

Display Elektronik GmbH

DATA SHEET

TFT MODULE

**DEM 19201080B VM-PW-N
(C-TOUCH)**

21,5" TFT + PCT

Product Specification

Ver.: 0

23.07.2020

Revise Records

Rev.	Date	Contents	Written	Approved
0	06.08.2020	Preliminary Specification	J	MH

Special Notes

Note1.	
Note2.	
Note3.	
Note4.	
Note5.	

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1. General Description and Features

This Module is a transmissive type color active matrix TFT (Thin Film Transistor) liquid crystal display (LCD) that uses amorphous silicon TFT as a switching device. This model is composed of a TFT-LCD module, a receiver circuit and a back-light unit. Graphics and texts can be displayed on a FHD 1920 (H) x RGB x 1080 (V) dots (16:9 aspect ratio) with 16.7M colors by supplying 24 bits data signal (8 bits each color). The following table described the features:

1.1 Features

- LVDS Interface.
- Projected capacitive touch Screen Panel
- ROHS Compliance

1.2 LCD Module

Item	Specification	Unit
Screen Size	21.53 Inches	Diagonal
Display Resolution	1920 x RGB x 1080	Pixel
Active Area	476.64 x 268.11	mm
Outline Dimension	517.06 x 311.79 x 14.40	mm
Display Mode	VA Mode, Normally Black	--
Pixel Arrangement	R.G.B Vertical Stripe	--
Pixel Size	0.24825 x 0.24825	Mm
Surface Treatment	Clear	-
Display Color	16.7 Million Colors	--
Viewing Direction	Full View	--
Input Interface	Dual Channel LVDS Interface, 8-Bits-RGB Data Input	--

2. Mechanical Information

Item	Min.	Typ.	Max.	Unit	Note
Module Size	Horizontal (H)	--	517.06	--	mm
	Vertical (V)	--	311.79	--	mm
	Thickness (T)	--	14.40	--	mm
Weight	--	TBD	--	--	--

Note (1) Refer to the Outline Dimension Drawing as attached.

3. Electrical Specifications

3.1 Absolute Max. Ratings

3.1.1 Absolute Ratings of Environment

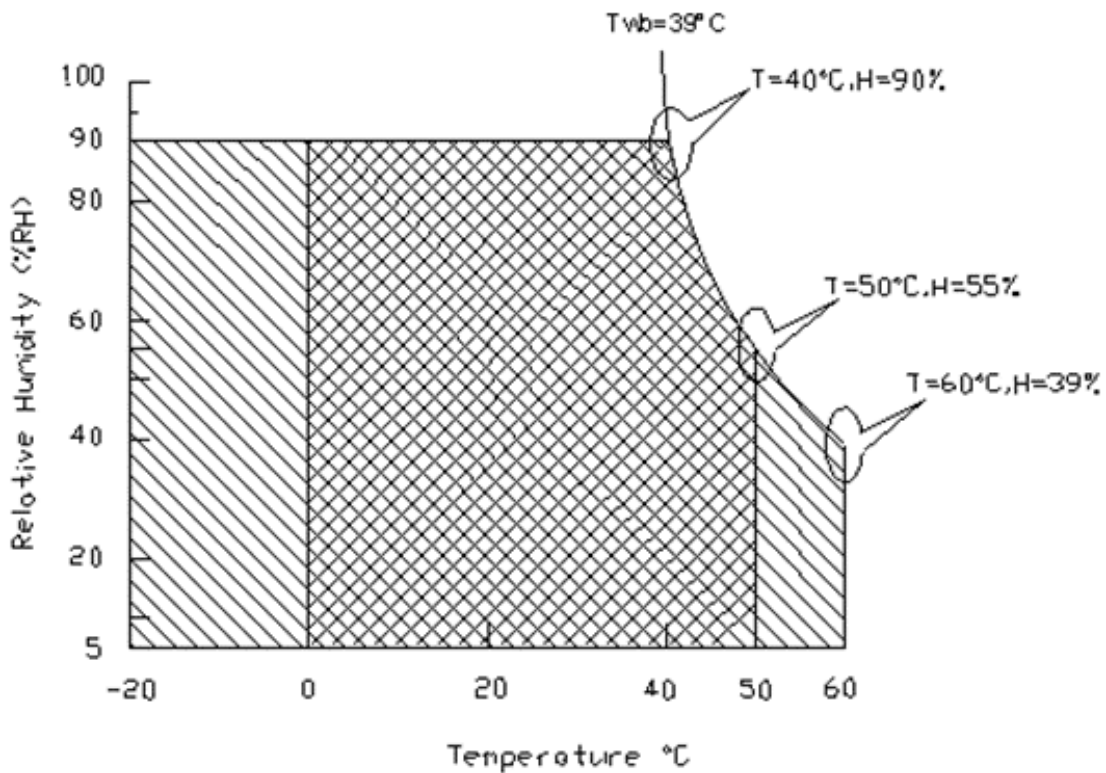
If the operating condition exceeds the following absolute maximum ratings, the TFT LCD module may be damaged permanently.




(Ta=25±2°C)

Item	Symbol	Min.	Max.	Unit	Note
Storage Temperature	T _{STG}	-20	60	°C	(1)
Storage Humidity	H _{St}	5	90	%RH	(1)
Operating Temperature	T _{OPR}	0	50	°C	(1)
Operation Humidity	H _{OP}	5	90	%RH	(1)

Note (1) Temperature and relative humidity range are shown as the below figure.

- 90% RH Max (Ta ≤ 39°C).
- Max wet-bulb temperature at 39°C or less. (Ta ≤ 39°C)
- No condensation



Operating Range  Storage Range  + 

3.1.2 Electrical Absolute Maximum Ratings

3.1.2.1 TFT-LCD Module

Parameter	Symbol	Min.	Max.	Unit	Remark
Power Supply Input Voltage	VDD	GND-0.3	+6.0	V	Ta=25°C

