SPECIFICATION

LCD Module specification
YM12864A

July 8, 2006
Version 1.0

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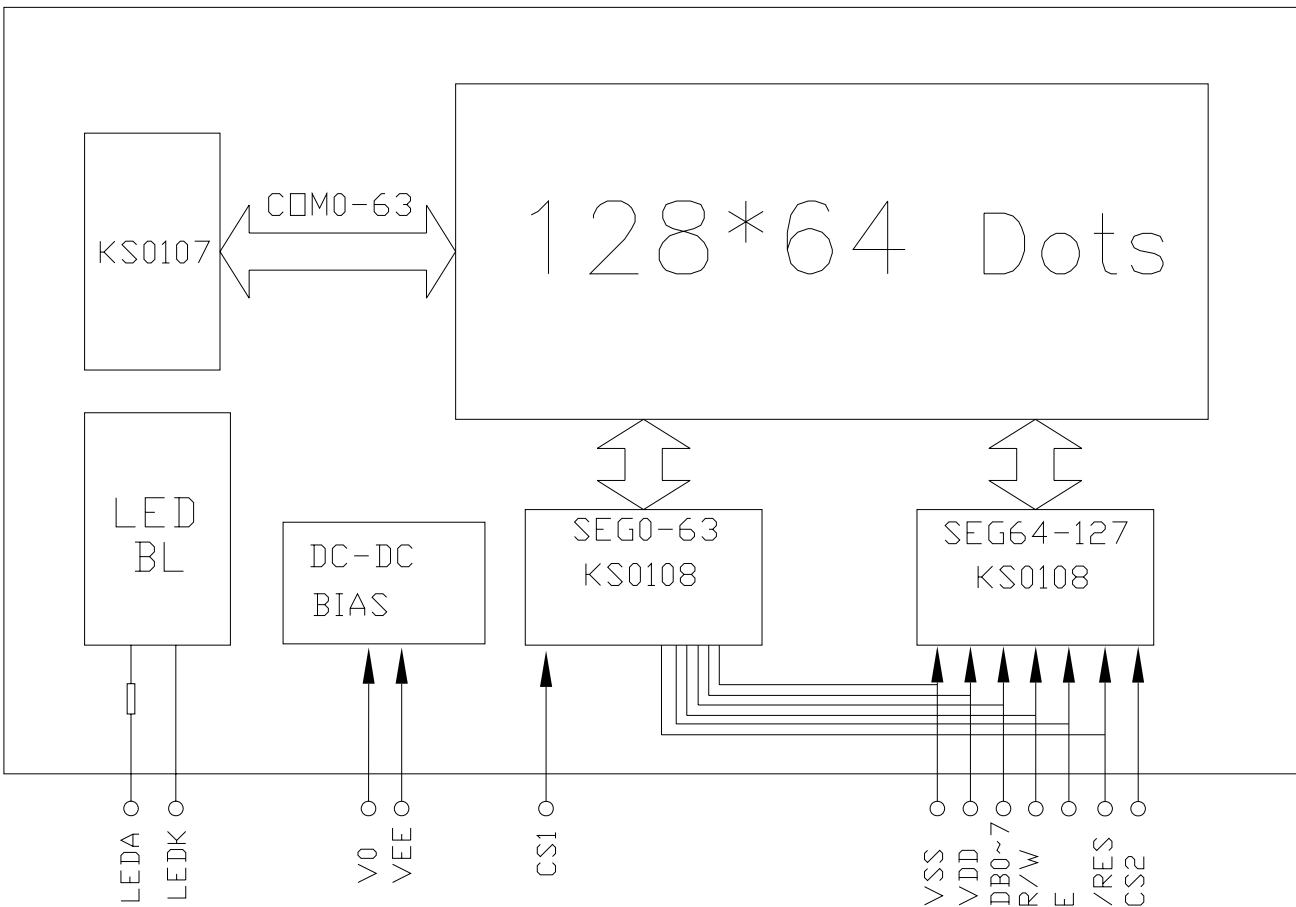WebSite: http://www.good-lcd.com

RECORDS OF REVISION

DATE	REVISED NO.	REVISED DESCRIPTIONS	PREPARED	CHECKED	APPROVED
JUL-8-2006	1.00	FIRST ISSUE	tfb		

CONTENTS

1. FEATURES：

ITEM	STANDARD VALUE	UNIT
Display Type	128*64 dots	-
LCD Type	■STN (YELLOW-GREEN), Transflective, Positive □STN (BLUE), Transflective, Negative	-
LCD Duty	1/64	-
LCD Bias	1/9	-
Viewing Direction	6:00	-
Backlight Type	■YELLOW-GREEN(LED) □WHITE(LED)	-
Interface	6800 Series	-
Driver IC	KS0108	-
Module Dimension	113.0(W) X65.0 (H) X14.0 (MAX)(T)	mm
Effective Display Area	64.974 (W) X32.462 (H)	mm
Dot Size	0.458 (W) X 0.458 (H)	mm
Dot Pitch	0.508 W) X 0.508 (H)	mm

2. BLOCK DIAGRAM &APPLICATION CIRCUIT：

Parallel Application


```
LCM
         RS   ───────────────▶
         R/W  ───────────────▶
         E    ───────────────▶
         /RES ───────────────▶        MCU
         /CS1 ───────────────▶
         /CS2 ───────────────▶
         DB0~DB7 ─────────────▶
         VEE    □OUTPUT -8.8V
         V0     □INPUT -7.5V
         VDD
         LEDA        5.0V
         LEDK        0V
         VSS         0V
```

3. OUTLINE DIMENSIONS

DETAIL FOR DOTS

SCALE 16:1

0.508
0.458
0.458
0.508

14.00MAX(11.0MAX)

8.20(5.0)

