



**SPECIFICATION
FOR
LCD Module
KD024B-3C**

MODULE:	KD024B-3C
CUSTOMER:	

REV	DESCRIPTION	DATE
1.0	FIRST ISSUE	2014.09.02
1.1	Updata Controller IC ST7789V	2015.10.24

STARTEK	INITIAL	DATE
PREPARED BY		
CHECKED BY		
APPROVED BY		

CUSTOMER	INITIAL	DATE
APPROVED BY		

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General Description

* Description

This is a color active matrix TFT (Thin Film Transistor) LCD (liquid crystal display) that uses amorphous silicon TFT as a switching device. This model is composed of a Transmissive type TFT-LCD Panel, driver circuit, back-light unit. The resolution of a 2.4" TFT-LCD contains 240x320 pixels, and can display up to 65K colors.

* Features

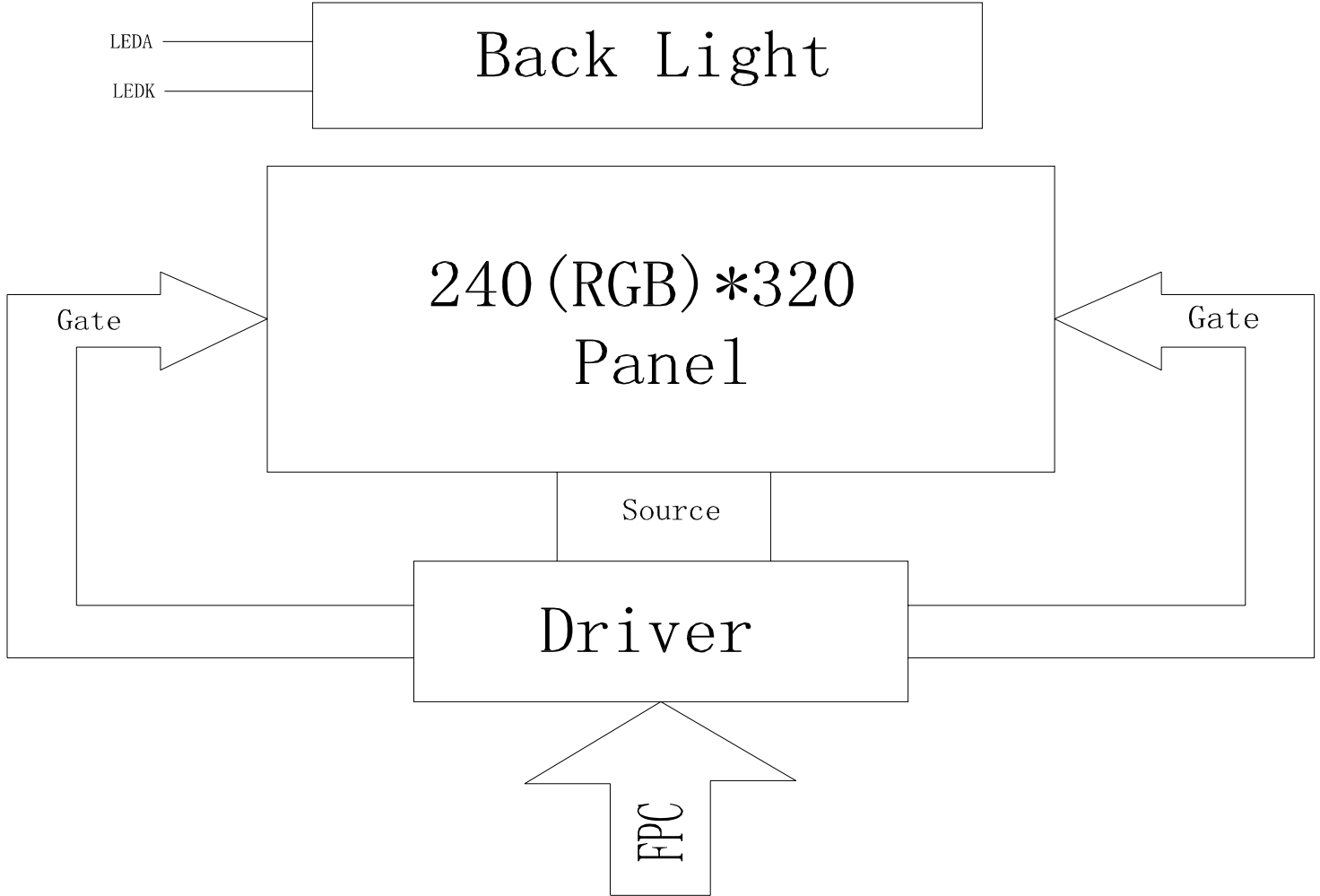
- Low Input Voltage: 3.3V(TYP)
- Display Colors of TFT LCD: 65K colors
- Interface: 16 BIT MCU interface

General Information Items	Specification	Unit	Note
	Main Panel		
Display area(AA)	36.72(H)*48.96(V) (2.4inch)	mm	-
Driver element	TFT active matrix	-	-
Display colors	65K	colors	-
Number of pixels	240(RGB)*320	dots	-
Pixel arrangement	RGB vertical stripe	-	-
Pixel pitch	0.153(H)*0.153(V)	mm	-
Viewing angle	ALL	o'clock	-
Controller IC	ST7789V	-	-
Display mode	Transmissive/ Normally Black	-	-
Operating temperature	-20~+70	°C	-
Storage temperature	-30~+80	°C	-

