



PRODUCT SPECIFICATION

TFT MODULE

MODEL: LT-024240320-C02N

Rev. A

CUSTOMER APPROVAL	
SIGNATURE	DATE

PREPARED	CHECKED	APPROVED

Revision History

Data	Rev. No.	Page	Summary
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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 2.8" TFT-LCD contains 240RGB x 320 pixels, and can display up to 262K colors.

* Features

- Low Input Voltage: VCC: 2.5V~3.3V
- Display Colors of TFT LCD: 262K colors
- CPU Interface: customer defined
- Internal Power Supply Circuit.

General Information Items	Specification	Unit	Note
	Main Panel		
Display area(AA)	36.72(H) * 48.96 (V) (2.4 inch)	mm	-
Driver element	a-Si TFT active matrix	-	-
Display colors	262K	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	-
Drive IC	ST7789V	-	-
Display mode	Transmissive/ Normally White	-	-
Operating temperature	-20~+70	°C	-
Storage temperature	-30~+80	°C	-

* Mechanical Information

Item		Min.	Typ.	Max.	Unit	Note
Module size	Horizontal(H)	-	42.00	-	mm	-
	Vertical(V)	-	59.00	-	mm	-
	Depth(D)	-	2.2	-	mm	-
Weight		-	TBD	-	g	-

1. Optical Characteristics

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

4.1 Optical specification

Item		Symbol	Condition	Min.	Typ.	Max.	Unit	Note
Transmittance (with Polarizer)		T (%)	Θ=0 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	CR>10	—	80	—	—	(1)(4) Measuring with Polarizer , Reference Only
		Θ _R		—	80	—		
	Ver.	Θ _U		—	80	—		
		Θ _D		—	80	—		
Optima View Direction		Free						(5)

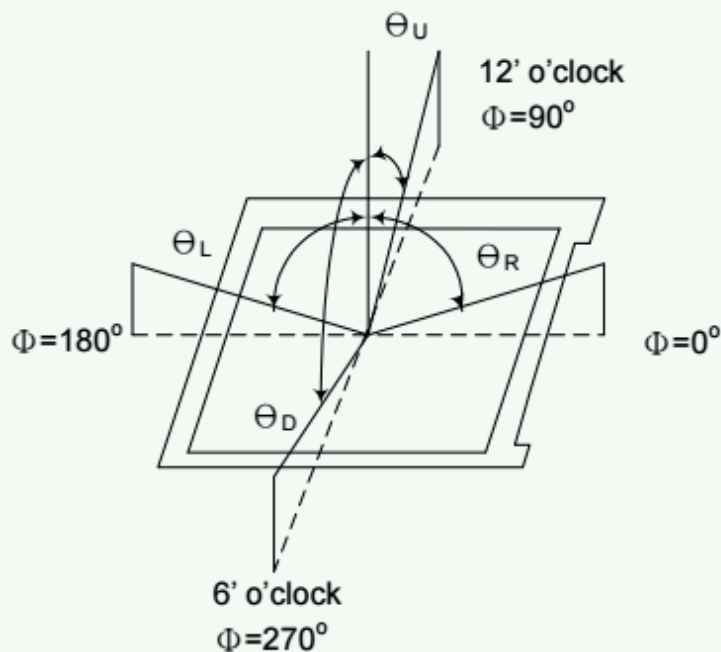
4.2 Measuring Condition

- Measuring surrounding : dark room
- Ambient temperature : $25 \pm 2^\circ\text{C}$
- 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.