1.60

4-Ø3.2

1.80

128X64 DOTS

113.0±0.5
105.0±0.3
97.0±0.3
93.0±0.3
73.4 V.A
64.974

1
P2.54X19=48.26
20

25.40

4.0±0.3
8.0±0.3
10.0±0.3
15.8

32.462

38.8 V.A

7.1

51.0±0.3

7.0±0.3

53.0±0.3

6.0±0.3

55.0±0.3

5.0±0.3

65.0±0.5
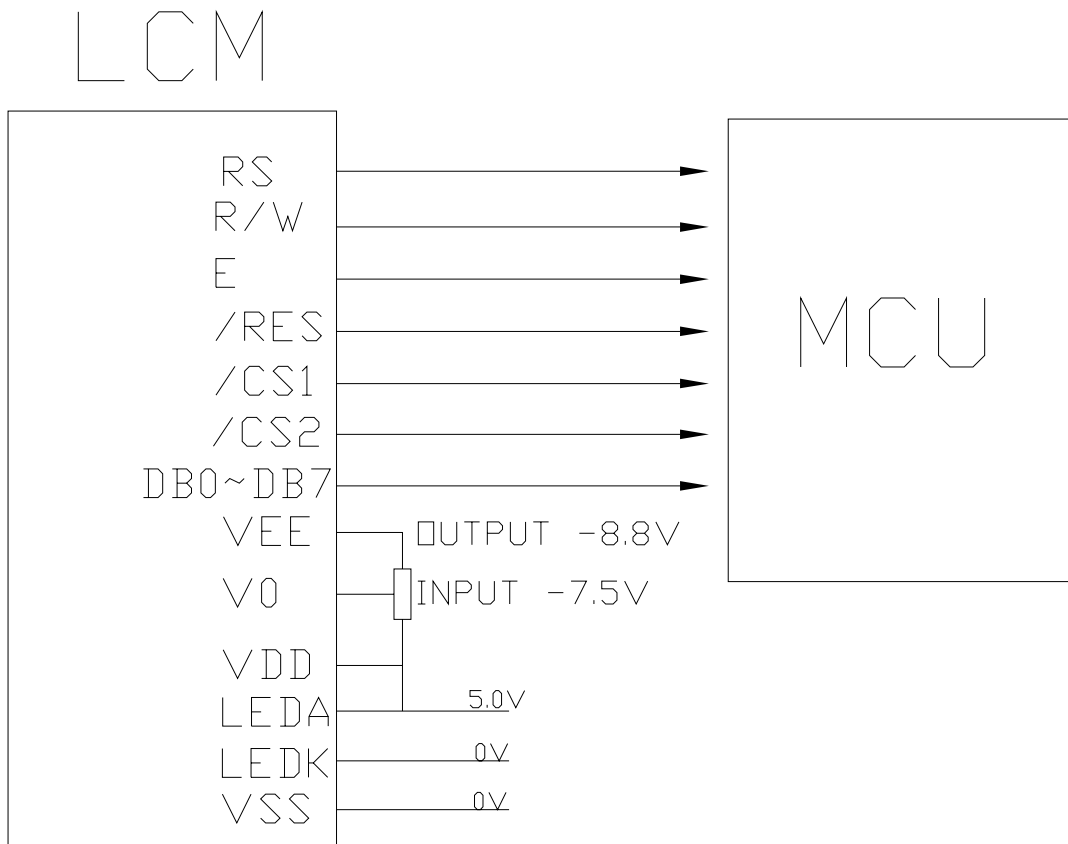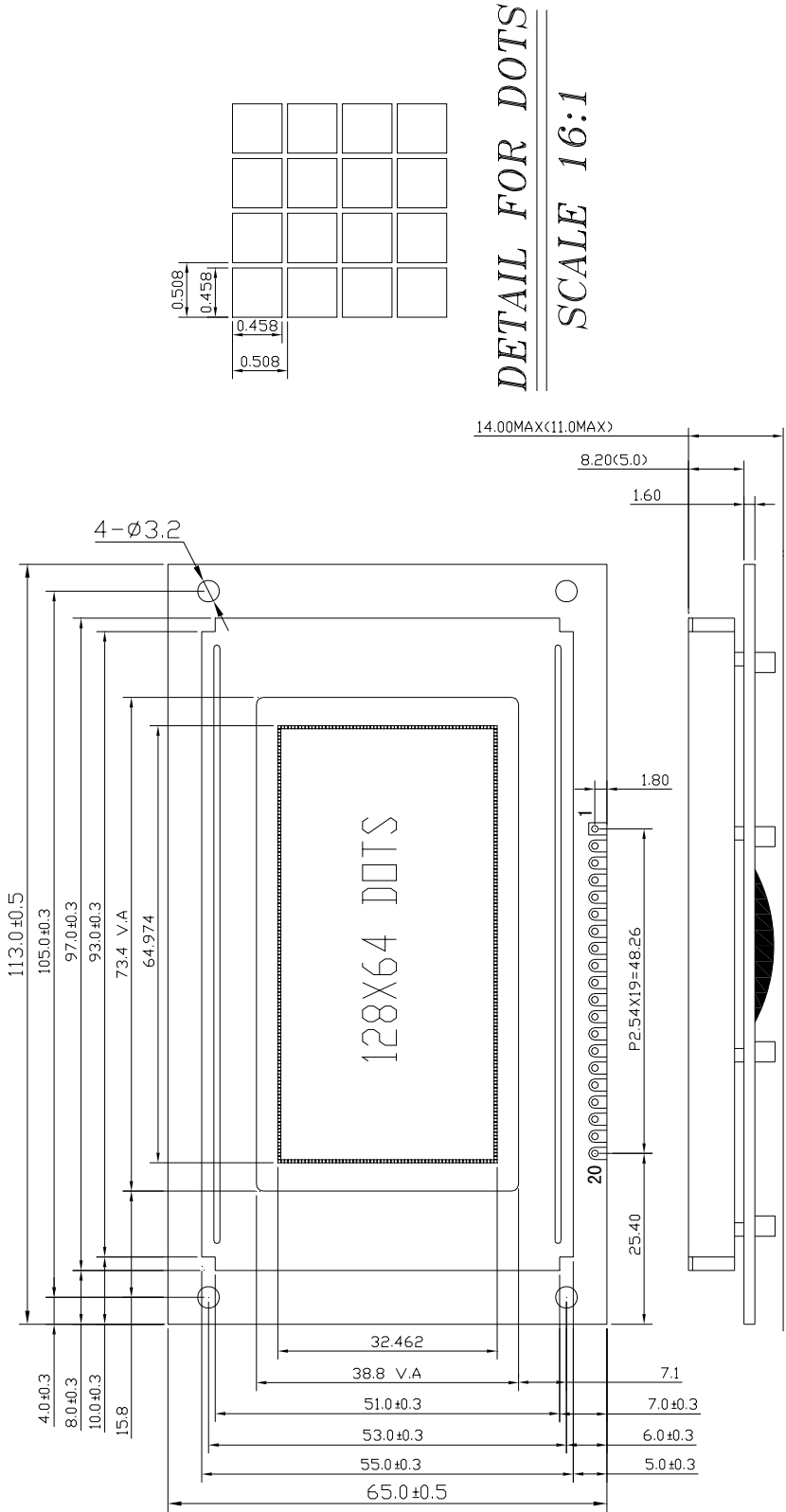
4. ABSOLUTE MAXIMUM RATING

ITEM	SYMBOL	CONDITION	STANDARD VALUE			UNIT
			MIN	TYP	MAX	
POWER SUPPLY FOR LOGIC	VDD	Ta=25℃	-0.3	—	+5.5	V
SUPPLY VOLTAGE	VEE	Ta=25℃	VDD-19	—	VDD+0.3	V
Module OPERATION TEMPERATURE	TOPR	---	-10	—	+60	℃
Module STORAGE TEMPERATURE	TSTG	---	- 20	—	+70	℃
Storage Humidity	H_D	Ta < 40 °C	-		90	%RH

5. ELECTRICAL CHARACTERISTICS

ITEM	SYMBOL	CONDITION	MIN	TYP	MAX	UNIT
Supply Voltage (logic)	VDD-VSS	-	4.8	5.0	5.2	V
Supply Voltage (LCD)	VDD-V0	Ta= +25℃	-	12.5	-	V
DC-DC OUTPUT	VEE	Ta= +25℃	-8.0	-8.8	-9.0	
Input signal voltage	V-IH	"H" level	2.0	-	VDD	V
	V-IL	"L" level	-	-	0.8	V
Output signal voltage	V-OH	"H" level	2.4	-	-	V
	VOL	"H" level	-	-	0.4	V
Supply Current (logic)	IDD	VDD=5.0V	-	10	15	mA
Backlight Voltage	V-BL	YELLOW-GREEN	-	4.2	-	V
		WHITE	-	3.1	-	
Backlight Current	I-BL	YELLOW-GREEN	-	160	-	mA
		WHITE	-	140		
Backlight Driver Wave						kHz
Backlight Brightness						
Backlight Life Time						

