NHD-0216BZ-FL-YBW

Character Liquid Crystal Display Module

NHD-	Newhaven Display
0216-	2 lines x 16 characters
BZ-	Model
F-	Transflective
L-	Yellow/Green LED Backlight
Y-	STN- Yellow/Green
B-	6:00 view
W-	Wide Temperature (-20°C~+70°C)
	RoHS Compliant

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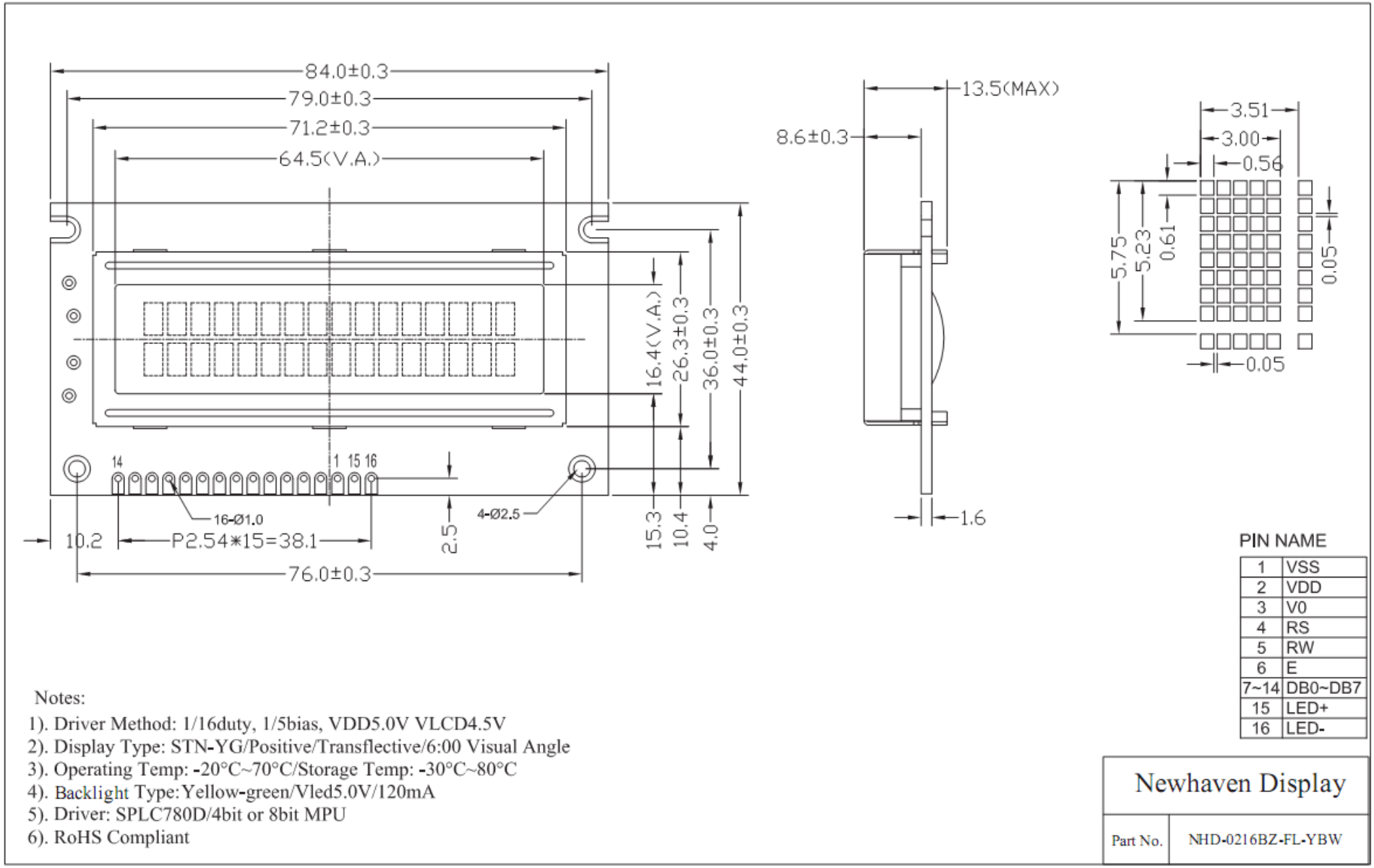
Document Revision History

Revision	Date	Description	Changed by
0	**3/3/2009**	**Initial Release**	**-**
1	**12/21/2009**	**User Guide Reformat**	**BE**
2	**1/7/2010**	**Optical revised**	**BE**

Functions and Features

- **2 lines x 16 characters**
- **Built-in controller (SPLC780D or equivalent)**
- **+5.0V Power Supply**
- **1/16 duty, 1/5 bias**
- **RoHS compliant**

Mechanical Drawing



PIN NAME

1	VSS
2	VDD
3	V0
4	RS
5	RW
6	E
7~14	DB0~DB7
15	LED+
16	LED-

Notes:

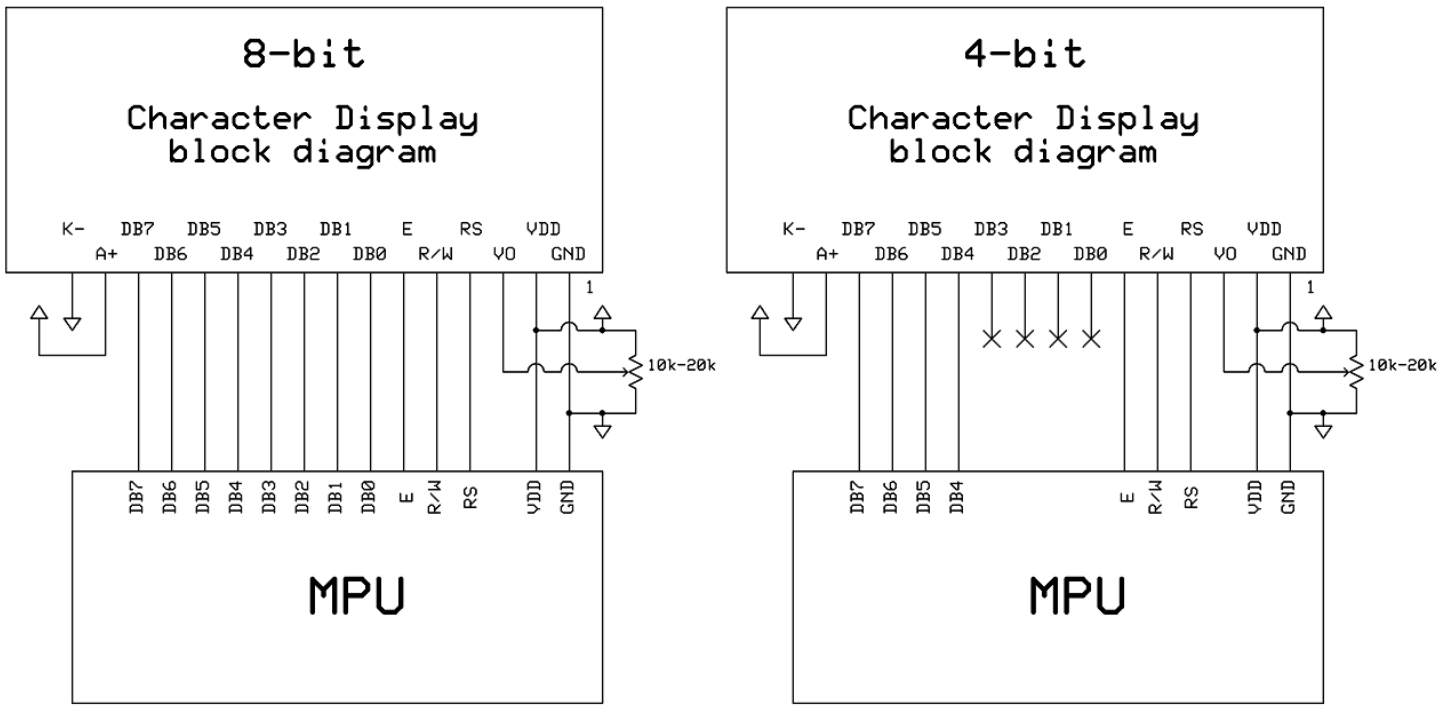
1). Driver Method: 1/16duty, 1/5bias, VDD5.0V VLCD4.5V
2). Display Type: STN-YG/Positive/Transflective/6:00 Visual Angle
3). Operating Temp: -20°C~70°C/Storage Temp: -30°C~80°C
4). Backlight Type:Yellow-green/Vled5.0V/120mA
5). Driver: SPLC780D/4bit or 8bit MPU
6). RoHS Compliant

Newhaven Display	
Part No.	NHD-0216BZ-FL-YBW

Pin Description and Wiring Diagram

Pin No.	Symbol	External Connection	Function Description
1	VSS	Power Supply	Ground
2	VDD	Power Supply	Supply Voltage for logic (+5.0V)
3	V0	Adj Power Supply	Power supply for contrast (approx. 0.5V)
4	RS	MPU	Register select signal. RS=0: Command, RS=1: Data
5	R/W	MPU	Read/Write select signal, R/W=1: Read R/W: =0: Write
6	E	MPU	Operation enable signal. Falling edge triggered.
7-10	DB0 – DB3	MPU	Four low order bi-directional three-state data bus lines. These four are not used during 4-bit operation.
11-14	DB4 – DB7	MPU	Four high order bi-directional three-state data bus lines.
15	LED+	Power Supply	Power supply for LED Backlight (+5.0V via on-board resistor)
16	LED-	Power Supply	Ground for Backlight

Recommended LCD connector: 2.54mm pitch pins
Backlight connector: --- **Mates with:** ---



Electrical Characteristics

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
Operating Temperature Range	Top	Absolute Max	-20	-	+70	°C
Storage Temperature Range	Tst	Absolute Max	-30	-	+80	°C
Supply Voltage	VDD		4.7	5.0	5.5	V
Supply Current	IDD	Ta=25°C, VDD=5.0V	-	1.5	2.5	mA
Supply for LCD (contrast)	VDD-V0	Ta=25°C	-	4.5	-	V
"H" Level input	Vih		2.2	-	VDD	V
"L" Level input	Vil		0	-	0.6	V
"H" Level output	Voh		2.4	-	-	V
"L" Level output	Vol		-	-	0.4	V
Backlight Supply Voltage	Vled	-	-	5.0	-	V
Backlight Supply Current	Iled	Vled=5.0V	-	120	-	mA

Optical Characteristics

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
Viewing Angle – Vertical (top)	AV	Cr ≥ 2	-	25	-	º
Viewing Angle – Vertical (bottom)	AV	Cr ≥ 2	-	70	-	º
Viewing Angle – Horizontal (left)	AH	Cr ≥ 2	-	30	-	º
Viewing Angle – Horizontal (right)	AH	Cr ≥ 2	-	30	-	º
Contrast Ratio	Cr		-	2	-	-
Response Time (rise)	Tr	-	-	120	150	ms
Response Time (fall)	Tf	-	-	120	150	ms

Controller Information

Built-in SPLC780D. Download specification at http://www.newhavendisplay.com/app_notes/SPLC780D.pdf

Table of Commands

Instruction	Instruction Code										Description	Execution time (fosc=270KHz)
	RS	R/W	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	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

Display character address code:

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F
40	41	42	43	44	45	46	47	48	49	4A	4B	4C	4D	4E	4F

Timing Characteristics

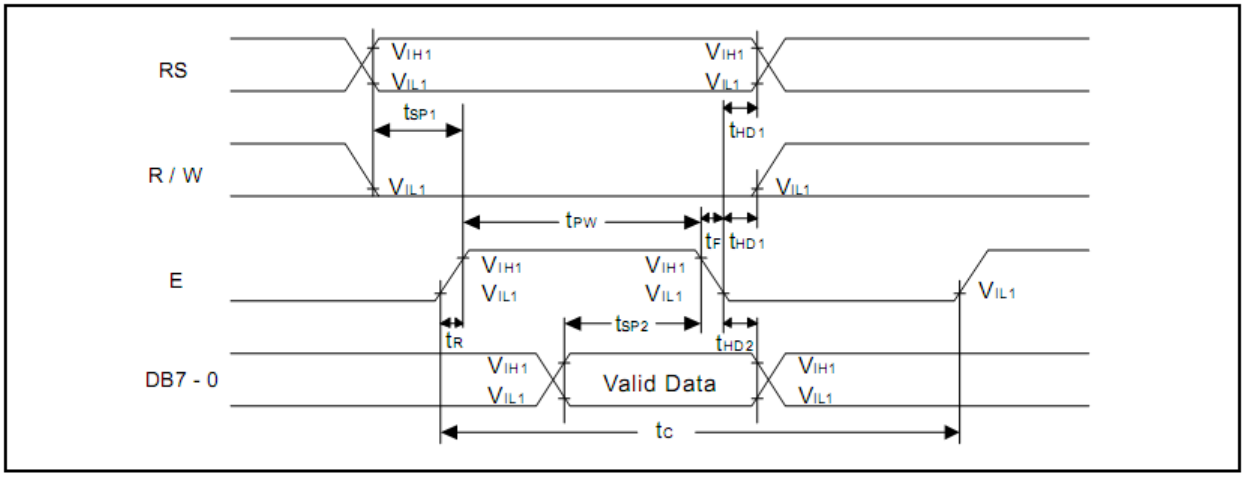
6.5.3. Write mode (Writing Data from MPU to SPLC780D)

Characteristics	Symbol	Limit			Unit	Test Condition
		Min.	Typ.	Max.		
E Cycle Time	t_C	500	-	-	ns	Pin E
E Pulse Width	t_{PW}	230	-	-	ns	Pin E
E Rise/Fall Time	t_R, t_F	-	-	20	ns	Pin E
Address Setup Time	t_{SP1}	40	-	-	ns	Pins: RS, R/W, E
Address Hold Time	t_{HD1}	10	-	-	ns	Pins: RS, R/W, E
Data Setup Time	t_{SP2}	80	-	-	ns	Pins: DB0 - DB7
Data Hold Time	t_{HD2}	10	-	-	ns	Pins: DB0 - DB7

