TINSHARP

TC1602B-01 VER:00

Specification For Approval

Customer Approval:_____ Date:_____

Prepared:_____Check:_____Approval:_____

Date:_____Date:_____Date:_____

Description

REV.	DESCREPTION	DATE
V00	First issue	Dec-01-2005

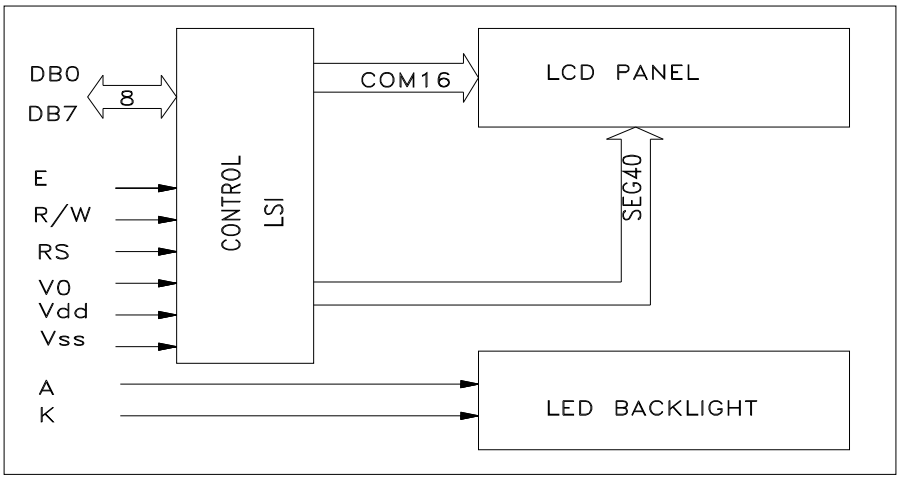
CONTENTS

1 . SPECIFICATIONS

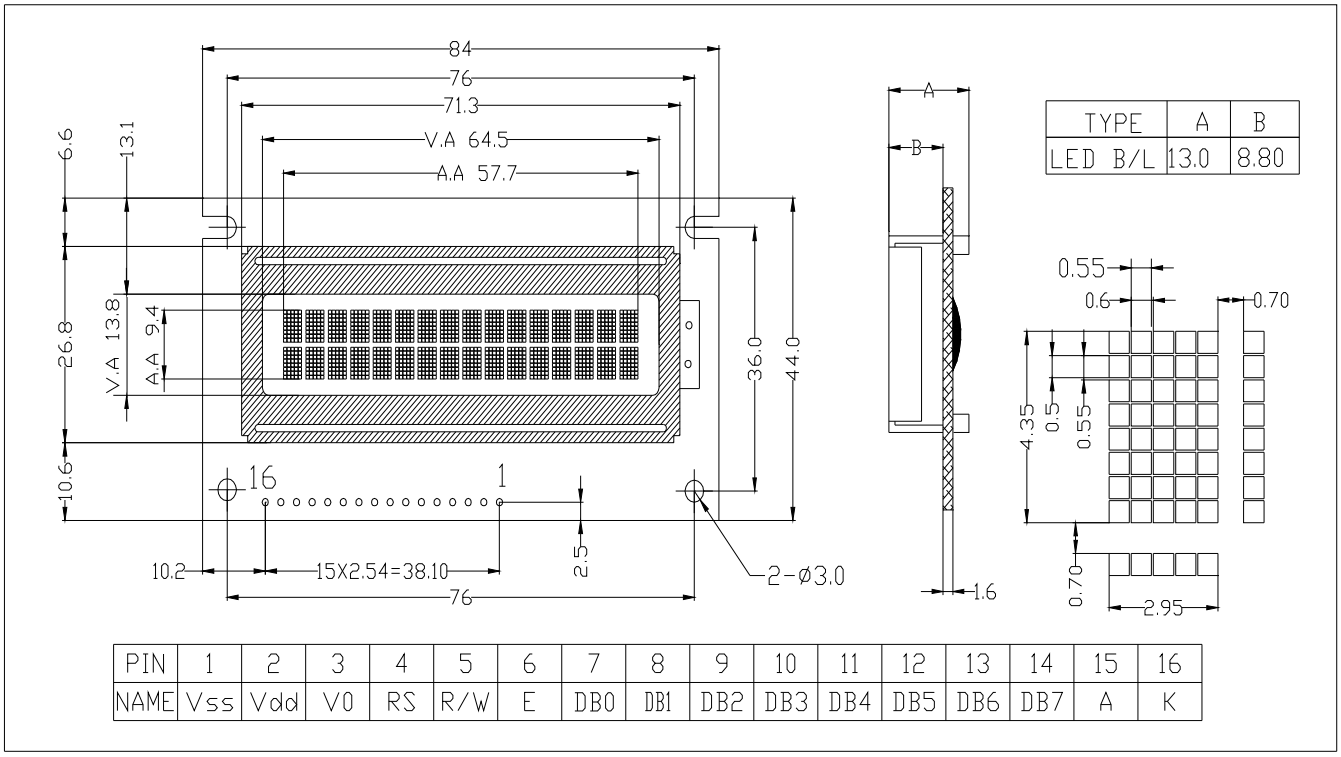
1.1 FEATURES

Item	Contents	Unit
LCD TYPE	STN/Transflective/Y-G	--
LCD duty	1/16	--
LCD bias	1/5	--
Viewing direction	6	o'clock
Operating Temperature	0℃--+55℃	
Storage Temperature	-10℃--+65℃	
Module size(W x H x T)	122.0 X 33.0 X 13.6	mm
Viewing area(W x H)	99.0 X 13.0	mm
Display Format	16 Characters X 1 Line	dots
Character Size (W x H)	4.84 X 9.66	mm
Character pitch(W x H)	6.0 X 9.66	mm

1.2. BLOCK DIAGRAM



1.3. MECHANICAL SPECIFICATION



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

1.4 ABSOLUTE MAXIMUM RATINGS (Ta = 25℃)

Characteristics	Symbol	Ratings
Operating Voltage	VDD	-0.3V to +7.0V
Driver Supply Voltage	V_{LCD}	VDD - 12V to VDD + 0.3V
Input Voltage Range	V_{IN}	-0.3V to VDD + 0.3V
Operating Temperature	T_A	-30℃ to +80℃
Storage Temperature	T_{STG}	-55℃ to +125℃

Note: Stresses beyond those given in the Absolute Maximum Rating table may cause operational errors or damage to the device. For normal operational conditions see AC/DC Electrical Characteristics.

1.5 DC CHARACTERISTICS(VDD = 3.5V to 5.0V, TA = 25℃)

Characteristics	Symbol	Limit			Unit	Test Condition
		Min.	Typ.	Max.		
Operating Current	I_{DD}	-	0.2	0.4	mA	External clock (Note)
Input High Voltage	V_{IH1}	0.7VDD	-	VDD	V	Pins:(E, RS, R/W, DB0 - DB7)
Input Low Voltage	V_{IL1}	-0.3	-	0.55	V	
Input High Voltage	V_{IH2}	0.7VDD	-	VDD	V	Pin OSC1
Input Low Voltage	V_{IL2}	-0.2	-	0.2VDD	V	
Input High Current	I_{IH}	-1.0	-	1.0	μA	Pins: (RS, R/W, DB0 - DB7)
Input Low Current	I_{IL}	-5.0	-15	-30	μA	VDD = 3.0V
Output High Voltage (TTL)	V_{OH1}	0.75VDD	-	-	V	I_{OH} = - 0.1mA Pins: DB0 - DB7
Output Low Voltage (TTL)	V_{OL1}	-	-	0.2VDD	V	I_{OL} = 0.1mA Pins: DB0 - DB7
Output High Voltage (CMOS)	V_{OH2}	0.8VDD	-	-	V	I_{OH} = - 40μA, Pins: CL1, CL2, M, D
Output Low Voltage (CMOS)	V_{OL2}	-	-	0.2VDD	V	I_{OL} = 40μA, Pins: CL1, CL2, M, D
Driver ON Resistance (COM)	R_{COM}	-	-	20	KΩ	I_O = ±50μA, V_{LCD} = 4.0V Pins: COM1 - COM16
Driver ON Resistance (SEG)	R_{SEG}	-	-	30	KΩ	I_O = ±50μA, V_{LCD} = 4.0V Pins: SEG1 - SEG40
LCD Voltage	V_{LCD}	3.0	-	9.0	V	VDD-V5, 1/4 bias or 1/5 bias

Note: FOSC = 250KHz, VDD = 3.0V, pin E = "L", RS, R/W, DB0 - DB7 are open, all outputs are no loads.

