TINSHARP

TG12864D-04

Specification For Approval

Rev .0.0

October 28, 2005

TINSHARP Electronics Inc.

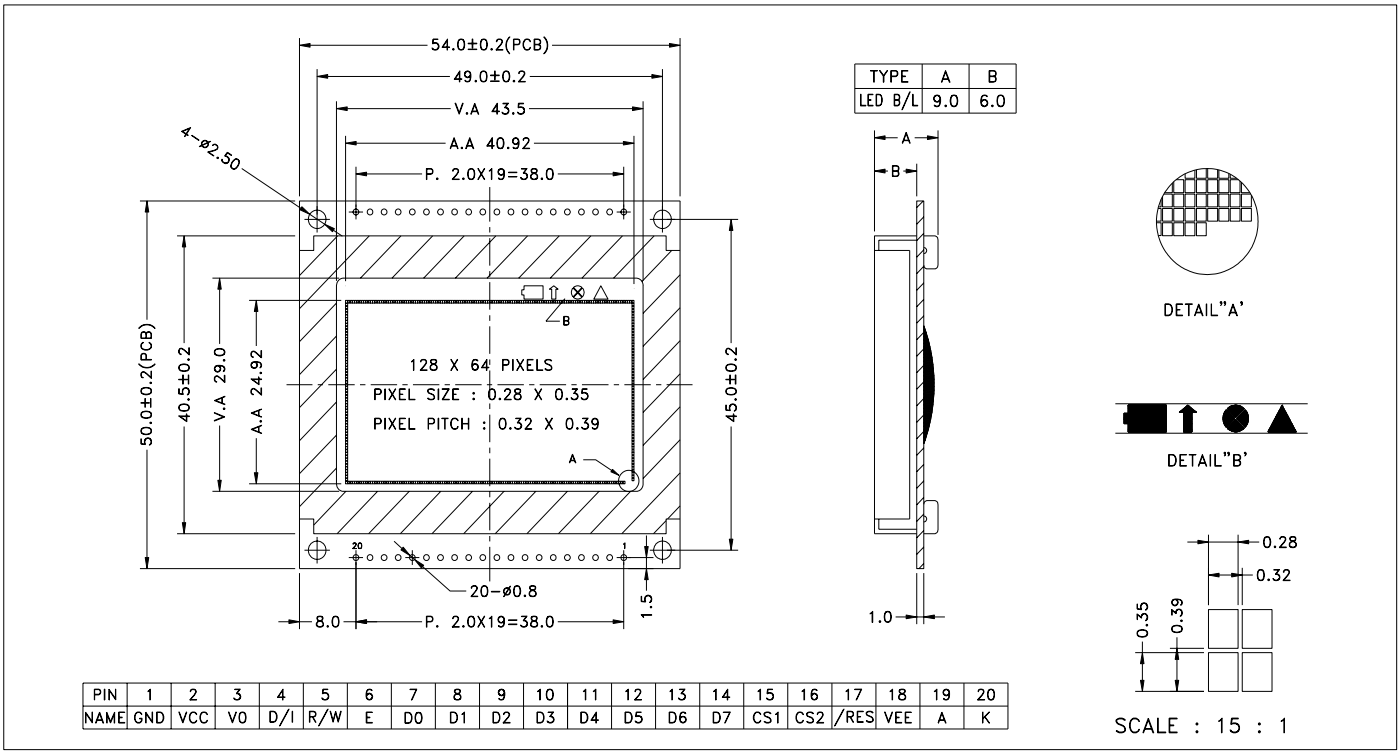
CONTENTS

1 . SPECIFICATIONS

1.1 Features

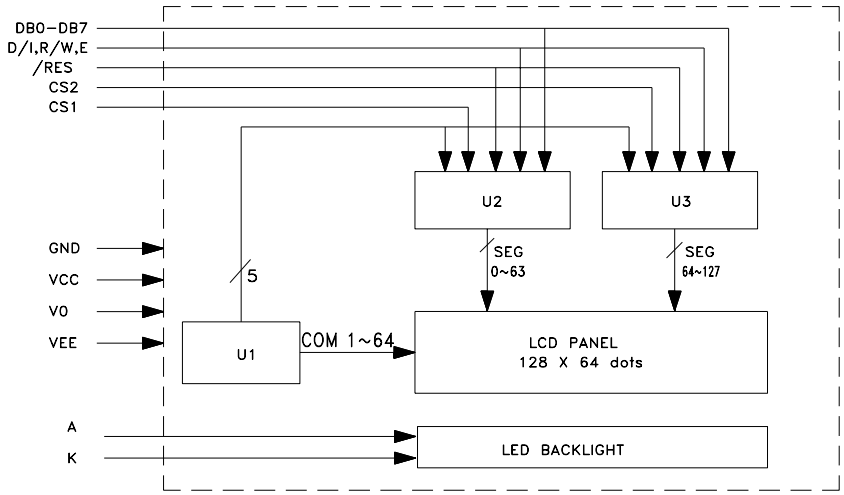
Item	Contents	Unit
LCD TYPE	STN/Transflective/Y-G	--
LCD duty	1/64	--
LCD bias	1/9	--
Viewing direction	6	o'clock
Operation Temperature	-10℃--+60℃	
Storage Temperature	-20℃--+70℃	
Module size(W x H x T)	54.0 X 50.0 X 6.0	mm
Viewing area(W x H)	43.5 X 29.0	mm
Number of dots	128 X 64	dots
Dots size(W x H)	0.28 X 0.35	mm
Dots pitch(W x H)	0.32 X 0.39	mm

1.2 EXTERNAL DIMENSIONS



PIN	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
NAME	GND	VCC	V0	D/I	R/W	E	D0	D1	D2	D3	D4	D5	D6	D7	CS1	CS2	/RES	VEE	A	K

1.3 BLOCK DIAGRAM



1.4 ABSOLUTE MAXIMUM RATINGS (Ta = 25℃)

Parameter	Symbol	Min	Max	Unit
Supply voltage for logic	V_{DD}	-0.3	7.0	V
Supply voltage for LCD	V_o	V_{DD}-19	V_{DD}+0.3	V
Input voltage	V_I	-0.3	V_{DD} +0.3	V
Normal Operating temperature	T_{OP}	-20	+70	℃
Normal Storage temperature	T_{ST}	-30	+80	℃

1.5 DC Electrical Characteristics

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Supply voltage for logic	VDD	--	4.5	5.0	5.5	V
Supply current for logic	IDD	--	--	2.02	4.0	mA
Operating voltage for LCD	VDD-V0	25℃	8.0	8.5	9.0	V
Input voltage “ H ” level	VIH	--	0.7 VDD	--	VDD	V
Input voltage “L” level	VIL	--	0	--	0.3VDD	V

1.6 AC Characteristics

(1) MPU Interfac

Charcacteristic	Symbol	Min.	Typ.	Max.	Unit
E cycle	tcyc	1000	---	---	ns
E higt level width	twhE	450	---	---	ns
E low level width	twlE	450	---	---	ns
E rise time	TI	--	---	25	ns
E fall time	tf	---	---	25	ns
Address set-up teme	tas	140	---	---	ns
Address hold time	tah	10	---	---	ns
Data set-up time	tdsw	200	---	---	ns
Data delay time	tddr	---	---	320	ns
Data hold time (write)	tdhw	10	---	---	ns
Data hold time(read)	tdhr	20	---	---	ns

Note : 1.