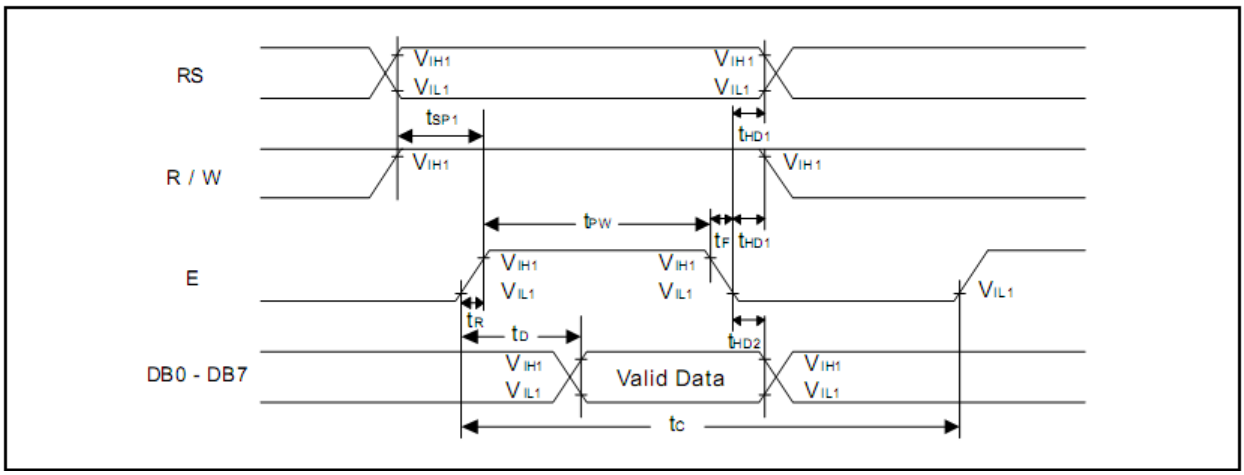
6.5.4. Read mode (Reading Data from SPLC780D to MPU)

Characteristics	Symbol	Limit			Unit	Test Condition
		Min.	Typ.	Max.		
E Cycle Time	t_C	500	-	-	ns	Pin E
E Pulse Width	t_W	230	-	-	ns	Pin E
E Rise/Fall Time	t_R, t_F	-	-	20	ns	Pin E
Address Setup Time	t_{SP1}	40	-	-	ns	Pins: RS, R/W, E
Address Hold Time	t_{HD1}	10	-	-	ns	Pins: RS, R/W, E
Data Output Delay Time	t_D	-	-	120	ns	Pins: DB0 - DB7
Data hold time	t_{HD2}	5.0	-	-	ns	Pin DB0 - DB7

6.5.6. Write mode timing diagram (Writing Data from MPU to SPLC780D)



6.5.7. Read mode timing diagram (Reading Data from SPLC780D to MPU)



Built-in Font Table

Lower 4 Bits \ Upper 4 Bits	0000	0001	0010	0011	0100	0101	0110	0111	1000	1001	1010	1011	1100	1101	1110	1111
xxxx0000	CG RAM (1)			0	@	P	`	p				ー	タ	ミ	α	p
xxxx0001	(2)		!	1	A	Q	a	q			。	ア	チ	ム	ä	q
xxxx0010	(3)		"	2	B	R	b	r			「	イ	ツ	メ	ß	θ
xxxx0011	(4)		#	3	C	S	c	s			」	ウ	テ	モ	ε	∞
xxxx0100	(5)		$	4	D	T	d	t			、	エ	ト	ヤ	μ	Ω
xxxx0101	(6)		%	5	E	U	e	u			・	オ	ナ	ユ	σ	ü
xxxx0110	(7)		&	6	F	V	f	v			ヲ	カ	ニ	ヨ	ρ	Σ
xxxx0111	(8)		'	7	G	W	g	w			ァ	キ	ヌ	ラ	g	π
xxxx1000	(1)		(	8	H	X	h	x			ィ	ク	ネ	リ	√	x̄
xxxx1001	(2)		)	9	I	Y	i	y			ゥ	ケ	ノ	ル	⁻¹	y
xxxx1010	(3)		*	:	J	Z	j	z			ェ	コ	ハ	レ	j	千
xxxx1011	(4)		+	;	K	[	k	{			ォ	サ	ヒ	ロ	ˣ	万
xxxx1100	(5)		,	<	L	¥	l	|			ャ	シ	フ	ワ	¢	円
xxxx1101	(6)		−	=	M	]	m	}			ュ	ス	ヘ	ン	£	÷
xxxx1110	(7)		.	>	N	^	n	→			ョ	セ	ホ	゛	ñ	
xxxx1111	(8)		/	?	O	_	o	←			ッ	ソ	マ	°	ö	■

Example Initialization Program

8-bit Initialization:

```
/*********************************************************/
void command(char i)
{
      P1 = i;                       //put data on output Port
      D_I =0;                       //D/I=LOW : send instruction
      R_W =0;                       //R/W=LOW : Write
      E  = 1;
      Delay(1);                     //enable pulse width  >= 300ns
        E  = 0;                     //Clock enable: falling edge
}
/*********************************************************/
void write(char i)
{
      P1 = i;                       //put data on output Port
      D_I =1;                       //D/I=LOW : send data
      R_W =0;                       //R/W=LOW : Write
      E  = 1;
      Delay(1);                     //enable pulse width  >= 300ns
      E  = 0;                       //Clock enable: falling edge
}
/*********************************************************/
void init()
{
      E = 0;
      Delay(100);                   //Wait >15 msec after power is applied
      command(0x30);                //command 0x30 = Wake up
      Delay(30);                    //must wait 5ms, busy flag not available
      command(0x30);                //command 0x30 = Wake up #2
      Delay(10);                    //must wait 160us, busy flag not available
      command(0x30);                //command 0x30 = Wake up #3
      Delay(10);                    //must wait 160us, busy flag not available
      command(0x38);                //Function set: 8-bit/2-line
      command(0x10);                //Set cursor
      command(0x0c);                //Display ON; Cursor ON
      command(0x06);                //Entry mode set
}
/*********************************************************/
```

4-bit Initialization:

```
/*********************************************************/
void command(char i)
{
      P1 = i;                       //put data on output Port
      D_I =0;                       //D/I=LOW : send instruction
      R_W =0;                       //R/W=LOW : Write
      Nybble();                     //Send lower 4 bits
      i = i<<4;                     //Shift over by 4 bits
      P1 = i;                       //put data on output Port
      Nybble();                     //Send upper 4 bits
}
/*********************************************************/
void write(char i)
{
      P1 = i;                       //put data on output Port
      D_I =1;                       //D/I=HIGH : send data
      R_W =0;                       //R/W=LOW : Write
      Nybble();                     //Clock lower 4 bits
      i = i<<4;                     //Shift over by 4 bits
      P1 = i;                       //put data on output Port
      Nybble();                     //Clock upper 4 bits
}
/*********************************************************/
void Nybble()
{
      E = 1;
      Delay(1);                     //enable pulse width  >= 300ns
      E = 0;                        //Clock enable: falling edge
}
/*********************************************************/
void init()
{
      P1 = 0;
      P3 = 0;
      Delay(100);                   //Wait >15 msec after power is applied
      P1 = 0x30;                    //put 0x30 on the output port
      Delay(30);                    //must wait 5ms, busy flag not available
      Nybble();                     //command 0x30 = Wake up
      Delay(10);                    //must wait 160us, busy flag not available
      Nybble();                     //command 0x30 = Wake up #2
      Delay(10);                    //must wait 160us, busy flag not available
      Nybble();                     //command 0x30 = Wake up #3
      Delay(10);                    //can check busy flag now instead of delay
      P1= 0x20;                     //put 0x20 on the output port
      Nybble();                     //Function set: 4-bit interface
      command(0x28);                //Function set: 4-bit/2-line
      command(0x10);                //Set cursor
      command(0x0F);                //Display ON; Blinking cursor
      command(0x06);                //Entry Mode set
}
/*********************************************************/
```

Quality Information

Test Item	Content of Test	Test Condition	Note
High Temperature storage	Endurance test applying the high storage temperature for a long time.	+80°C , 48hrs	2
Low Temperature storage	Endurance test applying the low storage temperature for a long time.	-30°C , 48hrs	1,2
High Temperature Operation	Endurance test applying the electric stress (voltage & current) and the high thermal stress for a long time.	+70°C 48hrs	2
Low Temperature Operation	Endurance test applying the electric stress (voltage & current) and the low thermal stress for a long time.	-20°C , 48hrs	1,2
High Temperature / Humidity Operation	Endurance test applying the electric stress (voltage & current) and the high thermal with high humidity stress for a long time.	+40°C , 90% RH , 48hrs	1,2
Thermal Shock resistance	Endurance test applying the electric stress (voltage & current) during a cycle of low and high thermal stress.	0°C,30min -> 25°C,5min -> 50°C,30min = 1 cycle 10 cycles	
Vibration test	Endurance test applying vibration to simulate transportation and use.	10-55Hz , 15mm amplitude. 60 sec in each of 3 directions X,Y,Z For 15 minutes	3
Static electricity test	Endurance test applying electric static discharge.	VS=800V, RS=1.5kΩ, CS=100pF One time	

Note 1: No condensation to be observed.
Note 2: Conducted after 4 hours of storage at 25°C, 0%RH.
Note 3: Test performed on product itself, not inside a container.

Precautions for using LCDs/LCMs

See Precautions at www.newhavendisplay.com/specs/precautions.pdf

Warranty Information and Terms & Conditions

http://www.newhavendisplay.com/index.php?main_page=terms

DATA SHEET

SUNPLUS

SPLC780D

16COM/40SEG Controller/Driver

Preliminary

AUG. 06, 2003

Version 0.1

Table of Contents

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16COM/40SEG CONTROLLER/DRIVER

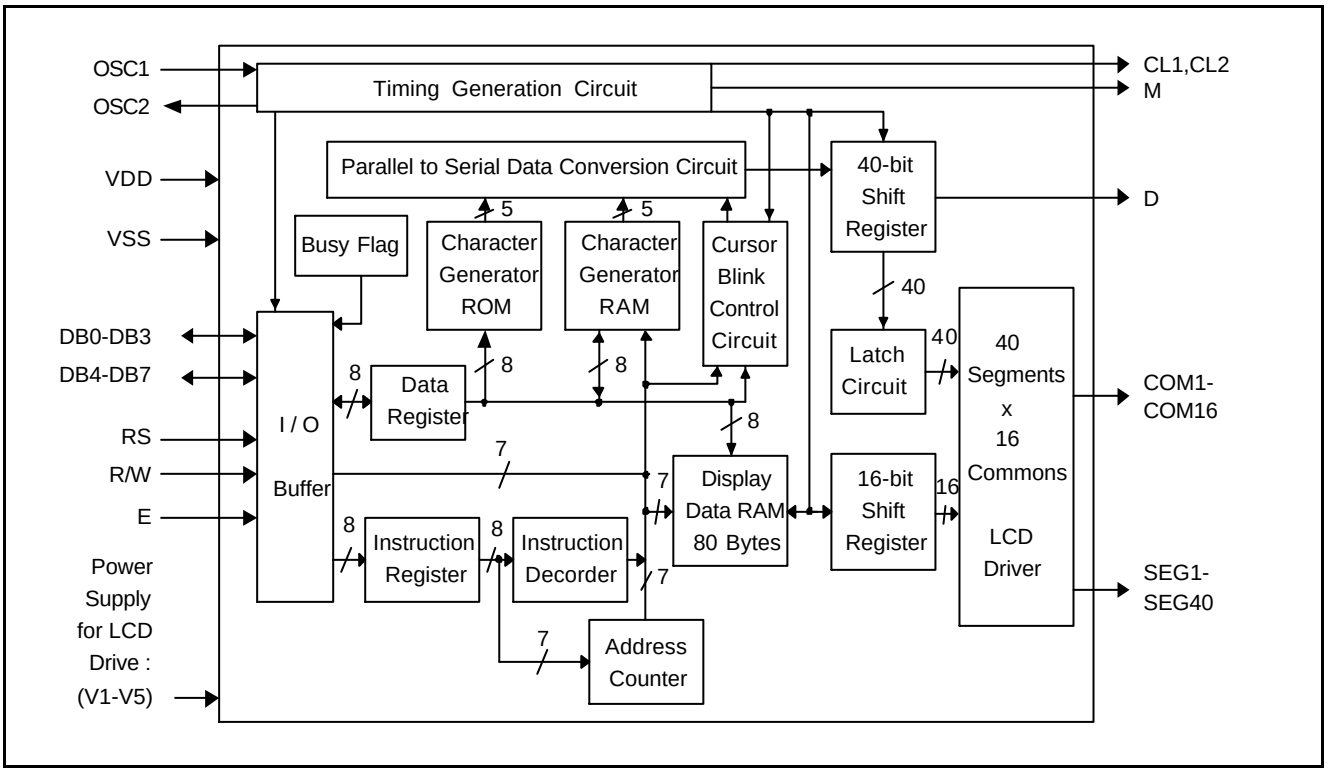
1. GENERAL DESCRIPTION

The SPLC780D, a dot-matrix LCD controller and driver from SUNPLUS, is a unique design for displaying alpha-numeric, Japanese-Kana characters and symbols. The SPLC780D provides two types of interfaces to MPU: 4-bit and 8-bit interfaces. The transferring speed of 8-bit is twice faster than 4-bit. A single SPLC780D is able to display up to two 8character lines. By cascading with SPLC100 or SPLC063, the display capability can be extended. The CMOS technology ensures the power saves in the most efficient way and the performance keeps in the highest rank.

