KEST

LCD MODULE

KST1602-SERIES

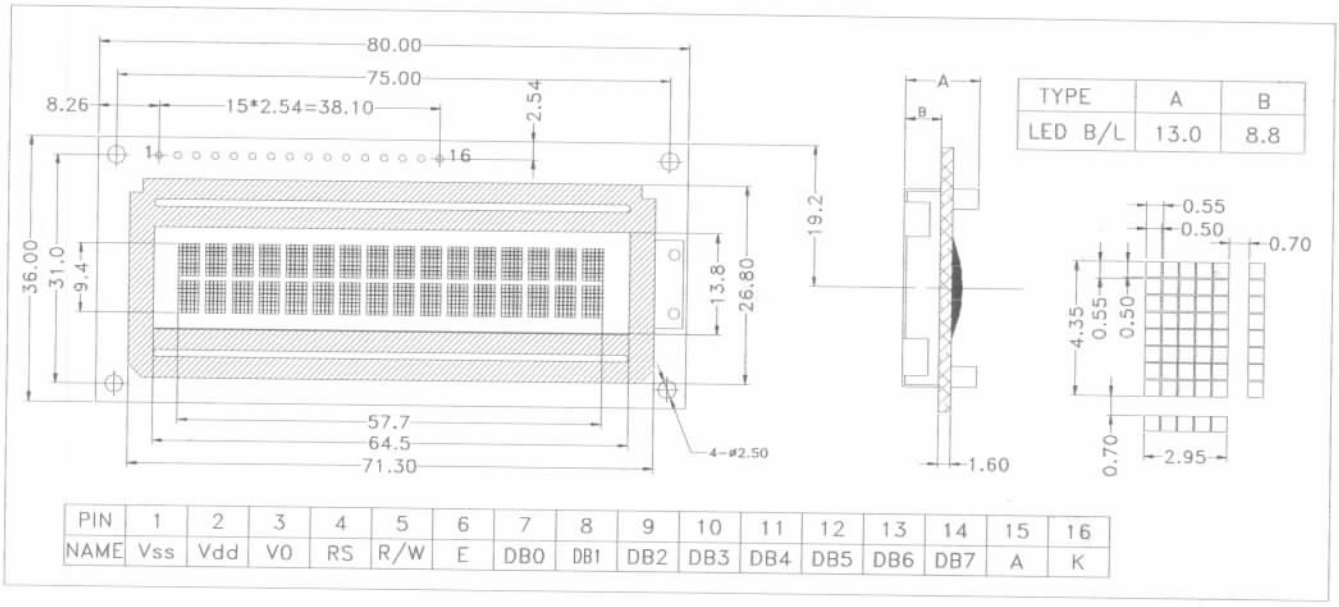
CONTENTS

1 . SPECIFICATIONS

1.1 Features

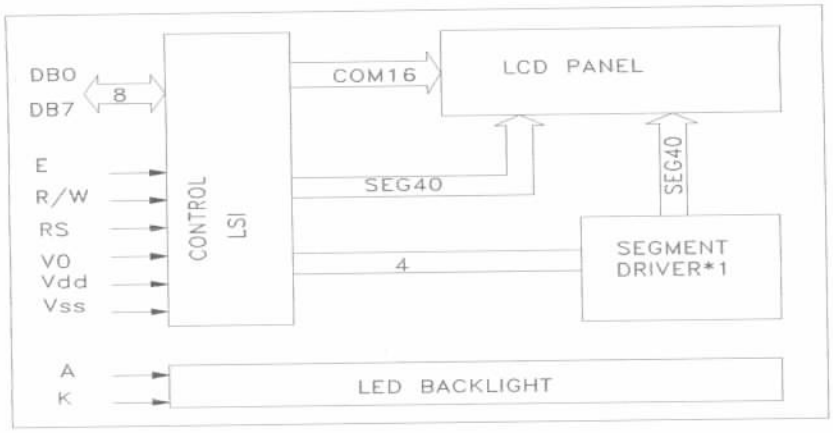
Item	Contents	Unit
LCD TYPE	STN/Transflective/Gray	--
LCD duty	1/16	--
LCD bias	1/5	--
Viewing direction	6	o'clock
Module size(W x H x T)	80.0 X 36.0 X 13.0	mm
Viewing area(W x H)	64.5 X 13.8	mm
Display Format	16 Characters X 2 Lines	dots
Character Size (W x H)	2.95 X 4.35	mm
Character pitch(W x H)	3.65 X 5.05	mm

1.2 EXTERNAL DIMENSIONS



PIN	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
NAME	Vss	Vdd	V0	RS	R/W	E	DB0	DB1	DB2	DB3	DB4	DB5	DB6	DB7	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}-12	V_{DD}+0.3	V
Input voltage	V_I	-0.3	V_{DD} +0.3	V
Nomal Operating temperature	T_{OP}	0	+50	℃
Nomal Storage temperature	T_{ST}	-20	+60	℃

1.5 DC CHARACTERISTICS (T_A = 25 :, VDD = 5V)

Characteristics	Symbol	Limit			Unit	Test Condition
		Min	Typ	Max		
Operating Voltage	V_{DD}	4.5	-	5.5	V	
Operating Current	I_{DD}	-	0.55	0.8	mA	External clock (Note)
Input High Voltage	V_{IH1}	2.2	-	V_{DD}	V	Pins: (E, RS, R/W, DB0 - DB7)
Input Low Voltage	V_{IL1}	-0.3	-	0.6	V	
Input High Voltage	V_{IH2}	V_{DD}-1	-	V_{DD}	V	Pin OSC1
Input Low Voltage	V_{IL2}	-0.2	-	1.0	V	Pin OSC1
Input High Current	I_{IH}	-	-	2	μA	Pins: (RS, R/W, DB0 - DB7)
Input Low Current	I_{IL}	-50	-125	-250	μA	
Output High Voltage (TTL)	V_{OH1}	2.4	-	V_{DD}	V	I_{OH} = - 0.1 mA Pins: DB0 - DB7
Output Low Voltage (TTL)	V_{OL1}	-	-	0.4	V	I_{OL} = 0.1 mA Pins: DB0 - DB7
Output High Voltage (CMOS)	V_{OH2}	0.9V_{DD}	-	V_{DD}	V	I_{OH} = - 40 μA Pins: CLK1,CLK2,M,D

Output Low Voltage (CMOS)	V_{OL2}	-	-	0.1V_{DD}	V	I_{OL} = 40 μA, Pins: CLK1,CLK2,M,D
LCD Driver Voltage	V_{LCD}	V_{DD}-0.3		12	V	V_{DD} - V5
Voltage Drop	Vdcom	-	-	1	V	I_O = 0.1 mA Pins: COM1-COM16
	Vdseg	-	-	1	V	I_O = 0.1 mA Pins: SEG1-SEG40

1.6 AC Characteristics

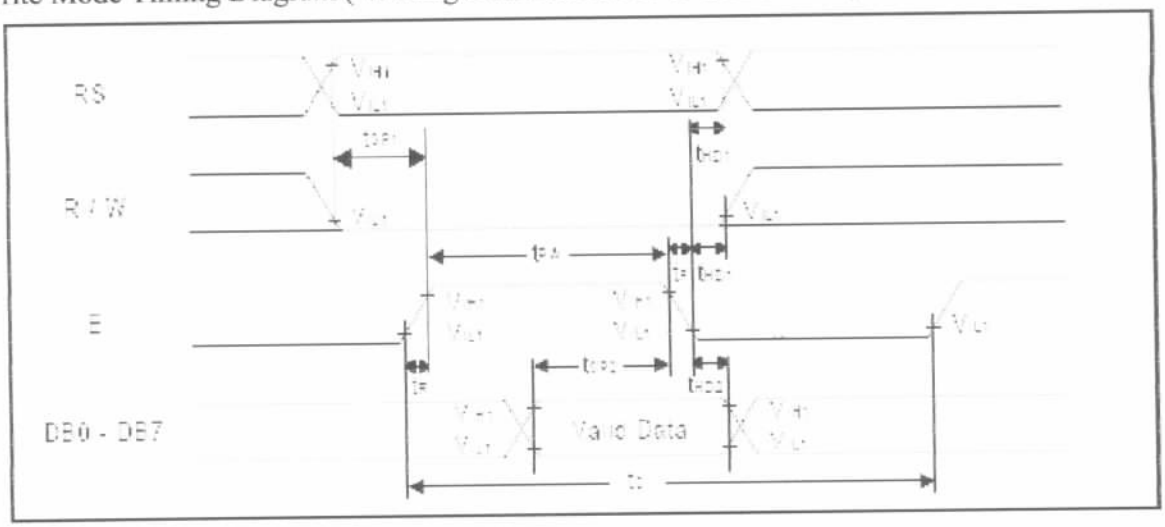
(1) Write Mode (Writing data from MPU to SPLC780A)