1.6 AC CHARACTERISTICS

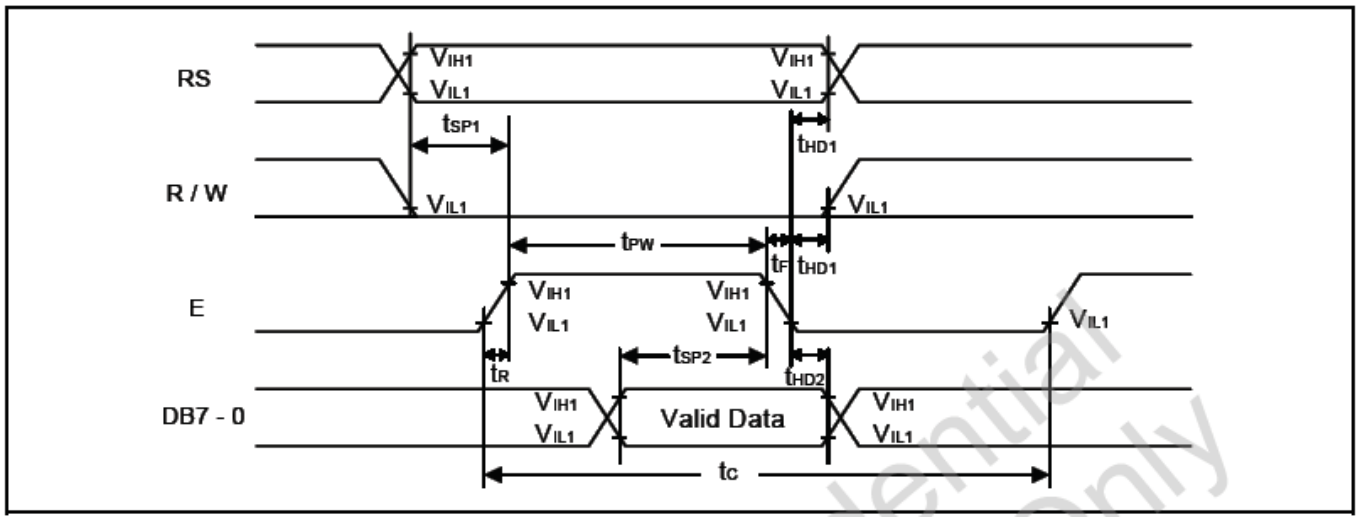
(1) Write Mode (Writing data from MPU to SPLC780D)

Characteristics	Symbol	Limit			Unit	Test Condition
		Min.	Typ.	Max.		
E Cycle Time	t_C	1000	-	-	ns	Pin E
E Pulse Width	t_{PW}	450	-	-	ns	Pin E
E Rise/Fall Time	t_R, t_F	-	-	25	ns	Pin E
Address Setup Time	t_{SP1}	60	-	-	ns	Pins: RS, R/W, E
Address Hold Time	t_{HD1}	20	-	-	ns	Pins: RS, R/W, E
Data Setup Time	t_{SP2}	195	-	-	ns	Pins: DB0 - DB7
Data Hold Time	t_{HD2}	10	-	-	ns	Pins: DB0 - DB7

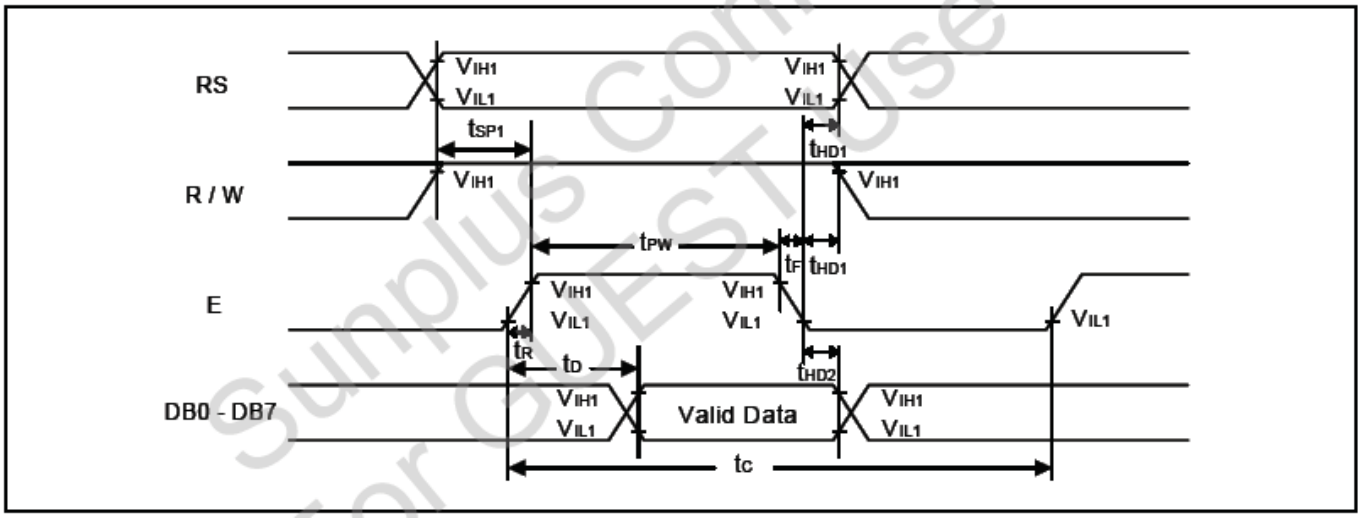
(2) Read Mode (Reading data from SPLC780D to MPU)

Characteristics	Symbol	Limit			Unit	Test Condition
		Min.	Typ.	Max.		
E Cycle Time	t_C	1000	-	-	ns	Pin E
E Pulse Width	t_W	450	-	-	ns	Pin E
E Rise/Fall Time	t_R, t_F	-	-	25	ns	Pin E
Address Setup Time	t_{SP1}	60	-	-	ns	Pins: RS, R/W, E
Address Hold Time	t_{HD1}	20	-	-	ns	Pins: RS, R/W, E
Data Output Delay Time	t_D	-	-	360	ns	Pins: DB0 - DB7
Data hold time	t_{HD2}	5.0	-	-	ns	Pin DB0 - DB7

(3) Write Mode Timing Diagram (Writing data from MPU to SPLC780D)

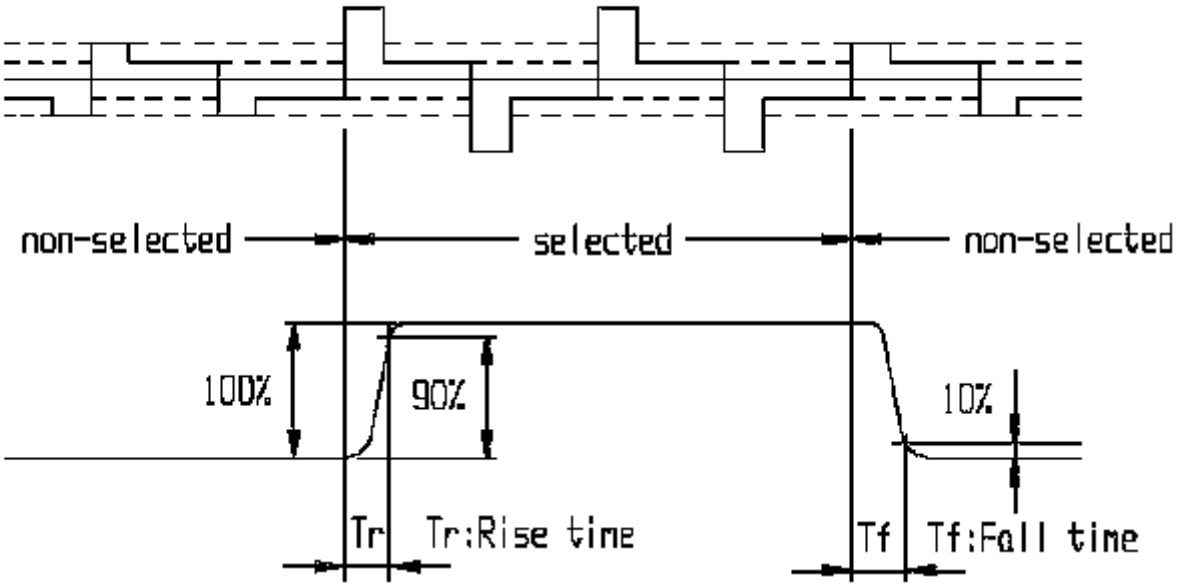


(4) Read Mode Timing Diagram (Reading data from SPLC780D to MPU)



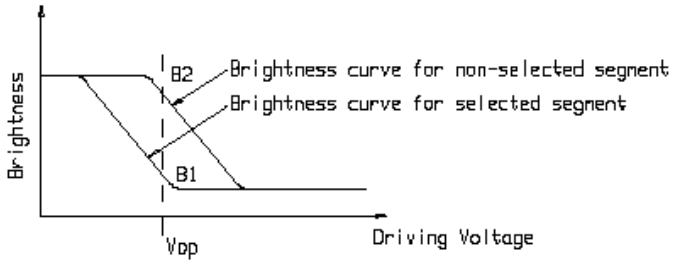
1.7 ELECTRO-OPTICAL CHARACTERISTICS

Note1 : Definition of response time.

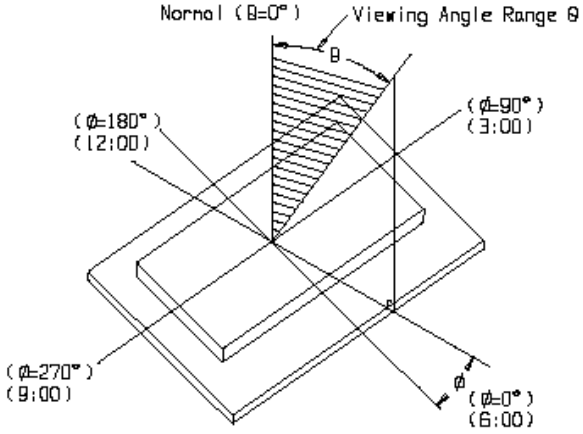


Note2: Definition of contrast ratio 'Cr' .