2. FEATURES

- Character generator ROM: 10880 bits
  - Character font 5 x 8 dots: 192 characters
  - Character font 5 x 10 dots: 64 characters
- Character generator RAM: 512 bits
  - Character font 5 x 8 dots: 8 characters
  - Character font 5 x 10 dots: 4 characters
- 4-bit or 8-bit MPU interfaces
- Direct driver for LCD: 16 COMs x 40 SEGs
- Duty factor (selected by program):
  - 1/8 duty: 1 line of 5 x 8 dots
  - 1/11 duty: 1 line of 5 x 10 dots
  - 1/16 duty: 2 lines of 5 x 8 dots / line
- Built-in power on automatic reset circuit
- Built-in oscillator circuit (with external resistor)
- Support external clock operation
- Low Power Consumption
- Package form: 80 QFP or bare chip available

3. BLOCK DIAGRAM



4. SIGNAL DESCRIPTIONS

Mnemonic	PIN No.	Type	Description
VDD	33	I	Power input
VSS	23	I	Ground
OSC1 OSC2	24 25	-	Both OSC1 and OSC2 are connected to resistor for internal oscillator circuit. For external clock operation, the clock is input to OSC1.
V1 - V5	26 - 30	I	Supply voltage for LCD driving.
E	38	I	A start signal for reading or writing data.
R/W	37	I	A signal for selecting read or write actions. 1: Read, 0: Write.
RS	36	I	A signal for selecting registers. 1: Data Register (for read and write) 0: Instruction Register (for write), Busy flag - Address Counter (for read).
DB0 - DB3	39 - 42	I/O	Low 4-bit data
DB4 - DB7	43 - 46	I/O	High 4-bit data
CL1	31	O	Clock to latch serial data D.
CL2	32	O	Clock to shift serial data D.
M	34	O	Switch signal to convert LCD waveform to AC.
D	35	O	Sends character pattern data corresponding to each common signal serially. 1: Selection, 0: Non-selection.
SEG1 - SEG22 SEG23 - SEG40	22 - 1 80 - 63	O	Segment signals for LCD.
COM1 - COM16	47 - 62	O	Common signals for LCD.

4.1. Ordering Information

Product Number	Package Type
SPLC780D-NnnV-C	Chip form
SPLC780D-NnnV-PQ05	Package form - QFP 80L

Note1: Code number is assigned for customer.

Note2: Code number (N = A - Z or 0 - 9, nn = 00 - 99); version (V = A - Z).

5. FUNCTIONAL DESCRIPTIONS

5.1. Oscillator

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

5.2. Control and Display Instructions

Control and display instructions are described in details as follows:

5.2.1. 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.

5.2.2. 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.

5.2.3. 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

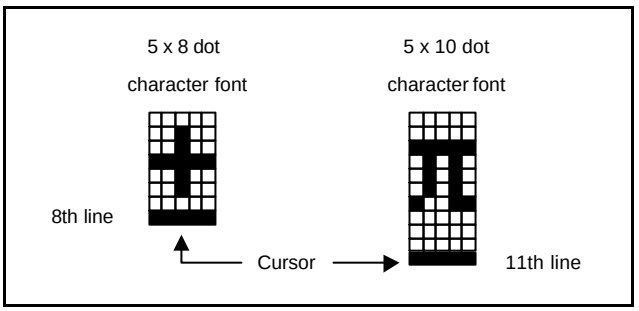
5.2.4. Display ON/OFF control

	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

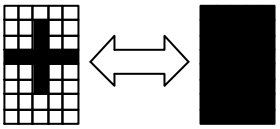
B = 1: Blinks on, B= 0: Blinks off



5.2.5. 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



Blink display alternately

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

5.2.6. 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.

5.2.7. 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.

5.2.8. 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.

5.2.9. 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.

5.2.10. 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 $(dddddddd)_2$ to character generator RAM or display data RAM.

5.2.11. 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 $(dddddddd)_2$ 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.

5.3. Instruction Table

Instruction	Instruction Code										Description	Execution time (fosc=270KHz)
	RS	R/W	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	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: 8bit/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

5.4. 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).

5.5. 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.

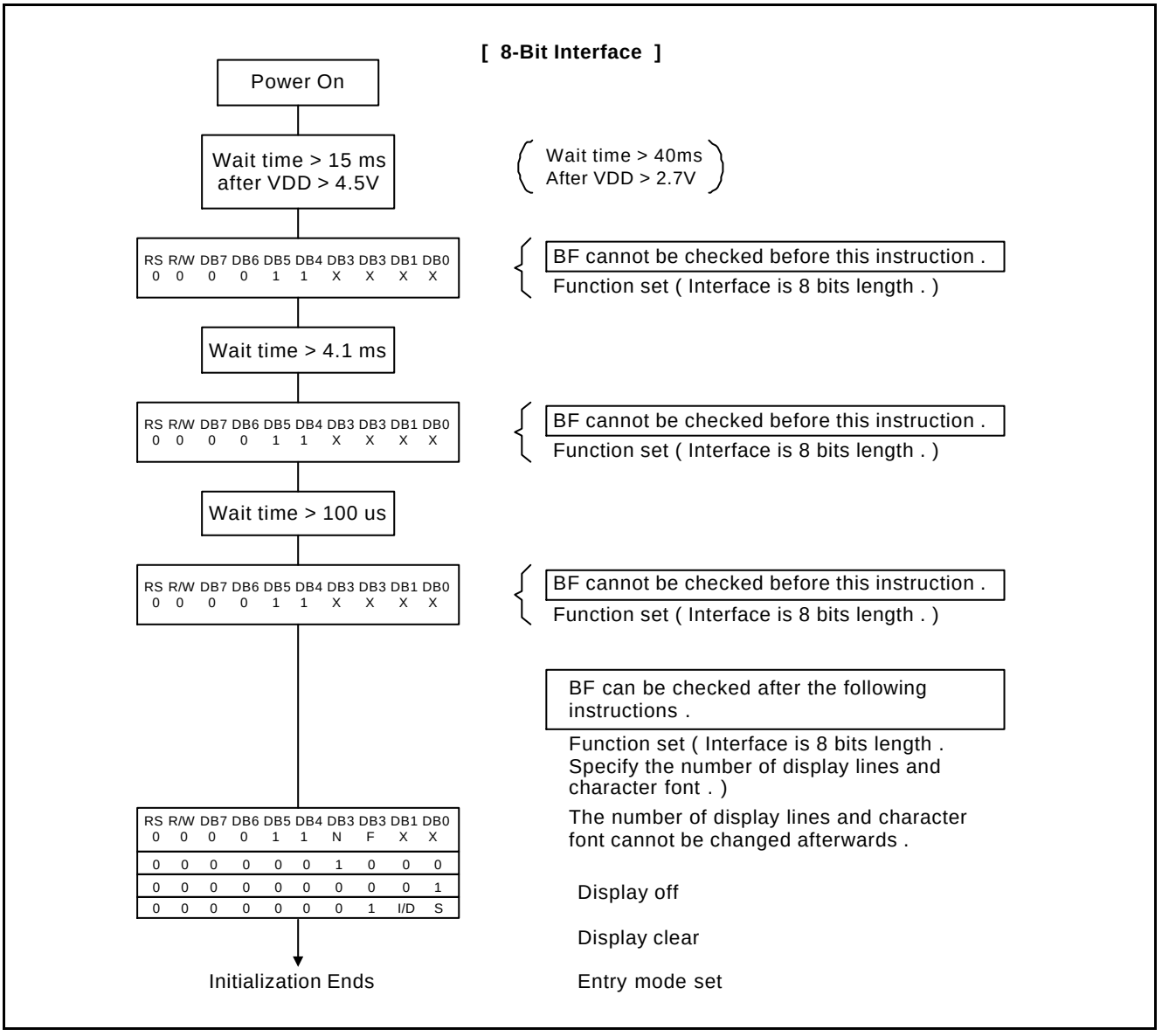
5.6. 8-Bit Operation and 8-Digit 2-Line Display (Using Internal Reset)

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.

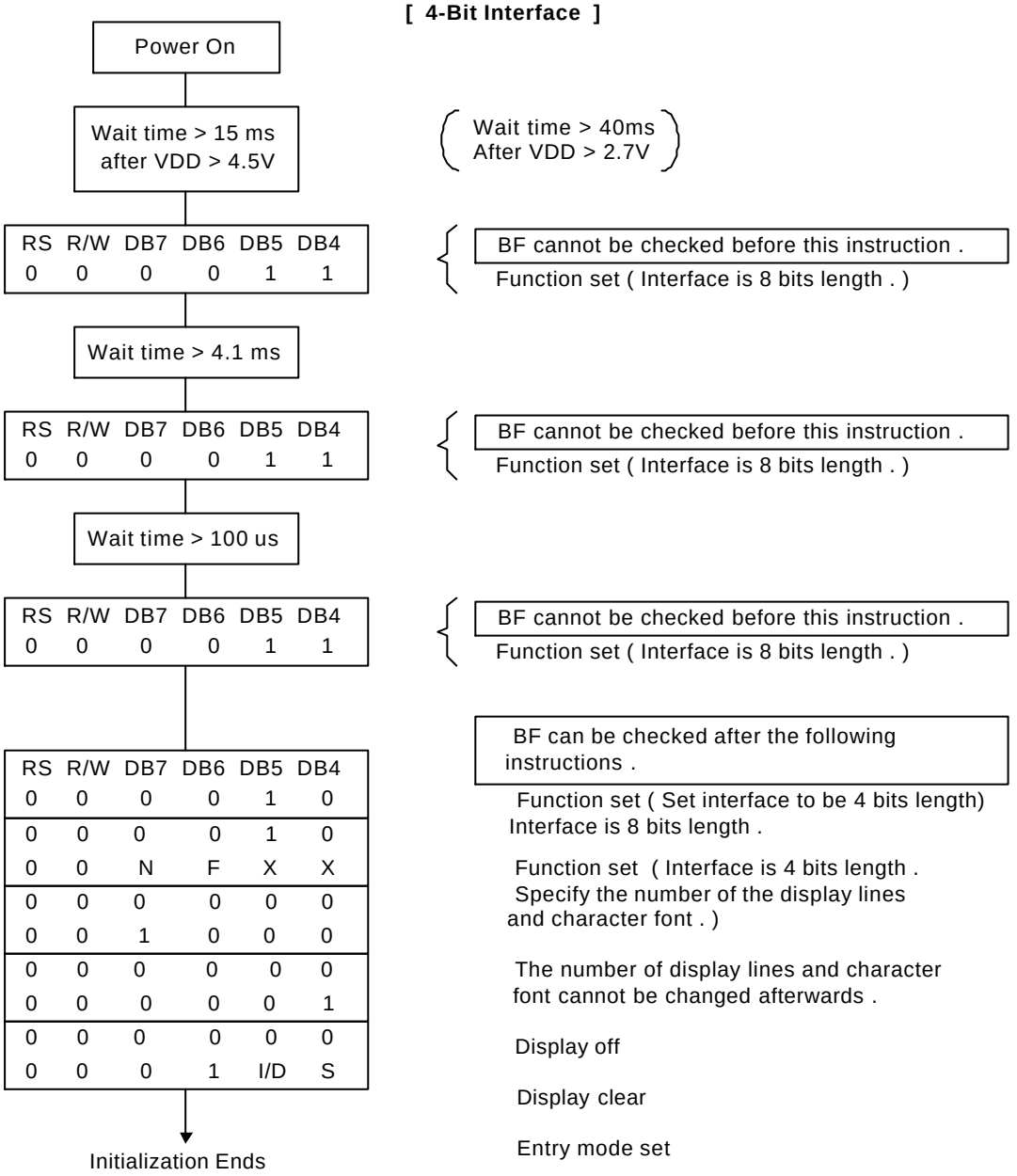
No.	Instruction	Display	Operation
12	Entry mode set 0 0 0 0 0 0 0 1 1 1	WELCOME TO PART_	When writing, it sets mode for the display shift.
13	Write data to CG RAM / DD RAM 1 0 0 1 0 1 1 0 0 1	ELCOME O PARTY_	Write " Y ". The cursor is incremented by one and shifted to the right.
14	:	:	:
15	Return home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

5.7. Reset Function

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

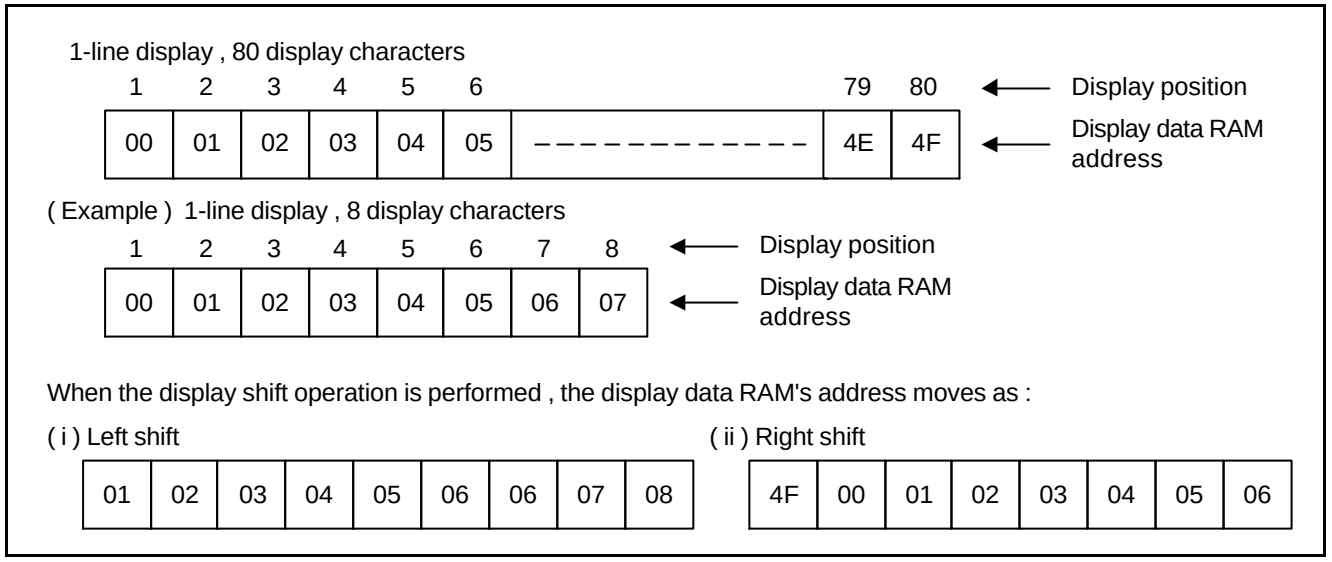


[4-Bit Interface]



5.8. 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.



