

# User's Guide

# NHD-0224AZ-FL-YBW

# LCM

(Liquid Crystal Display Module)

**RoHS Compliant**

- NHD-** Newhaven Display
- 0224-** 2 Lines x 24 Characters
- AZ-** Version Line
- F-** Transflective
- L-** Yellow/Green LED B/L
- Y-** STN-Yellow/Green
- B-** 6:00 View
- W-** Wide Temperature (-20 ~ +70c)

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**DOCUMENT REVISION HISTORY**

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**1.Features**

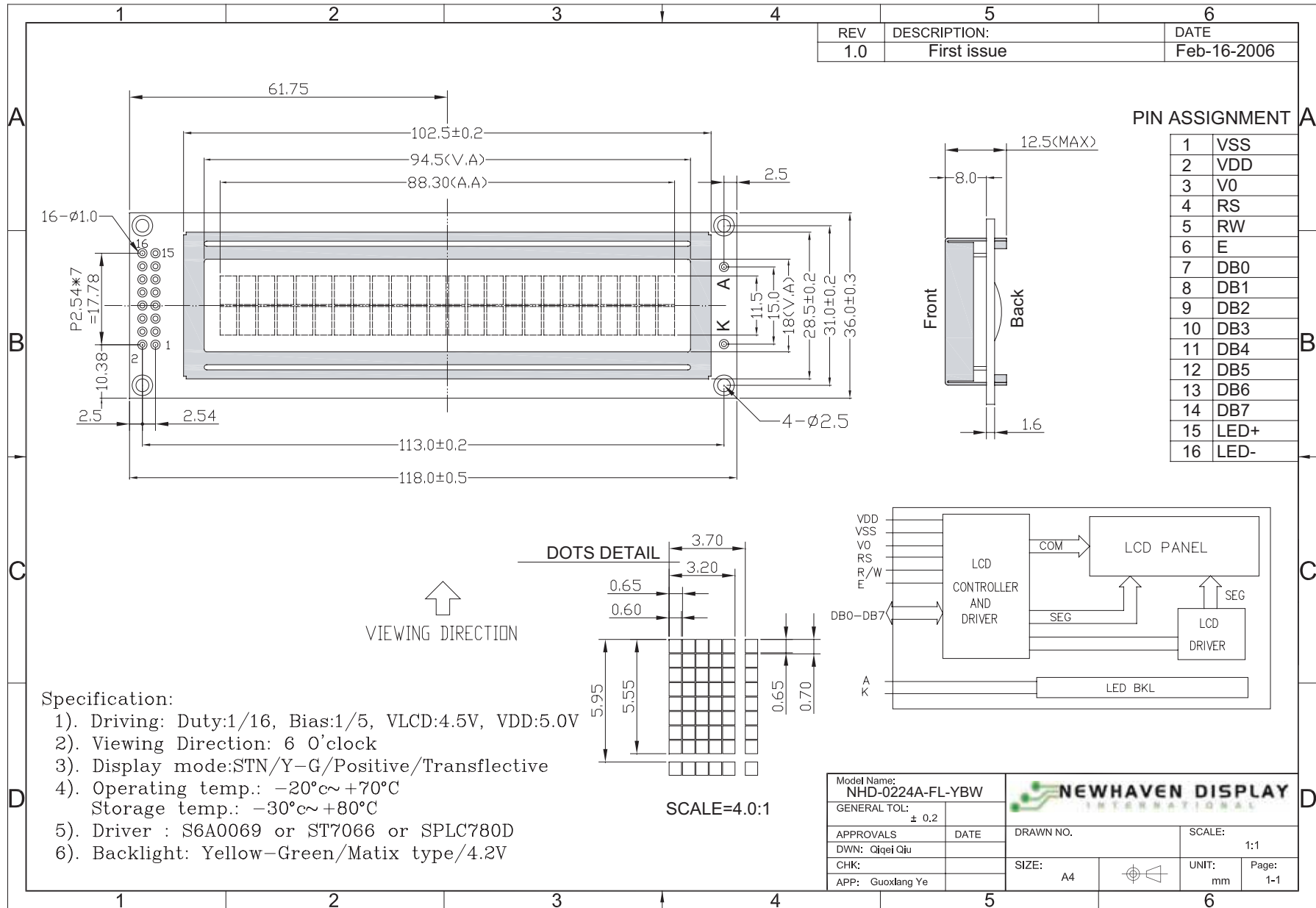
1. 5x8 dots with cursor
2. Built-in controller (S6A0069 or equivalent)
3. +5V power supply
4. 1/16 duty cycle;1/5bias
5. BKL to be driven by pin15, pin16
6. 16characters \*2lines display
- 7.

<b>LCD type</b>	<input type="checkbox"/> FSTN positive		<input type="checkbox"/> FSTN Negative	
	<input checked="" type="checkbox"/> STN Yellow Green	<input type="checkbox"/> STN Gray		<input type="checkbox"/> STN-Blue
<b>View direction</b>	<input checked="" type="checkbox"/> 6 O'clock		<input type="checkbox"/> 12 O'clock	
<b>Rear Polarizer</b>	<input type="checkbox"/> Reflective		<input checked="" type="checkbox"/> Transflective	<input type="checkbox"/> Transmissive
<b>Backlight Type</b>	<input type="checkbox"/> LED	<input type="checkbox"/> EL	<input type="checkbox"/> Internal Power	<input checked="" type="checkbox"/> 5.0V input
		<input type="checkbox"/> CCFL	<input type="checkbox"/> External Power	<input type="checkbox"/> 3.3V input
<b>Backlight Color</b>	<input type="checkbox"/> White	<input type="checkbox"/> Amber	<input type="checkbox"/> Blue-Green	<input checked="" type="checkbox"/> Yellow-Green
<b>Temperature Range</b>	<input type="checkbox"/> Normal		<input checked="" type="checkbox"/> Wide	<input type="checkbox"/> Super Wide
<b>DC to DC circuit</b>	<input type="checkbox"/> Build-in		<input checked="" type="checkbox"/> Not Build-in	
<b>EI Driver IC</b>	<input type="checkbox"/> Build-in		<input checked="" type="checkbox"/> Not Build-in	
<b>Touch screen</b>	<input type="checkbox"/> With		<input checked="" type="checkbox"/> Without	
<b>Font type</b>	<input checked="" type="checkbox"/> English-Japanese	<input type="checkbox"/> English-European	<input type="checkbox"/> English-Russian	<input type="checkbox"/> Other
		open		

