Dalian Dongfu Color Display Co.,Ltd

LCD Module User Manual
DM 2402-01

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REVISION RECORD		
REV. NO.	DATE	REVISION ITEMS
1.0	Jul 5, 2007	First Release Version

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1.Scope

This manual defines general provisions as well as inspection standards for standard LCD module. If the event of unforeseen problem or unspecified items may occur, please contact the nearest supplier or our company.

2.Warranty

If module is not stored or used as specified in this manual, it will be void the 12-month warranty.

3.Features

3-1. Features

(1) Display mode: ┌ Transflective / Positive type
└ STN LCD

(2) Display color: ┌ Display dots: Black
└ Background:Yellow—Green/Grey

(3)Input data: 8-bit parallel data interfaced from a MPU

(4) Multiplex ratio: 1/16 Duty, 1/5 Bias

(5)Viewing direction: 6 O'clock

(6) Back light: Yellow—Green

3-2. Mechanical features

Item	Specifications	Unit
Outline dimensions	118.0(W)×36.0(H) ×14.0Max.(T)	mm
Viewing Area	93.50(W)×15.80(H)	mm
Image Area	88.30(W)×11.50(H)	mm
Character Size	3.20(W) ×5.55(H)	mm
Distance between characters	0.50(W)×0.4(H)	mm
Dot Size	0.55(W) ×0.6 (H)	mm
Dot Pitch	0.60(W)×0.65(H)	mm
Weight	---	g

3-3. Absolute maximum ratings

Item	Symbol	Condition	Min	Max	Units
Power supply for logic	Vdd-Vss	25℃	- 0.3	7.0	V
Operating voltage for LCD	Vdd-V0	25℃	- 0.3	13.0	V
Input voltage	Vin	25℃	- 0.3	Vdd+0.3	V
Operating temperature	Top	---	- 20	70	℃
Storage temperature	Tstg	---	- 25	80	℃

Note:

1) The modules may be destroyed if they are used beyond absolute maximum ratings. In ordinary operation, it is desirable to use them within recommended operation conditions. Using the modules beyond these conditions may cause malfunction and poor reliability.
2) All voltage values are referenced to GND=0V.

3-4 Electrical characteristics (VDD=2.7V to 4.5V, Ta = 25℃)