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



Note3: Definition of viewing angle range 'θ'.



1.8 BACKLIGHT CHARACTERISTICS

LCD Module with LED Backlight

ABSOLUTE MAXIMUM RATINGS(Ta=25℃)

Item	Symbol	Conditions	Rating	Unit
Absolute maximum forward current	Ifm		150	mA
Peak forward current	Ifp	I macc 脉冲，1/10 占空比 I msec plus 10% Duty Cycle	600	mA
Reverse voltage	V_r		10	V
Power dissipation	P_d		660	mW
Operating Temperature Range	T_{OPr}		-30~+70℃	℃
Storage Temperature Range	Tstg		-40~+80℃	℃

ELECTRICAL –OPTICAL CHARACTERISTICS(Ta=25℃)

Item	Symbol	Min.	Typ.	Max.	Unit	Conditions
Forward Voltage	Vf	4.0	4.2	4.4	V	If = 100 mA
Reverse Current	I_r			100	uA	Vr = 10 V
Peak wave length	λρ		570		nm	If = 100 mA
Spectral line hair width	Δλ		35		nm	If = 100 mA
Luminance	Lv				cd/m^2	If = 100 mA

2. MODULE STRUCTURE

2.1 INTERFACE PIN DESCRIPTION

Pin No.	Symbol	Level	Description
1	VSS	0V	Ground
2	VDD	5.0V	Supply voltage for logic
3	V0	--	Input for adjusting the LCD contrast
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 the clock latch signal input
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

SPLC780D oscillator supports not only the internal oscillator operation, but also the external clock operation.

Control and Display Instructions

Control and display instructions are described in details as follows:

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.

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.

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

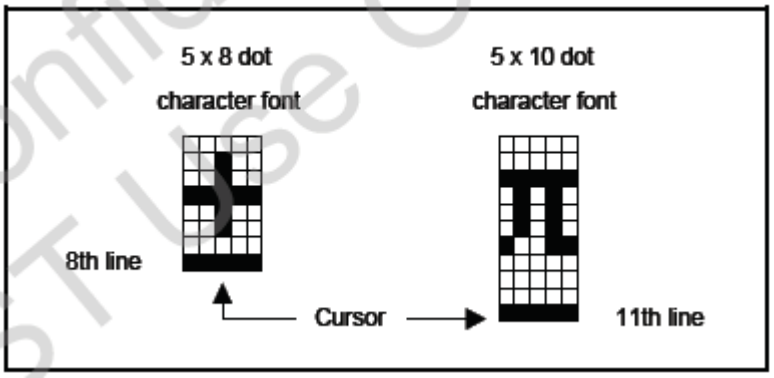
4. Display On/Off Control

	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

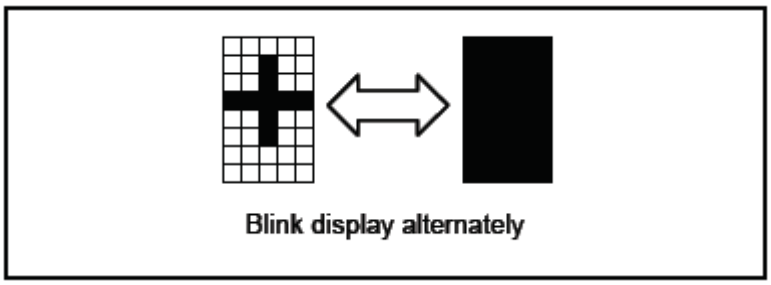
B = 1: Blinks on, B= 0: Blinks off



5. Cursor or Display Shift

Without changing DD RAM 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



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

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

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: 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.

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. 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.

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.

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

No.	Instruction	Display	Operation
1	Power on. (SPLC780D 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	COMPAMY_	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	OMPANY_	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	COMPAMY_	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. (SPLC780D 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	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	0 0 0 0 0 0 0 0 1 1 1 0	_	Display on. Cursor appears.
5	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	1 0 0 1 0 1 1 0 0 1 1 1	W_	Write " W ". The cursor is incremented by one and shifted to the right.

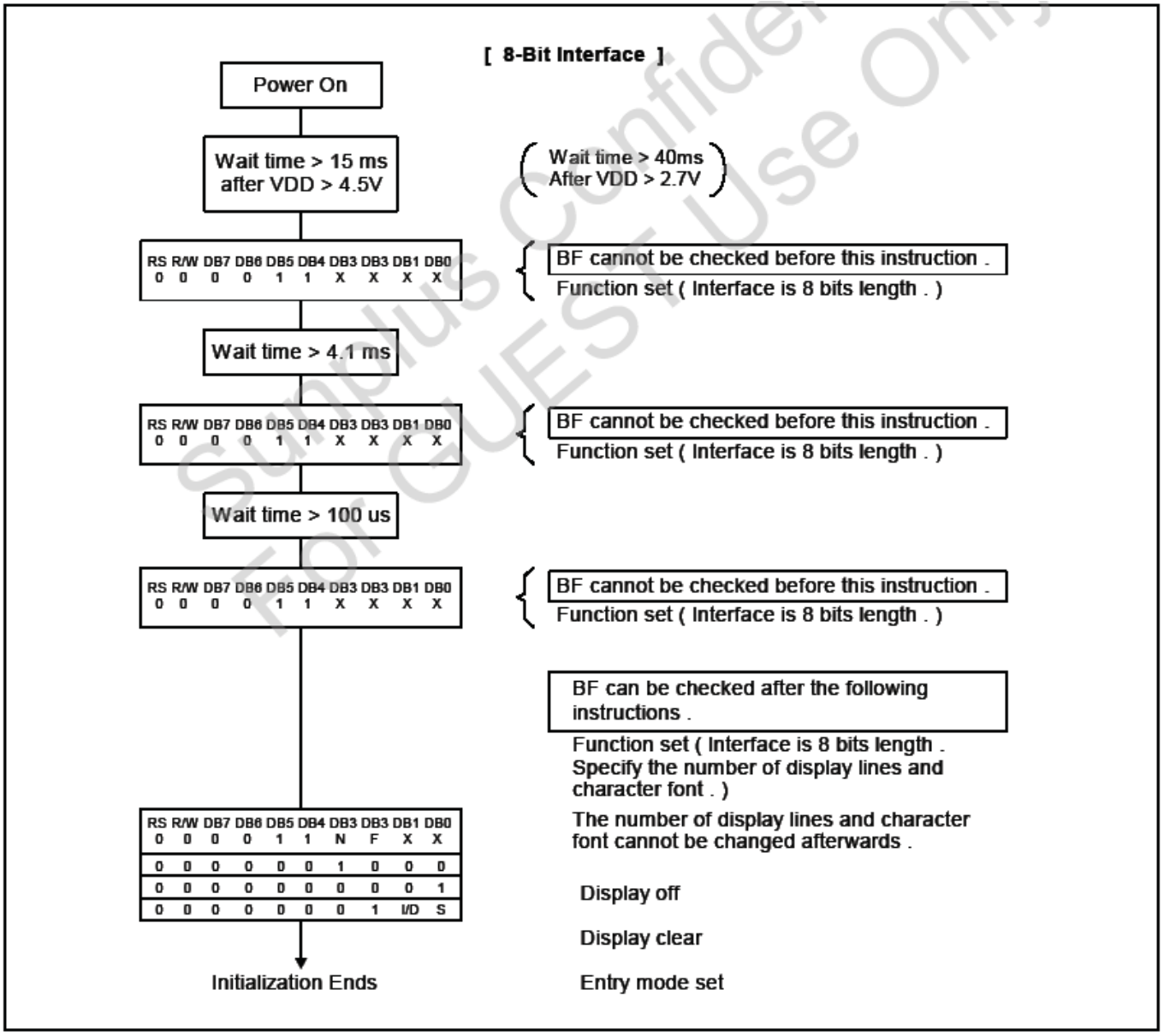
8-Bit Operation and 8-Digit 2-Line Display (Using Internal Reset)

