



Display Future Ltd

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LCD MODULE SPECIFICATION

Model: DF-TFC0502FW-M1

This module uses ROHS materials

For customer acceptance

Customer		date
Approved		
Comments		

The standard product specification may change without prior notice in order to improve performance or quality. Please contact Display Future Ltd for updated specification and product status before design for the standard product or release of the order.

Revision	1.0
Engineering	
Date	2018/01/4
Our Reference	

REVISION RECORD

[illegible]

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■ GENERAL INFORMATION

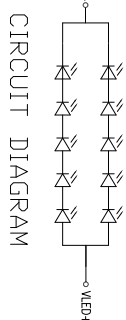
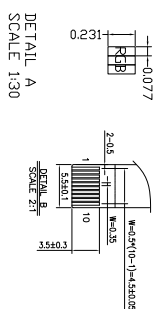
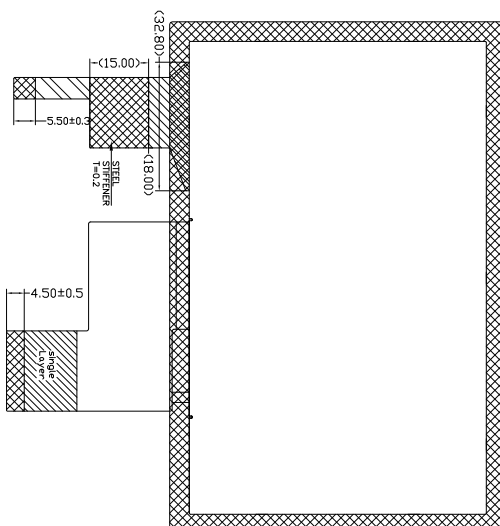
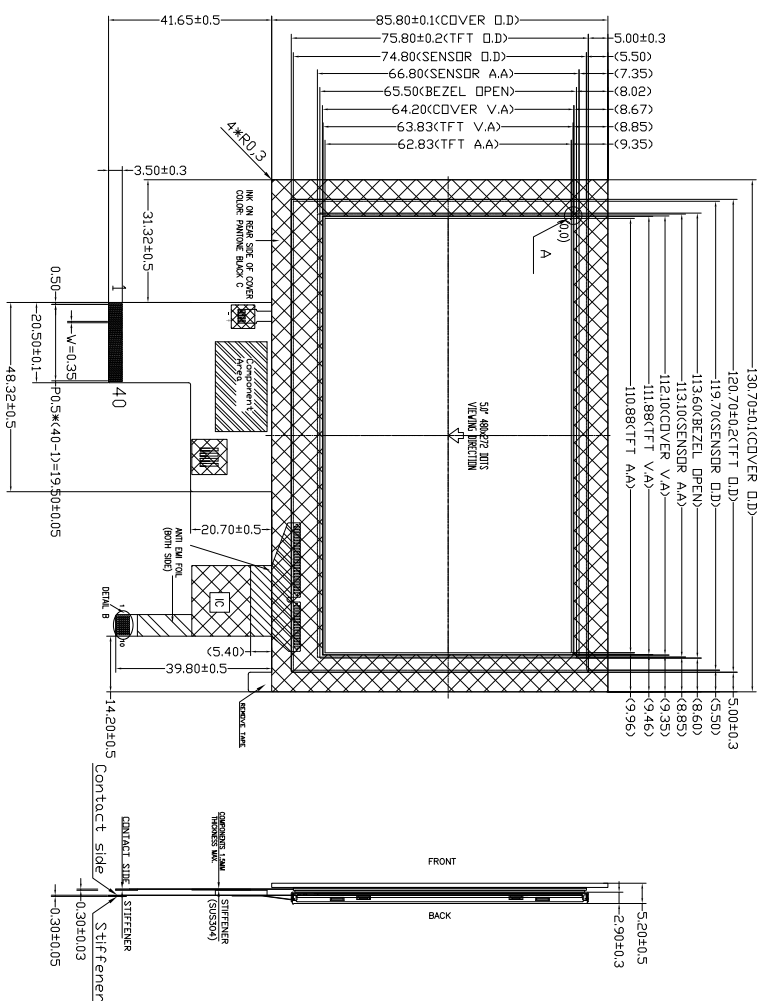
Item	Contents	Unit
LCD type	TFT/Transmissive/Normally white	/
Size	5.0	Inch
Viewing direction	12:00(without image inversion and least brightness change)	O' Clock
Gray scale inversion direction	6:00(contrast peak located at)	O' Clock
LCM (W × H)× D	130.70×85.80×5.20	mm ³
Active area (W×H)	110.88×62.83	mm ²
Pixel pitch (W×H)	0.231×0.231	mm ²
Number of dots	480 (RGB) × 272	/
Driver IC	ILI6480B	/
Backlight type	10 LEDs	/
Interface type	24-bit RGB	/
Color depth	16.7M	/
Pixel configuration	R.G.B vertical stripe	/
Top polarizer surface treatment	Anti-glare	/
Input voltage	3.3	V
With/Without TSP	With CTP	/
TP surface treatment	TBD	/
Weight	TBD	g

Note 1: RoHS compliant;

Note 2: LCM weight tolerance: ± 5% .

NOTES FOR TFT:



1. DISPLAY TYPE: TFT, TRANSMISSIVE, NORMALLY WHITE.
2. OPERATING VOLTAGE: VDD=3.3V.
3. VIEWING DIRECTION: 12 O'CLOCK.
4. IC DRIVER: ILI6480B.
5. OPERATING TEMP: -20°C ~ 70°C.
6. STORAGE TEMP: -30°C ~ 80°C.
7. LED BACKLIGHT: 10-CHIP WHITE LED. If=40mA, Vf=1.6V.
8. SURFACE LUMINANCE: 200cd/m²(TP).
9. TREATMENT OF TOP SURFACE : ANTI-GLARE.
10. FPC CONNECTOR SUGGESTION "FH19SC-40S-0.5SH"
11. GENERAL TOLERANCE: ±0.2.
12. ROHS COMPLIANT.




1	VEED-	1	Tf1 I/O PINS
2	VEED+	2	
3	IND	3	
4	VDD	4	
5	R0	5	
6	R1	6	
7	R2	7	
8	R3	8	
9	R4	9	
10	R5	10	
11	R6	11	
12	R7	12	
13	G0	13	
14	G1	14	
15	G2	15	
16	G3	16	
17	G4	17	
18	G5	18	
19	G6	19	
20	G7	20	
21	B0	21	
22	B1	22	
23	B2	23	
24	B3	24	
25	B4	25	
26	B5	26	
27	B6	27	
28	B7	28	
29	GND	29	
30	CLK	30	
31	DSP	31	
32	HSPNC	32	
33	VSPNC	33	
34	DE	34	
37	NC	37	
38	NC	38	
39	NC	39	
40	NC	40	

CTP I/D PINS

1	VSS
2	VCC
3	SCL
4	NC
5	SDA
6	NC
7	/RST
8	NC
9	/INT
10	VSS

01	First issue	2016.10.26	APPROVED BY:	mm	DESCRIPTION: TFT & CTP MODULE
VER. REVISED DESCRIPTION	DATE	VERSION NO:	01		
					



Display Future Ltd.

■ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Min	Max	Unit
Supply voltage for logic	VDD	-0.3	3.6	V
Supply current(One LED)	I _{LED}	-	30	mA
Operating temperature	T _{OP}	-20	70	°C
Storage temperature	T _{ST}	-30	80	°C
Humidity	RH	-	90%(Max60°C)	RH

■ELECTRICAL CHARACTERISTICS

Parameter	Symbol	Min	Typ	Max	Unit
Supply voltage for logic	VDD	3.0	3.3	3.6	V
Current for driver	I _{vdd}	-	18	26	mA
Input voltage 'H' level	V _{IH}	0.8VDD	-	VDD	V
Input voltage 'L' level	V _{IL}	-0.3	-	0.2VDD	V

■ BACKLIGHT CHARACTERISTICS

Item	Symbol	Min.	Typ.	Max.	Unit	Condition
Forward voltage	V _f	15.0	16.0	17.0	V	Ta=25±2°C, 60%RH±5%
Forward current	I _f	-	40	-	mA	
Power consumption	W _{BL}	-	640	-	mW	
Operating life time	-	20000	-	-	Hrs	

Note :

Operating life time means brightness goes down to 50% initial brightness;

The life time of LED will be reduced if LED is driven by high current,high ambient temperature and humidity conditions;

■ELECTRO-OPTICAL CHARACTERISTICS

Item		Symbol	Condition	Min	Typ	Max	Unit	Remark	Note
Response time		Tr+Tf	$\theta=0^{\circ}$ $\varnothing=0^{\circ}$ Ta=25°C	-	30	-	ms	FIG 1.	4
Contrast ratio		Cr		350	500	-	---	FIG 2.	1
Luminance uniformity		δ WHITE		80	85	-	%	FIG 2.	3
Surface Luminance		Lv		-	200	-	cd/m ²	FIG 2.	2
Viewing angle range		θ	$\varnothing = 90^{\circ}$	-	55	-	deg	FIG 3.	6
			$\varnothing = 270^{\circ}$	-	65	-	deg	FIG 3.	
			$\varnothing = 0^{\circ}$	-	65	-	deg	FIG 3.	
			$\varnothing = 180^{\circ}$	-	65	-	deg	FIG 3.	
CIE (x, y) chromaticity	Red	x	$\theta=0^{\circ}$ $\varnothing=0^{\circ}$ Ta=25°C	0.558	0.608	0.658	FIG 2.	5	
		y		0.266	0.316	0.366			
	Green	x		0.255	0.305	0.355			
		y		0.506	0.556	0.606			
	Blue	x		0.085	0.135	0.185			
		y		0.087	0.137	0.187			
	White	x		0.255	0.305	0.355			
		y		0.284	0.334	0.384			

Note 1. Contrast Ratio(CR) is defined mathematically as For more information see FIG 2.

$$\text{Contrast Ratio} = \frac{\text{Average Surface Luminance with all white pixels (P1, P2, P3, P4, P5)}}{\text{Average Surface Luminance with all black pixels (P1, P2, P3, P4, P5)}}$$

Note 2. Surface luminance is the LCD surface from the surface with all pixels displaying white. For more information see FIG 2.

$$L_v = \text{Average Surface Luminance with all white pixels (P1, P2, P3, P4, P5)}$$

Note 3. The uniformity in surface luminance , δ WHITE is determined by measuring luminance at each test position 1 through 5, and then dividing the maximum luminance of 5 points luminance by minimum luminance of 5 points luminance. For more information see FIG 2.

$$\delta \text{ WHITE} = \frac{\text{Minimum Surface Luminance with all white pixels (P1, P2, P3, P4, P5)}}{\text{Maximum Surface Luminance with all white pixels (P1, P2, P3, P4, P5)}}$$

Note 4. Response time is the time required for the display to transition from White to black(Rise Time, Tr) and from black to white(Decay Time, Tf). For additional information see FIG 1. The test equipment is Autronic-Melchers's ConoScope. Series.

