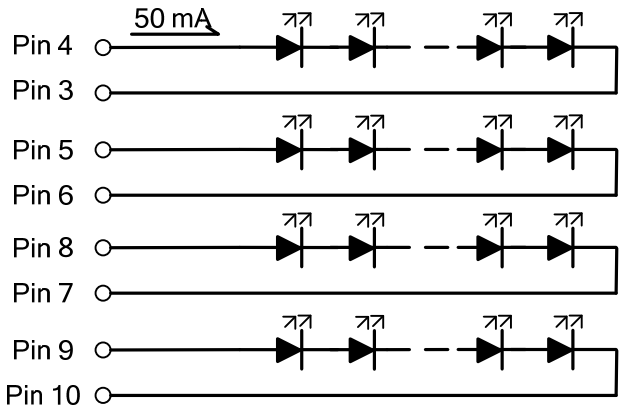


Fig 5.1

6. OPTICAL CHARACTERISTICS

The optical characteristics are measured based on the conditions as below:

- Supplying the signals and voltages defined in the section of electrical characteristics.
- The backlight unit needs to be turned on for 30 minutes.
- The ambient temperature is 25°C.
- In the dark room less than 100 lx, the equipment has been set for the measurements as shown in Fig 6.1.

$T_a = 25\ ^\circ C$, $f_{Frame} = 60$ Hz, $V_{DD} = 3.3V$

Item		Symbol	Condition	Min.	Typ.	Max.	Unit	Remarks
Brightness of White		-	$\phi = 0^\circ, \theta = 0^\circ$, I_{LED}= 50 mA	960	1200	-	cd/m^2	Note 1
Brightness Uniformity		-		70	-	-	%	Note 2
Contrast Ratio		CR		-	800	-	-	Note 3
Response Time		Tr + Tf	$\phi = 0^\circ, \theta = 0^\circ$	-	16	-	ms	Note 4
NTSC Ratio		-	$\phi = 0^\circ, \theta = 0^\circ$	-	50	-	%	-
Viewing Angle		θ x	$\phi = 0^\circ$, CR ≥ 10	-	75	-	Degree	Note 5
		θ x′	$\phi = 180^\circ$, CR ≥ 10	-	75	-		
		θ y	$\phi = 90^\circ$, CR ≥ 10	-	60	-		
		θ y′	$\phi = 270^\circ$, CR ≥ 10	-	70	-		
Color Chromaticity	Red	X	$\phi = 0^\circ, \theta = 0^\circ$	0.59	0.62	0.67	-	Note 6
		Y		0.29	0.34	0.39		
	Green	X		0.29	0.32	0.37		
		Y		0.53	0.58	0.63		
	Blue	X		0.10	0.15	0.20		
		Y		0.07	0.12	0.17		
	White	X		0.26	0.31	0.36		
		Y		0.29	0.34	0.39		

Note 1: The brightness is measured from the center point of the panel, P5 in Fig. 6.2, for the typical value.

Note 2: The brightness uniformity is calculated by the equation as below:

$$\text{Brightness uniformity} = \frac{\text{Min. Brightness}}{\text{Max. Brightness}} \text{ X100\%}$$

which is based on the brightness values of the 9 points in active area measured by BM-5 as shown in Fig. 6.2.

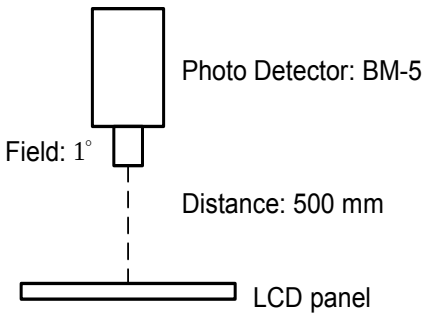


Fig 6.1

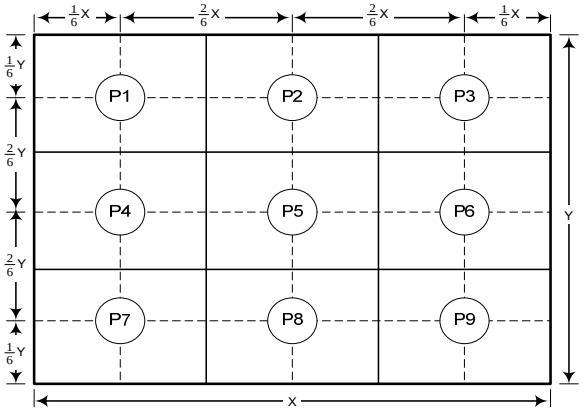


Fig 6.2

Note 3: The Contrast ratio is measured from the center point of the panel, P5, and defined as the following equation:

$$CR = \frac{\text{Brightness of White}}{\text{Brightness of Black}}$$

Note 4: The definition of response time is shown in Fig. 6.3. The rising time is the period from 90% brightness to 10% brightness when the data is from white to black. Oppositely, Falling time is the period from 10% brightness rising to 90% brightness.

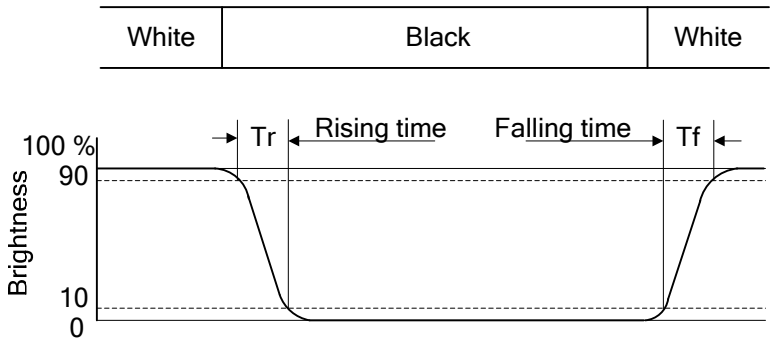


Fig 6.3

Note 5: The definition of viewing angle is shown in Fig. 6.4. Angle ϕ is used to represent viewing directions, for instance, $\phi = 270^\circ$ means 6 o'clock, and $\phi = 0^\circ$ means 3 o'clock. Moreover, angle θ is used to represent viewing angles from axis Z toward plane XY.

The viewing direction of this display is 12 o'clock, which means that a photograph with gray scale would not be reversed in color and the brightness change would be less from this direction. However, the best contrast peak would be located at 6 o'clock.