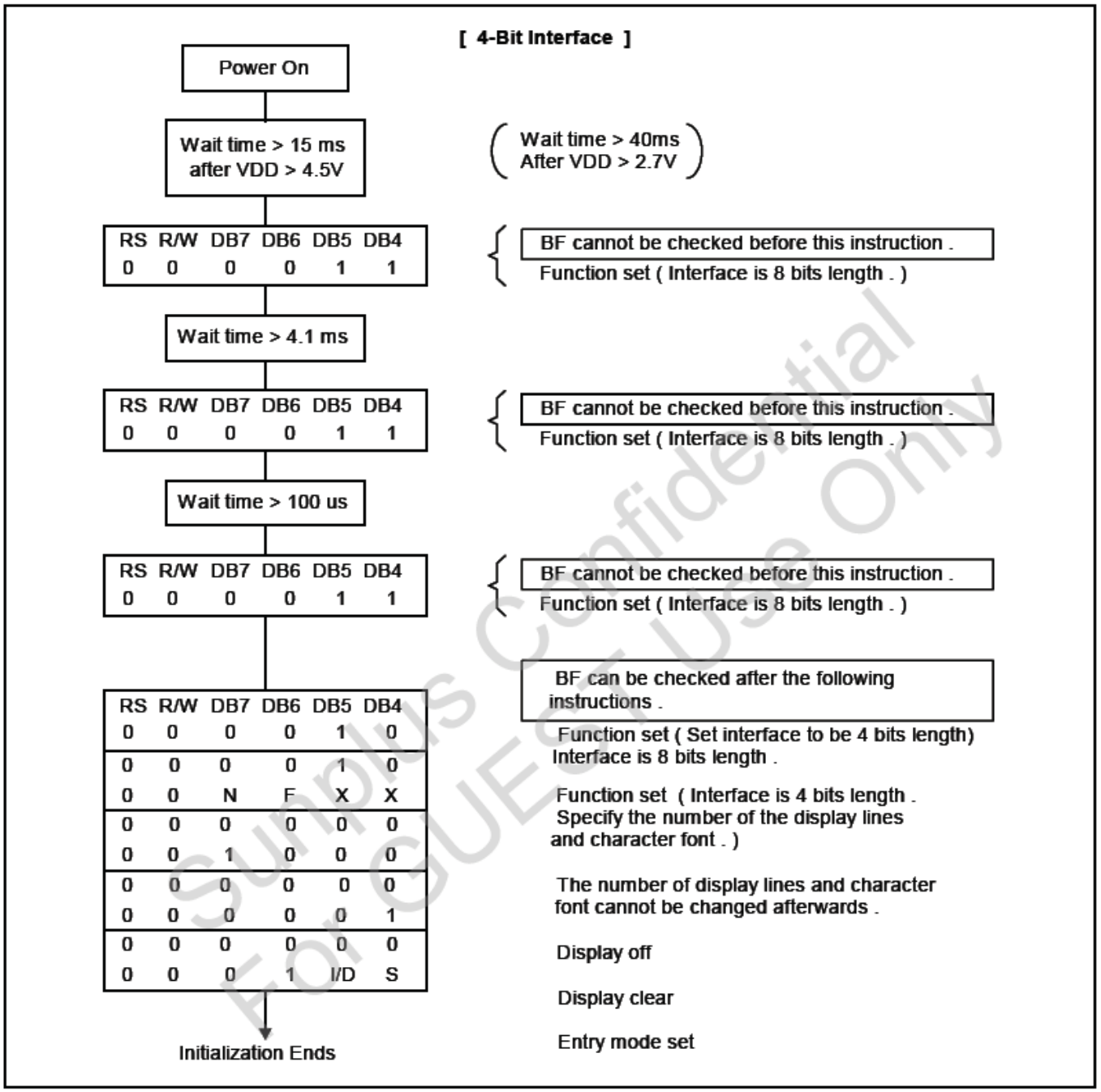
No.	Instruction	Display	Operation
1	Power on. (SPLC780D starts initializing)		Power on reset. No display.
2	Function set RS R/W DB7 DB6 DB5 DB4 DB3 DB2 DB1 DB0 0 0 0 0 1 1 1 0 X X		Set to 8-bit operation and select 2-line display line and 5 x 8 dot character font.
3	Display on / off control 0 0 0 0 0 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.

No.	Instruction	Display	Operation
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).

2.3. RESET FUNCTION

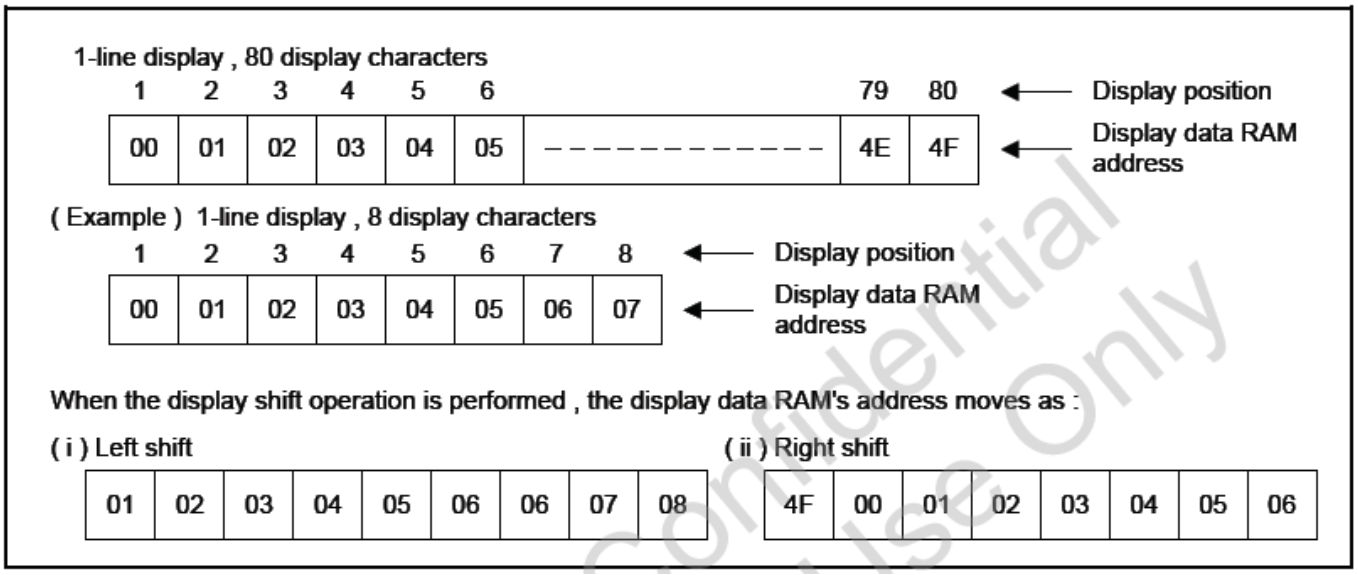
At power on, SPLC780D starts the internal auto-reset circuit and executes the initial instructions. The initial procedures are shown as follows:





2.4. 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.



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.

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

Character Generator ROM (CG ROM)

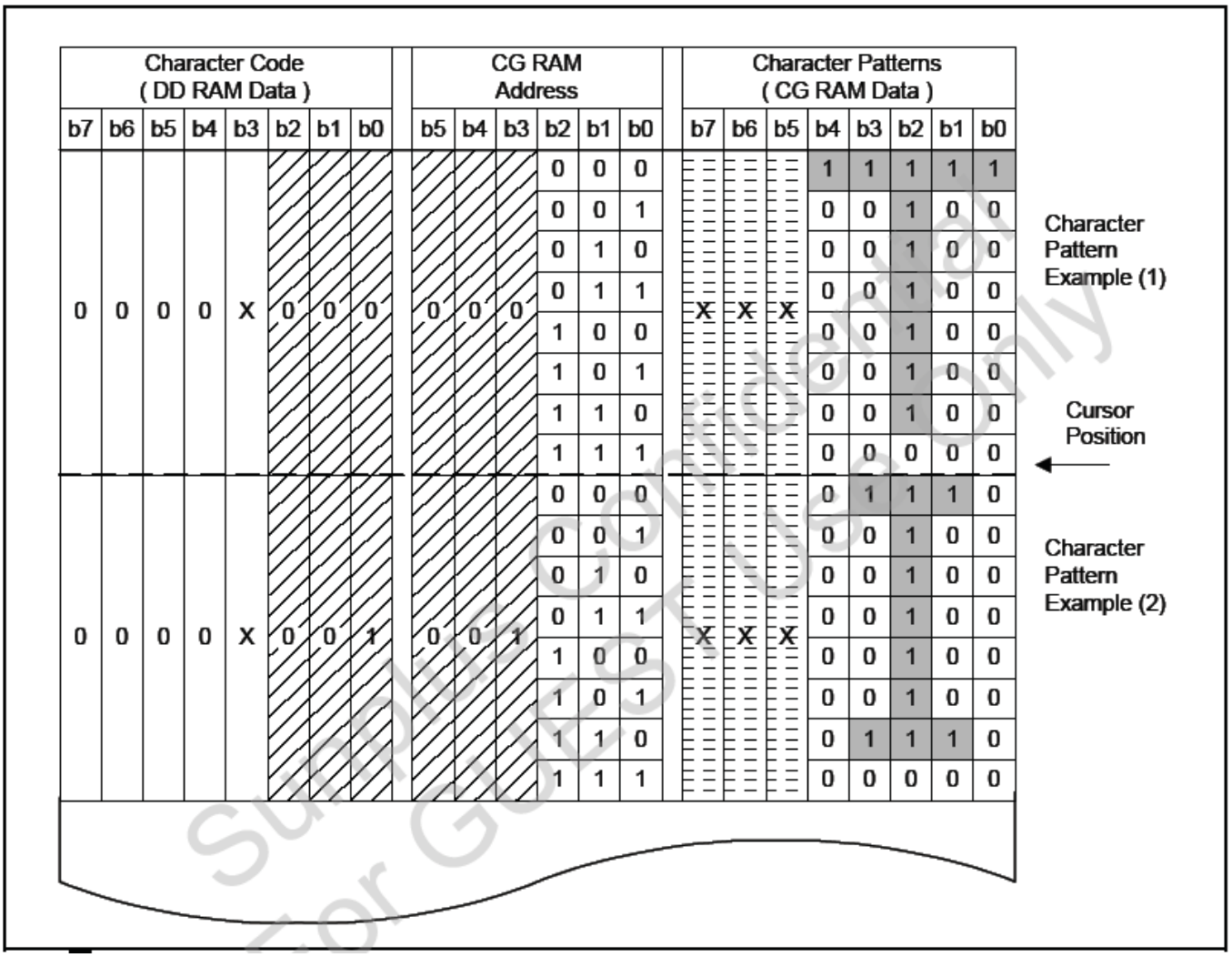
Using 8-bit character code, the character generator ROM generates 5 x 8 dots or 5 x 10 dots character patterns. It also can generate 192’s 5 x 8 dots character patterns and 64’s 5 x 10 dots character patterns.