6. OPTICAL CHARACTERISTICS

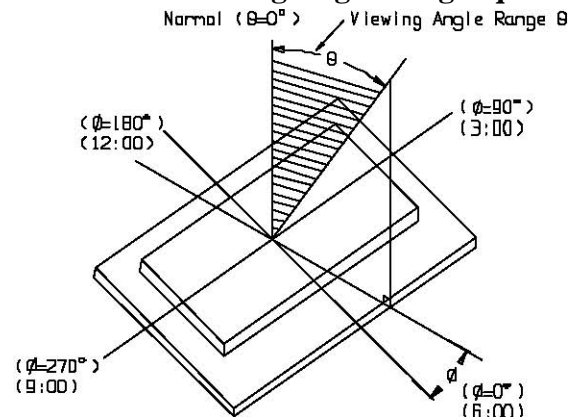| Item	Symbol	Condition	Min	Typ	Max	Unit	Remarks	Note
Response	Tr	-	-	-	-	ms	-	1
Time	Tf	-	-	-	-	ms	-	1
Contrast Ratio	Cr	-	-	-	-	-	-	2
Viewing Angle Range	θ	Cr≥ 2	-	-	-	deg	Ø= 90	3
			-	-	-	deg	Ø = 270	3
			-	-	-	deg	Ø = 0	3
			-	-	-	deg	Ø = 180	3

Note 1. Definition of response time
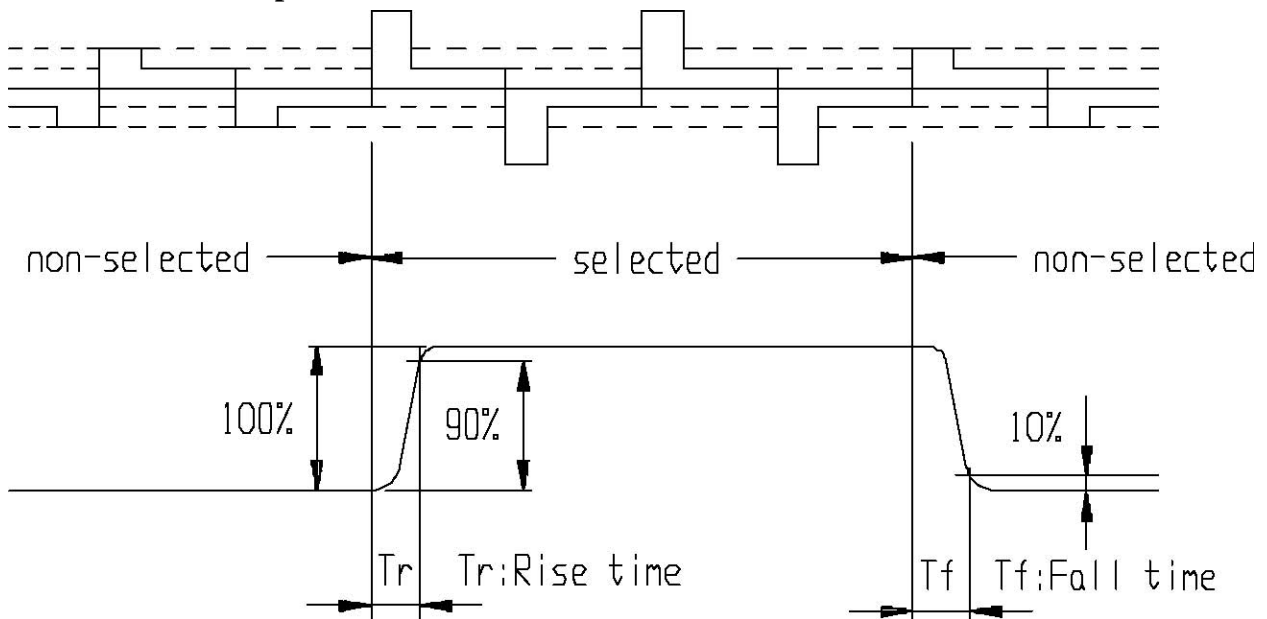
Note 2. Definition of Contrast Ratio 'Cr'

$$Cr = \frac{Brightness\ of\ non\text{-}selected\ segment(B2)}{Brightness\ of\ selected\ segment(B1)}$$
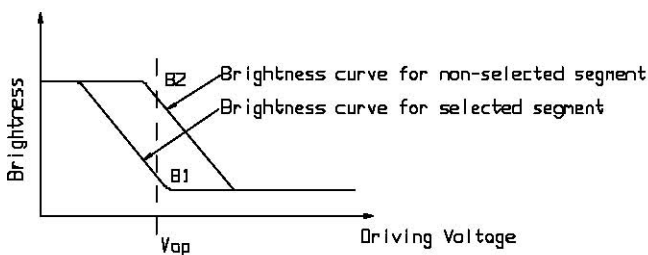
**Note 3. Definition of Viewing Angle Range 'q'**