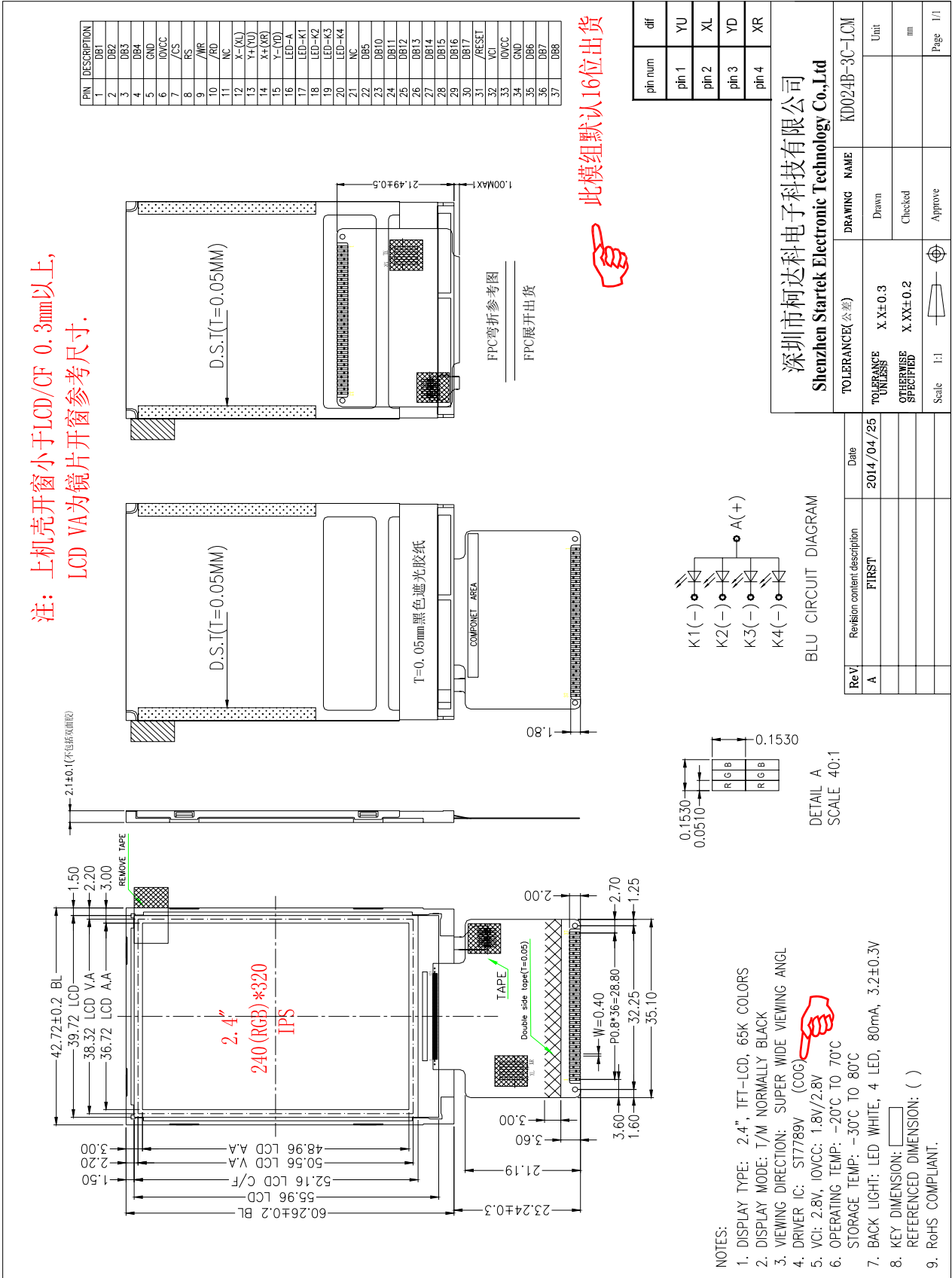
* Mechanical Information

Item		Min.	Typ.	Max.	Unit	Note
Module size	Horizontal(H)		42.72		mm	-
	Vertical(V)		60.26		mm	-
	Depth(D)		2.1		mm	-
Weight			TBD		g	-

1. Block Diagram



2. Outline dimension



深圳市柯达电子科技有限公司
Shenzhen Startek Electronic Technology Co., Ltd

TOLERANCE(公差)	DRAWING NAME	Unit
TOLERANCE UNLESS OTHERWISE SPECIFIED	Drawn	mm
X.X±0.3	Checked	
X.XX±0.2	Approve	

Scale 1:1

Rev	Revision content description	Date
A	FIRST	2014 / 04 / 25

NOTES:

1. DISPLAY TYPE: 2.4", TFT-LCD, 65K COLORS
2. DISPLAY MODE: T/M NORMALLY BLACK
3. VIEWING DIRECTION: SUPER WIDE VIEWING ANGL
4. DRIVER IC: ST7789V (COG)
5. VCI: 2.8V, IOVCC: 1.8V/2.8V
6. OPERATING TEMP: -20°C TO 70°C
STORAGE TEMP: -30°C TO 80°C
7. BACK LIGHT: LED WHITE, 4 LED, 80mA, 3.2±0.3V
8. KEY DIMENSION: REFERENCED DIMENSION: ()
9. RoHS COMPLIANT.

3. Input terminal Pin Assignment

NO.	SYMBOL	DISCRIPTION	I/O
1-4	DB1-DB4	Data bus.	I/O
5	GND	Ground.	P
6	IOVCC	Supply voltage for IO (1.8V-3.3V).	P
7	/CS	Chip select input pin ("Low" enable). Fix this pin at VCI or GND when not in use.	I
8	RS	Display data / Command selection . D/CX='1': Display data. D/CX='0': Command data.	I
9	/WR	Write enable in parallel interface.	I
10	/RD	Serves as a read signal and MCU read data at the rising edge. Fix this pin at VCI or GND when not in use.	I
11	NC	NC	
12	X-(XL)	Touch panel LEFT Glass Terminal.	I
13	Y+(YU)	Touch panel Top Film Terminal.	I
14	X+(XR)	Touch panel Right Glass Terminal.	I
15	Y-(YD)	Touch panel Bottom Film Terminal.	I/O
16	LEDA	Anode pin of backlight.	P
17	LED-K1	Cathode pin of backlight.	P
18	LED-K2	Cathode pin of backlight.	P
19	LED-K3	Cathode pin of backlight.	P
20	LED-K4	Cathode pin of backlight.	P
21	NC	NC	
22	DB5	Data bus.	I/O
23	DB10-DB17	Data bus.	I/O
31	RESET	Setting either pin low initializes the LSI. Must be reset after power is supplied.	I
32	VCI	Supply voltage(3.3V).	P
33	IOVCC	Supply voltage for IO (1.8V-3.3V).	p
34	GND	Ground.	p
35-37	DB6-DB8	Data bus.	I/O

