KOE

JDI Group

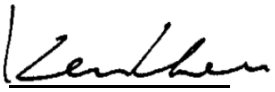
Kaohsiung Opto-Electronics Inc.

FOR MESSRS : _____ DATE : Apr. 15th, 2013

CUSTOMER'S ACCEPTANCE SPECIFICATIONS

TX16D21VM5BAA

Contents

ACCEPTED BY: _____ PROPOSED BY: 

2. RECORD OF REVISION

DATE	SHEET No.	SUMMARY

3. GENERAL DATA

3.1 DISPLAY FEATURES

This module is a 6.2” HVGA of 8:3 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	TX16D21VM5BAA
Module Dimensions	173.0(W) mm x 70.0(H) mm x (7.0) typ (D) mm
LCD Active Area	148.8(W) mm x 53.76(H) mm
Dot Pitch	0.0775(W) mm x 3(R, G, B)(W) x 0.224(H) mm
Resolution	640 x 3(RGB)(W) x 240(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 Colors (6-bit RGB)
Backlight	21 LED (3 series x 7) (Life-time 40 khr)
Weight	110 g typ.
Interface	LVDS (20pins)
Power Supply Voltage	3.3V for LCD; 12V for Backlight
Power Consumption	396mW for LCD ;1W for backlight
Viewing Direction	Super wide version

4. ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Min.	Max.	Unit	Remarks
Supply Voltage	V_{DD}	-0.3	5	V	-
Input Voltage of Logic	VI	-0.3	V_{DD}+0.3	V	Note 1
Operating Temperature	Top	-20	70	°C	Note 2
Storage Temperature	Tst	-30	80	°C	Note 2
Backlight Input Voltage	V_{LED}	-	15	V	-

Note 1: The rating is defined for the signal voltages of the interface such as CLK, DE, and RGB data bus.

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

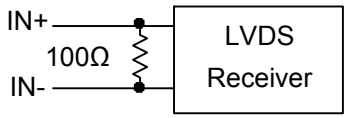
5.1 LCD CHARACTERISTICS

$T_a = 25\ ^\circ C,\ V_{SS} = 0V$

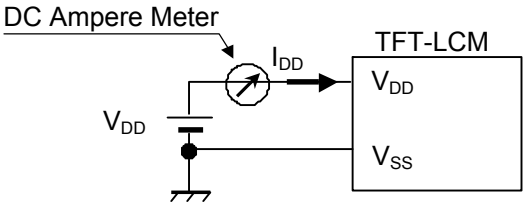
Item	Symbol	Condition	Min.	Typ.	Max.	Unit	Remarks
Power Supply Voltage	V_{DD}	-	3.0	3.3	3.6	V	-
Differential Input Voltage for LVDS Receiver Threshold	V_I	V_{IH}	-	-	+100	mV	Note 1
		V_{IL}	-100	-	-		
Power Supply Current	I_{DD}	V_{DD}-V_{SS} =3.3V	-	120	150	mA	Note 2,3
Vsync Frequency	f_v	-	-	60	68	Hz	Note 4
Hsync Frequency	f_H	-	15	17.4	19.8	KHz	
DCLK Frequency	f_{CLK}	-	18.6	22.45	26.5	MHz	

Note 1: VCM=+1.2V

VCM is common mode voltage of LVDS transmitter/receiver. The input terminal of LVDS transmitter is terminated with 100Ω.



Note 2: An all black check pattern is used when measuring I_{DD}. f_v is set to 60Hz.



Note 3: 0.5A fuse is applied in the module for I_{DD}. For display activation and protection purpose, power supply is recommended larger than 1.0A to start the display and break fuse once any short circuit occurred.

Note 4: For LVDS transmitter input.

5.2 BACKLIGHT CHARACTERISTICS

$T_a = 25\ ^\circ C$

Item	Symbol	Condition	Min.	Typ.	Max.	Unit	Remarks
LED Input Voltage	V_{LED}	Backlight Unit	11.5	12.0	12.5	V	Note 1
LED Forward Current	I_{LED}	Backlight Unit	-	84	95	mA	-
LED Lifetime	-	84 mA	-	40K	-	hrs	Note 2

Note 1: Fig. 5.1 shows the LED backlight circuit. The circuit has 21 LEDs in total and R is 268 Ω.

Note 2: The estimated lifetime is specified as the time to reduce 50% brightness by applying 84 mA at 25°C.

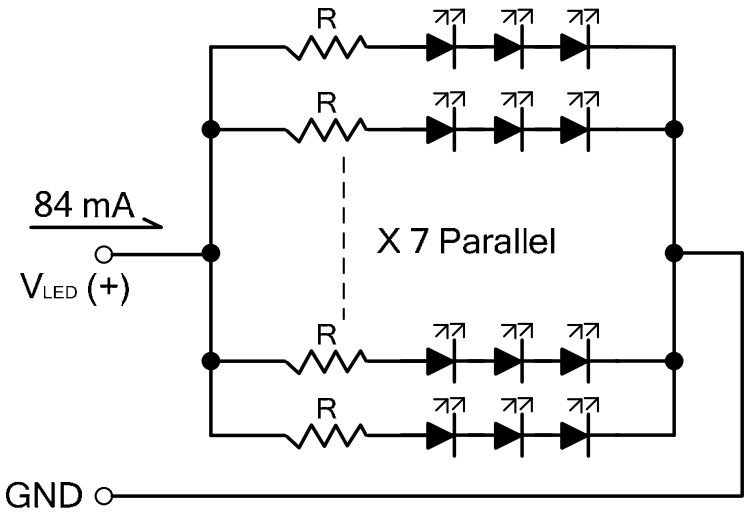


Fig 5.1

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 ambient temperature is 25°C.
- In the dark room around 500~1000 lx, the equipment has been set for the measurements as shown in Fig 6.1.