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 SPLC780D character patterns:
Correspondence between Character Codes and Character Patterns.

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

5 x 8 dot character patterns



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.

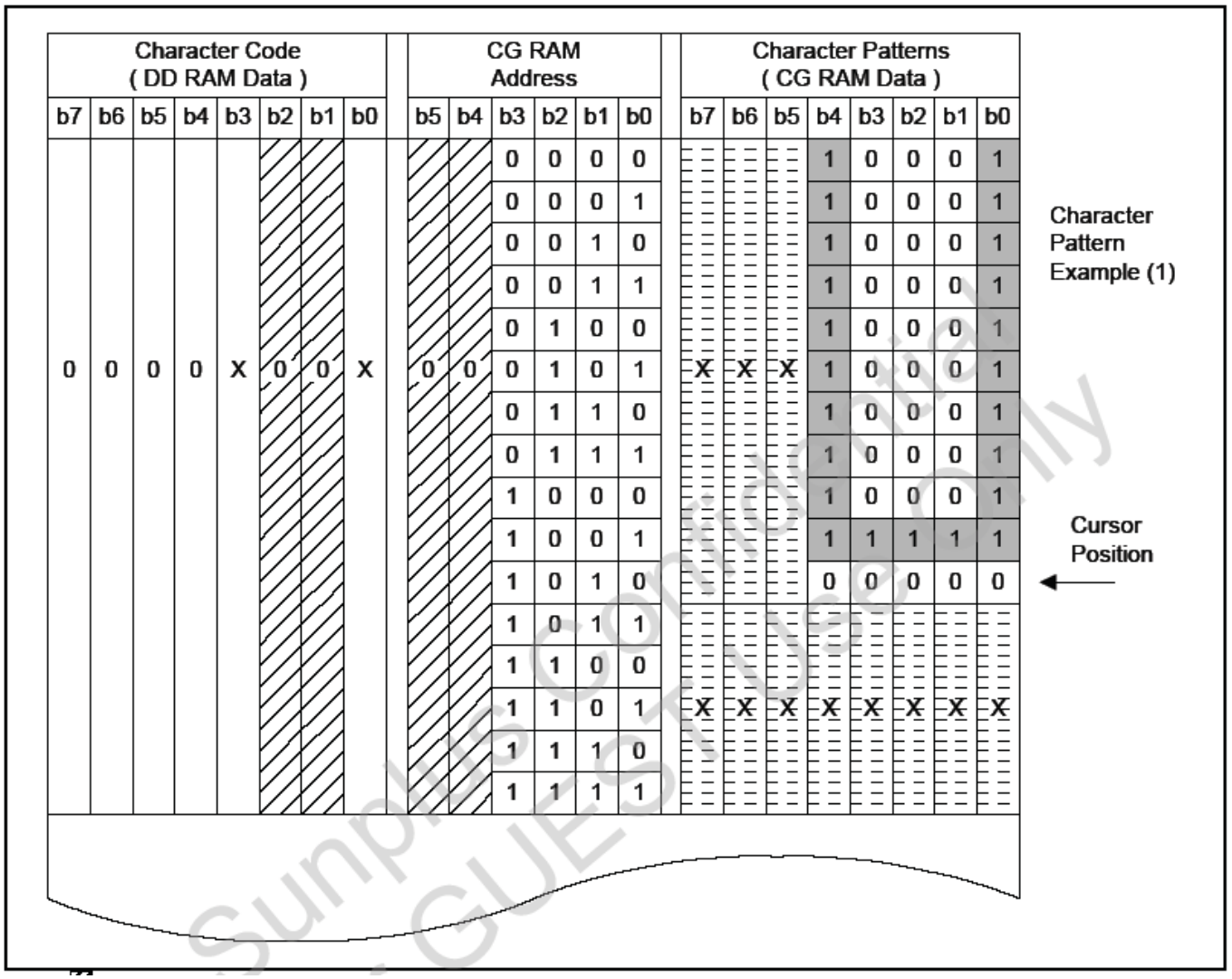
Note3: When all of the bit4-7 of the character code are 0, CG RAM character patterns are selected.

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 8th line is the cursor position and display is formed by logical OR
with the cursor.

5 X 10 dot character patterns



Note1: It means that the bit1~2 of the character code correspond to the bit4~5 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.

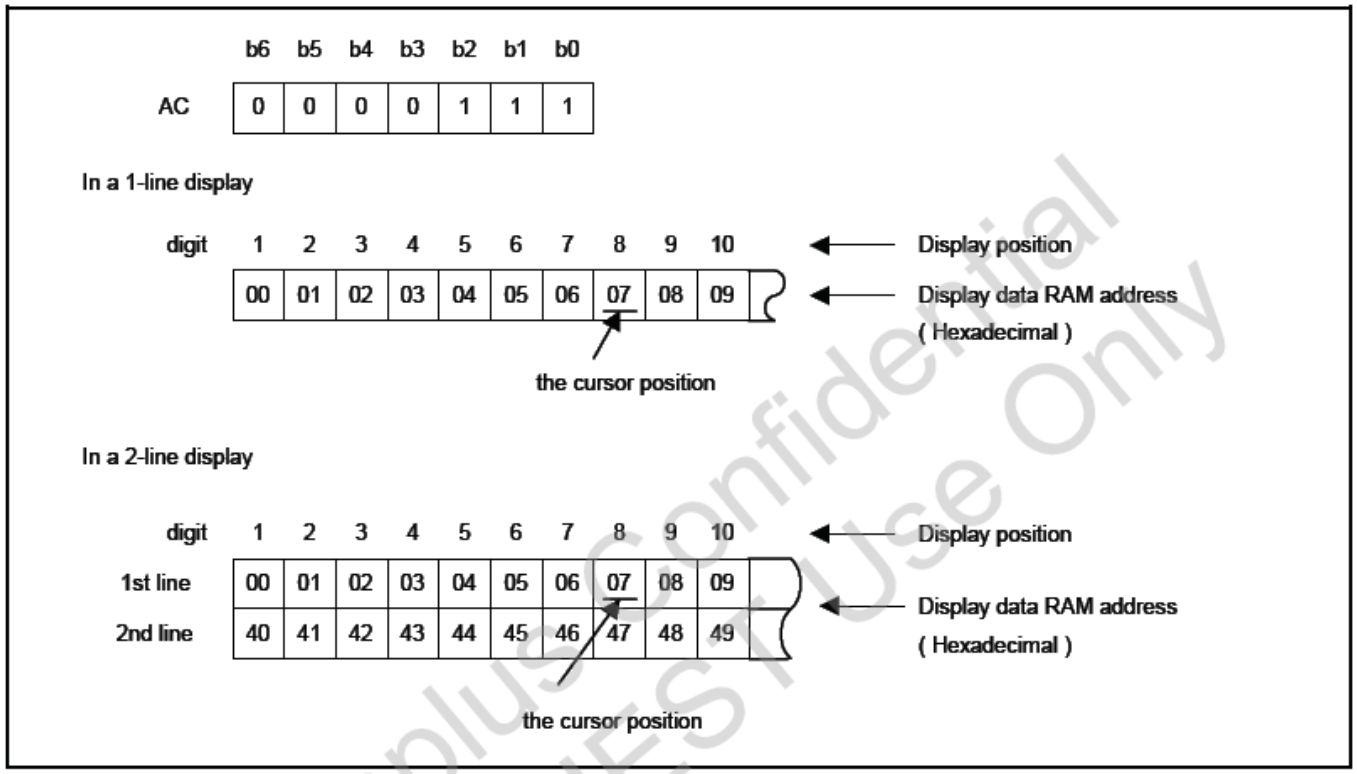
Note4: " 1 ": Selected, " 0 ": No selected, " X ": Do not care (0 or 1).

Note5: For example (1), set character code (b2 = b1 = 0, b3 = b0 = 0 or 1, b7-b4 = 0) to display " U ". That means all of the character codes (00) 16, (01) 16, (08) 16,and (09) 16 can display " U " character.

Note6: The bits 0-3 of the character code RAM is the character pattern line position. The 11th line is the cursor position and display is formed by logical OR with the cursor.

Cursor/Blink Control Circuit

This circuit generates 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 defined in the Address Counter.



Interfacing to MPU

There are two types of data operations: 4-bit and 8-bit operations. Using 4-bit MPU, the interfacing 4-bit data is transferred by 4-busline (DB4 to DB7). Thus, DB0 to DB3 bus lines are not used. Using 4-bit MPU to interface 8-bit data requires two times transferring. First, the higher 4-bit data is transferred by 4-busline (for 8-bit operation, DB7 to DB4). Secondly, the lower 4-bit data is transferred by 4-busline (for 8-bit operation, DB3 to DB0). For 8-bit MPU, the 8-bit data is transferred by 8-buslines (DB0 to DB7). When the Address Counter is (07) 16, the cursor position is shown as below:

REGISTER --- IR (Instruction Register) and DR(Data Register)

SPLC780D contains two 8-bit registers: Instruction Register (IR) and Data Register (DR). Using combinations of the RS pin and the R/W pin selects the IR and DR, see below:

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 by MPU, but it cannot be read by MPU.