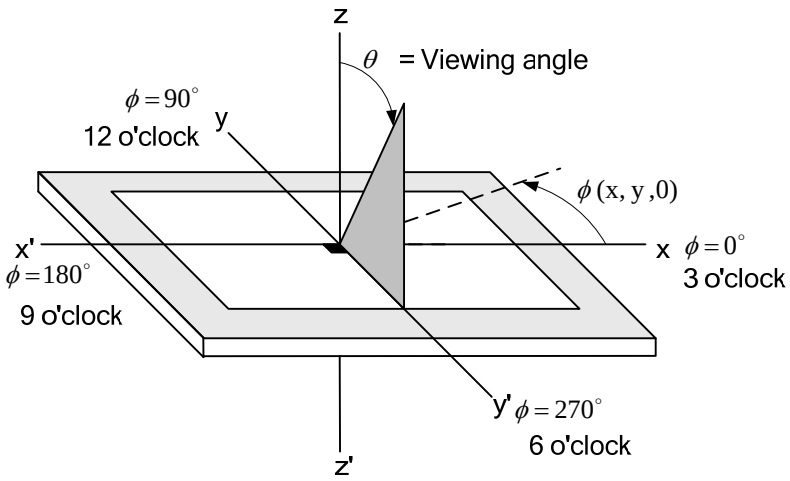
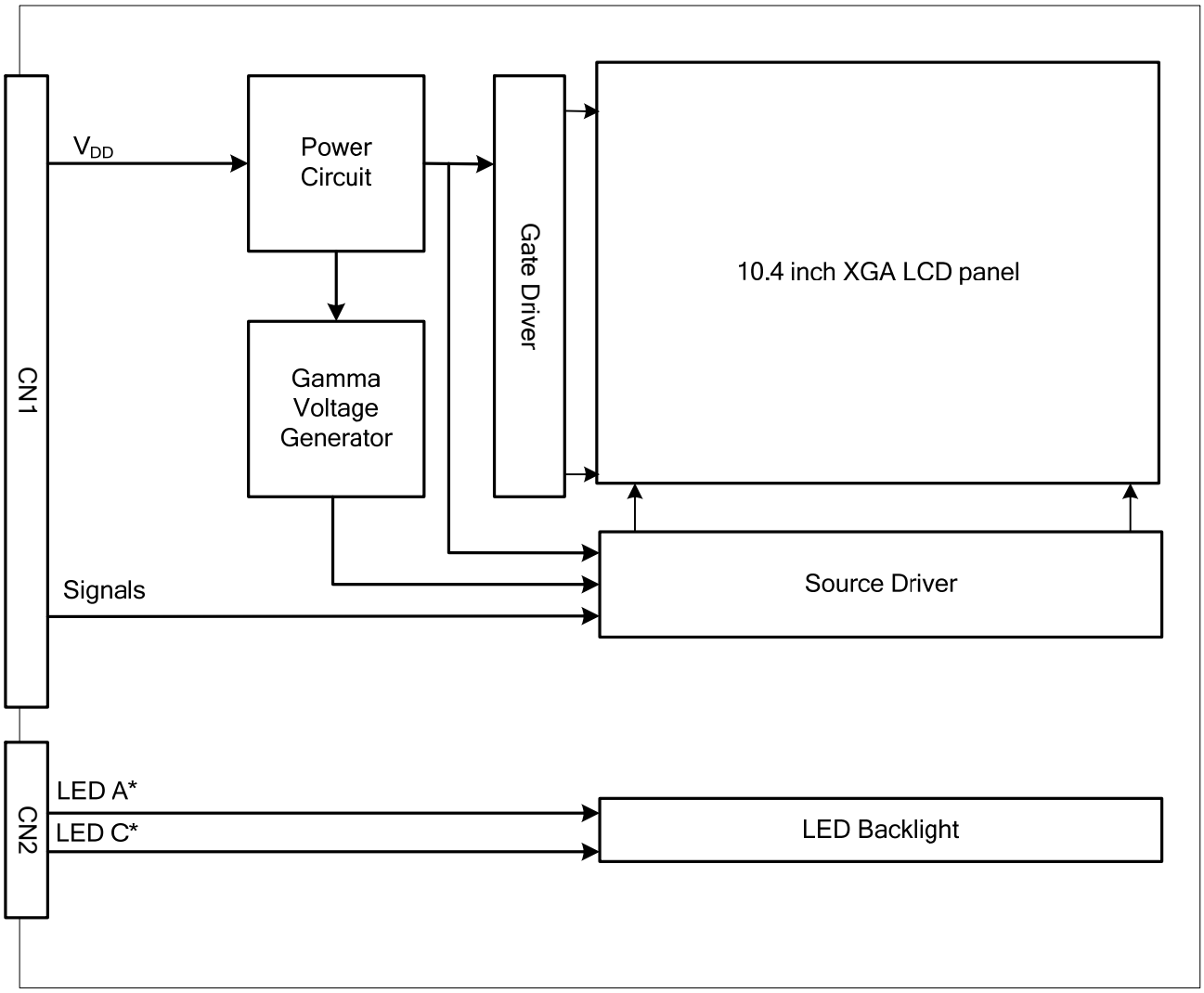


Fig 6.4

Note 6: The color chromaticity is measured from the center point of the panel, P5, as shown in Fig. 6.2.

7. BLOCK DIAGRAM



Note : Signals are CLK and pixel data pairs.

8. RELIABILITY TESTS

Test Item	Condition	
High Temperature	1) Operating 2) 70°C	240 hrs
Low Temperature	1) Operating 2) -20°C	240 hrs
High Temperature	1) Storage 2) 80°C	240 hrs
Low Temperature	1) Storage 2) -30°C	240 hrs
Heat Cycle	1) Operating 2) –20°C ~70°C 3) 3hrs~1hr~3hrs	240 hrs
Thermal Shock	1) Non-Operating 2) -35°C ↔ 85°C 3) 0.5 hr ↔ 0.5 hr	240 hrs
High Temperature & Humidity	1) Operating 2) 40°C & 85%RH 3) Without condensation	240 hrs (Note 3)
Vibration	1) Non-Operating 2) 20～200 Hz 3) 2G 4) X, Y, and Z directions	1 hr for each direction
Mechanical Shock	1) Non-Operating 2) 10 ms 3) 50G 4) ±X, ± Y and ±Z directions	Once for each direction
ESD	1) Operating 2) Tip: 150 pF, 330Ω 3) Air discharge for glass: ± 8KV 4) Contact discharge for metal frame: ± 8KV	1) Glass: 9 points 2) Metal frame: 8 points (Note 4)

Note 1: Display functionalities are inspected under the conditions defined in the specification after the reliability tests.

Note 2: The display is not guaranteed for use in corrosive gas environments.

Note 3: Under the condition of high temperature & humidity, if the temperature is higher than 40℃, the humidity needs to be reduced as Fig. 8.1 shown.

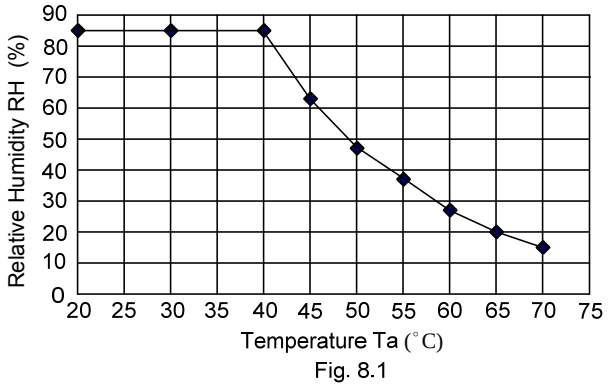


Fig. 8.1

Note 4: All pins of LCD interface (CN1) have been tested by ± 100V contact discharge of ESD under non-operating condition.