Characteristics	Symbol	Limit			Unit	Test Condition
		Min	Typ	Max		
E Cycle Time	t_C	400	-	-	ns	Pin E
E Pulse Width	t_{PW}	150	-	-	ns	Pin E
E Rise/Fall Time	t_R, t_F	-	-	25	ns	Pin E
Address Setup Time	t_{SP1}	30	-	-	ns	Pins: RS, R/W,E
Address Hold Time	t_{HD1}	10	-	-	ns	Pins: RS, R/W,E
Data Setup Time	t_{SP2}	40	-	-	ns	Pins: DB0 ~ DB7
Data Hold Time	t_{HD2}	10	-	-	ns	Pins: DB0 ~ DB7

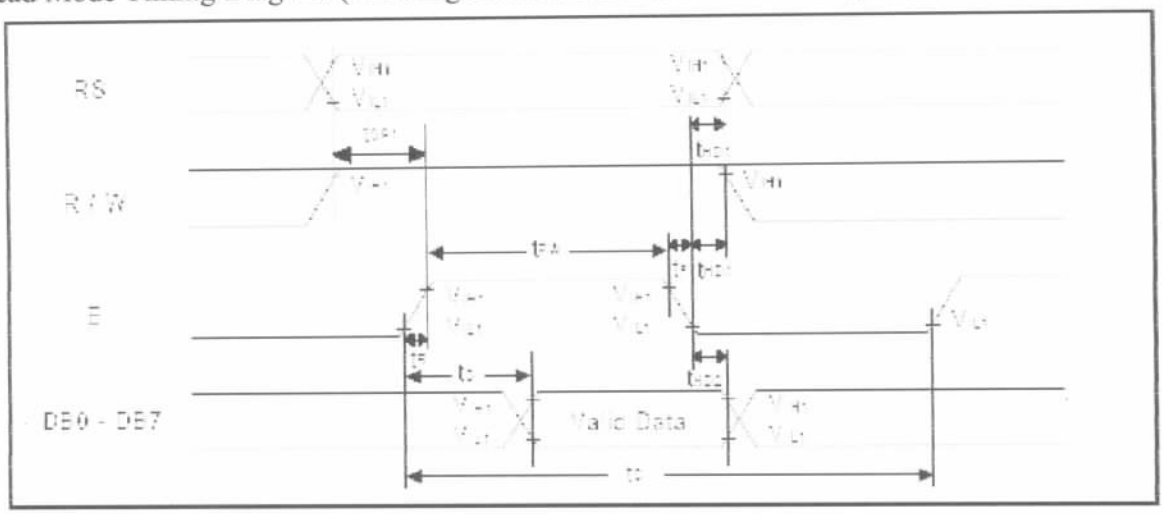
(2) Read Mode (Reading data from SPLC780A to MPU)

Characteristics	Symbol	Limit			Unit	Test Condition
		Min	Typ	Max		
E Cycle Time	t_C	400	-	-	ns	Pin E
E Pulse Width	t_W	150	-	-	ns	Pin E
E Rise/Fall Time	t_R, t_F	-	-	25	ns	Pin E
Address Setup Time	t_{SP1}	30	-	-	ns	Pins: RS, R/W,E
Address Hold Time	t_{HD1}	10	-	-	ns	Pins: RS, R/W,E
Data Output Delay Time	t_D	-	-	100	ns	Pins: DB0 ~ DB7
Data hold time	t_{HD2}	20	-	-	ns	Pin DB0 ~ DB7

(3) Write Mode Timing Diagram (Writing data from MPU to SPLC780A)



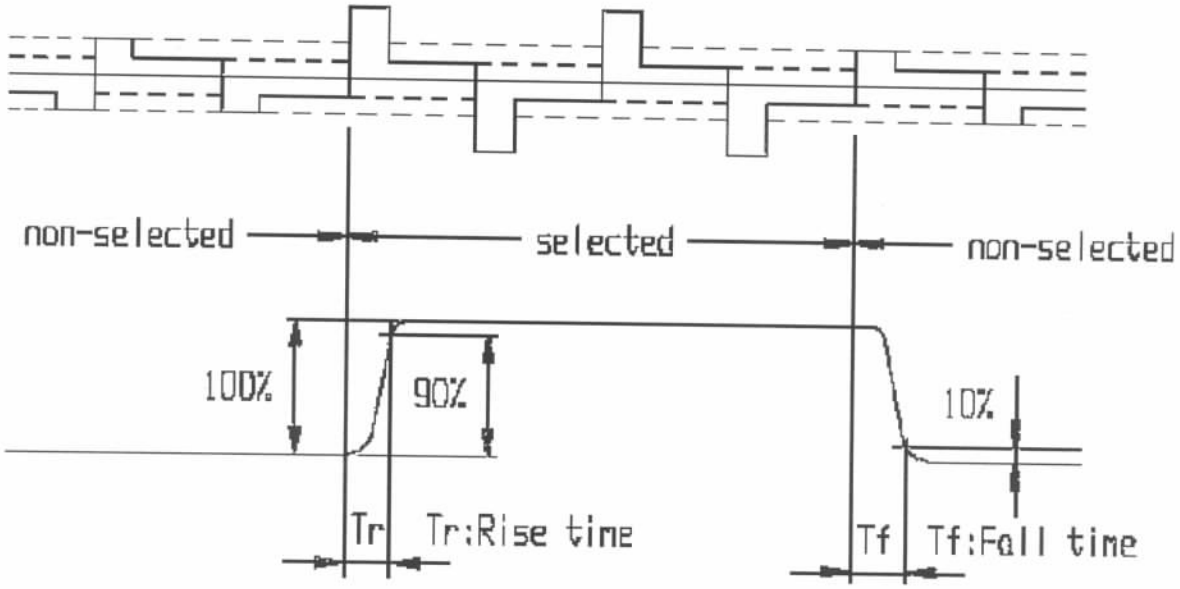
(4) Read Mode Timing Diagram (Reading data from SPLC780A to MPU)



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

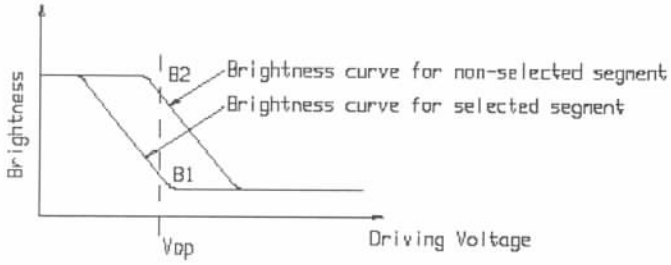
LCD mode	Typ response time Tr (ms)		Typ response time Tf (ms)		Typ contrast ratio Cr	Typ viewing angle θ (deg)			
	Normal temp	Wide temp	Normal temp	Wide temp		∅ = 0°	∅ = 90°	∅ = 180°	∅ = 270°
STN Y/G (B)	331	167	91	66	14	55	30	34	28
STN Blue (C)					4	47	24	29	23
STN Grey (D)					7	54	28	32	28
FSTN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

Note1 : Definition of response time.