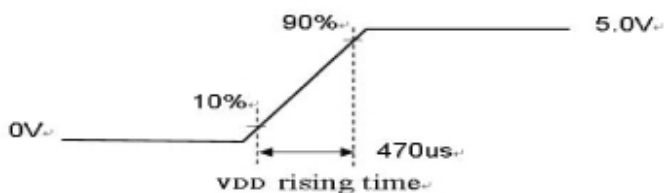
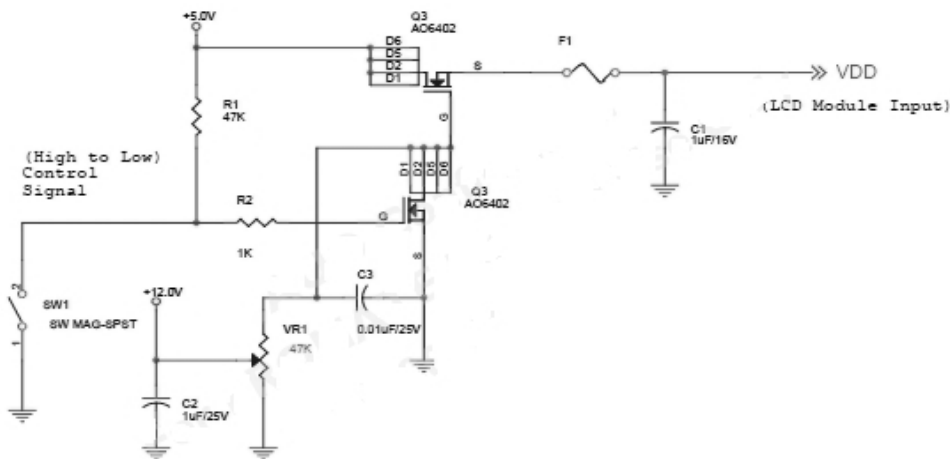
3.1.3 DC Electrical Characteristics of the TFT LCD

(Ta=25±2°C)

Item	Symbol	Min.	Typ.	Max.	Unit	Remark
Power Supply Input Voltage	VDD	4.5	5.0	5.5	V	
Power Supply Input Current (RMS)	IDD	--	0.62	0.74	A	VDD=5.0V, Black Pattern, Fv= 60Hz
			0.7	0.84	A	VDD=5.0V, Black Pattern, Fv=75Hz
VDD Power Consumption	PDD	--	3.1	3.7	Watt	VDD=5.0V, Black Pattern, Fv= 60Hz
			3.5	4.2	Watt	VDD=5.0V, Black Pattern, Fv=75Hz
Inrush Current	IRush	--	--	3.0	A	Note 1
Allowable V _{DD} Ripple Voltage	VDDrp	--	--	500	mV	VDD=5.0V, Black Pattern, Fv=75Hz

Note1: Inrush Current Measurement:

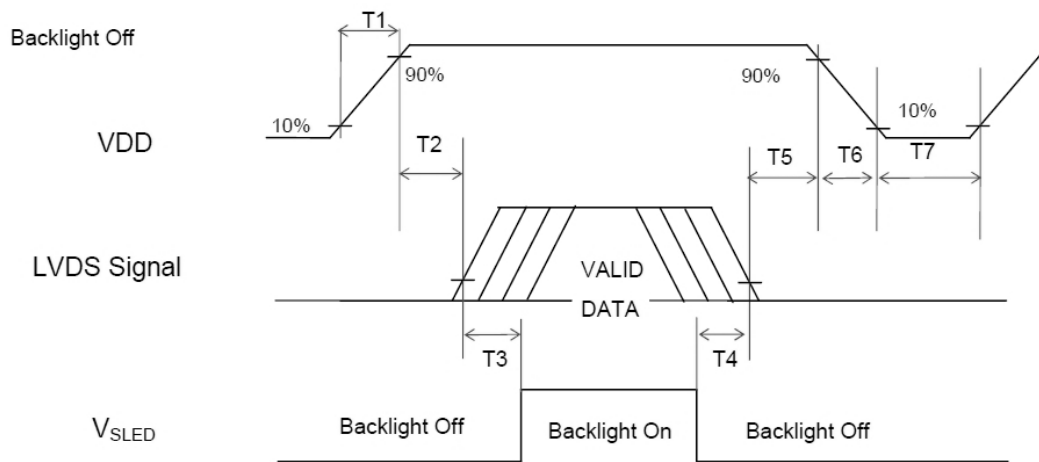
Test Circuit:



The duration of VDD rising time: 470µs.

3.1.4 Power Signal Sequence

VDD power LVDS signal and backlight on/off sequence are as following. LVDS Signals from any system shall be Hi-Z state or low level when VDD is off.



Power sequence timing

Parameter	Value			Units
	Min.	Typ.	Max.	
T1	0.5	-	10	ms
T2	0	-	50	ms
T3	500	-	-	ms
T4	100	-	-	ms
T5	0	-	50	ms
T6	0	-	100	ms
T7	1000	-	-	ms

Note 1: Recommend setting T5 = 0ms to avoid electronic noise when VDD is off.

Note 2: During T5 and T6 period, please keep the level of input LVDS signals with Hi-Z state.

3.2 AC Timing Characteristic of The LCD

3.2.1 Timing Condition

It only support DE mode, and the input timing are shown as the following table.

Signal	Item	Symbol	Min.	Typ.	Max.	Unit.
Vertical section	Period	Tv	1092	1130	1818	Th
	Active	Tdisp (v)	1080	1080	1080	Th
	Blanking	Tblk (v)	12	50	738	Th
	Frequency	Fv	50	60	76	Hz
Horizontal section	Period	Th	1034	1050	1100	Tclk
	Active	Tdisp(h)	960	960	960	Tclk
	Blanking	Tblk (h)	74	90	140	Tclk
	Frequency	Fh	55	68	91	KHz
LVDS Clock	Period	Tclk	10.6	14.0	17.7	ns
	Frequency	Fclk	56.5	71.2	94	MHZ

Note 1: The equation is listed as following. Please don't exceed the above recommended value.