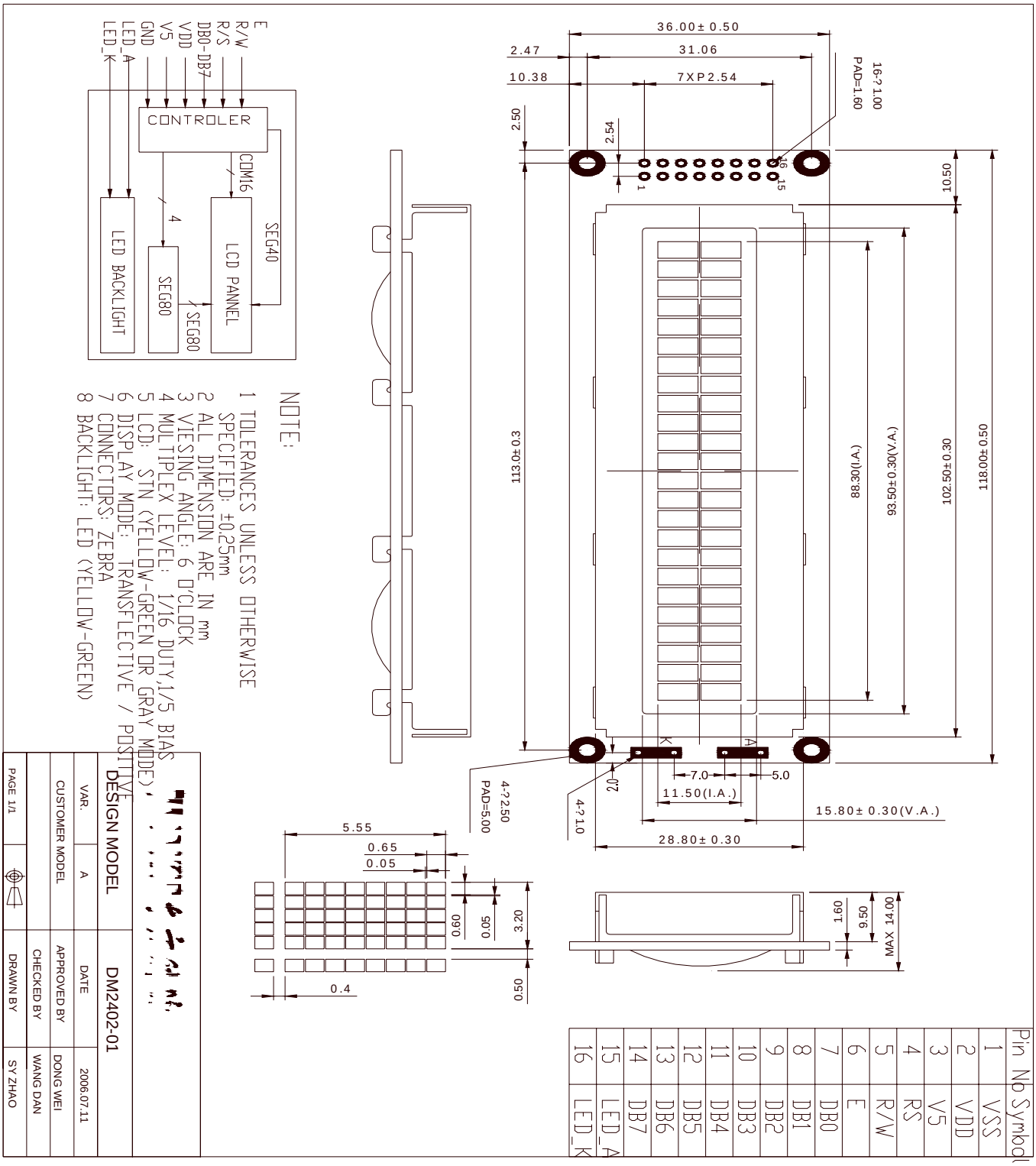
Item		Symbol	Condition	Min.	Typ.	Max.	Unit
Power Voltage	Logic	Vdd		2.7	4.5	5.0	V
	LCDdrive	Vdd-Vss		---	4.5	---	
Input Voltage	"H" Level	Vih1	Pins:E,RS,R/W, DB7-DB0	0.7Vdd	---	Vdd	
	"L" Level	Vil1		-0.3	---	0.55	
Input Voltage	"H" Level	Vih2		0.7Vdd	---	Vdd	
	"L" Level	Vil2		-0.2	---	0.2Vdd	
Output Voltage (TTL)	"H" Level	Voh1	-Ioh=0.1mA Pins:DB7-DB0	0.75Vdd	---	---	
	"L" Level	Vol1	Iol=0.1mA Pins:DB7-DB0	---	---	0.2Vdd	
Output Voltage (COMS)	"H" Level	Voh2	-Ioh=40uA Pins:CL1,CL2,M,D	0.8Vdd	---	---	
	"L" Level	Vol2	Iol=40Ua Pins:CL1,CL2,M,D	---	---	0.2Vdd	
Frame Frequency		Fosc	Vdd=5.0V Rf=91kΩ±2%	190	270	350	KHz
Power Consumption		Idd		---	0.2	0.4	mA

Note： All the dots are in the static state.

3-5.Electro-optical Characteristics

Item		Symbol	Temp	Conditions	Min.	Typ.	Max.	Unit
LCD Driving Voltage		Vop	25℃	Φ=0°， θ=0°		4.5		V
Response Time	Rise Time	tr	0℃	Φ=0°， θ=0°	----	750	1100	ms
			25℃		----	150	200	
	Decay Time	td	0℃		----	1000	1500	
			25℃		----	150	200	
Viewing Angle		Δ Φ	25℃	Vertical	-45	---	45	deg
				Horizontal	-55	---	55	
Contrast Ratio		K	25℃	Φ=0°， θ=0°	2.0	5.0	----	----