5.9. 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.

5.10. 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.

5.11. 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.

5.12. 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.

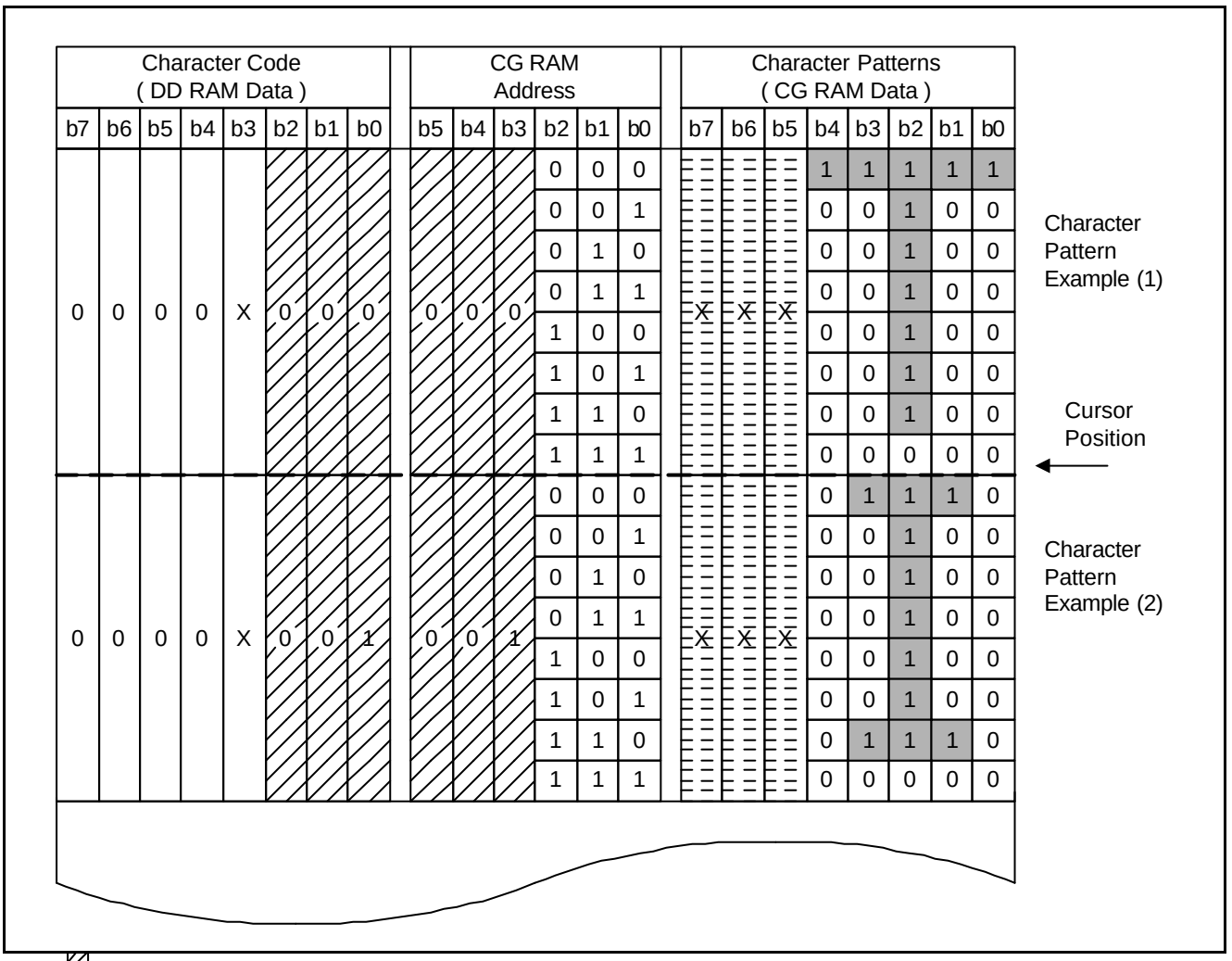
The following diagram shows the SPLC780D character patterns:

Correspondence between Character Codes and Character Patterns.

Lower 4-bit (D0 to D3) of Character Code (Hexadecimal)	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
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:

5.12.1. 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	0	0	0	0	0	0	X	X	X	1	1	1	1	1
											0	0	1				0	0	1	0	0
											0	1	0				0	0	1	0	0
											0	1	1				0	0	1	0	0
											1	0	0				0	0	1	0	0
											1	0	1				0	0	1	0	0
											1	1	0				0	0	1	0	0
											1	1	1				0	0	0	0	0
0	0	0	0	X	0	0	1	0	0	1	0	0	0	X	X	X	0	1	1	1	0
											0	0	1				0	0	1	0	0
											0	1	0				0	0	1	0	0
											0	1	1				0	0	1	0	0
											1	0	0				0	0	1	0	0
											1	0	1				0	0	1	0	0
											1	1	0				0	1	1	1	0
											1	1	1				0	0	0	0	0

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.

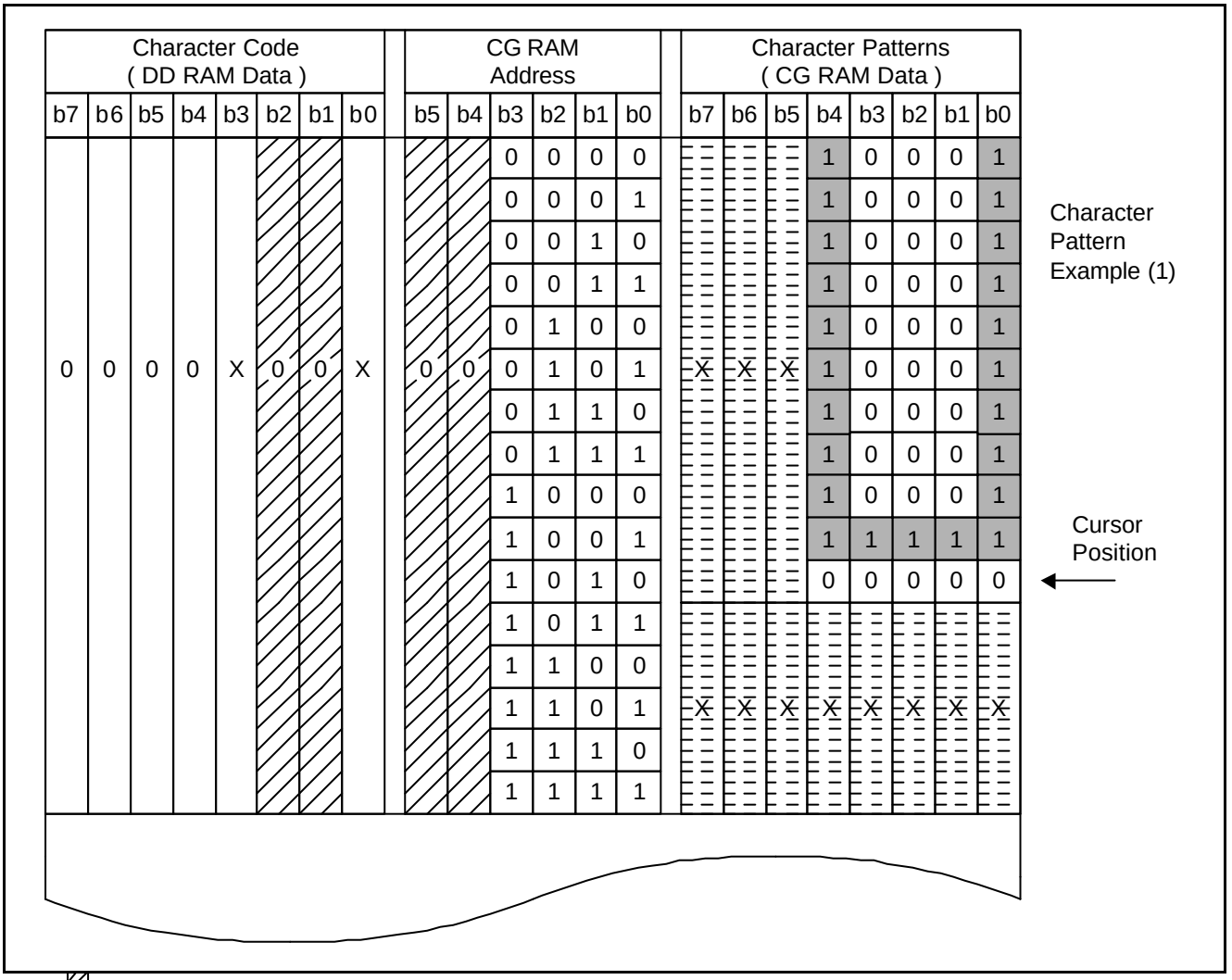
Note3: When all of the bit4-7 of the character code are 0, CG RAM character patterns are selected.

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.

5.12.2. 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.

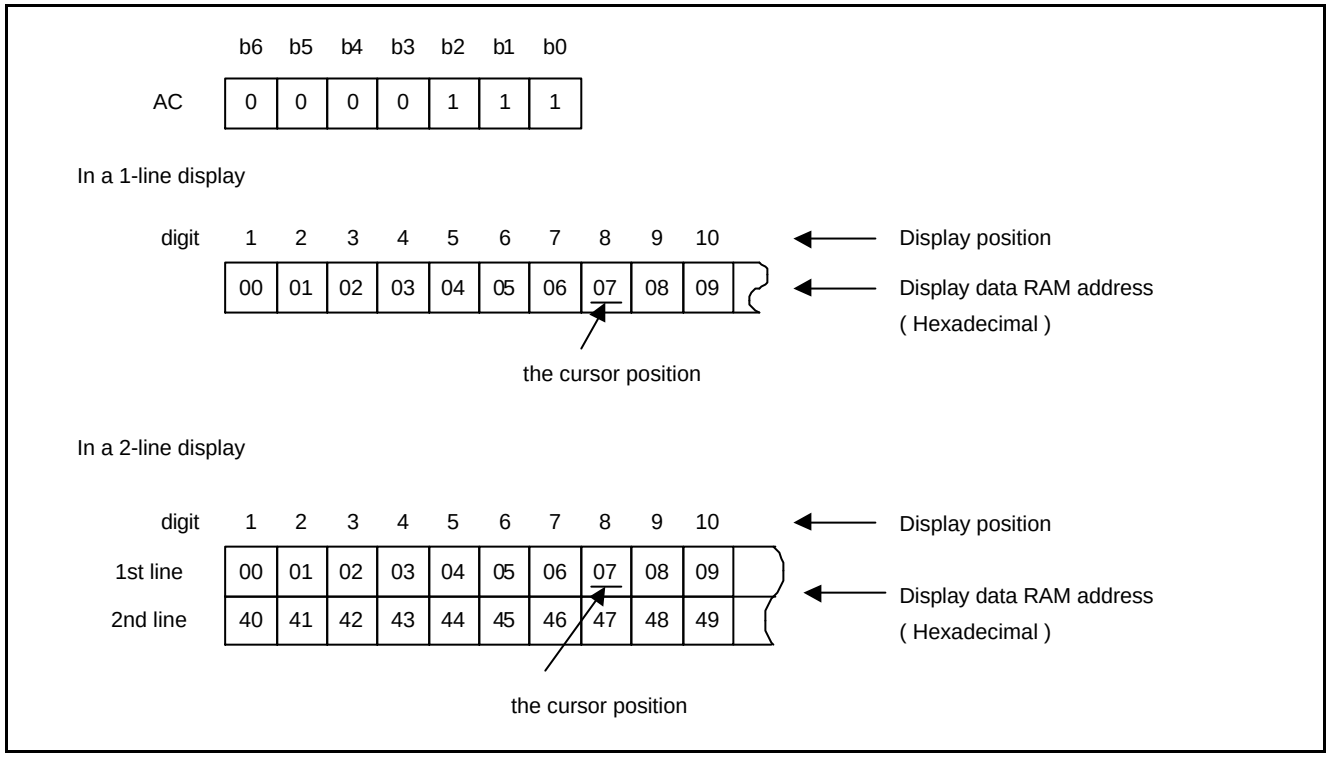
Note4: " 1 " : Selected, " 0 " : No selected, " X " : Do not care (0 or 1).

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.