$$Fh (\text{Min.}) = Fclk (\text{Min.}) / Th (\text{Min.})$$

$$Fh (\text{Typ.}) = Fclk (\text{Typ.}) / Th (\text{Typ.})$$

$$Fh (\text{Max.}) = Fclk (\text{Max.}) / Th (\text{Min.})$$

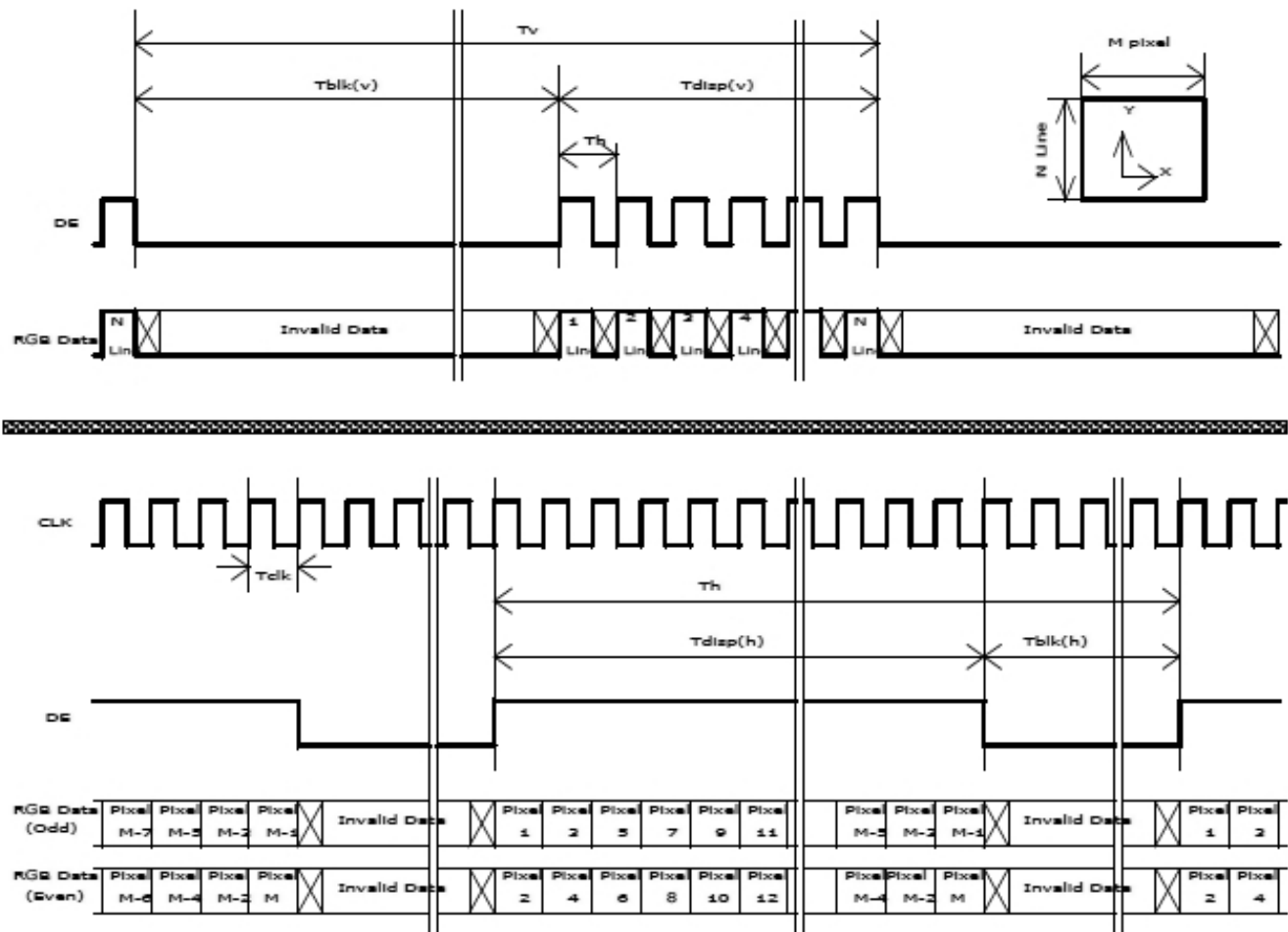
Note 2: The equation is listed as following. Please don't exceed the above recommended value.

$$Fclk (\text{Min.}) = Fv (\text{Min.}) \times Th (\text{Min.}) \times Tv (\text{Min.})$$

$$Fclk (\text{Typ.}) = Fv (\text{Typ.}) \times Th (\text{Typ.}) \times Tv (\text{Typ.})$$

$$Fclk (\text{Max.}) = Fv (\text{Max.}) \times Th (\text{Typ.}) \times Tv (\text{Typ.})$$

3.2.2 Timing Characteristic
 3.2.2.1 Timing Diagram



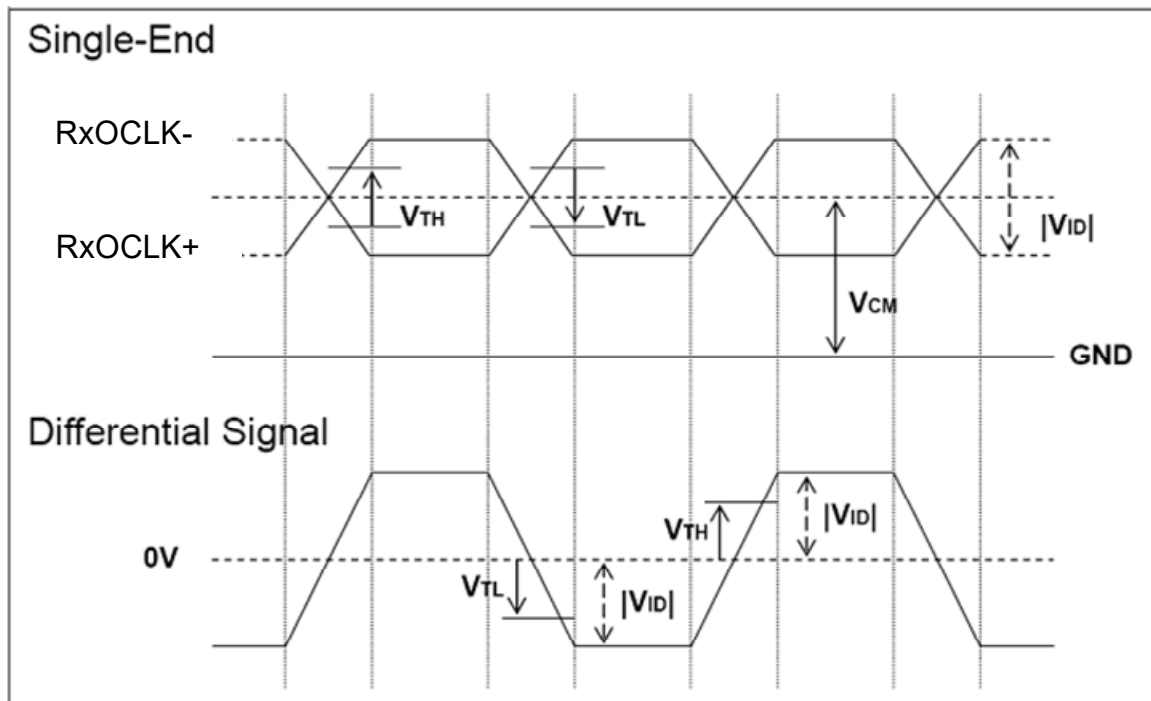
3.3 LVDS Switching Characteristics

3.3.1 DC Characteristics

Item	Symbol	Min.	Typ.	Max.	Unit	Remark
LVDS Differential Input High Threshold	V_{TH}	--	--	+100	mV	$V_{ICM}=1.2V$
LVDS Differential Input Low Threshold	V_{TL}	-100	--	--	mV	$V_{ICM}=1.2V$
LVDS Differential Input Voltage	$ V_{ID} $	100	--	600	mV	
LVDS Common Mode Voltage	V_{CM}	+1.0	+1.2	+1.5	V	$V_{TH}-V_{TL} = 200mV$