4. Mechanical Diagram



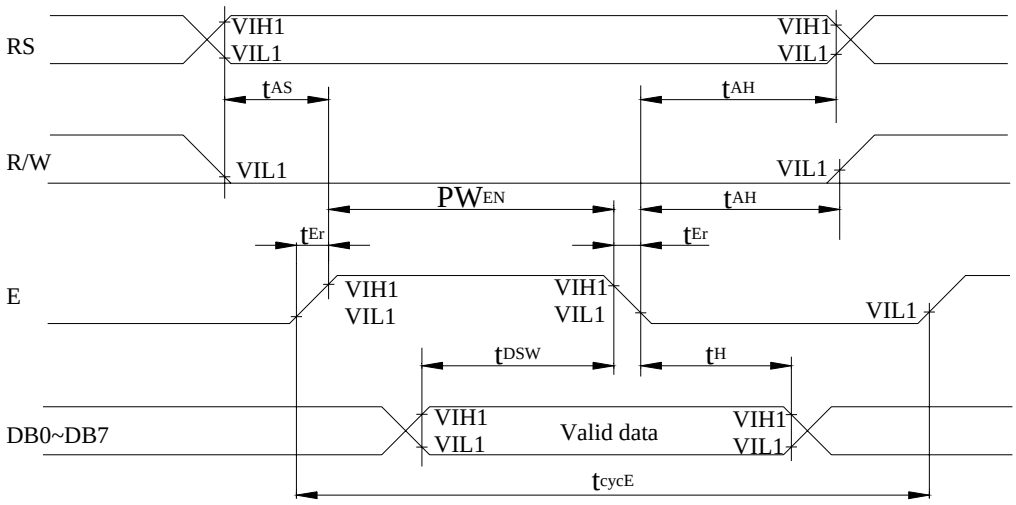
Pin No	Symbol
1	VSS
2	VDD
3	V5
4	RS
5	R/W
6	E
7	DB0
8	DB1
9	DB2
10	DB3
11	DB4
12	DB5
13	DB6
14	DB7
15	LED_A
16	LED_K

5.I/O Terminal

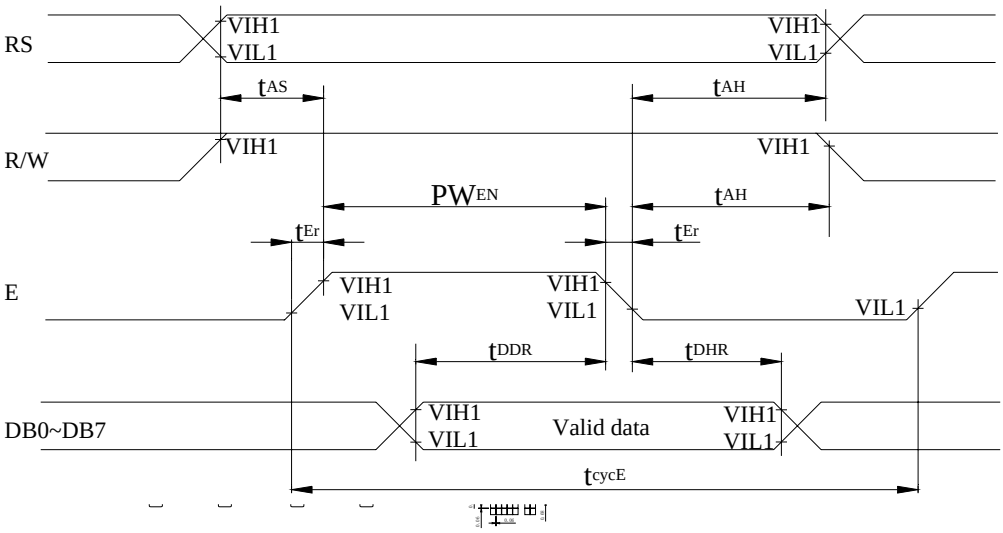
5-1 I/O Connection

Pin No.	Symbol	Function
1	VSS	Power supply (GND)
2	VDD	Power supply (+)
3	V0	Contrast adjust
4	RS	Input terminal, interfaced with MPU Register select signal RS=0, Instruction register (for write) Busy flag: address counter (for read) RS=1, Data register (for write and read)
5	R/W	Input terminal, interfaced with MPU Data read/write R/W=1 Read ； R/W=0 Write
6	E	Input terminal, interfaced with MPU Enabe signal
7-14	DB0-DB7	Input/output terminal, interfaced with MPU, transfers and receives data between the MPU and module. DB4~DB7: Four high order bi-directional data bus pins. DB7 can be used as a busy flag. DB0-DB3: Four low order bi-directional data bus pins. These pins are not used during 4-bit operation.
15	LED A	Power supply for LED (+)
16	LED K	Power supply for LED (-)

