
SPECIFICATION



(ISO9001:2008)

PRODUCT : LCM
MODEL NO. : HC1624-B-LWH
SUPPLIER : TSINGTEK DISPLAY CO.,LTD
REVISION : B

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[illegible]

PRODUCT CODING SYSTEM

HG 320240 C – B - LW H- NV- L4- TPSD- U- T

(1) (2) (3) (4) (5) (6) (7) (8) (9) (10) (11)

- (1): Brand and Display Type
 HC→Tsingtek Character Type
 HG→Tsingtek SMT/COB Graphic Type
 HGT→Tsingtek TAB Type
 HGO→Tsingtek COG Type
 HGR→Tsingtek CSTN
 HGF→Tsingtek TFT
 HGS→Tsingtek OLED
 HCS→Tsingtek Character Type OLED
- (2): Character→Words per lines×lines
 Graphic→row dots×column dots
- (3): Series No.
- (4): LCD module:
 Nil→STN Yellow-Green Mode
 G→STN Gray Mode
 B→STN Blue Mode
 F→FSTN Transflective
 T→FSTN Transmission
 OLED module:
 Y→Yellow
 G→Green
 B→Blue
 W→White
- (5): Backlight Type
 Nil→Without Backlight
 LY→LED Yellow-Green Array
 SY→LED Yellow-Green Edge
 LW→LED White
 LB→LED Blue
 LR→LED Red
 LA→LED Amber
 LG→LED Green
- EB→EL Blue
 EG→EL Green
 EW→EL White
 CW→CCFL White
- (6): Temperature
 Nil→Normal Temperature
 H→Wide Temperature
 EH→Super Wide Temperature
- (7): Power Supply
 Nil→5V
 NV→5V Without Booster for LCM Driving Supply
 SV→5V With Temperature Compensation
 LV→3.3V
 LNV→3.3V Without Booster for LCM Driving Supply
 LSV→3.3V With Temperature Compensation
 OV→Please refer to the spc.of LCM
- (8): Power supply for Backlight
 Please refer to the spc.of LCM
- (9): Special Coding
 TP→With Touch Panel
 S→Serial Interface
- (10): Viewing Direction
 Nil→6:00
 U→12:00
 L→9:00
 R→3:00
- (11): Interior Coding

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TSINGTEK DISPLAY

1. BASIC SPECIFICATIONS

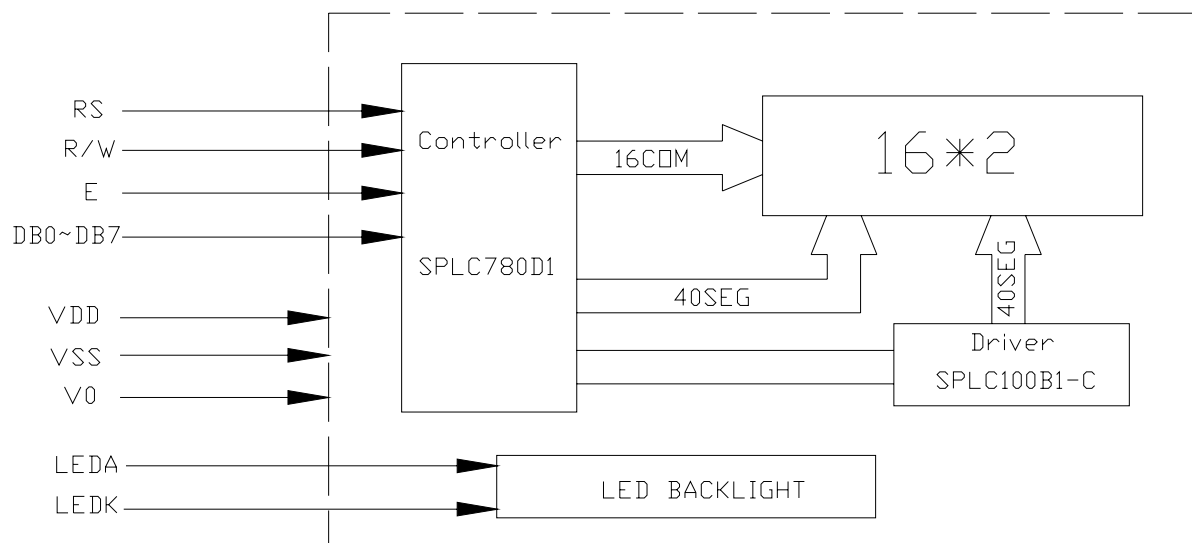
1.1 DISPLAY SPECIFICATION

ITEM	SPECIFICATION
DISPLAY TYPE	STN/BLUE/NEGATIVE/TRANSMISSIVE
COLOR	DISPLAY DOT: WHITE
	DISPLAY BACKGROUNTND: BLUE
INPUT DATA	68 SERIES
DUTY	1/16DUTY
VIEW ANGLE	6 O'CLOCK
CONTROLLER	SPLC780D1
BEZEL	0.6T
BACKLIGHT	LED (WHITE)
OPERATING TEMPERATURE	-20 °C ~70 °C
STORAGE TEMPERATURE	-30 °C ~ 80 °C
OTHERS	

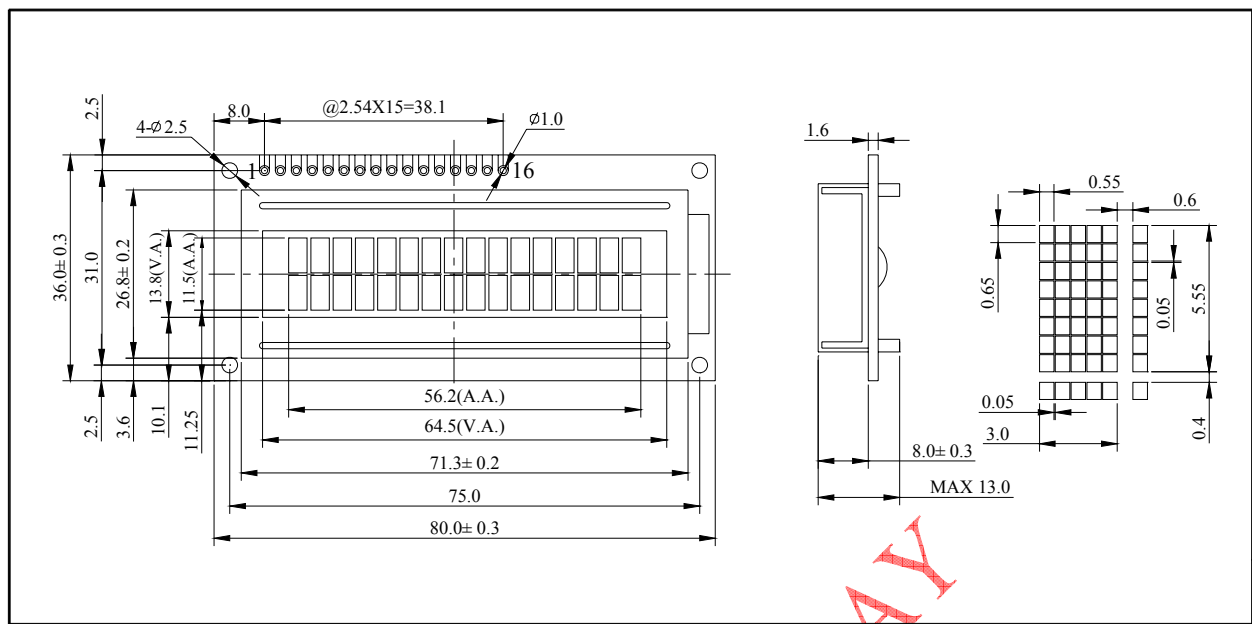
1.2 MECHANICAL SPECIFICATION

ITEM	SPECIFICATION	UNIT	NOTE
DIMENSIONAL OUTLINE	80.0(W)×36.0(H)×13.0MAX.(T)	mm	
VIEW AREA	64.5(W)×13.8(H)	mm	
EFFECTIVE V/AREA	56.2(W)×11.5(H)	mm	
NUMBER OF CHARACTERS	16Characters×2Lines	---	
CHARACTER PITCH	3.00(W)×5.55(H)	mm	
DOT SIZE	0.55(W)×0.65(H)	mm	

