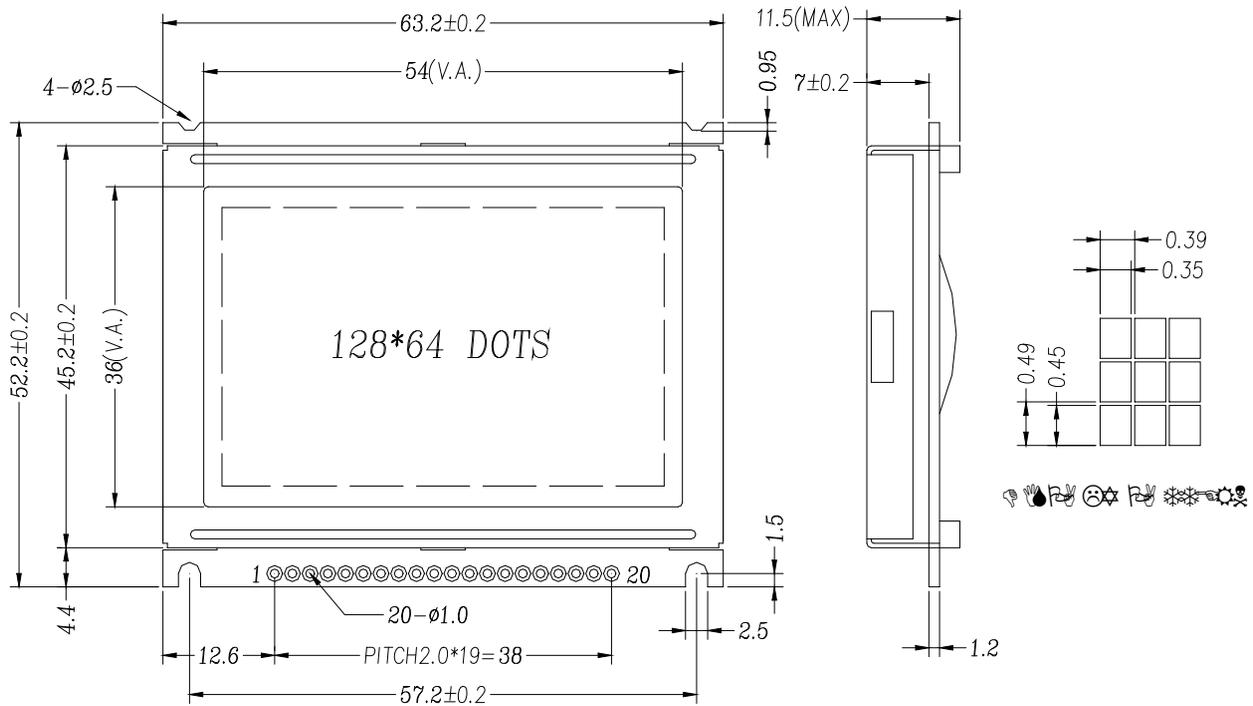# A M O T E C

ADM12864M

SPECIFICATIONS OF LCD MODULE

Features

- Display format: 128*64 dots matrix graphic
- Easy interface with 8-bit MPU
- Low power consumption
- LED backlight
- Driving method: 1/64 duty, 1/9 bias
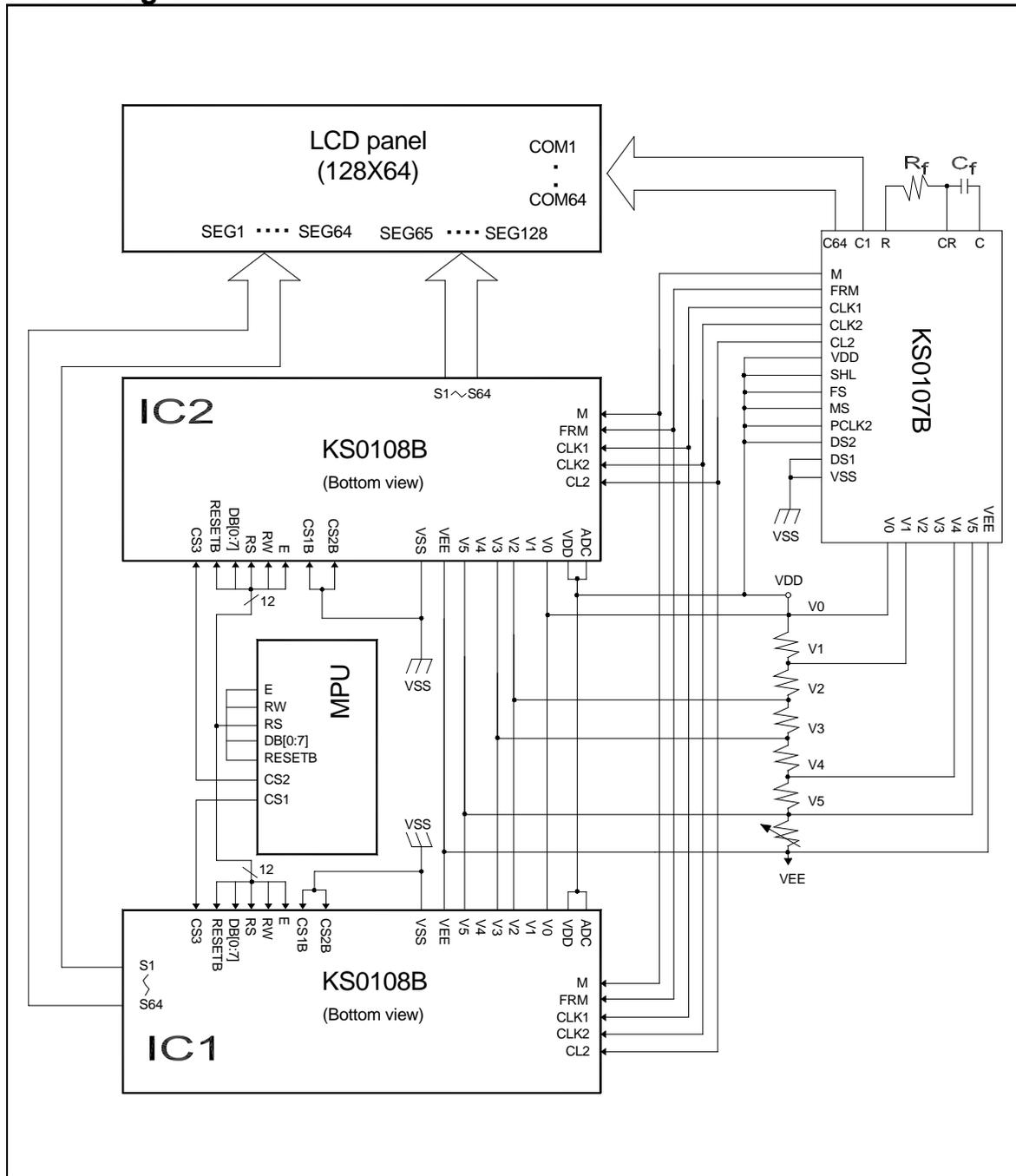- LCD driver IC:S6B0108

Outline dimension

Unit:mm

Absolute maximum ratings

Item	Symbol	Standard			Unit
Power voltage	V_{DD}-V_{SS}	0	-	7.0	V
Input voltage	VIN	VSS	-	VDD	
Operating temperature range	Top	-20	-	+70	℃
Storage temperature range	Tst	-30	-	+80	

Block diagram

LCD panel
(128X64)

COM1
⋮
COM64

SEG1 ···· SEG64   SEG65 ···· SEG128

R_f C_f

C64 C1 R   CR C

KS0107B

M
FRM
CLK1
CLK2
CL2
VDD
SHL
FS
MS
PCLK2
DS2
DS1
VSS

VSS

V0 V1 V2 V3 V4 V5 VEE

IC2

S1∼S64

KS0108B

(Bottom view)