5.13. 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:



5.14. Interfacing to MPU

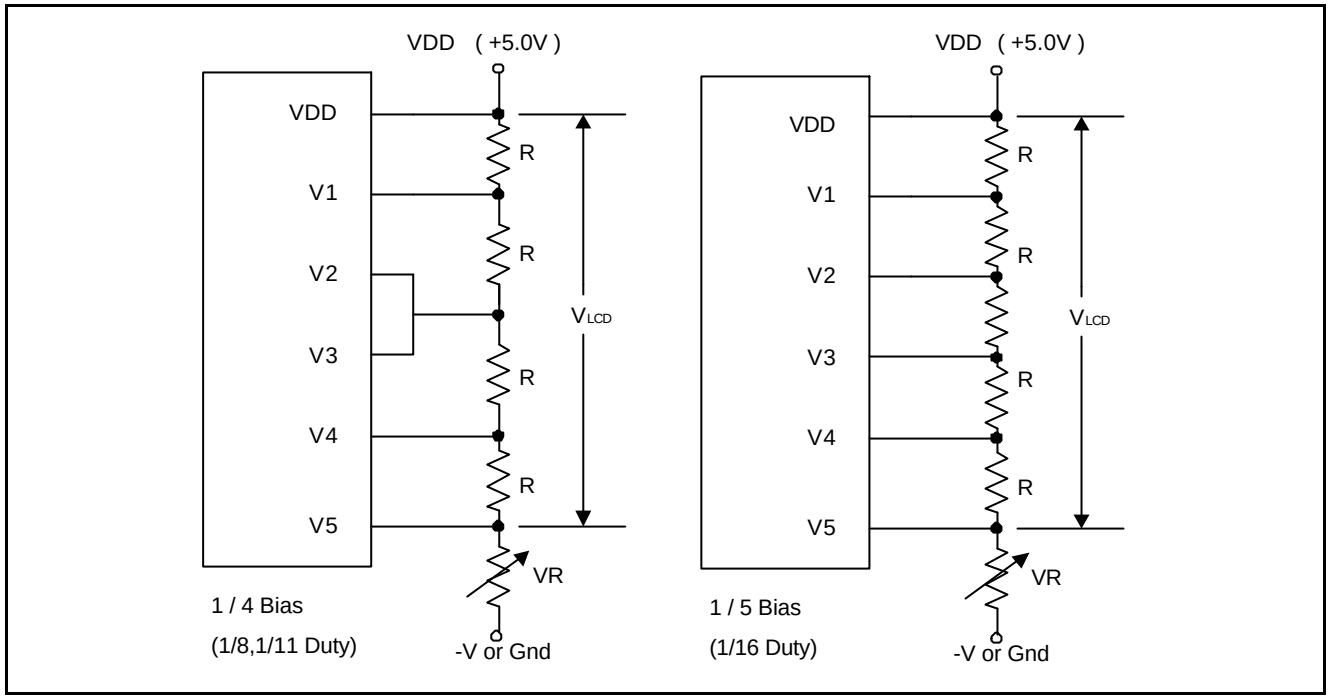
There are two types of data operations: 4-bit and 8-bit operations. Using 4-bit MPU, the interfacing 4bit data is transferred by 4-busline (DB4 to DB7). Thus, DB0 to DB3 bus lines are not used. Using 4-bit MPU to interface 8-bit data requires two times transferring. First, the higher 4-bit data is transferred by 4-busline (or 8-bit operation, DB7 to DB4). Secondly, the lower 4-bit data is transferred by 4-busline (or 8-bit operation, DB3 to DB0). For 8-bit MPU, the 8-bit data is transferred by 8-buslines (DB0 to DB7).

5.15. Supply Voltage for LCD Drive

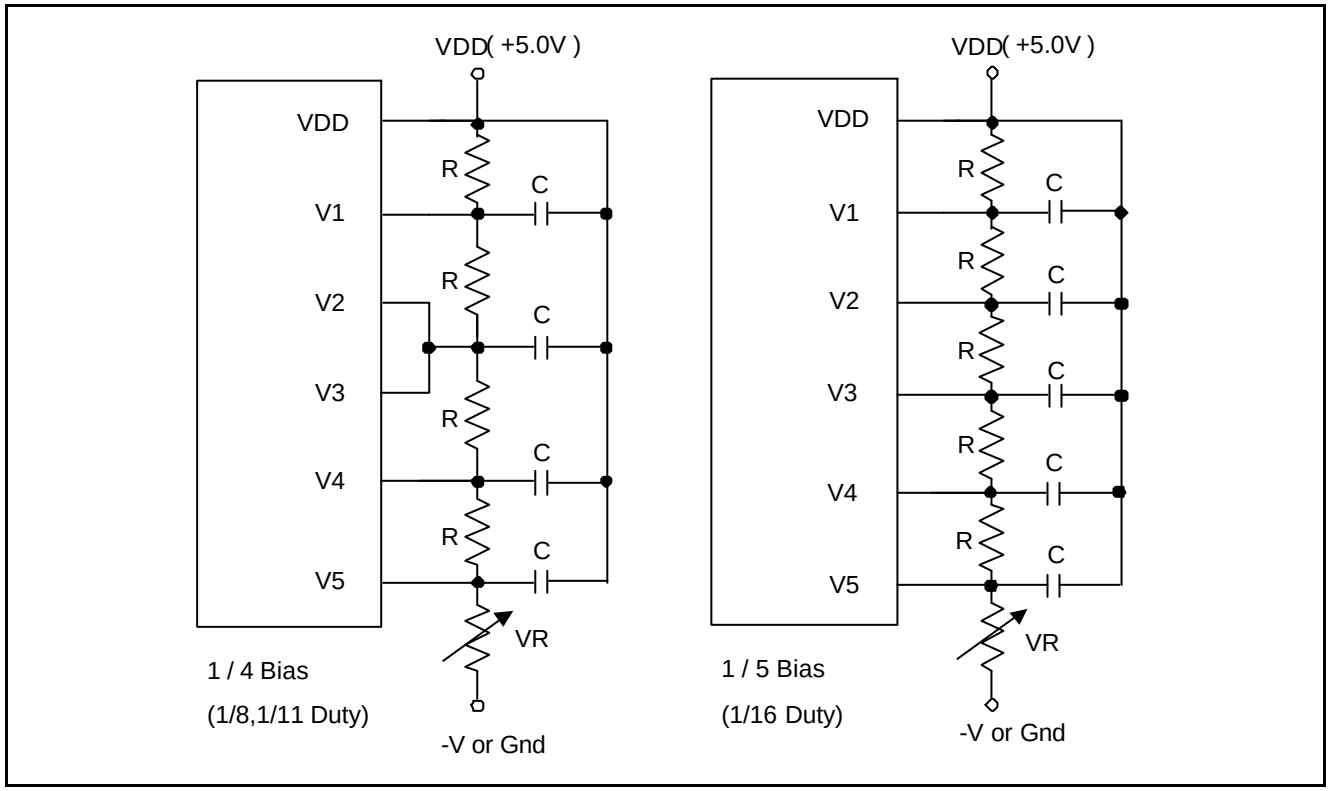
Different voltages can be supplied to SPLC780D' s pins (V5 - 1) for obtaining LCD drive-waveform. The relationships between bias, duty factor and supply voltages are shown as belows:

Duty Factor / Supply Voltage	1/8, 1/11	1/16
	1/4	1/5
V1	VDD – 1/4 V_{LCD}	VDD – 1/5 V_{LCD}
V2	VDD – 1/2 V_{LCD}	VDD – 2/5 V_{LCD}
V3	VDD – 1/2 V_{LCD}	VDD – 3/5 V_{LCD}
V4	VDD – 3/4 V_{LCD}	VDD – 4/5 V_{LCD}
V5	VDD – V_{LCD}	VDD – V_{LCD}

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



The bypass-capacitor improves the LCD display quality.



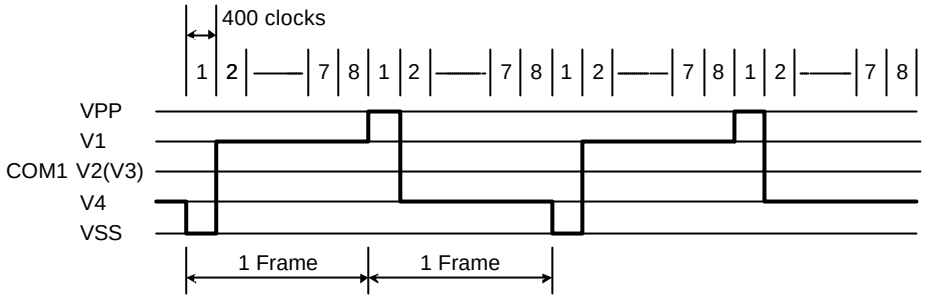
The bias voltage must have the following relations:

VDD > V1 > V2 ≧ V3 > V4 > V5.

5.15.2. The relationship between LCD frame's frequency and oscillator's frequency.

(Assume the oscillation frequency is 250KHz, 1 clock cycle time = 4.0μs)

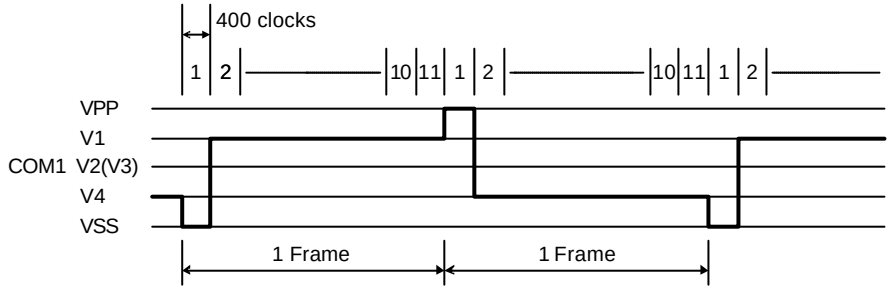
5.15.2.1. 1/8 Duty, TYPE-B waveform



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

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

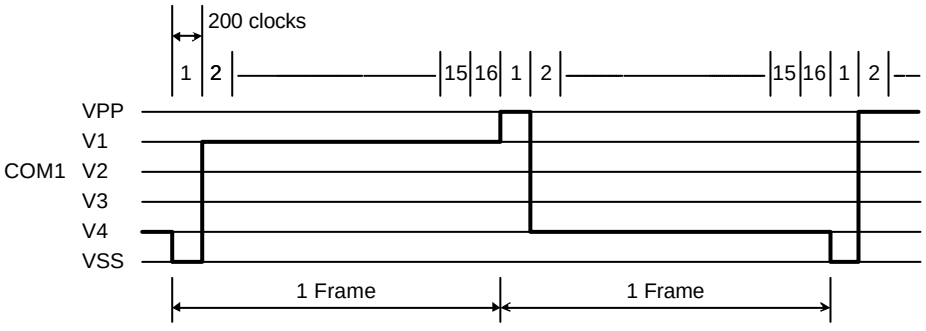
5.15.2.2. 1/11 Duty, TYPE-B waveform



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

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

5.15.2.3. 1/16 Duty, TYPE-B waveform



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

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

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

SPLC780D contains two 8bit 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.

5.17. Busy Flag (BF)

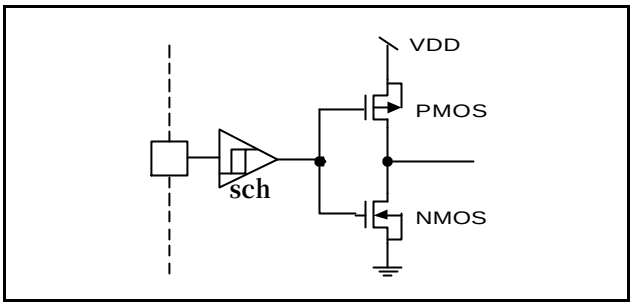
When RS = 0 and R/W = 1, the busy flag is output to DB7. As the busy flag =1, SPLC780D is in busy state and does not accept any instruction until the busy flag = 0.

5.18. Address Counter (AC)

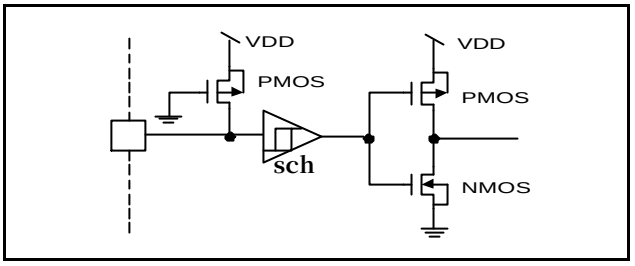
The Address Counter assigns addresses to Display Data RAM and Character Generator RAM. When an instruction for address is written in IR, the address information is sent from IR to AC. After writing to/reading from Display Data RAM or Character Generator RAM, AC is automatically incremented by one (or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

5.19. I/O Port Configuration

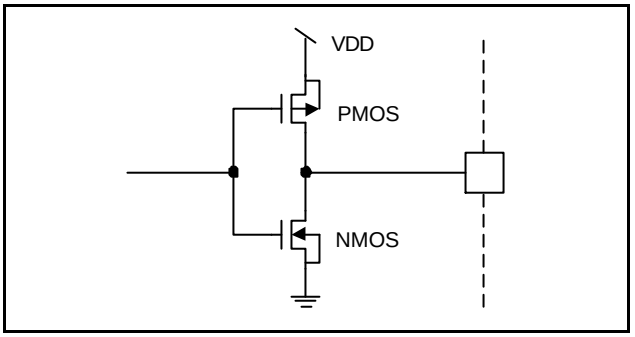
5.19.1. Input port: E



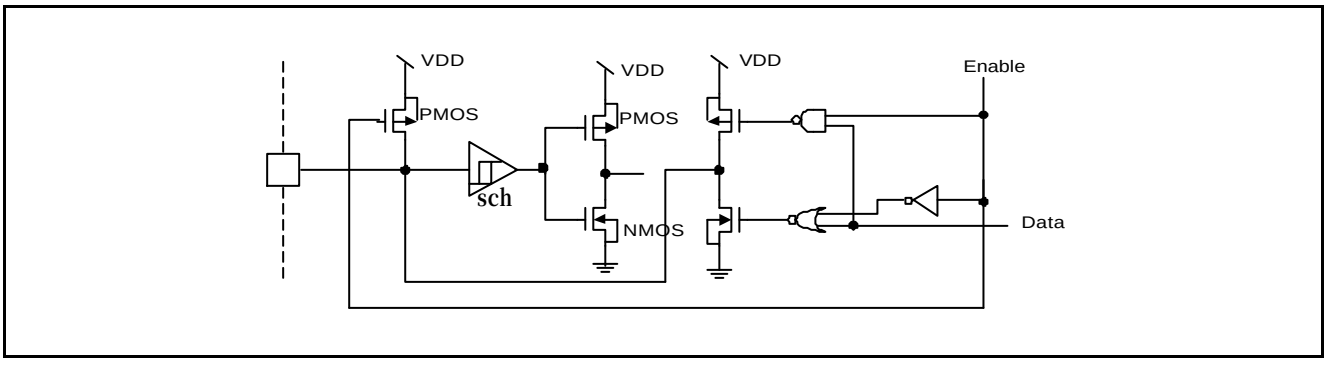
5.19.2. Input port: R/W, RS



5.19.3. Output port: CL1, CL2, M, D



5.19.4. Input / Output port: DB7 - DB0



6. ELECTRICAL SPECIFICATIONS

6.1. Absolute Maximum Ratings

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_{STO}	-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.