Busy Flag (BF)

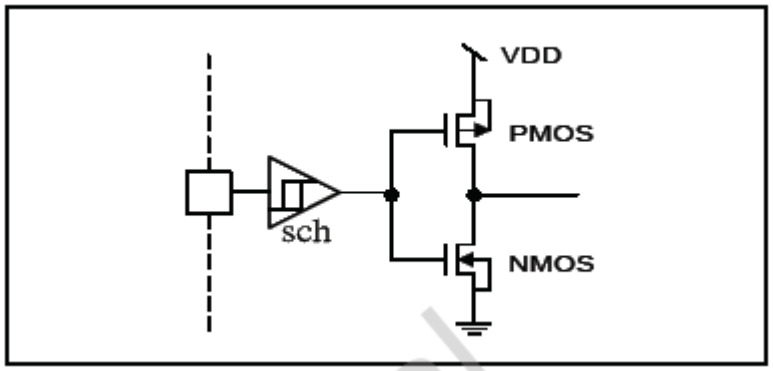
When RS = 0 and R/W = 1, the busy flag is output to DB7. As the busy flag =1, SPLC780D is in busy state and does not accept any instruction until the busy flag = 0.

Address Counter (AC)

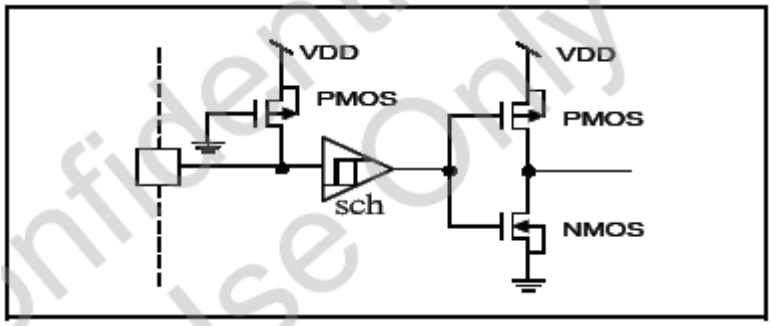
The Address Counter assigns addresses to Display Data RAM and Character Generator RAM. When an instruction for address is written in IR, the address information is sent from IR to AC .After writing to/reading from Display Data RAM or Character Generator RAM, AC is automatically incremented by one (or decremented by one). The contents of AC are output to DB0 - DB6 when RS = 0 and R/W=1.

I/O Port Configuration

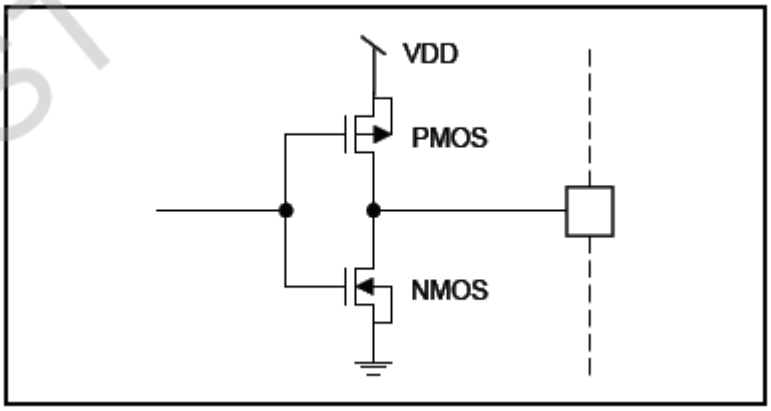
Input port: E



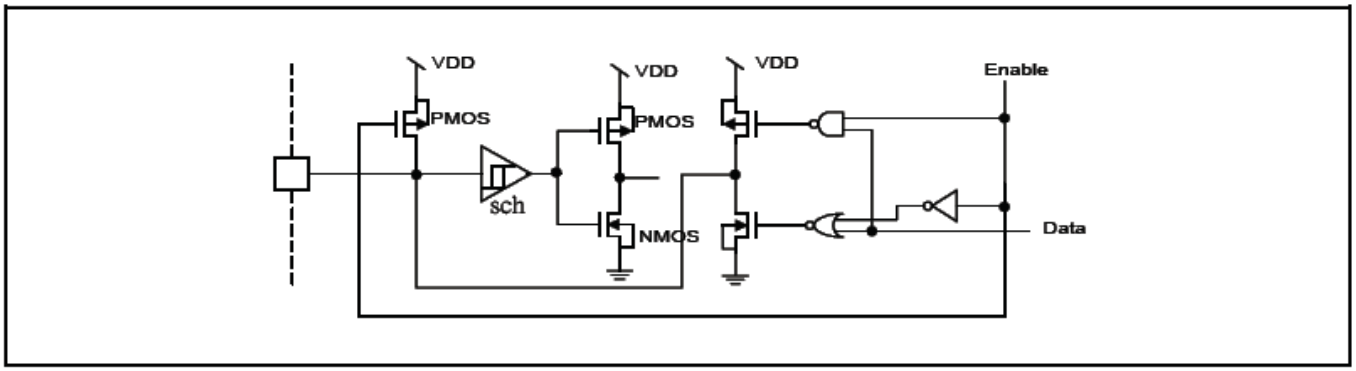
Input port: R/W, RS



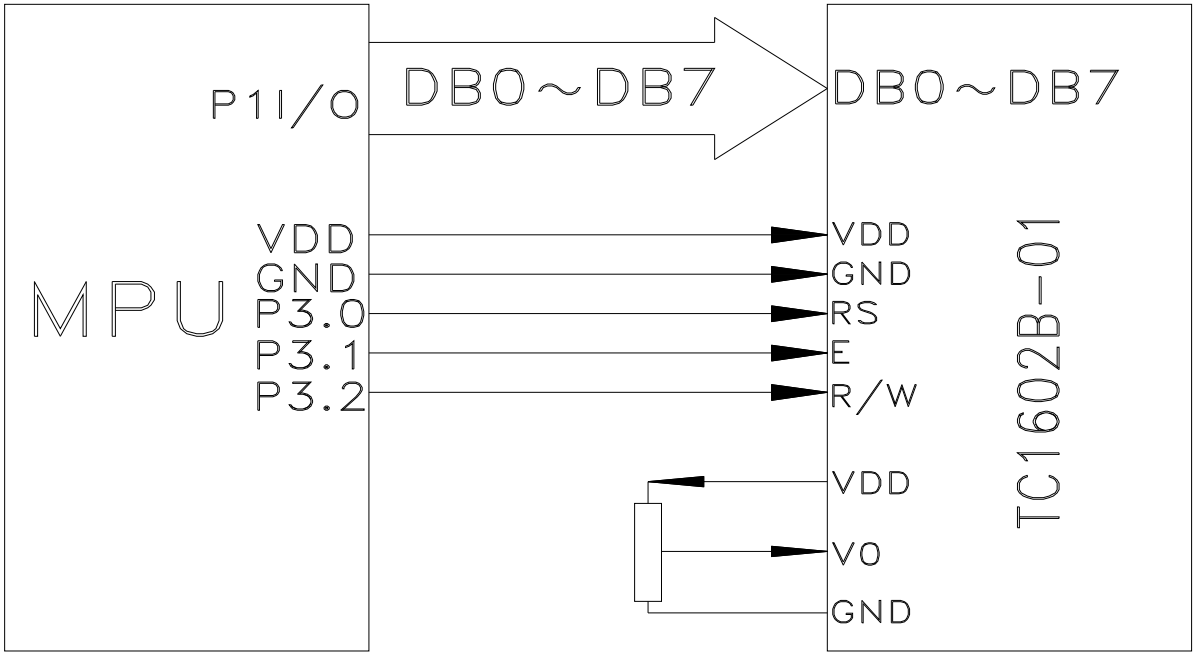
Output port: CL1, CL2, M, D



Input / Output port: DB7 - DB0



MPU and Module Connect:



3. RELIABILITY TEST AND QUALITY

3.1. RELIABILITY TEST CONDITION

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	------

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

Mechanical Test

Vibration test	Endurance test applying the vibration during transportation and using	10~22Hz→1.5mmp-p 22~500Hz→1.5G Total 0.5hour	MIL-202E-201A JIS-C5025 JIS-C7022-A-10
Shock test	Constructional and mechanical endurance test applying the shock during transportation.	50G half sign wave 11 msede 3 times of each direction	MIL-202E-213B
Atmospheric pressure test	Endurance test applying the atmospheric pressure during transportation by air	115mbar 40hrs	MIL-202E-105C
Static electricity test	Endurance test applying the electric stress to the terminal	VS=800V,RS-1.5KΩ CS=100pF, 1 time	MIL-883B-3015.1

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

3.2. QUALITY GURANTEE

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

Definition of 'LOT'

One lot means the delivery quality to customer at once time.