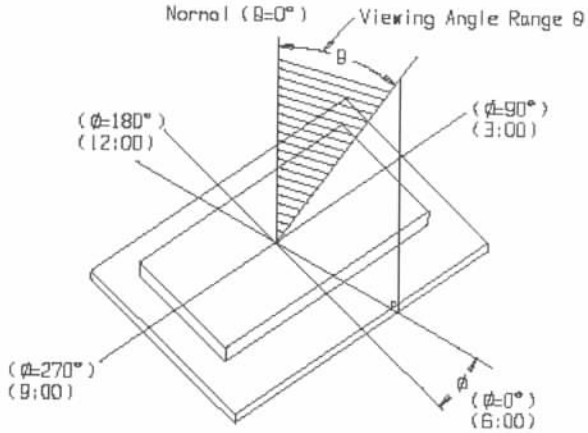


Note2: Definition of contrast ratio "Cr"

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



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		20	mA
Peak forward current	Ifp	I macc 脉冲，1/10 占空比 I msec plus 10% Duty Cycle	60	mA
Reverse voltage	V_r		5	V
Power dissipation	P_d		70	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	Vf	3.0	3.2	3.5	V	If = 18 mA
Reverse Current	I_r			10	uA	Vr = 5.0 V
Peak wave length	λρ		470		nm	If = 18 mA
Spectral line hair width	Δλ		25		nm	If = 18 mA
Luminance	Lv				cd/m^2	If = 18 mA

2. MODULE STRUCTURE

2.1 INTERFACE PIN CONNECTIONS

Pin No.	Symbol	Level	Description
1	VSS	0V	Ground
2	VDD	5.0V	Supply voltage for logic
3	V0	--	Input voltage for LCD
4	RS	H/L	H : Data signal, L : Instruction signal
5	R/W	H/L	H : Read mode, L : Write mode
6	E	H/L	It is a start signal to read data or write 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	A	+5V	LED Back light anode
16	K	0V	LED Back light cathode

2. 2 FUNCTION DESCRIPTION

Oscillator

SPLC780A has a good oscillator that supports not only the internal oscillator operation but also the external clock operation.

Control and Display Instructions

Control and display instructions will show in details as following:

1. Clear Display

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

It clears the whole display and sets display data RAM s address 0 in address counter.

2. Return Home

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

X: Do not care (0 or 1)

It sets display data RAM s address 0 in address counter and display returns to its original position. The cursor or blink goes to the left edge of the display (to the 1st line if 2 lines are displayed). The contents of the Display Data RAM do not change.

3. Entry Mode Set

During writing and reading data, it sets cursor move direction and shifts the display.

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

I / D = 1: Increment, I / D = 0: Decrement.

S = 1: The display shift, S = 0: The display does not shift.

S = 1	I / D = 1	It shifts the display to the left
S = 1	I / D = 0	It shifts the display to the right

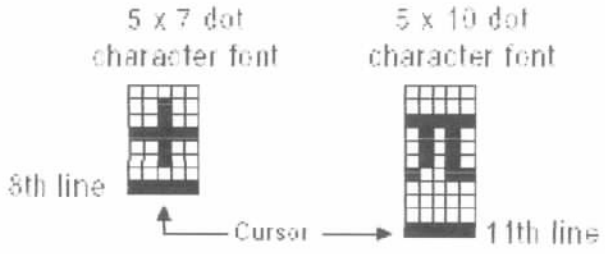
4. Display On/Off Control

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

D = 1: Display on, D = 0: Display off

C = 1: Cursor on , C = 0: Cursor off

B = 1: Blinks on, B= 0: Blinks off



5. Cursor or Display Shift

Without changing DD RAM s datas, it can move cursor and shift display.

Blink display alternately

	RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
Code	0	0	0	0	0	1	S/C	R/L	X	X

S/C	R/L	Description	Address Counter
0	0	Shift cursor to the left	AC = AC - 1
0	1	Shift cursor to the right	AC = AC + 1
1	0	Shift display to the left. Cursor follows the display shift	AC = AC
1	1	Shift display to the right. Cursor follows the display shift	AC = AC

6. Function Set

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

X: Do not care (0 or 1)

DL: It sets interface data length.

DL = 1: Datas are transferred with 8-bit lengths (DB0 ~ DB7).

DL = 0: Datas are transferred with 4-bit lengths (DB4 ~ DB7).

(It needs two times to transfer datas)

N: It sets the number of the display line.

N = 0: One-line display.

N = 1: Two-line display.

F: It sets the character font.

F = 0: 5 x 7 dots character font.

F = 1: 5 x 10 dots character font.

N	F	No. of Display Lines	Character Font	Duty Factor
0	0	1	5 X 7 dots	1 / 8
0	1	1	5 x 10 dots	1 / 11
1	X	2	5 x 7 dots	1 / 16

It cannot display two lines with 5 x 10 dot character font.

7. Set Character Generator RAM Address

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

It sets character generator RAM address $(aaaaaa)_2$ to the address counter.

Character generator RAM data can read or write after this setting.

8. Set Display Data RAM Address

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

It sets display data RAM address (aaaaaaa)2 to the address counter.
Display data RAM can read or write after this setting.
In one-line display (N = 0), (aaaaaaa)2: (00)16 ~ (4F)16.
In two-line display (N = 1), (aaaaaaa)2: (00)16 ~ (27)16 for the first line,
(aaaaaaa)2: (40)16 ~ (67)16 for the second line.

9. Read Busy Flag and Address

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

When (BF = 1) indicates that the system is busy now, it will not accept any instruction until no busy (BF = 0). At the same time, the address counter ccontents's (aaaaaaa)2 is read out.

10. Write Data to Character Generator RAM or Display Data RAM

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

It writes data (dddddddd)2 to character generator RAM or display data RAM.

11. Read Data from Character Generator RAM or Display Data RAM

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

It reads data (dddddddd)2 from character generator RAM or display data RAM.
To get the correct data readout is shown belows:
(i) Set the address of the character generator RAM or display data RAM
or shift the cursor instruction.
(ii) Send the " Read " instruction.

8-Bit operation and 8-digit 1-line display (using internal reset)

No.	Instruction	Display	Operation
1	Power on . (SPLC780A starts initializing)		Power on reset . No display .
2	Function set RS R/W DB7 DB6 DB5 DB4 DB3 DB2 DB1 DB0 0 0 0 0 1 1 0 0 X X		Set to 8-bit operation and select 1-line display line and character font .
3	Display on / off control 0 0 0 0 0 0 1 1 1 0	_	Display on . Cursor appear .
4	Entry mode set 0 0 0 0 0 0 0 1 1 0	_	Increase address by one . It will shift the cursor to the right when writing to the DD RAM / CG RAM . Now the display has no shift .
5	Write data to CG RAM / DD RAM 1 0 0 1 0 1 0 1 1 1	W_	Write " W " . The cursor is incremented by one and shifted to the right .