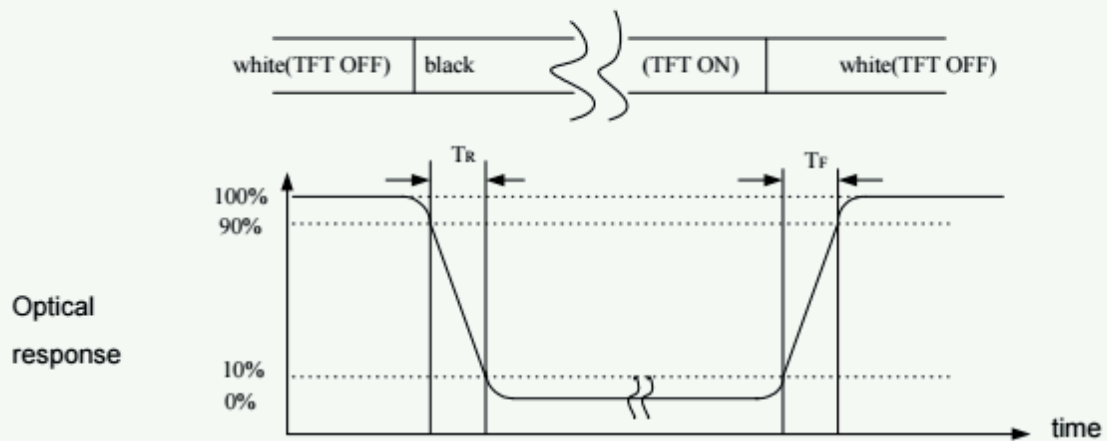
Note (1) Definition of Viewing Angle:



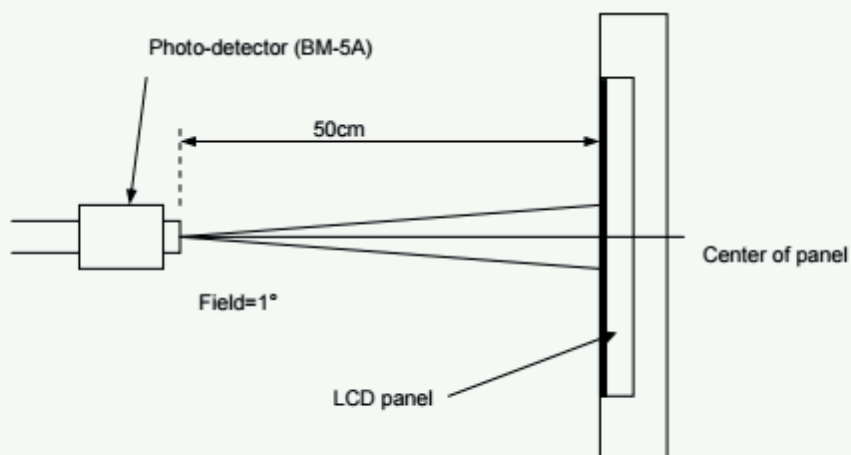
Note (2) Definition of Contrast Ratio (CR) :
measured at the center point of panel

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

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



Note (4) Definition of optical measurement setup



2. Electrical Characteristics

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

Characteristics	Symbol	Min.	Typ.	Max.	Unit	Note
System voltage	VCC	-0.3		+ 4.6	V	
Supply voltage (Digital)	VCC	-0.3		+ 4.6	V	
Supply voltage (Logic)	VCC	-0.3		+ 4.6	V	
Operating temperature	T _{OP}	-20		+ 70	°C	1
Storage temperature	T _{ST}	-30		+ 80	°C	2

Note1: Background color changes slightly depending on ambient temperature. This phenomenon is reversible. Ta70°C: 75%RH max

