

SPECIFICATION



YMSC-C1602M-1DBSWWN

September 28, 2007
Version 1.01

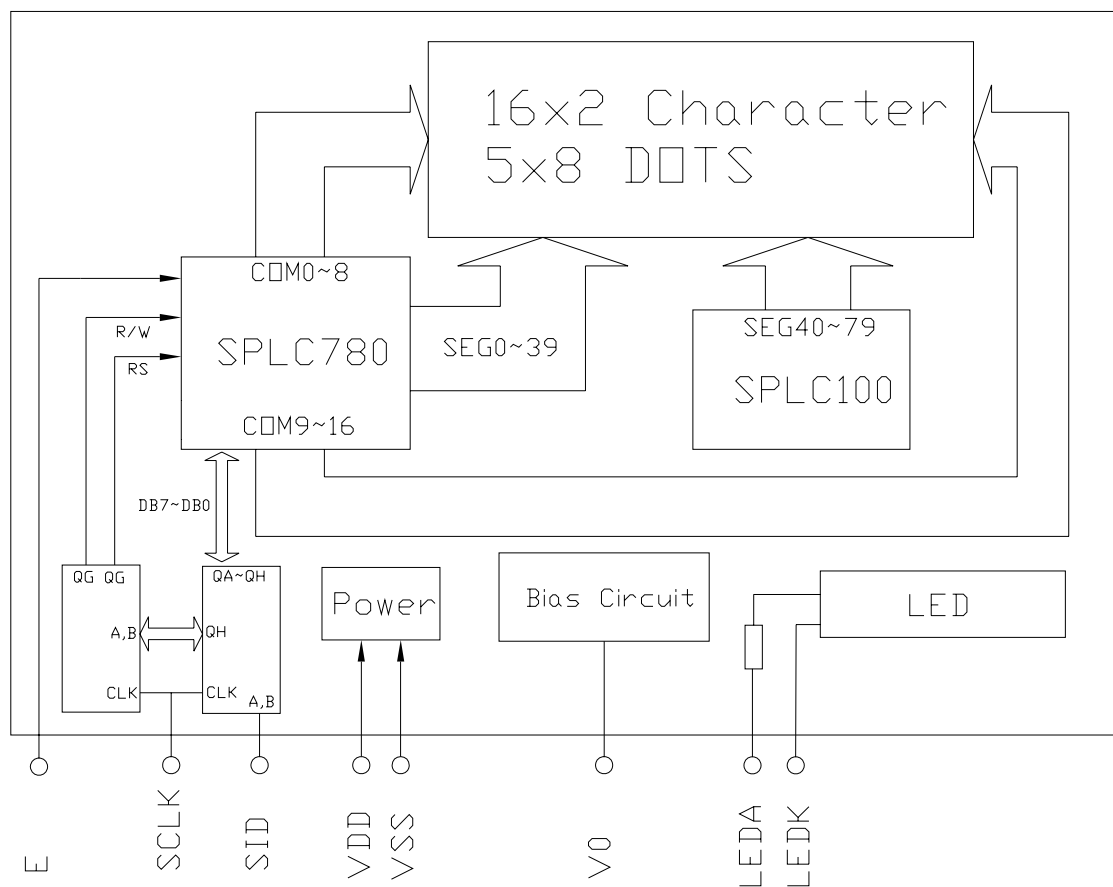


CONTENTS

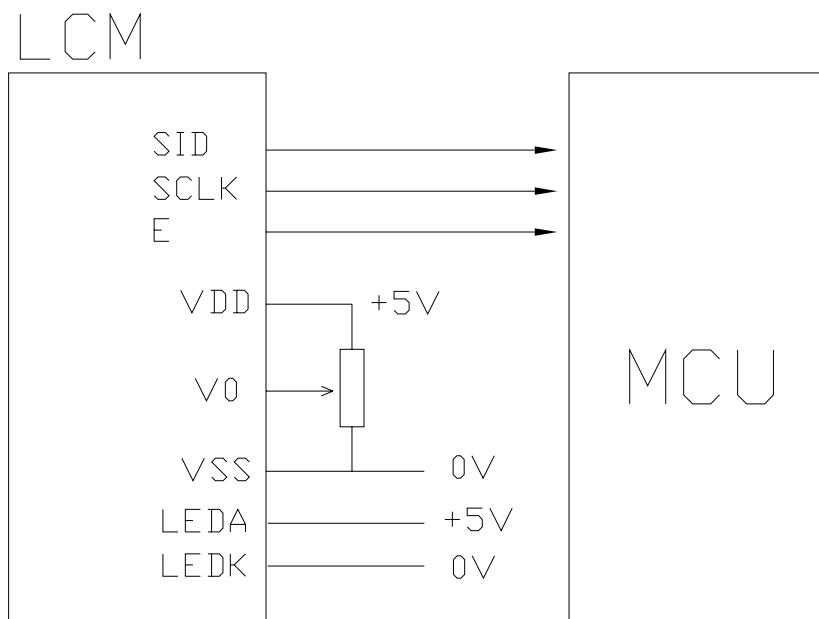
1.	FEATURES-----	1
2.	BLOCK DIAGRAM &APPLICATION CIRCUIT -----	1
3.	OUTLINE DIMENSIONS-----	2
4.	ABSOLUTE MAXIMUM RATING -----	3
5.	ELECTRICAL CHARACTERISTICS -----	3
6.	OPTICAL CHARACTERISTICS-----	4
7.	TIMING CHARACTERISTICS -----	5
8.	FUNCTIONAL DESCRIPTIONS-----	6
9.	CHARACTER GENERATOR ROM-----	19
10.	INTERFACE PIN CONNECTIONS-----	17
11.	RELIABILITY -----	18
12.	QUALITY GUARANTEE -----	19
13.	INSPECTION CRITERIA -----	20
14.	PRECAUTIONS FOR USING LCD MODULES -----	21
15.	USING LCD MODULES -----	22