1.3 BLOCK DIAGRAM



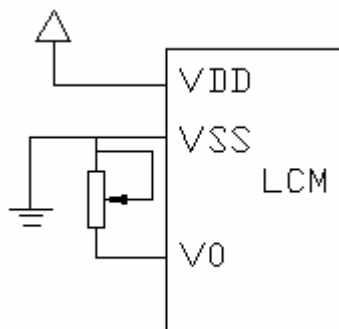
1.4 DIMENSIONAL OUTLINE



1.5 TERMINAL FUNCTIONS

PIN NO.	SYMBOL	LEVEL	FUNCTION
1	VSS	0V	GND
2	VDD	+5.0V	Power Supply for logic
3	V ₀	0V	Operating voltage for LCD
4	RS	H/L	H: Data L: Instruction code
5	R/W	H/L	H: Read L: Write
6	E	H-L	Chip Enable signal
7~14	DB0~DB7	H/L	Data bus line
15	LEDA	+5.0V	Power Supply for LED Back Light
16	LEDK	0V	

1.6 POWER SUPPLY AND CONTRAST ADJUST CIRCUIT



2. ABSOLUTE MAXIMUM RATINGS

(Ta=25 °C, Vss=0V)

PARAMETER	SYMBOL	RATINGS	UNITS
POWER SUPPLY FOR LOGIC	V _{DD} -V _{SS}	-0.3~7.0	V
POWER SUPPLY FOR LCD DRIVER	V _{DD} ~V _S	0 ~ 10.0	V
INPUT VOLTAGE	V _{IN}	V _{SS} ~ V _{DD}	V
OPERATING TEMPERATURE	Topr	-20 ~70	°C
STORAGE TEMPERATURE	Tstg	-30 ~ 80	°C

3. ELECTRICAL CHARACTERISTICS

3.1 ELECTRICAL CHARACTERISTICS

(Ta=25 °C ,Vss=0V)

ITEM	SYMBOL	CONDITION	MIN	TYPE	MAX.	UNIT	NOTE
LOGIC CIRCUIT POWER SUPPLY VOLTAGE	V _{DD} -V _{SS}	--	4.5	5.0	5.3	V	
INPUT VOLTAGE	V _{IL}	--	-0.3	--	0.6	V	
INPUT VOLTAGE	V _{IH}	--	2.2	--	V _{DD}	V	
OUTPUT VOLTAGE	V _{OL}	--	0	--	0.4	V	
OUTPUT VOLTAGE	V _{OH}	--	2.4	--	V _{DD}	V	
LOGIC CIRCUIT POWER SUPPLY CURRENT	I _{DD}	V _{DD} -V _{SS} =5.0V	--	1.1	--	mA	
RECOMMENDED LCD DRIVING VOLTAGE	*V _{LCD} Φ=0 θ=0	Ta=25 °C	--	5.0	--	V	

*Note: VLCD is produced by module's inside circuit, do not need the external input. The customer only need to offer +5.0V voltage which is stated in the interface definition.

3.2 LED BACKLIGHT SPECIFICATION

ITEM	SYMBOL	MIN.	TYP.	MAX.	UNIT	CONDITIONS
FORWARD VOLTAGE	Vf	3.0	3.1	3.2	V	If= 30mA
COLOR	WHITE					

4. TIMING CHARACTERISTICS

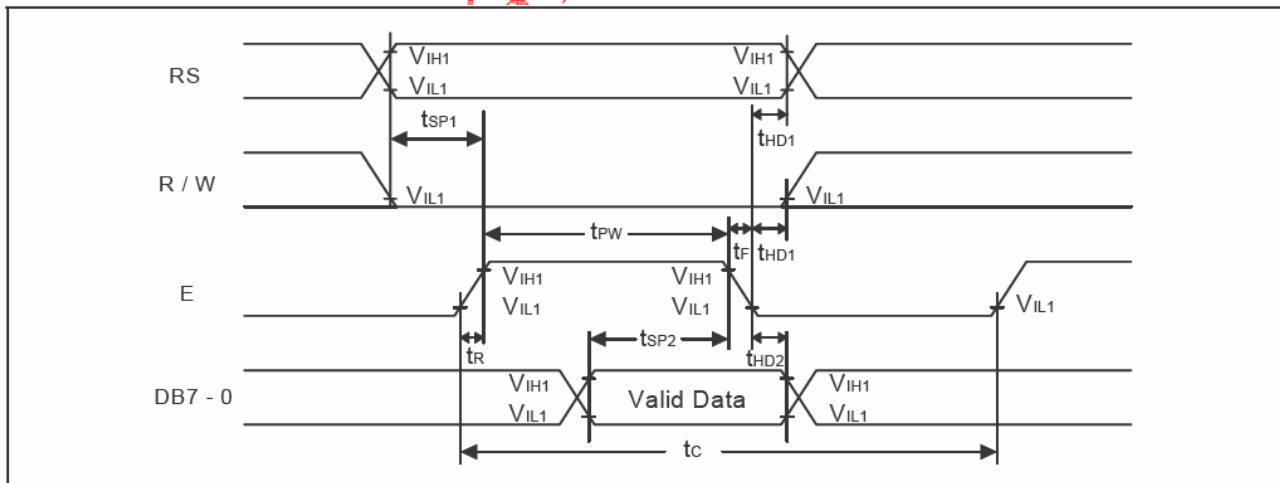
4.1 Write mode (Writing Data from MPU to SPLC780D1)