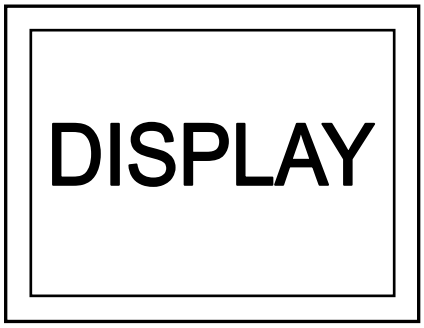
9. LCD INTERFACE

9.1 INTERFACE PIN CONNECTIONS

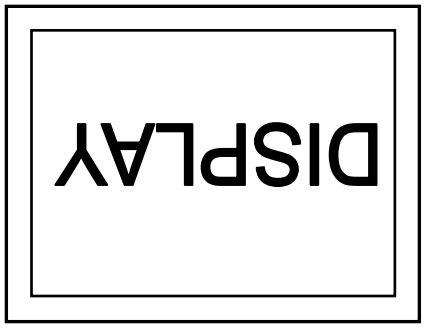
The display interface connector is CN1 MSB24013P20HA made by STM and pin assignment is as below:

Pin No.	Signal	Signal	Pin No.	Signal	Signal
1	V_{DD}	Power Supply for Logic	11	IN2-	B2~B5, DE
2	V_{DD}		12	IN2+	
3	V_{SS}	GND	13	V_{SS}	GND
4	SD	Scan Direction Control (Note 1)	14	CLK IN-	Pixel Clock
5	IN0-	R0~R5, G0	15	CLK IN+	
6	IN0+		16	V_{SS}	GND
7	V_{SS}	GND	17	IN3-	R6~R7, G6~G7, B6~B7
8	IN1-	G1~G5, B0~B1	18	IN3+	
9	IN1+		19	SEL	Data selection (H:8 bits L/NC:6bits)
10	V_{SS}	GND	20	NC	Test Pin

Note 1: Scan direction is available to be switched as below.



SD：Low or Open



SD：High

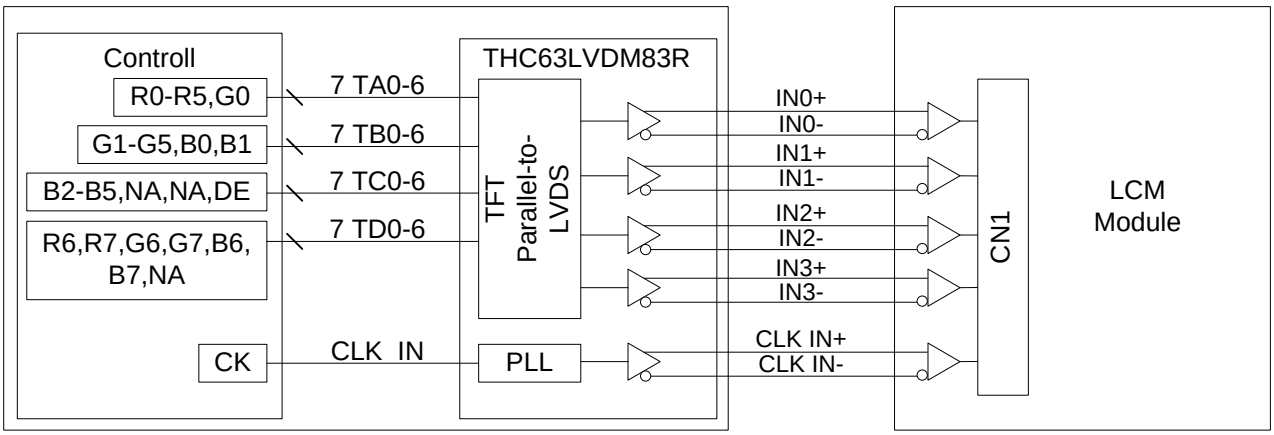
Note 2: INn- and INn+ (n=0,1,2,3), CLK IN- and CLK IN+ should be wired by twist-pairs or side-by-side FPC patterns, respectively.

The backlight interface connector CN2 is SM10B-SHLS-TS made by JST, and pin assignment as below:

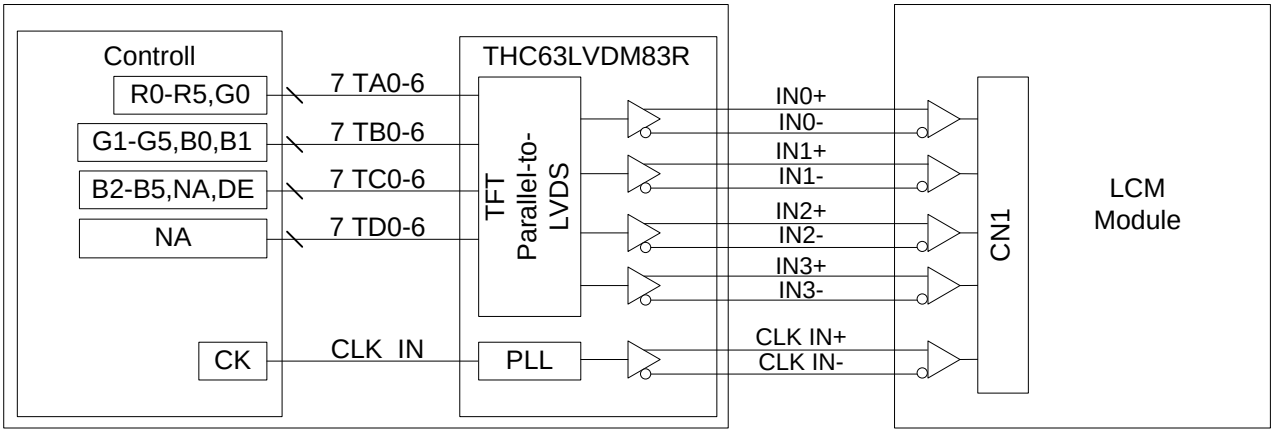
Pin No.	Signal	Level	Function
1	NC	-	No Connection
2	NC	-	No Connection
3	LED C1	-	LED Cathode1
4	LED A1	-	LED Anode1
5	LED A2	-	LED Anode2
6	LED C2	-	LED Cathode2
7	LED C3	-	LED Cathode3
8	LED A3	-	LED Anode3
9	LED A4	-	LED Anode4
10	LED C4	-	LED Cathode4

9.2 LVDS INTERFACE

(1) 8Bit Mode (SEL = H)



(2) 6Bit Mode (SEL = L)



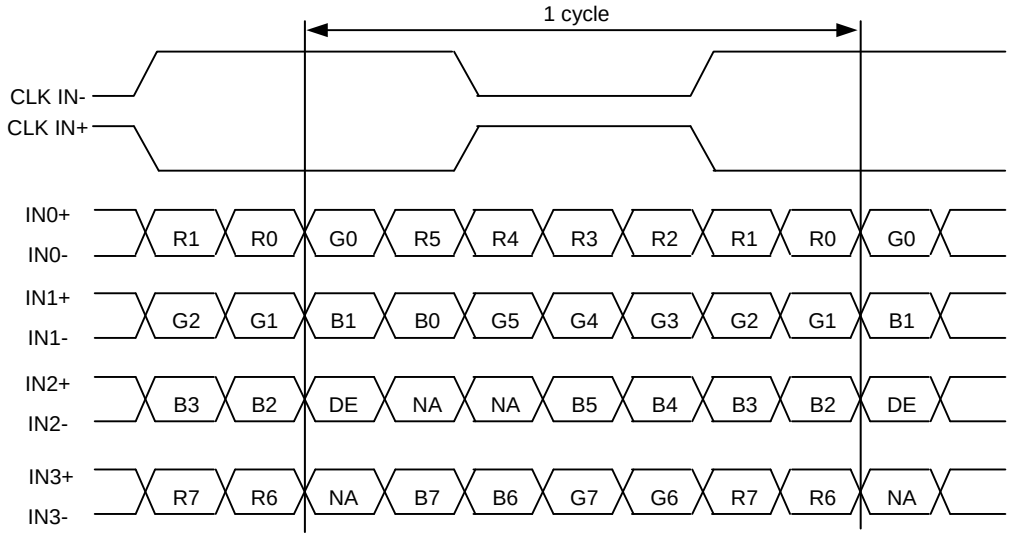
Note 1: LVDS cable impedance should be 100 ohms per signal line when each 2-lines (+,-) is used in differential mode.