Note 5. CIE (x, y) chromaticity, The x, y value is determined by measuring luminance at each test position 1 through 5, and then make average value.

Note 6. Viewing angle is the angle at which the contrast ratio is greater than 2. For TFT module the contrast ratio is greater than 10. The angles are determined for the horizontal or x axis and the vertical or y axis with respect to the z axis which is normal to the LCD surface. For more information see FIG 3.

Note 7. For viewing angle and response time testing, the testing data is base on Autronic-Melchers's ConoScope. Series Instruments For contrast ratio, Surface Luminance, Luminance uniformity, CIE The test data is base on TOPCON's BM-5 photo detector.

FIG. 1 The definition of Response Time

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

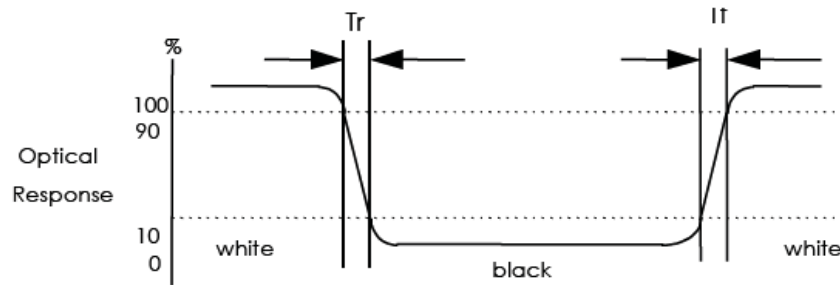


FIG. 2 Measuring method for Contrast ratio, surface luminance, Luminance uniformity, CIE (x, y) chromaticity

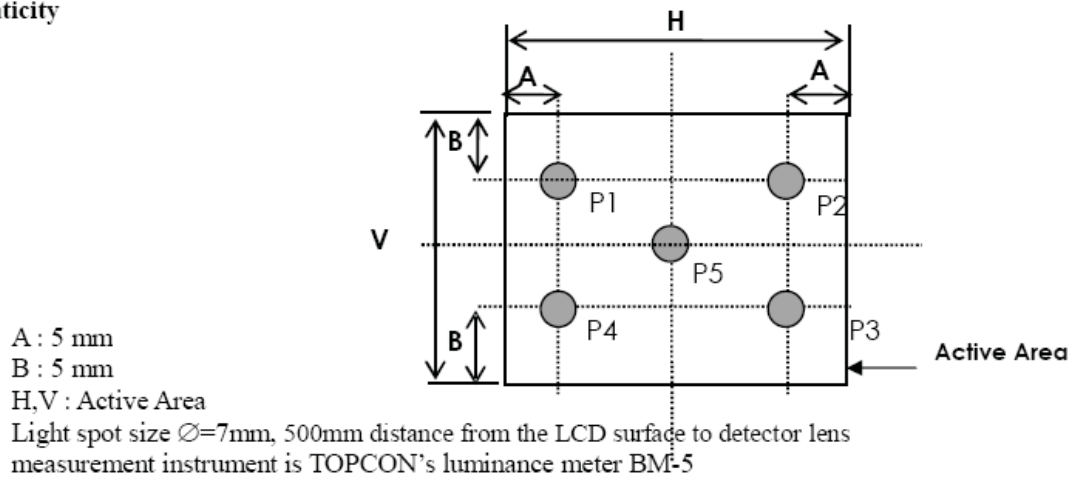
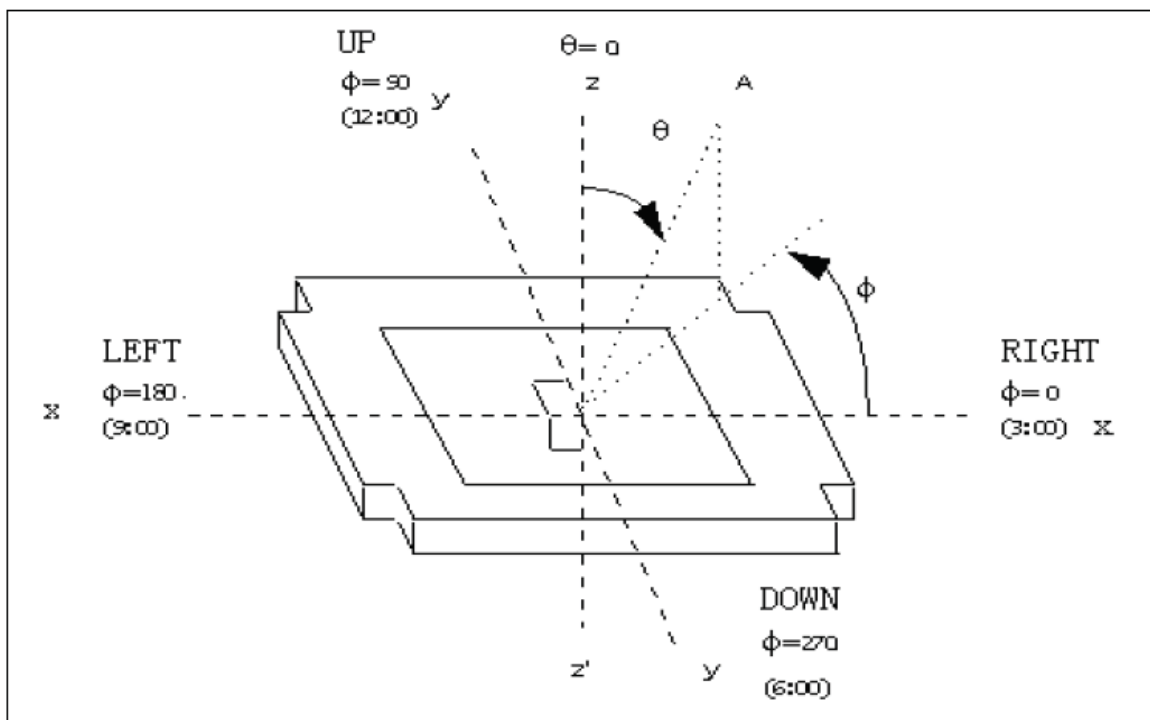


FIG. 3 The definition of viewing angle



■ INTERFACE DESCRIPTION**1. TFT LCD Panel Driving Section**

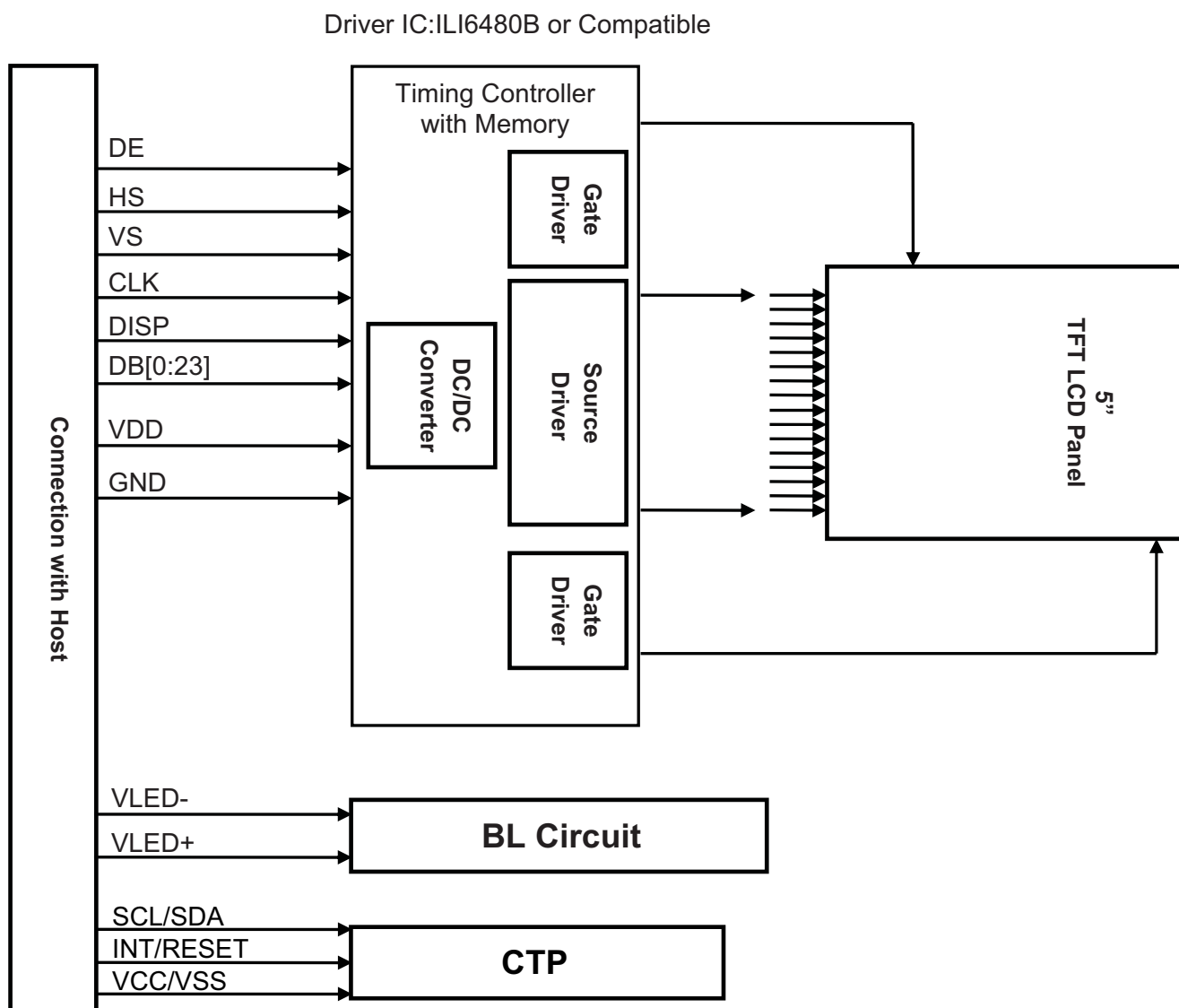
FPC Connector is used for the module electronics interface. The recommended model is FH19SC-40S-0.5SH manufactured by HIROSE.