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

Item		Symbol	Condition	Min.	Typ.	Max.	Unit	Remarks
Brightness of White		-	$\phi = 0^\circ, \theta = 0^\circ$, I_{LED}= 84 mA	320	400	-	cd/m^2	Note 1
Brightness Uniformity		-		75	-	-	%	Note 2
Contrast Ratio		CR		200	400	-	-	Note 3
Response Time		Rise + Fall	$\phi = 0^\circ, \theta = 0^\circ$	-	45	-	ms	Note 4
NTSC Ratio		-	$\phi = 0^\circ, \theta = 0^\circ$	-	60	-	%	-
Viewing Angle		θ x	$\phi = 0^\circ$, CR ≥ 10	-	80	-	Degree	Note 5
		θ x′	$\phi = 180^\circ$, CR ≥ 10	-	80	-		
		θ y	$\phi = 90^\circ$, CR ≥ 10	-	80	-		
		θ y′	$\phi = 270^\circ$, CR ≥ 10	-	80	-		
Color Chromaticity	Red	X	$\phi = 0^\circ, \theta = 0^\circ$	0.57	0.62	0.67	-	Note 6
		Y		0.29	0.34	0.39		
	Green	X		0.30	0.35	0.40		
		Y		0.55	0.60	0.65		
	Blue	X		0.09	0.14	0.19		
		Y		0.04	0.09	0.14		
	White	X		0.24	0.29	0.34		
		Y		0.26	0.31	0.36		

Note 1: The brightness is measured from 9 point average value 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 measured by BM-5 as shown in Fig. 6.2.

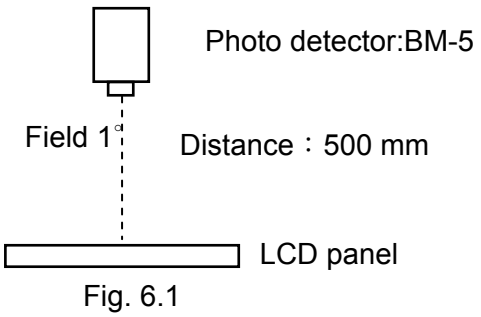


Fig. 6.1

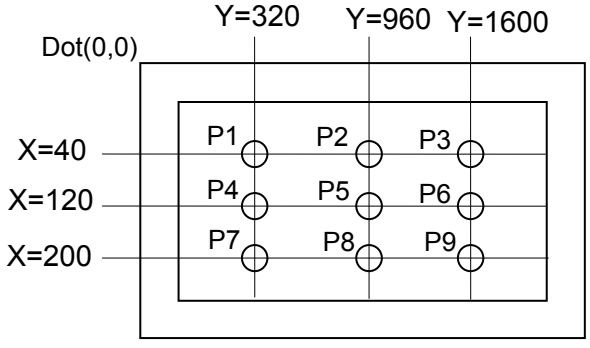


Fig. 6.2

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.

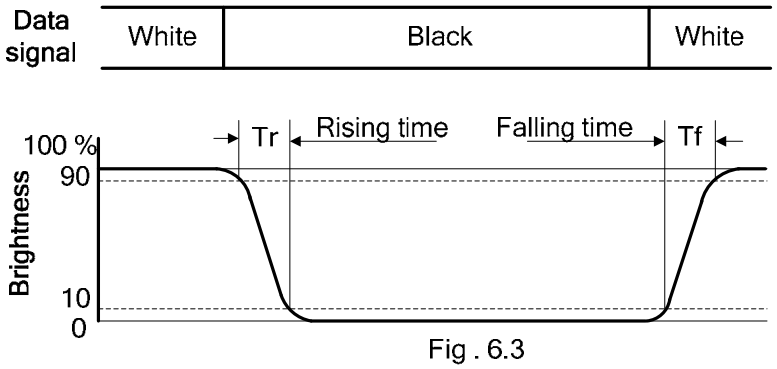


Fig . 6.3

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.