**2. MECHANICAL SPECIFICATIONS**

Module size	118.0mm(L)*36.0mm(W)* Max12.5(H)mm
Viewing area	94.5mm(L)*18.0mm(W)
Character size	3.2mm(L)*5.55mm(W)
Character pitch	3.7mm(L)*5.95mm(W)
Weight	Approx.

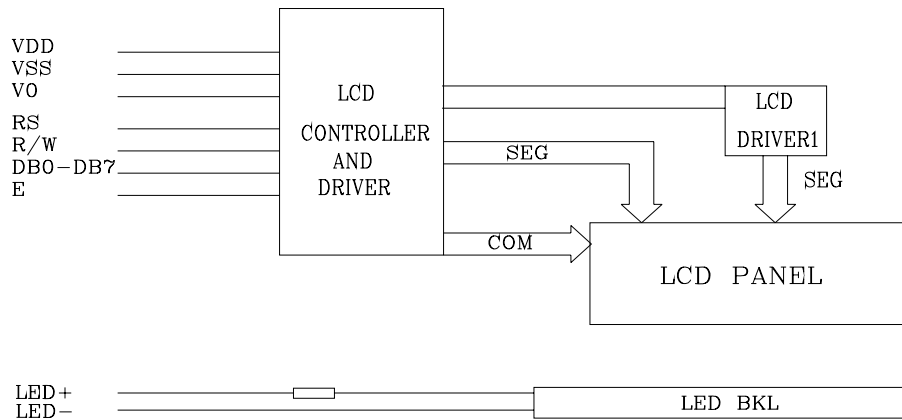
### 3.Outline dimension



#### 4. Absolute maximum ratings

Item	Symbol	Standard			Unit
Power voltage	$V_{DD}-V_{SS}$	0	-	7.0	V
Input voltage	$V_{IN}$	VSS	-	VDD	
Operating temperature range	$V_{OP}$	-20	-	+70	°C
Storage temperature range	$V_{ST}$	-30	-	+80	

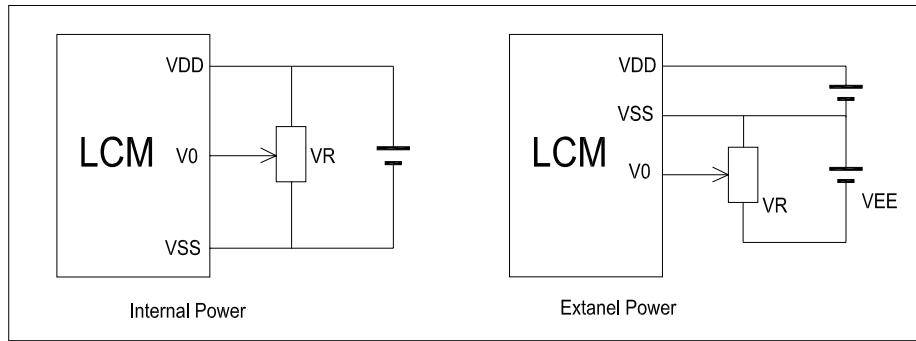
#### 5. Block diagram



#### 8. Interface pin description

Pin no.	Symbol	External connection	Function
1	$V_{SS}$	Power supply	Signal ground for LCM (GND)
2	$V_{DD}$		Power supply for logic (+5V) for LCM
3	$V_0$		Contrast adjust
4	RS	MPU	Register select signal
5	R/W	MPU	Read/write select signal
6	E	MPU	Operation (data read/write) enable signal
7~10	DB0~DB3	MPU	Four low order bi-directional three-state data bus lines. Used for data transfer between the MPU and the LCM. These four are not used during 4-bit operation.
11~14	DB4~DB7	MPU	Four high order bi-directional three-state data bus lines. Used for data transfer between the MPU
15	LED+	Power supply	Power supply for LED backlight (+5V)
16	LED-		Power supply for LED backlight (0V)

### 7. Contrast adjust



$V_{DD}-V_0$ : LCD Driving voltage  
 VR: 10k~20k

### 8. Optical characteristics

STN type display module ( $T_a=25^{\circ}C$ ,  $V_{DD}=5.0V$ )

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
Viewing angle	$\theta$	$C_r \geq 3$	10	-	60	deg
	$\Phi$		-45	-	45	
Contrast ratio	$C_r$	-	-	3	-	-
Response time (rise)	$T_r$	-	-	100	150	ms
Response time (fall)	$T_r$	-	-	150	200	

FSTN type display module ( $T_a=25^{\circ}C$ ,  $V_{DD}=5.0V$ )

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
Viewing angle	$\theta$	$C_r \geq 3$	-10	-	60	deg
	$\Phi$		-45	-	45	
Contrast ratio	$C_r$	-	-	5	-	-
Response time (rise)	$T_r$	-	-	100	150	ms
Response time (fall)	$T_r$	-	-	150	200	