5-2 Signal timing diagram



Write mode timing diagram



Read mode timing diagram

(1) Write Operations

Item	Symbol	Condition	Min.	Max.	Unit
Enable cycle time	t_{cycE}	Vdd=3.3V ±5% Vss=0V Ta=25℃	1000	—	ns
Enable pulse width (high level)	PW_{EN}		450	—	
Enable rise / fall time	t_{Er},t_{Ef}		—	25	
Address set-up time (RS,R/W to E）	t_{AS}		60	—	
Address hold time	t_{AH}		20	—	
Data set-up time	t_{DSW}		195	—	
Data hold time	t_H		10	—	

(2)Read Operation

Item	Symbol	Condition	Min.	Max.	Unit
Enable cycle time	t_{cycE}	Vdd=3.3V ±5% Vss=0V Ta=25℃	1000	—	ns
Enable pulse width (high level)	PW_{EN}		450	—	
Enable rise / fall time	t_{Er},t_{Ef}		—	25	
Address set-up time (RS,R/W to E）	t_{AS}		60	—	
Address hold time	t_{AH}		20	—	
Data set-up time	t_{DSW}		---	360	
Data hold time	t_H		5.0	—	

5-3 Application features of modules：

5-3-1 Basic Setting

To drive the LCD module correctly and provide normaly disply,please use the following setting :

N=1,2-Line DIisply

F=0,5*8 dots font

D=1,disply on

Note: 1.These setting should issue to the LCD module while start up.
2. See the Disply Commands Section for details.

5-3-2. Character Generator RAM (CGRAM)

Character Generator RAM is for storing the User-defined Charachers , Users can store custom character pattern data of 8 • 5X8-dot character (character code=00h-07h) by using CGRAM.

Note:The details of The CGRAM,please refer to SPLC780D

5-3-4 Disply Data RAM (DDRAM)

The display positions of characters on LCD panels correspond to the storage addresses of character codes in DDRAM.

The following is the relationship between DDRAM address and display positions on the LCD panel.

Display position		1	2	3	…	38	39	40
DDRAM Address	The first line	00H	01H	03H	…	25H	26H	27H
DDRAM Address	The second line	40H	41H	42H	…	65H	66H	67H

Note:The details of The DDRAM,please refer to SPLC780D

5-3-5. Character Code Rom

Please refer to SPLC780D Data sheet

5-4. Instruction Table

Instruction	Instruction code										Description
	RS	RW	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	
Clear display	0	0	0	0	0	0	0	0	0	1	writes“20H”toDDRAMaddresses
Return home	0	0	0	0	0	0	0	0	1	*	SetDDRAM address to “00h”from AC and return cursor to its original positionifshifted.Thecontents of DDRAM are not changed.
Entry mode set	0	0	0	0	0	0	0	1	I/D	S	Assign cursor moving Direction and enable the shift of entire display.
Display on/off control	0	0	0	0	0	0	1	D	C	B	The display is on when D is 1 and off when D is 0. Thecursor is displayed whenCis1andnotdisplayedwhenCis 0.blinking of cursor on/offcontrol bit.

Cursor or display shift	0	0	0	0	0	1	S/C	R/L	*	*	SetCursor moving and displayshiftcontrolbit,and the direction,without changingDDRAMdata.
Function set	0	0	0	0	1	DL	N	F	*	*	Sets the interface datalength(DL:8bit/4bit). N：Sets the numbers of display lines,and displayfonttype(F:5*10 dots/5*8dots).
Set CGRAM address	0	0	0	1	ACG5	ACG4	ACG3	ACG2	ACG1	ACG0	SetCGRAM address in address counter.
Set DDRAM address	0	0	1	ADD6	ADD5	ADD4	ADD3	ADD2	ADD1	ADD0	SeDDRAM address in address counter.
Read busy flag and address	0	1	BF	AC6	AC5	AC4	AC3	AC2	AC1	AC0	Whether during internal operation or not can be known by Reading BF.the contents of address Counter can also be read.
Write Data to RAM	1	0	D7	D6	D5	D4	D3	D2	D1	D0	Write data into internalRAM(DDRAM/ CGRAM).
Readdata from RAM	1	1	D7	D6	D5	D4	D3	D2	D1	D0	Read data from internalRAM(DDRAM/ CGRAM)..