Pin No.	Symbol	I/O	Function	Remark
1	V _{LED-}	P	Power for LED backlight cathode	
2	V _{LED+}	P	Power for LED backlight anode	
3	GND	P	Power ground	
4	V _{DD}	P	Power voltage	
5	R0	I	Red data (LSB)	
6	R1	I	Red data	
7	R2	I	Red data	
8	R3	I	Red data	
9	R4	I	Red data	
10	R5	I	Red data	
11	R6	I	Red data	
12	R7	I	Red data (MSB)	
13	G0	I	Green data (LSB)	
14	G1	I	Green data	
15	G2	I	Green data	
16	G3	I	Green data	
17	G4	I	Green data	
18	G5	I	Green data	
19	G6	I	Green data	

20	G7	I	Green data (MSB)	
21	B0	I	Blue data (LSB)	
22	B1	I	Blue data	
23	B2	I	Blue data	
24	B3	I	Blue data	
25	B4	I	Blue data	
26	B5	I	Blue data	
27	B6	I	Blue data	
28	B7	I	Blue data (MSB)	
29	GND	P	Power ground	
30	CLK	I	Pixel clock	
31	DISP	I	Display on/off	
32	HSYNC	-	Horizontal sync signal	
33	VSYNC	-	Vertical sync signal	
34	DE	I	Data Enable	
35	NC	-	No Connection	
36	GND	P	Power ground	
37	NC	-	No Connection	
38	NC	-	No Connection	
39	NC	-	No Connection	
40	NC	-	No Connection	