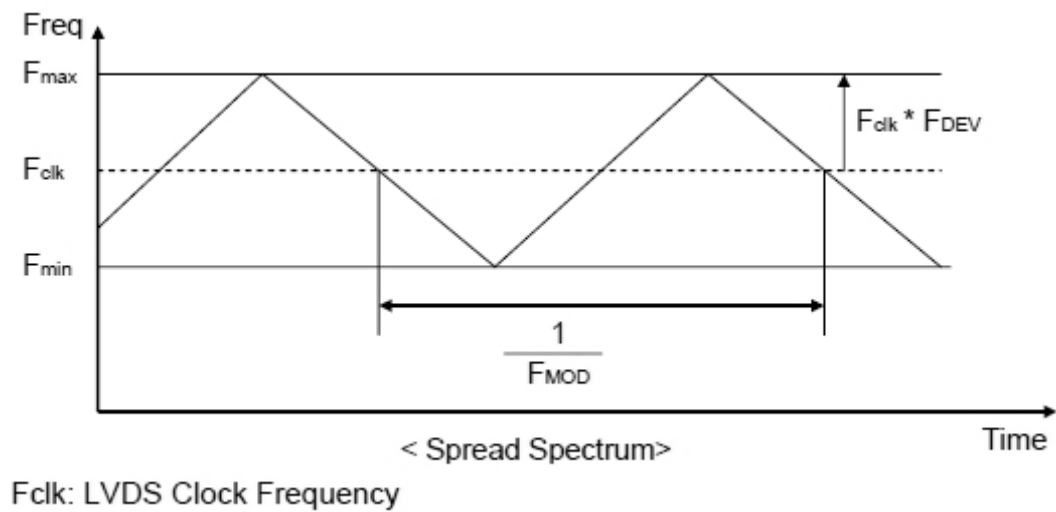
LVDS Signal Waveform

Use RxOCLK- & RxOCLK+ as example.

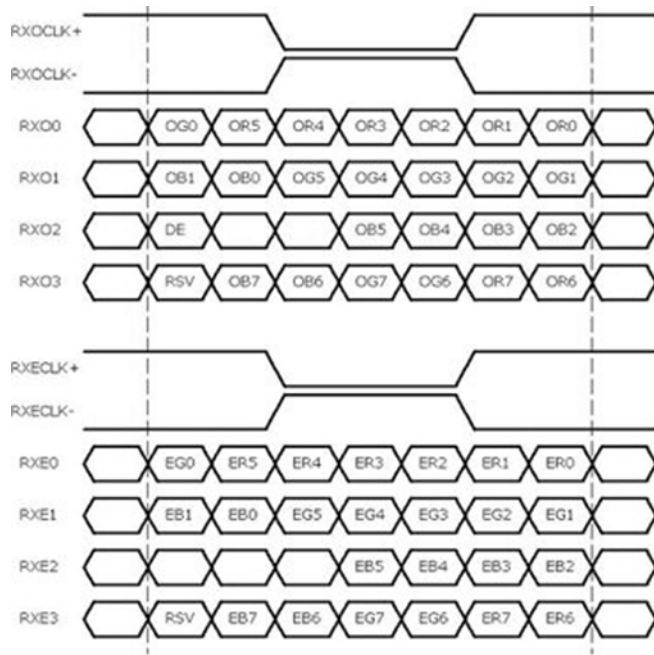


3.3.2 AC Characteristics

Item	Symbol	Min.	Max.	Unit	Remark
Maximum deviation of input clock frequency during Spread Spectrum	F_{DEV}	--	± 3	%	
Maximum modulation frequency of input clock during Spread Spectrum	F_{MOD}	--	200	KHZ	



3.3.3 LVDS Data Format



8 Bit Color Bit Order			
MSB	R7	G7	B7
	R6	G6	B6
	R5	G5	B5
	R4	G4	B4
	R3	G3	B3
	R2	G2	B2
	R1	G1	B1
LSB	R0	G0	B0

Note a. : O = "Odd Pixel Data" EVEN E = "Even Pixel Data".

3.4 Backlight Unit

Following characteristics are measured under a stable condition at 25°C (Room Temperature):

Item	Symbol	Min.	Typ.	Max.	Unit	Remark	
Input Voltage	VBL	10.8	12	13.2	V		
Input Current	IBL	--	3.17	--	A	100% PWM Duty	
Power Consumption	PBL	--	38	--	W	100% PWM Duty	
On Control Voltage	B/L for LED DRIVER Control Signals	2.5	--	5.5	V		
Off Control Voltage		-0.3	0	0.5	V		
PWM Dimming Frequency		500	--	1500	HZ		
Pulse Duty for High Voltage		2.5	--	5.5	V		
Pulse Duty for Low Voltage		0	--	0.5	V		
Brightness Adjust		30	--	100	%		
LED Lifetime		--	30.000	50.000	--	Hrs	

notes :

1. Electrical characteristics are determined after the unit has been 'ON' and stable for approximately 60 minutes at $25 \pm 2^\circ\text{C}$. The specified current and power consumption are under the typical supply Input voltage 24V and V_{BR} ($\text{Ext}V_{BR-B} : 100\%$), it is total power consumption.
2. The life time (MTTF) is determined as the time which luminance of the LED is 50% compared to that of initial value at the typical LED current ($\text{Ext}V_{BR-B} : 100\%$) on condition of continuous operating in LCM state at $25 \pm 2^\circ\text{C}$.
3. The duration of rush current is about 200ms. This duration is applied to LED on time.
4. Even though inrush current is over the specified value, there is no problem if I^2T spec of fuse is satisfied. $\text{Ext}V_{BR-B}$ signal have to input available duty range and sequence.
5. After Driver ON signal is applied, $\text{Ext}V_{BR-B}$ should be sustained from 30% to 100% more than 500ms. After that, $\text{Ext}V_{BR-B}$ 30% and 100% is possible

4. Optical Characteristics

4.1 Optical characteristic of the LCD

The following items are measured under stable conditions. The optical characteristics should be measured in a dark room or equivalent state with the methods.