Conditions of Cosmetic Inspection

. Environmental condition

The inspection should be performed at the 1metre height from the LCD module under 2 pieces of 40W white fluorescent lamps (Normal temperature 20~25℃ and normal humidity 60±15%RH).

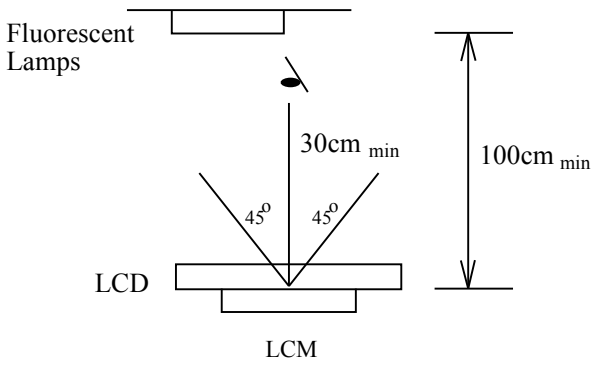
Driving voltage

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℃.).

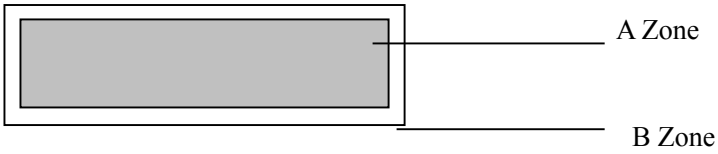
3.3. INSPECTION METHOD

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

Viewing direction for inspection is 45° from vertical against LCM.



Definition of zone:

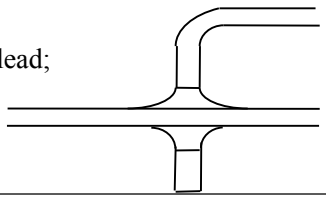
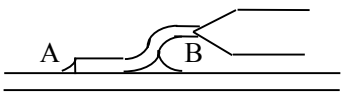
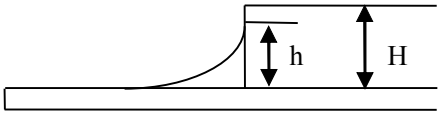


A Zone: Active display area (minimum viewing area).

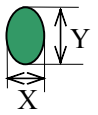
B Zone: Non-active display area (outside viewing area).

3.4. INSPECTION STANDARD FOR SOLDER

Module Cosmetic Criteria

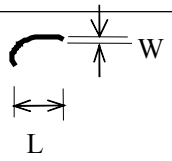
No.	Item	Judgment Criterion	Partition
1	Difference in Spec.	None allowed	Major
2	Pattern Peeling	No substrate pattern peeling and floating	Major
3	Soldering defects	No soldering missing No soldering bridge No cold soldering	Major Major Minor
4	Resist flaw on substrate	Invisible copper foil (Φ0.5mm or more) on substrate pattern	Minor
5	Accretion of metallic Foreign matter	No soldering dust No accretion of metallic foreign matters (Not exceed Φ0.2mm)	Minor Minor
6	Stain	No stain to spoil cosmetic badly	Minor
7	Plate discoloring	No plate fading, rusting and discoloring	Minor
8	Plate discoloring 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 	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

3.5. SCREEN COSMETIC CRITERIA (APPEARANCE)

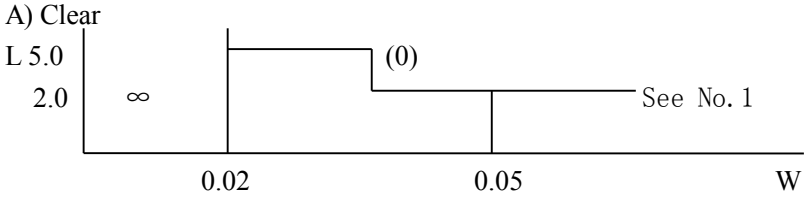
<table>
<tr><th>No.</th><th>Item</th><th>Criterion</th></tr>
<tr><td rowspan="8">1</td><td>Short or open circuit</td><td rowspan="8">No allow</td></tr>
<tr><td>LC leakage</td></tr>
<tr><td>Flickering</td></tr>
<tr><td>No display</td></tr>
<tr><td>Wrong viewing direction</td></tr>
<tr><td>Wrong Back-light</td></tr>
<tr><td>Wrong or missing component</td></tr>
<tr><td rowspan="2">2</td><td>Contrast defect (dim, ghost)</td><td rowspan="2">Refer to the approval sample</td></tr>
<tr><td>Background color deviation</td></tr>
<tr><td>3</td><td>Point defect, Black spot, dust (including Polarizer)
Φ=(X+Y)/2</td><td> 

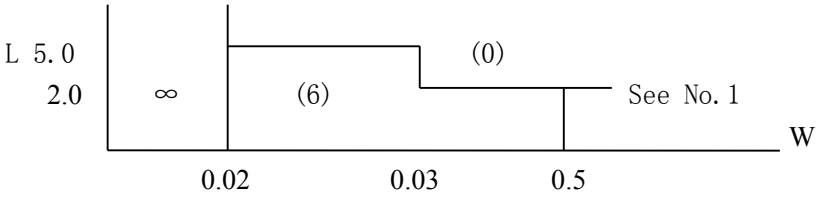
<table>
<tr><th>Point Size</th><th>Acceptable Qty.</th></tr>
<tr><td>ϕ≤0.10</td><td>Disregard</td></tr>
<tr><td>0.10<ϕ≤0.20</td><td>6</td></tr>
<tr><td>0.20<ϕ≤0.3</td><td>2</td></tr>
<tr><td>ϕ>0.30</td><td>0</td></tr>
</table></td></tr>
</table>

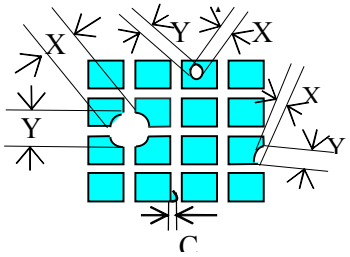
<table>
<tr><th>No.</th><th>Item</th><th>Criterion</th></tr>
<tr><td>4</td><td>Line defect,

Scratch: In accordance with spots and lines operating cosmetic criteria. When the light reflective on the panel surface, the scratches are not to be remarkable.</td><td>


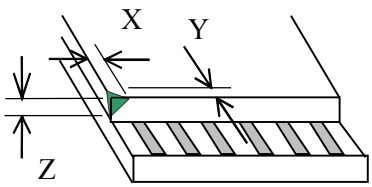
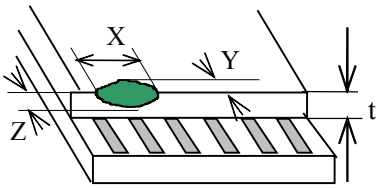
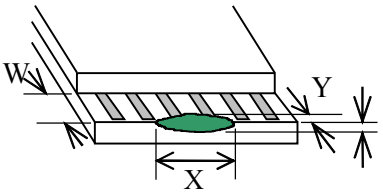
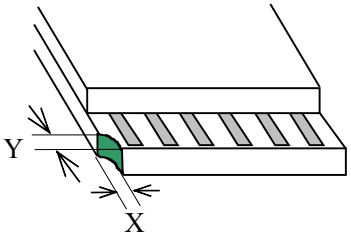
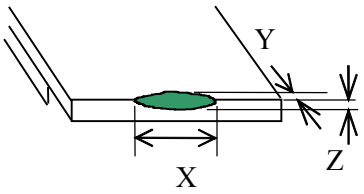
<table>
<tr><th colspan="2">Line</th><th>Acceptable Qty.</th></tr>
<tr><td>L</td><td>W</td><td></td></tr>
<tr><td>---</td><td>0.015≥W</td><td>Disregard</td></tr>
<tr><td>3.0≥L</td><td>0.03≥W</td><td rowspan="2">2</td></tr>
<tr><td>2.0≥L</td><td>0.05≥W</td></tr>
<tr><td>1.0≥L</td><td>0.1＞W</td><td>1</td></tr>
<tr><td>---</td><td>0.05<W</td><td>Applied as point defect</td></tr>
</table>
Unit: mm

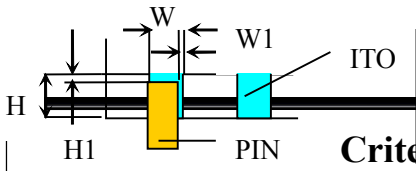
A) Clear


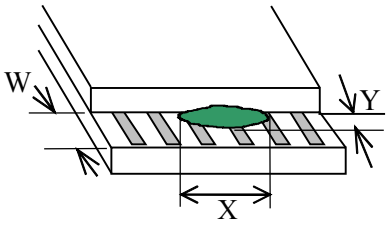
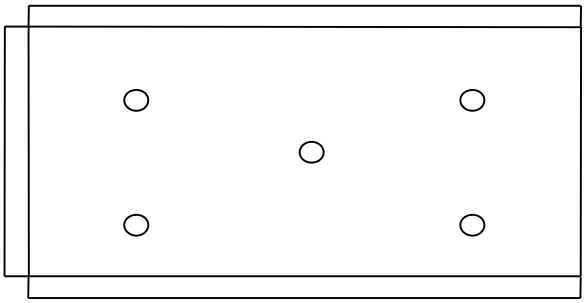
Note: ( ) –Acceptable Qty in active area
L –Length (mm) W –Width (mm) ∞ –Disregard
B) Unclear