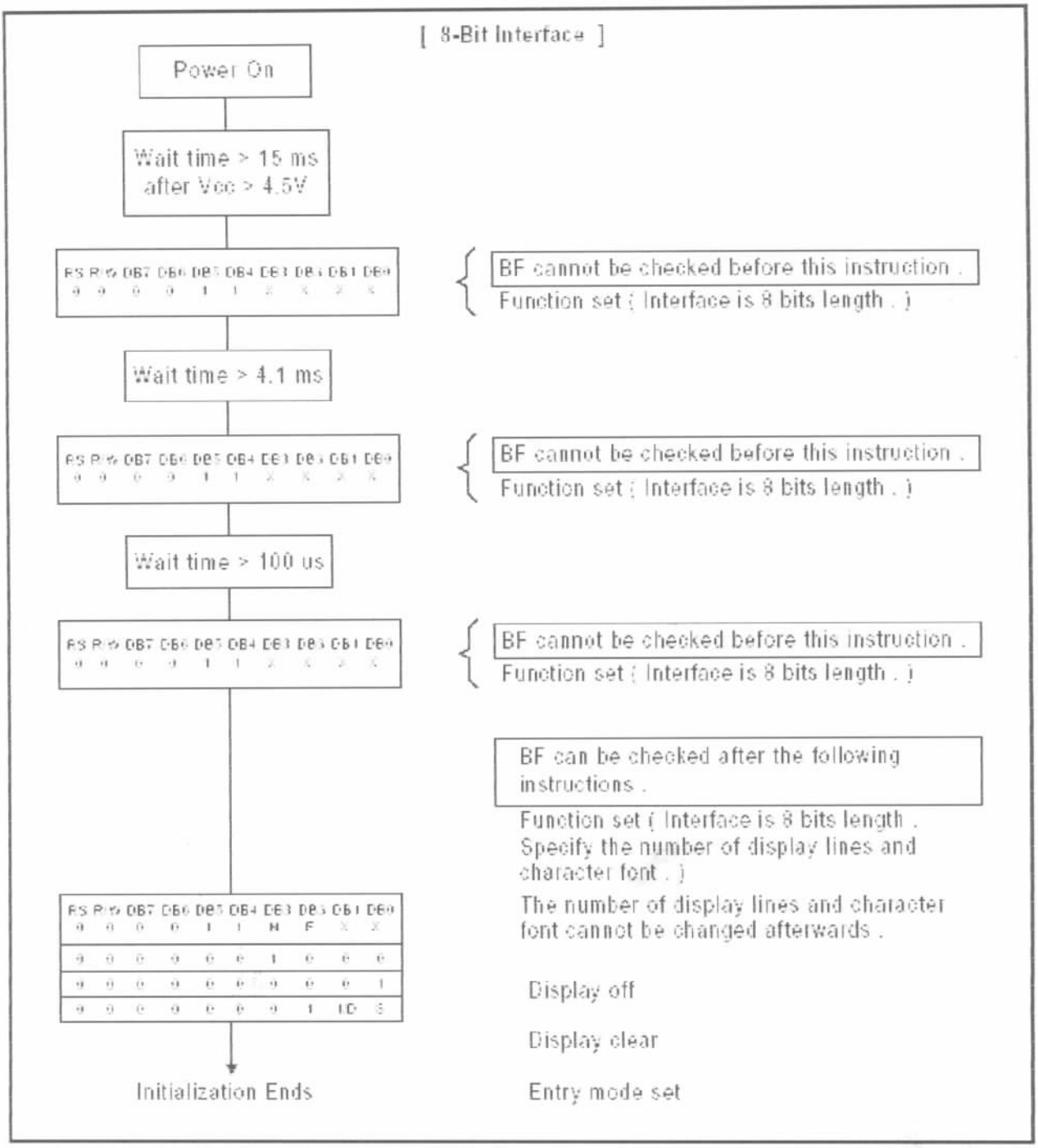
6	Write data to CG RAM / DD RAM 1 0 0 1 0 0 0 1 0 1	WE_	Write " E " . The cursor is incremented by one and shifted to the right .
7	⋮	⋮	
8	Write data to CG RAM / DD RAM 1 0 0 1 0 0 0 1 0 1	WELCOME_	Write " E " . The cursor is incremented by one and shifted to the right .
9	Entry mode set 0 0 0 0 0 0 0 1 1 1	WELCOME_	Set mode for display shift when writing
10	Write data to CG RAM / DD RAM 1 0 0 0 1 0 0 0 0 0	ELCOME _	Write " "(space) . The cursor is incremented by one and shifted to the right .
11	Write data to CG RAM / DD RAM 1 0 0 1 0 0 0 0 1 1	LCOME C_	Write " C " . The cursor is incremented by one and shifted to the right .
12	⋮	⋮	
13	Write data to CG RAM / DD RAM 1 0 0 1 0 1 1 0 0 1	COMPAMY_	Write " Y " . The cursor is incremented by one and shifted to the right .
14	Cursor or display shift 0 0 0 0 0 1 0 0 X X	COMPAMY	Only shift the cursor's position to the left (Y) .
15	Cursor or display shift 0 0 0 0 0 1 0 0 X X	COMPAMY	Only shift the cursor's position to the left (M) .
16	Write data to CG RAM / DD RAM 1 0 0 1 0 0 1 1 1 0	OMPANY	Write " N " . The display moves to the left .
17	Cursor or display shift 0 0 0 0 0 1 1 1 X X	COMPANY	Shift the display and the cursor's position to the right .
18	Cursor or display shift 0 0 0 0 0 1 0 1 X X	COMPANY_	Shift the display and the cursor's position to the right .
19	Write data to CG RAM / DD RAM 1 0 0 1 0 0 0 0 0 0	OMPANY _	Write " " (space) . The cursor is incremented by one and shifted to the right .
20	⋮	⋮	
21	Return home 0 0 0 0 0 0 0 0 1 0	WELCOME	Both the display and the cursor return to the original position (address 0) .

4-Bit operation and 8-digit 1-line display (using internal reset)

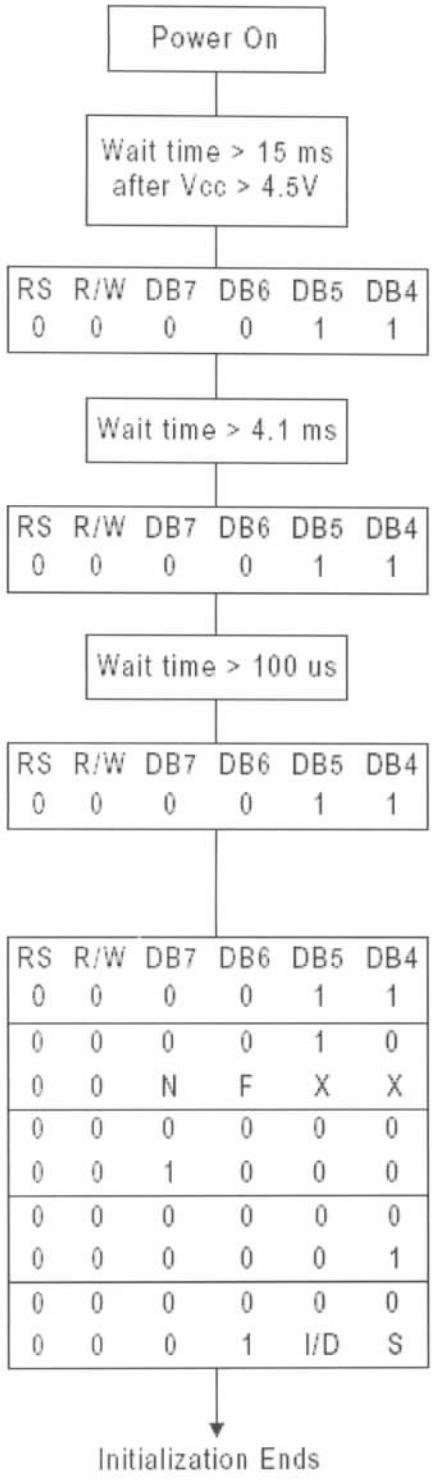
No.	Instruction	Display	Operation
1	Power on . (SPLC780A starts initializing)		Power on reset . No display .
2	Function set RS R/W DB7 DB6 DB5 DB4 0 0 0 0 1 0		Set to 4-bit operation .
3	Function set 0 0 0 0 1 0 0 0 0 0 X X		Set to 4-bit operation and select 1-line display line and character font .
4	Display on / off control 0 0 0 0 0 0 0 0 1 1 1 0	_	Display on . Cursor appears .
5	Entry mode set 0 0 0 0 0 0 0 0 0 1 1 0	_	Increase address by one . It will shift the cursor to the right when writing to the DD RAM / CG RAM . Now the display has no shift .
6	Write data to CG RAM / DD RAM 1 0 0 1 0 0 1 0 1 0 0 0	W_	Write " W " . The cursor is incremented by one and shifted to the right .

3. **Reset Function**

At power on, it starts the internal auto-reset circuit and executes the initial instructions.
There are the initial procedures shown as belows:



[4-Bit Interface]



BF cannot be checked before this instruction .
Function set (Interface is 8 bits length .)