Measuring equipment: BM-7A

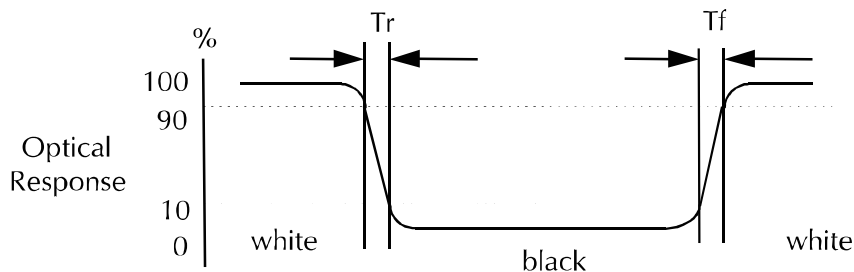
Item	Symbol	Condition	Min	Type	Max	Unit	Note	
Brightness	B	--	650	850	--	cd/m ²	a,f	
Response Time	T _r	θ=0°	--	13	28	ms	b	
	T _f		--	5	8	ms		
Contrast Ratio	CR	At optimized viewing angle	2000	3000	--	--	c	
Luminance Uniformity	ΔL	--	75	80	--	%	g	
Color Gamut	--	--	--	72	--	%	h	
Color Chromaticity (CIE 1931)	White	W _x	θ=0° Normal Viewing Angle	0.283	0.313	0.343	--	a,f
		W _y		0.299	0.329	0.359		
Viewing Angle	Hor.	θ _R	CR≥10	75	89	--	Degree	e
		θ _L		75	89	--		
	Ver.	θ _U		75	89	--		
		θ _D		75	89	--		

a. Test equipment setup

After stabilizing and leaving the panel alone shall be warmed up for the stable operation of LCM, the measurement should be executed. Measurement should be executed in a stable, windless, and dark room. Optical specifications are measured by Topcon BM-7(fast) with a viewing angle of 2° at a distance of 50cm and normal direction.

b. Definition of response time: Tr and Tf

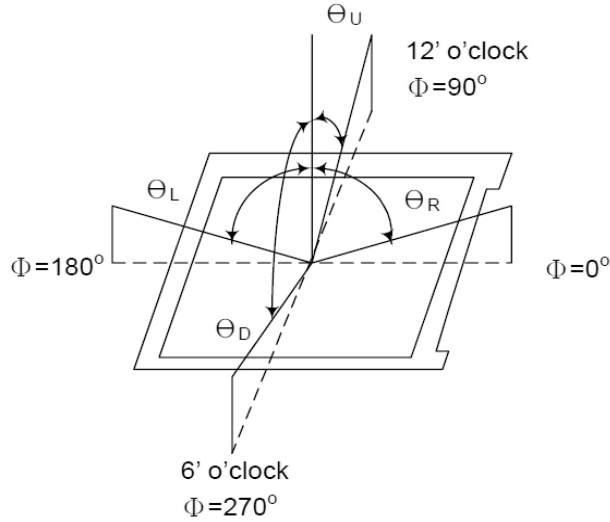
The response time is defined as the following figure and shall be measured by switching the input signal for "black" and "white".



c. Definition of contrast ratio:

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

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



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

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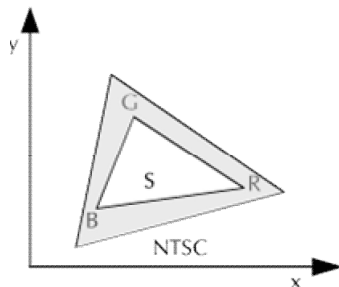
- g. Definition of White Uniformity

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

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

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

Color Gamut : NTSC(%) = (RGB Triangle Area / NTSC Triangle Area) x 100



5. I/O Terminal**5.1 LCD Pin Assignment**

Pin No.	Symbol	Function	Remark
1	RXOIN0-	Negative LVDS differential data input (Odd data)	
2	RXOIN0+	Positive LVDS differential data input (Odd data)	
3	RXOIN1-	Negative LVDS differential data input (Odd data)	
4	RXOIN1+	Positive LVDS differential data input (Odd data)	
5	RXOIN2-	Negative LVDS differential data input (Odd data)	
6	RXOIN2+	Positive LVDS differential data input (Odd data)	
7	GND	Power Ground	
8	RXOCLKIN-	Negative LVDS differential data input (Odd clock)	
9	RXOCLKIN+	Positive LVDS differential data input (Odd clock)	
10	RXOIN3-	Negative LVDS differential data input (Odd data)	
11	RXOIN3+	Positive LVDS differential data input (Odd data)	
12	RXEIN0-	Negative LVDS differential data input (Even data)	
13	RXEIN0+	Positive LVDS differential data input (Even data)	
14	GND	Power Ground	
15	RXEIN1-	Negative LVDS differential data input (Even data)	
16	RXEIN1+	Positive LVDS differential data input (Even data)	
17	GND	Power Ground	
18	RXEIN2-	Negative LVDS differential data input (Even data)	
19	RXEIN2+	Positive LVDS differential data input (Even data)	
20	RXECLKIN-	Negative LVDS differential data input (Even clock)	
21	RXECLKIN+	Positive LVDS differential data input (Even clock)	
22	RXEIN3-	Negative LVDS differential data input (Even data)	
23	RXEIN3+	Positive LVDS differential data input (Even data)	
24	GND	Power Ground	
25	NC	NC	
26	NC	NC	
27	NC	NC	
28	VDD	Power Supply Input Voltage	
29	VDD	Power Supply Input Voltage	
30	VDD	Power Supply Input Voltage	

Note 1: User connector part No: P-TWO AL230F-A0G1D-P or equivalent.

Mating housing part No: JAE FI-X30HL (Locked Type) or equivalent.

5.2 LED Backlight Unit

Pin No.	Symbol	Function	Remark
1	VCC	Power Supply Voltage for LED backlight	
2	VCC	Power Supply Voltage for LED backlight	
3	VCC	Power Supply Voltage for LED backlight	
4	VCC	Power Supply Voltage for LED backlight	
5	VCC	Power Supply Voltage for LED backlight	
6	GND	Power Ground	
7	GND	Power Ground	
8	GND	Power Ground	
9	GND	Power Ground	
10	GND	Power Ground	
11	NC	Not Connect	
12	ON/OFF	Output Enable Signal	
13	DIM	Dimming Signal	
14	NC	Not Connect	