4. LCD Optical Characteristics

4.1 Optical specification

Item		Symbol	Condition	Min.	Typ.	Max.	Unit	Note
Transmittance (with Polarizer)		T (%)	Normal viewing angle	—	4.65	—	%	Measuring with Polarizer , Reference Only
Transmittance (without Polarizer)		T (%)		—	14.6	—	%	
Contrast		CR		640	800	—	—	(1)(2)
Response time	Rising	T _R		—	16	21	msec	(1)(3)
	Falling	T _F		—	19	24		
Color gamut		(%)		—	70	—	%	C-light
Color chromaticity (CIE1931)	White	W _x		0.290	0.310	0.330	—	(1)(4) CF glass
		W _y		0.316	0.336	0.356		
	Red	R _x		0.627	0.647	0.667	—	
		R _y		0.297	0.317	0.337	—	
	Green	G _x	0.255	0.275	0.295	—		
		G _y	0.562	0.582	0.602			
	Blue	B _x	0.120	0.140	0.160	—		
		B _y	0.068	0.088	0.108			
Viewing angle	Hor.	Θ _L	—	80	—	—	(1)(4) Measuring with Polarizer , Reference Only	
		Θ _R	—	80	—			
	Ver.	Θ _U	—	80	—			
		Θ _D	—	80	—			
Optima View Direction		Free					(5)	

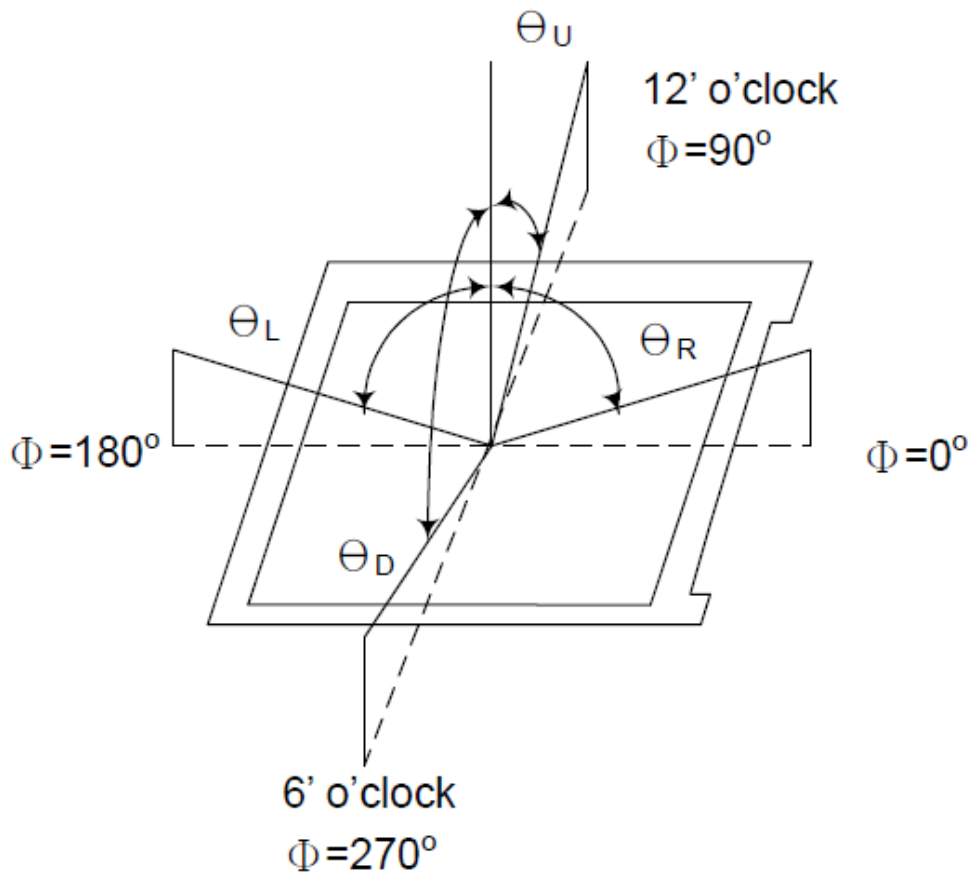
4.2 Measuring Condition

- Measuring surrounding : dark room
- Ambient temperature : 25±2oC
- 15min. warm-up time

4.3 Measuring Equipment

FPM520 of Westar Display technologies, INC., which utilized SR-3 for Chromaticity and BM-5A for other optical characteristics.

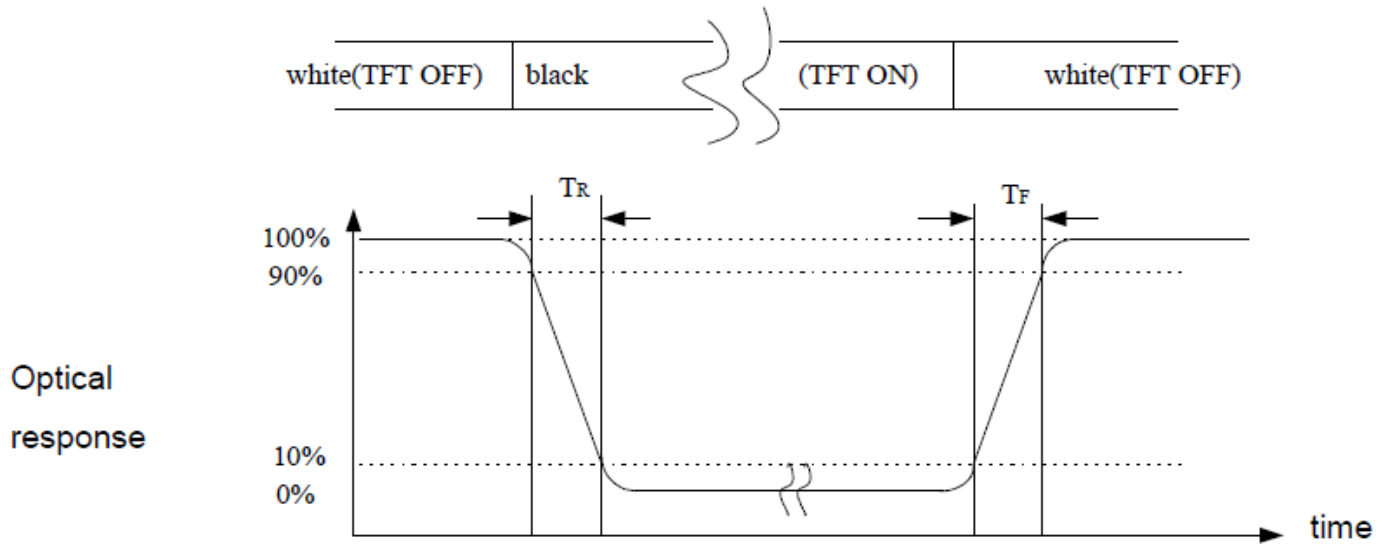
Note (1) Definition of Viewing Angle:



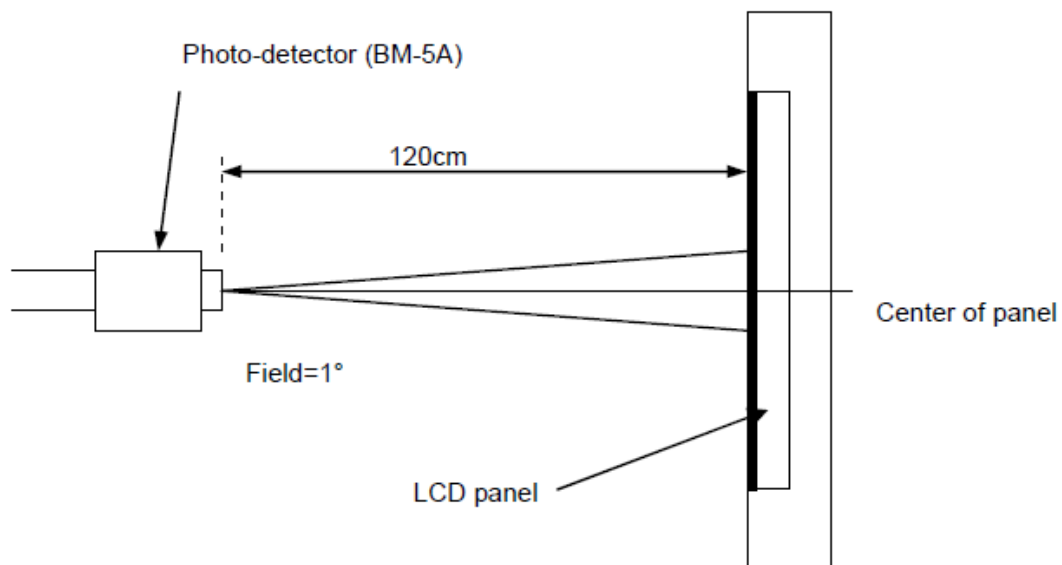
Note (2) Definition of Contrast Ratio (CR) :
 measured at the center point of panel

$$CR = \frac{\text{Luminance with all pixels white}}{\text{Luminance with all pixels black}}$$

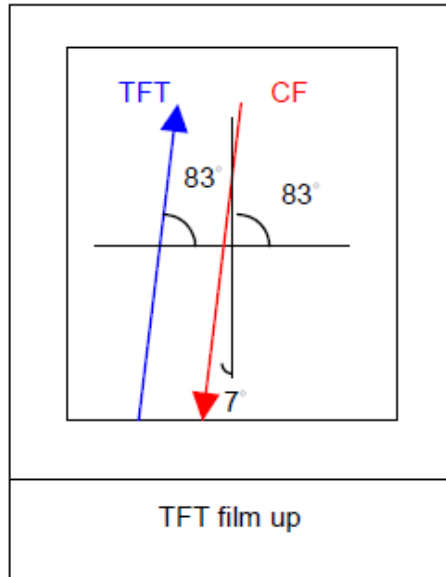
Note (3) Definition of Response Time : Sum of T_R and T_F



Note (4) Definition of optical measurement setup



Note (5) Rubbing Direction (The different Rubbing Direction will cause the different optima view direction.



5. Electrical Characteristics

5.1 Absolute Maximum Rating (Ta=25 VSS=0V)

Characteristics	Symbol	Min.	Max.	Unit
Digital Supply Voltage	VDD	-0.3	4.2	V
Digital interface supply Voltage	VDDIO	-0.3	VDD	V
Operating temperature	T _{OP}	-20	+ 70	°C
Storage temperature	T _{ST}	-30	+ 80	°C

5.2 DC Electrical Characteristics

Characteristics	Symbol	Min.	Typ.	Max.	Unit	Note
Digital Supply Voltage	VDD	2.6	3..3	4.2	V	
Digital interface supply Voltage	VDDIO	1.65	3.3	4.2	V	
Normal mode Current consumption	IDD	--	8	--	mA	
Level input voltage	V _{IH}	0.7V _{DDIO}		VDDIO	V	
	V _{IL}	GND		0.3V _{DDIO}	V	
Level output voltage	V _{OH}	0.8VDDIO		VDDIO	V	
	V _{OL}	GND		0.2VDDIO	V	

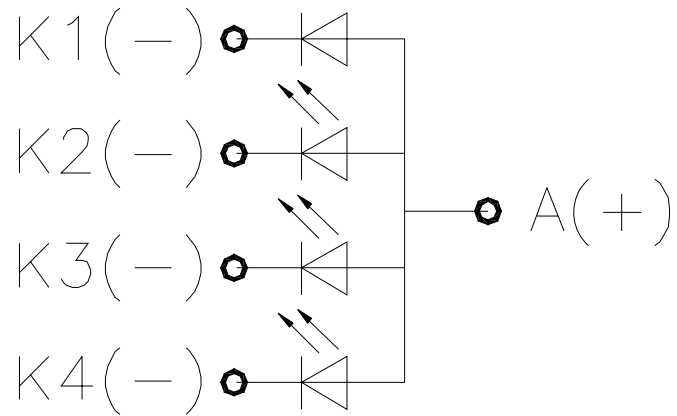
5.3 LED Backlight Characteristics

The back-light system is edge-lighting type with 4chips White LED

Item	Symbol	Min.	Typ.	Max.	Unit	Note
Forward Current	I _F	60	80	--	mA	
Forward Voltage	V _F	2.9	3.2	3.4	V	
LCM Luminance	L _V	400	--	--	cd/m ²	IF=80MA
LED life time	Hr	50000	--	--	Hour	Note1,2
Uniformity	AVG	80	--	--	%	

Note (1) LED life time (Hr) can be defined as the time in which it continues to operate under the condition: Ta=25±3 °C, typical IL value indicated in the above table until the brightness becomes less than 50%.