BF cannot be checked before this instruction .
Function set (Interface is 8 bits length .)

BF cannot be checked before this instruction .
Function set (Interface is 8 bits length .)

BF can be checked after the following instructions .

Function set (Set interface to be 4 bits length)
Interface is 8 bits length .

Function set (Interface is 4 bits length .
Specify the number of the display lines
and character font .)

The number of display lines and character font cannot be changed afterwards .

Display off

Display clear

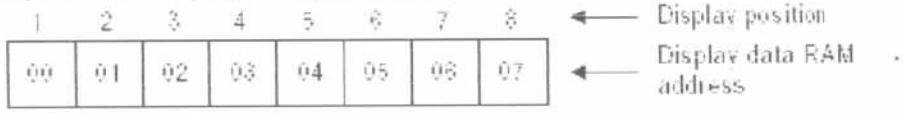
Entry mode set

4. Display Data RAM (DD RAM)

The DD RAM stores display data and its RAM size is 80 bytes. The area in DD RAM that is not used for display can be used as a general data RAM. Its address is set in the address counter. There are the relations between the display data RAM¢s address and the LCD¢s position shown belows.

1-line display , 80 display characters

(Example) 1-line display , 8 display characters



When the display shift operation is performed , the display data RAM's address moves as :

(i) Left shift

(ii) Right shift

1. Character Generator ROM (CG ROM)

Using 8-bit character code, the character generator ROM generates 5 x 7 dot or 5 x 10 dot character patterns. It also can generate 160 5 x 7 dot character patterns and 32 5 x 10 dot character patterns.

2. Character Generator RAM (CG RAM)

Using the programs, users can easily change the character patterns in the character generator RAM. It can be written with 5 x 7 dots, 8 character patterns or written with 5 x 10 dots, 4 character patterns.

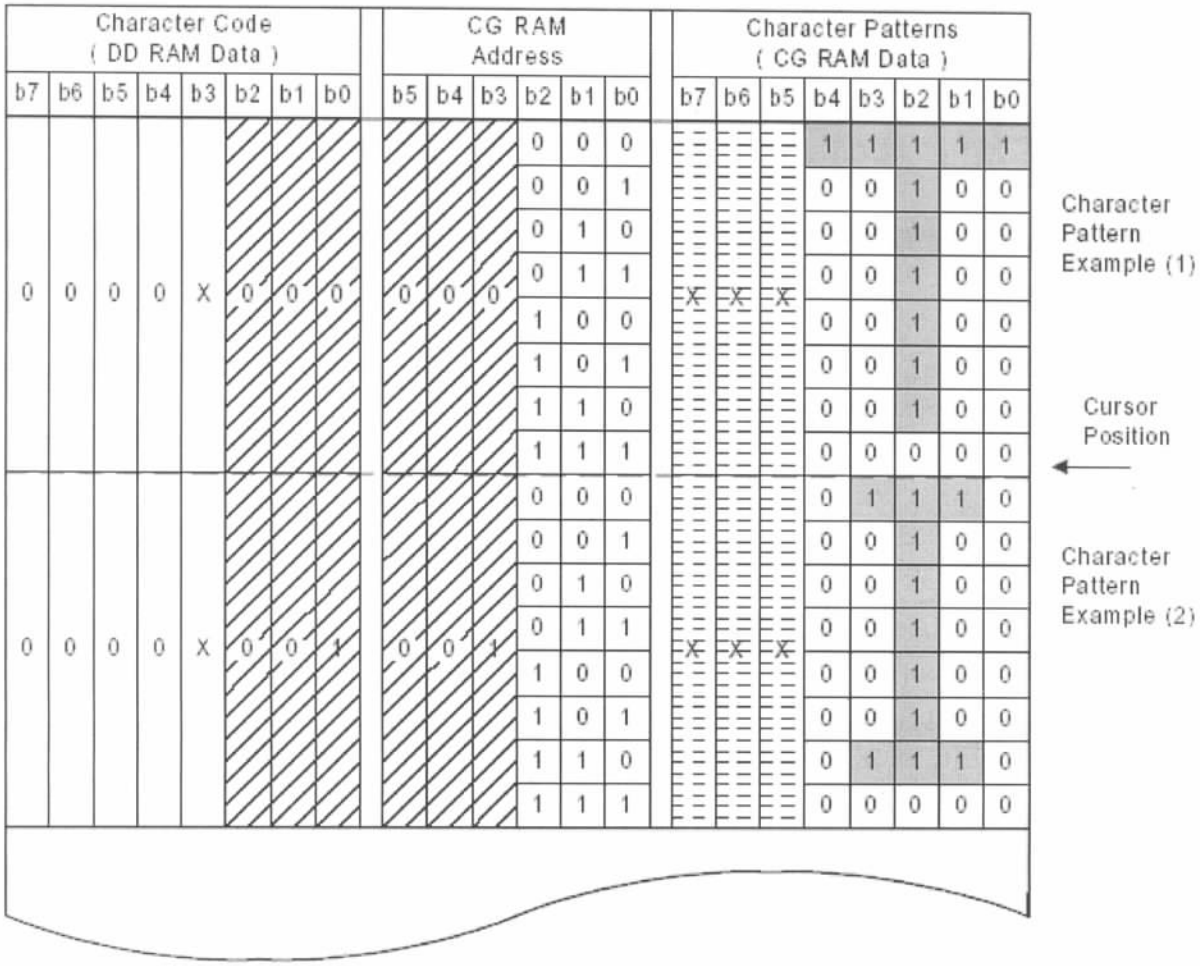
Here are the SPLC780A¢s character patterns shown as belows:

Correspondence between Character Codes and Character Patterns(ROM Code: 01)

Correspondence between Character Codes and Character Patterns (ROM Code: 02)

There are the relations between character generator RAM addresses, character generator RAM datas (character patterns) and character codes shown as belows:

5 X 7 dot character patterns



1. : ▨ It means that the bit0~2 of the character code correspond to the bit3~5 of the CG RAM address .
2. : ▤ These areas are not used for display , but can be used for the general data RAM .
3. When all of the bit4-7 of the character code are 0 , CG RAM character patterns are selected .
4." 1 " : Selected , " 0 " : No selected , " X " : Do not care (0 or 1) .
5. For example (1), to set character code (b2 = b1 = b0 = 0, b3 = 0 or 1, b4~b7 = 0) is to display " T ". That means character code (00) 16,and (08) 16 can display " T " character.
6. The bits 0~2 of the character code RAM is character pattern line position. The 8th line is the cursor position and display is formed by logical OR with the cursor.

3.Timing Generation Circuit

The timing generation circuit can generate needed timing signals to the internal circuits. In order to prevent the internal timing interface, the MPU access timing and the RAM access timing are separately generated.

4. **LCD Driver Circuit**

There are 16 commons x 40 segments signal drivers in the LCD driver circuit. When a program specifies the character fonts and line numbers, the corresponding common signals will output drive waveforms and the others still output unselected waveforms.

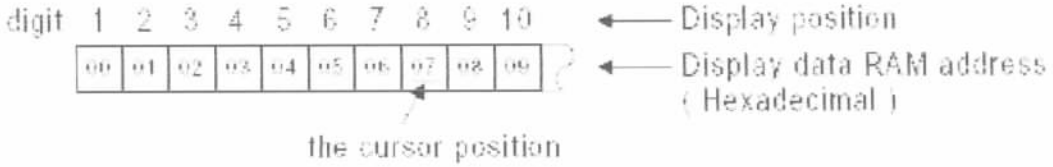
5.Cursor / Blink Control Circuit

It can generate the cursor or blink in the cursor / blink control circuit. The cursor or the blink appears in the digit at the display data RAM address set in the address counter.