</td></tr>
<tr><td>5</td><td>Rainbow</td><td>Not more than two colors change across the viewing area</td></tr>
<tr><td>6</td><td>Dot-matrix pattern
ϕ = (X+Y)/2</td><td>Pin hole:


<table>
<tr><th>Size</th><th>Acceptable Qty.</th></tr>
<tr><td>ϕ<0.1</td><td>Disregard</td></tr>
<tr><td>0.10≤ϕ≤0.20</td><td>1</td></tr>
<tr><td>ϕ>0.20</td><td>0</td></tr>
</table>
C: Shall not touch other dot(s).</td></tr>
</table>

No.	Item	Criterion
7	Chip Remark: X: Length direction Y: Short direction Z: Thickness direction t: Glass thickness W: Terminal Width	 Acceptable criterion X: ≤2 / Y: 0.5mm / Z: ≤t  Acceptable criterion X: ≤2 / Y: 0.5mm / Z: ≤t/2  Acceptable criterion X: Disregard / Y: ≤0.2 / Z: ≤t  Acceptable criterion X: ≤3 / Y: ≤2 / Z: ≤t shall not reach to ITO  Acceptable criterion X: ≤5 / Y: ≤2 / Z: ≤t/3



No.	Item	Crite
8	Total no. of acceptable Defect	A. Zone Maximum 2 minor non-conformities per one unit. Defect distance: each point to be separated over 10mm B. Zone It is acceptable when it is no trouble for quality and assembly in customer's end product.
9	Protruded W: Terminal Width	 Acceptable criteria: Y ≤ 0.4
10	PIN	Position
11	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 
12	Allowable density	Above defects should be separated more than 10mm each other.
13	Rubbing line	Not to be noticeable.
14	Dot size	To be 95% ~ 105% of the dot size (typ.) in drawing, Partial defects of each dot (ex. Pin-hole) shold be t4reated as 'spot'.(see Screen Cosmetic Criteria (operating) No.)

No.	Item	Criterion	
15	Bubbles in polarizer	Size : d mm	Acceptable Qty in active area
		d≦0. 3	Disregard
		0.3<d≦1. 0	3
		1. 0<d≦1. 5	1
		1. 5<d	0
16	Allowable density	Above defects should be seated more than 30mm each other	
17	Coloration	Not to be noticeable coloration in the viewing area of the LCD panels. Backlit type should be judged with back-lit on state only.	
18	Contamination	Not to be noticeable.	

Note:

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

'Unclear'= the shade and size are changed by V0.

Size: d=(long length + short length)/2

The limit samples for each item have priority

Complete defects are defined item by item, but if the number of defects is defined in above table, the total number should not exceed 10.

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 Φ2mm

-10 or over defects in circle of Φ10㎜

-20 or over defects in circle of Φ20㎜

3.6. PRECAUTION FOR USING LCM MODULE

1. Liquid Crystal Display Modules

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

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

(2) Do not touch, push or rub the exposed polarizer with anything harder than an HB Pencil lead (Glass, tweezers, etc.).

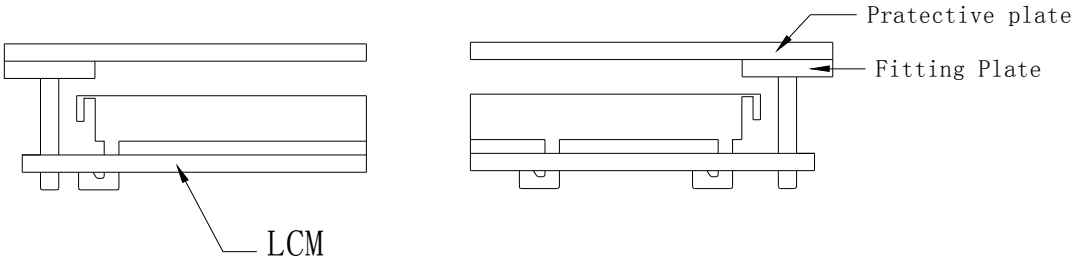
(3) N-hexane is recommended for cleaning the adhesives used to attach front/rear polarizers and reflectors made of organic, substances which will be damaged by chemicals such as acetone, toluene, ethanol and isopropyl alcohol.

(4) When the display surface becomes dusty, wipe gently with absorbent cotton or other soft material like chamois soaked in petroleum 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 the must be warmed up in a container before coming is contacting temperature air.



(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]

3.8. PRECAUTION FOR HANDING LCM MODULE

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 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

3.9. Electro-Static DISCHARGE CONTROL

Since this module uses a CMOS LSI, the same 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 workbench 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.

3.10. PRECAUTION FOR SOLDERING TO THE LCM

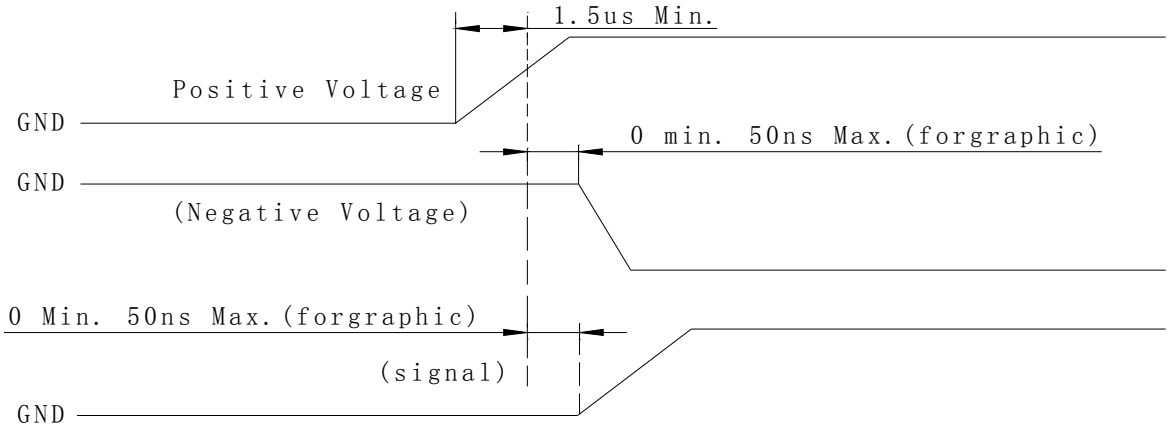
(1) Observe the following when soldering lead wire , connector cable and etc. to the LCM
-Soldering iron temperature: 280℃±10℃
-Soldering time: 3-4 seconds
-Solder: eutectic solder.

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 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 electro-luminescent 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 electro-luminescent panel from the PC board, be sure the solder has completely melted, the soldered pad on the PX board could be damaged.

3.11. PRECAUTIONS FOR OPERATION

(1) Viewing angle varies with the change of liquid crystal driving voltage (V0). 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 cell 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. Used under the relative condition of 40℃, 50%RH.
(5) When turning the power on input each signal after the positive/negative voltage becomes stable.



3.12. STORAGE

When storing LCD as spares for some years, the following precautions 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℃ and 35℃

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

(4) Environmental conditions:

-Don not leave them for more than 168hrs. at 60℃

-Should not be left for more than 48hrs. at -20℃.

3.13. SAFETY

(1) It is recommended to crush damaged or unnecessary LCD 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.

3.14. 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 TINSHAR LCD acceptance standards (copies available upon request) for a period of one year from date of shipments. Cosmetic/visual defects must be returned to TINSHARP within 90 days of shipment. Confirmation of such date shall be based on freight documents. The warranty liability of TINSHARP limited to repair and/ or replacement on the terms set forth above. TINSHARP will not be responsible for any subsequent or consequential events.

3.15. RETURN LCM UNDER WARRANTY

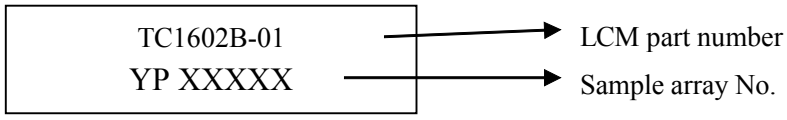
No warranty can be granted if the precautions stated above have been disregarded. The typical examples of violations are:

-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 lay 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 eyelets, conductors and terminals.

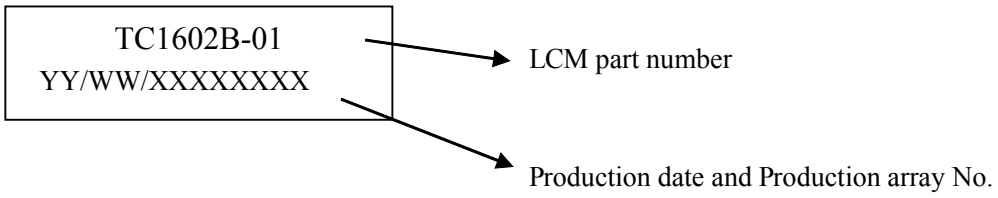
4. DATE CODE RULES

4-1. DATE CODE FOR SAMPLE



YP: meaning sample

4-2. DATE CODE FOR PRODUCTION



A. TC1602B-01 represents LCM part number
C. YY/WW represents Year, Month, and Week
YY—Year WW—Week
XXXXXXXX—Production array No.

*****END*****