M
FRM
CLK1
CLK2
CL2

CS3
RESETB
DB[0:7]
RS
RW
E
CS1B
CS2B

VSS

VEE
V5
V4
V3
V2
V1
V0
ADC
VDD

12

VSS

VDD

V0

V1

V2

V3

V4

V5

VEE

MPU

E
RW
RS
DB[0:7]
RESETB
CS2
CS1

VSS

VSS

12

S1
⌇
S64

CS3
RESETB
DB[0:7]
RS
RW
E
CS1B
CS2B

VSS

VEE
V5
V4
V3
V2
V1
V0
ADC
VDD

KS0108B

(Bottom view)

M
FRM
CLK1
CLK2
CL2

IC1

Contrast adjust

LCM

VDD

V0   VR

VEE

5V

10V

VSS

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

ADM12864M

Interface pin description

Pin no.	Symbol	External connection	Function
1	V_{DD}		Power supply for logic (+5V) for LCM
2	V_{SS}	Power supply	Signal ground for LCM (GND)
3	V₀		Contrast adjust
4~11	DB0~DB7	MPU	Data bus [0~7] Bi-directional data bus
12	CS2	MPU	Chip selection: When CS1=H,CS2=L, select IC1
13	CS1	MPU	When CS1=L,CS2=H, select IC2
14	RST	MPU	Reset signal. When RSTB=L
15	R/W	MPU	Read/write select signal
16	D/I		Register select signal
17	E		Operation (data read/write) enable signal
18	VSS		Signal ground for LCM (GND)
19	A	LED BKL Power supply	Power supply for BKL (Anode)
20	K		Power supply for BKL (GND)

LED ratings

Item	Symbol	Min	Typ.	Max	Unit
Forward Voltage	V_F		-	3.2	V
Forward current	IF	-	36	45	mA
Power	P			255	mW
Peak wave length	p				nm
Luminance	Lv				Cd/m^2

Optical characteristics

STN type display module (Ta=25℃, VDD=5.0V)

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
Viewing angle	θ	$C_r \geqslant 2$	-60	-	35	deg
	Φ		-40	-	40	
Contrast ratio	C_r		-	8	-	-
Response time (rise)	T_r	-	-	200	250	ms
Response time (fall)	T_r	-	-	300	350	

ADM12864M

DC Electrical Characteristics

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Supply voltage for LCD	V_{DD}-V_0	Ta =25℃	-	8.2	-	V
Input voltage	V_{DD}		4.7	-	5.5	
Supply current	I_{DD}	Ta=25℃, V_{DD}=5.0V	-	2.0	3.5	mA
Input leakage current	I_{LKG}		-	-	5.0	uA
"H" level input voltage	V_{IH}		2.2	-	V_{DD}	
"L" level input voltage	V_{IL}	Twice initial value or less	0	-	0.6	V
"H" level output voltage	V_{OH}	LOH=-0.25mA	2.4	-	-	
"L" level output voltage	V_{OL}	LOH=1.6mA	-	-	0.4	