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

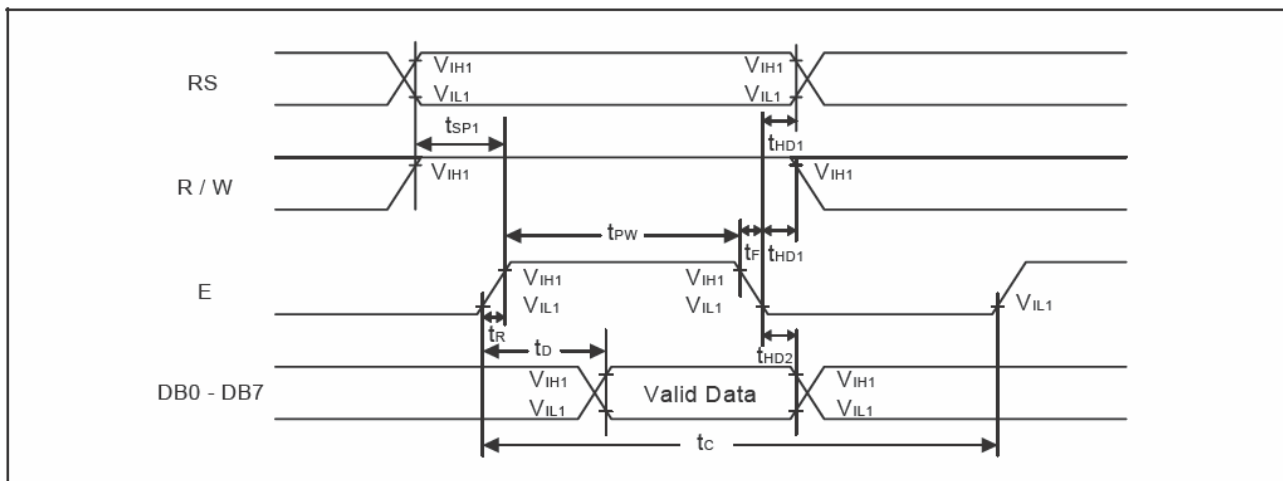
4.2 Read mode (Reading Data from SPLC780D1 to MPU)

Characteristics	Symbol	Limit			Unit	Test Condition
		Min.	Typ.	Max.		
E Cycle Time	t_C	400	-	-	ns	Pin E
E Pulse Width	t_W	150	-	-	ns	Pin E
E Rise/Fall Time	t_R, t_F	-	-	25	ns	Pin E
Address Setup Time	t_{SP1}	30	-	-	ns	Pins: RS, R/W, E
Address Hold Time	t_{HD1}	10	-	-	ns	Pins: RS, R/W, E
Data Output Delay Time	t_D	-	-	100	ns	Pins: DB0 - DB7
Data hold time	t_{HD2}	5.0	-	-	ns	Pin DB0 - DB7

4.3 Write mode timing diagram (Writing Data from MPU to SPLC780D1)



4.4 Read mode timing diagram (Reading Data from SPLC780D1 to MPU)



5. COMMANDS AND FUNCTION DESCRIPTIONS

5.1 Control and Display Instructions

Control and display instructions are described in details as follows:

5.1.1 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.

5.1.2 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.

5.1.3 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

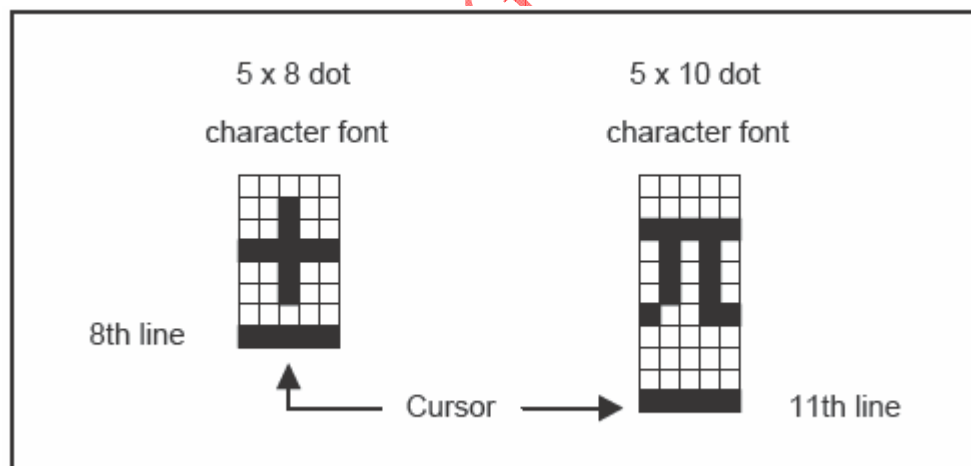
5.1.4 Display ON/OFF control

	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

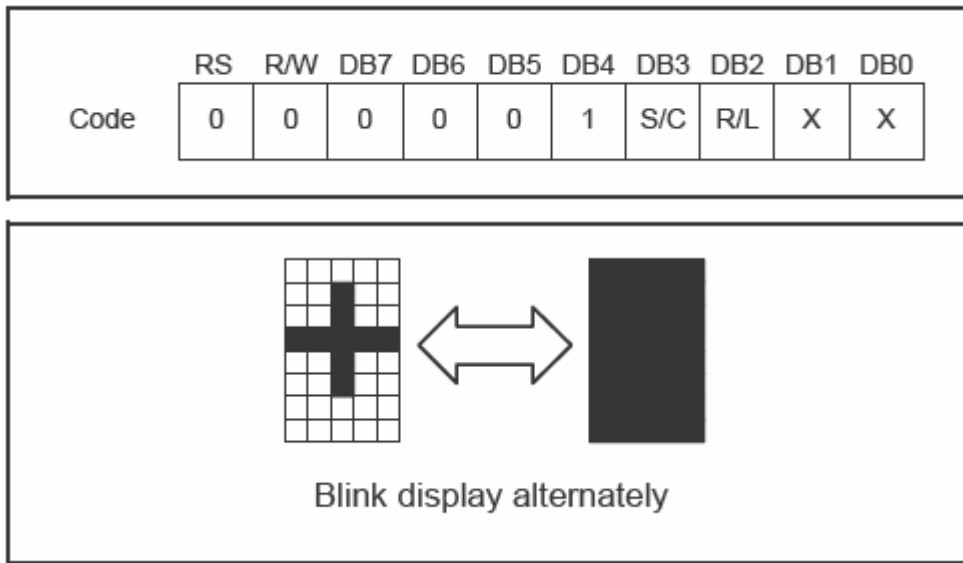
C = 1: Cursor on, C = 0: Cursor off

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



5.1.5 Cursor or display shift

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



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

5.1.6 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.

5.1.7 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.

5.1.8 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.

5.1.9 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.

5.1.10 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.

5.1.11 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.

5.2 Instruction Table

Instruction	Instruction Code										Description	Execution time (Temp = 25°C)		
	RS	RW	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0		Fosc= 190KHz	Fosc= 270KHz	Fosc= 350KHz
Clear Display	0	0	0	0	0	0	0	0	0	1	Write "20H" to DDRAM and set DDRAM address to "00H" from AC	2.16ms	1.52ms	1.18ms
Return Home	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.	2.16ms	1.52ms	1.18ms
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	53μs	38μs	29μs
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.	53μs	38μs	29μs
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.	53μs	38μs	29μs
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)	53μs	38μs	29μs
Set CGRAM Address	0	0	0	1	AC5	AC4	AC3	AC2	AC1	AC0	Set CGRAM address in address counter.	53μs	38μs	29μs
Set DDRAM Address	0	0	1	AC6	AC5	AC4	AC3	AC2	AC1	AC0	Set DDRAM address in address counter	53μs	38μs	29μs
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).	53μs	38μs	29μs
Read Data from RAM	1	1	D7	D6	D5	D4	D3	D2	D1	D0	Read data from internal RAM (DDRAM/CGRAM).	53μs	38μs	29μs

Note1: "-": don't care

Note2: In the operation condition under -20°C ~ 75°C, the maximum execution time for majority of instruction sets is 100μs, except two instructions, "Clear Display" and "Return Home", in which maximum execution time can take up to 4.1ms.