1. FEATURES :

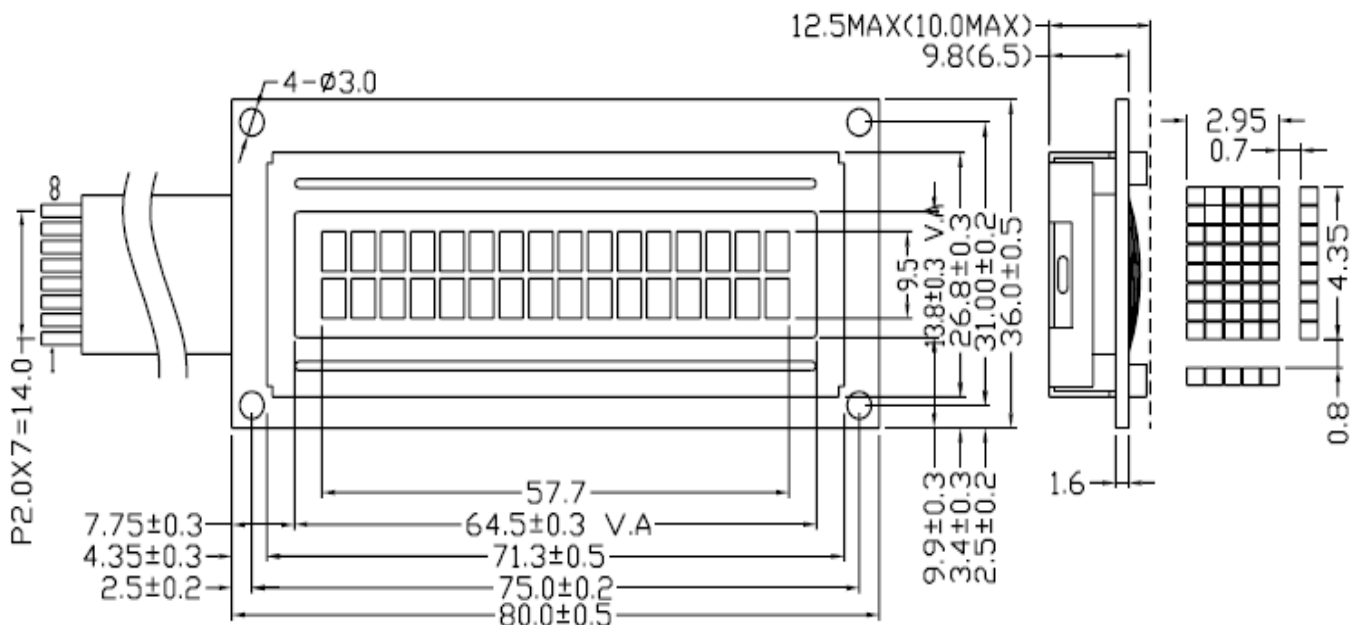
ITEM	STANDARD VALUE	UNIT
Display Type	5×8(1 Cursor) dots, 16×2 Characters	-
LCD Type	<input checked="" type="checkbox"/> STN, BLUE, Transflective, Position <input type="checkbox"/> STN, YELLOW-GREEN, Transflective, Position	-
LCD Duty	1/240	-
LCD Bias	1/17	-
Viewing Direction	6:00	-
Backlight Type	<input checked="" type="checkbox"/> LED(WHITE) <input type="checkbox"/> LED(YELLOW-GREEN)	-
Interface	Serial Interface	-
Driver IC	<input checked="" type="checkbox"/> SPLC780 or KS0066	-
Module Dimension	80.0(W) X 36.0(H) X12.5(MAX)(T)	mm
Effective Display Area	57.7 (W) X9.5 (H)	mm
Character Size	2.95 (W) X4.35(H)	mm
Character Pitch	3.65(W) X 5.15(H)	mm

2. BLOCK DIAGRAM &APPLICATION CIRCUIT :


Serial Interface Application



3. OUTLINE DIMENSIONS



4. ABSOLUTE MAXIMUM RATING

ITEM	SYMBOL	CONDITION	STANDARD VALUE			UNIT
			MIN	TYP	MAX	
POWER SUPPLY FOR LOGIC	VDD	Ta=25°C	-0.3	—	7.0	V
INPUT VOLTAGE	VIN	Ta=25°C	-0.3	—	VDD+0.3	V
Module OPERATION TEMPERATURE	TOPR	---	-10	—	+60	°C
Module STORAGE TEMPERATURE	TSTG	---	-20	—	+80	°C
Storage Humidity	H _D	Ta < 40 °C	-		90	%RH

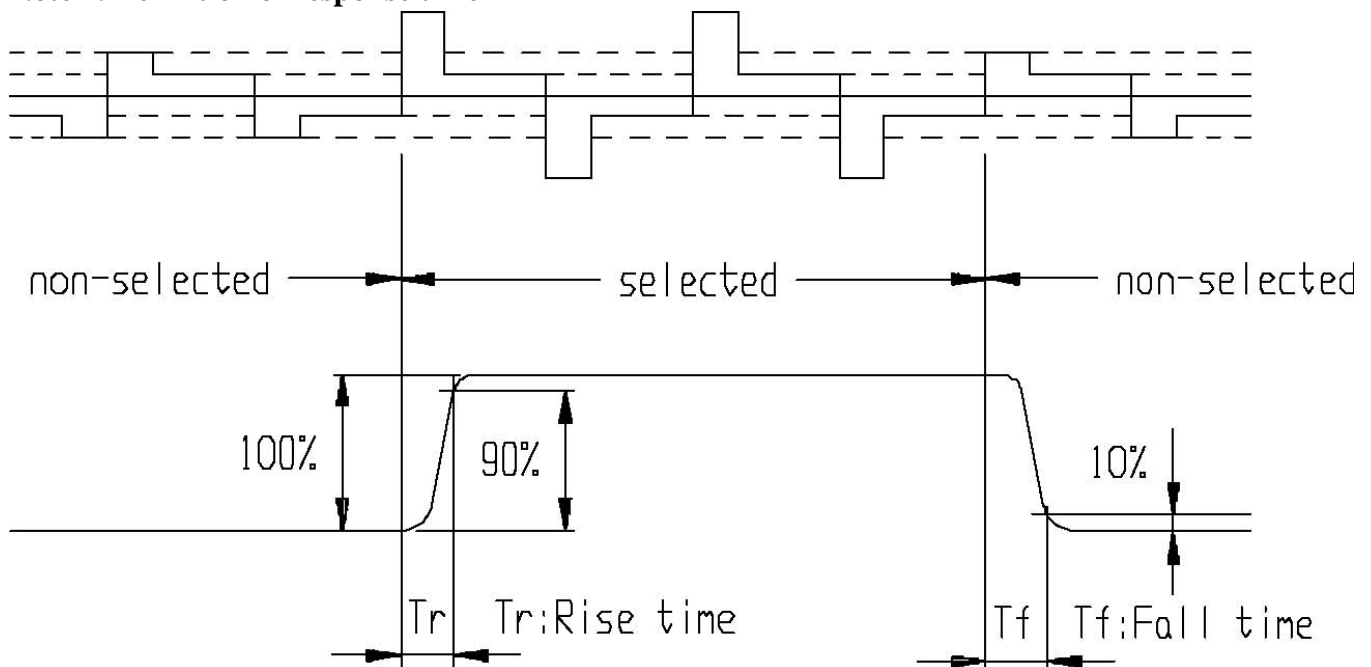
5. ELECTRICAL CHARACTERISTICS

ITEM	SYMBOL	CONDITION	MIN	TYP	MAX	UNIT
Supply Voltage (logic)	VDD-VSS	-	2.7	5.0	5.5	V
Supply Voltage (LCD)	VDD-V0	Ta= +25°C	-	-	-	V
Input signal voltage	V-IH	VDD=4.5~5.5V	3.15	-	-	V
		VDD=2.7~4.5V	1.5	-	-	V
	V-IL	VDD=4.5~5.0V	-	-	1.35	V
		VDD=2.7~4.5V	-	-	0.5	V
Output signal voltage	V-OH	VDD=4.5~5.0V	4.3	-	-	V
		VDD=2.7~4.5V	1.9	-	-	V
	VOL	VDD=4.5~5.0V	-	-	0.1	V
		VDD=2.7~4.5V	-	-	0.1	V
Supply Current (logic)	IDD	VDD=5.0V	-	0.2	-	mA
		VDD=3.0V	-	0.55	-	mA
Backlight Voltage(Y/G)	V-BL	LED	-	4.2	-	V
Backlight Voltage(W)	V-BL	LED	-	3.0	-	V
Backlight Current(Y/G)	I-BL	LED		130		mA
Backlight Current(W)	I-BL	LED	-	-	-	mA