Note:The details of The Display Commands please refer to SPLC780D data sheet.

6. Quality Level

6-1 Inspection conditions

6-1-1The environmental conditions for inspection shall be as follows:

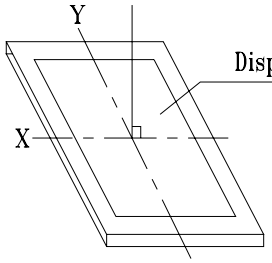
Room temperature: 20±3℃

Humidity: 65±20% RH

6-1-2 The external visual inspection:

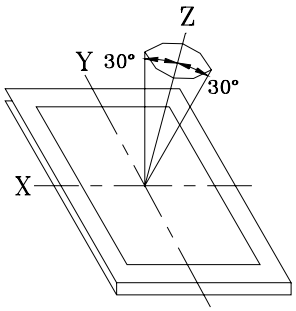
The inspection shall be performed by using a 20W fluorescent lamp for illumination and the distance between LCD and the eyes of the inspector should be at least 30cm.

6-1-3 (1) Light method



Fluorescent lamp set the perpendicular to the display surface

(2) Inspection distance and angle



Inspection should be performed within ø (ø=30°) from Z axis to each X and Y axis.

Inspection distance of any direction within ø must be kept 30±50cm to the display surface.

6-2 Sampling procedures for each item's acceptance level table

Defect type	Sampling procedure	AQL
Major defect	MIL-STD-105D Inspection Level I Normal inspection Single sample inspection	QC/-07-2006(1)
Minor defect	MIL-STD-105D Inspection Level I Normal inspection Single sample inspection	QC/-07-2006(1)

6-3 Classification of defects

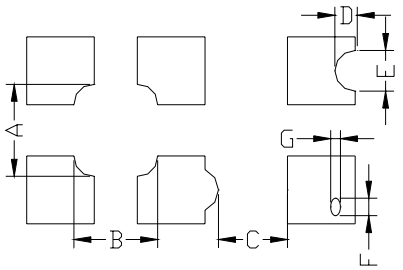
6-3-1 Major defect

A major defect refers to a defect that may substantially degrade usability for product applications.

6-3-2 Minor defect

A minor defect refers to a defect that deviates from existing standards almost unrelated to the effective use of the product or its operation.

6-4 Inspection standards

<table>
<tr><th>Item</th><th>Criterion for defects</th><th>Defect type</th></tr>
<tr><td>1) Display on inspection</td><td>(1) Non display (2) Vertical line is deficient
(3) Horizontal line is deficient (4) Cross line is deficient</td><td>Major</td></tr>
<tr><td>2) Black / White spot</td><td><table><tr><th>Size Φ(mm)</th><th>Acceptable number</th></tr><tr><td>Φ≤0.3</td><td>Ignore (note)</td></tr><tr><td>0.3<Φ≤0.45</td><td>3</td></tr><tr><td>0.45<Φ≤0.6</td><td>1</td></tr><tr><td>0.3<Φ</td><td>0</td></tr></table>(Note) Not allowed if four more spots crowd together</td><td>Minor</td></tr>
<tr><td>3) Black / White line</td><td><table><tr><th>Length (mm)</th><th>Width (mm)</th><th>Acceptable number</th></tr><tr><td>L≤10</td><td>W≤0.03</td><td>Ignore</td></tr><tr><td>5.0≤L≤10</td><td>0.03<W≤0.04</td><td>3</td></tr><tr><td>5.0≤L≤10</td><td>0.04<W≤0.05</td><td>2</td></tr><tr><td>1.0≤L≤10</td><td>0.05<W≤0.06</td><td>2</td></tr><tr><td>1.0≤L≤10</td><td>0.06<W≤0.08</td><td>1</td></tr><tr><td>L≤10</td><td>0.08<W</td><td>follows 2) point defect</td></tr></table>Defects separate with each other at an interval of more than 20mm.</td><td>Minor</td></tr>
<tr><td>4) Display pattern</td><td>  [Unit: mm]<table><tr><td>A+B≤0.45
2</td><td>0<C</td><td>D+E≤0.35
2</td><td>F+G≤0.35
2</td></tr></table>Note: 1) Up to 3 damages acceptable
2) Not allowed if there are two or more pinholes every 3 of fourths inch.</td><td>Minor</td></tr>
<tr><td>5) Spot-like contrast irregularity</td><td><table><tr><th>Size Φ(mm)</th><th>Acceptable Number</th></tr><tr><td>Φ≤0.7</td><td>Ignore (note)</td></tr><tr><td>0.7<Φ≤1.0</td><td>3</td></tr><tr><td>1.0<Φ≤1.5</td><td>1</td></tr><tr><td>1.5<Φ</td><td>0</td></tr></table>Note: 1) Conformed to limit samples.
2)Intervals of defects are more than 30mm.</td><td>Minor</td></tr>
</table>