I: input, O: output, P: Power

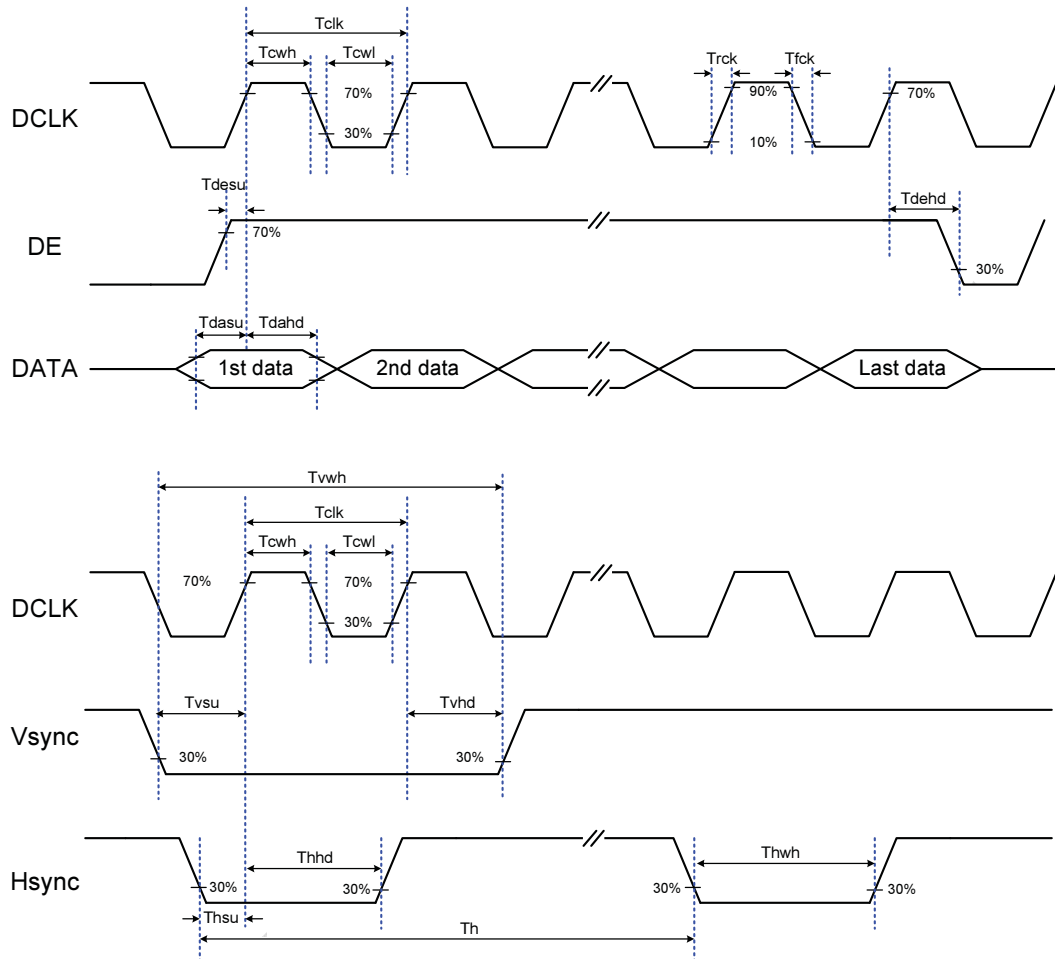
■ BLOCK DIAGRAM



■ APPLICATION NOTES

1. Timing Chart

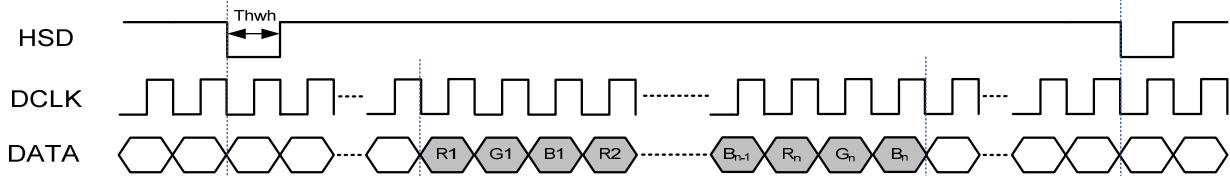
1.1 Clock And Input Data Waveforms



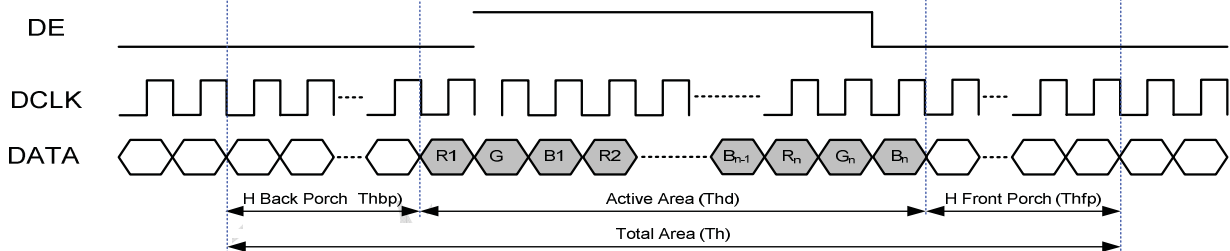
1.2 Data Input Format

Serial 8bit RGB Mode Data Format

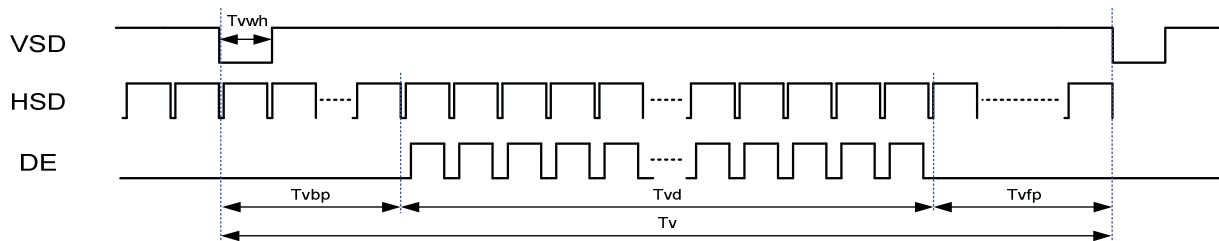
HV Mode



DE Mode



Vertical Input Timing

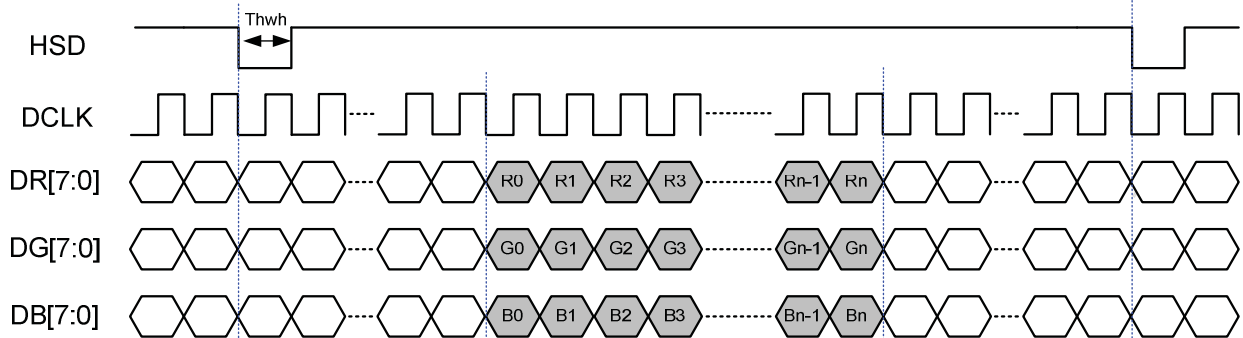


Serial RGB input timing table

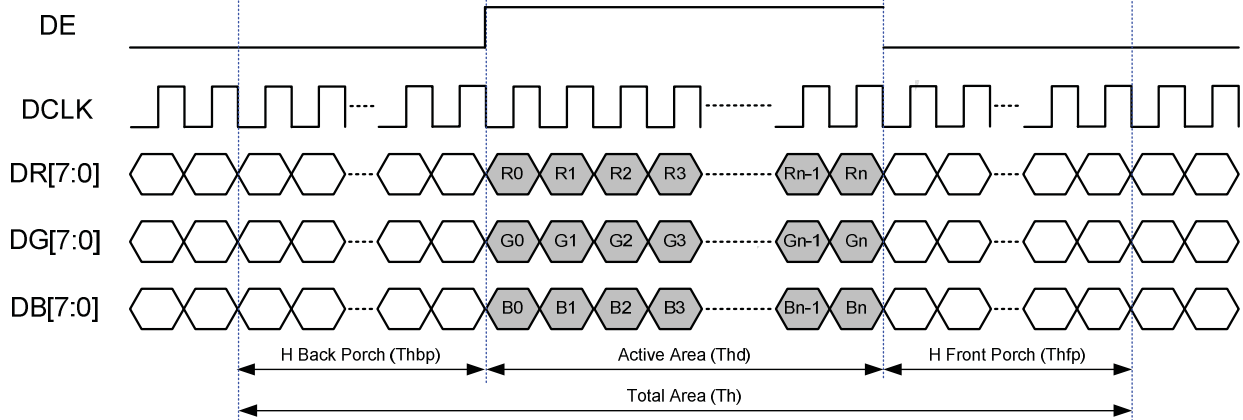
Parameter	Symbol	Value			Unit
		Min.	Typ.	Max.	
DCLK frequency	fclk	-	27	-	MHz
VSD period time	Tv	277	288	400	H
VSD display area	Tvd	272			H
VSD back porch	Tvb	3	8	31	H
VSD front porch	Tvfp	2	8	97	H
HSD period time	Th	-	1728	-	DCLK
HSD display area	Thd	1440			DCLK
HSD back porch	Thbp	-	120	-	DCLK
HSD front porch	Thfp	-	168	-	DCLK

Parallel RGB mode data format

HV Mode



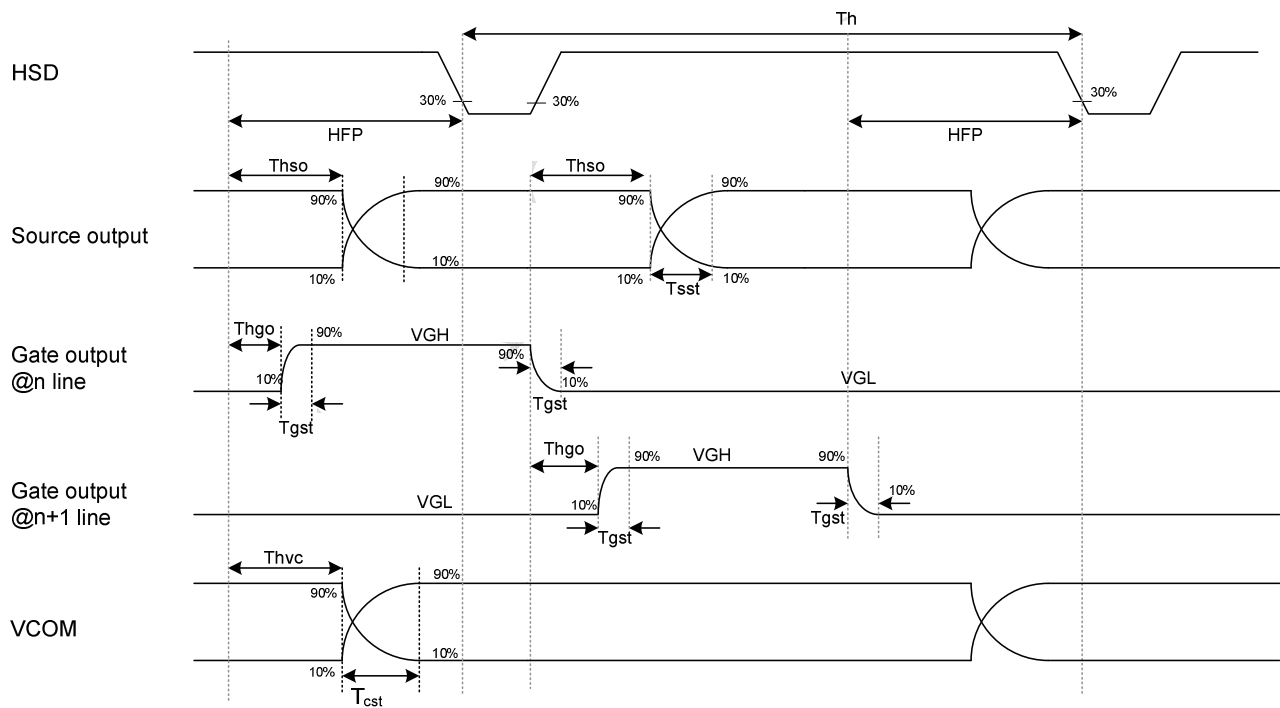
DE Mode



Parallel RGB input timign table

Parameter	Symbol	Value			Unit
		Min.	Typ.	Max.	
DCLK frequency	fclk	5	9	12	MHz
VSD period time	Tv	277	288	400	H
VSD display area	Tvd	272			H
VSD pulse width	Tvw	-	2	-	H
VSD back porch	Tvb	3	8	31	H
VSD front porch	Tvfp	2	8	97	H
HSD period time	Th	520	525	800	DCLK
HSD display area	Thd	480			DCLK
HSD pulse width	Thw	-	2	-	DCLK
HSD back porch	Thbp	34	38	253	DCLK
HSD front porch	Thfp	4	5	65	DCLK

1.4 Output Timing Diagram



■ CTP SPECIFICATIONS

1. GENERAL SPECIFICATIONS

Item	Specification	Unit
Type	Transparent type projected capacitive touch panel	
Input mode	Human's finger	
Finger	Up to 5	
Resolution	480 x 272	dots
Hardness	7H	Pencil hardness
Driver IC	ILI2139C(SMT)	/

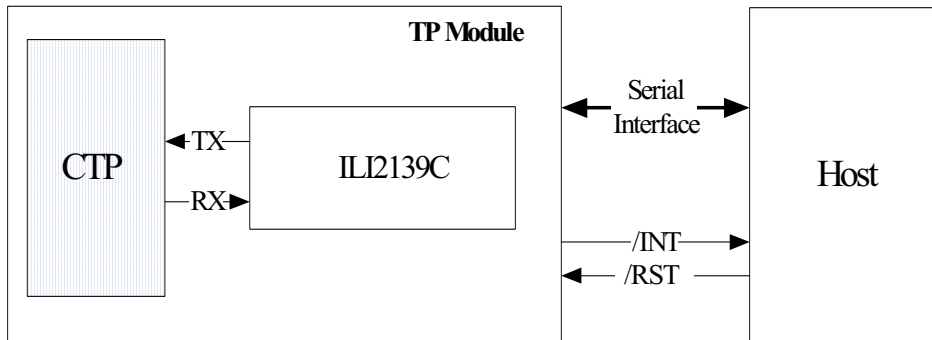
2. ABSOLUTE MAXIMUM RATINGS

Symbol	Description	Min.	Typ.	Max.	Unit	Notes
VCC	Supply voltage for logic	-	3.3	-	V	
IDD	Supply current for logic	-	TBD	-	mA	
VIH	Input high (driven)	0.5	-	0.3VCC	V	
VIL	Input low	0.7VCC	-	-	V	
VOL	Low-level output voltage ¹	0	-	0.4	V	(Open-drain or open-collector) at 3 mA sink current; VDD>2V

3. PIN CONNECTIONS

No.	Type	Name	Description
1	P	VSS	Ground
2	P	VCC	Power supply
3	I/O	SCL	I ² C clock input.
4	-	NC	No connection.
5	I/O	SDA	I ² C data signal.
6	-	NC	No connection
7	I/O	/RST	Reset.active low.
8	-	NC	No connection
9	I/O	/INT	Interrupt signal to host from CTP.
10	P	VSS	Ground