MPU Interface

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

MPU Write timing

MPU Read timing
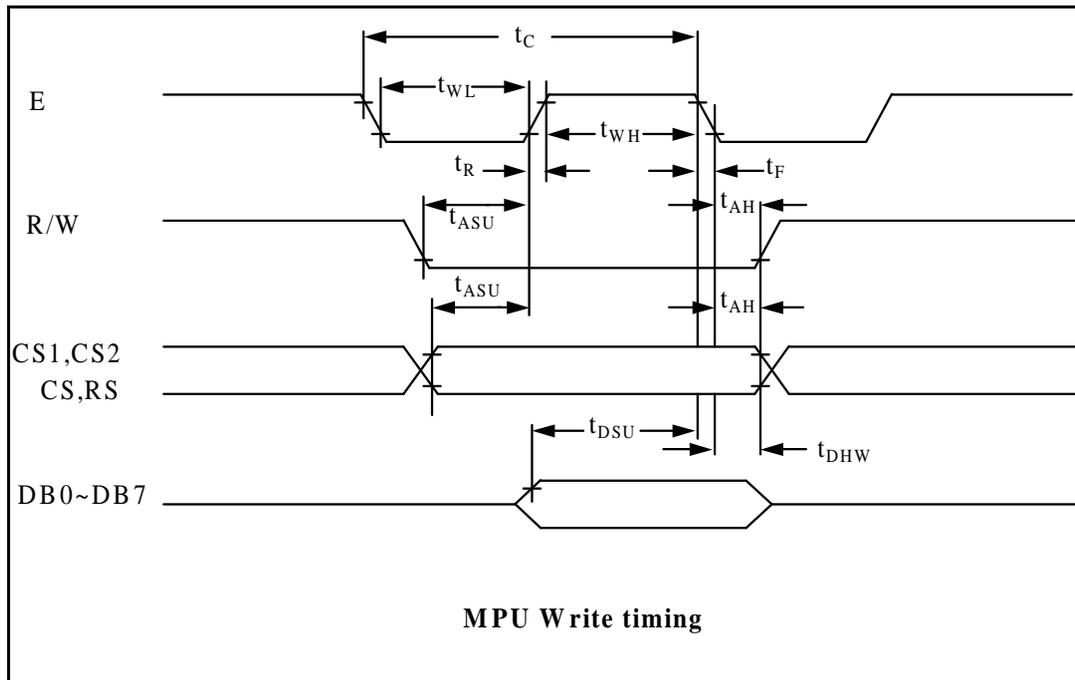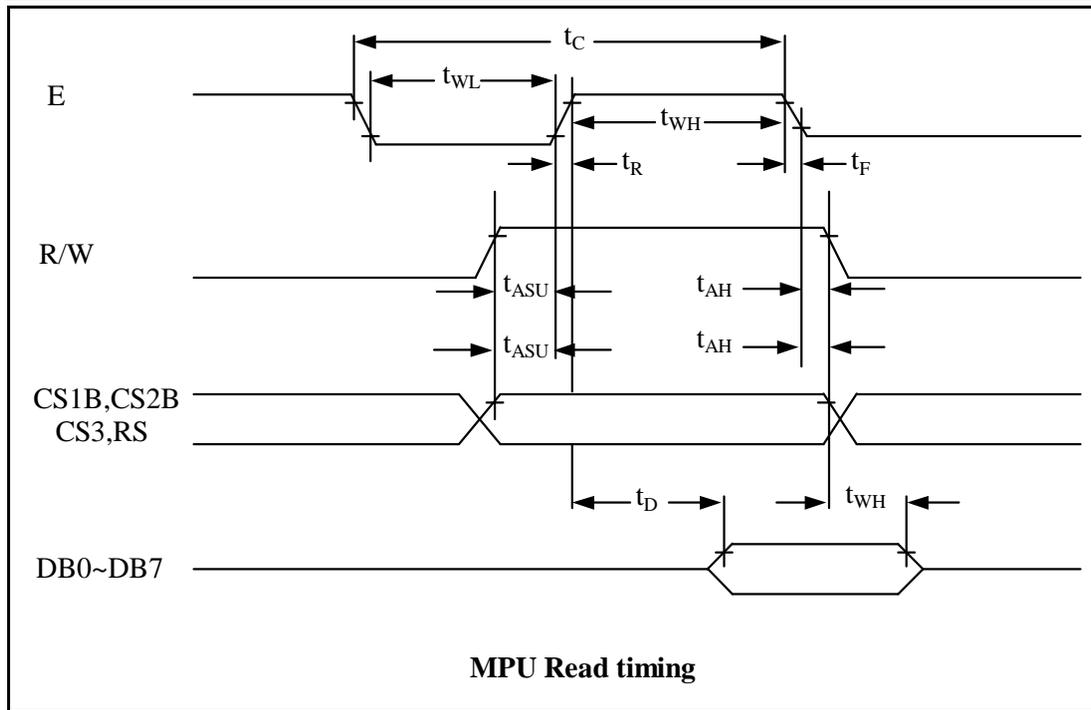
OPERATING PRINCIPLES & METHODS