Note 2: The recommended transmitter, THC63LVDM83R, is made by Thine or equivalent, which is not contained in the module.

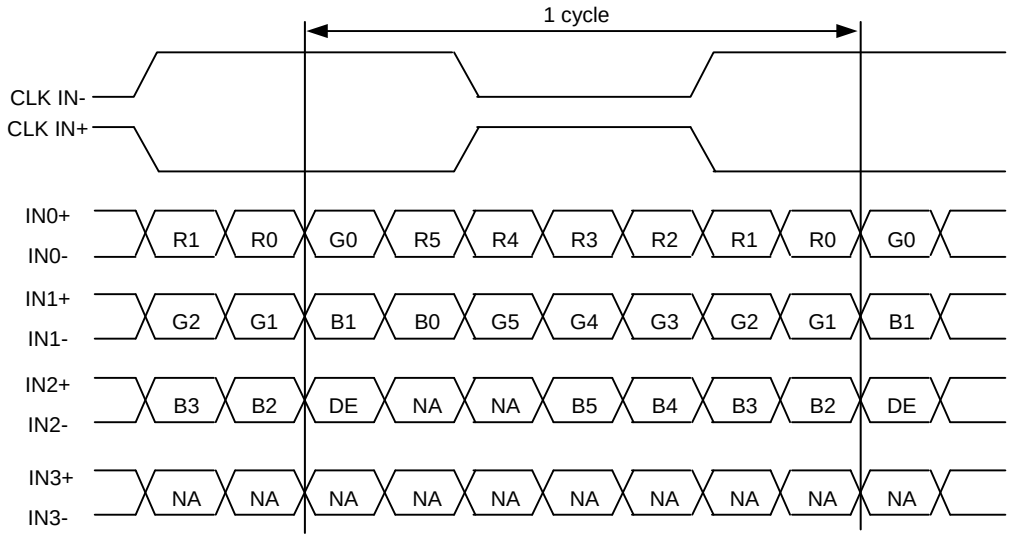
9.3 DATA MAPPING

Transmitter		8Bit Mode	6Bit Mode
Pin No.	Pin name	SEL	
		HIGH	LOW
51	TA0	R0(LSB)	R0(LSB)
52	TA1	R1	R1
54	TA2	R2	R2
55	TA3	R3	R3
56	TA4	R4	R4
3	TA5	R5	R5(MSB)
4	TA6	G0(LSB)	G0(LSB)
6	TB0	G1	G1
7	TB1	G2	G2
11	TB2	G3	G3
12	TB3	G4	G4
14	TB4	G5	G5(MSB)
15	TB5	B0(LSB)	B0(LSB)
19	TB6	B1	B1
20	TC0	B2	B2
22	TC1	B3	B3
23	TC2	B4	B4
24	TC3	B5	B5(MSB)
27	TC4	(NA)	(NA)
28	TC5	(NA)	(NA)
30	TC6	DE	DE
50	TD0	R6	(NA)
2	TD1	R7(MSB)	(NA)
8	TD2	G6	(NA)
10	TD3	G7(MSB)	(NA)
16	TD4	B6	(NA)
18	TD5	B7(MSB)	(NA)
25	TD6	(NA)	(NA)

(1) 8Bit Mode (SEL = H)



(2) 6Bit Mode (SEL = L)