6.2. DC Characteristics (VDD = 2.7V to 4.5V, T_A = 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: F_{osc} = 250KHz, VDD = 3.0V, pin E = "L", RS, R/W, DB0 - DB7 are open, all outputs are no loads.

6.3. AC Characteristics (VDD = 2.7V to 4.5V, T_A = 25℃)

6.3.1. Internal clock operation

Characteristics	Symbol	Limit			Unit	Test Condition
		Min.	Typ.	Max.		
OSC Frequency	F_{OSC1}	190	270	350	KHz	VDD = 3.0V, Rf = 75KΩ±2%

6.3.2. External clock operation

Characteristics	Symbol	Limit			Unit	Test Condition
		Min.	Typ.	Max.		
External Frequency	F_{OSC2}	125	250	350	KHz	
Duty Cycle		45	50	55	%	
Rise/Fall Time	t r, t f	-	-	0.2	µs	

6.3.3. 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

6.3.4. 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

6.4. DC Characteristics (VDD = 4.5V to 5.5V, T_A = 25℃)

Characteristics	Symbol	Limit			Unit	Test Condition
		Min.	Typ.	Max.		
Operating Current	I_{DD}	-	0.55	0.8	mA	External clock (Note)
Input High Voltage	V_{IH1}	2.2	-	VDD	V	Pins:(E, RS, R/W, DB0 - DB7)
Input Low Voltage	V_{IL1}	-0.3	-	0.6	V	
Input High Voltage	V_{IH2}	VDD-1	-	VDD	V	Pin OSC1
Input Low Voltage	V_{IL2}	-0.2	-	1.0	V	Pin OSC1
Input High Current	I_{IH}	-2.0	-	2.0	μA	Pins: (RS, R/W, DB0 - DB7) VDD = 5.0V
Input Low Current	I_{IL}	-20	-50	-100	μA	
Output High Voltage (TTL)	V_{OH1}	2.4	-	VDD	V	I_{OH} = - 0.1mA Pins: DB0 - DB7
Output Low Voltage (TTL)	V_{OL1}	-	-	0.4	V	I_{OL} = 0.1mA Pins: DB0 - DB7
Output High Voltage (CMOS)	V_{OH2}	0.9VDD	-	VDD	V	I_{OH} = - 40μA, Pins: CL1, CL2, M, D
Output Low Voltage (CMOS)	V_{OL2}	-	-	0.1VDD	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	-	11	V	VDD-V5, 1/4 bias or 1/5 bias

Note: F_{osc} = 250KHz, VDD = 5.0V, pin E = "L", RS, R/W, DB0 - DB7 are open, all outputs are no loads.

6.5. AC Characteristics (VDD = 4.5V to 5.5V, T_A = 25℃)

6.5.1. Internal clock operation

Characteristics	Symbol	Limit			Unit	Test Condition
		Min.	Typ.	Max.		
OSC Frequency	F_{OSC1}	190	270	350	KHz	VDD = 5.0V, Rf = 91KΩ±2%

6.5.2. External clock operation

Characteristics	Symbol	Limit			Unit	Test Condition
		Min.	Typ.	Max.		
External Frequency	F_{OSC2}	125	250	350	KHz	
Duty Cycle		45	50	55	%	
Rise/Fall Time	t r, t f	-	-	0.2	μs	

6.5.3. Write mode (Writing Data from MPU to SPLC780D)

Characteristics	Symbol	Limit			Unit	Test Condition
		Min.	Typ.	Max.		
E Cycle Time	t_C	500	-	-	ns	Pin E
E Pulse Width	t_{PW}	230	-	-	ns	Pin E
E Rise/Fall Time	t_R, t_F	-	-	20	ns	Pin E
Address Setup Time	t_{SP1}	40	-	-	ns	Pins: RS, R/W, E
Address Hold Time	t_{HD1}	10	-	-	ns	Pins: RS, R/W, E
Data Setup Time	t_{SP2}	80	-	-	ns	Pins: DB0 - DB7
Data Hold Time	t_{HD2}	10	-	-	ns	Pins: DB0 - DB7

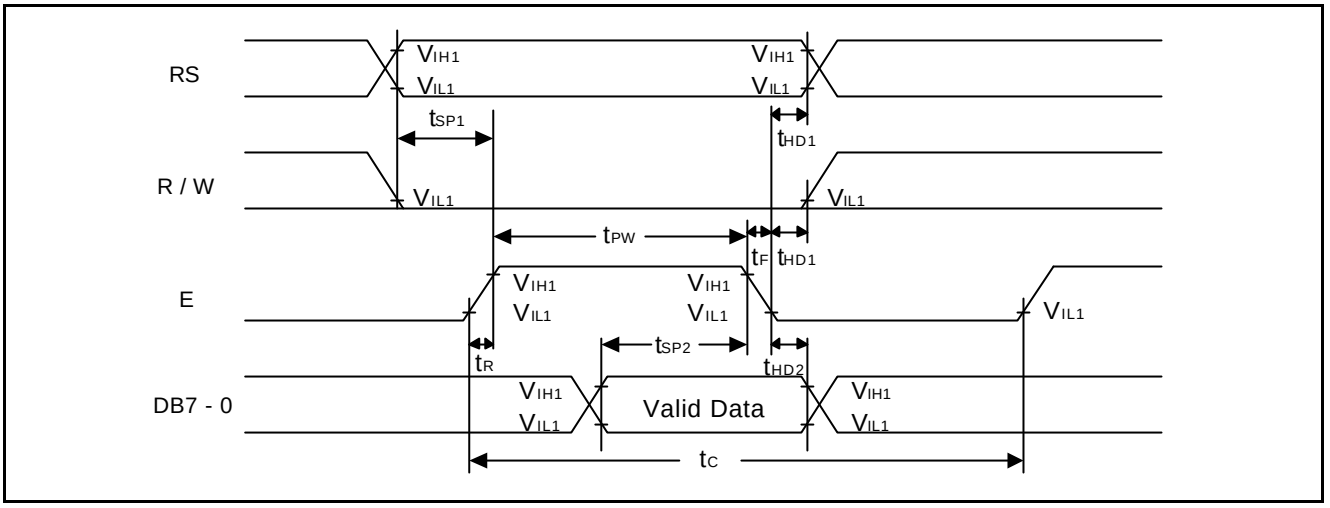
6.5.4. Read mode (Reading Data from SPLC780D to MPU)

Characteristics	Symbol	Limit			Unit	Test Condition
		Min.	Typ.	Max.		
E Cycle Time	t_C	500	-	-	ns	Pin E
E Pulse Width	t_W	230	-	-	ns	Pin E
E Rise/Fall Time	t_R, t_F	-	-	20	ns	Pin E
Address Setup Time	t_{SP1}	40	-	-	ns	Pins: RS, R/W, E
Address Hold Time	t_{HD1}	10	-	-	ns	Pins: RS, R/W, E
Data Output Delay Time	t_D	-	-	120	ns	Pins: DB0 - DB7
Data hold time	t_{HD2}	5.0	-	-	ns	Pin DB0 - DB7

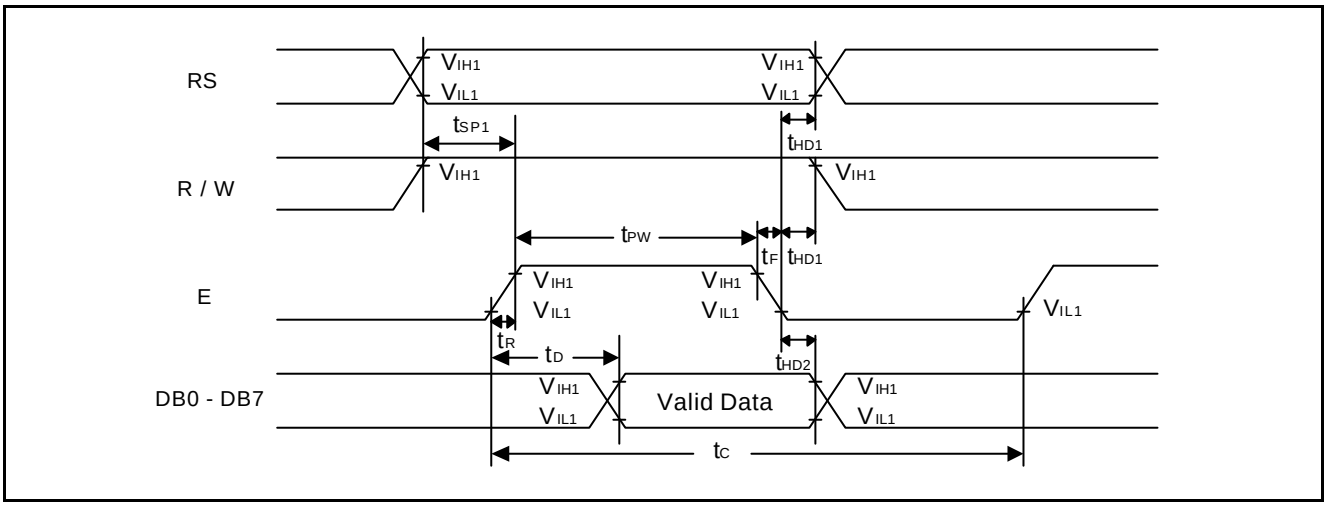
6.5.5. Interface mode with LCD Driver (SPLC100A1)

Characteristics	Symbol	Limit			Unit	Test Condition
		Min.	Typ.	Max.		
Clock pulse width high	t_{PWH}	800	-	-	ns	Pins: CL1, CL2
Clock pulse width low	t_{PWL}	800	-	-	ns	Pins: CL1, CL2
Clock setup time	t_{CSP}	500	-	-	ns	Pins: CL1, CL2
Data setup time	t_{DSP}	300	-	-	ns	Pins: D
Data hold time	t_{HD}	300	-	-	ns	Pins: D
M delay time	t_D	-1000	-	1000	ns	Pins: M

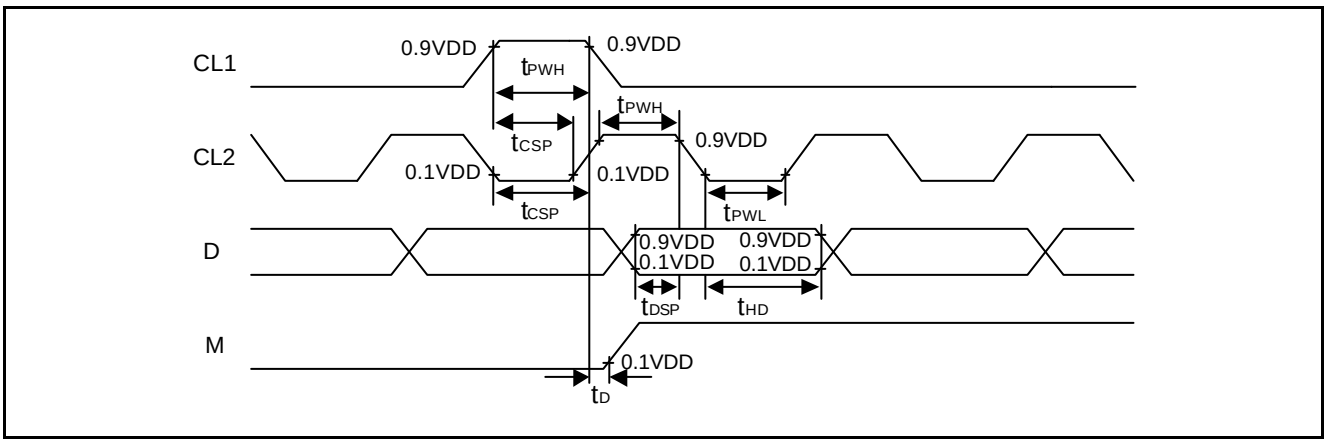
6.5.6. Write mode timing diagram (Writing Data from MPU to SPLC780D)



6.5.7. Read mode timing diagram (Reading Data from SPLC780D to MPU)



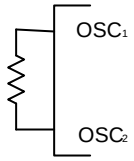
6.5.8. Interface mode with SPLC100A1 timing diagram



7. APPLICATION CIRCUITS

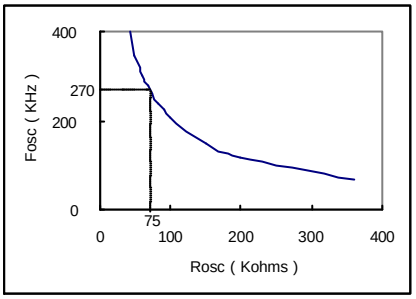
7.1. R-Oscillator

The oscillation resistor R_f is used only for the internal oscillator operation mode.

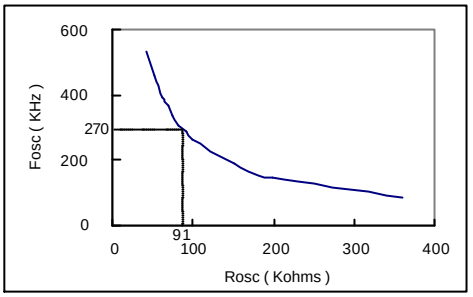


R_f : 75.0KΩ±2% (when VDD = 3.0V)
R_f : 91KΩ±2% (when VDD = 5.0V)

Since the oscillation frequency varies depending on the OSC_1 and OSC_2 pin capacitance, the wiring length to these pins should be minimized.