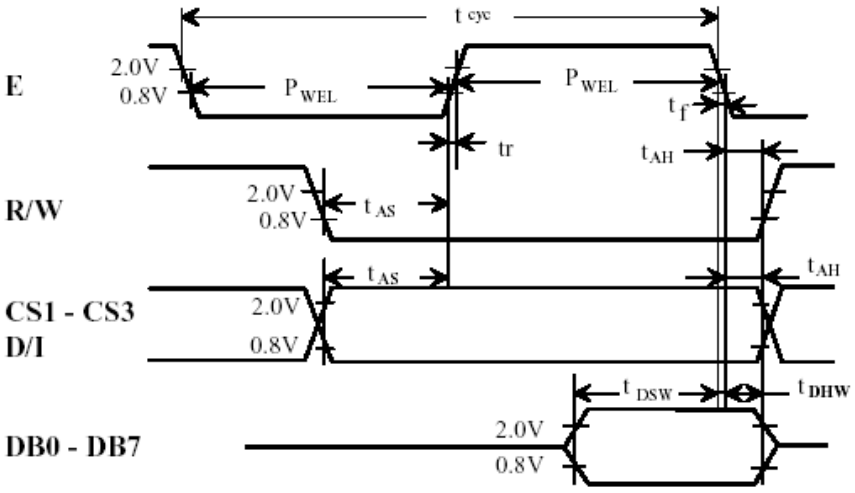


Figure 1 CPU Write Timing

Note : 2.

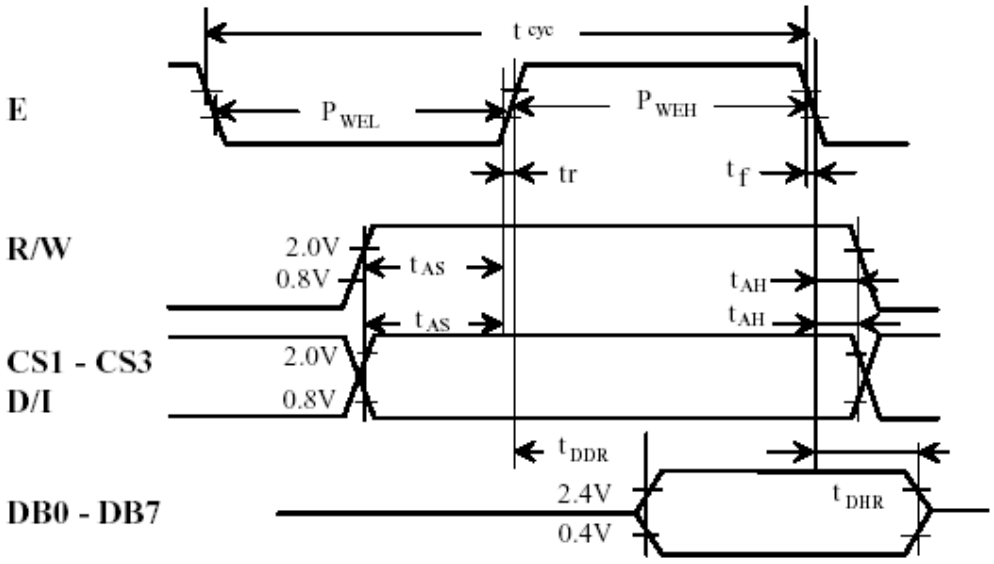


Figure 2 CPU Read Timing

(2) Clock Timing

(GND = 0 V, Vcc = 4.5Vto5.5v, Ta = -20 to + 75℃)

Limit						
Item	Symbol	Min	Typ	Max	Unit	Test Condition
φ1, φ2 cycle time	t_{CYC}	2.5	--	20	us	Fig. 3
φ1 low level width	$t_{WL\varphi1}$	625	--	--	ns	Fig. 3
φ2 low level width	$t_{WL\varphi2}$	625	--	--	ns	Fig. 3
φ1 high level width	$t_{WH\varphi1}$	1,875	--	--	ns	Fig. 3
φ2 high level width	$t_{WH\varphi2}$	1,875	--	--	ns	Fig. 3
φ1 - φ2 phase difference	t_{D12}	625	--	--	ns	Fig. 3
φ2 - φ1 phase difference	t_{D21}	625	--	--	ns	Fig. 3
φ1 - φ2 rise time	tr	--	--	150	ns	Fig. 3
φ1 - φ2 fall time	tf	--	--	150	ns	Fig. 3

*Increase parameter values by 200% when Vcc=+3V

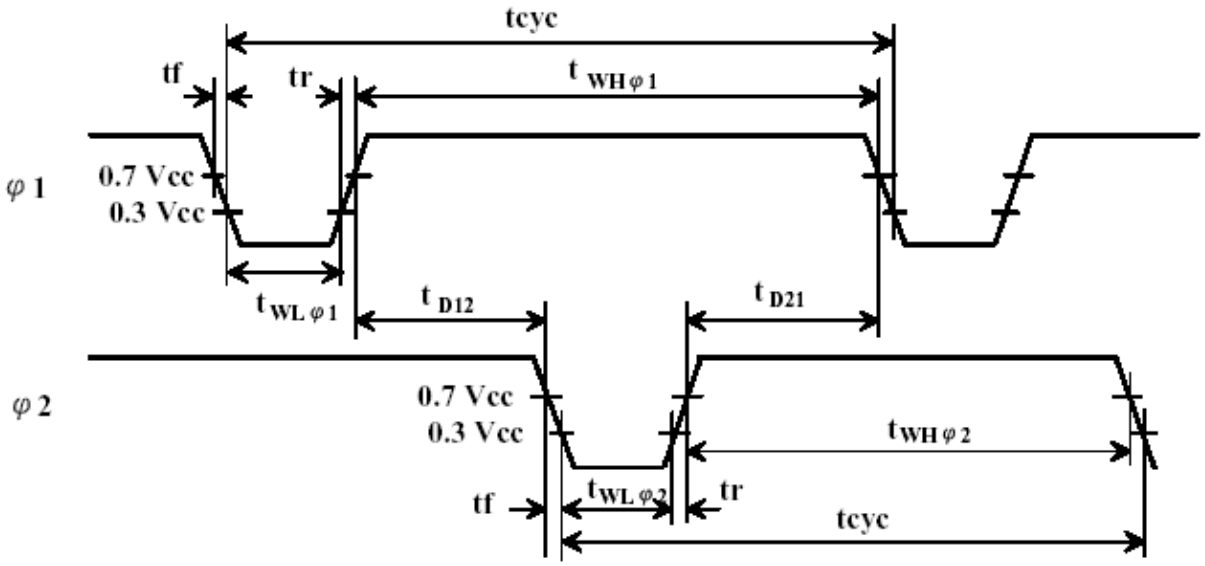


Figure 3 External Clock Waveform

(3)Display Control Timing

(GND = 0V, Vcc = 5v, Ta = -20 to +75℃)

Limit						
Item	Symbol	Min	Typ	Max	Unit	Test Condition
FRM delay time	t_{DFRM}	-2	--	2	μs	Fig. 4
M delay time	t_{DM}	-2	--	2	μs	Fig. 4
CL "low" level width	t_{WLCL}	35	--	--	μs	Fig. 4
CL "high" level width	t_{WHCL}	35	--	--	μs	Fig. 4