DE : Display Enable

NA : Not Available

9.4 TIMING CHART

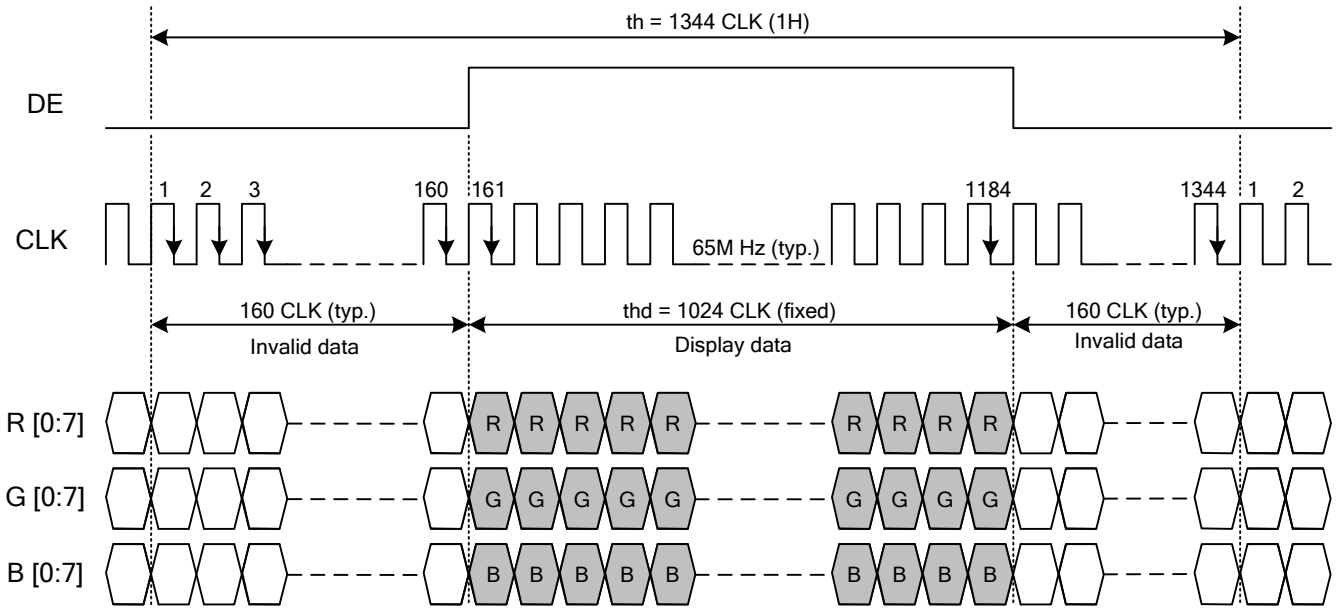


Fig. 9.1 Horizontal Timing

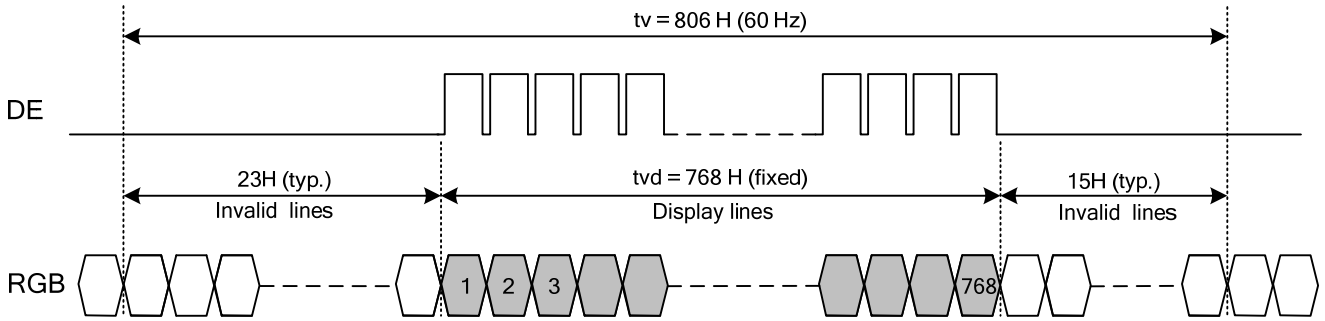


Fig. 9.2 Vertical Timing

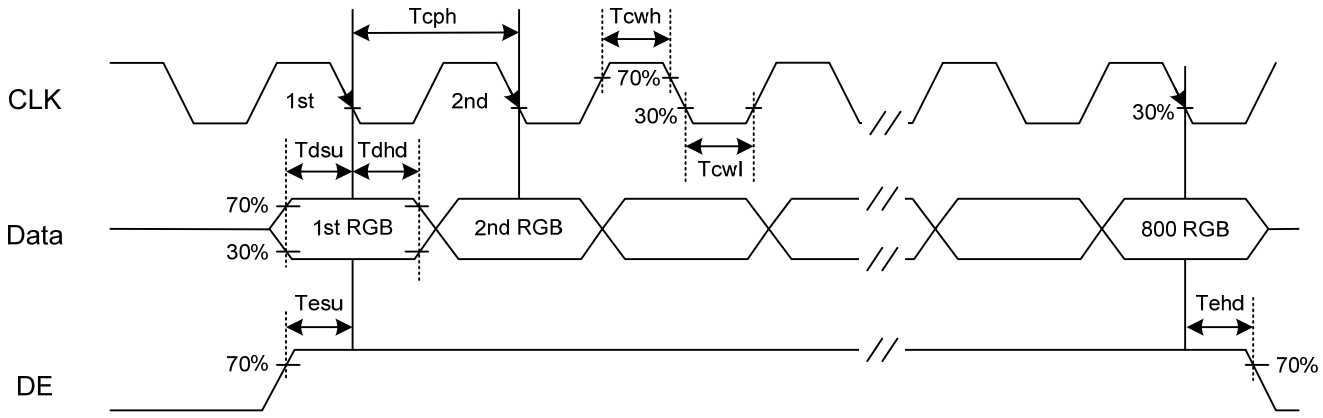


Fig. 9.3 Setup & Hold Time

9.5 TIME TABLE

The column of timing sets including minimum, typical, and maximum as below are based on the best optical performance, frame frequency (f_{Frame}) = 60 Hz to define. If 60 Hz is not the aim to set, less than 66 Hz for f_{Frame} is recommended to apply for better performance by other parameter combination as the definitions in section 5.1.

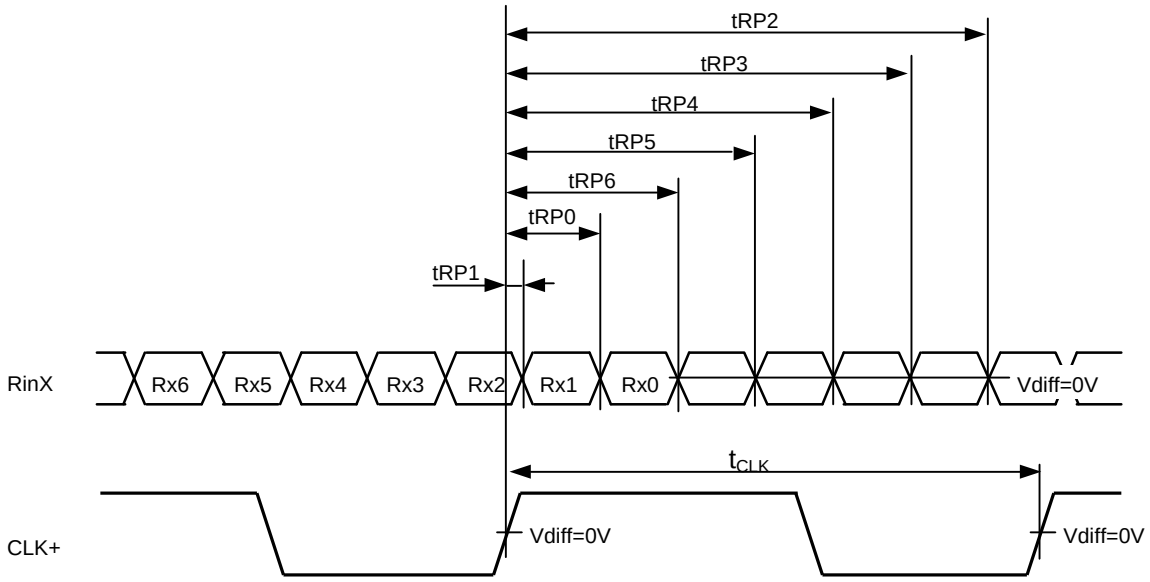
A. Horizontal and Vertical Timing

Item		Symbol	Min.	Typ.	Max.	Unit
Horizontal	CLK Frequency	fclk	52	65	71	M Hz
	Display Data	thd		1024		CLK
	Cycle Time	th	1114	1344	1400	
Vertical	Display Data	tvd		768		H
	Cycle Time	tv	778	806	845	

B. Setup and Hold Time

Item		Symbol	Min.	Typ.	Max.	Unit
CLK	Duty	Tcwh	40	50	60	%
	Cycle Time	Tcph	14	15.38	-	ns
Data	Setup Time	Tdsu	5	-	-	
	Hold Time	Tdhd	5	-	-	
DE	Setup Time	Tesu	5	-	-	
	Hold Time	Tehd	5	-	-	

9.6 LVDS RECEIVER TIMING



RinX= (RinX+)-(RinX-) (X=0, 1, 2, 3)

Item		Symbol	Min.	Typ.	Max.	Unit
CLK	Cycle frequency	1/tcLK	52	65	71	MHz
RinX (X=0,1,2,3)	0 data position	tRP0	1/7* t_{CLK} -0.49	1/7* t_{CLK}	1/7* t_{CLK} +0.49	ns
	1st data position	tRP1	-0.49	0	+0.49	
	2nd data position	tRP2	6/7* t_{CLK} -0.49	6/7* t_{CLK}	6/7* t_{CLK} +0.49	
	3rd data position	tRP3	5/7* t_{CLK} -0.49	5/7* t_{CLK}	5/7* t_{CLK} +0.49	
	4th data position	tRP4	4/7* t_{CLK} -0.49	4/7* t_{CLK}	4/7* t_{CLK} +0.49	
	5th data position	tRP5	3/7* t_{CLK} -0.49	3/7* t_{CLK}	3/7* t_{CLK} +0.49	
	6th data position	tRP6	2/7* t_{CLK} -0.49	2/7* t_{CLK}	2/7* t_{CLK} +0.49	

9.7 DATA INPUT for DISPLAY COLOR

(8Bit Mode)

Input color		Red Data								Green Data								Blue Data							
		R7	R6	R5	R4	R3	R2	R1	R0	G7	G6	G5	G4	G3	G2	G1	G0	B7	B6	B5	B4	B3	B2	B1	B0
		MSB							LSB	MSB							LSB	MSB							LSB
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	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	0	0
	Green(255)	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
	Blue(255)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	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	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	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	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	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	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	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	0	0
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
	Red(253)	1	1	1	1	1	1	0	1	0	0	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	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	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	0	0
	Green(1)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
	Green(2)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
	Green(253)	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0	1	0	0	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	0	0
	Green(255)	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	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	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	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	0	1	0
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
	Blue(253)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0	1
	Blue(254)	0	0	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	0	0	1	1	1	1	1	1	1	1

Note 1: Definition of gray scale : Color(n) Number in parenthesis indicates gray scale level. Larger number corresponds to brighter level.