<table>
<tr><th>Item</th><th>Criterion for defects</th><th>Defect type</th></tr>
<tr><td>6) Bubbles in polarizer</td><td><table><tr><th>Size Φ(mm)</th><th>Acceptable Number</th></tr><tr><td>Φ≤0.4</td><td>Ignore (note)</td></tr><tr><td>0.4<Φ≤0.65</td><td>2</td></tr><tr><td>0.65<Φ≤1.2</td><td>1</td></tr><tr><td>1.2<Φ</td><td>0</td></tr></table></td><td>Minor</td></tr>
<tr><td>7) Scratches and dent on the polarizer</td><td>Scratches and dent on the polarizer shall be in the accordance with “2) Black/white spot”, and “3) Black/White line”.</td><td>Minor</td></tr>
<tr><td>8) Stains on the surface of LCD panel</td><td>Stains which cannot be removed even when wiped lightly with a soft cloth or similar cleaning.</td><td>Minor</td></tr>
<tr><td>9) Rainbow color</td><td>No rainbow color is allowed in the optimum contrast on state within the active area.</td><td>Minor</td></tr>
<tr><td>10) Viewing area encroachment</td><td>Polarizer edge or line is visible in the opening viewing area due to polarizer shortness or sealing line.</td><td>Minor</td></tr>
<tr><td>11) Bezel appearance</td><td>Rust and deep damages that are visible in the bezel are rejected.</td><td>Minor</td></tr>
<tr><td>12) Defect of land surface contact</td><td>Evident crevices that are visible are rejected.</td><td>Minor</td></tr>
<tr><td>13) Parts mounting</td><td>(1) Failure to mount parts
(2) Parts not in the specifications are mounted
(3) For example: Polarity is reversed, HSC or TCP falls off.</td><td>Major</td></tr>
<tr><td>14) Part alignment</td><td>(1) LSI, IC lead width is more than 50% beyond pad outline.
(2) More than 50% of LSI, IC leads is off the pad outline.</td><td>Minor</td></tr>
<tr><td>15) Conductive foreign matter (solder ball, solder hips)</td><td>(1) 0.45<Φ, N≥1
(2) 0.3<Φ≤0.45, N≥1
Φ: Average diameter of solder ball (unit: mm)
(3) 0.5<L, N≥1
L: Average length of solder chip (unit: mm)</td><td>Major
Minor

Minor</td></tr>
<tr><td>16) PCB pattern damage</td><td>(1) Deep damage is found on copper foil and the pattern is nearly broken.
(2) Damage on copper foil other than 1) above</td><td>Major
Minor</td></tr>
<tr><td>17) Faulty PCB correction</td><td>(1) Due to PCB copper foil pattern burnout, the pattern is connected, using a jumper wire for repair;2 or more places are corrected per PCB.
(2) Short-circuited part is cut, and no resist coating has been performed.</td><td>Minor</td></tr>
<tr><td>18) Bezel flaw</td><td>Bezel claw missing or not bent</td><td>Minor</td></tr>
<tr><td>19) Indication on name plate (sampling indication label)</td><td>(1) Failure to stamp or label error, or not legible.(all acceptable if legible)
(2) The separation is more than 1/3 for indication discoloration, in which the characters can be checked.</td><td>Minor</td></tr>
</table>