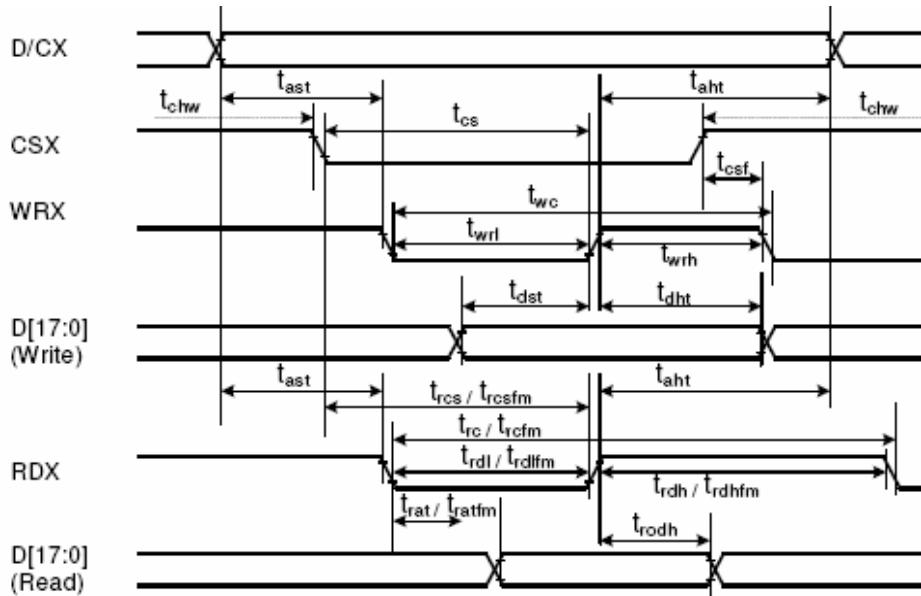
Note (2) The “LED life time” is defined as the module brightness decrease to 50% original brightness at Ta=25°C and IL=80mA. The LED lifetime could be decreased if operating IL is larger than 80mA. The constant current driving method is suggested.



BLU CIRCUIT DIAGRAM

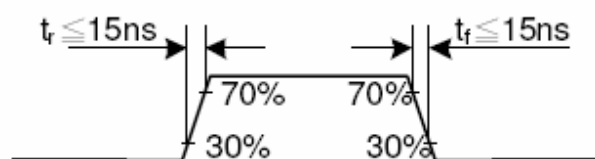
6. AC Characteristic

6.1 Display Parallel 8/16-bit Interface Timing Characteristics (8080- I system)

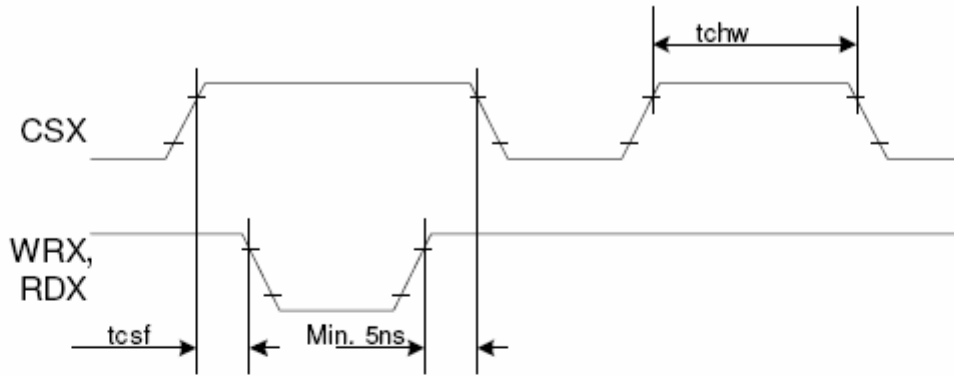


Signal	Symbol	Parameter	min	max	Unit	Description
DCX	t _{ast}	Address setup time	0	-	ns	
	t _{ahh}	Address hold time (Write/Read)	0	-	ns	
CSX	t _{chw}	CSX "H" pulse width	0	-	ns	
	t _{cs}	Chip Select setup time (Write)	15	-	ns	
	t _{rcs}	Chip Select setup time (Read ID)	45	-	ns	
	t _{rcsfm}	Chip Select setup time (Read FM)	355	-	ns	
	t _{csf}	Chip Select Wait time (Write/Read)	10	-	ns	
WRX	t _{wc}	Write cycle	66	-	ns	
	t _{wrh}	Write Control pulse H duration	15	-	ns	
	t _{wrl}	Write Control pulse L duration	15	-	ns	
RDX (FM)	t _{rcfm}	Read Cycle (FM)	450	-	ns	
	t _{rdhfm}	Read Control H duration (FM)	90	-	ns	
	t _{rdlfm}	Read Control L duration (FM)	355	-	ns	
RDX (ID)	t _{rc}	Read cycle (ID)	160	-	ns	
	t _{rdh}	Read Control pulse H duration	90	-	ns	
	t _{rdl}	Read Control pulse L duration	45	-	ns	
D[17:0], D[15:0], D[8:0], D[7:0]	t _{dst}	Write data setup time	10	-	ns	For maximum CL=30pF For minimum CL=8pF
	t _{dht}	Write data hold time	10	-	ns	
	t _{rat}	Read access time	-	40	ns	
	t _{ratfm}	Read access time	-	340	ns	
	t _{rodh}	Read output disable time	20	80	ns	

Note: $T_a = -30$ to 70 °C, $V_{DDI} = 1.65V$ to $3.3V$, $V_{CI} = 2.5V$ to $3.3V$, $V_{SS} = 0V$

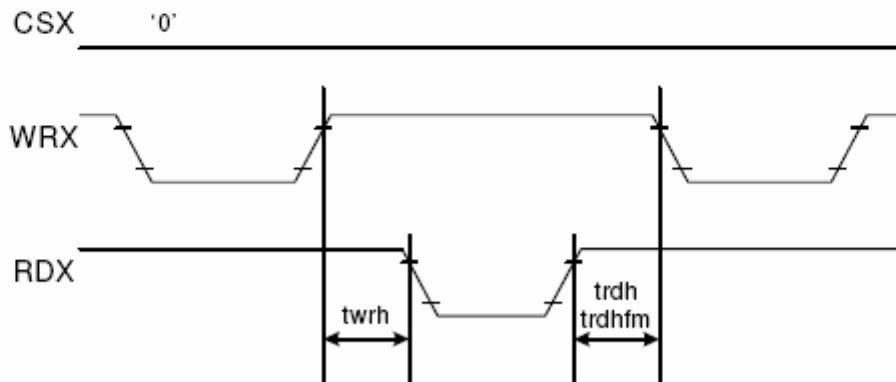


CSX timings :