*Increase parameter values by 200% when Vcc=+3V

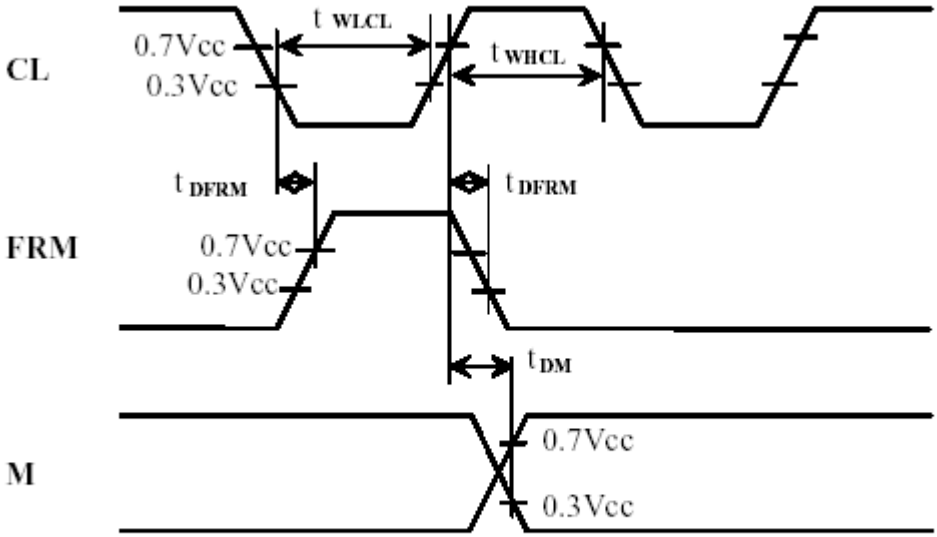
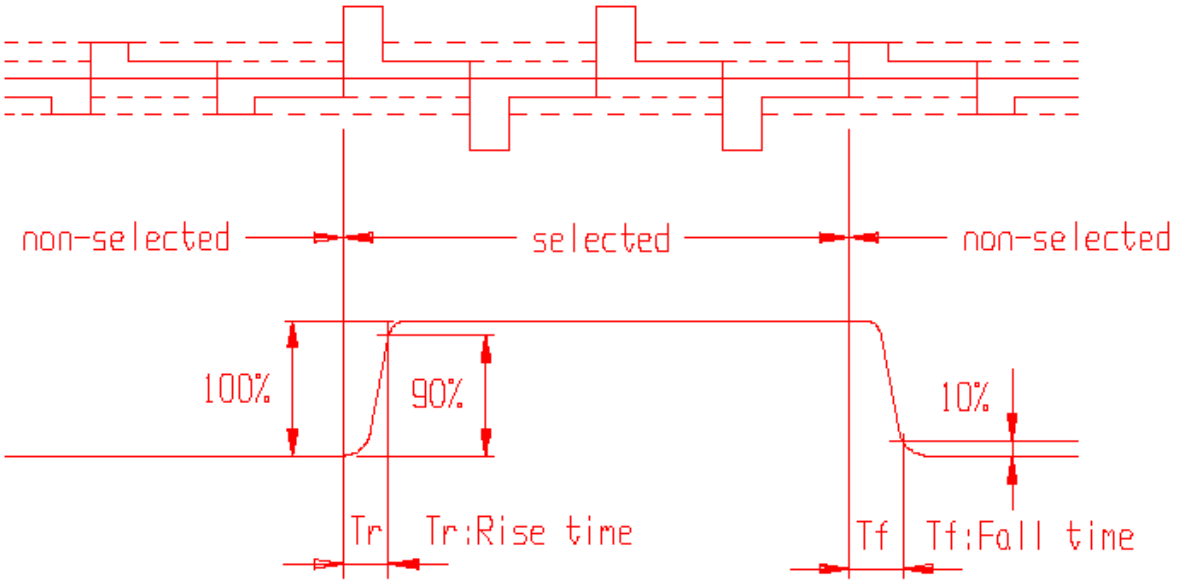


Figure 4 Display Control Signal Waveform

1.7 ELECTRO-OPTICAL CHARACTERISTICS (V_{OP} = 8.5V, Ta = 25°C)

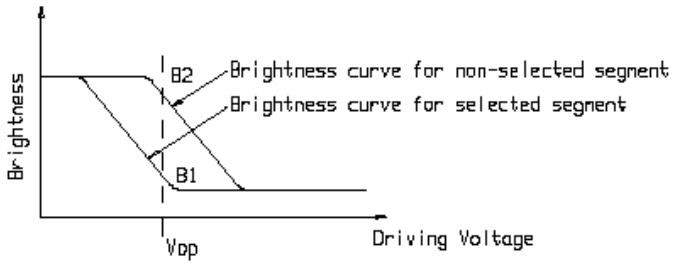
LCD mode	Typ response time Tr (ms)		Typ response time Tf (ms)		Typ contrast ratio Cr	Typ viewing angle θ (deg)			
	Normal temp	Wide temp	Normal temp	Wide temp		∅ = 0°	∅ = 90°	∅ = 180°	∅ = 270°
STN Y/G (B)	331	167	91	66	14	55	30	34	28
STN Blue (C)					4	47	24	29	23
STN Grey (D)					7	54	28	32	28
FSTN (F)					21	60	45	53	43
FSTN Negative (G)					9	48	24	30	23

Note1: Definition of response time.

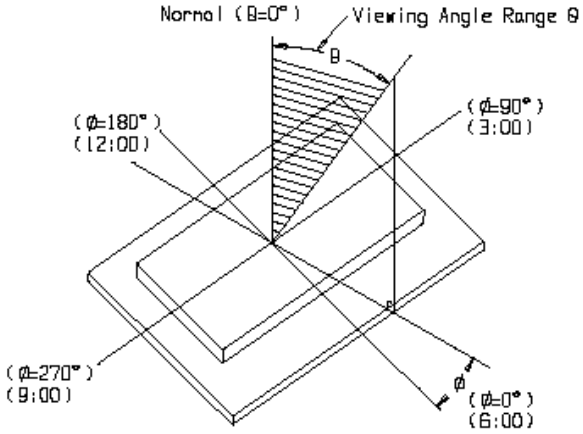


Note2: Definition of contrast ratio 'Cr' .

$$Cr = \frac{\text{Brightness of non-selected segment(B2)}}{\text{Brightness of selected segment(B1)}}$$



Note3: Definition of viewing angle range 'θ'.



1.8 Backlight Characteristics

LCD Module with LED Backlight

ABSOLUTE MAXIMUM RATINGS

(Ta=25℃,Unless specified ,The Amblent temperature Ta=25℃)

Item	Symbol	Conditions	Rating	Unit
Abslout maximum forward current	Ifm		180	mA
Peak forward current	Ifp	I macc 脉冲，1/10 占空比 I msec plus 10% Duty Cycle	480	mA
Reverse voltage	V_r		10	V
Power dissipation	P_d		6864	mW
Operating Temperature Range	T_{OPr}		-30~+70℃	℃
Storage Temperature Range	Tstg		-40~+85℃	℃

ELECTRICAL –OPTICAL CHARACTERISTICS

(Ta=25℃,Unless apecifled ,The Amblent temperature Ta=25℃)

Item	Symbol	Min.	Typ.	Max.	Unit	Conditions
Forward Voltage	vr	4.0	4.2	4.4	v	If = 120 mA
Reverse Current	I_r			80	uA	Vr =10.0 V
Peak wave length	λρ		570		Nm	If = 120 mA
Spectral line hair width	Δλ		30		nm	If = 120 mA
Luminance	Lv				Cd/m^2	If = 120 mA