5.3 8-Bit Operation and 8-Digit 1-Line Display (Using Internal Reset)

No.	Instruction	Display	Operation
1	Power on. (SPLC780D1 starts initializing)		Power on reset. No display.
2	Function set RS R/W DB7 DB6 DB5 DB4 DB3 DB2 DB1 DB0 		Set to 8-bit operation and select 1-line display line and character font.
3	Display on / off control 		Display on. Cursor appear.
4	Entry mode set 		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 		Write " W ". The cursor is incremented by one and shifted to the right.
6	Write data to CG RAM / DD RAM 		Write " E ". The cursor is incremented by one and shifted to the right.
7	:	:	
8	Write data to CG RAM / DD RAM 		Write " E ". The cursor is incremented by one and shifted to the right.
9	Entry mode set 		Set mode for display shift when writing
10	Write data to CG RAM / DD RAM 		Write " "(space). The cursor is incremented by one and shifted to the right.
11	Write data to CG RAM / DD RAM 		Write " C ". The cursor is incremented by one and shifted to the right.
12	:	:	
13	Write data to CG RAM / DD RAM 		Write " Y ". The cursor is incremented by one and shifted to the right.
14	Cursor or display shift 		Only shift the cursor's position to the left (Y).
15	Cursor or display shift 		Only shift the cursor's position to the left (M).
16	Write data to CG RAM / DD RAM 		Write " N ". The display moves to the left.
17	Cursor or display shift 		Shift the display and the cursor's position to the right.
18	Cursor or display shift 		Shift the display and the cursor's position to the right.
19	Write data to CG RAM / DD RAM 		Write " "(space). The cursor is incremented by one and shifted to the right.
20	:	:	
21	Return home 		Both the display and the cursor return to the original position (address 0).

5.4 4-Bit Operation and 8-Digit 1-Line Display (Using Internal Reset)

No.	Instruction	Display	Operation
1	Power on. (SPLC780D1 starts initializing)	<div></div>	Power on reset. No display.
2	Function set RS R/W DB7 DB6 DB5 DB4 <div><div>000010</div></div>	<div></div>	Set to 4-bit operation.
3	<div><div>000010</div><div>0000XX</div></div>	<div></div>	Set to 4-bit operation and select 1-line display line and character font.
4	<div><div>000000</div><div>001110</div></div>	<div><div>-</div></div>	Display on. Cursor appears.
5	<div><div>000000</div><div>000110</div></div>	<div><div>-</div></div>	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	<div><div>100101</div><div>100111</div></div>	<div><div>W-</div></div>	Write " W ". The cursor is incremented by one and shifted to the right.

5.5 8-Bit Operation and 8-Digit 2-Line Display (Using Internal Reset)

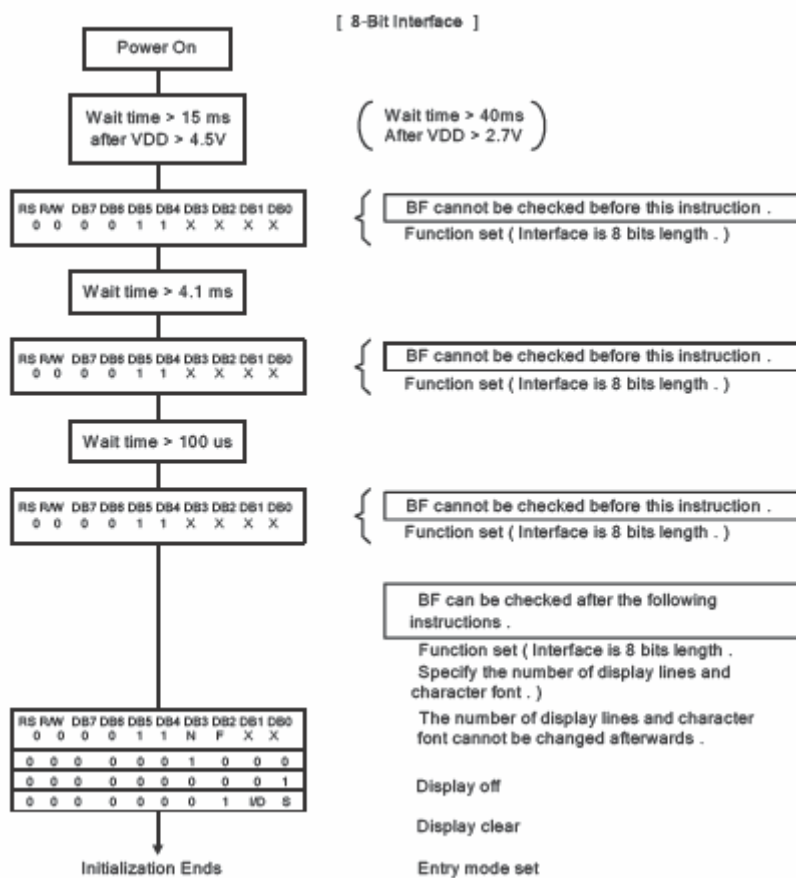
No.	Instruction	Display	Operation
1	Power on. (SPLC780D1 starts initializing)	<div></div> <div></div>	Power on reset. No display.
2	Function set RS R/W DB7 DB6 DB5 DB4 DB3 DB2 DB1 DB0 <div><div>0</div><div>0</div><div>0</div><div>0</div><div>1</div><div>1</div><div>1</div><div>0</div><div>X</div><div>X</div></div>	<div></div> <div></div>	Set to 8-bit operation and select 2-line display line and 5 x 8 dot character font.
3	Display on / off control <div><div>0</div><div>0</div><div>0</div><div>0</div><div>0</div><div>0</div><div>1</div><div>1</div><div>1</div><div>0</div></div>	<div></div> <div></div>	Display on. Cursor appear.
4	Entry mode set <div><div>0</div><div>0</div><div>0</div><div>0</div><div>0</div><div>0</div><div>0</div><div>1</div><div>1</div><div>0</div></div>	<div></div> <div></div>	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 <div><div>1</div><div>0</div><div>0</div><div>1</div><div>0</div><div>1</div><div>0</div><div>1</div><div>1</div><div>1</div></div>	<div>W</div> <div></div>	Write " W ". The cursor is incremented by one and shifted to the right.
6	:	:	:
7	Write data to CG RAM / DD RAM <div><div>1</div><div>0</div><div>0</div><div>1</div><div>0</div><div>0</div><div>0</div><div>1</div><div>0</div><div>1</div></div>	<div>WELCOME</div> <div></div>	Write " E ". The cursor is incremented by one and shifted to the right.
8	Set DD RAM address <div><div>0</div><div>0</div><div>1</div><div>1</div><div>0</div><div>0</div><div>0</div><div>0</div><div>0</div><div>0</div></div>	<div>WELCOME</div> <div></div>	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 <div><div>1</div><div>0</div><div>0</div><div>1</div><div>0</div><div>1</div><div>0</div><div>1</div><div>0</div><div>0</div></div>	<div>WELCOME</div> <div>T</div>	Write " T ". The cursor is incremented by one and shifted to the right.
10	:	:	:
11	Write data to CG RAM / DD RAM <div><div>1</div><div>0</div><div>0</div><div>1</div><div>0</div><div>1</div><div>0</div><div>1</div><div>0</div><div>0</div></div>	<div>WELCOME</div> <div>TO PART</div>	Write " T ". The cursor is incremented by one and shifted to the right.