6. OPTICAL CHARACTERISTICS

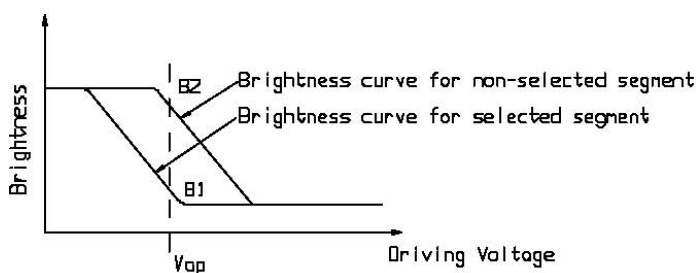
Item	Symbol	Condition	Min	Typ	Max	Unit	Remarks	Note
Response Time	Tr	25 °C	-	150	200	ms	-	1
	Tf	25 °C	-	200	250	ms	-	1
Contrast Ratio	Cr	25 °C	2.0	5.0	-	-	-	2
Viewing Angle Range	θ	Cr ≥ 2	30	-	-	deg	$\theta = 90$	3
			30	-	-	deg	$\theta = 270$	3
			35	-	-	deg	$\theta = 0$	3
			35	-	-	deg	$\theta = 180$	3

Note 1. Definition of response time

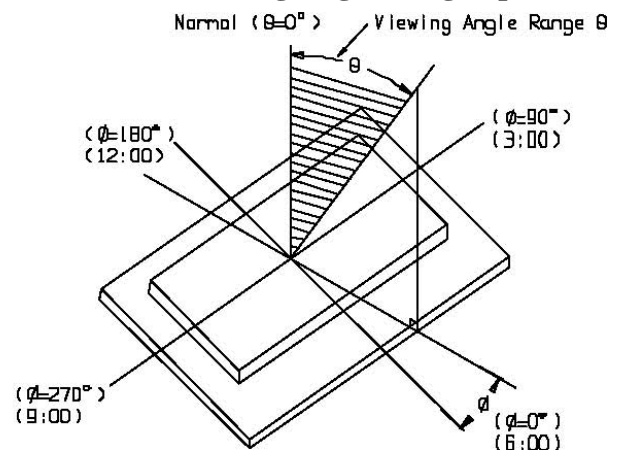


Note 2. Definition of Contrast Ratio 'Cr'

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

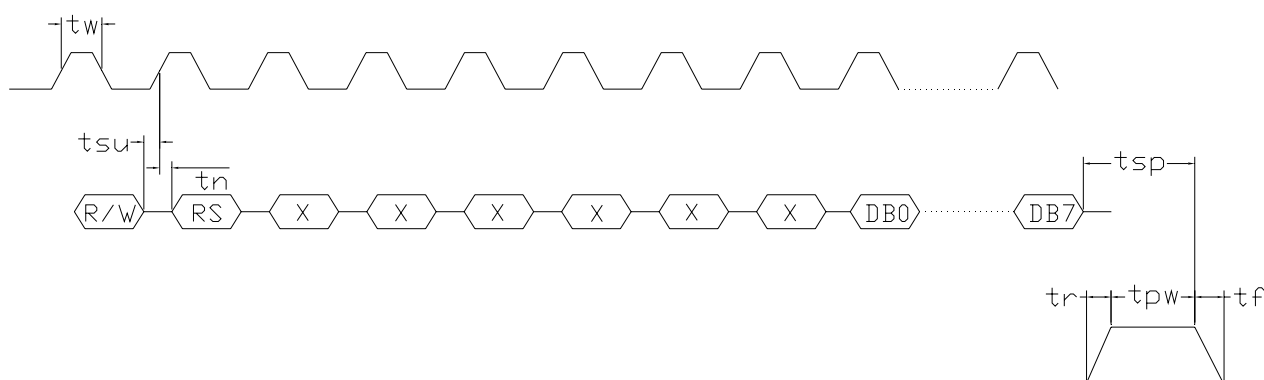


Note 3. Definition of Viewing Angle Range 'q'



7. TIMING CHARACTERISTICS

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
tw	Clock pulse width	27	-	-	ns
tsu	Set-up time	18	-	-	ns
tsp	Hold time	4	-	-	ns
tpw	E pulse width	230	-	-	ns
tr	E rise time	-	-	20	ns
tf	E fall time	-	-	20	ns


RS

A signal for selecting registers:

- 1: Data register (for read and write)
- 0: Instruction register (for write)
- Busy flag – Address Counter (for read).

R/W

A signal for selecting read and write actions: $R/W=0$

8. FUNCTIONAL DESCRIPTIONS

8.1. Oscillator

SPLC780C oscillator supports not only the internal oscillator operation, but also the external clock operation.

8.2. Control and Display Instructions

Control and display instructions are described in details as follows:

8.2.1. 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 entire display and sets Display Data RAM Address 0 in Address Counter.

8.2.2. 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 Address 0 in Address Counter and the display returns to its original position. The cursor or blink goes to the most-left side of the display (to the 1st line if 2 lines are displayed). The contents of the Display Data RAM do not change.

8.2.3. Entry mode set

During writing and reading data, it defines cursor moving 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

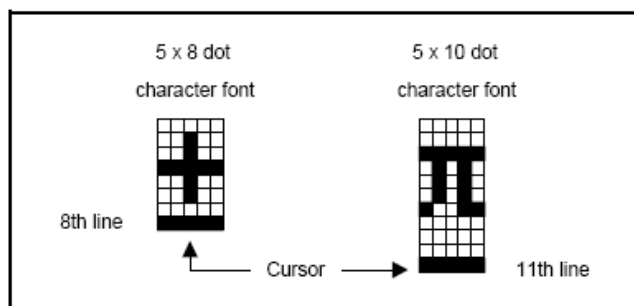
8.2.4. Display ON/OFF control

	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

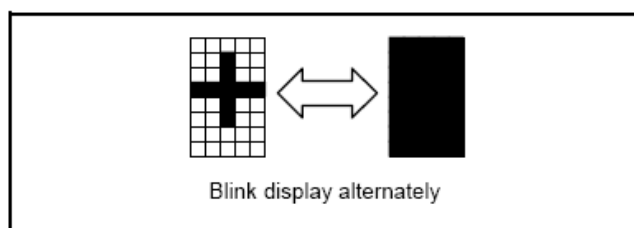
B = 1: Blinks on, B = 0: Blinks off



8.2.5. Cursor or display shift

Without changing DD RAM data, it moves cursor and shifts display.

	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

8.2.6. 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: Data transferred with 8-bit length (DB7 - 0).

DL = 0: Data transferred with 4-bit length (DB7 - 4).

It requires two times to accomplish data transferring.

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 8 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 8 dots	1 / 8
0	1	1	5 x 10 dots	1 / 11
1	X	2	5 x 8 dots	1 / 16

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

8.2.7. 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 be read or written after this setting.

8.2.8. 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 be read or written 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.

8.2.9. 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, it indicates the system is busy now and it will not accept any instruction until not busy (BF = 0). At the same time, the content of Address Counter (aaaaaaa)₂ is read.

8.2.10. 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 (ddddddd)₂ to character generator RAM or display data RAM.

8.2.11. 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 (ddddddd)₂ from character generator RAM or display data RAM.

To read data correctly, do the following:

- 1). The address of the Character Generator RAM or Display Data RAM or shift the cursor instruction.
- 2). The "Read" instruction.