2. MODULE STRUCTURE

2.1 INTERFACE PIN CONNECTIONS

Pin No.	Symbol	Level	Description
1	GND	0V	Ground
2	VCC	5.0V	Supply voltage for logic
3	V0	--	Input voltage for LCD
4	D/I	H/L	H : Data signal, L : Instruction signal
5	R/W	H/L	H : Read mode, L : Write mode
6	E	H/L	H : Output data, L : Latches data
7	DB0	H/L	Data bit 0
8	DB1	H/L	Data bit 1
9	DB2	H/L	Data bit 2
10	DB3	H/L	Data bit 3
11	DB4	H/L	Data bit 4
12	DB5	H/L	Data bit 5
13	DB6	H/L	Data bit 6
14	DB7	H/L	Data bit 7
15	CS1	H/L	Chip select signal for U3(SEG 0 - 63)
16	CS2	H/L	Chip select signal for U4(SEG 64 - 127)
17	/RES	L	Reset signal
18	VEE	-10V	Negative voltage to LCD
19	A	5.0V	Backlight anther
20	K	0V	Backlight canther

2. 2 OPERATING PRINCIPLES AND METHODS

- **Interface Control**

1. I/O Buffer

Data is transferred through 8 data bus lines (
DB0 - DB7) .
DB7 : MSB (Most significant bit)
DB0 : LSB (lleast significant bit)when
Data can neither be input nor output unless CS1 and CS2 are in the active mode.
Therefore,When CS1 and CS2 are not in active mode it is useless to switch the signals of input terminals except RST and ADC: that is namely, the internal state is maintained and no instruction excutes. Besides, pay attention to RST and ADC which operate irrespectively of CS1 and CS2.

2. Register

Both input register and output register are provided to interface to an MPU whose speed is different from that of internal operation. The selection of these registers depend on the combination of R/W and D/I signals (table 1).

Table 1 Register Selection

D/I	R/W	Operation
1	1	Reads data out of output register as internal operation (display data RAM → output register)
1	0	Writes data into input register as internal operation (input register → display data RAM)
0	1	Busy check. Read of status data.
0	0	Instruction

a. Input register
The input register is used to store data temporarily before writing it into display data RAM. The data from MPU is written into the input register, then into display data RAM automatically by internal operation. When CS1 and CS2 are in the active mode and D/I and R/W select the input register as shown in table 1, data is latched at the fall of the E signal.

b. Output register
The output register is used to store data temporarily that is read from display data RAM. To read out the data from output register, CS1 and CS2 should be in the active mode and both D/I and R/W should be 1. With the read display data instruction, data stored in the output register is output while E is high level. Then, at the fall of E, the display data at the indicated address is latched into the output register and the address is increased by 1.
The contents in the output register are rewritten by the read display data instructiion. but ree held by address set instruction, etc.
Therefore, the data of the specified address cannot be output with the read display data instruction right after the address is set, but can be output at the second read of data. That is to say, one dummy read is necessary.**Figure 5 shows the CPU read timing.**

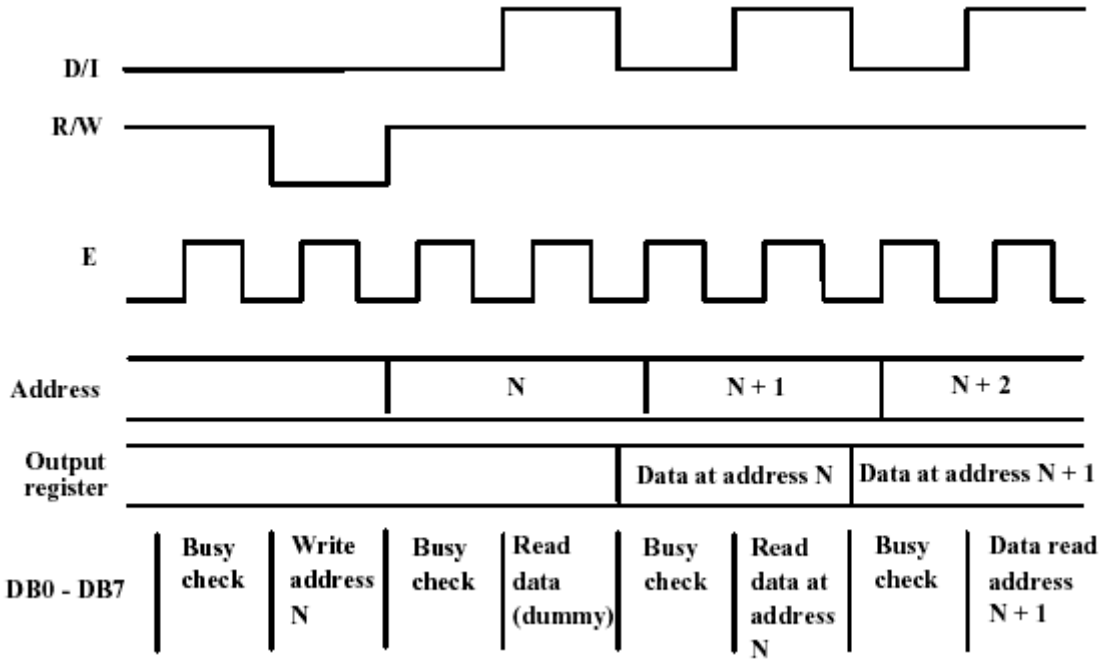
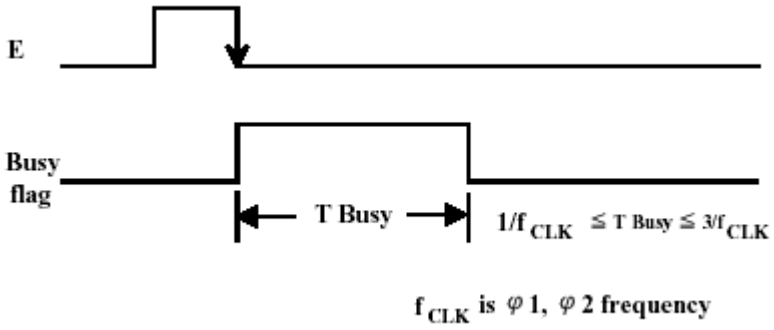


Figure 5 CPU Read Timing

- **Busy Flay**

Busy flag = 1 indicates that AX6108(U3 or U4) is operating and no instructions except status read instruction
can be accepted. The value of the busy flag is read out on DB7 by the status read instruction. Make sure that the busy flag is reset (“0”) before issuing insstructions.



- **Display On/Off Flip Flop**

The display on/off flip flop selects one of two states, on state and off state of segments Y1 to Y64. In on state, the display data corresponding to that in RAM is output to the segments. On the other hand, thedisplay data at all segments disappear in off state independent of the data in RAM. It is controlled by display on/off instruction. RST signal = 0 sets the segments in off state. The status of the flip/flop is output to DB5 by status read instruction.
Display on/off instruction does not influence data in RAM. To control display data latch by this flip/flop, CL signal (display synchronous signal) should be input correctly.