4. BLOCK DIAGRAM



5. CTP TIMING

1. I2C TIMING

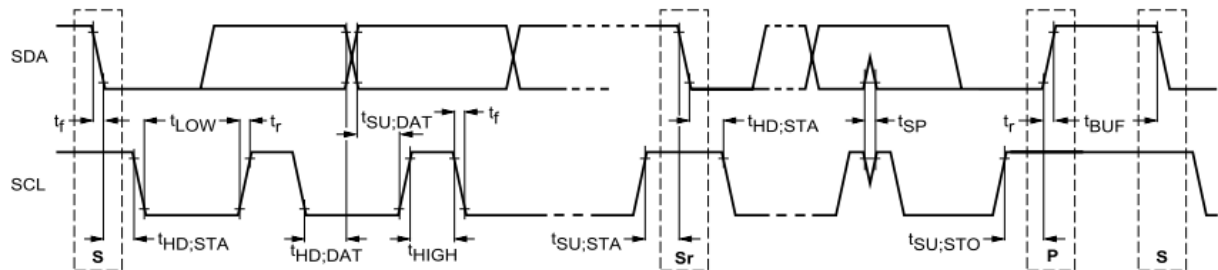


Fig 2: The timing of I²C Interface

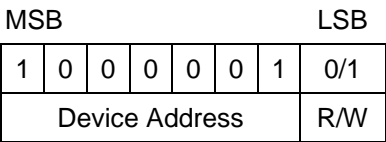
Characteristics of the SDA and SCL bus lines

Symbol	Parameter	Standard mode			Fast Mode		
		Min	Max	Unit	Min	Max	Unit
f_{SCL}	SCL clock frequency	0	100	kHz	0	400	kHz
$t_{HD;STA}$	Hold time (repeated) START condition. After this period, the first clock pulse is generated	4.0	–	μs	0.6	–	μs
t_{LOW}	LOW period of the SCL clock	4.7	–	μs	1.3	–	μs
t_{HIGH}	HIGH period of the SCL clock	4.0	–	μs	0.6	–	μs
$t_{SU;STA}$	Set-up time for a repeated START condition	4.7	–	μs	0.6	–	μs
$t_{HD;DAT}$	Data hold time	5.0	–	μs	0	0.9	μs
$t_{SU;DAT}$	Data set-up time	250	–	ns	100	–	ns
t_r	Rise time of both SDA and SCL signals	–	1000	ns	–	300	ns
t_f	Fall time of both SDA and SCL signals	–	300	ns	–	300	ns
$t_{SU;STO}$	Set-up time for STOP condition	4.0	–	μs	0.6	–	μs
t_{BUF}	Bus free time between a STOP and START condition	4.7	–	μs	1.3	–	μs

2. I2C Interface Data Structure

2.1 Device Address

The device addresses are 7-binary bits long and are conventionally expressed as 4 bits followed by 3 bits followed by the letter 'b', 1000 001b. These addresses occupy the high seven bits of an eight-bit field on the bus.

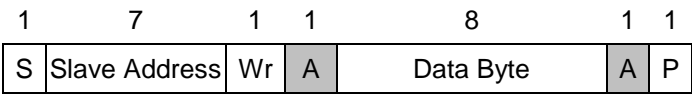


7-bit Device Address: 0x41
8-bit Device Read Address:0x83
8-bit Device Write Address:0x82

Fig 3: I²C Device Address

2.2 Data Transfer

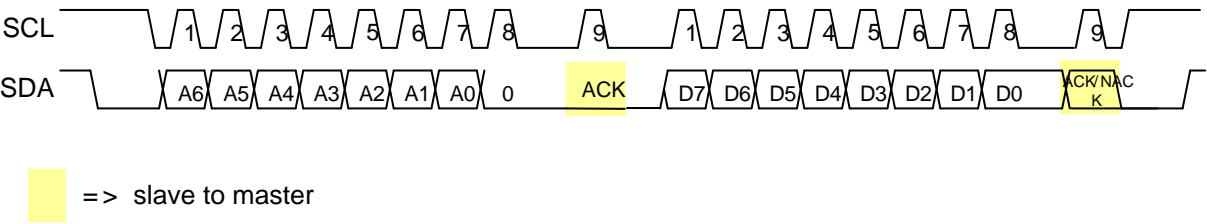
Data is transferred over the I²C bus with 8-bit address and 8-bit data. The related protocol and timing diagrams are shown as below.



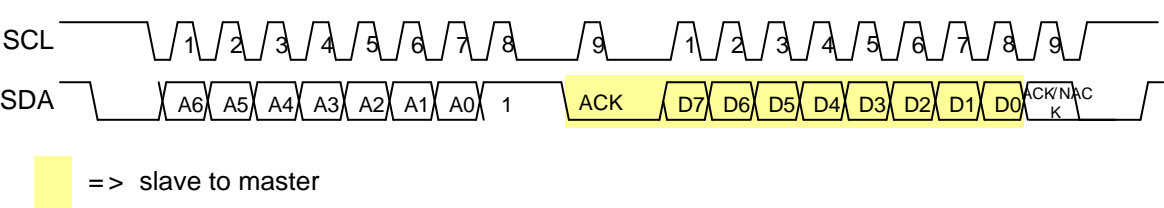
- S Start Condition
- Sr Repeated Start Condition
- Rd Read (bit value of 1)
- Wr Write (bit value of 0)
- A Acknowledge (this bit position may be '0' for an ACK or '1' for a NACK)
- P Stop Condition
- | | |
|-----|-----------------|
| | Master-to-Slave |
| | Slave-to-Master |
| --- | Continue |