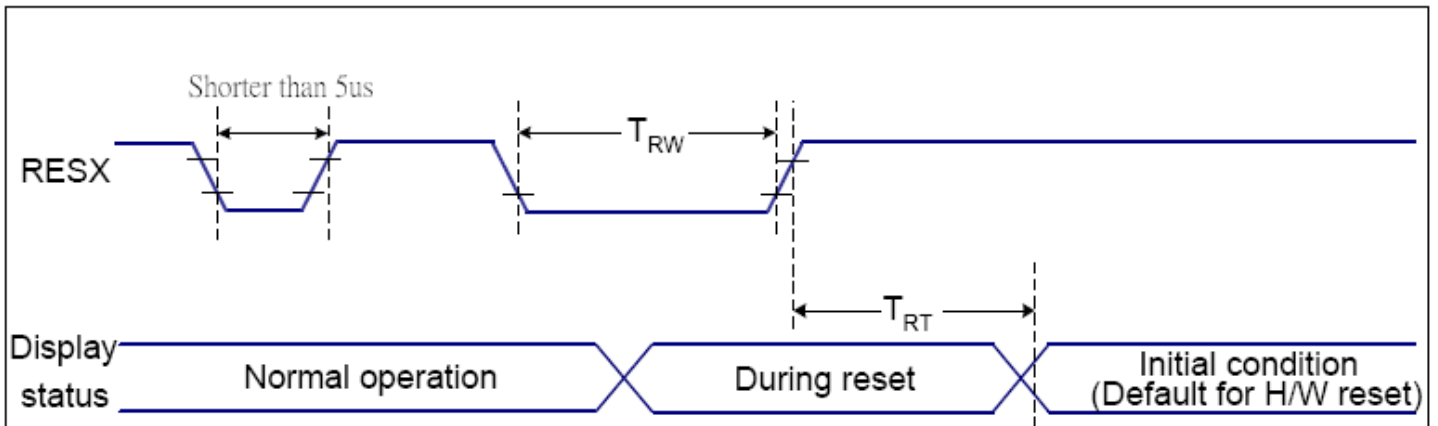
Note: Logic high and low levels are specified as 30% and 70% of VDDI for Input signals.

Write to read or read to write timings:



Note: Logic high and low levels are specified as 30% and 70% of VDDI for Input signals.

6.2 Reset Timing Characteristics



$V_{DDI}=1.65$ to $3.3V$, $V_{DD}=2.4$ to $3.3V$, $AGND=DGND=0V$, $T_a=-30 \sim 70 \text{ } ^\circ\text{C}$

Related Pins	Symbol	Parameter	MIN	MAX	Unit
RESX	TRW	Reset pulse duration	10	-	us
	TRT	Reset cancel	-	5 (Note 1, 5)	ms
			120 (Note 1, 6, 7)	ms	

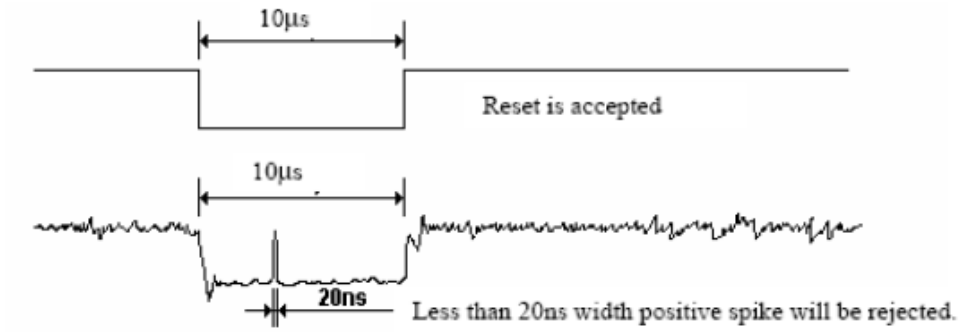
Notes:

- The reset cancel includes also required time for loading ID bytes, VCOM setting and other settings from NVM (or similar device) to registers. This loading is done every time when there is HW reset cancel time (t_{RT}) within 5 ms after a rising edge of RESX.
- Spike due to an electrostatic discharge on RESX line does not cause irregular system reset according to the table below:

RESX Pulse	Action
Shorter than 5us	Reset Rejected
Longer than 9us	Reset
Between 5us and 9us	Reset starts

- During the Resetting period, the display will be blanked (The display is entering blanking sequence, which maximum time is 120 ms, when Reset Starts in Sleep Out –mode. The display remains the blank state in Sleep In –mode.) and then return to Default condition for Hardware Reset.

- Spike Rejection also applies during a valid reset pulse as shown below:



- 5. When Reset applied during Sleep In Mode.
- 6. When Reset applied during Sleep Out Mode.
- 7. It is necessary to wait 5msec after releasing RESX before sending commands. Also Sleep Out command cannot be sent for 120msec.

7. LCD Module Out-Going Quality Level

7.1 VISUAL & FUNCTION INSPECTION STANDARD

7.1.1 Inspection conditions

Inspection performed under the following conditions is recommended.

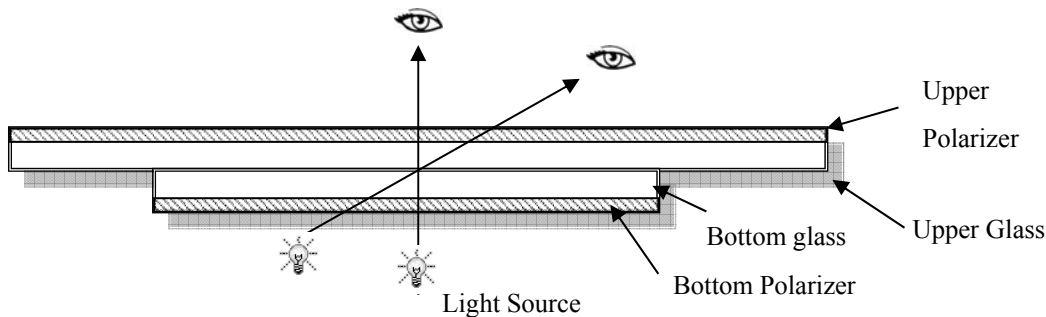
Temperature : $25 \pm 5^\circ\text{C}$

Humidity : $65\% \pm 10\% \text{RH}$

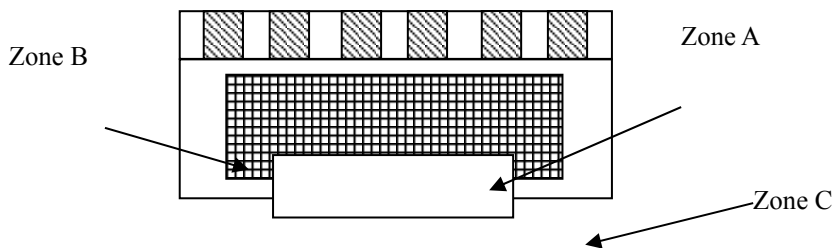
Viewing Angle : Normal viewing Angle.