- **Display Start Line Register**

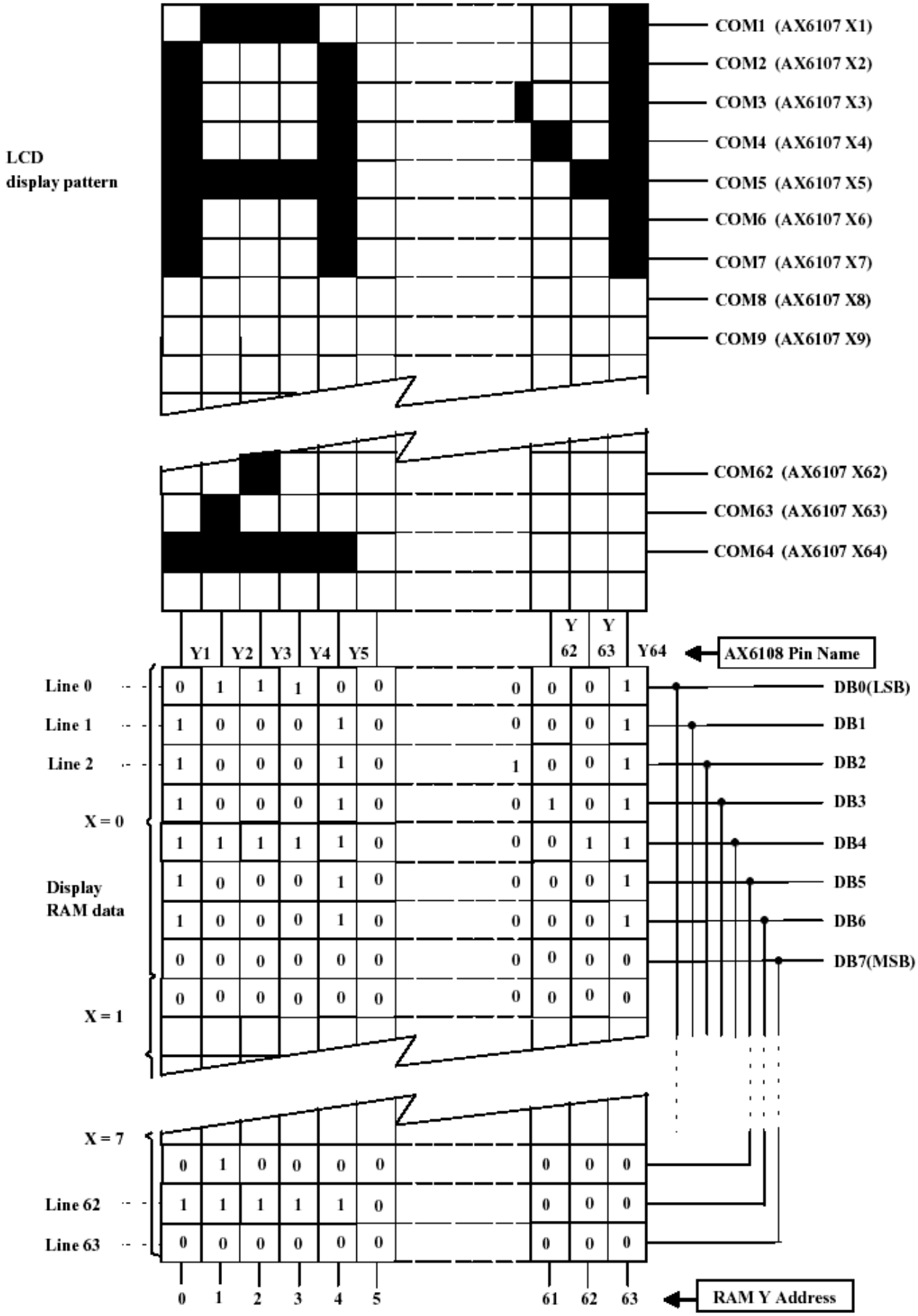
The display start line register specifies the line in RAM which corresponds to the top line of LCD panel, when displaying contents in display data RAM on the LCD panel. It is used for scrolling of the screen.
6-bit display start line information is written into this register by the display start line set instruction. When high level of the FRM signal starts the display, the information in this register is transferred to the Z address counter, which controls the display address, presetting the Z address counter.

- **X, Y Adddress Counter**

A 9-bit counter which designates addresses of the internal display data RAM. X address counter (upper 3 bits) and Y address counter (lower 6 bits) should be set to each address by the respective instructions.
(1) X address counter
Ordinary register with no count functions. An address is set by instruction.
(2) Y address counter
An address is set by instruction and is increased by 1 automatically by R/W operations of display data The Y address counter loops the values of 0 to 63 to count.