7．TIMING CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
E Cycle	t_C	1000	-	-	ns
E High Level Width	t_{WH}	450	-	-	ns
E Low Level Width	t_{WL}	450	-	-	ns
E Rise Time	t_R	-	-	25	ns
E Fall Time	t_F	-	-	25	ns
Address Set-Up Time	t_{ASU}	140	-	-	ns
Address Hold Time	t_{AH}	10	-	-	ns
Data Set-Up Time	t_{DSU}	200	-	-	ns
Data Delay Time	t_D	-	-	320	ns
Data Hold Time (Write)	t_{DHW}	10	-	-	ns
Data Hold Time (Read)	t_{DHR}	20	-	-	ns
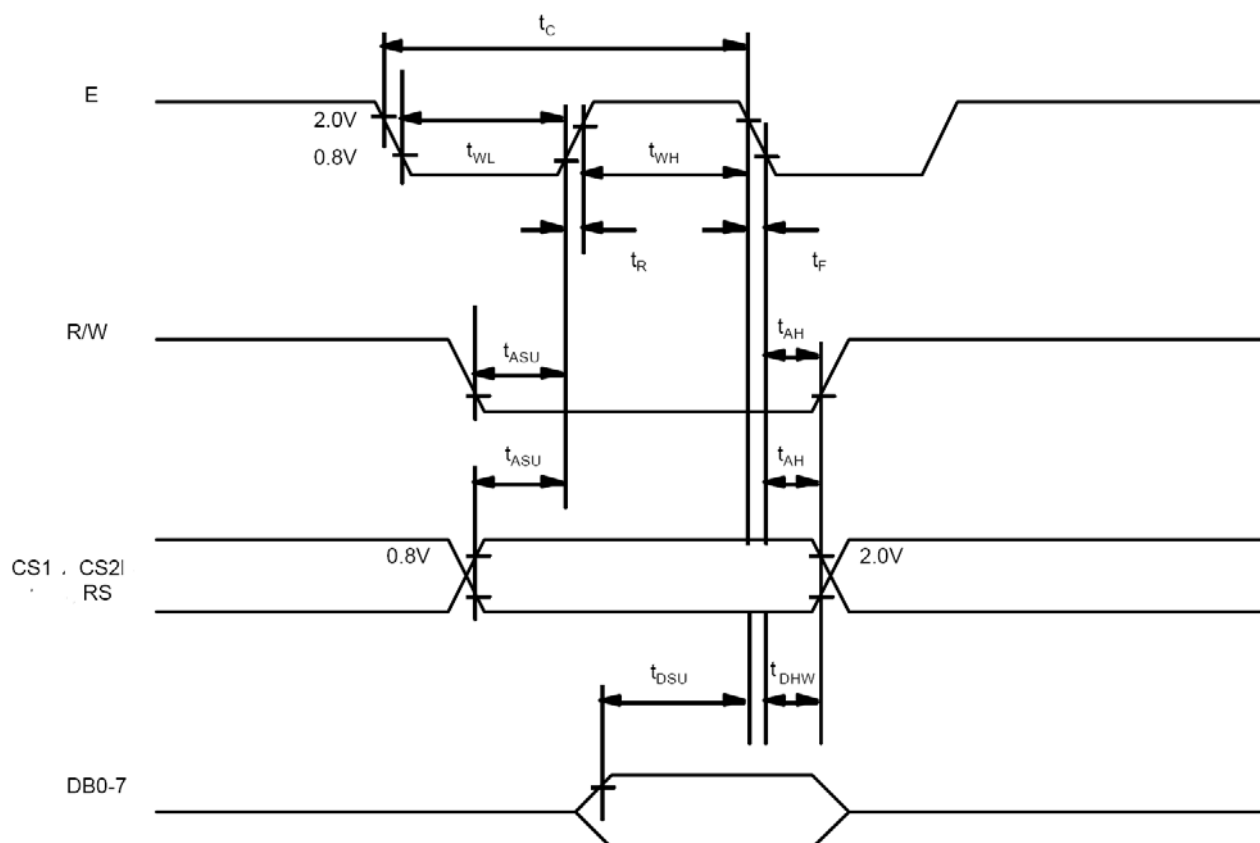
MPU WRITE TIMING
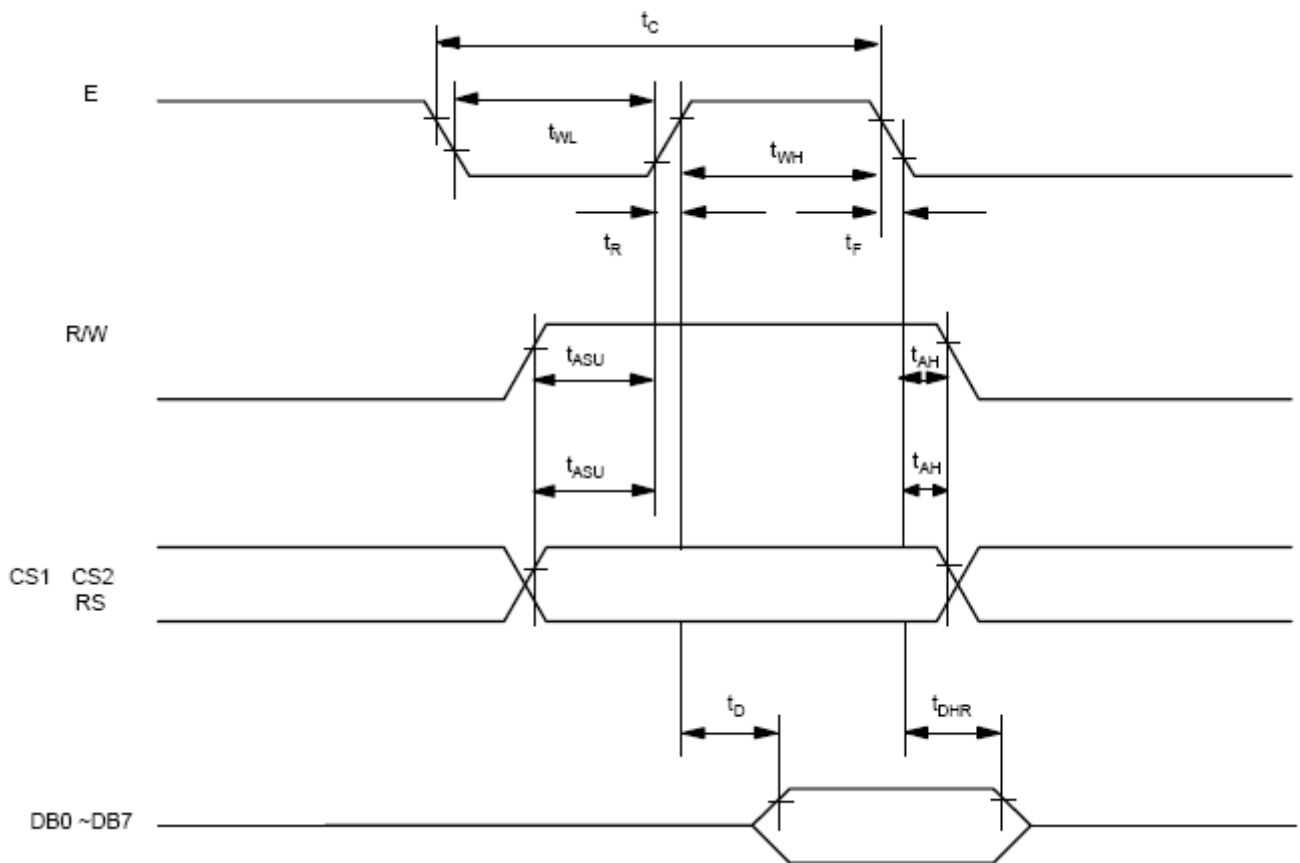
MPU READ TIMING

8. DISPLAY CONTROL INSTRUCTION

The display control instructions control the internal state of the KS0108B. Instruction is received from MPU to KS0108B for the display control. The following table shows various instructions.

Instruction	RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	Function
Display ON/OFF	L	L	L	L	H	H	H	H	H	L/H	Controls the display on or off. Internal status and display RAM data is not affected. L:OFF, H:ON
Set Address (Y address)	L	L	L	H	Y address (0~63)						Sets the Y address in the Y address counter.
Set Page (X address)	L	L	H	L	H	H	H		Page (0~7)		Sets the X address at the X address register.
Display Start Line (Z address)	L	L	H	H	Display start line (0~63)						Indicates the display data RAM displayed at the top of the screen.
Status Read	L	H	BUSY	L	ON/OFF	RESET	L	L	L	L	Read status. BUSY L: Ready H: In operation ON/OFF L: Display ON H: Display OFF RESET L: Normal H: Reset
Write Display Data	H	L	Write Data								Writes data (DB0:7) into display data RAM. After writing instruction, Y address is increased by 1 automatically.
Read Display Data	H	H	Read Data								Reads data (DB0:7) from display data RAM to the data bus.

1. Display On/Off

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

The display data appears when D is 1 and disappears when D is 0.
Though the data is not on the screen with D=0, it remains in the display data RAM.
Therefore, you can make it appear by changing D=0 into D=1.

2. Set Address (Y Address)

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

Y address (AC0 ~ AC5) of the display data RAM is set in the Y address counter.
An address is set by instruction and increased by 1 automatically by read or write operations
of display data.

3. Set Page (X Address)

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

X address(AC0 ~ AC2) of the display data RAM is set in the X address register.
Writing or reading to or from MPU is executed in this specified page until the next page
is set.

4. Display Start Line (Z Address)

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

Z address (AC0 ~ AC5) of the display data RAM is set in the display start line register and
displayed at the top of the screen.
When the display duty cycle is 1/64 or others(1/32 ~ 1/64), the data of total line number of
LCD screen, from the line specified by display start line instruction, is displayed.