Note 2: Data Signal : 1 : High, 0 : Low

(6Bit Mode)

Input color		Red Data						Green Data						Blue Data					
		R5	R4	R3	R2	R1	R0	G5	G4	G3	G2	G1	G0	B5	B4	B3	B2	B1	B0
		MSB					LSB	MSB					LSB	MSB					LSB
Basic Color	Black	0	0	0	0	0	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(63)	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0
	Blue(63)	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(61)	1	1	1	1	0	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(61)	0	0	0	0	0	0	1	1	1	1	0	1	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(61)	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	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

Note 1: Definition of gray scale : Color(n) Number in parenthesis indicates gray scale level. Larger number corresponds to brighter level.

Note 2: Data Signal : 1 : High, 0 : Low

9.8 POWER SEQUENCE

Interface signals are also shown in the chart. Signals from any system shall be Hi- resistance state or low level when V_{DD} voltage is off.

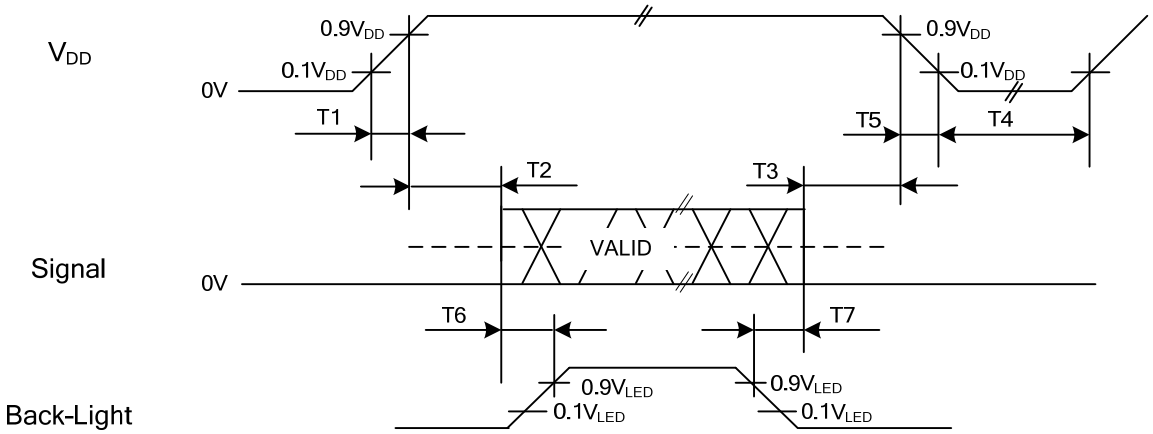
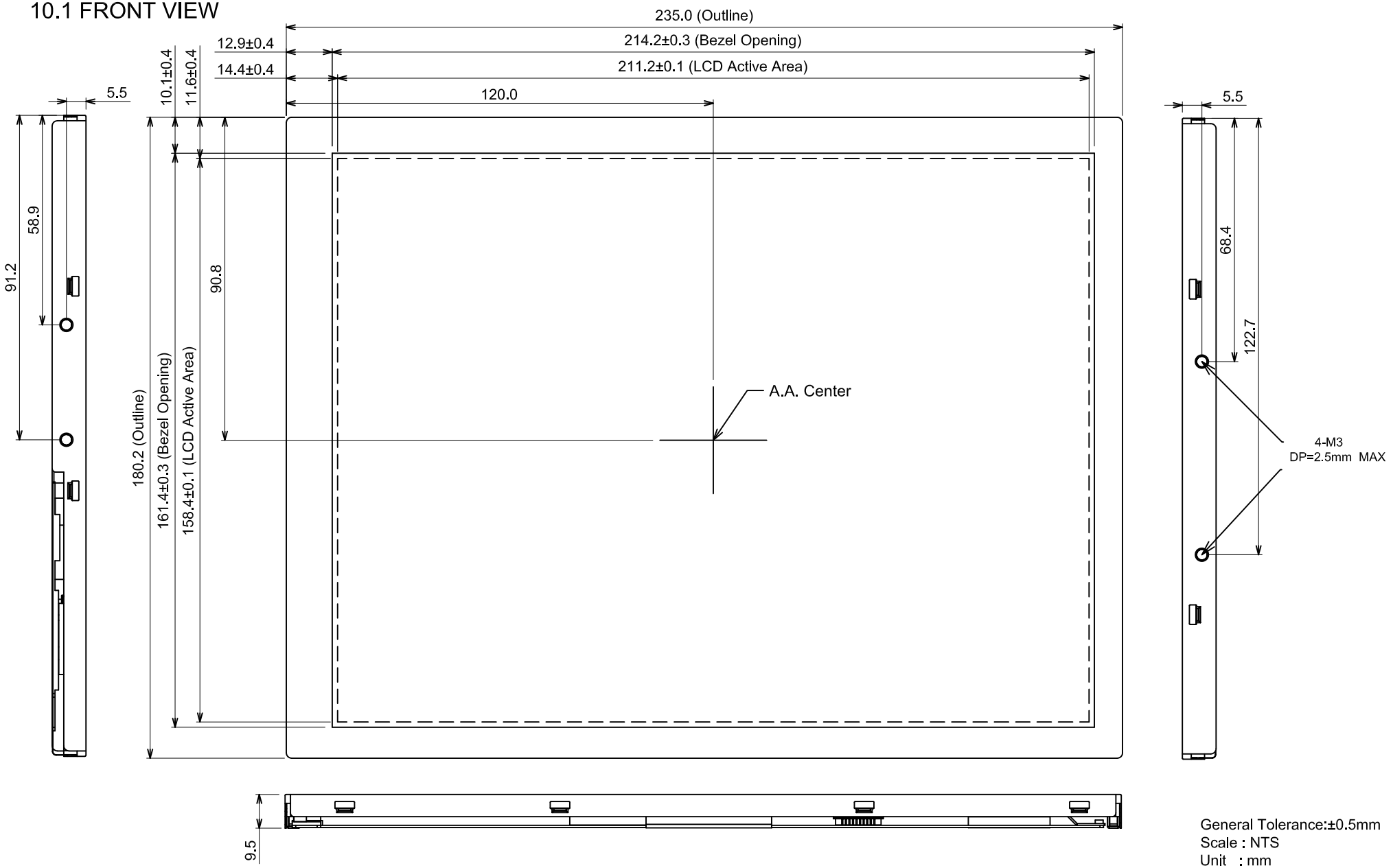


Fig 9.4 Power Sequence

Parameter	Symbol	Min.	Typ.	Max.	Unit
V_{DD} rising time from 10% to 90%	T1	0.5	-	10	ms
Delay from V_{DD} to valid data at power ON	T2	30	-	50	ms
Delay from valid data OFF to V_{DD} OFF at power OFF	T3	0	-	50	ms
V_{DD} OFF time for windows restart	T4	500	-	-	ms
V_{DD} falling time from 90% to 10%	T5	0.5	-	10	ms
Delay from valid data to BL ON	T6	200	-	-	ms
Delay from valid data to BL OFF	T7	200	-	-	ms