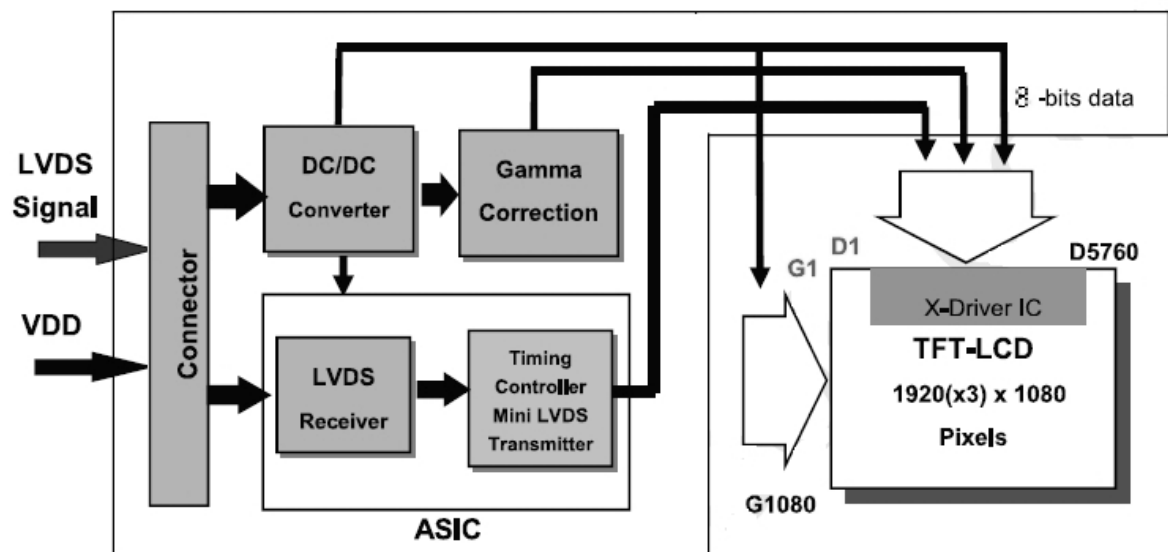
Note: User connector part No: PH2.0-14(2.0mmX14) or equivalent.

5.3 Touch Panel Pin Assignments

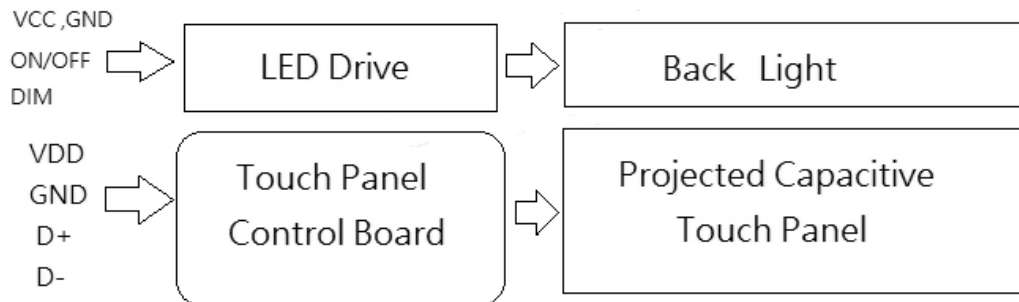
Pin No.	Symbol	Function	Remark
1	GND	Ground	
2	VDD	Power supply 5V (USB)	
3	GND	Ground	
4	D+	Data+ (USB)	
5	D-	Data- (USB)	

Note: User connector part No: ACES 50271-0050N-001 or equivalent.

5.4 Block Diagram



Control Board



6. Displayed Color and Input Data

	Color & Gray Scale	Data Signal																							
		R7	R6	R5	R4	R3	R2	R1	R0	G7	G6	G5	G4	G3	G2	G1	G0	B7	B6	B5	B4	B3	B2	B1	B0
Basic Color	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	Red	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	Green	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	
	Blue	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	
	Cyan	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
	Magenta	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	
	Yellow	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	
	White	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Red	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	Red(1)	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	Red(2)	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:		
	Red(127)	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:		
	Red(254)	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	Red(255)	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Green	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	Green(1)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	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		
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:		
	Green(127)	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0		
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:		
	Green(254)	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0		
	Green(255)	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	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	0	0	0	0		
	Blue(1)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1		
	Blue(2)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1		
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:		
	Blue(127)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1		
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:		
	Blue(254)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0		
	Blue(255)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1		

0 : Low level voltage, 1 :High level voltage

Each basic color can be displayed in 256 gray scales from 8 bit data signals. With the combination of total 24 bit data signals, the 16.7M color display can be achieved on the screen.

7. Projected capacitive touch Screen Panel Specifications**7.1 Touch Panel**

Item	Specification	Unit
Screen Size	21.5 Inches	Diagonal
Type	Projected Capacitive Touch Panel	--
Input Mode	Human's Finger or Through a special stylus	--
Construction	Cover Glass + OCA + Sensor Glass	--
Sensor Active Area	480.64 x 272.11	mm
Cover Glass Pencil-Hardness	>= 6H	--
Interface	USB	--
Digital Power Supply	5V DC	V
Touch Function	2	points
IC solution	EETI (EXC80W84) or equivalent	--

8. Reliability Condition

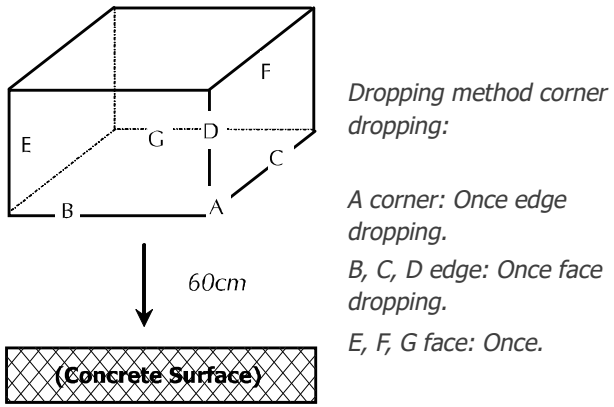
No change on display and in operation under the following test condition.

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

Temperature: 20°C ± 5°C.