5. Status Read

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
1	0	BUSY	0	ON/OFF	RESET	0	0	0	0

- BUSY
  When BUSY is 1, the Chip is executing internal operation and no instructions are accepted.
  When BUSY is 0, the Chip is ready to accept any instructions.
- ON/OFF
  When ON/OFF is 1, the display is on.
  When ON/OFF is 0, the display is off.
- RESET
  When RESET is 1, the system is being initialized.
  In this condition, no instructions except status read can be accepted.
  When RESET is 0, initializing has finished and the system is in the usual operation condition.

6. Write Display Data

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

Writes data (D0 ~ D7) into the display data RAM.
After writing instruction, Y address is increased by 1 automatically.

7. Read Display Data

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

Reads data (D0 ~ D7) from the display data RAM.
After reading instruction, Y address is increased by 1 automatically.

9. DISPLAY CONTROL FUNCTIONS

1. I/O Buffer

Input buffer controls the status between the enable and disable of chip. Unless the CS1B to CS3 is in active mode, Input or output of data and instruction does not execute. Therefore internal state is not change. But RSTB and ADC can operate regardless CS1B-CS3.

2. Input register

Input register is provided to interface with MPU which is different operating frequency. Input register stores the data temporarily before writing it into display RAM.

When CS1B to CS3 are in the active mode, R/W and RS select the input register. The data from MPU is written into input register. Then Writing it into display RAM. Data latched for falling of the E signal and write automatically into the display data RAM by internal operation.

3. Output register

Output register stores the data temporarily from display data RAM when CS1B, CS2B and CS3 are in active mode and R/W and RS=H, stored data in display data RAM is latched in output register. When CS1B to CS3 is in active mode and R/W=H, RS=L, status data (busy check) can read out.

To read the contents of display data RAM, twice access of read instruction is needed. In first access, data in display data RAM is latched into output register. In second access, MPU can read data which is latched. That is, to read the data in display data RAM, it needs dummy read. But status read is not needed dummy read.

RS	R/W	Function
L	L	Instruction
	H	Status read (busy check)
H	L	Data write (from input register to display data RAM)
	H	Data read (from display data RAM to output register)

4. Reset

The system can be initialized by setting RSTB terminal at low level when turning power on, receiving instruction from MPU. When RSTB becomes low, following procedure is occurred.

1. Display off
2. Display start line register become set by 0.(Z-address 0)

While RSTB is low, No instruction except status read can be accepted. Therefore, execute other instructions after making sure that DB4=0 (clear RSTB) and DB7=0 (ready) by status read instruction.

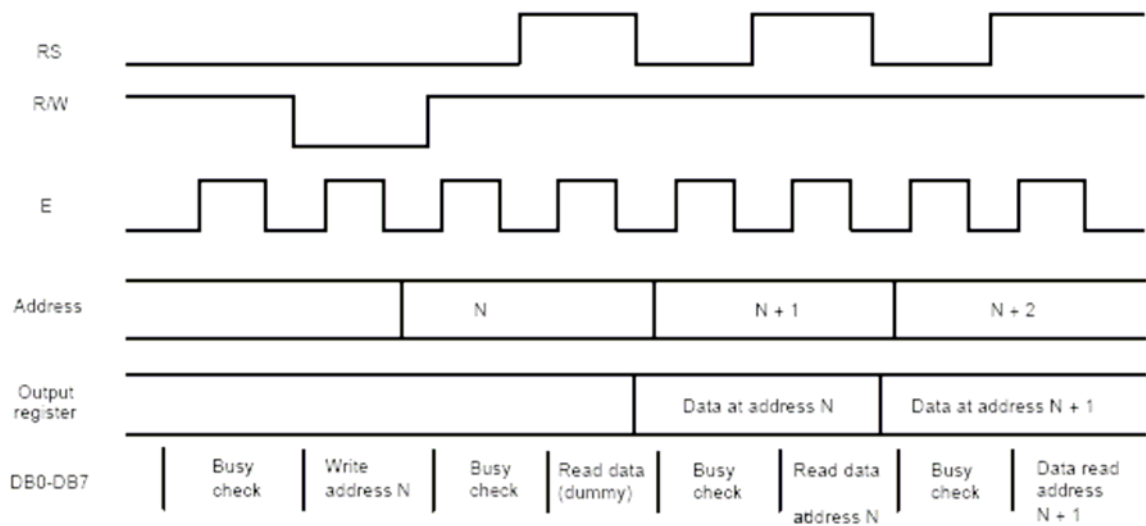The Conditions of power supply at initial power up are shown in table 1.

Table 1. Power Supply Initial Conditions

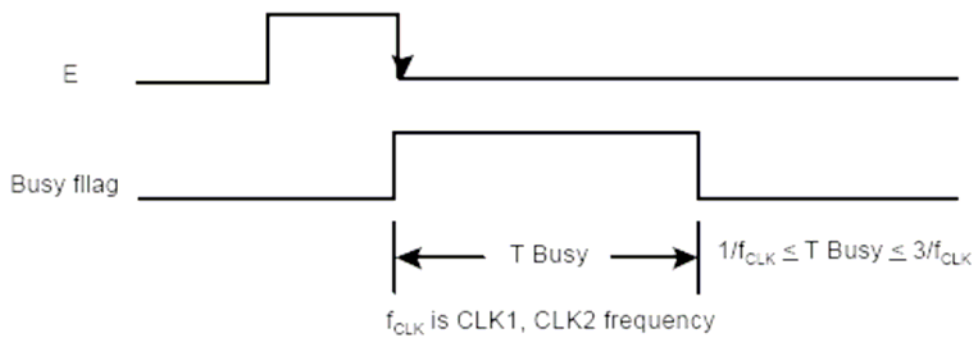| Item	Symbol	Min	Typ	Max	Unit
Reset Time	t_{R3}	1.0	-	-	us
Rise Time	t_R	-	-	200	ns
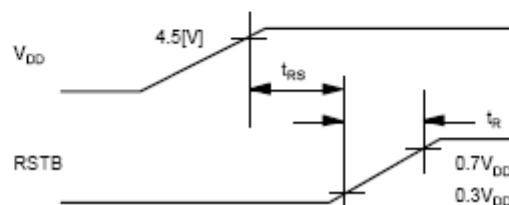
5. Busy flag

Busy flag indicates that KS0108B is operating or no operating. When busy flag is high, KS0108B is in internal operating.
When busy flag is low, KS0108B can accept the data or instruction.
DB7 indicates busy flag of the KS0108B.

RS

R/W

E

Address

	N	N + 1	N + 2

Output register

		Data at address N	Data at address N + 1

DB0-DB7

Busy check	Write address N	Busy check	Read data (dummy)	Busy check	Read data address N	Busy check	Data read address N + 1

Busy Check

E

Busy fllag

$\longleftarrow$ T Busy $\longrightarrow$ $1/f_{CLK} \le T\,Busy \le 3/f_{CLK}$

f_{CLK} is CLK1, CLK2 frequency

Busy Flag

6. Display On/Off Flip - Flop

The display on/off flip-flop makes on/off the liquid crystal display. When flip-flop is reset (logical low), selective voltage or non selective voltage appears on segment output terminals. When flip-flop is set (logic high), non selective voltage appears on segment output terminals regardless of display RAM data.