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 CS!B -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 dat a 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 re ad. 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 by accepted. Therefore, execute other instructions after making sure that DB4= (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

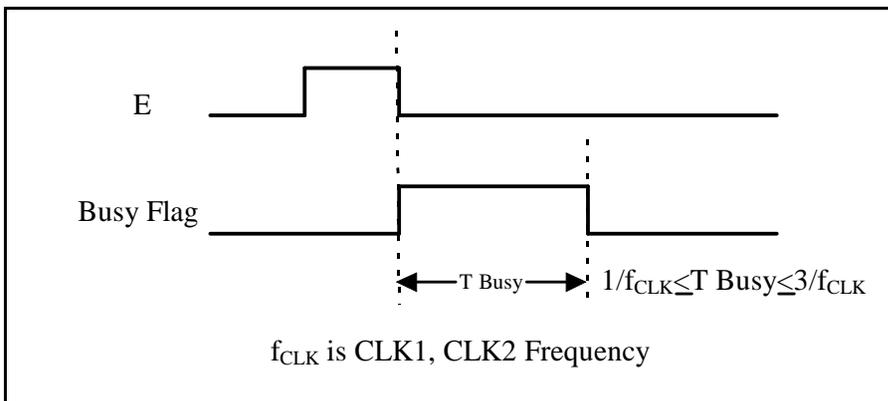| Item	Symbol	Min	Typ	Max	Unit
Reset Time	t_{RS}	1.0	-	-	us
Rise Time	t_R	-	-	200	ns
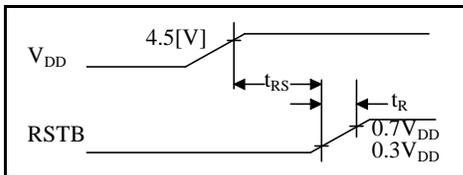
5. Busy flag

Busy flag indicates that S6B0108 is operating or no operating. When busy flag is high, S6B0108 is in internal operating .
When busy flag is low, S6B0108 can accept the data or instruction.
DB7indicates busy flag of the S6B0108.

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 datra1. The other way , off state, writes 0.
    Display data RAM address and segment output can be controlled by ADC signal.
    ADC=H => Y-address 0: S1~Y address 63: S64
    ADC=L => Y-address 0: S64~Yaddress 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 FR M is high, presetting the Z address counter.
    It is used for scrolling of the liquid crystal display screen.

Display Control Instruction

The display control instructions control the internal state of the S6B0108. Instruction is received from MPU to S6B0108 for the display control. The following table shows various instructions.

Instruction	RS	RW	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	Function
Read Display Date	1	1				Read data					Reads data (DB[7:0]) from display data RAM to the data bus.
Write Display Date	1	0				Write data					Writes data (DB[7:0]) into the DDRAM. After writing instruction, Y address is incriminated by 1 automatically
Status Read	0	1	Busy	0	ON/OFF	Re-set	0	0	0	0	Reads the internal status BUSY 0: Ready 1: In operation ON/OFF 0: Display ON 1: Display OFF RESET 0: Normal 1: Reset
Set Address (Y address)	0	0	0	1			Y address (0~63)				Sets the Y address at the column address counter
Set Display Start Line	0	0	1	1			Display start line (0~63)				Indicates the Display Data RAM displayed at the top of the screen.
Set Address (X address)	0	0	1	0	1	1	1		Page (0~7)		Sets the X address at the X address register.
Display On/off	0	0	0	0	1	1	1	1	1	0/1	Controls the display ON or OFF. The internal status and the DDRAM data is not affected. 0: OFF, 1: ON

1. **Display On/Off**

    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.

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

2. **Set Address (Y Address)**

    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.

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

3. Set Page (X Address)

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.

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

4. Display Start Line (Z Address)

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.

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

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

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

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

7. Read Display Data

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

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

LCM Operation Precautions

(1) It is an indispensable condition to drive LCD within the specified voltage limit since the higher voltage than the limit causes the shorter LCD life. An electrochemical reaction due to direct current causes LCD's undesirable deterioration, so that the use of direct current driver should be avoided.