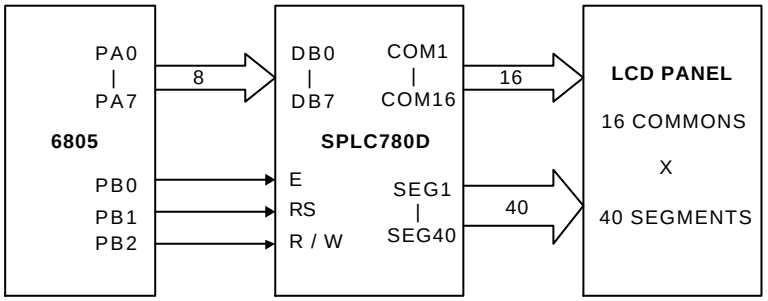
VDD = 3.0V



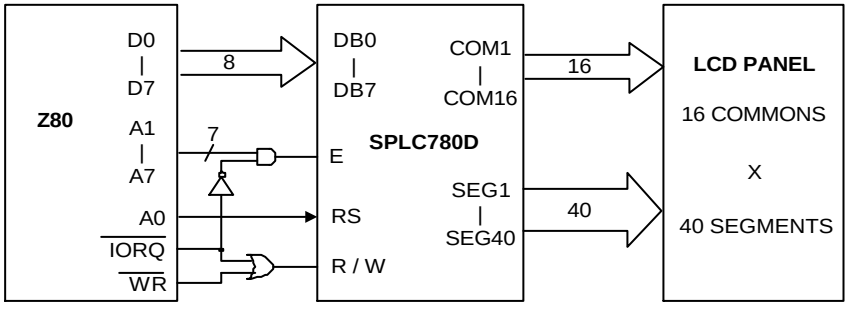
VDD = 5.0V

7.2. Interface to MPU

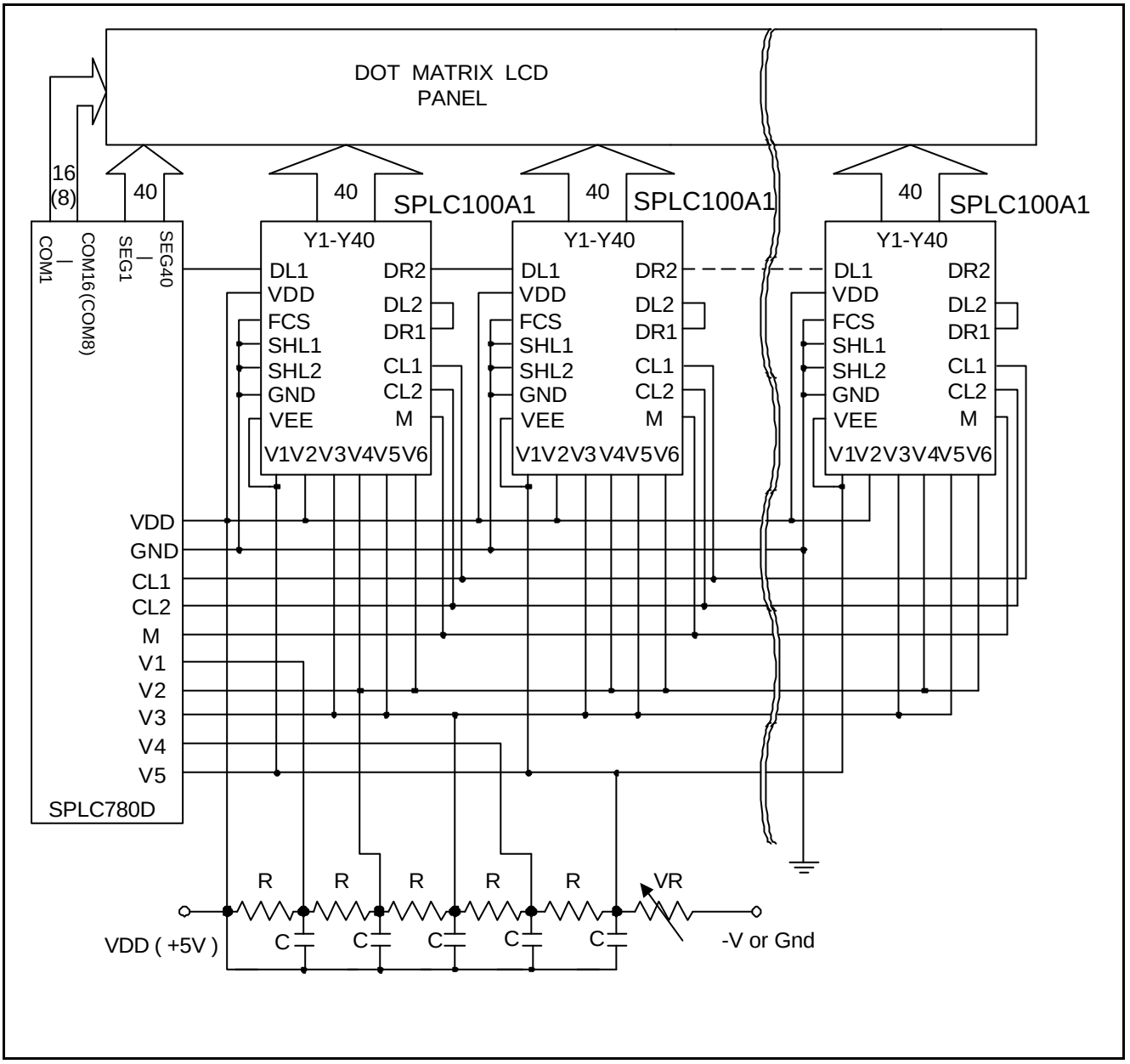
7.2.1. Interface to 8-bit MPU (6805)



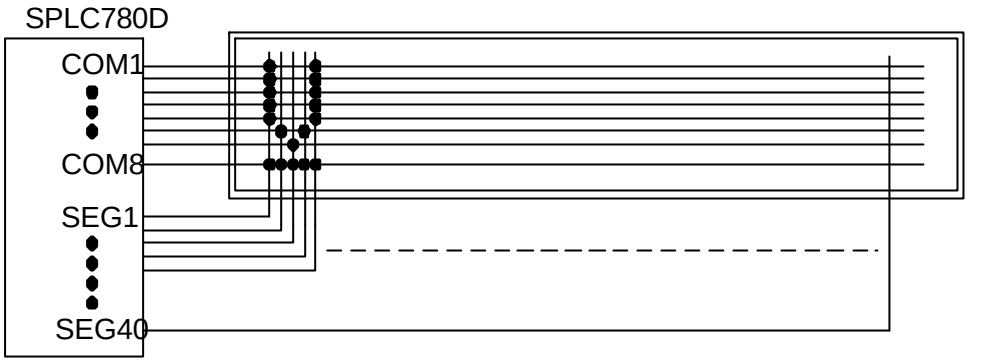
7.2.2. Interface to 8-bit MPU (Z80)



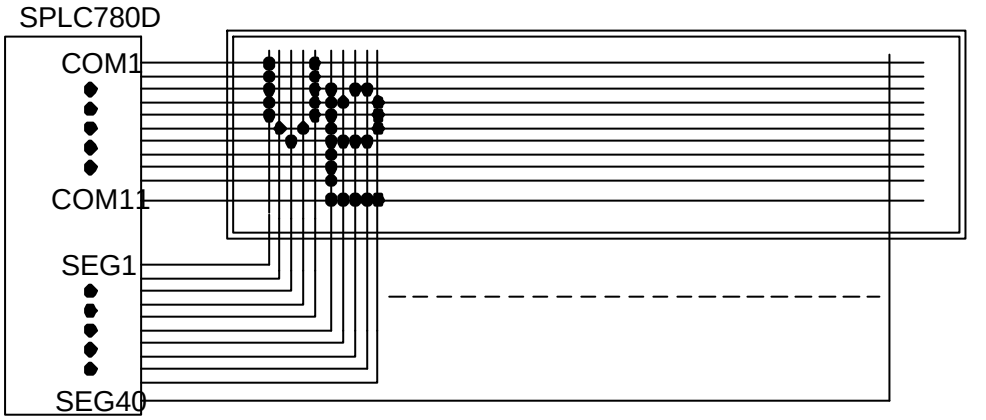
7.3. SPLC780D Application Circuit



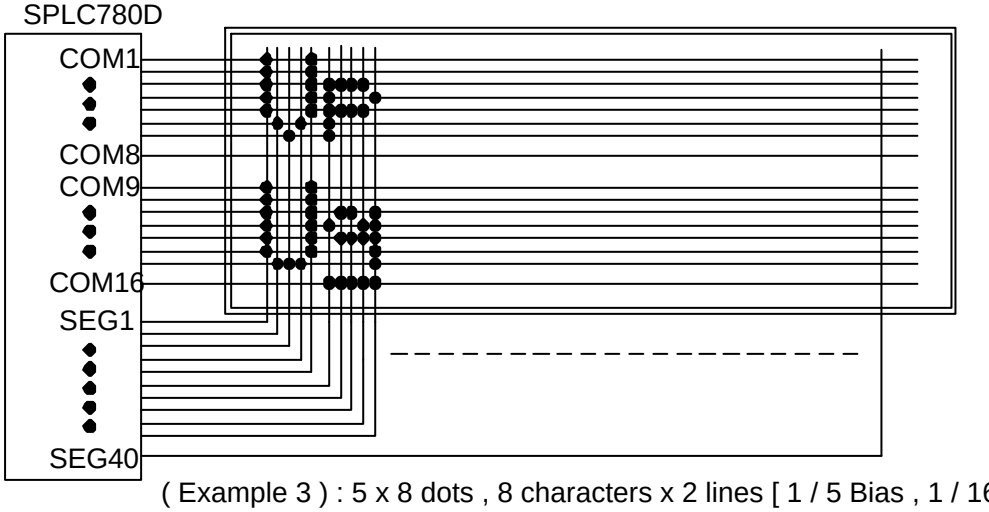
7.4. Applications for LCD



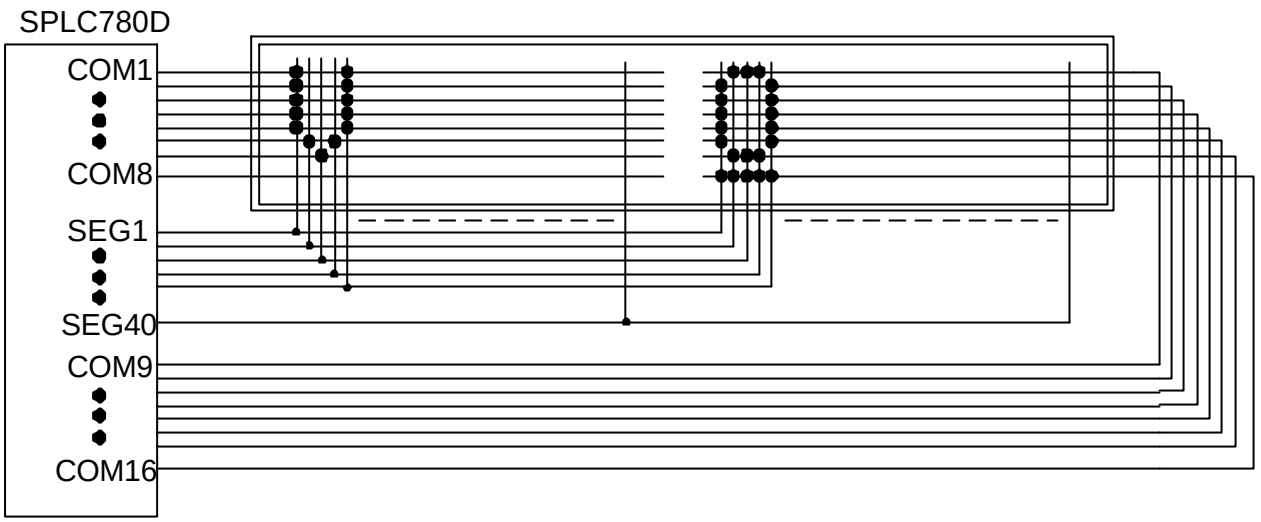
(Example 1) : 5 x 8 dots , 8 characters x 1 line [1 / 4 Bias , 1 / 8 Duty]



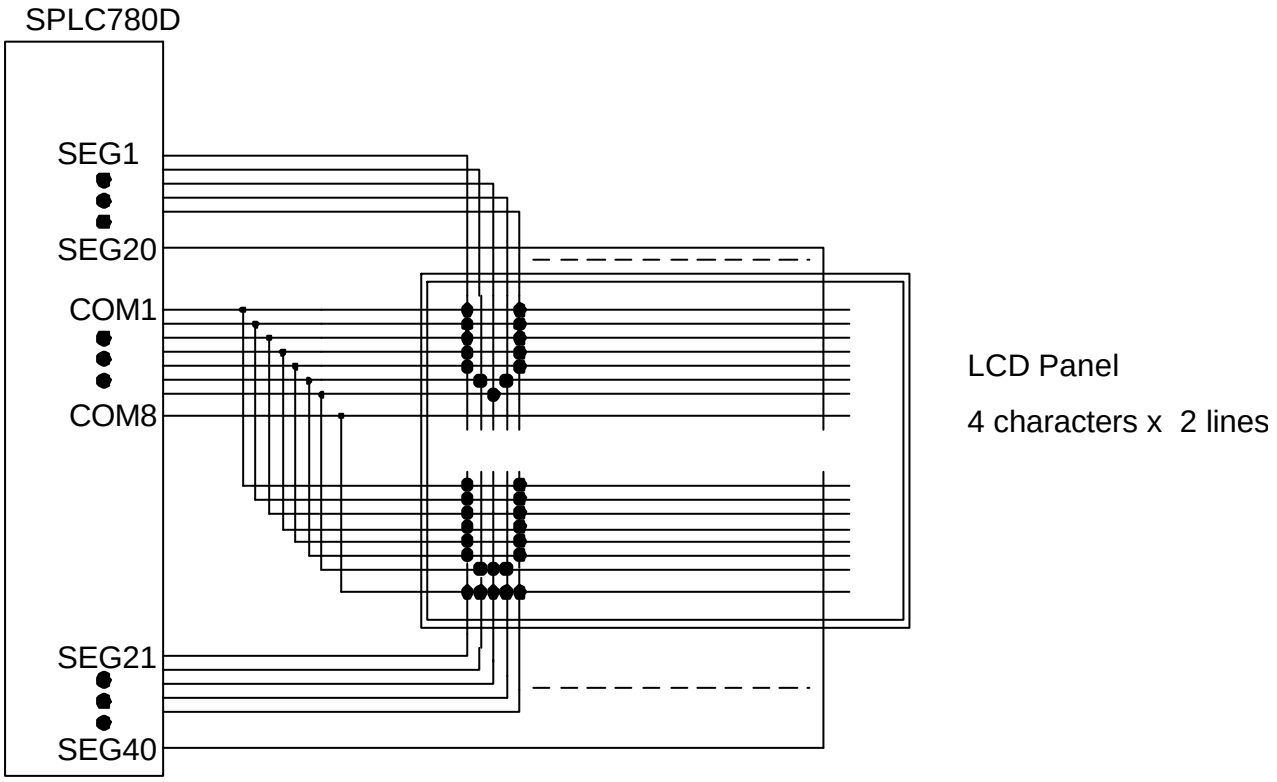
(Example 2) : 5 x 10 dots , 8 characters x 1 line [1 / 4 Bias , 1 / 11 Duty]