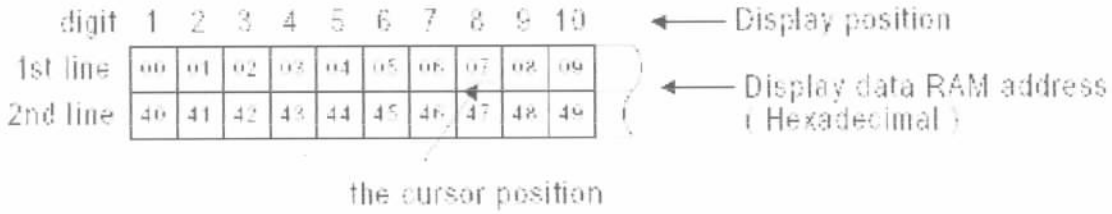
When the address counter is (07) 16, the cursor¢s position is shown as belows:

	b6	b5	b4	b3	b2	b1	b0
AC	0	0	0	0	1	1	1

In a 1-line display



In a 2-line display



6.Interfacing to MPU

There are two kinds of data operations - one is 4-bit operations, the other is 8-bit operations. Using 4-bit MPU, the interfacing 4-bit datas are transferred by 4-busline (DB4 - DB7). DB0 - DB3 buslines are not used. Using 4-bit MPU to interface 8-bit datas needs two times. First, the higher order 4-bit datas are transferred by 4-busline (DB4 - DB7). Secondly, the lower order 4-bit datas are transferred by 4-busline (DB0 - DB3).

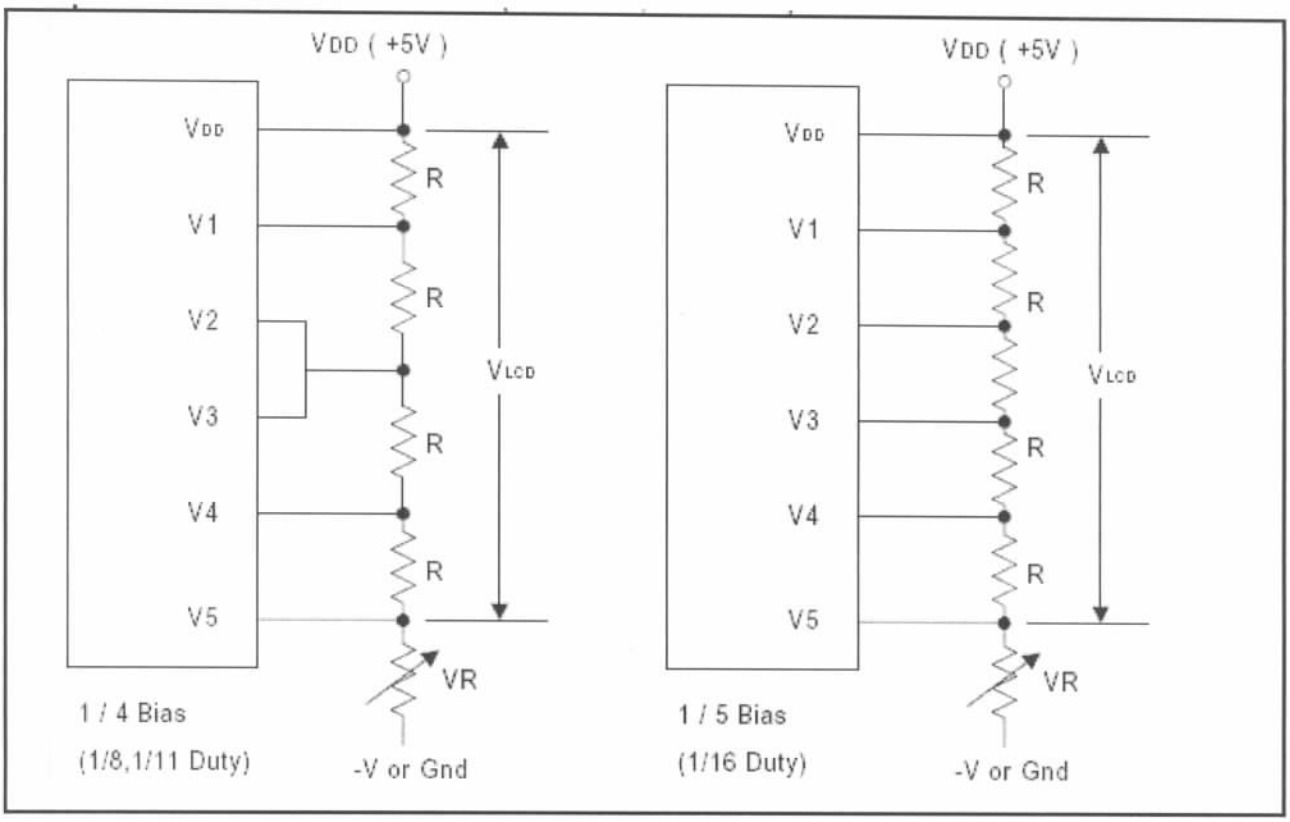
Using 8-bit MPU, the interfacing 8-bit datas are transferred by 8-buslines (DB0-DB7).

7.Supply Voltage for LCD Drive

There are different voltages that supply to SPLC780A¢s pins (V1 ~ V5) to obtain LCD drive waveform. The relations of the bias, duty factor and supply voltages are shown as belows:

Duty Factor / Bias / Supply Voltage	1 / 8 , 1 / 11	1 / 16
	1 / 4	1 / 5
V1	VDD - 1/4 VLCD	VDD - 1/5 VLCD
V2	VDD - 1/2 VLCD	VDD - 2/5 VLCD
V3	VDD - 1/2 VLCD	VDD - 3/5 VLCD
V4	VDD - 3/4 VLCD	VDD - 4/5 VLCD
V5	VDD - VLCD	VDD - VLCD

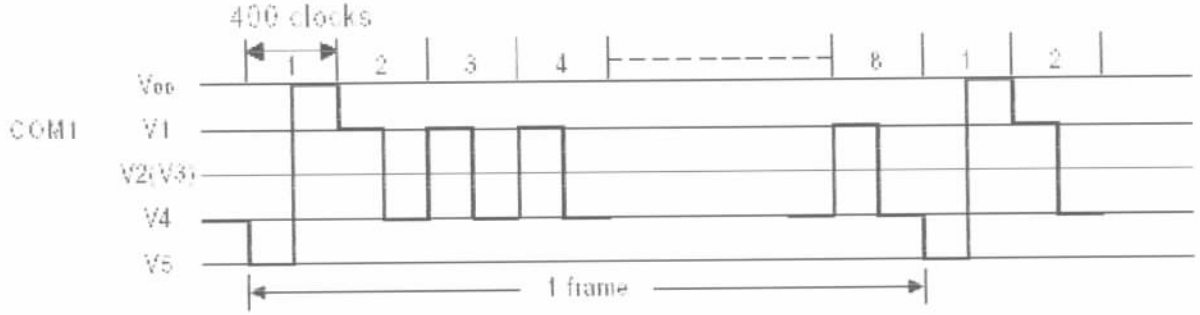
. **The power connections for LCD (1/4 Bias, 1/5 Bias) are shown belows:**



. The relations between LCD frame¢s frequency and oscillator¢s frequency

(Assume the oscillation frequency is 250KHz, 1 clock cycle time = 4 ms)

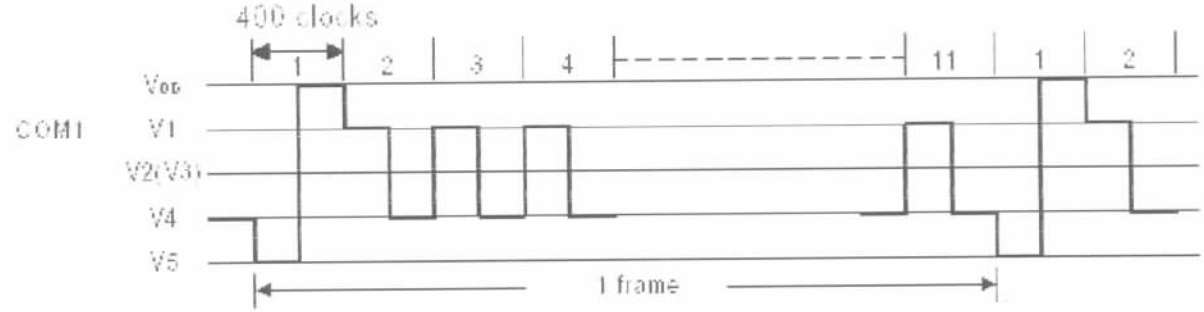
1. 1 / 8 Duty



1 frame = 4 (μs) x 400 x 8 = 12800 (us) = 12.8 ms

Frame frequency = $\frac{1}{12.8\ (ms)}$ = 78.1 (Hz)