### 9. Electrical characteristics

DC characteristics

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Supply voltage for LCD	$V_{DD}-V_0$	$T_a = 25^{\circ}C$	-	4.6	-	V
Input voltage	$V_{DD}$		4.7	5.0	5.5	
Supply current	$I_{DD}$	$T_a=25^{\circ}C$ , $V_{DD}=5.0V$	-	1.5	2.5	mA
Input leakage current	$I_{LKG}$		-	-	1.0	$\mu A$
"H" level input voltage	$V_{IH}$		2.2	-	$V_{DD}$	V
"L" level input voltage	$V_{IL}$	Twice initial value or less	0	-	0.6	
"H" level output voltage	$V_{OH}$	LOH=-0.25mA	2.4	-	-	
"L" level output voltage	$V_{OL}$	LOH=1.6mA	-	-	0.4	
Backlight supply voltage	$V_F$	$T_a = 25^{\circ}C$	-	5.0	-	

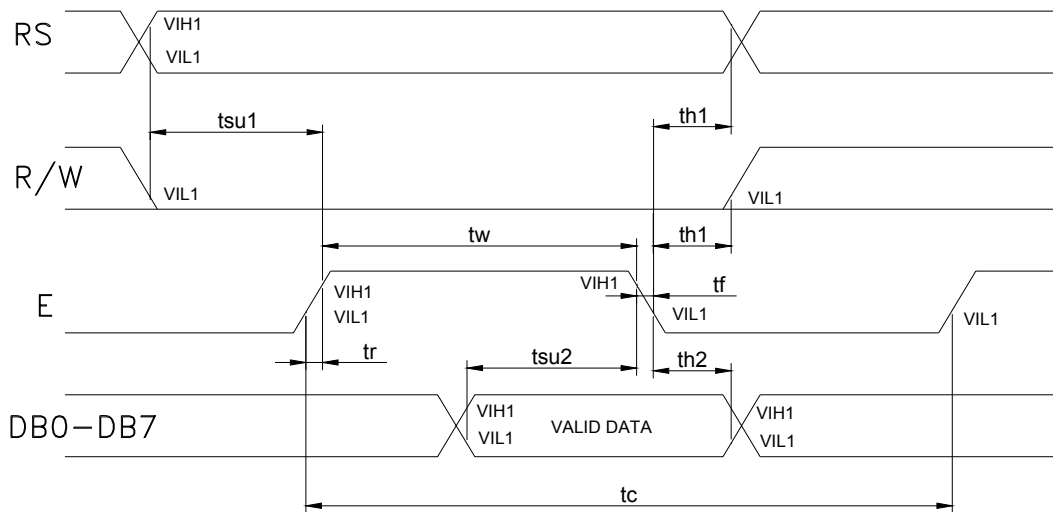
Backlight supply current	$I_{LED}$	$V_F=5.0V$	-	160	-	mA
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### 10. Timing Characteristics

Write cycle ( $T_a=25^\circ C$ ,  $V_{DD}=5.0V$ )

Parameter	Symbol	Test pin	Min.	Typ.	Max.	Unit
Enable cycle time	$t_c$	E	500	-	-	ns
Enable pulse width	$t_w$		300	-	-	
Enable rise/fall time	$t_r, t_f$		-	-	25	
RS; R/W setup time	$t_{su1}$	RS; R/W RS; R/W	100	-	-	
RS; R/W address hold time	$t_{h1}$		10	-	-	
Read data output delay	$t_{su2}$	DB0~DB7	60	-	-	
Read data hold time	$t_{h2}$		10	-	-	

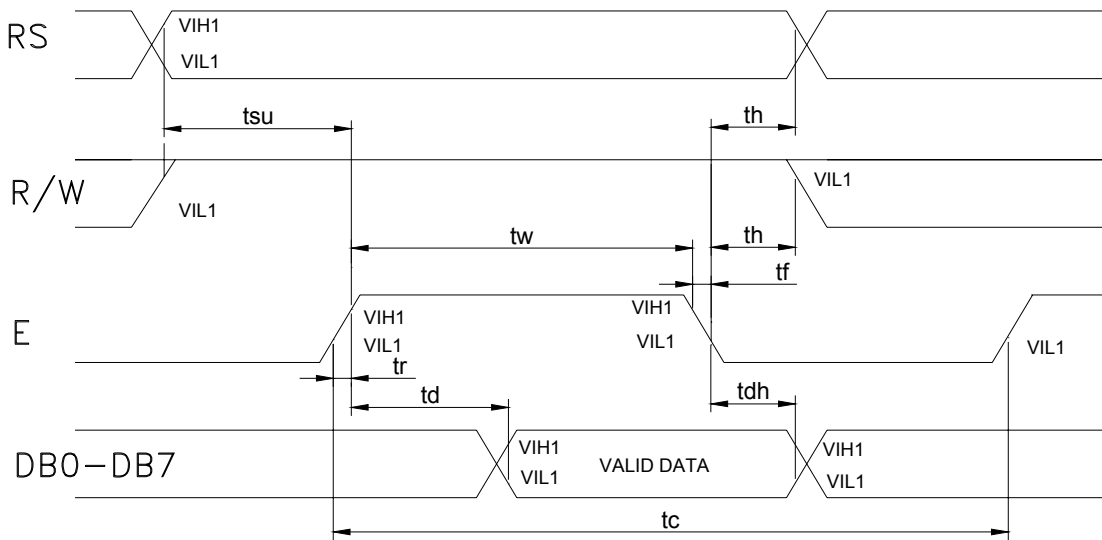
#### Write mode timing diagram



Read cycle (Ta=25°C, VDD=5.0V)

Parameter	Symbol	Test pin	Min.	Typ.	Max.	Unit
Enable cycle time	$t_c$	E	500	-	-	ns
Enable pulse width	$t_w$		300	-	-	
Enable rise/fall time	$t_r, t_f$		-	-	25	
RS; R/W setup time	$t_{su}$	RS; R/W RS; R/W	100	-	-	
RS; R/W address hold time	$t_h$		10	-	-	
Read data output delay	$t_d$	DB0~DB7	60	-	90	
Read data hold time	$t_{dh}$		20	-	-	

Read mode timing diagram





## 11. Instruction description

### 11.1 Outline

To overcome the speed difference between the internal clock of S6A0069 and the MPU clock, S6A0069 performs internal operations by storing control in formations to IR or DR. The internal operation is determined according to the signal from MPU, composed of read/write and data bus (Refer to Table7).