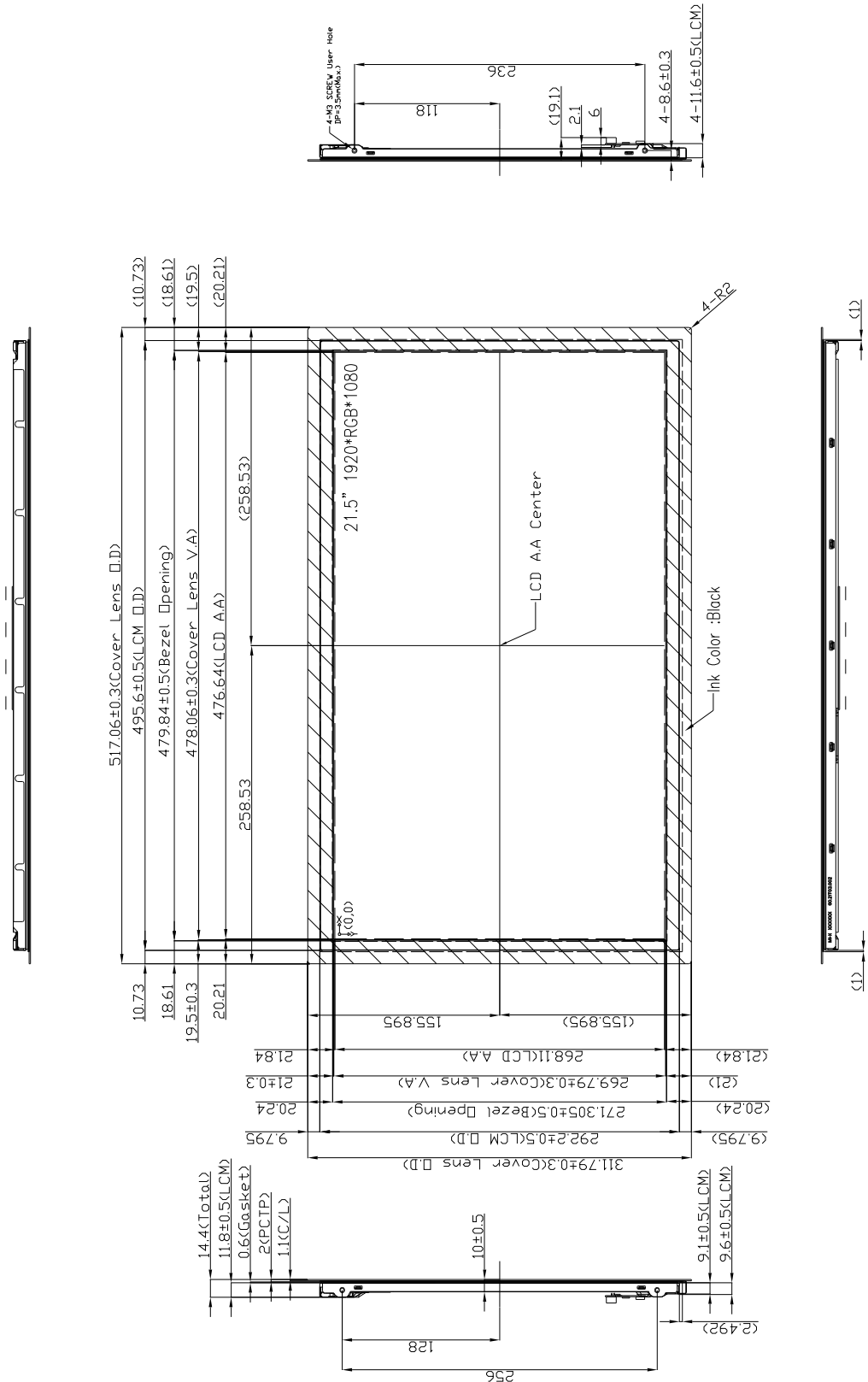
Humidity: 65%RH ± 5%RH.

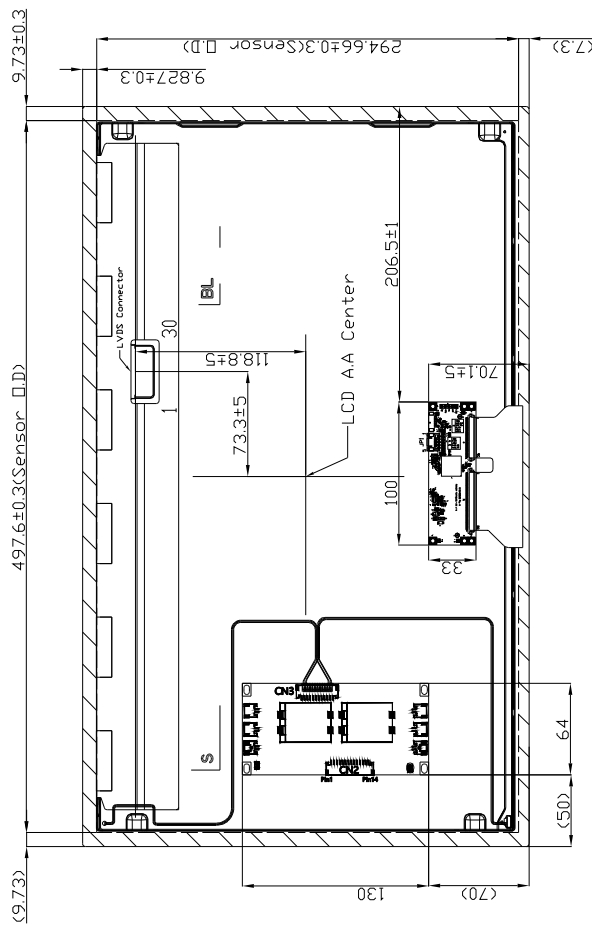
Tests will be not conducted under functioning state.

No.	Parameter	Condition	Notes
1	High Temperature Operating	+50°C±2°C, 240hrs.	
2	Low Temperature Operating	+0°C±2°C, 240hrs.	1
3	High Temperature Storage	+60°C±2°C, 240hrs.	2
4	Low Temperature Storage	-20°C±2°C, 240hrs.	1,2
5	High Temperature and High Humidity Operation Test	+50°C±2°C, 80%RH, 240hrs.	1,2
6	Thermal Shock (non Operation)	-20°C/30min~+60°C/30min for a total 100 cycles.	1,2
6	Vibration Test	Total fixed amplitude: 1.5mm. Vibration Frequency: 10~55Hz. One cycle 60 seconds to 3 direction of X, Y, Z each 15 minutes.	3
7.	Drop Test	To be measured after dropping from 60cm high on the concrete surface in packing state.  <i>Dropping method corner dropping:</i> <i>A corner: Once edge dropping.</i> <i>B, C, D edge: Once face dropping.</i> <i>E, F, G face: Once.</i>	

- Notes:
1. No dew condensation to be observed.
 2. The function test shall be conducted after 4 hours storage at the normal temperature and humidity after removed from the test chamber.
 3. Vibration test will be conducted to the product itself without putting I in a container.