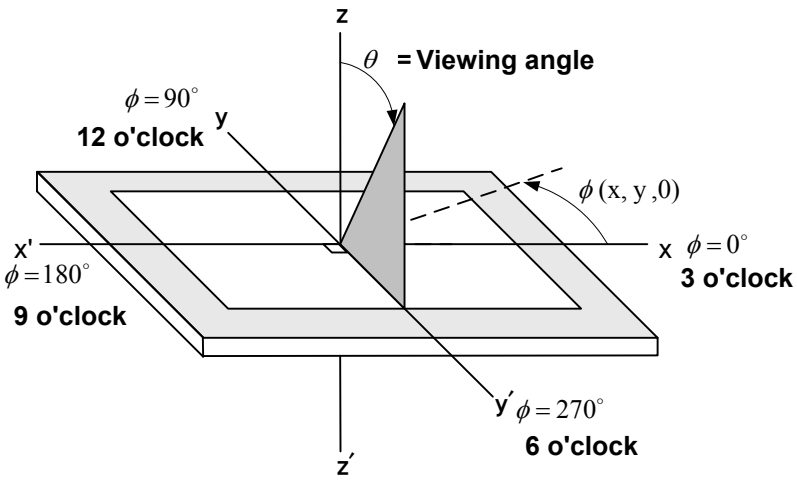
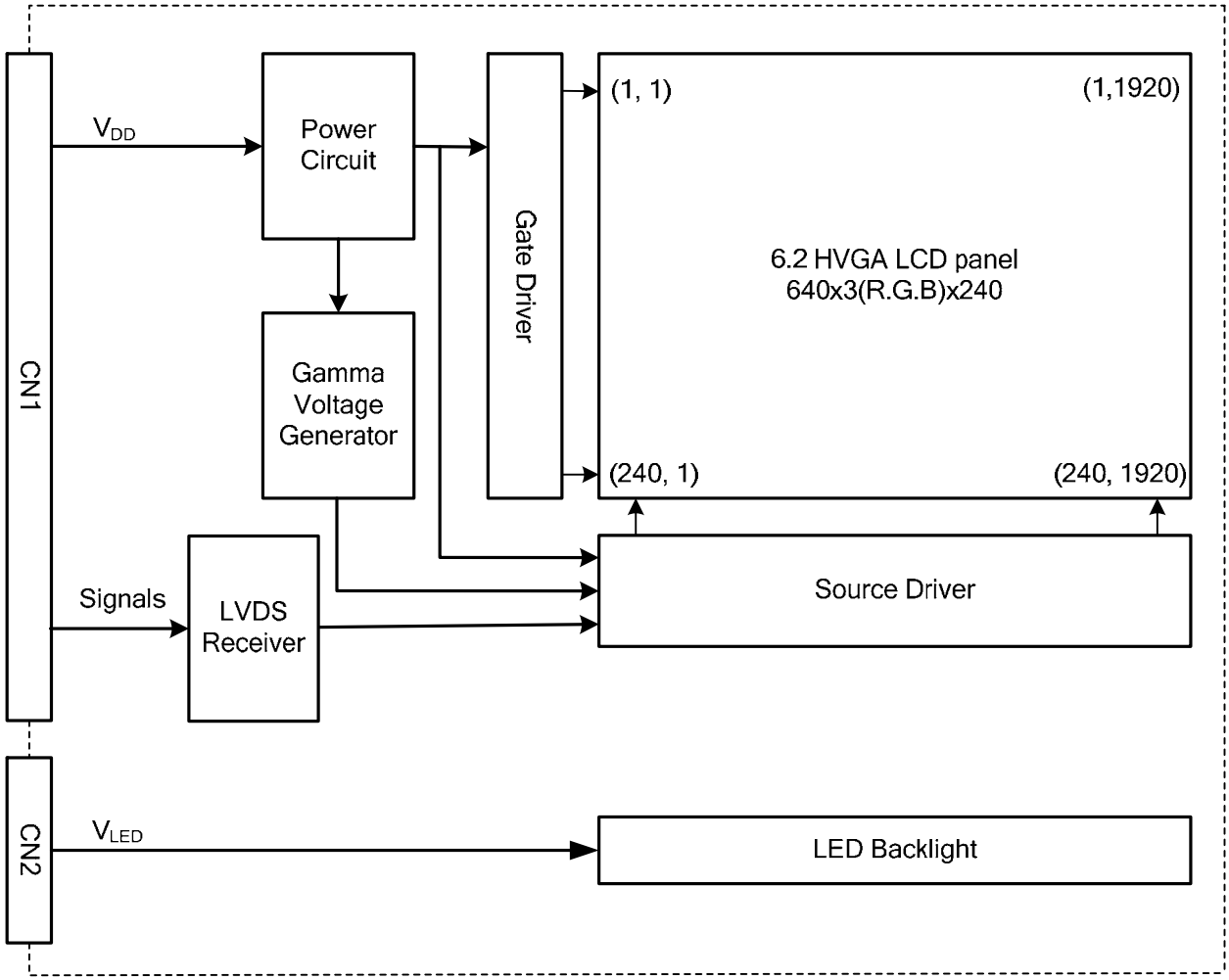


Fig. 6.4

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, DE 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 (Note4)	240 hrs
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: 200 pF, 250Ω 3) Air discharge for glass: ± 8KV 4) Contact discharge for metal frame: ± 8KV	1) Glass: 9 points 2) Metal frame: 8 points (Note3)

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

Note 4: 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.

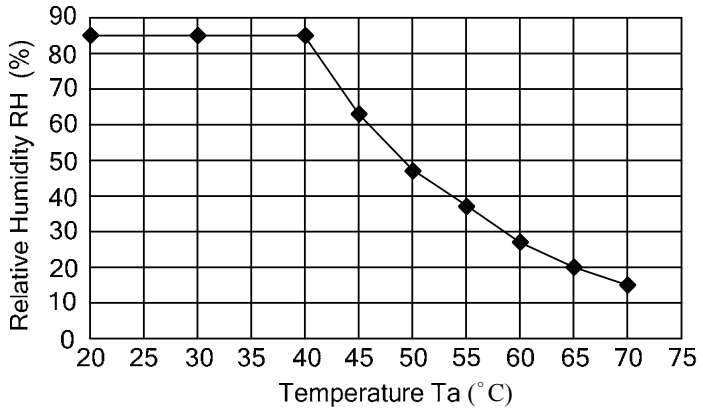


Fig. 8.1

9. LCD INTERFACE

9.1 INTERFACE PIN CONNECTIONS

The display interface connector (CN1) is FI-SEB20P-HF13E-E1500 made by JAE and pin assignment is as below:

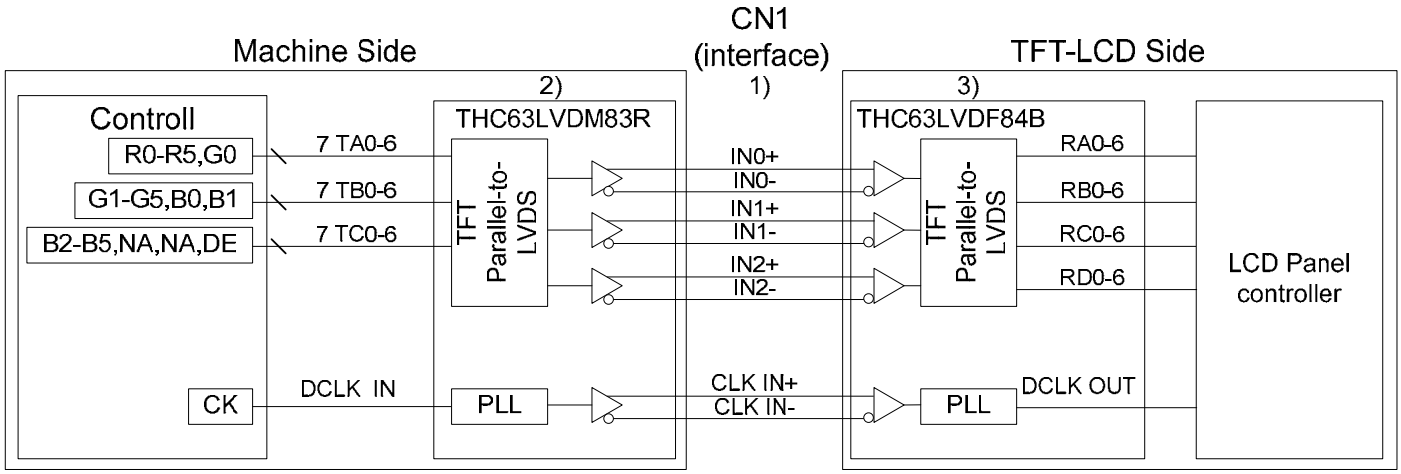
Pin No.	Signal	Signal	Pin No.	Signal	Signal
1	V_{DD}	Power Supply for Logic	11	IN2-	B2~B5, DE
2	V_{DD}		12	IN2+	
3	V_{SS}	GND	13	V_{SS}	GND
4	V_{SS}		14	CLK IN-	Pixel Clock
5	IN0-	R0~R5, G0	15	CLK IN+	
6	IN0+		16	V_{SS}	GND
7	V_{SS}	GND	17	NC	No Connection
8	IN1-	G1~G5, B0~B1	18	NC	No Connection
9	IN1+		19	NC	No Connection
10	V_{SS}	GND	20	NC	No Connection

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

The backlight interface connector (CN2) is BHR-03VS-1 made by JST, and pin assignment is as below:

Pin No.	Signal	Level	Function
1	V_{LED}+	-	Power Supply for LED
2	NC	-	No Connection
3	V_{LED}-	-	GND

9.2 LVDS INTERFACE

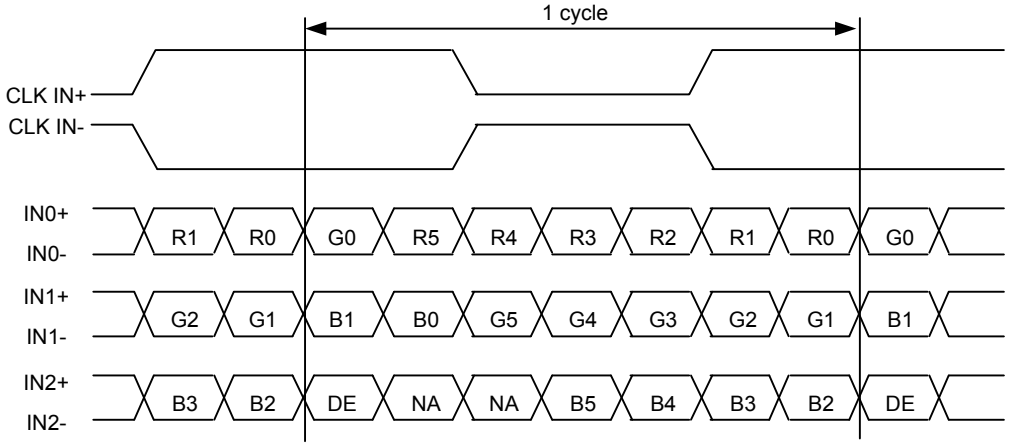


Note 1: LVDS cable impedance should be 100 ohms per signal line when each 2-lines (+, -) is used in differential mode.

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

Note 3: The receiver built-in the module is THC63LVDF84B made by Thine.

9.3 LVDS DATA FORMAT



DE: Display Enable

NA: Not Available

9.4 TIMING TABLE

The column of timing sets including minimum, typical, and maximum as below are based on the best optical performance, frame frequency (Vsync) = 60Hz to define.

A. DE MODE

Item		Symbol	Min.	Typ.	Max.	Unit
Horizontal	CLK Frequency	fclk	18.6	22.45	26.5	MHz
	Display Data	thd	640	640	640	CLK
	Cycle Time	th	1240	1290	1340	
Vertical	Display Data	tvd	240	240	240	H
	Cycle Time	tv	250	290	330	

B. CLOCK AND DATA INPUT TIMING

Item		Symbol	Min.	Typ.	Max.	Unit
CLK	Duty	Tcwh	45	50	55	%
	Cycle Time	Tcph	-	44.5	-	ns
Data	Setup Time	Tdsu	5	-	-	
	Hold Time	Tdhd	5	-	-	
DE	Setup Time	Tesu	5	-	-	
	Hold Time	Tehd	5	-	-	