Instructions can be divided largely into four groups:

- 1) S6A0069 function set instructions (set display methods, set data length, etc.)
- 2) Address set instructions to internal RAM
- 3) Data transfer instructions with internal RAM
- 4) Others

The address of the internal RAM is automatically increased or decreased by 1.

Note: during internal operation, busy flag (DB7) is read "High".  
 Busy flag check must be preceded by the next instruction.

### 11.2 Instruction Table

Instruction	Instruction code										Description	Execution time (fosc=270 KHZ)
	RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0		
Clear Display	0	0	0	0	0	0	0	0	0	1	Write "20H" to DDRA and set DDRAM address to "00H" from AC	1.53ms
Return Home	0	0	0	0	0	0	0	0	1	-	Set DDRAM address to "00H" From AC and return cursor to its original position if shifted. The contents of DDRAM are not changed.	1.53ms
Entry mode Set	0	0	0	0	0	0	0	1	I/D	SH	Assign cursor moving direction And blinking of entire display	39us
Display ON/OFF control	0	0	0	0	0	0	1	D	C	B	Set display (D), cursor (C), and Blinking of cursor (B) on/off Control bit.	
Cursor or Display shift	0	0	0	0	0	1	S/C	R/L	-	-	Set cursor moving and display Shift control bit, and the Direction, without changing of DDRAM data.	39us
Function set	0	0	0	0	1	DL	N	F	-	-	Set interface data length (DL: 8-Bit/4-bit), numbers of display Line (N: =2-line/1-line) and, Display font type (F: 5x11/5x8)	39us
Set CGRAM Address	0	0	0	1	AC5	AC4	AC3	AC2	AC1	AC0	Set CGRAM address in address Counter.	39us
Set DDRAM Address	0	0	1	AC6	AC5	AC4	AC3	AC2	AC1	AC0	Set DDRAM address in address Counter.	39us
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.	0us
Write data to Address	1	0	D7	D6	D5	D4	D3	D2	D1	D0	Write data into internal RAM (DDRAM/CGRAM).	43us
Read data From RAM	1	1	D7	D6	D5	D4	D3	D2	D1	D0	Read data from internal RAM (DDRAM/CGRAM).	43us

NOTE:

When an MPU program with checking the busy flag (DB7) is made, it must be necessary 1/2fosc is necessary for executing the next instruction by the falling edge of the “E” signal after the busy flag (DB7) goes to “Low”.

11.3Contents

1) Clear display

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	0	0	0	0	0	1

Clear all the display data by writing “20H” (space code) to all DDRAM address, and set DDRAM address to “00H” into AC (address counter).

Return cursor to the original status, namely, bring the cursor to the left edge on the first line of the display. Make the entry mode increment (I/D=“High”).

2) Return home

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	0	0	0	0	1	-

Return home is cursor return home instruction.

Set DDRAM address to “00H” into the address counter.

Return cursor to its original site and return display to its original status, if shifted.

Contents of DDRAM does not change.

3) Entry mode set

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	0	0	0	1	I/D	SH

Set the moving direction of cursor and display.

**I/D: increment / decrement of DDRAM address (cursor or blink)**

When I/D=“high”, cursor/blink moves to right and DDRAM address is increased by 1.

When I/D=“Low”, cursor/blink moves to left and DDRAM address is increased by 1.

\*CGRAM operates the same way as DDRAM, when reading from or writing to CGRAM.

**SH: shift of entire display**

When DDRAM read (CGRAM read/write) operation or SH=“Low”, shifting of entire display is not performed. If SH =“High” and DDRAM write operation, shift of entire display is performed according to I/D value. (I/D=“high”. shift left, I/D=“Low”. Shift right).

4) Display ON/OFF control

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	0	0	1	D	C	B

Control display/cursor/blink ON/OFF 1 bit register.

**D: Display ON/OFF control bit**

When D=“High”, entire display is turned on.

When D=“Low”, display is turned off, but display data remains in DDRAM.

**C: cursor ON/OFF control bit**

When D=“High”, cursor is turned on.

When D=“Low”, cursor is disappeared in current display, but I/D register preserves its data.

**B: Cursor blink ON/OFF control bit**

When B=“High”, cursor blink is on, which performs alternately between all the “High” data and display characters at the cursor position.

When B=“Low”, blink is off.

5) Cursor or display shift

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
----	-----	-----	-----	-----	-----	-----	-----	-----	-----

0	0	0	0	0	1	S/C	R/L	-	-
---	---	---	---	---	---	-----	-----	---	---

Shifting of right/left cursor position or display without writing or reading of display data.

This instruction is used to correct or search display data.

During 2-line mode display, cursor moves to the 2nd line after the 40th digit of the 1st line.

Note that display shift is performed simultaneously in all the lines.

When display data is shifted repeatedly, each line is shifted individually.

When display shift is performed, the contents of the address counter are not changed.