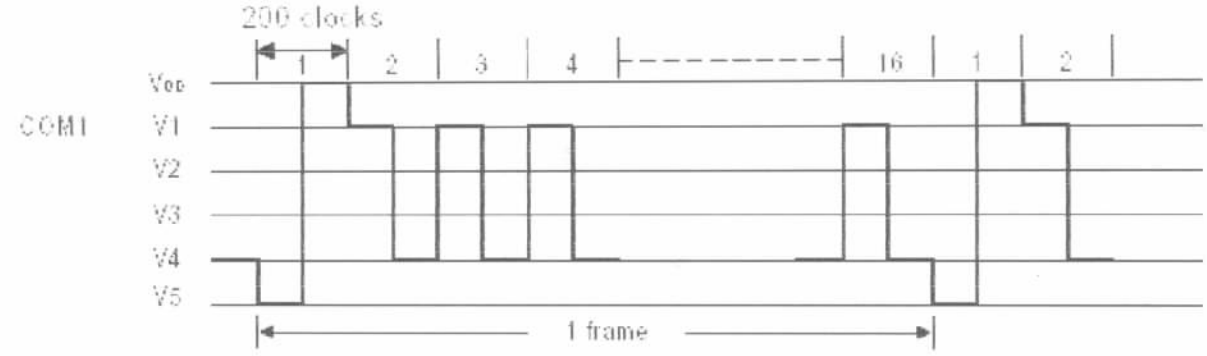
2. 1 / 11 Duty



1 frame = 4 (μs) x 400 x 11 = 17600 (us) = 17.6 ms

Frame frequency = $\frac{1}{17.6\ (ms)}$ = 56.8 (Hz)

3. 1 / 16 Duty



1 frame = 4 (μs) x 200 x 16 = 12800 (us) = 12.8 ms

Frame frequency = $\frac{1}{12.8\ (ms)}$ = 78.1 (Hz)

. **Register --- IR (Instruction Register) and DR (Data Register)**

SPLC780A has two 8-bit registers - IR (instruction register) and DR (data register).
In the followings, we can use the combinations of the RS pin and the R/W pin to select the IR and DR.

RS	R/W	Operation
0	0	IR write(Display clear, etc.)
0	1	Read busy flag (DB7) and address counter (DB0~DB6)
1	0	DR write (DR to Display data RAM or Character generator RAM)
1	1	DR read (Display data RAM or Character generator RAM to DR)

The IR can be written from the MPU but cannot read by the MPU.

. **Busy Flag (BF)**

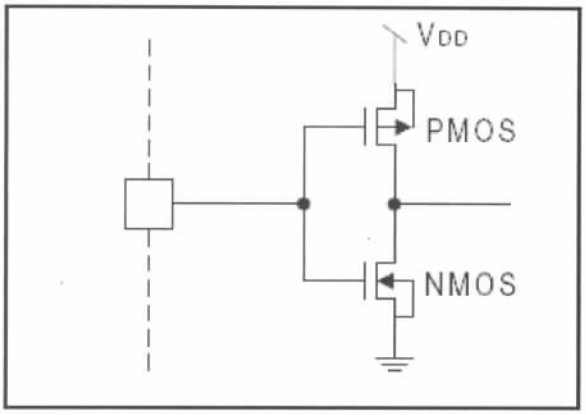
When RS=0 and R/W = 1, the busy flag is output to DB7.
As the busy flag =1,SPLC780A is in busy state and does not accept any instructions until the busy flag = 0.

. **Address Counter (AC)**

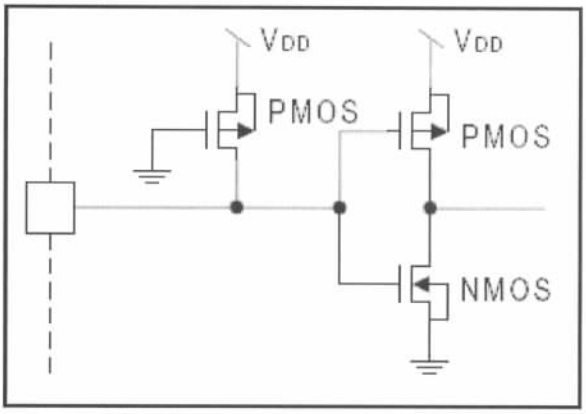
The address counter assigns addresses to display data RAM and character generator RAM.
When an instruction for address is written in IR, the address information is sent from IR to AC.
After writing into (or reading from) display data RAM or character generator RAM, AC is automatically incremented by +1 (or decremented by -1).
AC contents are output to DB0 ~ DB6 when RS = 0 and R/W = 1.

I/O PORT CONFIGURATION

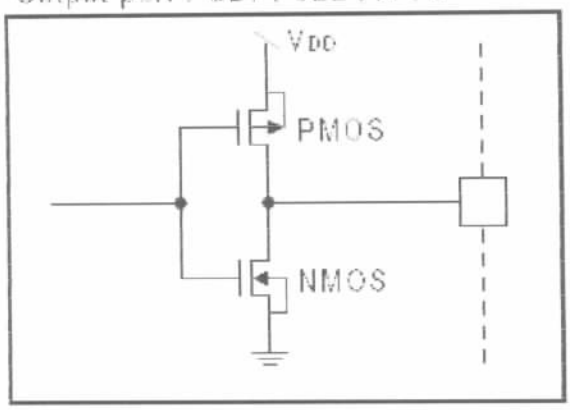
Input port : E



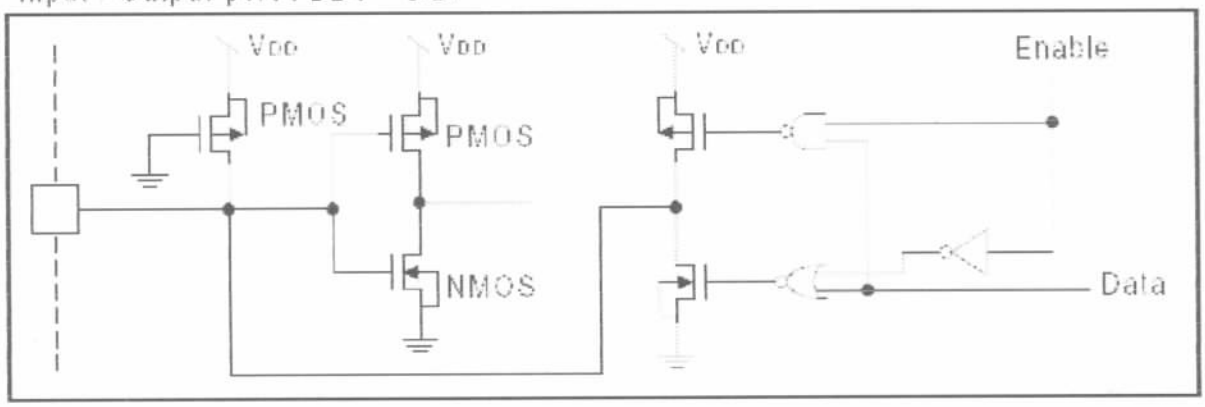
Input port : R / W , RS



Output port : CL1 , CL2 , M , D



Input / Output port : DB0 ~ DB7



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 15RH).