Illumination: Single fluorescent lamp (300 to 700Lux)

Viewing distance: 30-50cm



7.1.2 Definition



Zone A : Effective Viewing Area(Character or Digit can be seen)

Zone B : Viewing Area except Zone A

Zone C : Outside (Zone A+Zone B) which can not be seen after assembly by customer .)

Note:

As a general rule ,visual defects in Zone C can be ignored when it doesn't effect product function or appearance after assembly by customer.

7.1.3 Sampling Plan

According to GB/T 2828-2003 ; , normal inspection, Class II

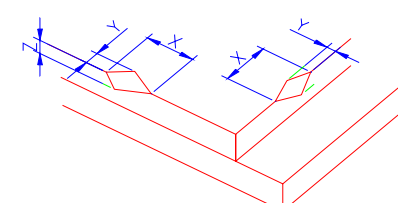
AQL:

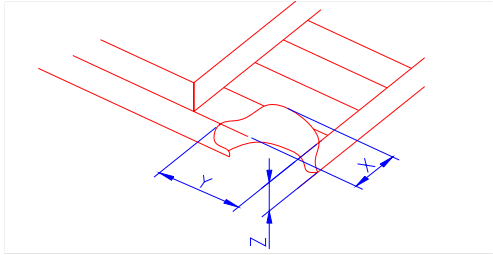
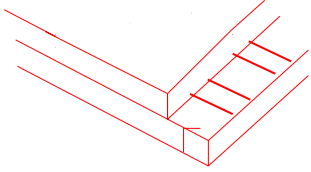
Major defect	Minor defect
0.65	1.5

LCD: Liquid Crystal Display , TP: Touch Panel , LCM: Liquid Crystal Module

No	Items to be inspected	Criteria	Classification of defects
1	Functional defects	1) No display, Open or miss line 2) Display abnormally, Short 3) Backlight no lighting, abnormal lighting. 4) TP no function	Major
2	Missing	Missing component	
3	Outline dimension	Overall outline dimension beyond the drawing is not allowed	
4	Color tone	Color unevenness, refer to limited sample	Minor
5	Soldering appearance	Good soldering , Peeling off is not allowed.	
6	LCD/Polarizer/TP	Black/White spot/line, scratch, crack, etc.	

7.1.4 Criteria (Visual)

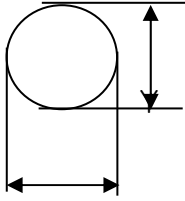
Number	Items	Criteria(mm)						
1.0 LCD Crack/Broken	(1) The edge of LCD broken	 <table border="1"> <tr> <td>X</td> <td>Y</td> <td>Z</td> </tr> <tr> <td>≤3.0mm</td> <td><Inner border line of the seal</td> <td>≤T</td> </tr> </table>	X	Y	Z	≤3.0mm	<Inner border line of the seal	≤T
X	Y	Z						
≤3.0mm	<Inner border line of the seal	≤T						
NOTE: X: Length Y: Width								

<p>Z: Height L: Length of ITO, T: Height of LCD</p>	<p>(2)LCD corner broken</p>	 <table border="1"> <tr> <td>X</td> <td>Y</td> <td>Z</td> </tr> <tr> <td>≤3.0mm</td> <td>≤L</td> <td>≤T</td> </tr> </table>	X	Y	Z	≤3.0mm	≤L	≤T
	X	Y	Z					
≤3.0mm	≤L	≤T						
<p>(3) LCD crack</p>	 <p>Crack Not allowed</p>							

Number	Items	Criteria (mm)		
--------	-------	---------------	--	--

2.0

Spot defect



X

$$\Phi = (X+Y)/2$$

① light dot (LCD/TP/Polarizer black/white spot , light dot, pinhole, dent, stain)

Zone Size (mm)	Acceptable Qty		
	A	B	C
$\Phi \leq 0.10$	Ignore		
$0.15 < \Phi \leq 0.2$	3(distance $\geq 10\text{mm}$)		
$0.25 < \Phi \leq 0.35$	2		
$0.4 < \Phi$	0		

② Dim spot (LCD/TP/Polarizer dim dot, light leakage, dark spot)

Zone Size (mm)	Acceptable Qty		
	A	B	C
$\Phi \leq 0.1$	Ignore		
$0.1 < \Phi \leq 0.25$	3(distance $\geq 10\text{mm}$)		
$0.25 < \Phi \leq 0.35$	2		
$\Phi > 0.4$	0		


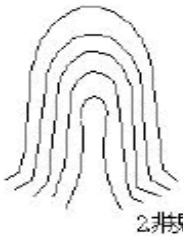

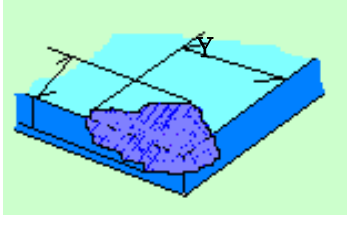
③ Polarizer accidented spot

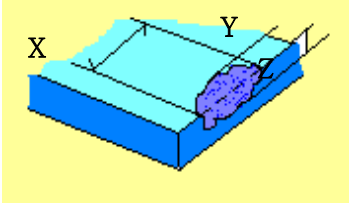
Zone Size (mm)	Acceptable Qty		
	A	B	C
$\Phi \leq 0.2$	Ignore		
$0.2 < \Phi \leq 0.5$	2(distance $\geq 10\text{mm}$)		
$\Phi > 0.5$	0		

Line defect
(LCD/TP
/Polarizer
black/white
line,
scratch,
stain)

Width(mm)	Length(mm)	Acceptable Qty		
		A	B	C
$\Phi \leq 0.03$	Ignore	Ignore		Ignore
$0.03 < W \leq 0.05$	$L \leq 3.0$	$N \leq 2$		
$0.05 < W \leq 0.08$	$L \leq 2.0$	$N \leq 2$		
$0.08 < W$	Define as spot defect			