The display on/off flip-flop can changes status by instruction. The display data at all segment disappear while RSTB is low.

The status of the flip-flop is output to DB5 by status read instruction.

The display on/off flip-flop synchronized by CL signal.

7. X Page Register

X page register designates pages of the internal display data RAM.

Count function is not available. An address is set by instruction.

8. Y address counter

Y address counter designates address of the internal display data RAM. An address is set by instruction and is increased by 1 automatically by read or write operations of display data.

9. Display Data RAM

Display data RAM stores a display data for liquid crystal display. To indicate on state dot matrix of liquid crystal display, write data 1. The other way, off state, writes 0.

Display data RAM address and segment output can be controlled by ADC signal.

ADC=H$\Rightarrow$ Y-address 0:S1 ~ Y address 63:S64

ADC=L$\Rightarrow$ Y-address 0:S64 ~ Y address 63:S1

ADC terminal connect the V_{DD} or V_{SS}.

10. Display Start Line Register

The display start line register indicates of display data RAM to display top line of liquid crystal display.

Bit data (DB<0:5>) of the display start line set instruction is latched in display start line register. Latched data is transferred to the Z address counter while FRM is high, presetting the Z address counter.

It is used for scrolling of the liquid crystal display screen.

10. INTERFACE PIN CONNECTIONS

PIN	SYMBOL	I/O	FUNCTION
1	VSS	-	Ground pin, connected to 0V
2	VDD	-	Power for supply(5.0V)
3	V0	I	Contrast control (VDD~VOUT)
4	RS	I	Data or Instruction: RS=H : DB0~Db7 Display RAM Data. RS=L : DB0~Db7 Instruction Data.
5	R/W	I	Read or Write: R/W=H : Data appears at DB0~DB7 and can be read by the CPU while E =H. R/W=L :Display data DB0~DB7 can be written at falling of E.
6	E	I	Enable signal: Write mode(R/W=L): data of DB0~DB7 is latched at the falling edge of E. Read mode(R/W=H): DB0~DB7 appears the reading data while E is at high level.
7	DB0	I/O	Data bus, three state I/O common terminal.
8	DB1	I/O	Data bus, three state I/O common terminal.
9	DB2	I/O	Data bus, three state I/O common terminal.
10	DB3	I/O	Data bus, three state I/O common terminal.
11	DB4	I/O	Data bus, three state I/O common terminal.
12	DB5	I/O	Data bus, three state I/O common terminal.
13	DB6	I/O	Data bus, three state I/O common terminal.
14	DB7	I/O	Data bus, three state I/O common terminal.
15	CS1	I/O	Chip selection: CS1=H : Left screen selected.
16	CS2	I/O	Chip selection: CS1=H : Right screen selected.
17	/RES	I/O	Reset signal: /RES= L : Chip reset,
18	VEE	I/O	Power output , LCD power supply(-8.8V output)
19	LEDA	I/O	LED anode (+5V)
20	LEDK	I/O	LED cathode (0V)

11.RELIABILITY

Content of Reliability Test

Environmental Test				
No.	Test Item	Content of Test	Test Condition	Applicable Standard
1	High temperature storage	Endurance test applying the high storage temperature for a long time.	80 ℃ 200 hrs	

2	Low temperature storage	Endurance test applying the low storage temperature for a long time.	-20 ℃ 200 hrs	
3	High temperature operation	Endurance test applying the electric stress (Voltage & Current) and the thermal stress to the element for a long time.	60 ℃ 200 hrs	
4	Low temperature operation	Endurance test applying the electric stress under low temperature for a long time.	-10 ℃ 200 hrs	
5	High temperature Humidity storage	Endurance test applying the high temperature and high humidity storage for a long time.	50 ℃ , 90 RH 96 hrs	MIL-202E-103B JIS-C5023
6	High temperature Humidity operation	Endurance test applying the electric stress (Voltage & Current) and temperature humidity stress to the element for a long time.	50 ℃ , 90 RH 96 hrs	MIL-202E-103B JIS-C5023
7	Temperature cycle	Endurance test applying the low and high temperature cycle. -20°C 30min. ⇌ 25°C 5min. ⇌ 70°C 30min. ← 1 cycle →	-10℃ ～ 60℃ 10 cycles	
Mechanical Test				
8	Vibration test	Endurance test applying the vibration during transportation and using.	10-22Hz → 1.5mmp-p 22-500Hz → 1.5G Total 0.5hrs	MIL-202E-201A JIS-C5025 JIS-C7022-A-10
9	Shock test	Constructional and mechanical endurance test applying the shock during transportation.	50G half sign wave 1l msedc 3 times of each direction	MIL-202E-213B
10	Atmospheric pressure test	Endurance test applying the atmospheric pressure during transportation by air.	115 mbar 40 hrs	MIL-202E-105C
Others				
11	Static electricity test	Endurance test applying the electric stress to the terminal.	VS=800V, RS=1.5 k CS=100 pF 1 time	MIL-883B-3015.1

∗∗∗ Supply voltage for logic system = 3V. Supply voltage for LCD system = Operating voltage at 25℃.

Failure Judgement Criterion

Criterion Item	Test Item No.											Failure Judgment Criterion
	1	2	3	4	5	6	7	8	9	10	11	
Basic specification												Out of the Basic Specification
Electrical characteristic												Out of the DC and AC Characterstic
Mechanical characterstic												Out of the Mechanical Specification Color change : Out of Limit

												Apperance Specification
Optical characterstic												Out of the Apperance Standard

12. QUALITY GUARANTEE

Acceptable Quality Level

Each lot should satisfy the quality level defined as follows.
- Inspection method : MIL-STD-105E LEVEL II Normal one time sampling
- AQL

Partition	AQL	Definition
A: Major	0.4%	Functional defective as product
B: Minor	1.5%	Satisfy all functions as product but not satisfy cosmetic standard

Definition of 'LOT'

One lot means the delivery quantity to customer at one time.

Conditions of Cosmetic Inspection

Environmental condition

The inspection should be performed at the 1cm of height from the LCD module under 2 pieces of

40W white fluorescent lamps (Normal temperature 20~25℃ and normal humidity 60±15%RH).

Inspection method

The visual check should be performed vertically at more than 30cm distance from the LCD panel.

Driving voltage

The VO value which the most optimal contrast can be obtained near the specified VO in the

specification. (Within ±0.5V of typical value at 25℃.).