(2) Response time will be extremely delayed at lower tempe rature than the specified operating temperature range and on the other hand LCD's show dark blue color in the higher temperature. However, those phenomena do not mean any malfunction or display out of order with LCD's, which will come back in the specified operation temperature range.

(3) If the display area is pushed hard during operation, some font s will be abnormally displayed. But it resumes normal condition after turning off once.

(4) A slight dew depositing on terminals could be a cause for electrochemical reaction resulting in terminal open circuit.

(5) Display contrast varies with the change of liquid crystal driving voltage (V_o). Adjust V_o to show the best contrast.

(6) Condensation on terminals can cause an electrochemical reaction disrupting the t erminal circuit. Therefore, it is suggested to use the LCD under the relative condition of 40°C, 85% RH.

(7) When turning the power on, input each signal after the positive/negative voltage becomes stable.
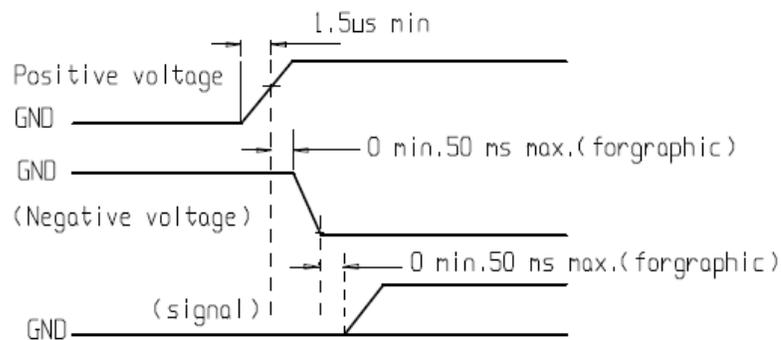
(8) The backlight must be operated within the co ndition of specification. The overload current or too high voltage will reduce the life time or destroy the backlight.

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 adj oining 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. Please handle the 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 n ot 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 w ork 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 wo rk 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.

Installing Precautions

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.
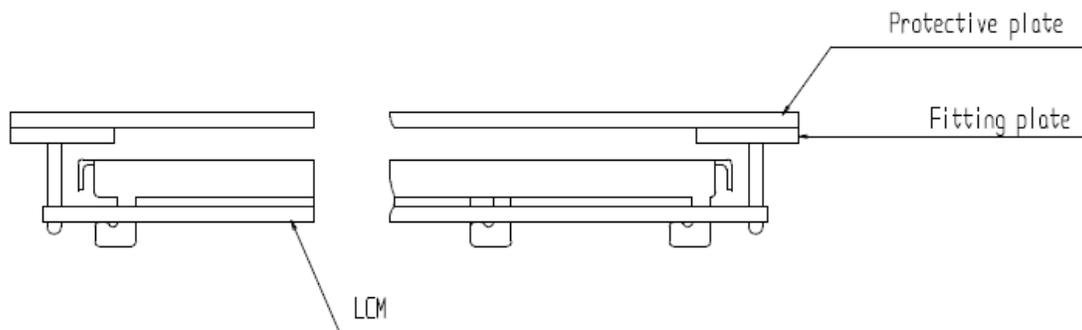
(2) When assembling the LCM into other equipment, the space r to the bit between the LCM and the fitting plate should have enough height to avoid causing stress to the module surface, refer to the individual specifications for measurements. The measurement tolerance should be 0.1mm.

Storage Precautions

In case of storing for a long period of time for the purpose of replacement use, the following ways are recommended.

(1) Storage in a polyethylene bag with the opening sealed so as not to enter fresh air outside in it, and with no desiccant.

(2) Placing in a dark place where neither exposure to direct sunlight nor light is, keeping temperature in the range from -30°C to 80°C

(3) Storing with no touch on polarizer surface by anything else. (It is recommended to store them as they have been contained in the inner container at the time of delivery from us.)

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 leaks out of a damaged glass c ell and comes in contact with the hands, wash off thoroughly with soap and water.

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.