9.5 TIMING CHART

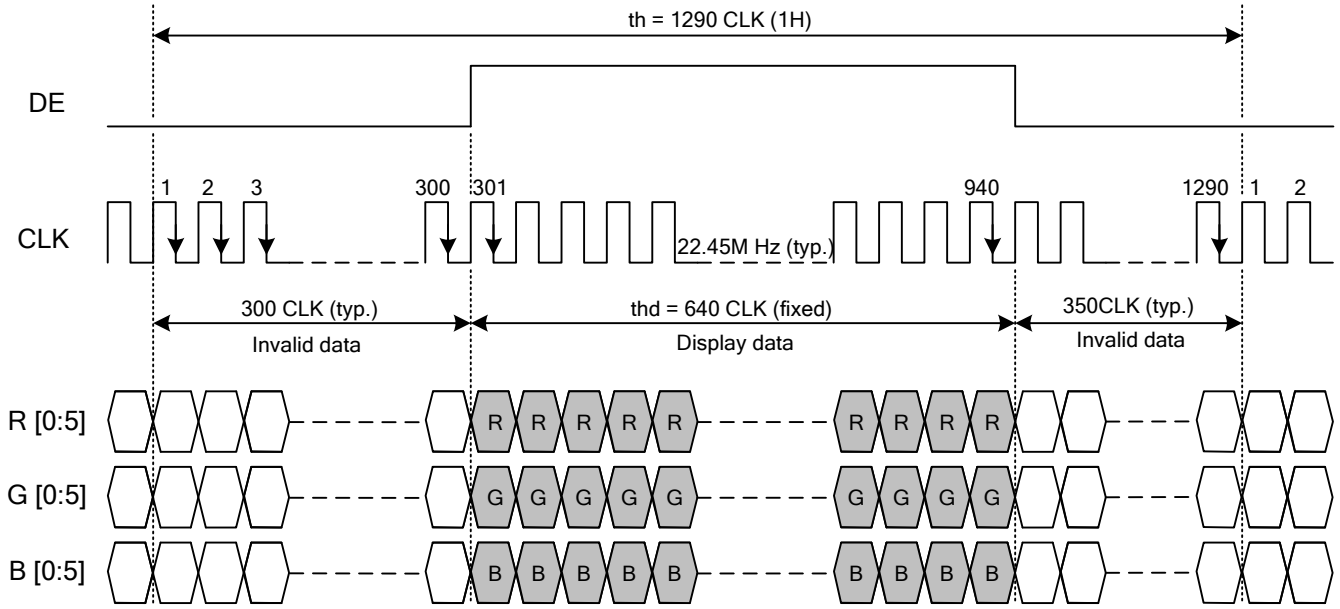


Fig. 9.1 Horizontal Timing of DE Mode

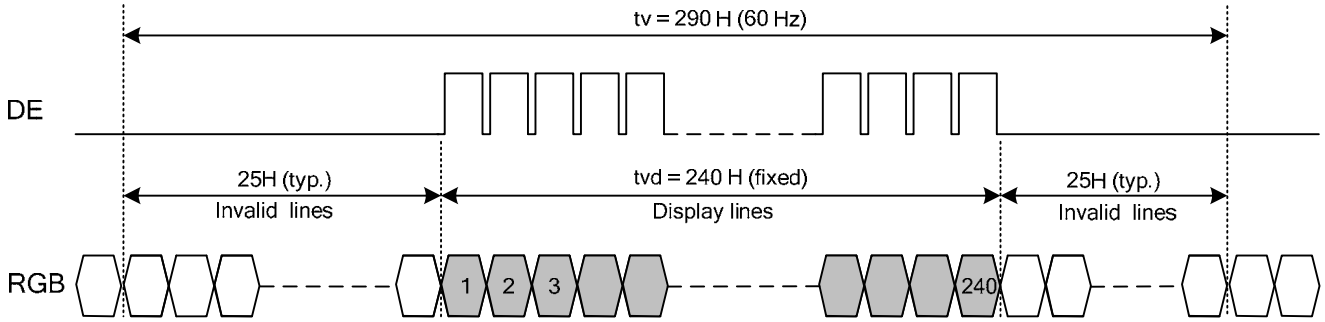


Fig. 9.2 Vertical Timing

CLOCK AND DATA INPUT TIMING

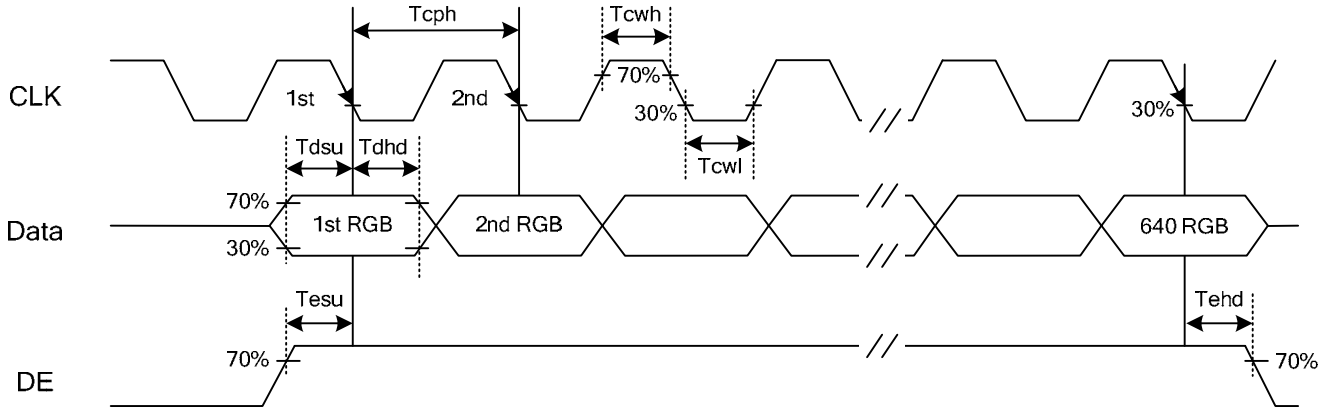
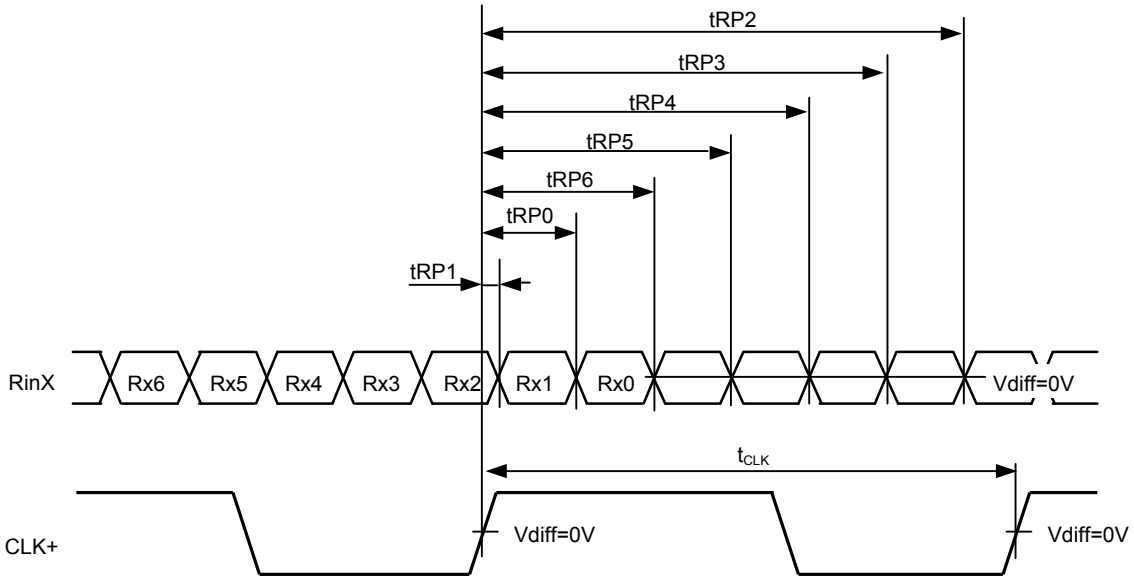


Fig. 9.3 Setup & Hold Time of Data and DE signal.

9.6 LVDS RECEIVER TIMING



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

Item		Symbol	Min.	Typ.	Max.	Unit
CLK	Frequency	$1/t_{CLK}$	18.6	22.45	26.5	MHz
RinX (X=0,1,2)	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

	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 (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 (63)	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
	Red (62)	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
	Red (2)	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	Red (1)	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 (63)	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
	Green (62)	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
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	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
	Green (2)	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0
	Green (1)	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 (63)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	Blue (62)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
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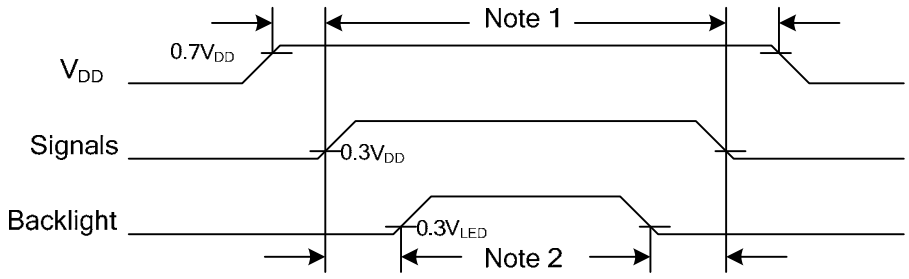
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
	Blue (2)	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0
	Blue (1)	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1