Ta>70°C: absolute humidity must be lower than the humidity of 75%RH at 70°C

Note2: Ta at -30°C will be <48hrs, at 80°C will be <120hrs

2.2 DC Electrical Characteristics

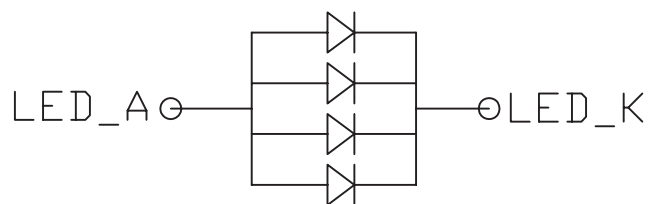
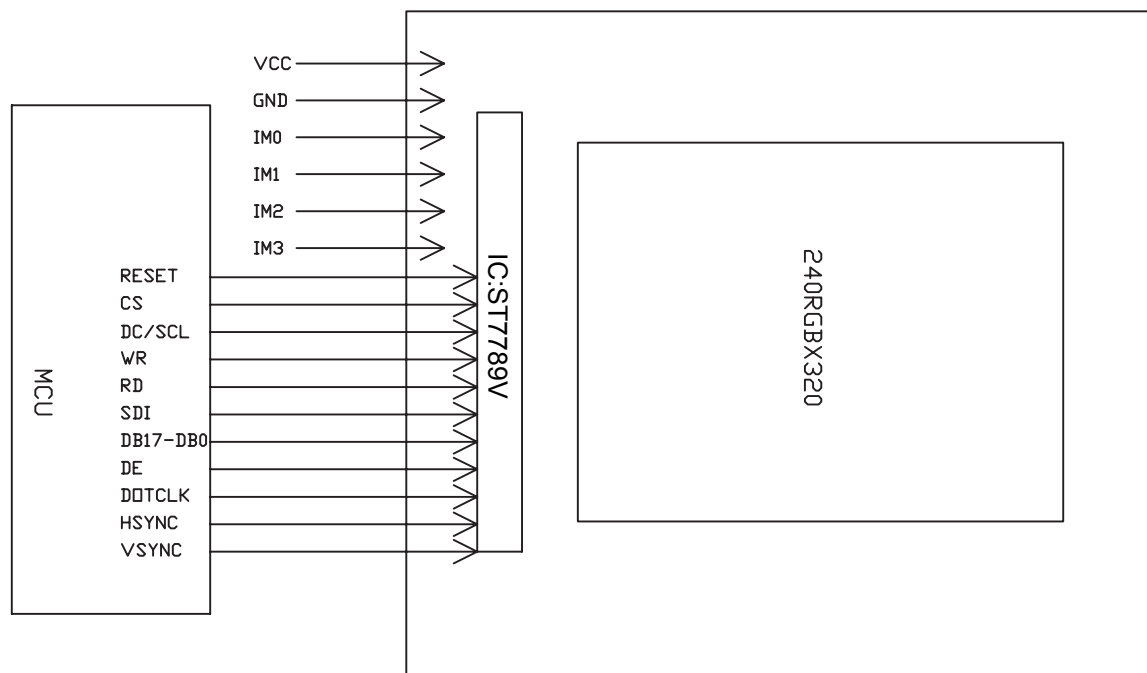
Characteristics	Symbol	Min.	Typ.	Max.	Unit	Note
System voltage	VCC	2.5		3.3	V	-
Normal mode Current consumption	VCC _I	-	6		mA	
Sleep-in mode Current consumption	VCC _I	-	10		uA	-
Level input voltage	V _{IH}	0.8 VCC	-	VCC	V	-
	V _{IL}	GND	-	0.2 VCC	V	-
Level output voltage	V _{OH}	0.8VCC	-	VCC	V	-
	V _{OL}	GND	-	0.2 VCC	V	-

2.3 LED Backlight Characteristics

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

Item	Symbol	Min.	Typ.	Max.	Unit	Note
Forward Current	I _F	-	60	-	mA	
Forward Voltage	V _F		3.2		V	-
LCM Luminance	L _V		200	-	cd/m ²	
Uniformity	AVg	80	-	-	%	-

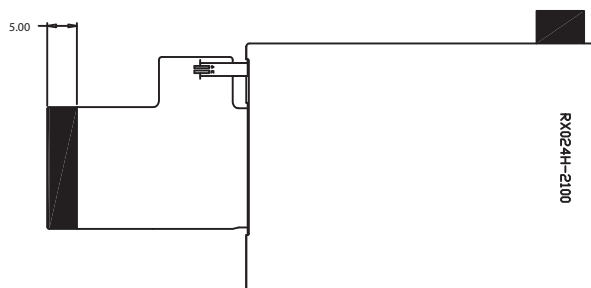
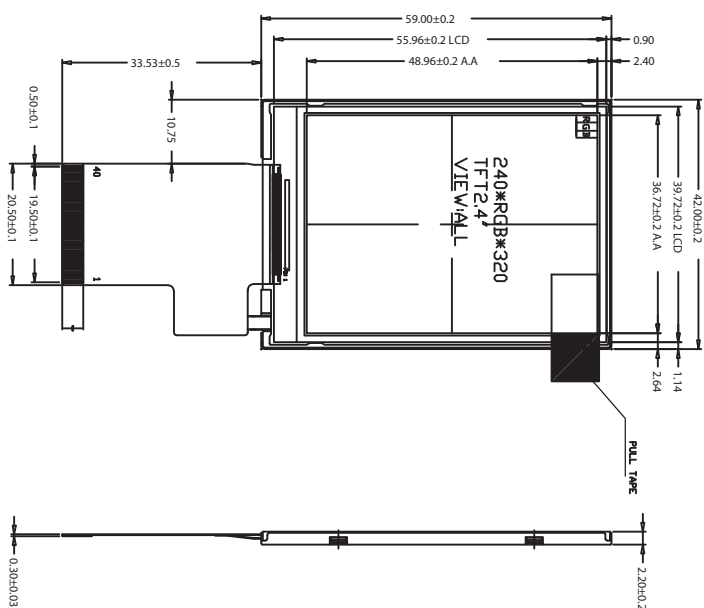
3. Block Diagram