8.3. Instruction Table

Instruction	Instruction Code										Description	Execution time (fosc=270KHz)
	RS	RW	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0		
Clear Display	0	0	0	0	0	0	0	0	0	1	Write "20H" to DDRAM and set DDRAM address to "00H" from AC	1.52ms
Return Home	0	0	0	0	0	0	0	0	0	1	- Set DDRAM address to "00H" from AC and return cursor to its original position if shifted. The contents of DDRAM are not changed.	1.52ms
Entry Mode Set	0	0	0	0	0	0	0	1	I/D	S	Assign cursor moving direction and enable the shift of entire display	38μs
Display ON/OFF Control	0	0	0	0	0	0	1	D	C	B	Set display(D), cursor(C), and blinking of cursor(B) on/off control bit.	38μs
Cursor or Display Shift	0	0	0	0	0	1	S/C	R/L	-	-	Set cursor moving and display shift control bit, and the direction, without changing of DDRAM data.	38μs
Function Set	0	0	0	0	1	DL	N	F	-	-	Set interface data length (DL: 8-bit/4-bit), numbers of display line (N: 2-line/1-line) and, display font type (F:5x10 dots/5x8 dots)	38μs
Set CGRAM Address	0	0	0	1	AC5	AC4	AC3	AC2	AC1	AC0	Set CGRAM address in address counter.	38μs
Set DDRAM Address	0	0	1	AC6	AC5	AC4	AC3	AC2	AC1	AC0	Set DDRAM address in counter	38μs
Read Busy Flag and Address Counter	0	1	BF	AC6	AC5	AC4	AC3	AC2	AC1	AC0	Whether during internal operation or not can be known by reading BF. The contents of address counter can also be read.	
Write Data to RAM	1	0	D7	D6	D5	D4	D3	D2	D1	D0	Write data into internal RAM (DDRAM/CGRAM).	38μs
Read Data from RAM	1	1	D7	D6	D5	D4	D3	D2	D1	D0	Read data from internal RAM (DDRAM/CGRAM).	38μs

Note: "-": don't care

8.4. 8-Bit Operation and 8-Digit 1-Line Display (Using Internal Reset)

No.	Instruction	Display	Operation
1	Power on. (SPLC780C starts initializing)	<input type="text"/>	Power on reset. No display.
2	Function set RS R/W DB7 DB6 DB5 DB4 DB3 DB2 DB1 DB0 <input type="text" value="00001100XX"/>	<input type="text"/>	Set to 8-bit operation and select 1-line display line and character font.
3	Display on / off control <input type="text" value="0000001110"/>	<input type="text" value="-"/>	Display on. Cursor appear.
4	Entry mode set <input type="text" value="000000110"/>	<input type="text" value="-"/>	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 <input type="text" value="1001010111"/>	<input type="text" value="W_"/>	Write " W ". The cursor is incremented by one and shifted to the right.
6	Write data to CG RAM / DD RAM <input type="text" value="1001000101"/>	<input type="text" value="WE_"/>	Write " E ". The cursor is incremented by one and shifted to the right.
7	:	:	
8	Write data to CG RAM / DD RAM <input type="text" value="1001000101"/>	<input type="text" value="WELCOME_"/>	Write " E ". The cursor is incremented by one and shifted to the right.
9	Entry mode set <input type="text" value="000000111"/>	<input type="text" value="WELCOME_"/>	Set mode for display shift when writing
10	Write data to CG RAM / DD RAM <input type="text" value="1000010000"/>	<input type="text" value="ELCOME_"/>	Write " "(space). The cursor is incremented by one and shifted to the right.
11	Write data to CG RAM / DD RAM <input type="text" value="1001000001"/>	<input type="text" value="LCOME C_"/>	Write " C ". The cursor is incremented by one and shifted to the right.
12	:	:	
13	Write data to CG RAM / DD RAM <input type="text" value="1001011000"/>	<input type="text" value="COMPAMY_"/>	Write " Y ". The cursor is incremented by one and shifted to the right.
14	Cursor or display shift <input type="text" value="00000100XX"/>	<input type="text" value="COMPAMY_"/>	Only shift the cursor's position to the left (Y).
15	Cursor or display shift <input type="text" value="00000100XX"/>	<input type="text" value="COMPAMY_"/>	Only shift the cursor's position to the left (M).
16	Write data to CG RAM / DD RAM <input type="text" value="1001001110"/>	<input type="text" value="OMPANY_"/>	Write " N ". The display moves to the left.
17	Cursor or display shift <input type="text" value="00000111XX"/>	<input type="text" value="COMPAMY_"/>	Shift the display and the cursor's position to the right.
18	Cursor or display shift <input type="text" value="00000101XX"/>	<input type="text" value="OMPANY_"/>	Shift the display and the cursor's position to the right.
19	Write data to CG RAM / DD RAM <input type="text" value="1001000000"/>	<input type="text" value="COMPAMY_"/>	Write " "(space). The cursor is incremented by one and shifted to the right.
20	:	:	
21	Return home <input type="text" value="000000010"/>	<input type="text" value="WELCOME_"/>	Both the display and the cursor return to the original position (address 0).

8.5. 4-Bit Operation and 8-Digit 1-Line Display (Using Internal Reset)

No.	Instruction	Display	Operation
1	Power on. (SPLC780C starts initializing)	<input type="text"/>	Power on reset. No display.
2	Function set RS R/W DB7 DB6 DB5 DB4 <input type="text"/>	<input type="text"/>	Set to 4-bit operation.
3	<input type="text"/>	<input type="text"/>	Set to 4-bit operation and select 1-line display line and character font.
4	<input type="text"/>	<input type="text"/>	Display on. Cursor appears.
5	<input type="text"/>	<input type="text"/>	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	<input type="text"/>	<input type="text"/>	Write " W ". The cursor is incremented by one and shifted to the right.

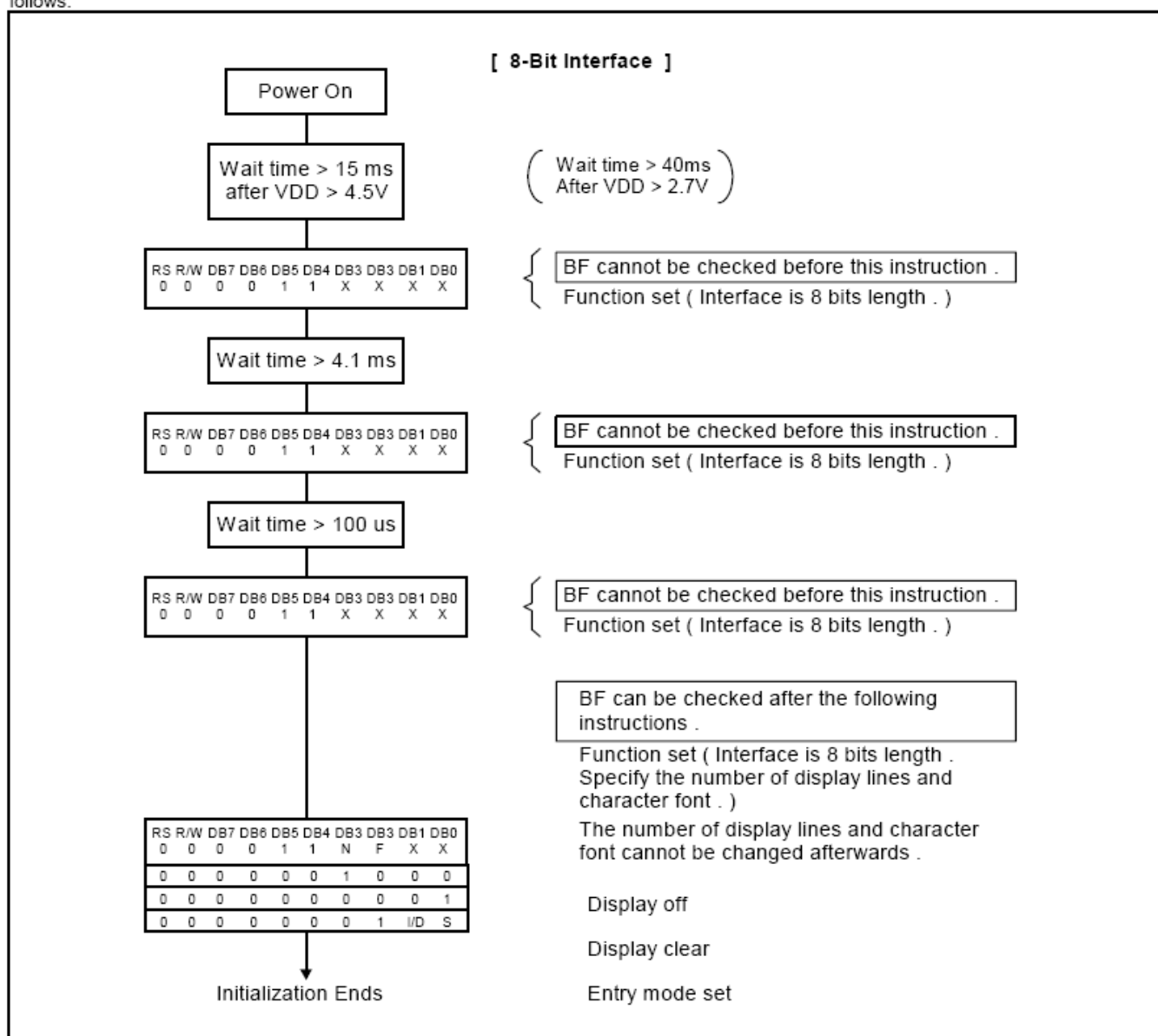
8.6. 8-Bit Operation and 8-Digit 2-Line Display (Using Internal Reset)