Fig 4: Generic Transaction Diagram

I2C Write timing



I2C Read timing



Byte Write

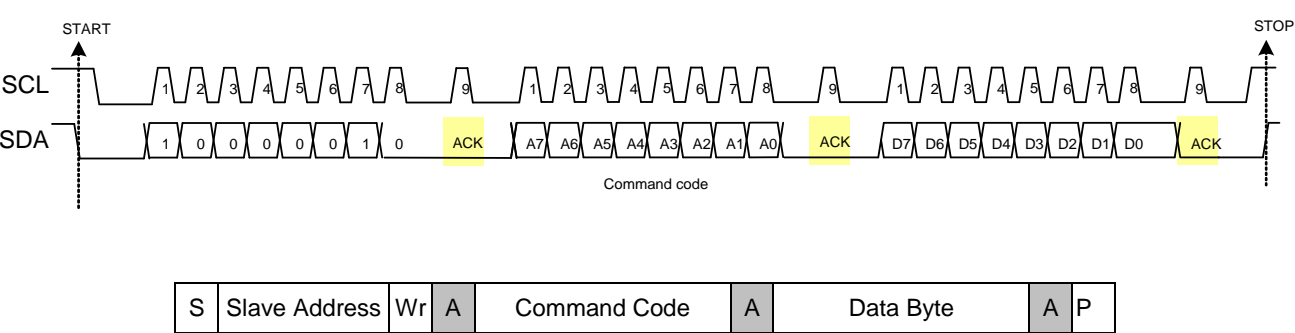


Fig 5: Byte Write

Byte Read

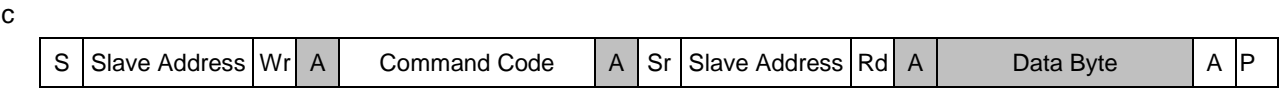


Fig 6: Byte Read

Multi-Byte Write

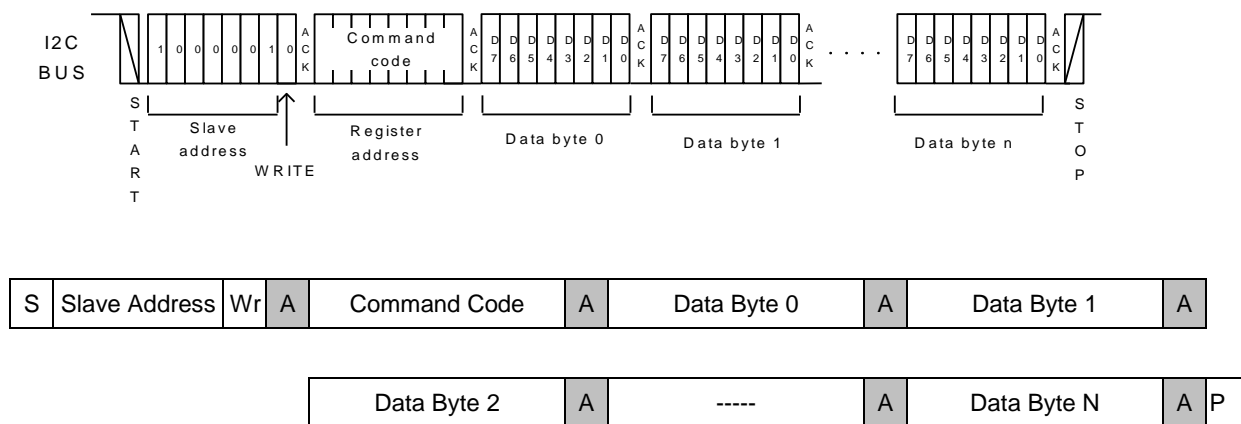


Fig 7: Multi-Byte Write

Multi-Byte Read

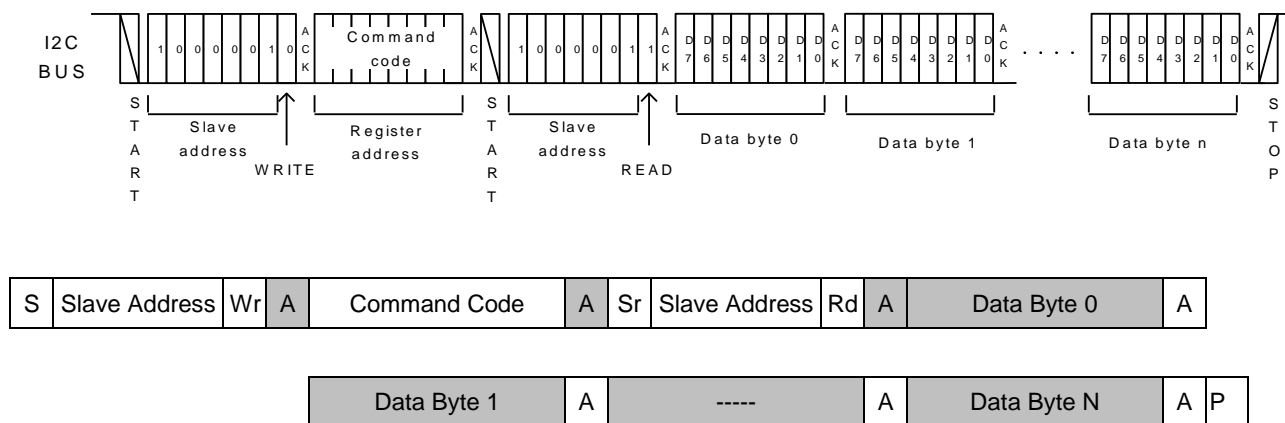


Fig 8: Multi-Byte Read

More information please refer to<ILI_TP_I2C_Programming Guide>.

■ RELIABILITY TEST

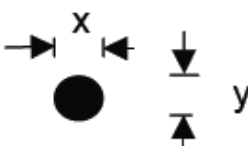
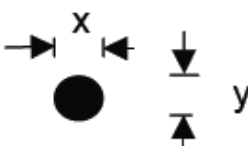
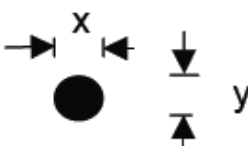
No.	Test Item	Test Condition	Remarks
1	High Temperature Storage Test	$T=80\pm2^{\circ}\text{C} / 240\text{h}$	Note2
2	Low Temperature Storage Test	$T=-30\pm2^{\circ}\text{C} / 240\text{h}$	Note1,2
3	High Temperature Operation Test	$T=70\pm2^{\circ}\text{C} / 240\text{h}$	
4	Low Temperature Operation Test	$T=-20\pm2^{\circ}\text{C} / 240\text{h}$	Note1
5	High Temperature and High Humidity Operation Test	$T_a=60\pm5^{\circ}\text{C}, 90\%\text{RH } 240\text{h}$	Note1,2
6	Thermal Shock Test (Non-operating)	$-30\pm2^{\circ}\text{C} (30\text{Min}) \sim 25\pm2^{\circ}\text{C} (5\text{Min}) \sim 80\pm2^{\circ}\text{C} (30\text{Min})$ 100Cycles	
7	Vibration Test (Non-operating)	Frequency: 10~55Hz Amplitude: 1.5mm Sweep Time: 11Mins Test Period: 6 Cycles For Each Direction Of X,Y,Z	
8	Shock Test (Non-operating)	100G, 6Ms Direction: $\pm X, \pm Y, \pm Z$ Cycle: 3Times	
9	Electro Static Discharge Test (Non-operating)	Voltage: $\pm 8\text{KV}$ R: 330Ω C: 150pF Air Discharge, 10 Time.	


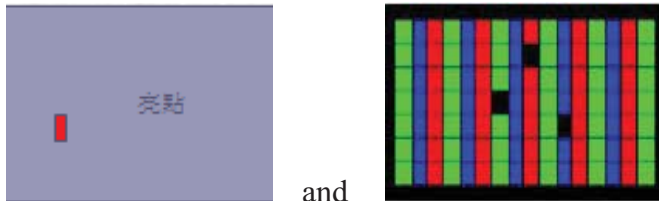
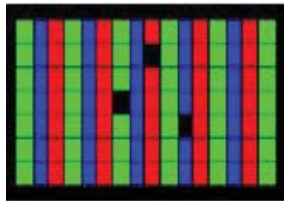
Note 1: Without water condensation

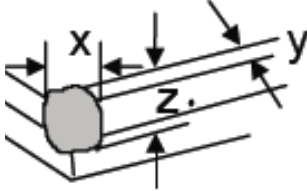
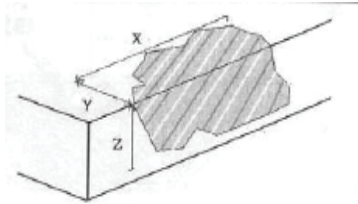
Note 2: The function test shall be conducted after 2 hours storage at the room temperature and humidity after removed from the test chamber.

■ INSPECTION CRITERION

OUTGOING QUALITY STANDARD	PAGE 1 OF 5
TITLE:FUNCTIONAL TEST & INSPECTION CRITERIA	
<p>This specification is made to be used as the standard acceptance/rejection criteria for TFT module.</p> <p>1 Sample plan</p> <p>1.1 Lot size: Quantity per shipment lot per model</p> <p>1.2 Sampling type: Normal inspection,Single sampling</p> <p>1.3 Inspection level: II</p> <p>1.4 Sampling table: MIL-STD-105D</p> <p>1.5 Acceptable quality level (AQL)</p> <p>Major defect: AQL=0.65</p> <p>Minor defect: AQL=1.50</p> <p>2. Inspection condition</p> <p>2.1 Ambient conditions:</p> <p>a. Temperature: Room temperature $25 \pm 5^{\circ}\text{C}$</p> <p>b. Humidity: $(60 \pm 10) \% \text{RH}$</p> <p>c. Illumination: Single fluorescent lamp non-directive (300 to 700 Lux)</p> <p>2.2 Viewing distance:</p> <p>The distance between the LCD and the inspector' s eyes shall be at least $35 \pm 5 \text{cm}$.</p> <p>2.3 Viewing Angle</p> <p>U/D: $45^{\circ} / 45^{\circ}$, L/R: $45^{\circ} / 45^{\circ}$</p> <div data-bbox="391 1196 911 1480"> </div> <p>3. Definition of Inspection Item.</p> <p>3.1 Definition of inspection zone in LCD.</p> <div data-bbox="384 1592 852 1800"> </div> <p>Zone A: character/Digit area</p> <p>Zone B: viewing area except Zone A (ZoneA+ZoneB=minimum Viewing area)</p> <p>Zone C: Outside viewing area (invisible area after assembly in customer's product)</p> <p>Fig.1 Inspection zones in an LCD.</p>	

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TITLE:FUNCTIONAL TEST & INSPECTION CRITERIA																																			
<p>Note: As a general rule, visual defects in Zone C are permissible, when it is no trouble for quality and assembly of customer’s product.</p> <p>4. Inspection standards</p> <p>Defects are classified as majot defects and minor defects according to the degree of defectiveness defined herein.</p> <p>4.1 Major defect</p> <table><tr><th>Item No</th><th>Items to be inspected</th><th colspan="2">Inspection Standard</th></tr><tr><td>4.1.1</td><td>All functional defects</td><td colspan="2">1) No display 2) Display abnormally 3) Short circuit 4) Line defect 5) Excess power consumption</td></tr><tr><td>4.1.2</td><td>Missing</td><td colspan="2">Missing function component</td></tr><tr><td>4.1.3</td><td>Crack</td><td colspan="2">Glass crack</td></tr></table> <p>4.2 Minor defect</p> <table><tr><th>Item No</th><th>Items to be inspected</th><th colspan="2">Inspection standard</th></tr><tr><td rowspan="5">4.2.1</td><td rowspan="5">Spot Defect Including Black spot White spot Pinhole Foreign particle Polarizer dirt</td><td colspan="2">For dark/white spot is defined $\varphi = (x + y) / 2$</td></tr><tr><td>Size φ(mm)</td><td>Acceptable Quantity</td></tr><tr><td>$\varphi \leq 0.15$ 2mm(min) apart</td><td>Ignore</td></tr><tr><td>$0.15 < \varphi \leq 0.25$ 5mm(min) apart</td><td>3</td></tr><tr><td>$0.25 < \varphi$</td><td>Not allowed</td></tr></table>				Item No	Items to be inspected	Inspection Standard		4.1.1	All functional defects	1) No display 2) Display abnormally 3) Short circuit 4) Line defect 5) Excess power consumption		4.1.2	Missing	Missing function component		4.1.3	Crack	Glass crack		Item No	Items to be inspected	Inspection standard		4.2.1	Spot Defect Including Black spot White spot Pinhole Foreign particle Polarizer dirt	For dark/white spot is defined $\varphi = (x + y) / 2$ 		Size φ (mm)	Acceptable Quantity	$\varphi \leq 0.15$ 2mm(min) apart	Ignore	$0.15 < \varphi \leq 0.25$ 5mm(min) apart	3	$0.25 < \varphi$	Not allowed
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TITLE:FUNCTIONAL TEST & INSPECTION CRITERIA				
4.2.2	Line Defect Including Black line White line Scratch	Define: 		
		Width(mm) Length(mm)	Acceptable Quantity	
		W≤0.05 and L≤10	Ignore	
		0.05 < W≤0.08 and L≤10 3mm(min) apart	3	
		0.08 < W≤0.10 and L≤5 3mm(min) apart	1	
		0.10 < W or 10 < L	Not allowed	
4.2.3	Polarizer Dent/Bubble	Size ϕ(mm)	Acceptable Quantity	
		ϕ≤0.25	Ignore	
		Non visible area	Ignore	
		0.25 < ϕ≤ 0.40 5mm(min) apart	2	
		0.40 < ϕ	Not allowed	
4.2.4	Electrical Dot Defect	Bright and Black dot define:  and 		
		Inspection pattern: Full white, Full black, Red, green and blue screens		
		Item	Acceptable Quantity	
		Black dot defect	2	
		Bright dot defect	0	
		Total Dot	2	

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4.2.5	Touch panel chips	 <p>1. Corner chips:</p>	
		Size(mm)	Acceptable Quantity
		$X \leq 3\text{mm}$ $Y \leq 3\text{mm}$ $Z \leq T$	Ignore T: Glass thickness X: Length Y: Width Z: thickness
		 <p>2. Side chips:</p>	
		Size(mm)	Acceptable Quantity
		$X \leq 5\text{mm}$ $Y \leq 3\text{mm}$ $Z \leq T$	Ignore T: Glass thickness X: Length Y: Width Z: thickness

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TITLE:FUNCTIONAL TEST & INSPECTION CRITERIA	
<p>Note:</p> <ol style="list-style-type: none">1. Dot defect is defined as the defective area of the dot area is larger than 50% of the dot area.2. The distance between black dot defects or black and bright dot defects should be more than 5mm apart. The distance between two bright dot defects should be more than 15mm apart3. Polarizer bubble is defined as the bubble appears on active display area. The defect of polarizer bubble shall be ignored if the polarizer bubble appears on the outside of active display area.4. Mura is checker by 6% ND filter.5. Foreign particle on the surface of the LCM should be ignore.	