60MA/3.2V TYPE

4. Outline dimension

1	LED_K
2	LED_A
3	NC
4	VCC
5	IN3
6	IN2
7	IN1
8	IN0
9	TE
10	STD
11	RESET
12	CS
13	DC/SC_L
14	WR
15	RD
16	VSYNC
17	HSYNC
18	DE
19	DOTCLK
20	SDI
21	GND
22	DB0
23	DB1
24	DB2
25	DB3
26	DB4
27	DB5
28	DB6
29	DB7
30	DB8
31	DB9
32	DB10
33	DB11
34	DB12
35	DB13
36	DB14
37	DB15
38	DB16
39	DB17
40	GND



NOTE:	
1. LCD TYPE:	2. 4" TFT
2. LCD IC:	S17789V
3. VIEWING DIRECTION:	
4. BACKLIGHT:	ALL
5. OPERATION TEMP:	-40 CHIPS WHITE LED
6. STORAGE TEMP:	-20°C ~ 70°C
7. GENERA TOLERANCE:	-30°C ~ 80°C
	±0.2

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REV	Re vision content description	Date
A	FIRST ISSUE	2018. 04. 19

TOLERANCE			Mod.Name	PART.Name	
TOL.BRINKE UNLESS OTHERWISE SPECIFIED	X.XX±0.3	X.XX±0.2		L CM	
UNIT	DESIGNED(structure)		DESIGNED(electron)	APPROVED	
mm					
					ASSEM BLE

5. Input terminal Pin Assignment

Pin NO.	Symbol	Level	Function
1	LED_K	L	Backlight-
2	LED_A	H	Backlight+
3	NC	/	NC
4	VCC	H	Power supply
5	IM3	H/L	Select the MCU interface mode
6	IM2	H/L	Select the MCU interface mode
7	IM1	H/L	Select the MCU interface mode
8	IM0	H/L	Select the MCU interface mode
9	TE	H/L	Tearing effect output pin
10	SDO	H/L	Serial output signal
11	RESET	H/L	Hardware reset pin
12	CS	H/L	Chip select pin
13	DC/SCL	H/L	A register select signal
14	WR	H/L	Write enable clock input pin
15	RD	H/L	Read enable clock input pin
16	VSYNC	H/L	Vertical SYNC input
17	HSYNC	H/L	Horizontal SYNC input
18	DE	H/L	Data enable input
19	DOTCLK	H/L	Dot Date Clock
20	SDI	H/L	Serial input signal
21	GND	L	Ground
22	DB0	H/L	DATA BUS DB0
23	DB1	H/L	DATA BUS DB1
24	DB2	H/L	DATA BUS DB2
25	DB3	H/L	DATA BUS DB3
26	DB4	H/L	DATA BUS DB4
27	DB5	H/L	DATA BUS DB5
28	DB6	H/L	DATA BUS DB6
29	DB7	H/L	DATA BUS DB7
30	DB8	H/L	DATA BUS DB8
31	DB9	H/L	DATA BUS DB9
32	DB10	H/L	DATA BUS DB10
33	DB11	H/L	DATA BUS DB11
34	DB12	H/L	DATA BUS DB12
35	DB13	H/L	DATA BUS DB13
36	DB14	H/L	DATA BUS DB14
37	DB15	H/L	DATA BUS DB15
38	DB16	H/L	DATA BUS DB16
39	DB17	H/L	DATA BUS DB17
40	GND	L	Ground

ST7789V supports 8/16/9/18 bit parallel data bus for 8080 series CPU, RGB serial interfaces. Selection of these interfaces are set by IM[3:0] pins as shown below.