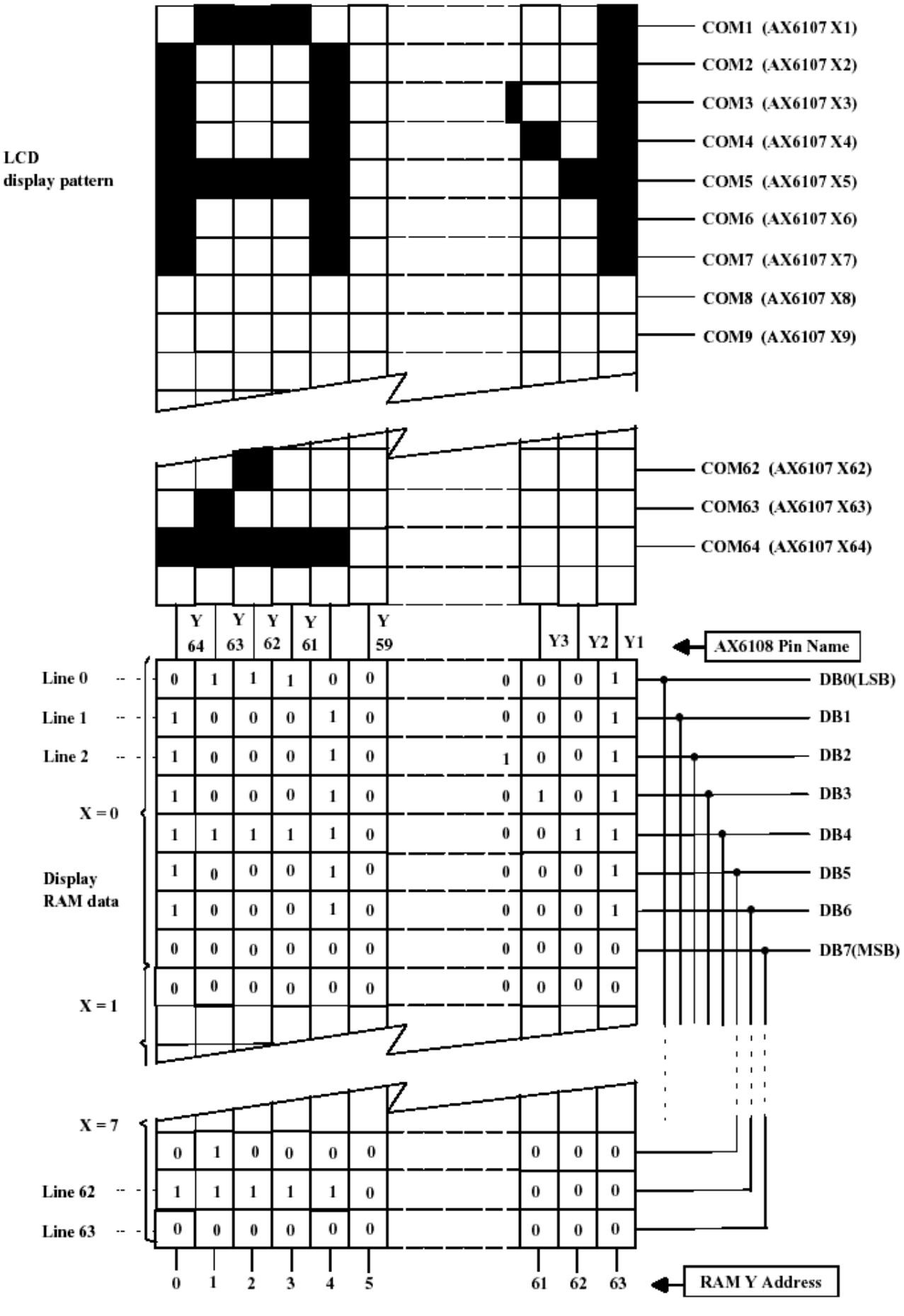
- **Display Data RAM**

Stores dot data for display. 1-bit data of this RAM corresponds to light on (data = 1) and light off (data = 0) of 1 dot in the display panel. The correspondence between Y addresses of RAM and segment pins can be reversed by ADC signal.
As the ADC signal controls the Y address counter, reversing of the signal during the operation causes malfunction and destruction of the contents of register and data of RAM. Therefore, never fail to connnect ADC pin to Vcc or GND when using.
Figure 6 shows the relations between Y address of RAM and segment pins in the cases of ADC = 1 and ADC = 0 (display start line = 0, 1/64 duty cycle).



(a) ADC = 1 (Connected to Vcc)

Fig 6 Relation between RAM Data and Display



(b) ADC = 0 (Connected to GND)

Fig 6 Relation between RAM Data and Display

- **Z Address Counter**

The Z address counter generates addresses for outputting the display data synchronized with the common signal. This counter consists of 6 bits and counts up at the fall of the CL signal. At the high level of FRM, the contents of the display start line register is preset at the Z counter.

- **Display Data Latch**

The display data latch stores the display data temporarily that is output from display data RAM to the liquid crystal driving circuit. Data is latched at the rise of the CL signal. The display on/off instruction controls the data in this latch and does not influence data in display data RAM.

- **Liquid Crystal Display Driver Circuit**

The combination of latched display data and M signal causes one of the 4 liquid crystal driver levels, V1, V2, V3 and V4 to be output.

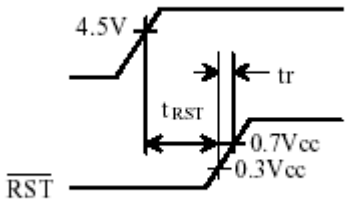
- **Reset**

The system can be initialized by setting RST terminal at low level when turning power on.
1. Display off
2. Set display start line register line 0.
While RST is low level, no instruction except status read can be accepted. Therefore, execute other instructions after making sure that DB4 = 0 (clear RESET) and DB7 = 0 (Ready) by status read instruction. The conditions of power supply at initial power up are shown in table 1.

Item	Symbol	Min	Typ	Max	Unit
Reset time	tRST	1	--	--	μs
Rise time	tr	--	--	200	ns

Table 1 Power Supply Initial Conditions

Do not forget to set the system again because RESET during operation may destroy the data in all the registers except on/off register and in RAM.



2.5 Display Control Instructions

2.5.1 Outline

Table 2 shows the instructions. Read/write (R/W) signal, data/instruction (D/I) signal, and data bus signals (DB0 to DB7) are also called instructions because the internal operation depends on the signals from the MPU.

These explanations are detailed in the following pages. Generally, there are following three kinds of instructions :

1. Instruction to set addresses in the internal RAM.
2. Instruction to transfer data from/to the internal RAM.
3. Other instructions.

In general use, the second type of instruction is used most frequently. Since Y address of the internal RAM is increased by 1 automatically after writing (reading) data, the program can be shortened.

During the execution of an instruction, the system cannot accept instructions other than status read instruction. Send instructions from MPU after making sure that the busy flag is 0, which is proof that an instruction is not being excuted.

	Code										
Instruction	R/W	D/I	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	Functions
Display on/off	0	0	0	0	1	1	1	1	1	1/0	Controls display on/off.RAM data and internal status are not affected.1:on,0:off.
Display start line	0	0	1	1	Display start line(0-63)						Specifies the RAM line displayed at the top of the screen.
Set page(Xaddress)	0	0	1	0	1	1	1	Page(0~7)			Sets the page(X address)of RAM at the page(X address) register.
Set address	0	0	0	1	Y address(0-63)						Sets the Y address in the Y address counter.
Status read	1	0	Busy	0	on/off	Reset	0	0	0	0	Reads the status. RESET 1:Reset 0: Normal ON/OFF 1: Display off 0: Display on Busy 1:Internal operation 0: Ready
Write display data	0	1	Write data								Writes data DB0 (LSB) to DB7 (MSB) on the data bus into display RAM. / Has access to the address of the display RAM specified in advance. After the access, Y address is increased by 1.
Read display data	1	1	Read data								Reads DB0 (LSB) to DB7 (MSB) fron the display RAM to the data bus.
Note : 1.Busy time varies with the frequency (f CLK) of φ1,and φ2. (1/f CLK≦T BUSY≦3/f CLK)											

2.5.2 **Detailed Explanation**

(1) Display on/off

	R/W	D/I	DB7						DB0
Code	0	0	0	0	1	1	1	1	1	D

← high-order bit low-order bit →

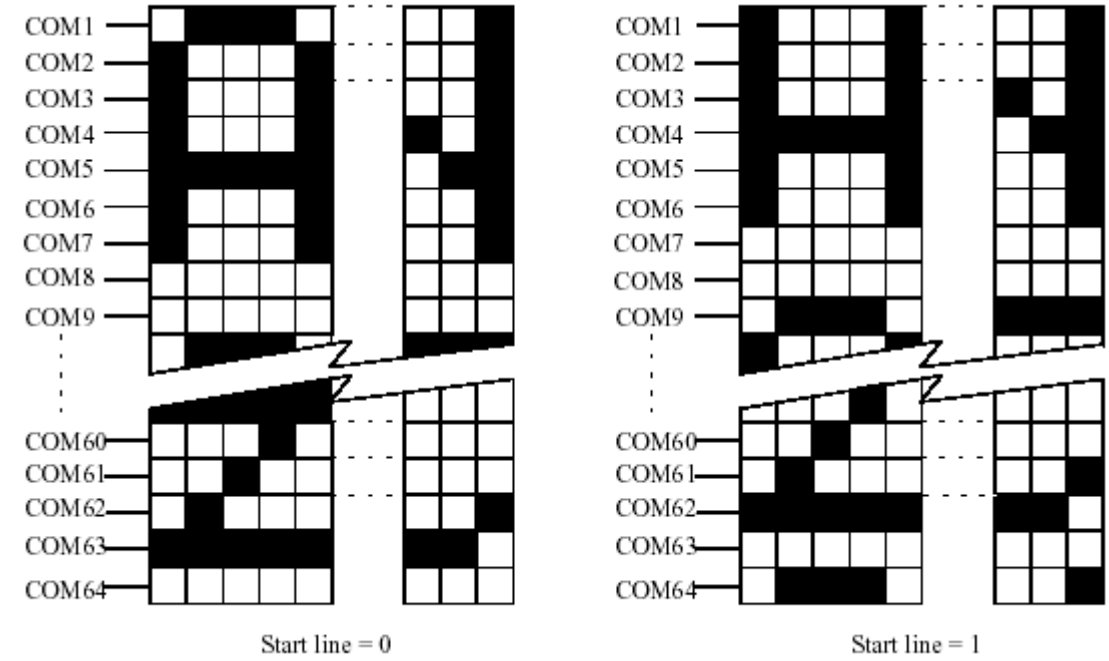
The display data appears when D is 1 and disappears when D is 0. Though the data is not on the screen with D = 0, it remains in the display data RAM. Therefore, you can make it appear by changing D = 0 into D = 1.