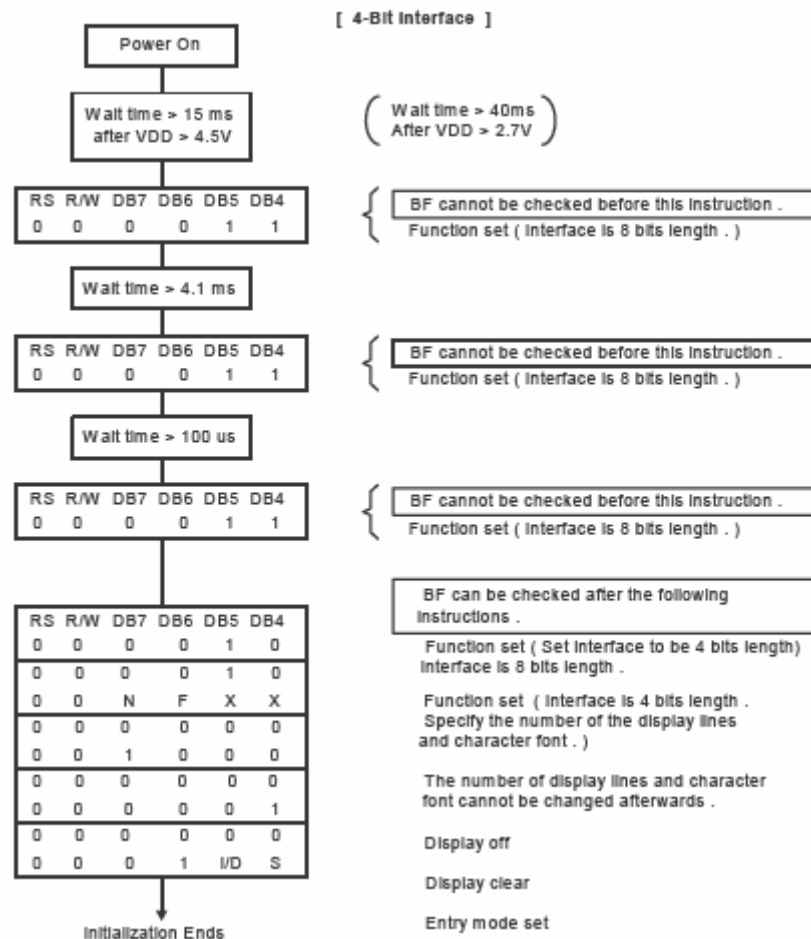
No.	Instruction	Display	Operation
12	Entry mode set 0 0 0 0 0 0 0 1 1 1	WELCOME TO PARTY_	When writing, it sets mode for the display shift.
13	Write data to CG RAM / DD RAM 1 0 0 1 0 1 1 0 0 1	ELCOME O PARTY_	Write " Y ". The cursor is incremented by one and shifted to the right.
14	:	:	:
15	Return home 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).

5.6 Reset Function

At power on, SPLC780D1 starts the internal auto-reset circuit and executes the initial instructions.

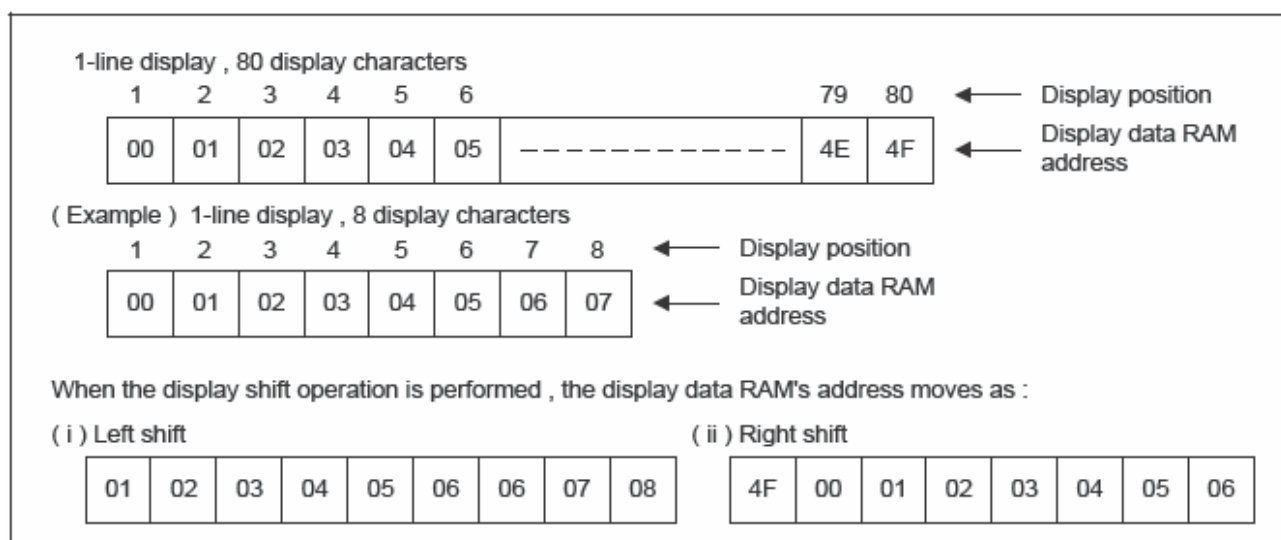
The initial procedures are shown as follows:





5.7 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.



5.8 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.

5.9 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.

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The following diagram shows the SPLC780D1 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:

5.9.1 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	0	0	0	0	0	0	X	X	X	1	1	1	1	1
																	0	0	1	0	0
																	0	0	1	0	0
																	0	0	1	0	0
																	0	0	1	0	0
																	0	0	1	0	0
																	0	0	1	0	0
																	0	0	1	0	0
0	0	0	0	X	0	0	1	0	0	0	1	0	0	X	X	X	0	1	1	1	0
																	0	0	1	0	0
																	0	0	1	0	0
																	0	0	1	0	0
																	0	0	1	0	0
																	0	0	1	0	0
																	0	0	1	0	0
																	0	1	1	1	0
																	0	0	0	0	0

Character
Pattern
Example (1)

Cursor
Position

Character
Pattern
Example (2)

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.

5.9.2 5 X 10 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	X	0	0	0	0	0	0	1	1	1	1	1	0	0	0	1
										0	0	0	1	1	1	1	1	0	0	0	1	
										0	0	1	0	1	1	1	1	0	0	0	1	
										0	0	1	1	1	1	1	1	0	0	0	1	
										0	1	0	0	1	1	1	1	0	0	0	1	
										0	1	1	0	1	1	1	1	0	0	0	1	
										0	1	1	1	0	1	1	1	0	0	0	1	
										1	0	0	0	0	0	0	0	0	0	0	1	
										1	0	0	1	0	0	0	0	0	0	0	1	
										1	0	1	0	0	0	0	0	0	0	0	1	
										1	0	1	1	0	0	0	0	0	0	0	1	
										1	1	0	0	0	0	0	0	0	0	0	1	
										1	1	0	1	0	0	0	0	0	0	0	1	
										1	1	1	0	0	0	0	0	0	0	0	1	
										1	1	1	1	0	0	0	0	0	0	0	1	

Character Pattern Example (1)

Cursor Position

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).