3.0	SMT	According to IPC-A-610C class II standard . Function defect and missing part are major defect ,the others are minor defect.																										
4.0	TP Related	TP bubble/ accidented spot	<table border="1"> <thead> <tr> <th rowspan="2">Size Φ(mm)</th> <th colspan="3">Acceptable Qty</th> </tr> <tr> <th>A</th> <th>B</th> <th>C</th> </tr> </thead> <tbody> <tr> <td>$\Phi \leq 0.1$</td> <td colspan="3">Ignore</td> </tr> <tr> <td>$0.2 < \Phi \leq 0.25$</td> <td colspan="3">3</td> </tr> <tr> <td>$0.25 < \Phi \leq 0.35$</td> <td colspan="3">2</td> </tr> <tr> <td>$0.4 < \Phi$</td> <td colspan="3">0</td> </tr> </tbody> </table>			Size Φ (mm)	Acceptable Qty			A	B	C	$\Phi \leq 0.1$	Ignore			$0.2 < \Phi \leq 0.25$	3			$0.25 < \Phi \leq 0.35$	2			$0.4 < \Phi$	0		
		Size Φ (mm)	Acceptable Qty																									
			A	B	C																							
		$\Phi \leq 0.1$	Ignore																									
$0.2 < \Phi \leq 0.25$	3																											
$0.25 < \Phi \leq 0.35$	2																											
$0.4 < \Phi$	0																											
Assembly deflection	beyond the edge of backlight $\leq 0.15\text{mm}$																											
Newton Ring	<p>Newton Ring area $> 1/3$ TP area NG</p> <p>Newton Ring area $\leq 1/3$ TP area OK</p>	 1 规律性  2 非规律性  似牛顿环																										
TP corner broken X : length Y : width Z : height	<table border="1"> <thead> <tr> <th>X</th> <th>Y</th> <th>Z</th> </tr> </thead> <tbody> <tr> <td>$X \leq 3.0\text{mm}$</td> <td>$Y \leq 3.0\text{mm}$</td> <td>$Z < \text{LCD thickness}$</td> </tr> </tbody> </table> <p>* Circuitry broken is not</p>		X	Y	Z	$X \leq 3.0\text{mm}$	$Y \leq 3.0\text{mm}$	$Z < \text{LCD thickness}$																				
X	Y	Z																										
$X \leq 3.0\text{mm}$	$Y \leq 3.0\text{mm}$	$Z < \text{LCD thickness}$																										

			allowed.	
		TP edge broken	X	Y
		X : length	X ≤ 6.0mm	Y ≤ 2.0mm
		Y : width		Z < LCD thickness
		Z : height	* Circuitry broken is not allowed.	
				

Criteria (functional items)

Number	Items	Criteria (mm)
1	No display	Not allowed
2	Missing segment	Not allowed
3	Short	Not allowed
4	Backlight no lighting	Not allowed
5	TP no function	Not allowed

8. Reliability Test Result

8.1 Condition

Item	Condition	Sample Size	Test Result	Note
Low Temperature Operating Life test	-20℃, 96HR	3ea	pass	-
Thermal Humidity Operating Life test	60℃, 90%RH, 96HR	3ea	pass	-
Temperature Cycle ON/OFF test	-20℃ ↔ 70℃, ON/OFF, 20CYC	3ea	pass	(1)
High Temperature Storage test	80℃, 96HR	3ea	pass	-
Low Temperature Storage test	- 30℃, 96HR	3ea	pass	-
ESD test	150pF, 330Ω, ±6KV(Contact)/± 8KV(Air), 5 points/panel, 10 times/point	3ea	pas	
Thermal Shock Resistance	The sample should be allowed to stand the following 5 cycles of operation: TSTL for 30 minutes -> normal temperature for 5 minutes -> TSTH for 30 minutes -> normal temperature for 5 minutes, as one cycle, then taking it out and drying it at normal temperature, and allowing it stand for 24 hours	3ea	pass	
Box Drop Test	1 Corner 3 Edges 6 faces, 66cm(MEDIUM BOX)	1box	pass	-

Note (1) ON Time over 10 seconds, OFF Time under 10 seconds

9. Cautions and Handling Precautions

9.1 Handling and Operating the Module

(1) When the module is assembled, it should be attached to the system firmly.

Do not warp or twist the module during assembly work.

(2) Protect the module from physical shock or any force. In addition to damage, this may cause improper operation or damage to the module and back-light unit.

(3) Note that polarizer is very fragile and could be easily damaged. Do not press or scratch the surface.

(4) Do not allow drops of water or chemicals to remain on the display surface.

If you have the droplets for a long time, staining and discoloration may occur.

(5) If the surface of the polarizer is dirty, clean it using some absorbent cotton or soft cloth.

(6) The desirable cleaners are water, IPA (Isopropyl Alcohol) or Hexane.

Do not use ketene type materials (ex. Acetone), Ethyl alcohol, Toluene, Ethyl acid or Methyl chloride. It might permanent damage to the polarizer due to chemical reaction.

(7) If the liquid crystal material leaks from the panel, it should be kept away from the eyes or mouth. In case of contact with hands, legs, or clothes, it must be washed away thoroughly with soap.

(8) Protect the module from static; it may cause damage to the CMOS ICs.

(9) Use finger-stalls with soft gloves in order to keep display clean during the incoming inspection and assembly process.

(10) Do not disassemble the module.

(11) Protection film for polarizer on the module shall be slowly peeled off just before use so that the electrostatic charge can be minimized.

(12) Pins of I/F connector shall not be touched directly with bare hands.

(13) Do not connect, disconnect the module in the "Power ON" condition.

(14) Power supply should always be turned on/off by the item 6.1 Power On Sequence & 6.2 Power Off Sequence

9.2 Storage and Transportation.

(1) Do not leave the panel in high temperature, and high humidity for a long time.

It is highly recommended to store the module with temperature from 0 to 35 °C and relative humidity of less than 70%

(2) Do not store the TFT-LCD module in direct sunlight.

(3) The module shall be stored in a dark place. When storing the modules for a long time, be sure to adopt effective measures for protecting the modules from strong ultraviolet radiation, sunlight, or fluorescent light.

(4) It is recommended that the modules should be stored under a condition where no condensation is allowed. Formation of dewdrops may cause an abnormal operation or a failure of the module.

In particular, the greatest possible care should be taken to prevent any module from being operated where condensation has occurred inside.

(5) This panel has its circuitry FPC on the bottom side and should be handled carefully in order not to be stressed.

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10.Packing

---TBD---

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