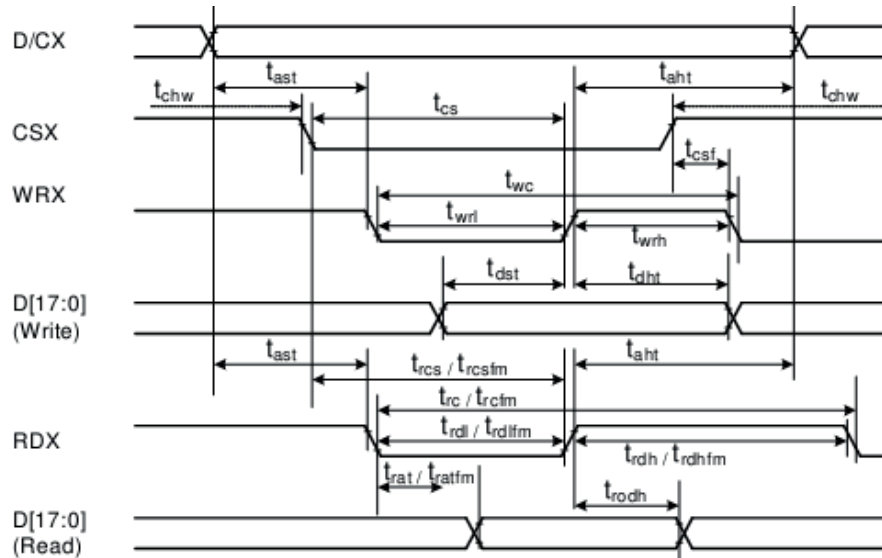
IM3	IM2	IM1	IM0	Interface	Read Back Data Bus Selection
0	0	0	0	80-8bit parallel I/F	DB[7:0]
0	0	0	1	80-16bit parallel I/F	DB[15:0]
0	0	1	0	80-9bit parallel I/F	DB[8:0]
0	0	1	1	80-18bit parallel I/F	DB[17:0],
0	1	0	1	3-line 9bit serial I/F	SDA: in/out
				2 data lane serial I/F	SDA: in/out, WRX: in
0	1	1	0	4-line 8bit serial I/F	SDA: in/out
1	0	0	0	80-16bit parallel I/F II	DB[17:10], DB[8:1]
1	0	0	1	80-8bit parallel I/F II	DB[17:10]
1	0	1	0	80-18bit parallel I/F II	DB[17:0],
1	0	1	1	80-9bit parallel I/F II	DB[17:9]
1	1	0	1	3-line 9bit serial I/F II	SDA: in/ SDO: out
1	1	1	0	4-line 8bit serial I/F II	SDA: in/ SDO: out

6. Operating Principle & Methods

Please refer to ST7789V datasheet for more details.

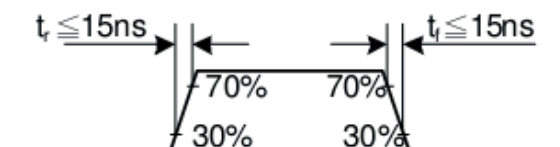
80-System Bus operation Interface Timing Characteristics .

Normal write operation (VCC=2.5V~3.60V)



Signal	Symbol	Parameter	min	max	Unit	Description
DCX	t _{ast}	Address setup time	0	-	ns	
	t _{ah}	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 _{rod}	Read output disable time	20	80	ns	

Note: T_a = -30 to 70 °C, VDDI=1.65V to 3.3V, VCI=2.5V to 3.3V, VSS=0V



7. Reliability Test Result

Item	Condition	Sample Size	Test Result	Note
Low Temperature Operating Life test	-20°C, 96HR	3ea	pass	-
Thermal Humidity Operating Life test	40°C, 90%RH, 96HR	3ea	pass	-
Temperature Cycle ON/OFF test	-20°C ↔ 70°C, ON/OFF, 20CYC	3ea	pass	(1)
High Temperature Storage test	80°C, 96HR	3ea	pass	-
Low Temperature Storage test	- 30°C, 96HR	3ea	pass	-
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

8. Packing

TBD

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.