7.Reliability

7-1 Lifetime

50,000 hours (25℃ in the room without ray of sun)

7-2 Items of reliability

Item	Condition	Criterion
1) High Temperature Operating	60℃ 96hrs	**No cosmetic failure is allowable.**
2) Low Temperature Operation	-20℃ 96hrs	**Contrast ratio should be between initial value ±10%.** Total current consumption should be below double of initial value.
3) Humidity	40℃, 90%RH, 96hrs	**No cosmetic failure is allowable.** **Contrast ratio should be between initial value ±20%.** Total current consumption should be below double of initial value.
4) High Temperature	70℃ 96hrs	
5) Low Temperature	-30℃ 96hrs	
6) Thermal shock	25℃→30℃→25℃→70℃ 5(min) 30(min) 5(min) 30(min) 5 cycle, 55~60%RH	
7) Vibration	10~55~10hz amplitude: 1.5mm 2hrs for each direction (X,Y,Z)	No defects in cosmetic and operational function are allowable. Total current consumption should be below double of initial value.

8.Handling Precautions

8-1 Mounting method

A panel of LCD module consists of two thin glass plates with polarizers that easily get damaged.

And since the module in so constructed as to be fixed by utilizing fitting holes in the printed circuit board (PCB).

Extreme care should be used when handling the LCD modules.

8-2 Cautions of LCD handling and cleaning

When cleaning the display surface, use soft cloth with solvent (recommended below) and wipe lightly.

- □ Isopropyl alcohol
- □ Ethyl alcohol
- □ Trichlorotriflorothane

Do not wipe the display surface with dry or hard materials that will damage the polarizer surface.

Do not use the following solvent:

- □ Water
- □ Ketone
- □ Aromatics

8-3 Caution against static charge

The LCD module use C-MOS LSI drivers. So we recommend you:

Connect any unused input terminal to V_{dd} or V_{ss}. Do not input any signals before power is turned on, and ground your body, work/assembly areas, assembly equipment to protect against static electricity.

8-4 Packaging

- Module employs LCD elements, and must be treated as such.
  Avoid intense shock and falls from a height.
- To prevent modules from degradation, do not operate or store them exposed direct to sunshine or high temperature/humidity.

8-5 Caution for operation

- It is an indispensable condition to drive LCD module within the limits of the specified voltage since the higher voltage over the limits may cause the shorter life of LCD module.
  An electrochemical reaction due to DC (direct current) causes LCD undesirable deterioration so that the uses of DC (direct current) drive should be avoided.
- Response time will be extremely delayed at lower temperature than the operating temperature range and on the other hand at higher temperature LCD module may show dark color in them. However those phenomena do not mean malfunction or out of order of LCD module, which will come back in the specified operating temperature.

8-6 Storage

In the case of storing for a long period of time, the following ways are recommended:

- Storage in polyethylene bag with the opening sealed so as not to enter fresh air outside in it. And with not desiccant.
- Placing in a dark place where neither exposure to direct sunlight nor light is. Keeping the storage temperature range.
- Storing with no touch on polarizer surface by any thing else.

8-7 Safety

- It is recommendable to crash damaged or unnecessary LCD into pieces and to wash off liquid crystal by either of solvents such as acetone and ethanol, which should be burned up later.
- When any liquid leaked out of a damaged glass cell comes in contact with your hands, please wash it off well at once with soap and water.

9.Precautions for Use

9-1 Both parties should provide a limit sample on an occasion when both parties agree its necessity.
The judgement by a limit sample shall take effect after the limit sample has been established and confirmed by both parties

9-2 On the following occasions, the handling of problem should be decided through discussion and agreement between responsible of the both parties.

-When a question is arisen in this manual.

-When a new problem is arisen which is not specified in this manual.

-Some problem is arisen due to the change of inspection and operating conditions in users.

-When a new problem is arisen at the customer's operating set for sample evaluation in the customer site.