■ PRECAUTIONS FOR USING LCD MODULES

Handling Precautions

(1) The display panel is made of glass and polarizer. As glass is fragile. It tends to become or chipped during handling especially on the edges. Please avoid dropping or jarring. Do not subject it to a mechanical shock by dropping it or impact.

(2) If the display panel is damaged and the liquid crystal substance leaks out, be sure not to get any in your mouth. If the substance contacts your skin or clothes, wash it off using soap and water.

(3) Do not apply excessive force to the display surface or the adjoining areas since this may cause the color tone to vary. Do not touch the display with bare hands. This will stain the display area and degraded insulation between terminals (some cosmetics are determined to the polarizer).

(4) The polarizer covering the display surface of the LCD module is soft and easily scratched. Handle this polarizer carefully. Do not touch, push or rub the exposed polarizers with anything harder than an HB pencil lead (glass, tweezers, etc.). Do not put or attach anything on the display area to avoid leaving marks on. Condensation on the surface and contact with terminals due to cold will damage, stain or dirty the polarizer. After products are tested at low temperature they must be warmed up in a container before coming is contacting with room temperature air.

(5) If the display surface becomes contaminated, breathe on the surface and gently wipe it with a soft dry cloth. If it is heavily contaminated, moisten cloth with one of the following solvents

- Isopropyl alcohol
- Ethyl alcohol

Do not scrub hard to avoid damaging the display surface.

(6) Solvents other than those above-mentioned may damage the polarizer. Especially, do not use the following.

- Water
- Ketone
- Aromatic solvents

Wipe off saliva or water drops immediately, contact with water over a long period of time may cause deformation or color fading. Avoid contacting oil and fats.

(7) Exercise care to minimize corrosion of the electrode. Corrosion of the electrodes is accelerated by water droplets, moisture condensation or a current flow in a high-humidity environment.

(8) Install the LCD Module by using the mounting holes. When mounting the LCD module make sure it is free of twisting, warping and distortion. In particular, do not forcibly pull or bend the I/O cable or the backlight cable.

(9) Do not attempt to disassemble or process the LCD module.

(10) NC terminal should be open. Do not connect anything.

(11) If the logic circuit power is off, do not apply the input signals.

(12) Electro-Static Discharge Control, Since this module uses a CMOS LSI, the same careful attention should be paid to electrostatic discharge as for an ordinary CMOS IC. To prevent destruction of the elements by static electricity, be careful to maintain an optimum work environment.

- Before remove LCM from its packing case or incorporating it into a set, be sure the module and your body have the same electric potential. Be sure to ground the body when handling the LCD modules.

- Tools required for assembling, such as soldering irons, must be properly grounded. make certain the AC power source for the soldering iron does not leak. When using an electric screwdriver to attach LCM, the screwdriver should be of ground potentiality to minimize as much as possible any transmission of electromagnetic waves produced sparks coming from the commutator of the motor.

- To reduce the amount of static electricity generated, do not conduct assembling and other work under dry conditions. To reduce the generation of static electricity be careful that the air in the work is not too dried. A relative humidity of 50%-60% is recommended. As far as possible make the electric potential of your work clothes and that of the work bench the ground potential

- The LCD module is coated with a film to protect the display surface. Exercise care when peeling off this protective film since static electricity may be generated

(13) Since LCM has been assembled and adjusted with a high degree of precision, avoid applying excessive shocks to the module or making any alterations or modifications to it.

- Do not alter, modify or change the shape of the tab on the metal frame.
- Do not make extra holes on the printed circuit board, modify its shape or change the positions of components to be attached.
- Do not damage or modify the pattern writing on the printed circuit board.
- Absolutely do not modify the zebra rubber strip (conductive rubber) or heat seal connector.
- Except for soldering the interface, do not make any alterations or modifications with a soldering iron.
- Do not drop, bend or twist LCM.

Handling precaution for LCM

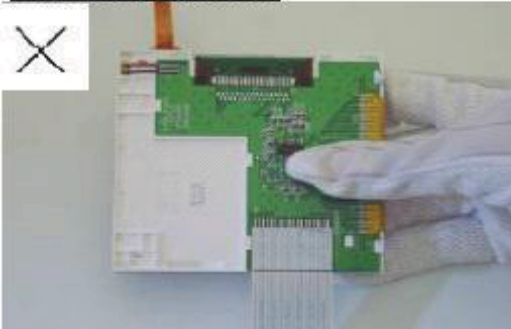
LCM is easy to be damaged.
Please note below and be careful for handling!

Correct handling:

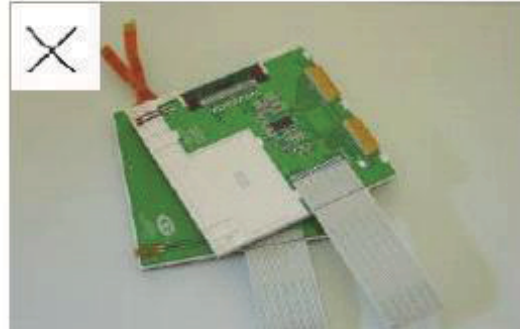


As above picture, please handle with anti-static gloves around LCM edges.

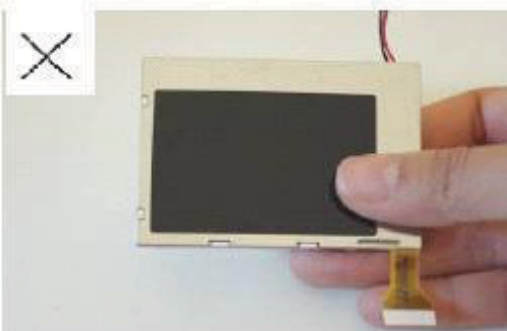
Incorrect handling:



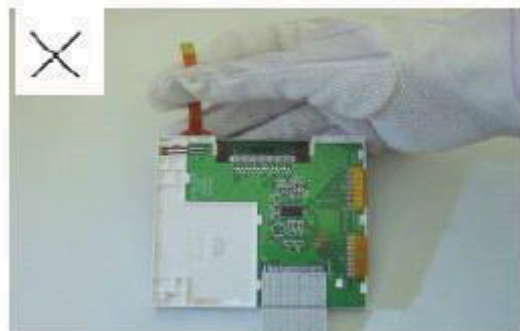
Please don't touch IC directly.



Please don't stack LCM.



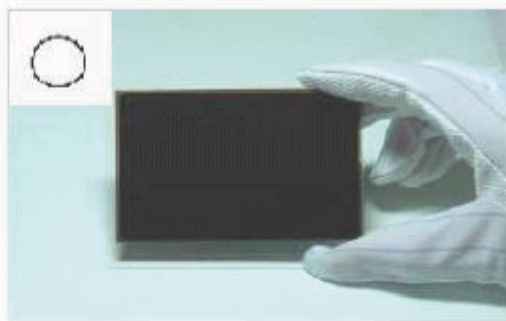
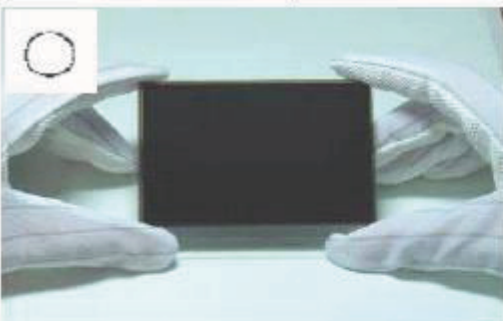
Please don't hold the surface of panel.



Please don't stretch interface of output, such as FPC cable.

Handling precaution for LCD

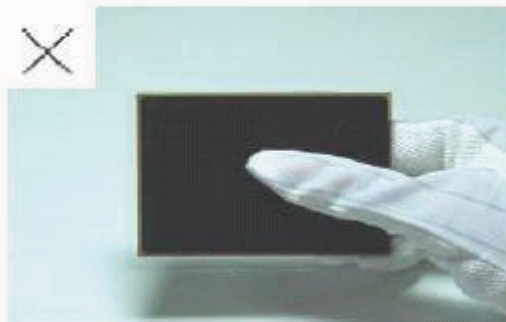
LCD is easy to be damaged.
Please note below and be careful for handling!