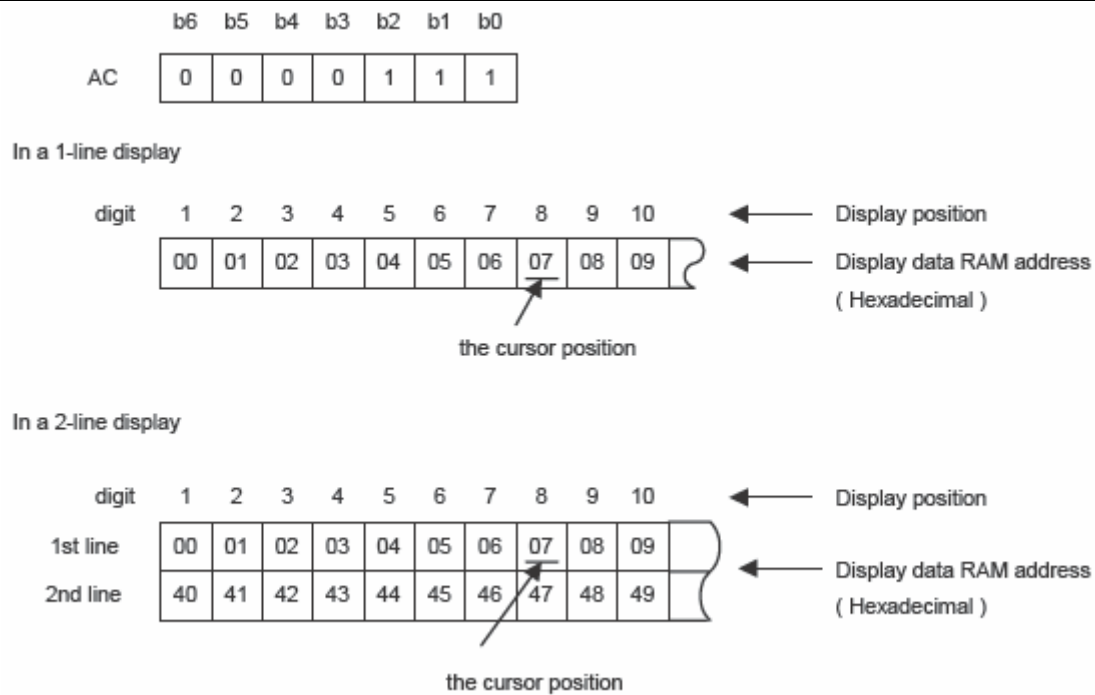
Note5: For example (1), set character code (b2 = b1 = 0, b3 = b0 = 0 or 1, b7-b4 = 0) to display " U ". That means all of the character codes (00) 16, (01) 16, (08) 16, and (09) 16 can display " U " character.

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.

5.10 Cursor/Blink Control Circuit

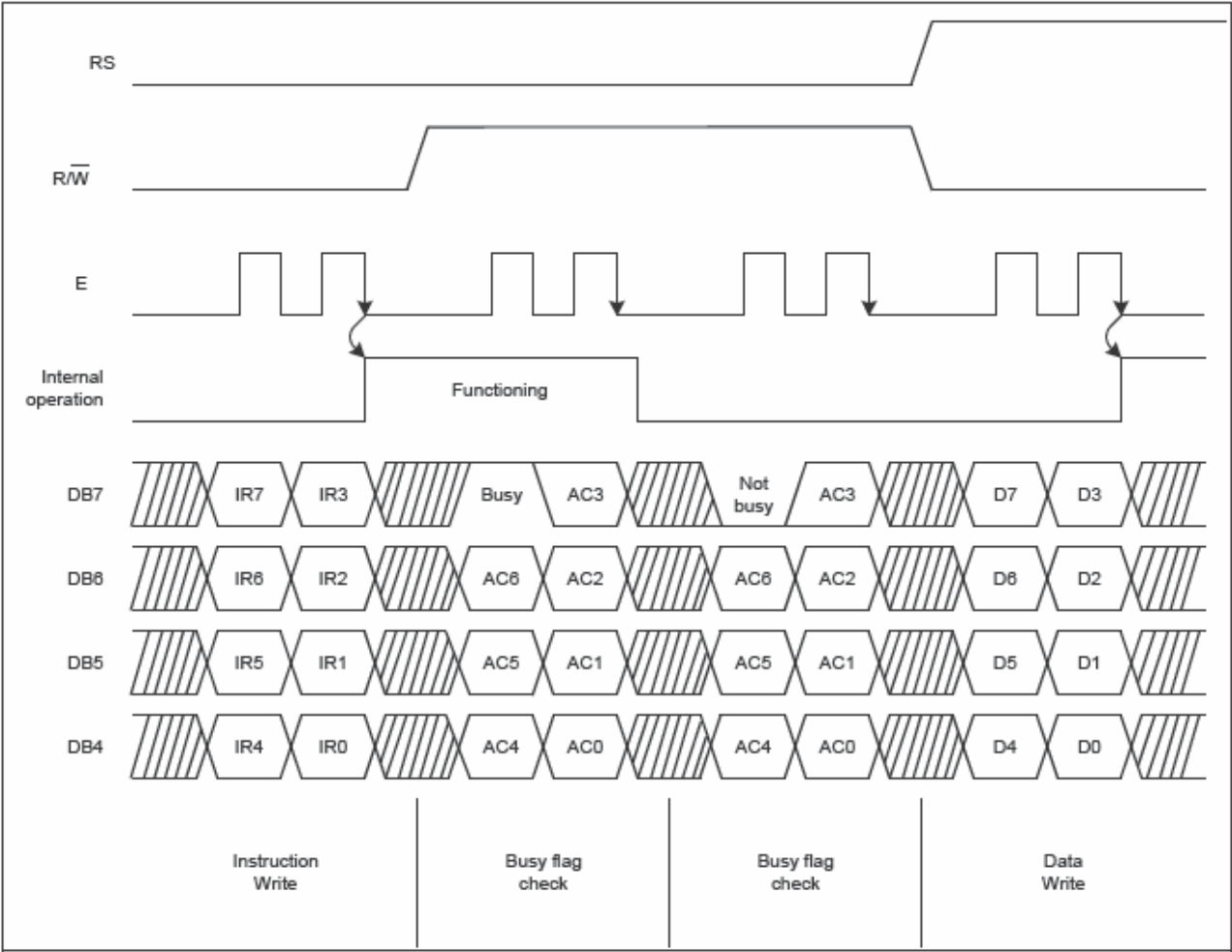
This circuit generates the cursor or blink in the cursor / blink control circuit. The cursor or the blink appears in the digit at the Display Data RAM Address defined in the Address Counter.