9.8 POWER SEQUENCE



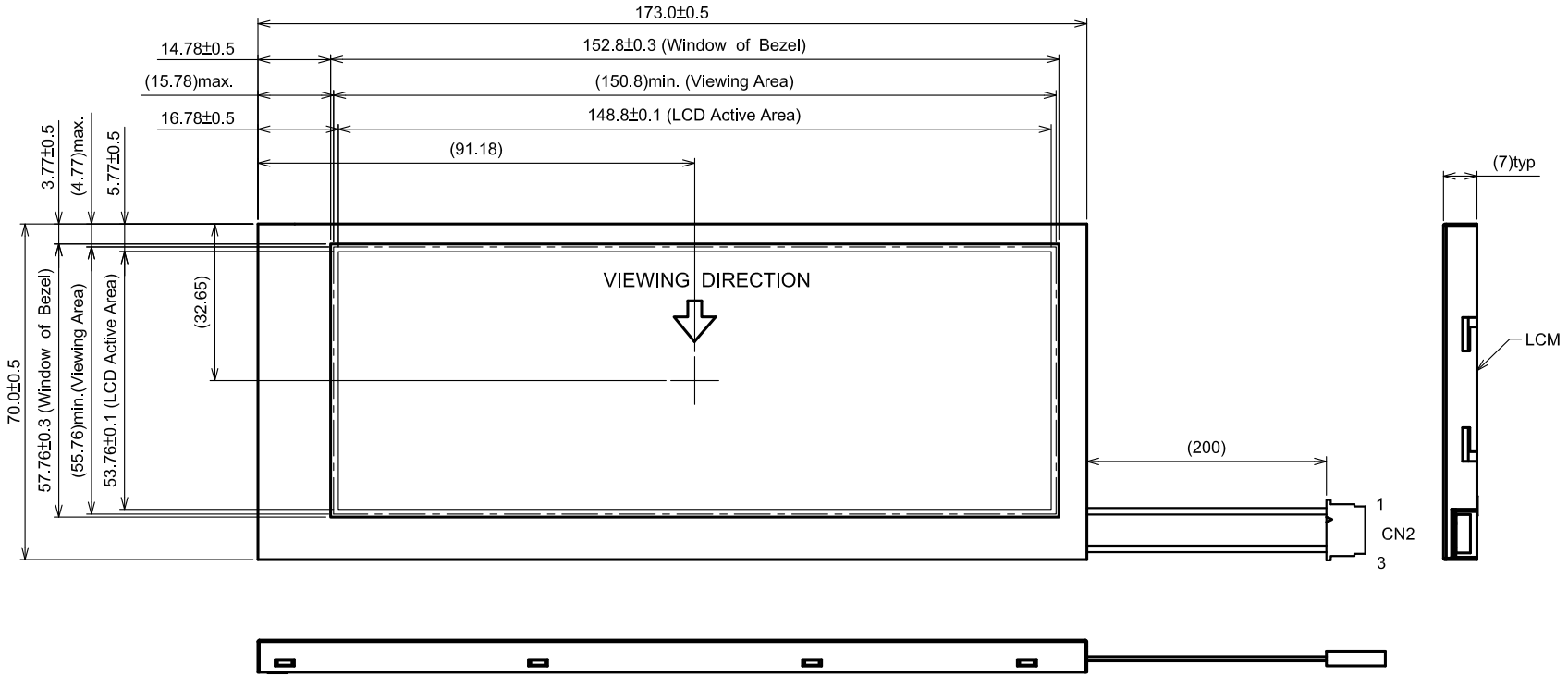
Power Sequence Timing

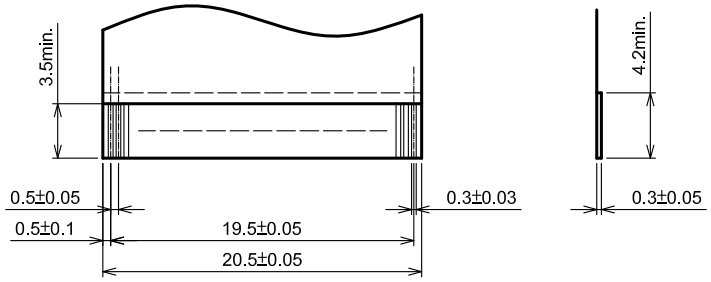
Note 1: In order to avoid any damages, V_{DD} has to be applied before all other signals. The opposite is true for power off where V_{DD} has to be remained on until all other signals have been switch off. The recommended time period is 1 second. Hot plugging might cause display damage due to incorrect power sequence, please pay attention on interface connecting before power on.

Note 2: In order to avoid showing uncompleted patterns in transient state. It is recommended that switching the backlight on is delayed for 1 second after the signals have been applied. The opposite is true for power off where the backlight has to be switched off 1 second before the signals are removed.

10. OUTLINE DIMENSIONS

10.1 FRONT VIEW





Recommended design rule for I/F FPC

Scale : NTS
Unit : mm

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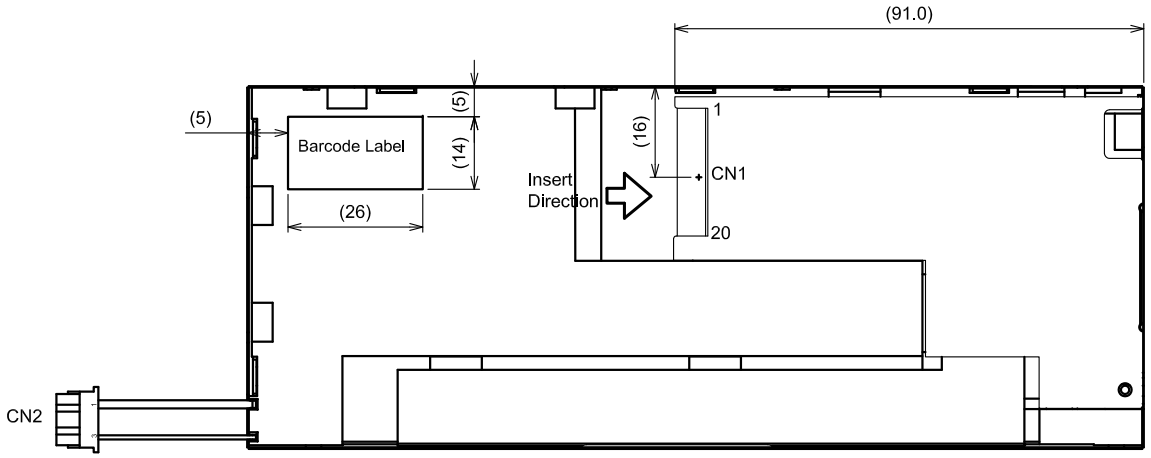
10.2 REAR VIEW



Scale : NTS
Unit : mm

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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.

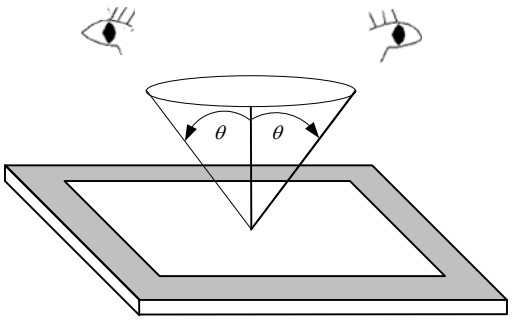


Fig. 11.1

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.