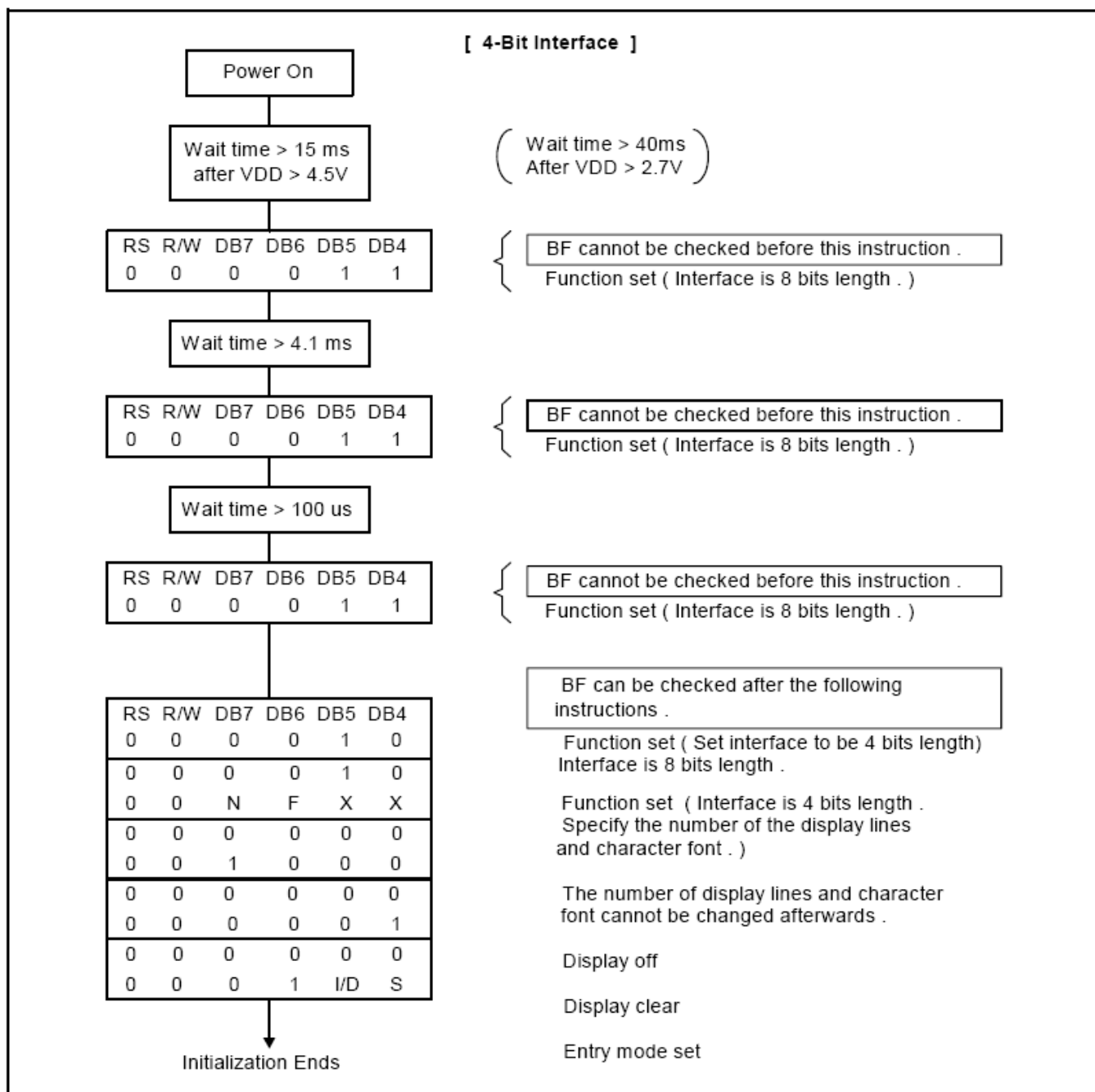
No.	Instruction	Display	Operation
1	Power on. (SPLC780C starts initializing)	<input type="text"/>	Power on reset. No display.
2	Function set RS R/W DB7 DB6 DB5 DB4 DB3 DB2 DB1 DB0 <input type="text"/>	<input type="text"/>	Set to 8-bit operation and select 2-line display line and 5 x 8 dot character font.
3	Display on / off control <input type="text"/>	<input type="text"/>	Display on. Cursor appear.
4	Entry mode set <input type="text"/>	<input type="text"/>	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 <input type="text"/>	<input type="text"/>	Write " W ". The cursor is incremented by one and shifted to the right.
6	:	:	:
7	Write data to CG RAM / DD RAM <input type="text"/>	<input type="text"/>	Write " E ". The cursor is incremented by one and shifted to the right.
8	Set DD RAM address <input type="text"/>	<input type="text"/>	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 <input type="text"/>	<input type="text"/>	Write " T ". The cursor is incremented by one and shifted to the right.
10	:	:	:
11	Write data to CG RAM / DD RAM <input type="text"/>	<input type="text"/>	Write " T ". The cursor is incremented by one and shifted to the right.

No.	Instruction	Display	Operation													
12	Entry mode set <table border="1" style="width: 100%; text-align: center;"> <tr><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td><td>1</td><td>1</td></tr> </table>	0	0	0	0	0	0	0	0	1	1	1	<table border="1" style="width: 100%; text-align: center;"> <tr><td>WELCOME</td></tr> <tr><td>TO PARTY_</td></tr> </table>	WELCOME	TO PARTY_	When writing, it sets mode for the display shift.
0	0	0	0	0	0	0	0	1	1	1						
WELCOME																
TO PARTY_																
13	Write data to CG RAM / DD RAM <table border="1" style="width: 100%; text-align: center;"> <tr><td>1</td><td>0</td><td>0</td><td>1</td><td>0</td><td>1</td><td>1</td><td>0</td><td>0</td><td>1</td></tr> </table>	1	0	0	1	0	1	1	0	0	1	<table border="1" style="width: 100%; text-align: center;"> <tr><td>ELCOME</td></tr> <tr><td>O PARTY_</td></tr> </table>	ELCOME	O PARTY_	Write "Y". The cursor is incremented by one and shifted to the right.	
1	0	0	1	0	1	1	0	0	1							
ELCOME																
O PARTY_																
14	:	:	:													
15	Return home <table border="1" style="width: 100%; text-align: center;"> <tr><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td></tr> </table>	0	0	0	0	0	0	0	0	0	1	0	<table border="1" style="width: 100%; text-align: center;"> <tr><td>WELCOME</td></tr> <tr><td>TO PARTY</td></tr> </table>	WELCOME	TO PARTY	Both the display and the cursor return to the original position (address 0).
0	0	0	0	0	0	0	0	0	1	0						
WELCOME																
TO PARTY																