#### Shift patterns according to S/C and R/L bits

S/C	R/L	Operation
0	0	Shift cursor to the left, AC is decreased by 1
0	1	Shift cursor to the right, AC is increased by 1
1	0	Shift all the display to the left, cursor moves according to the display
1	1	Shift all the display to the right, cursor moves according to the display

#### 6) Function set

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	1	DL	N	F	-	-

#### DL: Interface data length control bit

When DL="High", it means 8-bit bus mode with MPU.

When DL="Low", it means 4-bit bus mode with MPU. Hence, DL is a signal to select 8-bit or 4-bit bus mode.

When 4-bit bus mode, it needs to transfer 4-bit data twice.

#### N: Display line number control bit

When N="Low", 1-line display mode is set.

When N="High", 2-line display mode is set.

#### F: Display line number control bit

When F="Low", 5x8 dots format display mode is set.

When F="High", 5x11 dots format display mode.

#### 7) Set CGRAM address

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	1	AC5	AC4	AC3	AC2	AC1	AC0

Set CGRAM address to AC.

The instruction makes CGRAM data available from MPU.

#### 8) Set DDRAM address

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	1	AC6	AC5	AC4	AC3	AC2	AC1	AC0

Set DDRAM address to AC.

This instruction makes DDRAM data available from MPU.

When 1-line display mode (N=LOW), DDRAM address is from "00H" to "4FH". In 2-line display mode (N=High), DDRAM address in the 1st line from "00H" to "27H", and DDRAM address in the 2nd line is from "40H" to "67H".

#### 9) Read busy flag & address

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	1	BF	AC6	AC5	AC4	AC3	AC2	AC1	AC0

This instruction shows whether S6A0069 is in internal operation or not.

If the resultant BF is "High", internal operation is in progress and should wait BF is to be LOW, which by then the next instruction can be performed. In this instruction you can also read the value of the address counter.

#### 10) Write data to RAM

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
1	0	D7	D6	D5	D4	D3	D2	D1	D0

Write binary 8-bit data to DDRAM/CGRAM.

The selection of RAM from DDRAM, and CGRAM, is set by the previous address set instruction (DDRAM address set, CGRAM address set).

RAM set instruction can also determine the AC direction to RAM.

After write operation. The address is automatically increased/decreased by 1, according to the entry mode.

#### 11) Read data from RAM

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
1	1	D7	D6	D5	D4	D3	D2	D1	D0

Read binary 8-bit data from DDRAM/CGRAM.

The selection of RAM is set by the previous address set instruction. If the address set instruction of RAM is not performed before this instruction, the data that has been read first is invalid, as the direction of AC is not yet determined. If RAM data is read several times without RAM address instructions set before, read operation, the correct RAM data can be obtained from the second. But the first data would be incorrect, as there is no time margin to transfer RAM data.

In case of DDRAM read operation, cursor shift instruction plays the same role as DDRAM address set instruction, it also transfers RAM data to output data register.

After read operation, address counter is automatically increased/decreased by 1 according to the entry mode.

After CGRAM read operation, display shift may not be executed correctly.

NOTE: In case of RAM write operation, AC is increased/decreased by 1 as in read operation.

At this time, AC indicates next address position, but only the previous data can be read by the read instruction.

## 12. Display character address code:

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F
40	41	42	43	44	45	46	47	48	49	4A	4B	4C	4D	4E	4F

13. Standard character pattern

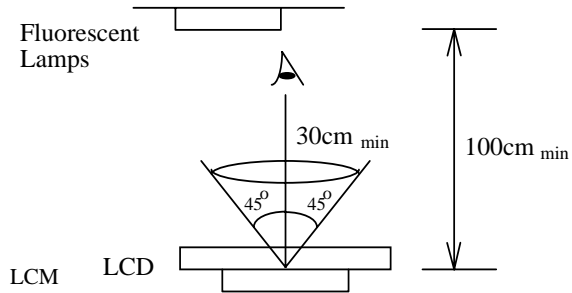
Upper 4 Bits Lower 4 Bits	0000	0001	0010	0011	0100	0101	0110	0111	1000	1001	1010	1011	1100	1101	1110	1111
xxxx0000	CG RAM (1)			0	Q	P	`	P				-	9	≡	α	ρ
xxxx0001	(2)		!	1	A	Q	a	q			。	ア	チ	△	≡	9
xxxx0010	(3)		"	2	B	R	b	r			「	イ	ツ	×	ρ	θ
xxxx0011	(4)		#	3	C	S	c	s			」	ウ	テ	モ	ε	∞
xxxx0100	(5)		\$	4	D	T	d	t			、	エ	ト	ホ	μ	Ω
xxxx0101	(6)		%	5	E	U	e	u			・	オ	ナ	1	ε	ū
xxxx0110	(7)		&	6	F	V	f	v			ヲ	カ	ニ	ヨ	ρ	Σ
xxxx0111	(8)		'	7	G	W	g	w			ア	キ	ヌ	ラ	9	π
xxxx1000	(1)		(	8	H	X	h	x			イ	ク	ネ	リ	フ	≡
xxxx1001	(2)		)	9	I	Y	i	y			ウ	ケ	ル	ル	'	γ
xxxx1010	(3)		*	:	J	Z	j	z			エ	コ	ン	レ	J	≠
xxxx1011	(4)		+	;	K	[	k	<			オ	サ	ヒ	ロ	*	≠
xxxx1100	(5)		,	<	L	¥	l	l			カ	シ	フ	ワ	≠	≠
xxxx1101	(6)		-	=	M	]	m	>			ユ	ス	ン	ン	≠	÷
xxxx1110	(7)		.	>	N	^	n	‡			ヨ	セ	ホ	°	≠	
xxxx1111	(8)		/	?	O	_	o	‡			ッ	ソ	マ	°	ö	■

**14.QUALITY SPECIFICATIONS**

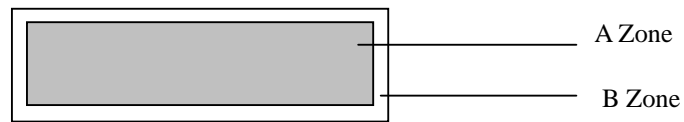
**14.1 Standard of the product appearance test**

Manner of appearance test: The inspection should be performed in using 20W x 2 fluorescent lamps. Distance between LCM and fluorescent lamps should be 100 cm or more. Distance between LCM and inspector eyes should be 30 cm or more.