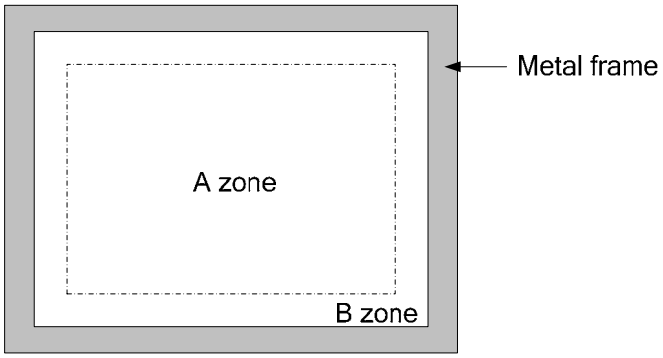


Fig. 11.2

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. 11.4 and Fig. 11.5.

Item	Criteria				Applied zone
Scratches	Length (mm)	Width (mm)	Maximum number	Minimum space	A
	L≦15	W≦0.02	Ignored	-	
	L≦15	0.02＜W≦0.1	5	-	
	L＞15	0.1＜W	0	-	
Dent	Serious one is not allowed				A
Wrinkles in polarizer	Serious one is not allowed				A
Bubbles on polarizer	Average diameter (mm)		Maximum number		A
	D≦0.3		Ignored		
	0.3≦D≦0.6		4		
	0.6＜D		0		
1) Stains 2) Foreign Materials 3) Dark Spot	Filamentous (Line shape)				A
	Length (mm)	Width (mm)	Maximum number		
	L≦2.0	W≦1.5	5		
	L＞2.0	1.5＜W	0		
	Round (Dot shape)				A
	Average diameter (mm)	Maximum number	Minimum Space		
	D≦0.2	Ignored	-		
	0.2≦D＜0.6	4	-		
	0.6≦D	0	-		
	Those wiped out easily are acceptable				
Dot-Defect		Area①	Area②	Maximum number	A (Note 1)
	Bright dot-defect	1 dot	2 dot	3 dot	
	Dark dot-defect	2 dot	3 dot	4 dot	
	Bright + Dark point	3 dot	4 dot	5 dot	

Note 1: The Dot-Defect inspection within A zone (active area) would be divided into area ①, ② as Fig. 11.3 shown.

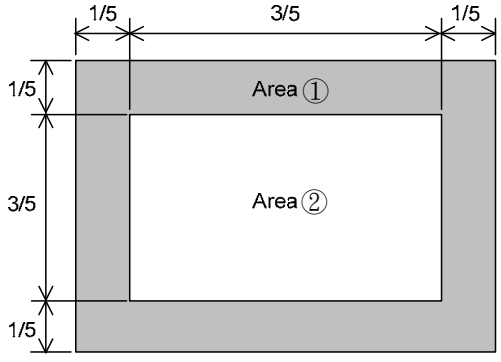


Fig. 11.3

LED BACKLIGHT APPEARANCE

Item	Criteria			Applied zone
Dark Spots White Spots Foreign Materials (Spot)	Average diameter (mm)		Maximum number	A
	D≦0.4		Ignored	
	0.4＜D		None	
Foreign Materials (Line)	Width (mm)	Length (mm)	Maximum number	A
	W≦0.2	L≦2.5	1	
		2.5＜L	None	
	0.2<W	-	None	
Scratches	Width (mm)	Length (mm)	Maximum number	A
	W≦0.1	-	Ignored	
	0.1＜W≦0.2	L≦11.0	1	
		11.0＜L	None	
	0.2＜W	-	None	

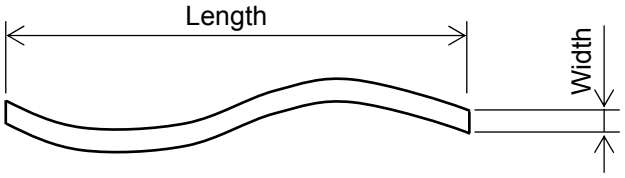
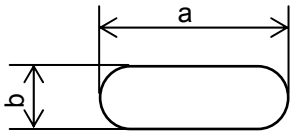


Fig 11.4



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

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.

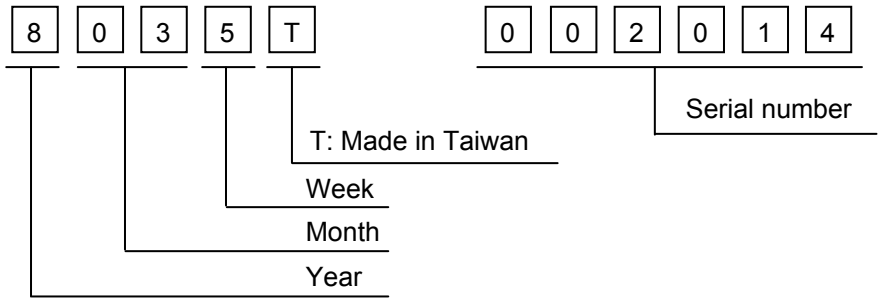
12.4 PRECAUTIONS of STORAGE

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 KOE, 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

1) The lot mark is showing in Fig.13.3. First 4 digits are used to represent production lot, T represented made in Taiwan, and the last 6 digits are the serial number.



2) The tables as below are showing what the first 4 digits of lot mark are shorted for.

Year	Mark
2013	3
2014	4
2015	5
2016	6
2017	7

Month	Mark	Month	Mark
1	01	7	07
2	02	8	08
3	03	9	09
4	04	10	10
5	05	11	11
6	06	12	12

Week (Days)	Mark
1~7	1
8~14	2
15~21	3
22~28	4
29~31	5

3) Except letters I and O, revision number will be shown on lot mark and following letters A to Z.

4) The location of the lot mark is on the back of the display shown in Fig. 13.3.

Fig 13.3