8.7. Reset Function

At power on, SPLC780C starts the internal auto-reset circuit and executes the initial instructions. The initial procedures are shown as follows:

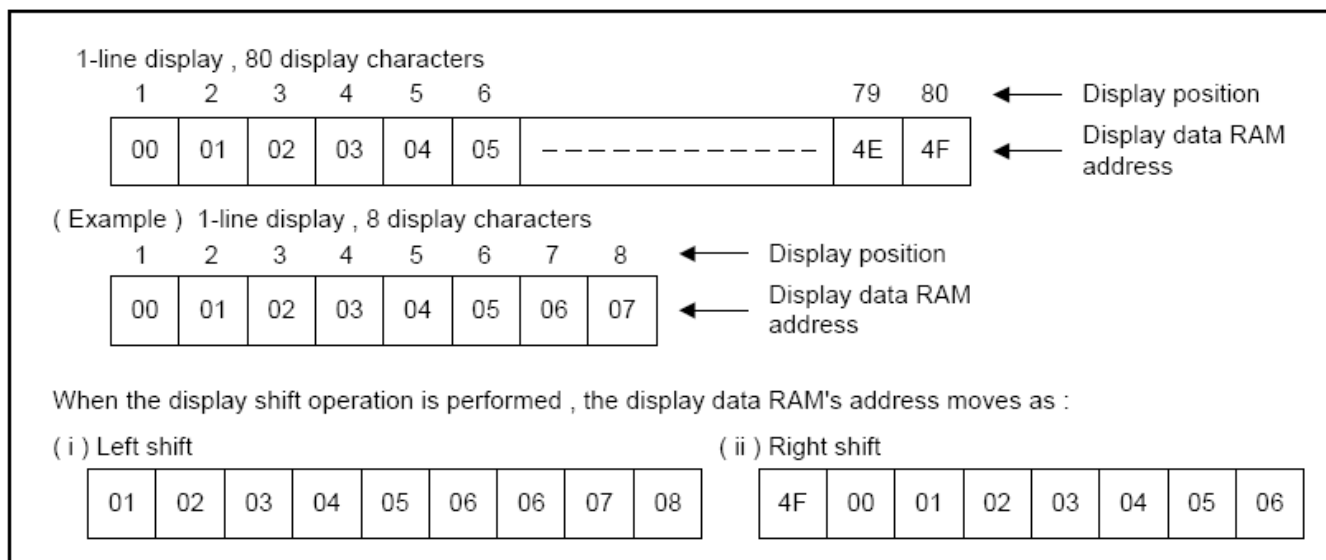




8.8. Display Data RAM (DD RAM)

The 80-bit DD RAM is normally used for storing display data. Those DD RAM not used for display data can be used as general data RAM. Its address is configured in the Address Counter.

The relationships between Display Data RAM Address and LCD's position are depicted as follows.



8.9. Timing Generation Circuit

The timing generating circuit is able to generate timing signals to the internal circuits. In order to prevent the internal timing interface, the MPU access timing and the RAM access timing are generated independently.

8.10. LCD Driver Circuit

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

8.11. Character Generator ROM (CG ROM)

Using 8-bit character code, the character generator ROM generates 5 x 8 dots or 5 x 10 dots character patterns. It also can generate 192's 5 x 8 dots character patterns and 64's 5 x 10 dots character patterns.

8.12. Character Generator RAM (CG RAM)

Users can easily change the character patterns in the character generator RAM through program. It can be written to 5 x 8 dots, 8-character patterns or 5 x 10 dots for 4-character patterns.

The following diagram shows the SPLC780C character patterns:

Correspondence between Character Codes and Character Patterns.

		Higher 4-bit (D4 to D7) of Character Code (Hexadecimal)																
		0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	
Lower 4-bit (D0 to D3) of Character Code (Hexadecimal)	0	CG RAM (1)																
	1	CG RAM (2)																
	2	CG RAM (3)																
	3	CG RAM (4)																
	4	CG RAM (5)																
	5	CG RAM (6)																
	6	CG RAM (7)																
	7	CG RAM (8)																
	8	CG RAM (1)																
	9	CG RAM (2)																
	A	CG RAM (3)																
	B	CG RAM (4)																
	C	CG RAM (5)																
	D	CG RAM (6)																
	E	CG RAM (7)																
	F	CG RAM (8)																

The relationships between Character Generator RAM Addresses, Character Generator RAM Data (character patterns), and Character Codes are depicted as follows:



8.12.1. 5 x 8 dot character patterns

Character Code (DD RAM Data)								CG RAM Address						Character Patterns (CG RAM Data)													
b7	b6	b5	b4	b3	b2	b1	b0	b5	b4	b3	b2	b1	b0	b7	b6	b5	b4	b3	b2	b1	b0						
0	0	0	0	X	/	/	/	/	/	/	0	0	0	/	/	/	/	/	/	/	1	1	1	1	1		
											0	0	1								0	0					
											0	1	0								0	0					
											0	1	1								0	0					
											1	0	0								0	0					
											1	0	1								0	0					
											1	1	0								0	0					
											1	1	1								0	0					
0	0	0	0	X	/	/	/	/	/	/	0	0	0	/	/	/	/	/	/	/	/	/	0	1	1	1	0
											0	0	1										0	0			
											0	1	0										0	0			
											0	1	1										0	0			
											1	0	0										0	0			
											1	0	1										0	0			
											1	1	0										0	0			
											1	1	1										0	0			

Character Pattern Example (1)

 Character Pattern Example (2)

 ← Cursor Position

- Note1:  It means that the bit0~2 of the character code correspond to the bit3~5 of the CG RAM address.
- Note2:  These areas are not used for display, but can be used for the general data RAM.
- Note3: When all of the bit4-7 of the character code are 0, CG RAM character patterns are selected.
- Note4: "1": Selected, "0": No selected, "X": Do not care (0 or 1).
- Note5: For example (1), set character code (b2 = b1 = b0 = 0, b3 = 0 or 1, b7-b4 = 0) to display "T". That means character code (00) 16, and (08) 16 can display "T" character.
- Note6: The bits 0-2 of the character code RAM is the character pattern line position. The 6th line is the cursor position and display is formed by logical OR with the cursor.