Viewing direction for inspection is 45° from vertical against LCM.



Definition of zone:



A Zone: Active display area (minimum viewing area).

B Zone: Non-active display area (outside viewing area).

**14.2 Specification of quality assurance**


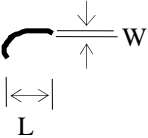
AQL inspection standard

Sampling method: MIL-STD-105E, Level II, single sampling

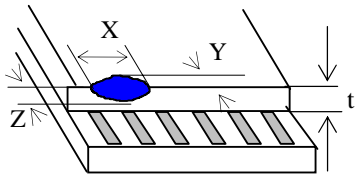
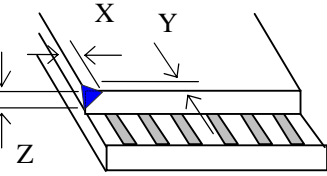
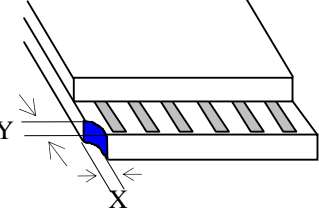
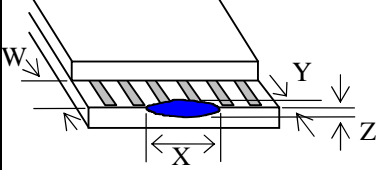
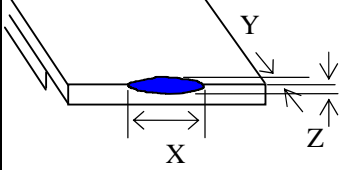
Defect classification **(Note: \* is not including)**

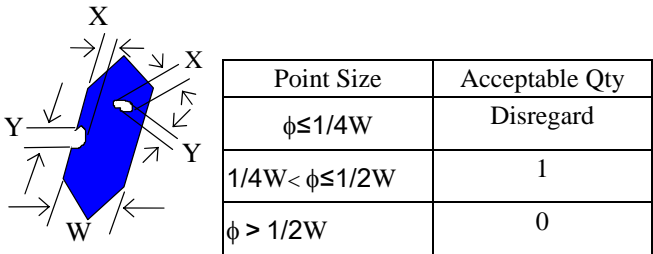
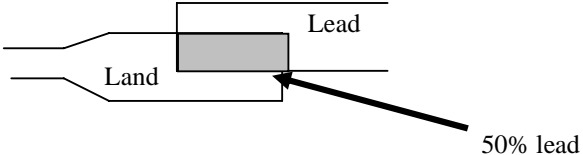
Classify	Item		Note	AQL
Major	Display state	Short or open circuit	1	0.65
		LC leakage		
		Flickering		
		No display		
		Wrong viewing direction		
		Contrast defect (dim, ghost)	2	
	Back-light	1,8		
	Non-display	Flat cable or pin reverse	10	
Wrong or missing component		11		
Minor	Display state	Background color deviation	2	1.0
		Black spot and dust	3	
		Line defect, Scratch	4	
		Rainbow	5	
		Chip	6	
		Pin hole	7	
	Polarizer	Protruded	12	
		Bubble and foreign material	3	
	Soldering	Poor connection	9	
	Wire	Poor connection	10	
	TAB	Position, Bonding strength	13	

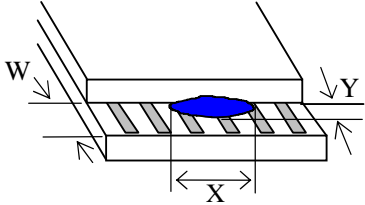
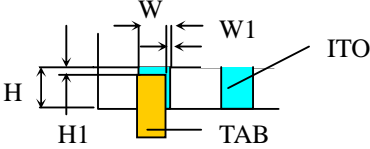
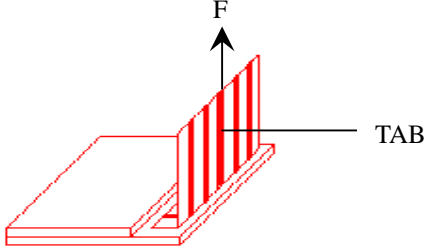
Note on defect classification