(2) Display start line

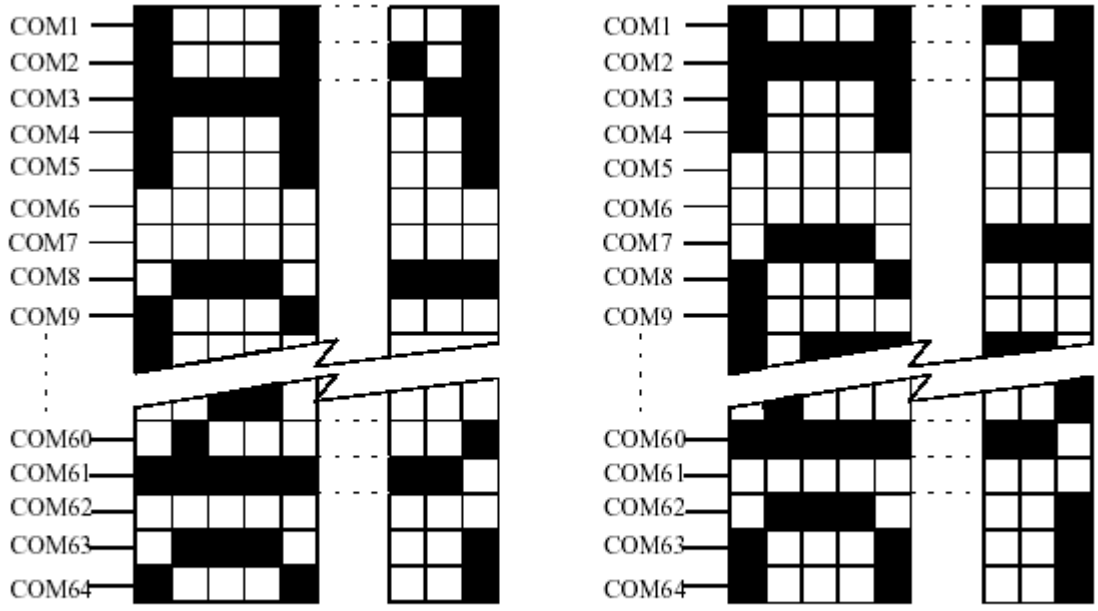
	R/W	D/I	DB7							DB0
Code	0	0	1	1	A	A	A	A	A	A

← high-order bit low-order bit →

Z address AAAAAA (binary) of the display data RAM is set in the display start line register and displayed at the top of the screen. Figure 7 shows examples of display (1/64 duty cycle) when the start line = 0 - 3. When the display duty cycle is 1/64 or more (ex. 1/32, 1/24 etc.), the data of total line number of LCD screen, from the line specified by display start line instruction, is displayed.



Start line = 0 Start line = 1



Start line = 2 Start line = 3

(3) Set page (X address)

	R/W	D/I	DB7							DB0
Code	0	0	1	0	1	1	1	A	A	A

← high-order bit low-order bit →

X address AAA (binary) of the display data RAM is set in the X address register. After that, writing or reading to or from MPU is executed in this specified page until the next page is set. See figure 9.

(4) Set Y address

	R/W	D/I	DB7							DB0
Code	0	0	0	1	A	A	A	A	A	A

← high-order bit low-order bit →

Y address AAAAAA (binary) of the display data RAM is set in the Y address counter. After that, Y address counter is increased by 1 every time the data is written or read to or from MPU.

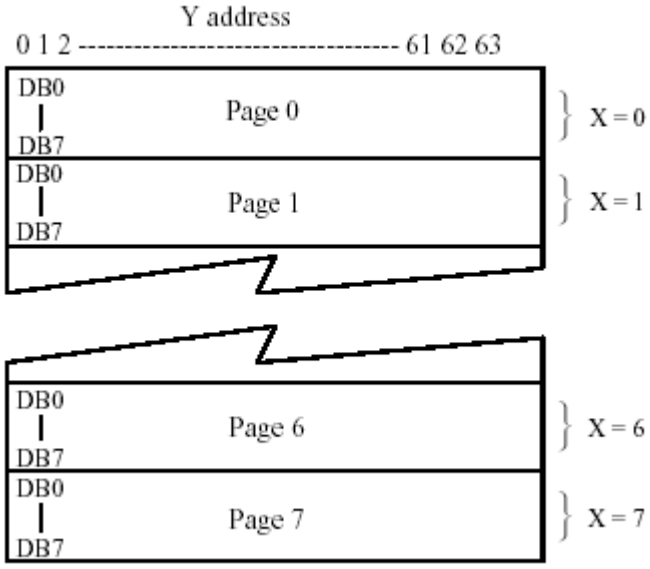


Figure 8 Address Configuration of Display Data RAM

(5) Status Read

	R/W	D/I	DB7							DB0
Code	1	0	Busy	0	ON/ OFF	RESET	0	0	0	0

← high-order bit low-order bit →

Busy : When Busy is 1, the LSI is executing internal operations. No instructions are accepted while Busy is 1, so you should make sure that Busy is 0 before writing the next instruction.

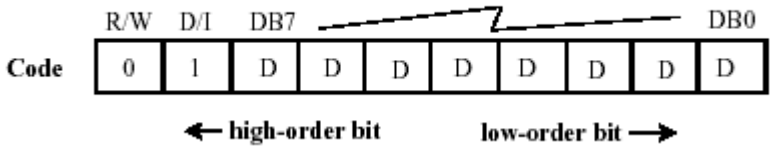
ON/OFF : Shows the liquid crystal display conditions: on condition or off condition.

When ON/OFF is 1, the display is in off condition.

When ON/OFF is 0, the display is in on condition.

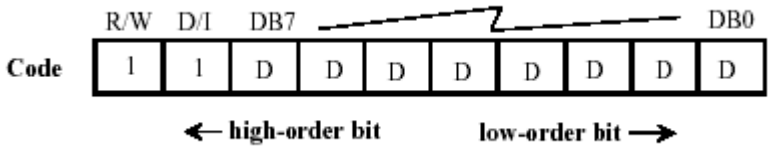
RESET : RESET = 1 shows that the system is being initialized. In this condition, no instructions except status read can be accepted.
RESET = 0 shows that initializing has finished and the system is in the usual operation.

(6) Write Display Data



Writes 8-bit data DDDDDDDD (binary) into the display data RAM. Then Y address is increased by 1 automatically.

(7) Read Display Data



Reads out 8-bit data DDDDDDDD (binary) from the display data RAM. Then Y address is increased by 1 automatically.One dummy read is necessary soon after the address setting. For details, refer to the explanation of output register in "FUNCTION OF EACH BLOCK".