Correct handling:

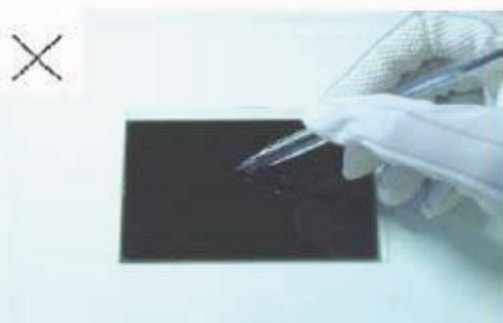
As above photo, please handle with anti-static gloves around LCD edges.

Incorrect handling:

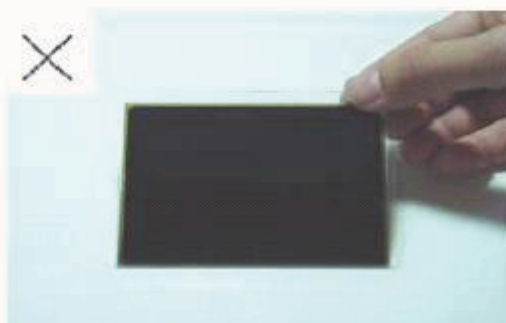
Please don't stack the LCDS.



Please don't hold the surface of LCD.



Please don't operate with sharp stick such as pens.



Please don't touch ITO glass without anti-static gloves.

Storage Precautions

When storing the LCD modules, the following precaution is necessary.

- (1) Store them in a sealed polyethylene bag. If properly sealed, there is no need for the dessicant.
- (2) Store them in a dark place. Do not expose to sunlight or fluorescent light, keep the temperature between 0°C and 35°C, and keep the relative humidity between 40%RH and 60%RH.
- (3) The polarizer surface should not come in contact with any other objects. (We advise you to store them in the anti-static electricity container in which they were shipped.

Others

Liquid crystals solidify under low temperature (below the storage temperature range) leading to defective orientation or the generation of air bubbles (black or white). Air bubbles may also be generated if the module is subject to a low temperature.

If the LCD modules have been operating for a long time showing the same display patterns, the display patterns may remain on the screen as ghost images and a slight contrast irregularity may also appear. A normal operating status can be regained by suspending use for some time. It should be noted that this phenomenon does not adversely affect performance reliability.

To minimize the performance degradation of the LCD modules resulting from destruction caused by static electricity etc., exercise care to avoid holding the following sections when handling the modules.

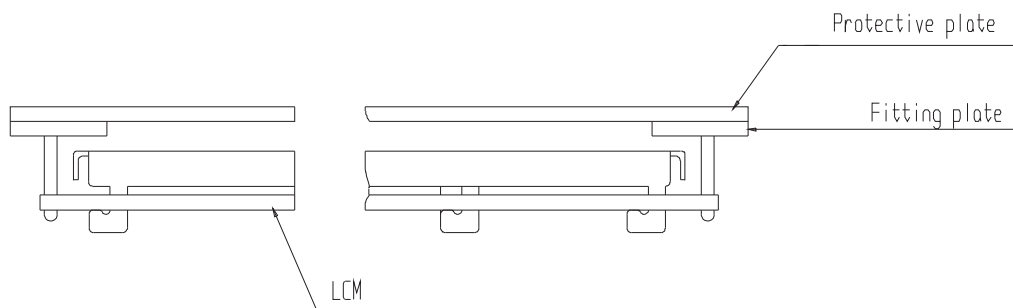
- Exposed area of the printed circuit board.
- Terminal electrode sections.

USING LCD MODULES

Installing LCD Modules

The hole in the printed circuit board is used to fix LCM as shown in the picture below. Attend to the following items when installing the LCM.

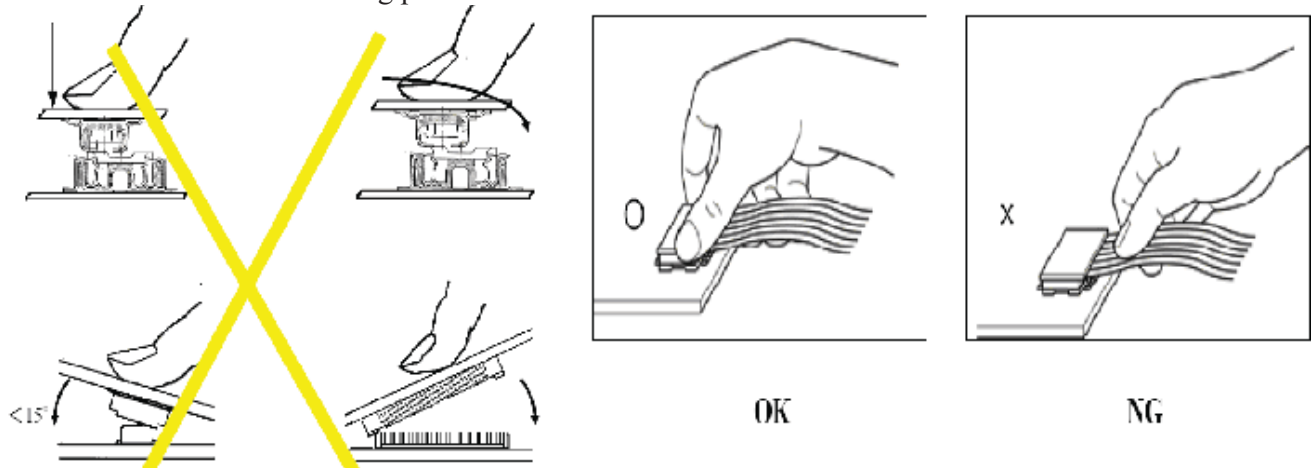
- (1) Cover the surface with a transparent protective plate to protect the polarizer and LC cell.



- (2) When assembling the LCM into other equipment, the spacer to the bit between the LCM and the fitting plate should have enough height to avoid causing stress to the module surface, refer to the individual specifications for measurements. The measurement tolerance should be ± 0.1 mm.

Precaution for assemble the module with BTB connector:

Please note the position of the male and female connector position, don't assemble or assemble like the method which the following picture shows



Precaution for soldering to the LCM

	Hand soldering	Machine drag soldering	Machine press soldering
No ROHS product	290°C ~350°C. Time : 3-5S.	330°C ~350°C. Speed : 4-8 mm/s.	300°C ~330°C. Time : 3-6S. Press: 0.8~1.2Mpa
ROHS product	340°C ~370°C. Time : 3-5S.	350°C ~370°C. Time : 4-8 mm/s.	330°C ~360°C. Time : 3-6S. Press: 0.8~1.2Mpa

(1) If soldering flux is used, be sure to remove any remaining flux after finishing to soldering operation. (This does not apply in the case of a non-halogen type of flux.) It is recommended that you protect the LCD surface with a cover during soldering to prevent any damage due to flux spatters.

(2) When soldering the electroluminescent panel and PC board, the panel and board should not be detached more than three times. This maximum number is determined by the temperature and time conditions mentioned above, though there may be some variance depending on the temperature of the soldering iron.

(3) When remove the electroluminescent panel from the PC board, be sure the solder has completely melted, the soldered pad on the PC board could be damaged.

Precautions for Operation

(1) Viewing angle varies with the change of liquid crystal driving voltage (VLCD). Adjust VLCD to show the best contrast.

(2) It is an indispensable condition to drive LCD's within the specified voltage limit since the higher voltage then the limit cause the shorter LCD life. An electrochemical reaction due to direct current causes LCD's undesirable deterioration, so that the use of direct current drive should be avoided.

(3) Response time will be extremely delayed at lower temperature than the operating temperature range and on the other hand at higher temperature LCD's show dark color in them. However those phenomena do not mean malfunction or out of order with LCD's, Which will come back in the specified operating temperature.

(4) If the display area is pushed hard during operation, the display will become abnormal. However, it will return to normal if it is turned off and then back on.

(5) A slight dew depositing on terminals is a cause for electro-chemical reaction resulting in terminal open circuit. Usage under the maximum operating temperature, 50%RH or less is required.

(6) Input each signal after the positive/negative voltage becomes stable.

(7) Please keep the temperature within specified range for use and storage. Polarization degradation, bubble generation or polarizer peel-off may occur with high temperature and high humidity.

Safety

(1) It is recommended to crush damaged or unnecessary LCDs into pieces and wash them off with solvents such as acetone and ethanol, which should later be burned.

(2) If any liquid leaks out of a damaged glass cell and comes in contact with the hands, wash off thoroughly with soap and water.

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Limited Warranty

Unless agreed otherwise between Display Future Ltd and customer, Display Future will replace or repair any of its LCD modules which are found to be functionally defective when inspected in accordance with LCD acceptance standards (copies available upon request) for a period of one year from date of production. Cosmetic/visual defects must be returned within 90 days of the shipment. Confirmation of such date shall be based on data code on the product.

The warranty liability of Display Future limited to repair and/or replacement on the terms set forth above. Display Future will not be responsible for any subsequent or consequential events.

Return LCM under warranty

No warranty can be granted if the precautions stated above have been disregarded. The typical examples of violations are :

- Broken LCD glass.
- PCB eyelet is damaged or modified.
- PCB conductors damaged.
- Circuit modified in any way, including addition of components.
- PCB tampered with by grinding, engraving or painting varnish.
- Soldering to or modifying the bezel in any manner.

Module repairs will be invoiced to the customer upon mutual agreement. Modules must be returned with sufficient description of the failures or defects. Any connectors or cable installed by the customer must be removed completely without damaging the PCB eyelet, conductors and terminals.

■ PRIOR CONSULT MATTER

- 1.①For Display Future standard products, we keep the right to change material and processes for improving the product, without notice to our customers.
②For OEM products, if any change is needed, which may affect the product property, we will consult with our customer in advance.
2. If you have special requirement about reliability condition, please let us know before you start the test on our samples.