No.	Item	Criterion																				
1	Short or open circuit	Not allow																				
	LC leakage																					
	Flickering																					
	No display																					
	Wrong viewing direction																					
	Wrong Back-light																					
2	Contrast defect	Refer to approval sample																				
	Background color deviation																					
3	Point defect, Black spot, dust (including Polarizer)  $\phi = (X+Y)/2$	 <table border="1" data-bbox="873 814 1279 1129"> <thead> <tr> <th>Point Size</th> <th>Acceptable Qty.</th> </tr> </thead> <tbody> <tr> <td><math>\phi \leq 0.10</math></td> <td>Disregard</td> </tr> <tr> <td><math>0.10 &lt; \phi \leq 0.20</math></td> <td>3</td> </tr> <tr> <td><math>0.20 &lt; \phi \leq 0.25</math></td> <td>2</td> </tr> <tr> <td><math>0.25 &lt; \phi \leq 0.30</math></td> <td>1</td> </tr> <tr> <td><math>\phi &gt; 0.30</math></td> <td>Unit : mm</td> </tr> </tbody> </table>	Point Size	Acceptable Qty.	$\phi \leq 0.10$	Disregard	$0.10 < \phi \leq 0.20$	3	$0.20 < \phi \leq 0.25$	2	$0.25 < \phi \leq 0.30$	1	$\phi > 0.30$	Unit : mm								
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4	Line defect, Scratch	 <table border="1" data-bbox="808 1224 1318 1507"> <thead> <tr> <th colspan="2">Line</th> <th>Acceptable Qty.</th> </tr> <tr> <th>L</th> <th>W</th> <th></th> </tr> </thead> <tbody> <tr> <td>---</td> <td><math>0.015 \geq W</math></td> <td>Disregard</td> </tr> <tr> <td><math>3.0 \geq L</math></td> <td><math>0.03 \geq W</math></td> <td rowspan="2">2</td> </tr> <tr> <td><math>2.0 \geq L</math></td> <td><math>0.05 \geq W</math></td> </tr> <tr> <td><math>1.0 \geq L</math></td> <td><math>0.1 &gt; W</math></td> <td>1</td> </tr> <tr> <td>---</td> <td><math>0.05 &lt; W</math></td> <td>Applied as point defect</td> </tr> </tbody> </table>	Line		Acceptable Qty.	L	W		---	$0.015 \geq W$	Disregard	$3.0 \geq L$	$0.03 \geq W$	2	$2.0 \geq L$	$0.05 \geq W$	$1.0 \geq L$	$0.1 > W$	1	---	$0.05 < W$	Applied as point defect
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		Unit: mm																				
5	Rainbow	Not more than two color changes across the viewing area.																				



No	Item	Criterion																																	
6	<p>Chip</p> <p>Remark:</p> <p>X: Length direction</p> <p>Y: Short direction</p> <p>Z: Thickness direction</p> <p>t: Glass thickness</p> <p>W: Terminal Width</p>	 <p>Acceptable criterion</p> <table border="1" data-bbox="938 275 1304 359"> <thead> <tr> <th>X</th> <th>Y</th> <th>Z</th> </tr> </thead> <tbody> <tr> <td><math>\leq 2</math></td> <td>0.5mm</td> <td><math>\leq t/2</math></td> </tr> </tbody> </table>  <p>Acceptable criterion</p> <table border="1" data-bbox="927 569 1304 653"> <thead> <tr> <th>X</th> <th>Y</th> <th>Z</th> </tr> </thead> <tbody> <tr> <td><math>\leq 2</math></td> <td>0.5mm</td> <td><math>\leq t</math></td> </tr> </tbody> </table>  <p>Acceptable criterion</p> <table border="1" data-bbox="943 842 1304 968"> <thead> <tr> <th>X</th> <th>Y</th> <th>Z</th> </tr> </thead> <tbody> <tr> <td><math>\leq 3</math></td> <td><math>\leq 2</math></td> <td><math>\leq t</math></td> </tr> <tr> <td colspan="2">shall not reach to ITO</td> <td></td> </tr> </tbody> </table>  <p>Acceptable criterion</p> <table border="1" data-bbox="927 1199 1308 1283"> <thead> <tr> <th>X</th> <th>Y</th> <th>Z</th> </tr> </thead> <tbody> <tr> <td>Disregard</td> <td><math>\leq 0.2</math></td> <td><math>\leq t</math></td> </tr> </tbody> </table>  <p>Acceptable criterion</p> <table border="1" data-bbox="927 1461 1276 1545"> <thead> <tr> <th>X</th> <th>Y</th> <th>Z</th> </tr> </thead> <tbody> <tr> <td><math>\leq 5</math></td> <td><math>\leq 2</math></td> <td><math>\leq t/3</math></td> </tr> </tbody> </table>	X	Y	Z	$\leq 2$	0.5mm	$\leq t/2$	X	Y	Z	$\leq 2$	0.5mm	$\leq t$	X	Y	Z	$\leq 3$	$\leq 2$	$\leq t$	shall not reach to ITO			X	Y	Z	Disregard	$\leq 0.2$	$\leq t$	X	Y	Z	$\leq 5$	$\leq 2$	$\leq t/3$
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No.	Item	Criterion								
7	Segment pattern $W = \text{Segment width}$ $\phi = (X+Y)/2$	(1) Pin hole $\phi < 0.10\text{mm}$ is acceptable.  <table border="1" data-bbox="865 405 1295 598"> <thead> <tr> <th>Point Size</th> <th>Acceptable Qty</th> </tr> </thead> <tbody> <tr> <td><math>\phi \leq 1/4W</math></td> <td>Disregard</td> </tr> <tr> <td><math>1/4W &lt; \phi \leq 1/2W</math></td> <td>1</td> </tr> <tr> <td><math>\phi &gt; 1/2W</math></td> <td>0</td> </tr> </tbody> </table>	Point Size	Acceptable Qty	$\phi \leq 1/4W$	Disregard	$1/4W < \phi \leq 1/2W$	1	$\phi > 1/2W$	0
Point Size	Acceptable Qty									
$\phi \leq 1/4W$	Disregard									
$1/4W < \phi \leq 1/2W$	1									
$\phi > 1/2W$	0									
8	Back-light	(1) The color of backlight should correspond its specification. (2) Not allow flickering								
9	Soldering	(1) Not allow heavy dirty and solder ball on PCB. (The size of dirty refer to point and dust defect) (2) Over 50% of lead should be soldered on Land. 								
10	Wire	(1) Copper wire should not be rusted (2) Not allow crack on copper wire connection. (3) Not allow reversing the position of the flat cable. (4) Not allow exposed copper wire inside the flat cable.								
11*	PCB	(1) Not allow screw rust or damage. (2) Not allow missing or wrong putting of component.								