10. BHL&BMDT Customer Quality Service Process

12. BHL&BMDT Customer Quality Service Process

In order to provide better service to Customer, BHL&BMDT shall apply the after-sales product quality service process as below:

1. According to the P/O from Customer, BHL&BMDT should deliver required product to the place appointed by Customer.
2. Customer will do IQC for the incoming product.
3. Inspection standard should be provided by BHL&BMDT, and it will be valid after confirmed by Customer. Inspection and Defects determination should be carried out according to the standard agreed by both Parties.
4. In order to guarantee in-time communication of product quality information and effective service, QA staff on Customer side should send Weekly Quality Report to the appointed CS staff in BHL&BMDT.
5. After BHL&BMDT get related information, both sides should arrange time and place to determine the defects found by Customer.
6. BHL&BMDT should cooperate with Customer for special quality requirement.
7. After confirmed by both side, BHL&BMDT should be responsible for the defect products which caused by its quality problem. BHL&BMDT should take back the confirmed defect product and return the good product to the place required by customer.
8. BHL&BMDT agree to provide related training of LCD product technology and usage.
9. Customer should use the LCD product according to the instruction. BHL&BMDT will not be responsible for the defect product caused by violation of Users' Instruction.
10. Both parties should deal with the quality problem with friendly cooperative policy. And both parties should negotiate to deal with the defect products of which the responsibility is not very clear.

11. LCD Module Operation Instruction

13. LCD Module Operation Instruction

BHL&BMDT

Part I. How to use the LCD Module

1. Don't hit the LCD Panel in any way because the LCD is made of glass.
2. Don't clean the surface of LCD with hard things. Please clean LCD with Air-gun or very soft cloth when necessary. The protective film on the POL can be removed just before assembly, otherwise, dust, spit or other foreign matter may attached on the LCD under the protective film. After the protective film is removed, only air-gun can be used to remove any dust or foreign matter. Fingure or cloth MUST NOT be used in such cases.
3. No chemical liquid is allowed to clean the LCD, such as alcohol, acetone and IPA. All of these can damage the LCD. Water on the LCD must be cleaned as soon as possible, for it will cause POL color change or other defect.
4. Please move and assemble LCD very carefully during assembly, and don't push or twist it.
5. Don't damage the FPC of LCD module. It will cause permanent defect.
6. Don't disassemble LCD module. It will cause permanent defect.
7. Don't expose LCD module under sunshine, strong fluorescence or ultraviolet radiation.
8. Please make sure that operators wear static-protective bands effectively and working tables are effectively earthing during operation.
9. Please place LCD module on the tray provided by BHL&BMDT while moving it, in order to avoid mechanical damage. Hold the module's side frames to avoide damage during moving.
10. Don't twist, disassemble, squeeze or hit the PCB. It will damage the circuit or component on PCB and cause functional defect.
11. Please use the connector according to the instruction provided by BHL&BMDT.
12. Please place dual module with the sub-panel upward. Trays should be placed in contrary direction. An empty tray should be placed on the top.
13. Sealing operation on PCB must be very careful to avoid short or cut the original circuit on PCB. Otherwise, it will cause permanant damage to the LCD.
14. Don't add direct DC or high voltage to LCD panel. It will cause functional damage to the LCD or shorten the life of LCD product.
15. LCD may respond slowly or display abnormally in extrem temperature (lower than -20℃ or higher than 50℃). But this doesn't mean LCD functional defect. LCD will display normally in regular temperature. Therefore, don't use LCD product in extrem temperature.
16. Don't push the display area of LCD panel, it will cause abnormal display. This doesn't mean LCD functional defect, neither. LCD will display normally in regular temperature.
17. Electrical test of LCD product is made by using mobile phone provided by Customer. We can use special test equipment to do the test, also.
18. The black band on IC on LCD product is used to protect the IC from light. Please do NOT remove it.
19. Please take great care to use connector. Customer should be responsible for connector defect caused by operation on Customer side.

Part II Storage

1. Physical status of liquid crystal will change in extrem temperature, and it can not be resumed when the temperature returns to be normal. So LCD module should be stored in required temperature.
2. LCD module should be stored in required humidity. Low humidity may add static, while high humidity may corrode the ITO circuit of LCD product. The suitable storage environment is: temperature: $22\pm5^{\circ}\text{C}$, humidity: $55\%\pm10\%$.
3. Don't expose LCD module under sunshine, strong fluorescence or ultraviolet radiation for a long time. It should be stored in dark area.
4. LCD should be stored in static-protective polythene bag. Don't expose it in the air for a long time.