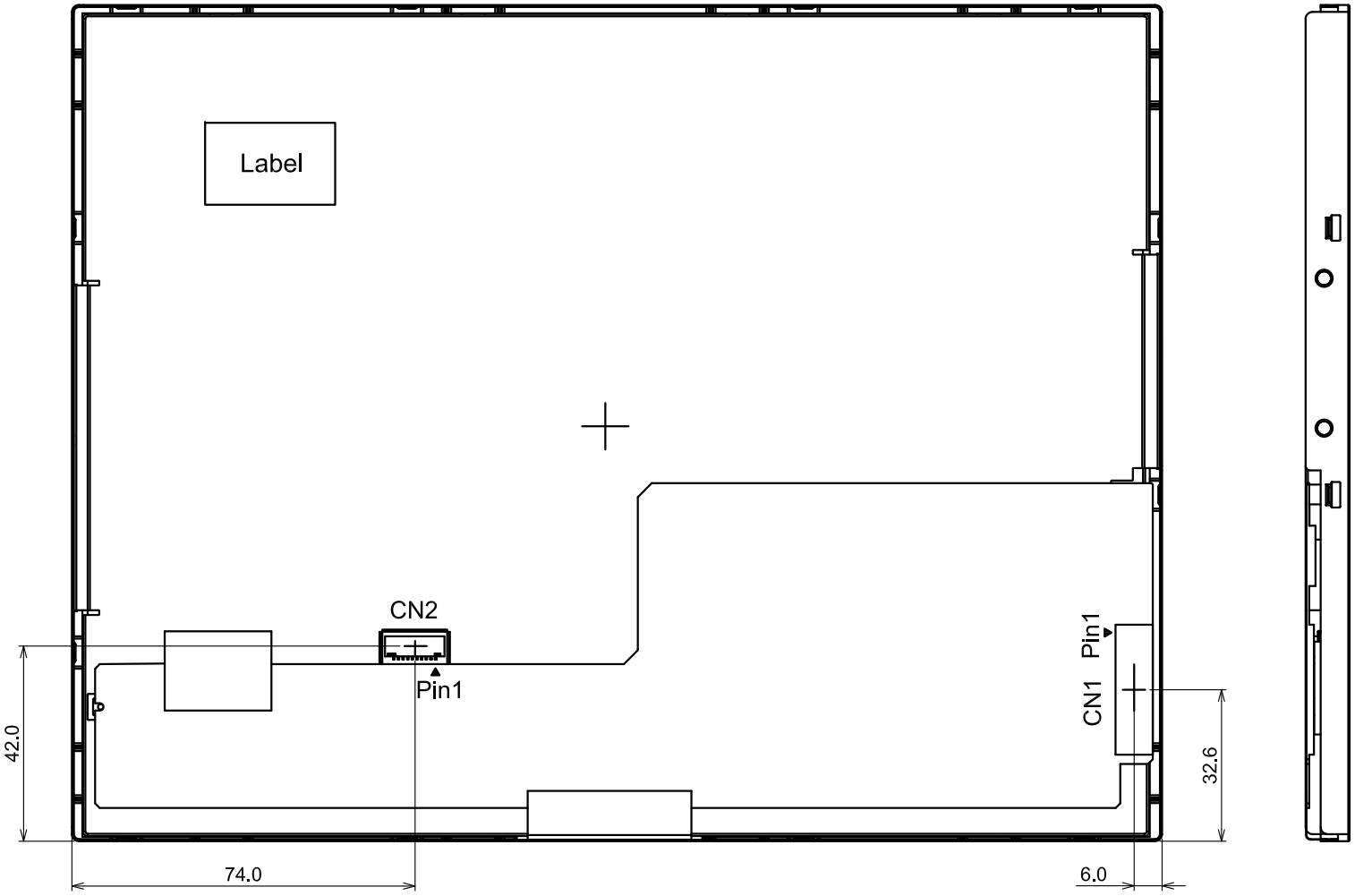
10. OUTLINE DIMENSIONS

10.1 FRONT VIEW



General Tolerance:±0.5mm
Scale : NTS
Unit : mm

10.2 REAR VIEW



General Tolerance:±0.5mm
Scale : NTS
Unit : mm

11. APPEARANCE STANDARD

The appearance inspection is performed in a dark room around 500~1000 lx based on the conditions as below:

- The distance between inspector's eyes and display is 30 cm.
- The viewing zone is defined with angle θ shown in Fig. 11.1 The inspection should be performed within 45° when display is shut down. The inspection should be performed within 5° when display is power on.

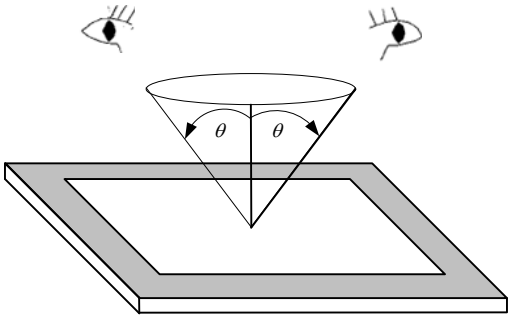


Fig. 11.1

11.1 THE DEFINITION OF LCD ZONE

LCD panel is divided into 2 areas as shown in Fig.11.2 for appearance specification in next section. A zone is the LCD active area (dot area); B zone is the area between A zone and metal frame.

In terms of housing design, B zone is the recommended window area customers' housing should be located in.

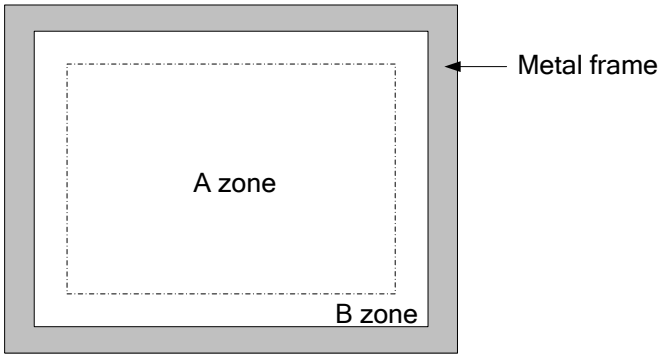


Fig. 11.2

11.2 LCD APPEARANCE SPECIFICATION

The specification as below is defined as the amount of unexpected phenomenon or material in different zones of LCD panel. The definitions of length, width and average diameter using in the table are shown in Fig. 11.3 and Fig. 11.4.