When the Address Counter is (07) 16, the cursor position is shown as belows:



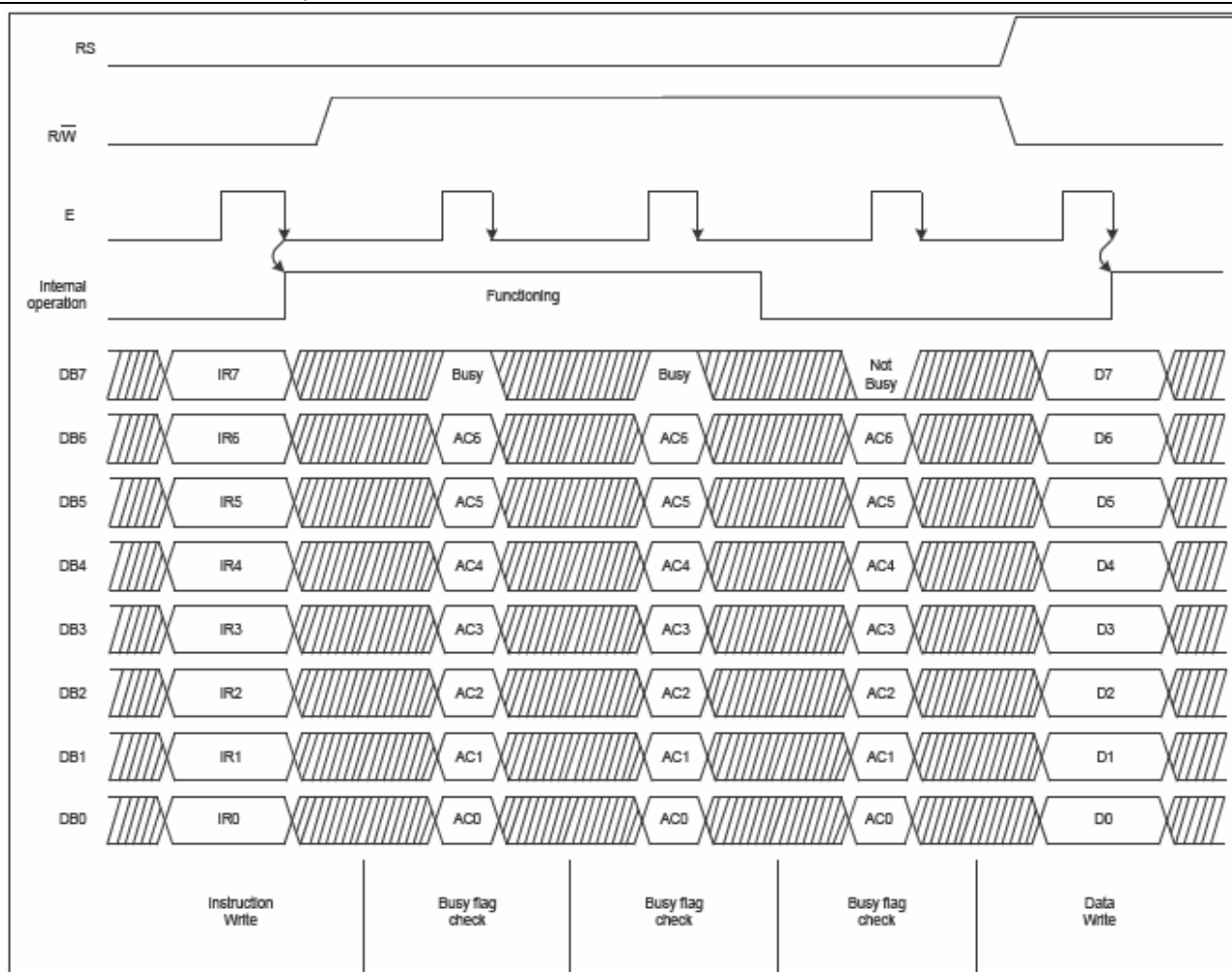
5.11 Interfacing to MPU

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).



Example of 4-bit Data Transfer Timing Sequence

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Example of 8-bit Data Transfer Timing Sequence

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

SPLC780D1 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.

5.13 Busy Flag (BF)

When RS = 0 and R/W = 1, the busy flag is output to DB7. As the busy flag = 1, SPLC780D1 is in busy state and does not accept any instruction until the busy flag = 0.

5.14 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.

TSINGTEK DISPLAY

5.15 CHARACTER GENERATOR ROM

SPLC780D1 – 001A:

Upper 4 bit Lower 4 bit	LLLL	LLLH	LLHL	LLHH	LHLL	LHLH	LHHL	LHHH	HLLL	HLLH	HLHL	HLHH	HHLL	HHHL	HHHH
1111				0	1	2	3	4	5	6	7	8	9	A	B
111H			!	1	2	3	4	5	6	7	8	9	A	B	C
11HL			"	2	3	4	5	6	7	8	9	A	B	C	D
11HH			#	3	4	5	6	7	8	9	A	B	C	D	E
1HLL			\$	4	5	6	7	8	9	A	B	C	D	E	F
1HHL			%	5	6	7	8	9	A	B	C	D	E	F	G
1HHH			&	6	7	8	9	A	B	C	D	E	F	G	H
HLLL			'	7	8	9	A	B	C	D	E	F	G	H	I
HLLH			(8	9	A	B	C	D	E	F	G	H	I	J
HLHL)	9	A	B	C	D	E	F	G	H	I	J	K
HLHH			*	A	B	C	D	E	F	G	H	I	J	K	L
HLLL			+	B	C	D	E	F	G	H	I	J	K	L	M
HHLL			,	C	D	E	F	G	H	I	J	K	L	M	N
HHHL			-	D	E	F	G	H	I	J	K	L	M	N	O
HHHL			.	E	F	G	H	I	J	K	L	M	N	O	P
HHHH			/	F	G	H	I	J	K	L	M	N	O	P	Q

6. QUALITY SPECIFICATIONS

6.1 ACCEPTABLE QUALITY LEVEL

Inspection items	Sampling procedures	AQL
Visual-operating (Electro-optical)	GB2828-81 Inspection level II Normal inspection Single sample inspection	0.65
Visual-not operating	GB2828-81 Inspection level II Normal inspection Single sample inspection	1.5
Dimension measurement	GB2828-81 Inspection level II Normal inspection Single sample inspection	1.5

6.2 INSPECTION CONDITIONS (THE ENVIRONMENTAL)

-Room temperature: 25 ± 3 °C

-Humidity: $65 \pm 20\%$ RH

6.3 INSPECTION STANDARDS

6.3.1 VISUAL WHILE OPERATING

Items to be inspected	Inspection standard
. No display	. If any pattern is not active at all, they can be rejected.
. Irregular operating	. No irregular operating are allowed . Appeared different display, which they should be chosen in the pattern, or appeared in different position where they should be chosen.
. Irregular display	. Any segment doesn't active, they can be rejected.
. Over current	. The total current required to activate the module should not be exceed the MAX current in specification.
. View angles	. Values that don't meet the minimum value noted in the specification. they can be rejected.
. Contrast	. Values that don't meet the minimum value noted in the specification, they can be reject.
. LCD operate voltage	. Meet the specification.