No	Item	Criterion
12	Protruded W: Terminal Width	 <p>Acceptable criteria:  <math>Y \leq 0.4</math></p>
13	TAB	<p>1. Position</p>  <div style="border: 1px solid black; padding: 5px; width: fit-content; margin-left: 100px;"> <math>W1 \leq 1/3W</math>  <math>H1 \leq 1/3H</math> </div> <p>2. TAB bonding strength test</p>  <p> <math>P (=F/TAB \text{ bonding width}) \geq 650\text{gf/cm}</math> ,(speed rate: 1mm/min)                      5pcs per SOA (shipment)                 </p>
14	Total no. of acceptable Defect	<p>A. Zone</p> <p>Maximum 2 minor non-conformities per one unit.                      Defect distance: each point to be separated over 10mm</p> <p>B. Zone</p> <p>It is acceptable when it is no trouble for quality and assembly in customer's end product.</p>

**14.3 Reliability of LCM**

Reliability test condition:

Item	Condition	Time (hrs)	Assessment
High temp. Storage	80°C	48	No abnormalities in functions and appearance
High temp. Operating	70°C	48	
Low temp. Storage	-30°C	48	
Low temp. Operating	-20°C	48	
Humidity	40°C/ 90%RH	48	
Temp. Cycle	0°C ← 25°C → 50°C (30 min ← 5 min → 30min)	10cycles	

Recovery time should be 24 hours minimum. Moreover, functions, performance and appearance shall be free from remarkable deterioration within 50,000 hours under ordinary operating and storage conditions room temperature (20±8°C), normal humidity (below 65% RH), and in the area not exposed to direct sun light.

**14.4 Precaution for using LCD/LCM**

LCD/LCM is assembled and adjusted with a high degree of precision. Do not attempt to make any alteration or modification. The followings should be noted.

**General Precautions:**

1. LCD panel is made of glass. Avoid excessive mechanical shock or applying strong pressure onto the surface of display area.
2. The polarizer used on the display surface is easily scratched and damaged. Extreme care should be taken when handling. To clean dust or dirt off the display surface, wipe gently with cotton, or other soft material soaked with isopropyl alcohol, ethyl alcohol or trichlorotrifluoroethane, do not use water, ketone or aromatics and never scrub hard.
3. Do not tamper in any way with the tabs on the metal frame.
4. Do not make any modification on the PCB without consulting Newhaven Display
5. When mounting a LCM, make sure that the PCB is not under any stress such as bending or twisting. Elastomer contacts are very delicate and missing pixels could result from slight dislocation of any of the elements.
6. Avoid pressing on the metal bezel, otherwise the elastomer connector could be deformed and lose contact, resulting in missing pixels and also cause rainbow on the display.
7. Be careful not to touch or swallow liquid crystal that might leak from a damaged cell. Any liquid crystal adheres to skin or clothes, wash it off immediately with soap and water.

**Static Electricity Precautions:**

1. CMOS-LSI is used for the module circuit; therefore operators should be grounded whenever he/she comes into contact with the module.
2. Do not touch any of the conductive parts such as the LSI pads; the copper leads on the PCB and the interface terminals with any parts of the human body.
3. Do not touch the connection terminals of the display with bare hand; it will cause disconnection or

- defective insulation of terminals.
4. The modules should be kept in anti-static bags or other containers resistant to static for storage.
  5. Only properly grounded soldering irons should be used.
  6. If an electric screwdriver is used, it should be grounded and shielded to prevent sparks.
  7. The normal static prevention measures should be observed for work clothes and working benches.
  8. Since dry air is inductive to static, a relative humidity of 50-60% is recommended.

**Soldering Precautions:**

1. Soldering should be performed only on the I/O terminals.
2. Use soldering irons with proper grounding and no leakage.
3. Soldering temperature:  $280^{\circ}\text{C}\pm 10^{\circ}\text{C}$
4. Soldering time: 3 to 4 second.
5. Use eutectic solder with resin flux filling.
6. If flux is used, the LCD surface should be protected to avoid spattering flux.
7. Flux residue should be removed.

**Operation Precautions:**

1. The viewing angle can be adjusted by varying the LCD driving voltage  $V_o$ .
2. Since applied DC voltage causes electro-chemical reactions, which deteriorate the display, the applied pulse waveform should be a symmetric waveform such that no DC component remains. Be sure to use the specified operating voltage.
3. Driving voltage should be kept within specified range; excess voltage will shorten display life.
4. Response time increases with decrease in temperature.
5. Display color may be affected at temperatures above its operational range.
6. Keep the temperature within the specified range usage and storage. Excessive temperature and humidity could cause polarization degradation, polarizer peel-off or generate bubbles.
7. For long-term storage over  $40^{\circ}\text{C}$  is required, the relative humidity should be kept below 60%, and avoid direct sunlight.

**Limited Warranty**

Newhaven Display LCDs and modules are not consumer products, but may be incorporated by Newhaven Display's customers into consumer products or components thereof, Newhaven Display does not warrant that its LCDs and components are fit for any such particular purpose.

1. The liability of Newhaven Display is limited to repair or replacement on the terms set forth below. Newhaven Display will not be responsible for any subsequent or consequential events or injury or damage to any personnel or user including third party personnel and/or user. Unless otherwise agreed in writing between Newhaven Display and the customer, Newhaven Display will only replace or repair any of its LCD which is found defective electrically or visually when inspected in accordance with Newhaven Display general LCD inspection standard . (Copies available on request)
2. No warranty can be granted if any of the precautions state in handling liquid crystal display above has been disregarded. Broken glass, scratches on polarizer mechanical damages as well as defects that are caused accelerated environment tests are excluded from warranty.
3. In returning the LCD/LCM, they must be properly packaged; there should be detailed description of the failures or defect.