9. Character Generation ROM

Upper 4 bit Lower 4 bit	LLLL	LLLH	LLHL	LLHH	LHLL	LHLH	LHHL	LHHH	HLLL	HLLH	HLHL	HLHH	HHLL	HHLH	HHHL	HHHH
LLLL																
LLLH																
LLHL																
LLHH																
LHLL																
LHLH																
LHHL																
LHHH																
HLLL																
HLLH																
HLHL																
HLHH																
HHLL																
HHLH																
HHHL																
HHHH																

10. INTERFACE PIN CONNECTIONS

PIN	SYMBOL	I/O	FUNCTION
1	VSS	I	Ground pin, connected to 0V
2	VDD	I	Power supply pin for logic (+5V)
3	V0	I	Contrast control (VDD~ -5V)
4	E	I	A signal for selecting reading and writing data: E=H: Start E=L: Stop
5	SID	I	Serial input data
6	SCLK	I	Serial input clock
7	LEDA	I	LED anode (+5V)
8	LEDK	I	LED cathode (0V)

11. RELIABILITY

Content of Reliability Test

Environmental Test				
No.	Test Item	Content of Test	Test Condition	Applicable Standard
1	High temperature storage	Endurance test applying the high storage temperature for a long time.	70 °C 200 hrs	
2	Low temperature storage	Endurance test applying the low storage temperature for a long time.	-20 °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.	60 °C 200 hrs	
4	Low temperature operation	Endurance test applying the electric stress under low temperature for a long time.	-10 °C 200 hrs	
5	High temperature Humidity storage	Endurance test applying the high temperature and high humidity storage for a long time.	70 °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.	60 °C , 90,RH 96 hrs	MIL-202E-103B JIS-C5023
7	Temperature cycle	Endurance test applying the low and high temperature cycle. <div style="text-align: center;"> $\begin{array}{ccccc} -10^{\circ}\text{C} & & +25^{\circ}\text{C} & & +60^{\circ}\text{C} \\ \leftarrow 30\text{min.} & \rightleftharpoons & 5\text{min.} & \rightleftharpoons & 30\text{min.} \rightarrow \\ & \longleftarrow & & & \longrightarrow \\ & & \text{1 cycle} & & \end{array}$ </div>	-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 1l msedc 3 times of each direction	MIL-202E-213B
10	Atmospheric pressure test	Endurance test applying the atmospheric pressure during transportation by air.	115 mbar 40 hrs	MIL-202E-105C
Others				
11	Static electricity test	Endurance test applying the electric stress to the terminal.	VS=800V, RS=1.5 k CS=100 pF 1 time	MIL-883B-3015.1

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

Failure Judgment 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 Characteristic
Mechanical characteristic													Out of the Mechanical Specification Color change : Out of Limit Appearance Specification
Optical characteristic													Out of the Appearance Standard

12. QUALITY GUARANTEE

Acceptable Quality Level

Each lot should satisfy the quality level defined as follows.

- Inspection method : MIL-STD-105E LEVEL II Normal one time sampling
- AQL

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

Definition of 'LOT'

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

Conditions of Cosmetic Inspection

Environmental condition

The inspection should be performed at the 1cm of height from the LCD module under 2 pieces of 40W white fluorescent lamps (Normal temperature 20~25°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.

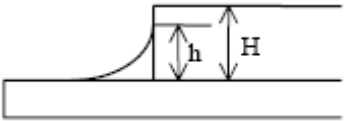
Driving voltage

The VO value which the most optimal contrast can be obtained near the specified VO in the specification. (Within ± 0.5V of typical value at 25°C.).

13. INSPECTION CRITERIA

13.1 Module Cosmetic Criteria

No.	Item	Judgment 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 Major
4	Resist flaw on substrate	Invisible copper foil (‘0.5mm or more) on substrate pattern	Minor
5	Accretion of metallic Foreign matter	No soldering dust No accretion of metallic foreign matters (Not exceed ‘0.2mm)	Minor Minor
6	Stain	No stain to spoil cosmetic badly	Minor
7	Plate discoloring	No plate fading, rusting and discoloring	Minor
8	Solder amount	a. Soldering side of PCB Solder to form a ‘Filet’ all around the lead. Solder should not hide the lead form perfectly. (too much)	Minor
	1. Lead parts	b. Components side (In case of ‘Through Hole PCB’) Solder to reach the Components side of PCB.	
	2. Flat packages	Either ‘Toe’ (A) or ‘Seal’ (B) of the lead to be covered by ‘Filet’.	Minor
		Lead form to be assume over solder. A B	

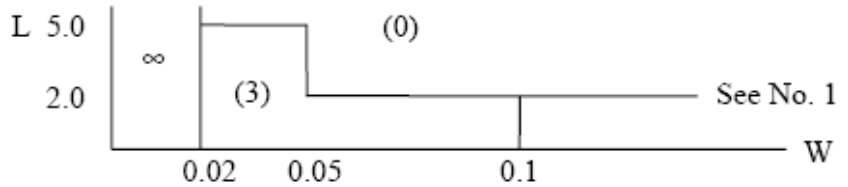

	3. Chips	$(3/2) H \geq h \geq (1/2) H$		Minor
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13.2 Screen Cosmetic Criteria (Non-Operating)

No.	Defect	Judgment Criterion	Partition										
1	Spots	In accordance with <i>Screen Cosmetic Criteria (Operating) No.1.</i>	Minor										
2	Lines	In accordance with <i>Screen Cosmetic Criteria (Operating) No.2.</i>	Minor										
3	Bubbles in polarizer	<table border="1" data-bbox="432 663 1305 853"> <thead> <tr> <th data-bbox="432 663 772 701">Size : d mm</th> <th data-bbox="772 663 1305 701">Acceptable Qty in active area</th> </tr> </thead> <tbody> <tr> <td data-bbox="432 701 772 739">d ≤ 0.3</td> <td data-bbox="772 701 1305 739">Disregard</td> </tr> <tr> <td data-bbox="432 739 772 777">0.3 < d ≤ 1.0</td> <td data-bbox="772 739 1305 777">3</td> </tr> <tr> <td data-bbox="432 777 772 815">1.0 < d ≤ 1.5</td> <td data-bbox="772 777 1305 815">1</td> </tr> <tr> <td data-bbox="432 815 772 853">1.5 < d</td> <td data-bbox="772 815 1305 853">0</td> </tr> </tbody> </table>	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
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												
4	Scratch	In accordance with spots and lines operating cosmetic criteria. When the light reflects on the panel surface, the scratches are not to be remarkable.	Minor										
5	Allowable density	Above defects should be separated more than 30mm each other.	Minor										
6	Coloration	Not to be noticeable coloration in the viewing area of the LCD panels. Back-lit type should be judged with back-lit on state only.	Minor										
7	Contamination	Not to be noticeable.	Minor										

13.3 Screen Cosmetic Criteria (Operating)

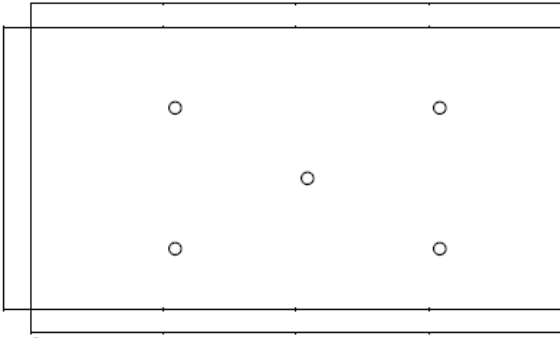
No.	Defect	Judgment Criterion	Partition																				
1	Spots	<p data-bbox="440 1397 644 1435">A) Clear Note :</p> <table border="1" data-bbox="451 1447 1294 1632"> <thead> <tr> <th data-bbox="451 1447 778 1485">Size : d mm</th> <th data-bbox="778 1447 1294 1485">Acceptable Qty in active area</th> </tr> </thead> <tbody> <tr> <td data-bbox="451 1485 778 1523">d ≤ 0.1</td> <td data-bbox="778 1485 1294 1523">Disregard</td> </tr> <tr> <td data-bbox="451 1523 778 1561">0.1 < d ≤ 0.2</td> <td data-bbox="778 1523 1294 1561">3</td> </tr> <tr> <td data-bbox="451 1561 778 1599">0.2 < d ≤ 0.3</td> <td data-bbox="778 1561 1294 1599">2</td> </tr> <tr> <td data-bbox="451 1599 778 1632">0.3 < d</td> <td data-bbox="778 1599 1294 1632">0</td> </tr> </tbody> </table> <p data-bbox="440 1644 1294 1722">Including pin holes and defective dots which must be within one pixel size.</p> <p data-bbox="440 1733 667 1771">B) Unclear Size :</p> <table border="1" data-bbox="451 1783 1294 1957"> <thead> <tr> <th data-bbox="451 1783 778 1821">Size : d mm</th> <th data-bbox="778 1783 1294 1821">Acceptable Qty in active area</th> </tr> </thead> <tbody> <tr> <td data-bbox="451 1821 778 1859">d ≤ 0.2</td> <td data-bbox="778 1821 1294 1859">Disregard</td> </tr> <tr> <td data-bbox="451 1859 778 1897">0.2 < d ≤ 0.5</td> <td data-bbox="778 1859 1294 1897">6</td> </tr> <tr> <td data-bbox="451 1897 778 1935">0.5 < d ≤ 0.7</td> <td data-bbox="778 1897 1294 1935">2</td> </tr> <tr> <td data-bbox="451 1935 778 1957">0.7 < d</td> <td data-bbox="778 1935 1294 1957">0</td> </tr> </tbody> </table>	Size : d mm	Acceptable Qty in active area	d ≤ 0.1	Disregard	0.1 < d ≤ 0.2	3	0.2 < d ≤ 0.3	2	0.3 < d	0	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
Size : d mm	Acceptable Qty in active area																						
d ≤ 0.1	Disregard																						
0.1 < d ≤ 0.2	3																						
0.2 < d ≤ 0.3	2																						
0.3 < d	0																						
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																						