9. Dimensional Outlines





Note:

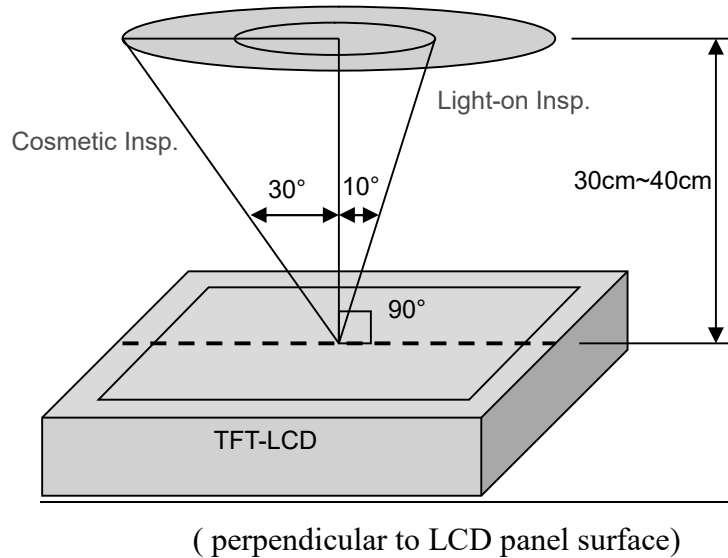
1. General tolerance : +/- 0.5mm.
2. LVDS connector : P-TWO AL230F-A0G1D-P or equivalent.
Mating connector : JAE FI-X30HL(Locked Type) or equivalent.
3. LED backlight connector (CN2) : PH2.0-14(2.0mmX14) or equivalent.
4. Touch Panel connector (JPI) : ACES 50271-0050N-001 or equivalent.
5. Torque of M3 user hole should be within 4 kgf-cm and re-screw 10 times.

10. Incoming Inspection Standards

10.1 Inspection and Environment Conditions

10.1.1 Inspection Conditions:

- (1) Inspection Distance: 35 cm±5cm
- (2) View Angle: Light-on Inspection Angle : ±10°
Cosmetic Inspection Angle : ±30°



10.1.2 Environment Conditions:

Ambient Temperature		20~25°C
Ambient Humidity		65±5%RH
Ambient Illumination	Display Surface	300~700 Lux
	Standard	500 Lux

10.1.3 Sampling Conditions:

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

Sampling Plan		MIL-STD-105E
		Normal Inspection, Single Sampling
		Level II
AQL	Major Defect	1.0%
	Minor Defect	2.5%

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

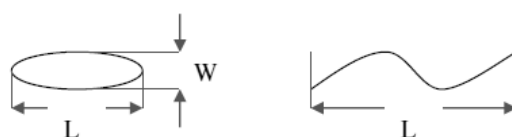
10.1.4 Inspection Criteria

10.1.4.1 Cosmetic Inspection (Panel):

Judge area	Judge item		Inspection specification		Judge criterion	
					Major	Minor
Active area (Note 4)	Particles scratch and bubbles in display area (include bright & dark spot, Note 1, 2,3)	Round	Average diameter: D (mm) 0.5 < D ≤ 1.0	Numbers(N) N ≤ 10		○
		Linear	Width: W (mm) Length: L (mm)	Numbers N ≤ 10		○
			0.15 < W ≤ 0.2 , 1 < L ≤ 20	N ≤ 10		○
Bezel	Scratch		No harm			○
	Dirt					○
	Wrap		No dangerous		○	
	Sunken		No harm		○	
Label (S/N, B/L, Week code	No label		No		○	
	Invert label				○	
	Broken				○	
	Dirt		Word can be read.			○
	Not clear					○
	Word out of shape					○
	Mistake		No			○
	Position		Be attached on right position			○
Solder	Appearance		Can't see the abnormal color, shape, hurt, dirt (fused goods, etc.). If it is necessary, please prepare sample.		○	
Screw	Not enough		No		○	
	Limp		No		○	
Connector	Connection status		Need correct connection		○	
FPC/FFC	Broken		No		○	

Note 1: When $L \geq 2W$, defect count as liner defect.

Note 2: $D = 1/2(W + L)$.



Note 3: To verify the responsibility of following defects was caused by supplier, the IQC checks as requested on above items before mass production such as the Polarizer Scratch, Gap Mura, TFT Glass broken...etc.

10.1.4.2 Functional Inspection:

Inspection Item	Specification	
Line/Block defect	Can't be seen.	
Bright dots	≤2 dots (note 1,4)	
Dark dots	≤5 dots	
Total dots defect	≤5 dots	
Adjacent dot defect (Note 1, 2, 3)	Two continuous bright dots (vertical, horizontal, oblique):	≤1 pair
	Three or more continuous bright dots (vertical, horizontal, oblique):	Not allow
	Two continuous dark dots (vertical, horizontal, oblique):	≤2 pair
	Three or more continuous dark dots (vertical, horizontal, oblique):	≤1 pair
	Distance between 2 Bright dots	Not allow
	Distance between 2 Dark dots	≥15mm
	Distance between Bright and Dark dot:	Not allow
Display Non-uniformity (Mura)	Use 2% ND filter or equivalent sample if necessary (note 5&6)	

Note 1) For bright dot defect, bright area should be larger than 1/2 area of a sub-pixel to be count as 1 dot defect. A dot defect that is smaller than the defined dot defect will be treated as small bright dot.

The drawing of 1/2 area sub-pixel definition: The 1/2 area sub-pixel can be defined as below one or more of specific shapes (Fig.1).



Fig.1



Fig.2

All bright dot defects should not be noticeable by observer under specified inspection environment.

Note 2) (Fig.2) Adjacent-dot defect (refer to picture, dot 1,2,...,8 around A are all A's adjacent dots) should be inspected under the same display pattern in any one of White /Black/Red /Green /Blue /Monotone Gray pattern.

Note 3): Adjacent-dot defect should be observed under any one of White /Black /Red /Green/ Blue pattern. 1 pair of bright dots equals 2 dots. Inspection patterns. Inspection patterns:

Standard inspection patterns of dot defect are listed below. SGD uses these patterns as standard criteria for judging dot defect. Please inform SGD if any other pattern is to be used to examine dot defect.

Test Pattern	Defect
Full Black	For bright dot(s)
Full White	For dark dot(s)
Monotone Red /Green /Blue	For bright and dark dot(s)

Note 4) The judgment criteria of particle occurred bright dot is the same as bright dot judgment criteria.

Note 5) The display uniformity (general mura) symptoms will use 2% ND Filter. That is, the definition of Not Noticeable means the symptom can be covered by 2% ND Filter. Movable mura should be ignored if the mura disappear after lightly patting on the mura area. And the weak line defect can be counted as mura which can be invisible while 2% ND filter applied.

Note 6) The inspection method of ND Filter - holding ND filter in front of the panel around 1 cm and examine the panel from 35±5 cm in the front view for 3 seconds.