<table>
<tr><td>Item</td><td colspan="3">Criteria</td><td>Applied zone</td></tr>
<tr><td rowspan="4">Scratches</td><td>Length (mm)</td><td>Width (mm)</td><td>Maximum number</td><td rowspan="4">A, B</td></tr>
<tr><td>Ignored</td><td>W≦0.02</td><td>Ignored</td></tr>
<tr><td>L≦10</td><td>0.02＜W≦0.1</td><td>4</td></tr>
<tr><td>-</td><td>0.1 ＜W</td><td>Not allowed</td></tr>
<tr><td>Wrinkles in polarizer</td><td colspan="3">Serious one is not allowed</td><td>A</td></tr>
<tr><td rowspan="4">Bubble Dent on polarizer</td><td colspan="2">Average diameter (mm)</td><td>Maximum number</td><td rowspan="4">A</td></tr>
<tr><td colspan="2">D≦0.3</td><td>Ignored</td></tr>
<tr><td colspan="2">0.3＜D≦0.5</td><td>4</td></tr>
<tr><td colspan="2">0.5＜D</td><td>Not allowed</td></tr>
<tr><td rowspan="15">1) Stains
2) Foreign Materials
3) Dark Spot</td><td colspan="3">Filamentous (Line shape)</td><td rowspan="5">A, B</td></tr>
<tr><td>Length (mm)</td><td>Width (mm)</td><td>Maximum number</td></tr>
<tr><td>L≦2.0</td><td>W≦0.03</td><td>Ignored</td></tr>
<tr><td>L≦3.0</td><td>0.03＜W≦0.05</td><td>4</td></tr>
<tr><td>L≦2.5</td><td>0.05＜W≦0.1</td><td>1</td></tr>
<tr><td colspan="3">Round (Dot shape)</td><td rowspan="7">A, B</td></tr>
<tr><td colspan="2">Average diameter (mm)</td><td>Maximum number</td></tr>
<tr><td colspan="2">D≦0.2</td><td>Ignored</td></tr>
<tr><td colspan="2">0.2＜D≦0.4</td><td>4</td></tr>
<tr><td colspan="2">0.4＜D</td><td>Not allowed</td></tr>
<tr><td colspan="2">In total</td><td>Filamentous + Round=8</td></tr>
<tr><td colspan="3">Those wiped out easily are acceptable</td></tr>
<tr><td rowspan="11">Dot-Defect
(Note 1)</td><td></td><td>Type</td><td>Maximum number</td><td rowspan="11">A</td></tr>
<tr><td rowspan="3">Bright dot-defect</td><td>1 dot</td><td>3</td></tr>
<tr><td>2 adjacent dot</td><td>1</td></tr>
<tr><td>3 adjacent dot or above</td><td>0</td></tr>
<tr><td rowspan="3">Dark dot-defect</td><td>1 dot</td><td>4</td></tr>
<tr><td>2 adjacent dot</td><td>1</td></tr>
<tr><td>3 adjacent dot or above</td><td>0</td></tr>
<tr><td rowspan="3">Distance</td><td>Type</td><td>Minimum Space</td></tr>
<tr><td>Minimum Between Bright</td><td>15 mm≦L</td></tr>
<tr><td>Minimum Between Dark</td><td>5 mm≦L</td></tr>
<tr><td colspan="2">In total</td><td>5</td></tr>
<tr><td>Small bright dot and micro bright dot</td><td colspan="3">Cannot be seen through by ND8%
1. N≦5
2. N≦3 within 50mm diameter area</td><td>A</td></tr>
<tr><td>Mura</td><td colspan="3">Judge by not visible through ND5%</td><td>A</td></tr>
</table>

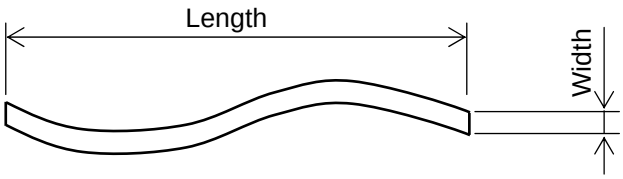
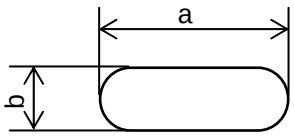


Fig 11.3



Average diameter = $\frac{a+b}{2}$

Fig 11.4

Note 1: The definitions of dot defect are as below:

- The defect area of the dot must be bigger than half of a dot.
- For bright dot-defect, showing black pattern, the dots can be seen through a 8% ND filter.
- For dark dot-defect, appearing dark and unchanged in size over 1/2 of whole dot in which LCD panel is displaying under pure red, green, blue picture.
- The definition of 1-dot-defect is the defect-dot, which is isolated and no adjacent defect-dot.
- The definition of adjacent dot is shown as Fig. 11.5.

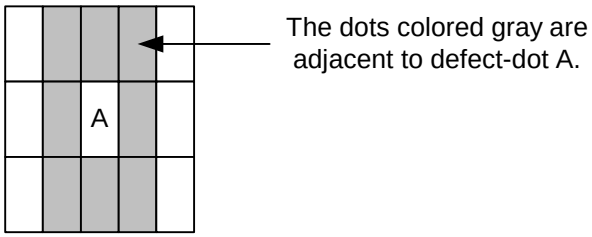


Fig. 11.5

12. PRECAUTIONS

12.1 PRECAUTIONS of ESD

1) Before handling the display, please ensure your body has been connected to ground to avoid any damages by ESD. Also, do not touch display's interface directly when assembling.

2) Please remove the protection film very slowly before turning on the display to avoid generating ESD.

12.2 PRECAUTIONS of HANDLING

1) In order to keep the appearance of display in good condition; please do not rub any surfaces of the displays by sharp tools harder than 3H, especially touch panel, metal frame and polarizer.

2) Please do not pile the displays in order to avoid any scars leaving on the display. In order to avoid any injuries, please pay more attention for the edges of glasses and metal frame, and wear finger cots to protect yourself and the display before working on it.

3) Touching the display area or the terminal pins with bare hand is prohibited. This is because it will stain the display area and cause poor insulation between terminal pins, and might affect display's electrical characteristics furthermore.

4) Do not use any harmful chemicals such as acetone, toluene, and isopropyl alcohol to clean display's surfaces.

5) Please use soft cloth or absorbent cotton with ethanol to clean the display by gently wiping. Moreover, when wiping the display, please wipe it by horizontal or vertical direction instead of circling to prevent leaving scars on the display's surface, especially polarizer.

6) Please wipe any unknown liquids immediately such as saliva, water or dew on the display to avoid color fading or any permanently damages.

7) Maximum pressure to the surface of the display must be less than $1{,}96 \times 10^4$ Pa. If the area of adding pressure is less than $1\,cm^2$, the maximum pressure must be less than 1.96N.

12.3 PRECAUTIONS OF OPERATING

1) Please input signals and voltages to the displays according to the values defined in the section of electrical characteristics to obtain the best performance. Any voltages over than absolute maximum rating will cause permanent damages to this display. Also, any timing of the signals out of this specification would cause unexpected performance.

2) When the display is operating at significant low temperature, the response time will be slower than it at $25\,C^\circ$. In high temperature, the color will be slightly dark and blue compared to original pattern. However, these are temperature-related phenomenon of LCD and it will not cause permanent damages to the display when used within the operating temperature.

3) The use of screen saver or sleep mode is recommended when static images are likely for long periods of time. This is to avoid the possibility of image sticking.

4) Spike noise can cause malfunction of the circuit. The recommended limitation of spike noise is no bigger than ± 100 mV.

12.4 PRECAUTIONS of STORAGE

If the displays are going to be stored for years, please be aware the following notices.

1) Please store the displays in a dark room to avoid any damages from sunlight and other sources of UV light.
2) The recommended long-term storage temperature is between 10℃~35℃ and 55%~75% humidity to avoid causing bubbles between polarizer and LCD glasses, and polarizer peeling from LCD glasses.
3) It would be better to keep the displays in the container, which is shipped from USMP, and do not unpack it.
4) Please do not stick any labels on the display surface for a long time, especially on the polarizer.

13. DESIGNATION of LOT MARK