2	Lines	<p>A) Clear</p>  <p>Note : () - Acceptable Qty in active area L -Length (mm) W - Width (mm) ∞ - Disregard</p> <p>B) Unclear</p> 	Minor
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'Clear' = The shade and size are not changed by VO.

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

13.4. Screen Cosmetic Criteria (Operating) (Continued)

No.	Defect	Judgment 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 <i>Screen Cosmetic Criteria (Operating) No.1</i>)	Minor
7	Uneven brightness (only back-lit type module)	<p>Uneven brightness must be $B_{MAX} / B_{MIN} \leq 2$</p> <ul style="list-style-type: none"> - BMAX : Max. value by measure in 5 points - BMIN : Min. value by measure in 5 points <p>Divide active area into 4 vertically and horizontally. Measure 5 points shown in the following figure.</p>  <p>○ : Measuring points</p>	Minor

Note :

- (1) Size : $d = (\text{long length} + \text{short length}) / 2$
- (2) The limit samples for each item have priority.
- (3) Complexed defects are defined item by item, but if the number of defects are defined in above table, the total number should not exceed 10.
- (4) In case of 'concentration', even the spots or the lines of 'disregarded' size should not allowed. Following three situations should be treated as 'concentration'.
 - 7 or over defects in circle of '5mm.
 - 10 or over defects in circle of '10mm.
 - 20 or over defects in circle of '20mm.

14. PRECAUTIONS FOR USING LCD MODULES

Handing Precautions

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

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

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

Storage Precautions

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

Others

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

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

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

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

15. USING LCD MODULES

Liquid Crystal Display Modules

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

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

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

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

(4) When the display surface becomes dusty, wipe gently with absorbent cotton or other soft material like chamois soaked in petroleum benzine. 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.

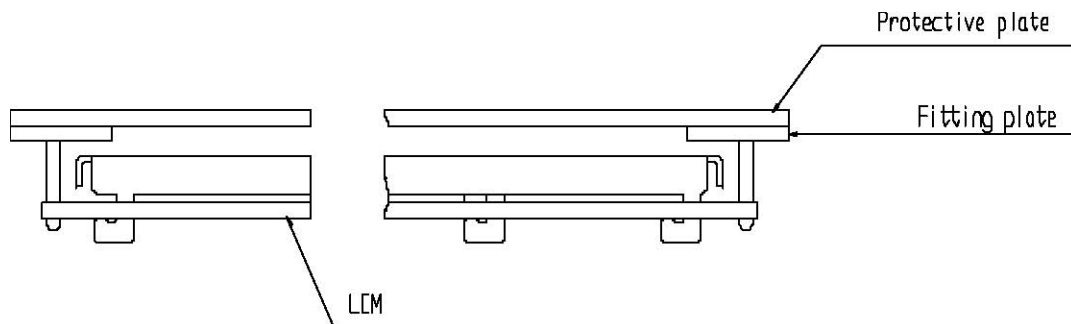
(7) Condensation on the surface and contact with terminals due to cold will damage, stain or dirty the polarizers. After products are tested at low temperature they must be warmed up in a container before coming in contact with room temperature air.

- (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.

Installing LCD Modules

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

- (1) Cover the surface with a transparent protective plate to protect the polarizer and LC cell.



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

Precaution for Handling LCD Modules

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

- (1) Do not alter, modify or change the the shape of the tab on the metal frame.
- (2) Do not make extra holes on the printed circuit board, modify its shape or change the positions of components to be attached.
- (3) Do not damage or modify the pattern writing on the printed circuit board.
- (4) Absolutely do not modify the zebra rubber strip (conductive rubber) or heat seal connector.
- (5) Except for soldering the interface, do not make any alterations or modifications with a soldering iron.
- (6) Do not drop, bend or twist LCM.

Electro-Static Discharge Control

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

- (1) Make certain that you are grounded when handing LCM.
- (2) Before remove LCM from its packing case or incorporating it into a set, be sure the module and your body have the same electric potential.
- (3) When soldering the terminal of LCM, make certain the AC power source for the soldering iron does not leak.
- (4) When using an electric screwdriver to attach LCM, the screwdriver should be of ground potentiality to

minimize as much as possible any transmission of electromagnetic waves produced sparks coming from the commutator of the motor.

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

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

Precaution for soldering to the LCM

(1) Observe the following when soldering lead wire, connector cable and etc. to the LCM.

- Soldering iron temperature : 280℃ ~ 300℃
- 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 due 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 electroluminescent panel from the PC board, be sure the solder has completely melted, the soldered pad on the PC board could be damaged.

Precautions for Operation

(1) Viewing angle varies with the change of liquid crystal driving voltage (VO). Adjust VO to show the best contrast.

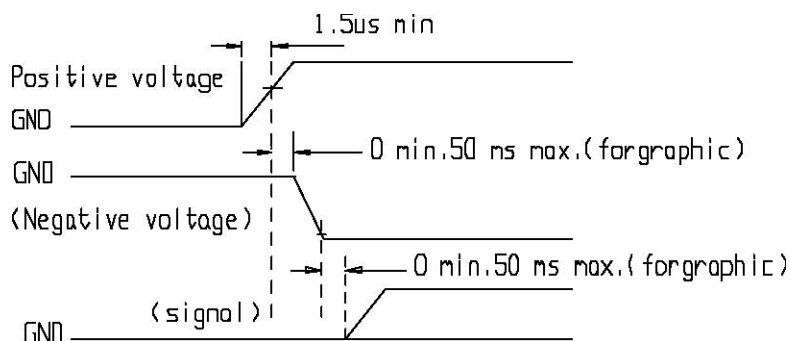
(2) Driving the LCD in the voltage above the limit shortens its life.

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

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

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

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



Storage

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

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

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

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

Safety

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

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

Limited Warranty

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

Return LCM under warranty

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

- Broken LCD glass.
- PCB eyelet's damaged or modified.
- PCB conductors damaged.
- Circuit modified in any way, including addition of components.
- PCB tampered with by grinding, engraving or painting varnish.
- soldering to or modifying the bezel in any manner.

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