6.3.2 Visual while not operating

Module dimension	. Meet the module outline drawing, not exceed the tolerance.
LCD panel scratch	<p>.Following scratches inside the effective viewing area considered as the defects when their width & length are larger than the following combinations.</p> <p>Number: one or more Width: 0.15 length: 5.0 two or more Width: 0.10 length: 3.0 three or more Width: 0.05 length: 2.0</p> <p>When the defects exceed this, it can be rejected.</p>

7.RELIABILITY

Test Item	Content of Test	Test Condition
High temperature storage	Endurance test applying the high storage temperature for a long time	60℃ 200hrs
Low temperature storage	Endurance test applying the low storage temperature for a long time	-10℃ 200hrs
High temperature operation	Endurance test applying the electric stress (Voltage and Current) and the thermal stress to the element for a long time	50℃ 200hrs
Low temperature operation	Endurance test applying the electric stress under low temperature for a long time	0℃ 200hrs
High temperature /Humidity storage	Endurance test applying the high temperature and high humidity storage for a long time	60℃,90%RH 96hrs
High temperature /Humidity operation	Endurance test applying the electric stress (Voltage and Current) and temperature /Humidity stress to the element for a long time	40℃,90%RH 96hrs
Temperature cycle	<p>Endurance test applying the low and high Temperature cycle</p> <p>-10℃→25℃→60℃ 30min←5min←30min</p> <p>————— 1 cycle</p>	-10℃/60℃ 10 cycle
Vibration test	Endurance test applying the vibration during transportation and using	10~22Hz→1.5mmp-p 22~500Hz→1.5G Total 0.5hrs

Note 1: Condensation of water is not permitted on the module.

Note 2: The module should be inspected after 4 hour storage in normal

8.TEST REPORT

(VDD=5V ,Ta=25℃)

Item	Condition	Standard	Note
High temp. storage	80℃,120 hrs	Appearance without defect	---
Low temp. storage	-30℃,120 hrs	Appearance without defect	---
High temp. operation	70℃,240 hrs	Appearance without defect	---
Low temp. operation	-20℃,240 hrs	Appearance without defect	---
High temp. & humi. Storage	50℃,90% RH,120 hrs	Appearance without defect	---
High temp .& humi.Operation	40℃,90% RH,120 hrs	Appearance without defect	---
Thermal shock	-10℃,30min→+25℃, 5min→+60℃,30min	Appearance without defect	10 cycles

9. PRECAUTIONS FOR USING LCD MODULES

9.1 Precaution

To our module ,we have made accurately assembly and debugging .So customer should do as follows:

- (1) Modules use LCD elements, so we must be treated as such avoid intense shock 、 impact 、 extrusion and falls from a height.
- (2) Avoid to twist and disassemble module's buckle legs.
- (3) Avoid to operate modules on the table if it's surface have printed circuit
- (4) Avoid to touch 、 adjust and modify the rubber that connects LCD and PCB.
- (5) Avoid to add DC(direct current) in module.
- (6) Liquid crystal is harmful Substances .When liquid crystal leaked out and contacted to your hand、 body or clothes ,you must wash it immediately with soap.

9.2 Caution Of Mounting

The panel of the LCD module consists of two thin glass plates with polarizes which easily get damaged since the module is fixed by utilizing fitting holes in the printed circuit board. Extreme care should be taken when handling the LCD modules.

9.3 Caution Of LCD Handling & Cleaning

When cleaning the display surface. Use soft cloth with solvent (recommended below) and wipe lightly.

- Isopropyl alcohol
- Ethyl alcohol

Do not wipe the display surface with dry or hard materials that will damage the polarizes surface.

Do not use the following solvent:

- Water
- Ketone

9.4 Caution Against Static Charge

The LCD modules use COMS LSI drivers. So we recommend that you connect any unused input terminal to Vdd or Vss, do not input any signals before power is turned on and ground your body. work/assembly table. And assembly equipment to protect against static electricity. the following ways are recommended.

- (1) If you doesn't intend to mount, please don't take module from bag. The module's packaging bag is handled by antistatic technology.
- (2) If you intend to operate module that you must make sure your body is good grounding , keeping your body and module at the same level.
- (3) The operating equipment requires to good grounding , especially the driver .In order to avoid interference we must make sure good grounding and no leakage.
- (4) Each module have a protective film .It is used to avoid the polaroid LCD is scratched or polluted .Please peel off the Protective Film slowly ,or else will produce static .
- (5) The humidity range at workshop: 50 ~ 60% RH

9.5 Current Protection Devices

Module was not equipped with current protection devices, so we must prepared the current protection devices for using. The proportion of DC voltage is as small as possible ,preferably no more than 50mV. Or else it will cause electrochemical reaction after a time .

9.6 Caution For Operation

-It is indispensable to drive LCM within the specified voltage limit since the higher voltage than the limit shortens LCM life.

-Response time will be extremely delayed at lower temperature than the operating temperature range and on the other hand at higher temperature LCD show dark color in them.

However those phenomena do not mean malfunction or out of order with LCD, which will come back in the specified operating temperature range.

-If the display area is pushed hard during operation. Some font will be abnormally displayed but it resumes normal condition after turning off once.

-A slight dew depositing on terminals is a cause for Electro-chemical reaction resulting in terminal open circuit.

Under the maximum operating temperature, 50%RH or less is required

9.7 Caution For Soldering

If need soldering, we must notice as follows:

※ Except the connect position of INPUT and OUTPUT doesn't allow to soldering.

※ Soldering iron required to be insulated.

(1) Soldering Conditions:

Iron Temperature : $280^{\circ}\text{C} \pm 10^{\circ}\text{C}$

Soldering Time: < 3-4S

Soldering Materials: Low melting point, can be fully molten solder

(2) Caution for repeat soldering:

Because connect line is through module's pad connected to module. Removing the line we must wait until the solder is completely melted . If solder doesn't completely melted , it is easily lead to the pad damage or loss.Using “ XI QIANG” is the best way to remove the connect line .Besides, we must notice that repeat soldering doesn't allow more than three time.

9.8 Packaging And Storage

When module needs to store a long time ,we should do as follows.If storage method is improper,it will have an effect on the Polaroid ,causing display not good.Meanwhile pads are easily oxidized lead to soldering didn't easily .

- (1) As far as possible to use the original packaging bag.
- (2) If we intend to store bulk modules ,we should put them in anti-static bag and sealing .
- (3) To prevent modules from degradation, do not operate or store them exposed directly to sunshine or high temperature/humidity.
- (4) The reasonable storage method is low humidity, temperature in 0℃ to 35℃
- (5) Storing with no touch on polarizes surface by the anythingelse.

10.PRECAUTIONS FOR CUSTOMER

- (1) A limit sample should be provided by the both parties on an occasion when the both parties agree its necessity.Judgement by a limit sample shall take effect after the limit sample has been established and confirmed by the both parties.
- (2) On the following occasions, the handling of problem should be decided through discussion and agreement between representative of the both parties.
 - When a question is arisen in this specification.
 - When a new problem is arisen which is not specified in this specifications.
 - When an inspection specification change or operating condition change in customer is reported to TSINGTEK, and some problem is arisen in this specification due to the change.
 - When a new problem is arisen at the customer's operating set for sample evaluation in the customer size.