13. INSPECTION CRITERIA

13.1 Module Cosmetic Criteria

No.	Item	Judgement Criterion	Partition

1	Difference in Spec.	None allowed	Major
2	Pattern peeling	No substrate pattern peeling and floating	Major
3	Soldering defects	No soldering missing	Major
		No soldering bridge	Major
		No cold soldering	Major
4	Resist flaw on substrate	Invisible copper foil ('0.5mm or more) on substrate pattern	Minor
5	Accretion of metallic Foreign matter	No soldering dust No accretion of metallic foreign matters (Not exceed '0.2mm)	Minor Minor
6	Stain	No stain to spoil cosmetic badly	Minor
7	Plate discoloring	No plate fading, rusting and discoloring	Minor
8	Solder amount 1. Lead parts	a. Soldering side of PCB 　　Solder to form a 'Filet' all around the lead. 　　Solder should not hide the lead form perfectly. (too much) b. Components side 　(In case of 'Through Hole PCB') Solder to reach the Components side of PCB.	Minor
	2. Flat packages	Either 'Toe' (A) or 'Seal' (B) of the lead to be covered by 'Filet'. Lead form to be assume over solder. A B	Minor
	3. Chips	$(3/2) H \geq h \geq (1/2) H$	Minor
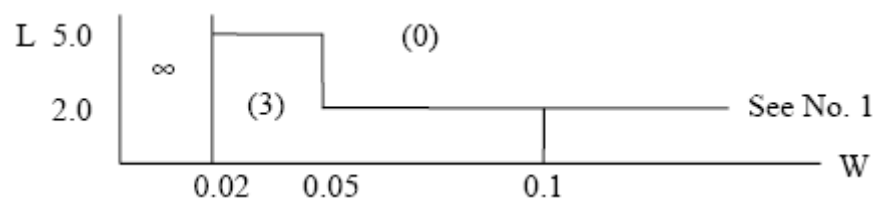
13.2 Screen Cosmetic Criteria (Non-Operating)

No.	Defect	Judgement Criterion	Partition
1	Spots	In accordance with *Screen Cosmetic Criteria (Operating) No.1.*	Minor
2	Lines	In accordance with *Screen Cosmetic Criteria (Operating) No.2.*	Minor

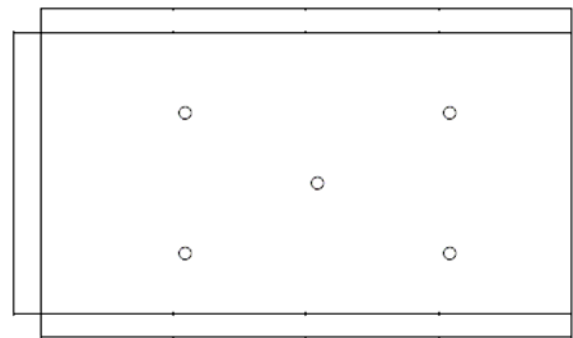| 3	Bubbles in polarizer	<table><tr><td>Size : d mm</td><td>Acceptable Qty in active area</td></tr><tr><td>d ≤ 0.3</td><td>Disregard</td></tr><tr><td>0.3 < d ≤ 1.0</td><td>3</td></tr><tr><td>1.0 < d ≤ 1.5</td><td>1</td></tr><tr><td>1.5 < d</td><td>0</td></tr></table>	Minor
4	Scratch	In accordance with spots and lines operating cosmetic criteria. When the light reflects on the panel surface, the scratches are not to be remarkable.	Minor
5	Allowable density	Above defects should be separated more than 30mm each other.	Minor
6	Coloration	Not to be noticeable coloration in the viewing area of the LCD panels. Back-lit type should be judged with back-lit on state only.	Minor
7	Contamination	Not to be noticeable.	Minor

13.3. Screen Cosmetic Criteria (Operating)

No.	Defect	Judgement Criterion	Partition
1	Spots	A) Clear Note : <table><tr><td>Size : d mm</td><td>Acceptable Qty in active area</td></tr><tr><td>d ≤ 0.1</td><td>Disregard</td></tr><tr><td>0.1 < d ≤ 0.2</td><td>3</td></tr><tr><td>0.2 < d ≤ 0.3</td><td>2</td></tr><tr><td>0.3 < d</td><td>0</td></tr></table> Including pin holes and defective dots which must be within one pixel size. B) Unclear Size : <table><tr><td>Size : d mm</td><td>Acceptable Qty in active area</td></tr><tr><td>d ≤ 0.2</td><td>Disregard</td></tr><tr><td>0.2 < d ≤ 0.5</td><td>6</td></tr><tr><td>0.5 < d ≤ 0.7</td><td>2</td></tr><tr><td>0.7 < d</td><td>0</td></tr></table>	Minor

2	Lines	A)Clear	Minor

Note : ( ) - Acceptable Qty in active area L
   -Length (mm) W - Width (mm)
   ∞ - Disregard

B) Unclear

'Clear' = The shade and size are not changed by VO.

'Unclear' = The shade and size are changed by VO.

13.4. Screen Cosmetic Criteria (Operating) (Continued)

No.	Defect	Judgement Criterion	Partition
3	Rubbing line	Not to be noticeable.	
4	Allowable density	Above defects should be separated more than 10mm each other.	Minor
5	Rainbow	Not to be noticeable.	Minor
6	Dot size	To be 95% ~ 105% of the dot size (Typ.) in drawing. Partial defects of each dot (ex. pin-hole) should be treated as 'Spot'. (see *Screen Cosmetic Criteria (Operating) No.1*)	Minor
7	Uneven brightness (only back-lit type module)	Uneven brightness must be BMAX / BMIN ≤ 2 - BMAX : Max. value by measure in 5 points - BMIN : Min. value by measure in 5 points Divide active area into 4 vertically and horizontally. Measure 5 points shown in the following figure. ○ : Measuring points	Minor

Note :
    (1) Size : d = (long length + short length) / 2
    (2) The limit samples for each item have priority.

    (3) Complexed defects are defined item by item, but if the number of defects are defined in above table, the total number should not exceed 10.
    (4) In case of 'concentration', even the spots or the lines of 'disregarded' size should not allowed. Following three situations should be treated as 'concentration'.
    - 7 or over defects in circle of ′5mm.
    - 10 or over defects in circle of ′10mm.
    - 20 or over defects in circle of ′20mm.

14. PRECAUTIONS FOR USING LCD MODULES

Handing Precautions
  (1) The display panel is made of glass. Do not subject it to a mechanical shock by dropping it or impact.
  (2) If the display panel is damaged and the liquid crystal substance leaks out, be sure not to get any in your mouth. If the substance contacts your skin or clothes, wash it off using soap and water.
  (3) Do not apply excessive force to the display surface or the adjoining areas since this may cause the color tone to vary.
  (4) The polarizer covering the display surface of the LCD module is soft and easily scratched. Handle this polarizer carefully.
  (5) If the display surface becomes contaminated, breathe on the surface and gently wipe it with a soft dry cloth. If it is heavily contaminated, moisten cloth with one of the following solvents :
  - Isopropyl alcohol
  - Ethyl alcohol
  (6) Solvents other than those above-mentioned may damage the polarizer. Especially, do not use the following.
  - Water
  - Ketone
  - Aromatic solvents
  (7) Exercise care to minimize corrosion of the electrode. Corrosion of the electrodes is accelerated by water droplets, moisture condensation or a current flow in a high-humidity environment.
  (8) Install the LCD Module by using the mounting holes. When mounting the LCD module make sure it is free of twisting, warping and distortion. In particular, do not forcibly pull or bend the IO cable or the backlight cable.
  (9) Do not attempt to disassemble or process the LCD module.
  (10) NC terminal should be open. Do not connect anything.
  (11) If the logic circuit power is off, do not apply the input signals.
  (12) To prevent destruction of the elements by static electricity, be careful to maintain an optimum work environment.
  - Be sure to ground the body when handling the LCD modules.

- Tools required for assembling, such as soldering irons, must be properly grounded.

- To reduce the amount of static electricity generated, do not conduct assembling and other work under dry conditions.

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

Storage Precautions

When storing the LCD modules, avoid exposure to direct sunlight or to the light of fluorescent lamps. Keep the modules in bags (avoid high temperature ~ high humidity and low temperatures below 0 C). Whenever possible, the LCD modules should be stored in the same conditions in which they were shipped from our company.