3 . RELIABILITY

3.1 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.	60 °C 200 hrs	------
2	Low temperature storage	Endurance test applying the low storage temperature for a long time.	-10 °C 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.	50 °C 200 hrs	------
4	Low temperature operation	Endurance test applying the electric stress under low temperature for a long time.	0 °C 200 hrs	------
5	High temperature / Humidity storage	Endurance test applying the high temperature and high humidity storage for a long time.	60 °C , 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.	40 °C , 90 %RH 96 hrs	MIL-202E-103B JIS-C5023
7	Temperature cycle	Endurance test applying the low and high temperature cycle. -10°C 30min ⇌ 25°C 5min. ⇌ 60°C 30min 1 cycle	-10°C / 60°C 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 11 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 kΩ CS=100 pF 1 time	MIL-883B-3015.1

*** Supply voltage for logic system = 5V. Supply voltage for LCD system = Operating voltage at 25°C.

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

3 . 2 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 1m of height from the LCD module under 2 pieces of 40W white fluorescent lamps (Normal temperature 20~25°C and normal humidity 60±15%RH).

- Inspection method

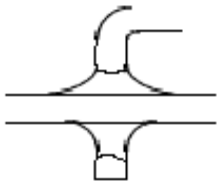
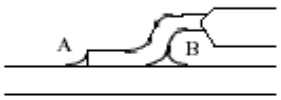
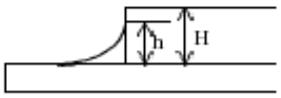
The visual check should be performed vertically at more than 30cm distance from the LCD panel.

- Driving voltage

The Vo value which the most optimal contrast can be obtained near the specified Vo in the specification. (Within of the typical value at 25°C.).

3 . 3 INSPECTION CRITERIA

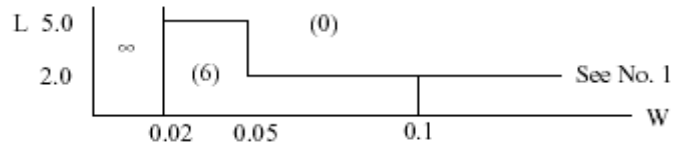
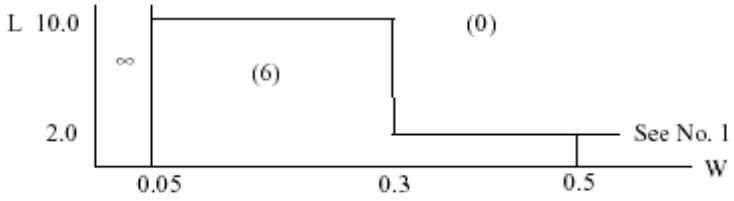
Module Cosmetic Criteria

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 No soldering bridge No cold soldering	Major Major Minor
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 'heal' (B) of the lead to be covered by 'Filet'. Lead form to be assume over solder. 	Minor
	3. Chips	(3/2) H ≥ h ≥ (1/2) H 	Minor

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	Size : d mm / Acceptable Qty in active area d ≤ 0.3 : Disregard 0.3 < d ≤ 1.0 : 3 1.0 < d ≤ 1.5 : 1 1.5 < d : 0	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

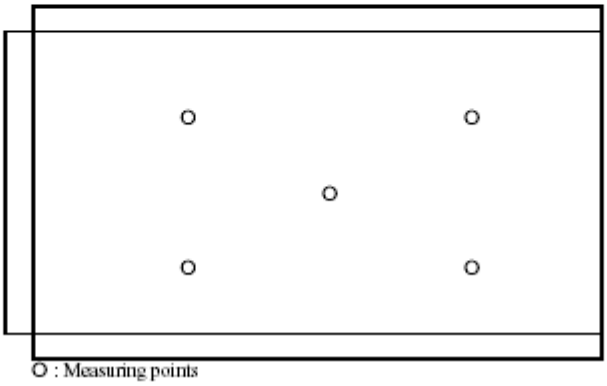
Screen Cosmetic Criteria (Operating)

No.	Defect	Judgement Criterion	Partition
1	Spots	A) Clear Size : d mm / Acceptable Qty in active area d ≤ 0.1 : Disregard 0.1 < d ≤ 0.2 : 6 0.2 < d ≤ 0.3 : 2 0.3 < d : 0 Note : Including pin holes and defective dots which must be within one pixel size. B) Unclear Size : d mm / Acceptable Qty in active area d ≤ 0.2 : Disregard 0.2 < d ≤ 0.5 : 6 0.5 < d ≤ 0.7 : 2 0.7 < d : 0	Minor
2	Lines	A) Clear  Note : ( ) - Acceptable Qty in active area L - Length (mm) W - Width (mm) ∞ - Disregard B) Unclear 	Minor

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

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

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.  O : 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.

4. PRECAUTIONS FOR USING LCM MODULES

1 . 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.).

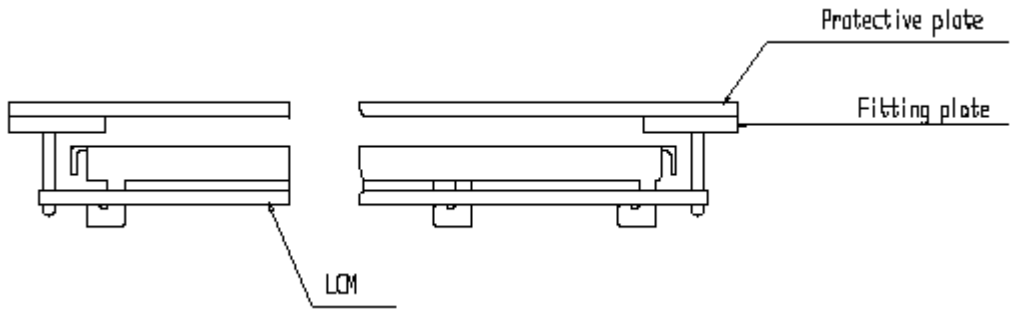
(3) N-hexane is recommended for cleaning the adhesives used to attach front/rear polarizers and reflectors made of organic
substances which will be damaged by chemicals such as acetone, toluene, ethanol and isopropylalcohol.

(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
temperature 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.

2 . Installing LCM 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.

3 . Precaution for Handing LCM 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.

4 . 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.

5 . 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.

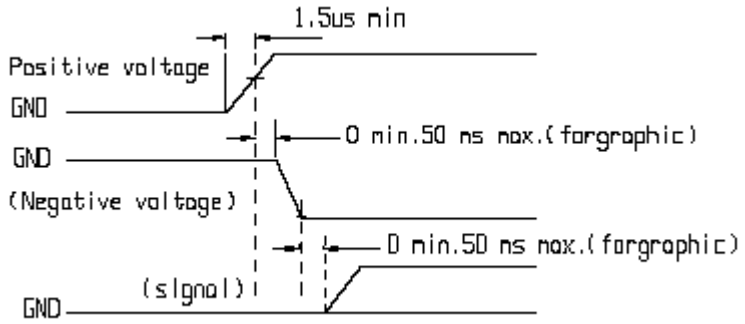
6 . Precautions for Operation

(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.



7. 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.)
(4) Environmental conditions :
- Do not leave them for more than 168hrs. at 60°C.
- Should not be left for more than 48hrs. at -20°C.

8 . 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.

9 . Limited Warranty

Unless agreed between TINSHARP and customer, TINSHARP will replace or repair any of its LCD modules
which are found to be functionally defective when inspected in accordance with TINSHARP LCD acceptance standards
(copies available upon request) for a period of one year from date of shipments. Cosmetic/visual defects must be returned to
TINSHARP within 90 days of shipment. Confirmation of such date shall be based on freight documents. The warranty

liability of TINSHARP limited to repair and/or replacement on the terms set forth above. TINSHARP will not be
responsible for any subsequent or consequential events.

10 . 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.