. 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

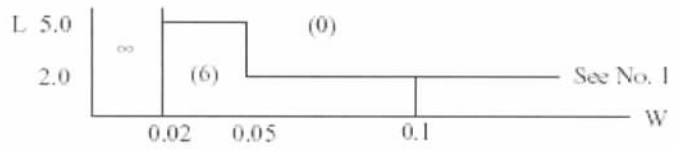
Module Cosmetic Criteria

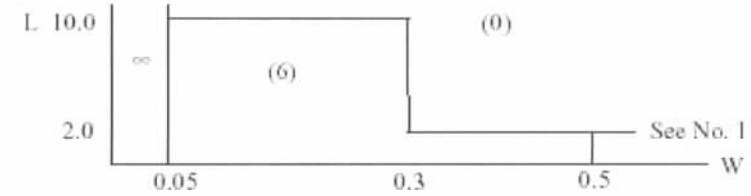
No.	Item	Judgement Criterion	Partition
1	Difference in Spec.	None allowed	Major
2	Pattern peeling	No substrate pattern peeling and floating	Major
3	Soldering defects	No soldering missing No soldering bridge No cold soldering	Major Major Minor
4	Resist flaw on substrate	Invisible copper foil (0.5mm or 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)

<table>
<tr><th>No.</th><th>Defect</th><th>Judgement Criterion</th><th>Partition</th></tr>
<tr><td>1</td><td>Spots</td><td>In accordance with Screen Cosmetic Criteria (Operating) No.1.</td><td>Minor</td></tr>
<tr><td>2</td><td>Lines</td><td>In accordance with Screen Cosmetic Criteria (Operating) No.2.</td><td>Minor</td></tr>
<tr><td>3</td><td>Bubbles in polarizer</td><td><table><tr><th>Size : d mm</th><th>Acceptable Qty in active area</th></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></td><td>Minor</td></tr>
<tr><td>4</td><td>Scratch</td><td>In accordance with spots and lines operating cosmetic criteria. When the light reflects on the panel surface, the scratches are not to be remarkable.</td><td>Minor</td></tr>
<tr><td>5</td><td>Allowable density</td><td>Above defects should be separated more than 30mm each other.</td><td>Minor</td></tr>
<tr><td>6</td><td>Coloration</td><td>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.</td><td>Minor</td></tr>
<tr><td>7</td><td>Contamination</td><td>Not to be noticeable.</td><td>Minor</td></tr>
</table>

Screen Cosmetic Criteria (Operating)

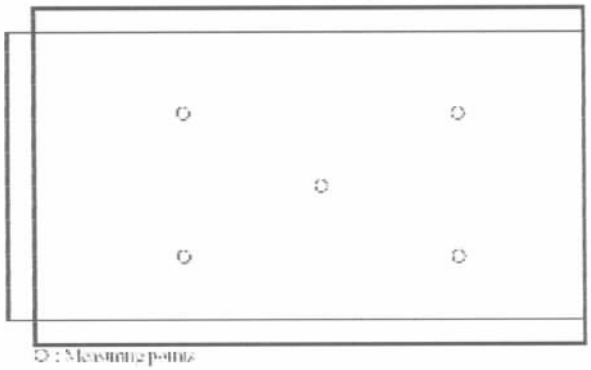
<table>
<tr><th>No.</th><th>Defect</th><th>Judgement Criterion</th><th>Partition</th></tr>
<tr><td>1</td><td>Spots</td><td>A) Clear<table><tr><th>Size : d mm</th><th>Acceptable Qty in active area</th></tr><tr><td>d ≤ 0.1</td><td>Disregard</td></tr><tr><td>0.1 < d ≤ 0.2</td><td>6</td></tr><tr><td>0.2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

Note : ( ) - Acceptable Qty in active area
L - Length (mm)
W - Width (mm)
∞ - Disregard
B) Unclear
 
</td><td>Minor</td></tr>
</table>

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

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

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.  ○ : Measure 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.).

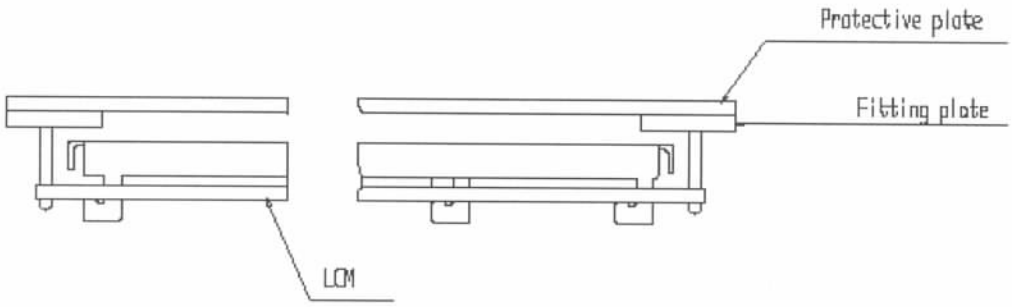
(3) N-hexane is recommended for cleaning the adhesives used to attach front/rear polarizers and reflectors made of organic
substances which will be damaged by chemicals such as acetone, toluene, ethanol and isopropylalcohol.

(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.

8-Bit operation and 8-digit 2-line display (using internal reset)

No.	Instruction	Display	Operation
1	Power on . (SPLC780A starts initializing)		Power on reset . No display .
2	Function set RS R/W DB7 DB6 DB5 DB4 DB3 DB2 DB1 DB0 0 0 0 0 1 1 1 0 X X		Set to 8-bit operation and select 2-line display line and 5 x 7 dot character font .
3	Display on / off control 0 0 0 0 0 0 1 1 1 0	_	Display on . Cursor appear .
4	Entry mode set 0 0 0 0 0 0 0 1 1 0	_	Increase address by one . It will shift the cursor to the right when writing to the DD RAM / CG RAM . Now the display has no shift .
5	Write data to CG RAM / DD RAM 1 0 0 1 0 1 0 1 1 1	W_	Write " W " . The cursor is incremented by one and shifted to the right .
6	⋮	⋮	
7	Write data to CG RAM / DD RAM 1 0 0 1 0 0 0 1 0 1	WELCOME_	Write " E " . The cursor is incremented by one and shifted to the right .
8	Set DD RAM address 0 0 1 1 0 0 0 0 0 0	WELCOME _	It sets DD RAM's address . The cursor is moved to the beginning position of the 2nd line .
9	Write data to CG RAM / DD RAM 1 0 0 1 0 1 0 1 0 0	WELCOME T_	Write " T " . The cursor is incremented by one and shifted to the right .
10	⋮	⋮	
11	Write data to CG RAM / DD RAM 1 0 0 1 0 1 0 1 0 0	WELCOME TO PART_	Write " T " . The cursor is incremented by one and shifted to the right .
12	Entry mode set 0 0 0 0 0 0 0 1 1 1	WELCOME TO PART_	When writing , it sets mode for the display shift .
13	Write data to CG RAM / DD RAM 1 0 0 1 0 1 1 0 0 1	ELCOME O PARTY_	Write " Y " . The cursor is incremented by one and shifted to the right .
14	⋮	⋮	
15	Return home 0 0 0 0 0 0 0 0 1 0	WELCOME TO PARTY	Both the display and the cursor return to the original position (address 0) .

(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.

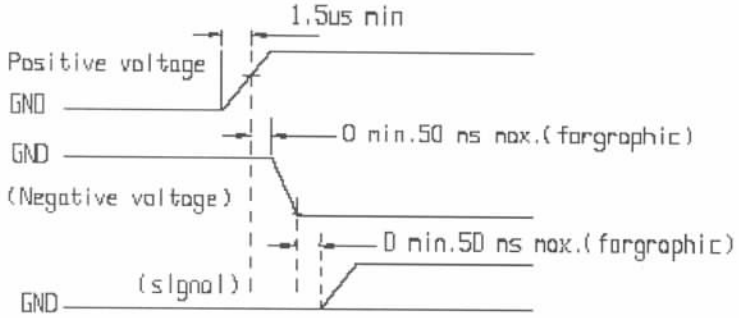
6 . Precautions for Operation

(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