Others

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

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

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

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

15. USING LCD MODULES

Liquid Crystal Display Modules

LCD is composed of glass and polarizer. Pay attention to the following items when handling.

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

(2) Do not touch, push or rub the exposed polarizers with anything harder than an HB pencil lead (glass, tweezers, etc.).

(3) N-hexane is recommended for cleaning the adhesives used to attach front/rear polarizers and reflectors made of organic substances which will be damaged by chemicals such as acetone, toluene, ethanol and isopropylalcohol.

(4) When the display surface becomes dusty, wipe gently with absorbent cotton or other soft material like chamois soaked in petroleum benzin. Do not scrub hard to avoid damaging the display surface.

(5) Wipe off saliva or water drops immediately, contact with water over a long period of time may cause deformation or color fading.

(6) Avoid contacting oil and fats.

(7) Condensation on the surface and contact with terminals due to cold will damage, stain or dirty the polarizers. After products are tested at low temperature they must be warmed up in a container before coming

is contacting with room temp erature air.

   (8) Do not put or attach anything on the display area to avoid leaving marks on.

   (9) Do not touch the display with bare hands. This will stain the display area and degradate insulation between terminals (some cosmetics are determinated to the polarizers).

   (10) As glass is fragile. It tends to become or chipped during handling especially on the edges. Please avoid dropping or jarring.

Installing LCD Modules

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

   (1) Cover the surface with a transparent protective plate to protect the polarizer and LC cell.
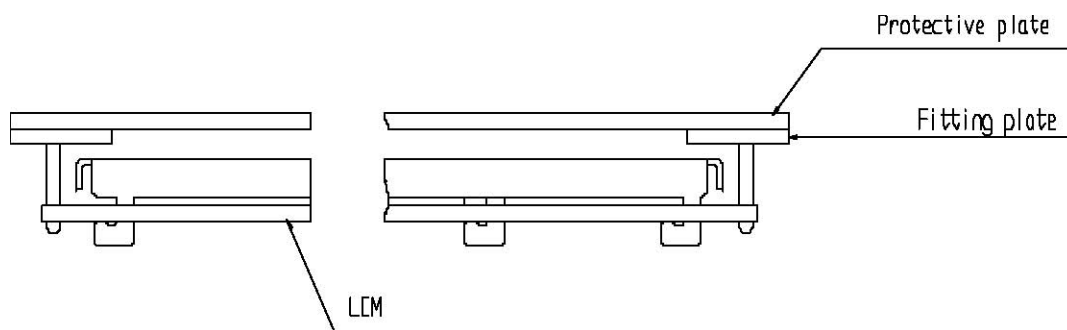
   (2) When assembling the LCM into other equipment, the spacer to the bit between the LCM and the fitting plate should have enough height to avoid causing stress to the module surface, refer to the individual specifications for measurements. The measurement tolerance should be   0.1mm.

Precaution for Handing LCD Modules

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

   (1) Do not alter, modify or change the the shape of the tab on the metal frame.

   (2) Do not make extra holes on the printed circuit board, modify its shape or change the positions of components to be attached.

   (3) Do not damage or modify the pattern writing on the printed circuit board.

   (4) Absolutely do not modify the zebra rubber strip (conductive rubber) or heat seal connector.

   (5) Except for soldering the interface, do not make any alterations or modifications with a soldering iron.

   (6) Do not drop, bend or twist LCM.

Electro-Static Discharge Control

   Since this module uses a CMOS LSI, the same careful attention should be paid to electrostatic discharge as for an ordinary CMOS IC.

   (1) Make certain that you are grounded when handing LCM.

   (2) Before remove LCM from its packing case or incorporating it into a set, be sure the module and your body have the same electric potential.

   (3) When soldering the terminal of LCM, make certain the AC power source for the soldering iron does not

leak.

(4) When using an electric screwdriver to attach LCM, the screwdriver should be of ground potentiality to minimize as much as possible any transmission of electromagnetic waves produced sparks coming from the commutator of the motor.

(5) As far as possible make the electric potential of your work clothes and that of the work bench the ground potential.

(6) To reduce the generation of static electricity be careful that the air in the work is not too dried. A relative humidity of 50%60% is recommended.

Precaution for soldering to the LCM

(1) Observe the following when soldering lead wire, connector cable and etc. to the LCM.
- Soldering iron temperature : 280 C 10 C.
- Soldering time : 3-4 sec.
- Solder : eutectic solder.

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

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

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

Precautions for Operation

(1) Viewing angle varies with the change of liquid crystal driving voltage (VO). Adjust VO to show the best contrast.
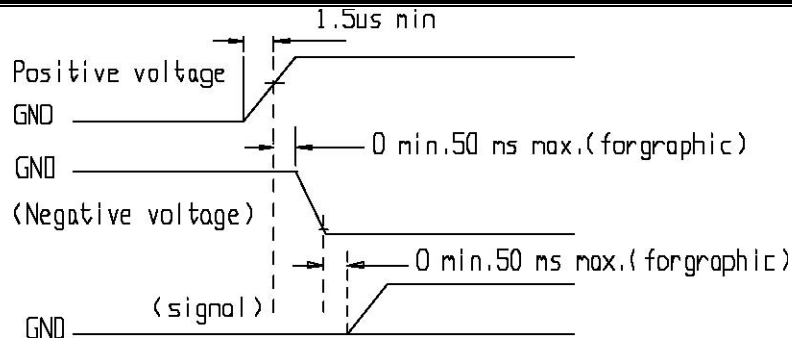
(2) Driving the LCD in the voltage above the limit shortens its life.

(3) Response time is greatly delayed at temperature below the operating temperature range. However, this does not mean the LCD will be out of the order. It will recover when it returns to the specified temperature range.

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

(5) Condensation on terminals can cause an electrochemical reaction disrupting the terminal circuit. Therefore, it must be used under the relative condition of 40 C , 50% RH.

(6) When turning the power on, input each signal after the positive/negative voltage becomes stable.

```
                        1.5us min
Positive voltage
GND _____
                    ___|___ 0 min.50 ms max.(forgraphic)
GND _____
(Negative voltage)
                        ___|___ 0 min.50 ms max.(forgraphic)
        (signal)
GND _____
```

Storage

When storing LCDs as spares for some years, the following precaution are necessary.

   (1) Store them in a sealed polyethylene bag. If properly sealed, there is no need for dessicant.

   (2) Store them in a dark place. Do not expose to sunlight or fluorescent light, keep the temperature between 0 C and 35 C.

   (3) The polarizer surface should not come in contact with any other objects. (We advise you to store them in the container in which they were shipped.)

Safety

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

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

Limited Warranty

Unless agreed betweenGoodDisplay and customer, Good Display will replace or repair any of its LCD modules which are found to be functionally defective when inspected in accordance with Good Display LCD acceptance standards (copies available upon request) for a period of one year from date of shipments. Cosmetic/visual defects must be returned to Good Display within 90 days of shipment. Confirmation of such date shall be based on freight documents. The warranty liability of Good Display limited to repair and/or replacement on the terms set forth above. Good Display will not be responsible for any subsequent or consequential events.

Return LCM under warranty

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

   - Broken LCD glass.

   - PCB eyelet's damaged or modified.

   - PCB conductors damaged.

   - Circuit modified in any way, including addition of components.

   - PCB tampered with by grinding, engraving or painting varnish.

   - soldering to or modifying the bezel in any manner.

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