(Example 3) : 5 x 8 dots , 8 characters x 2 lines [1 / 5 Bias , 1 / 16 Duty]



(Example 4) : 5 x 8 dots , 16 characters x 1 line [1 / 5 Bias , 1 / 16 Duty]



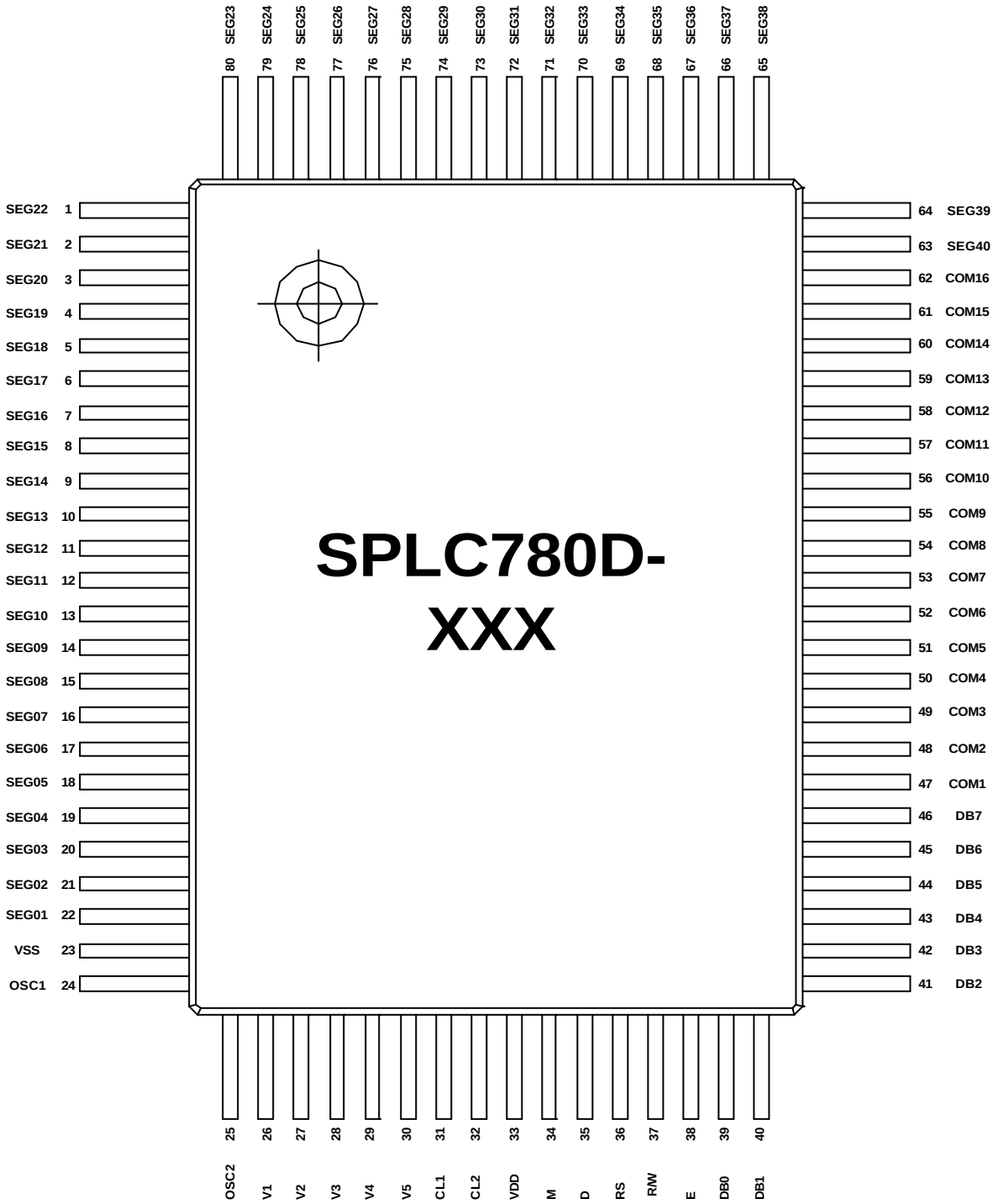
(Example 5) : 5 x 8 dots , 4 characters x 2 lines [1 / 4 Bias , 1 / 8 Duty]

8. CHARACTER GENERATOR ROM

8.1. SPLC780D - 001

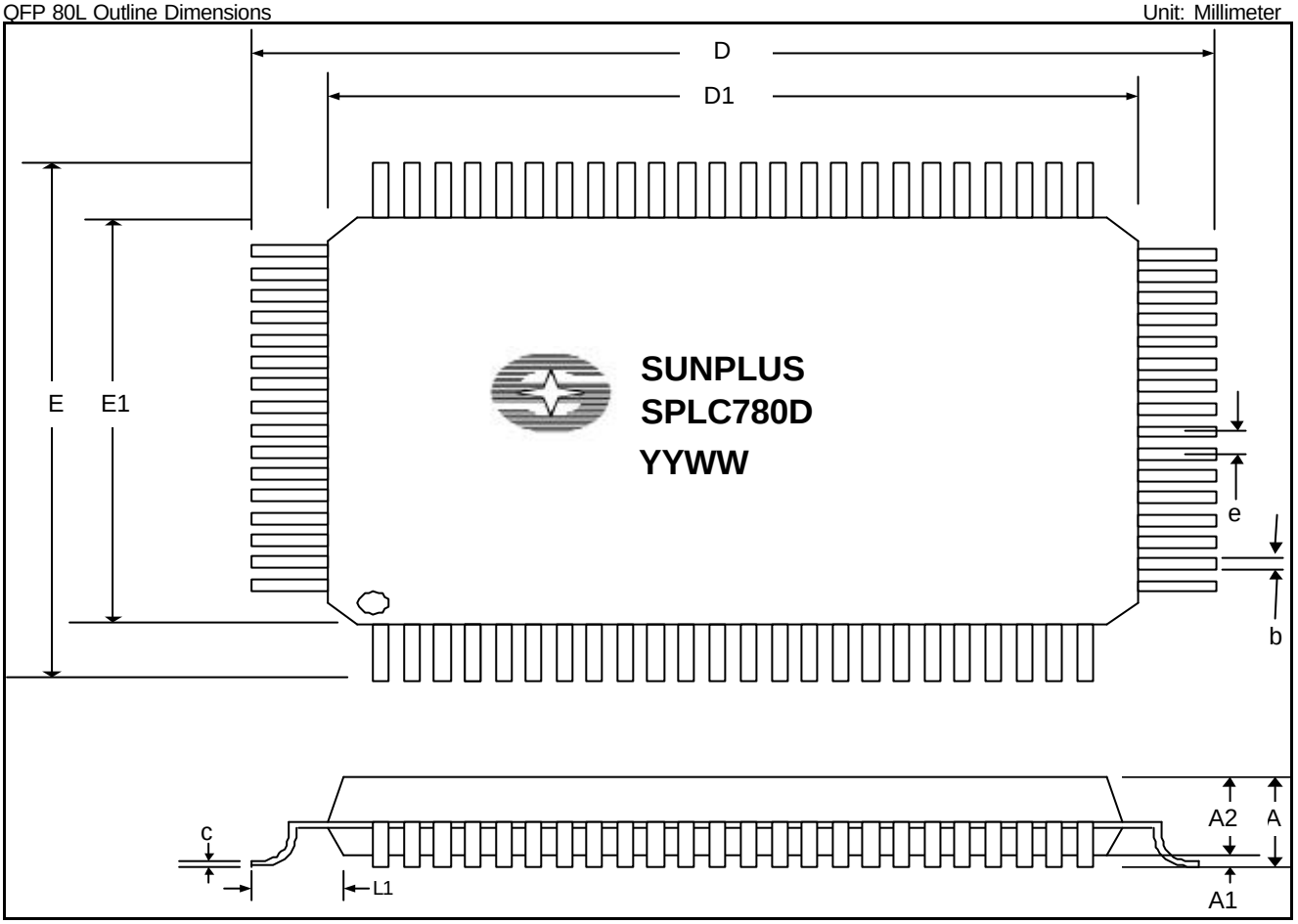
9.2. Package Configuration

QFP 80L Top View



9.3. Package Information

QFP 80L Outline Dimensions Unit: Millimeter



Symbol	Min.	Nom.	Max.	Unit
D		23.20 REF		Millimeter
D1		20.00 REF		Millimeter
E		17.20 REF		Millimeter
E1		14.00 REF		Millimeter
e		0.80 REF		Millimeter
b	0.30	0.35	0.45	Millimeter
A	-	-	3.40	Millimeter
A1	0.25	-	-	Millimeter
A2	2.50	2.72	2.90	Millimeter
c	0.11	0.15	0.23	Millimeter
L1		1.60 REF		Millimeter

NEWHAVEN DISPLAY INTERNATIONAL

User's Guide

LCD Safe Handling Procedure

For product support, contact

Newhaven Display International
2511 Technology Drive, #101
Elgin, IL 60124
Tel: (847)844-8795 Fax: (847)844-8796

USING LCD MODULES

LIQUID CRYSTAL DISPLAY MODULES

LCD's are composed of glass, liquid crystal fluid, and a polarizer. Please pay attention to the following items when handling:

1. Keep the temperature within a specified range for use and storage. Polarization degradation, bubble generation or polarizer peel-off may occur with high temperatures and high humidity.
2. Do not touch, push or rub the exposed polarizer with anything harder than an HB lead pencil (glass, tweezers, etc).
3. N-hexane is recommended for cleaning the adhesives used to attach the front/rear polarizer. Reflectors made of organic substances will be damaged by chemicals such as acetone, toluene, ethanol and isopropyl alcohol.
4. If the display surface becomes contaminated, breathe on the surface and gently wipe it with a soft dry cloth. If it is heavily contaminated, wipe it gently with absorbent cotton or another soft material like a chamois soaked in Isopropyl alcohol or Ethyl alcohol. Scrub gently to avoid damaging the display surface.
5. Wipe off saliva or water immediately! Contact with water over a long period of time may cause deformation or color fading.
6. Avoid contact with oil or any greasy substances.
7. If there is condensation on the surface and contact with the terminals while cold, it will damage, stain or dirty the polarizer. After the product is tested at a low temperature, they must be warmed up in a container before being exposed to room temperature environments.
8. Do not put or attach anything on the display area in order to avoid leaving marks.
9. Do not touch the display with bare hands. This will stain the display area and degrade the insulation between terminals. (Some cosmetics are detrimental to the polarizer).
10. 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.
11. As glass is fragile, care should be taken to avoid chipping, while handling the edges especially.

PRECAUTIONS FOR HANDLING LCD MODULES

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

1. Do not alter, modify or change 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 wiring on the printed circuit board.
4. Absolutely do not modify the zebra rubber strip (conductive rubber) or heat the 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 the LCD module. In particular, don't forcibly pull or bend the I/O cable or backlight cable.

7. In order to avoid cracking the FPC, pay attention to the area where the FPC is bent, the edge of the overlay, the area of the surface of Ni-Au plating, the area of soldering land, and the area of the through hole.

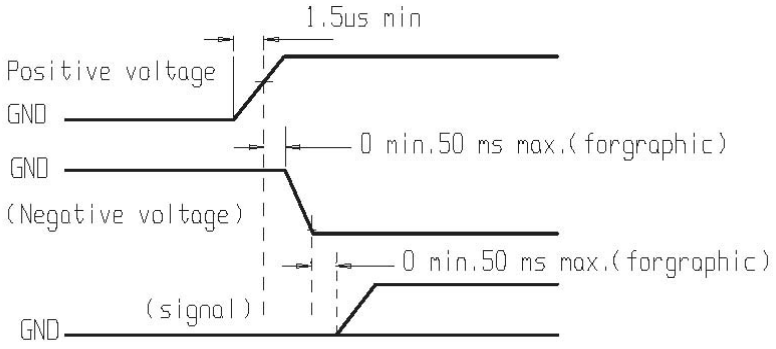
ELECTRO-STATIC DISCHARGE CONTROL

Since this module uses a CMOS LSI, give the same careful attention to the electrostatic discharge as you would for an ordinary CMOS IC.

1. Make sure you are grounded when handling LCD modules. To minimize the performance degradation of the LCD modules resulting from destruction caused by static electricity, exercise care to avoid holding the following sections when handling the modules: exposed area of the printed circuit board, terminal electrode sections.
2. Before removing the LCD module 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 the LCD module, make sure the AC power source for the soldering iron does not leak.
4. When using an electric screwdriver to attach the LCD module, the screwdriver should be of ground potentiality, to minimize any transmission of electromagnetic waves producing 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 working environment is not too dry. (A relative humidity of 50-60% is recommended).

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. 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.
4. Response time is greatly delayed at temperatures below the operating temperature range, however this does not mean the LCD will be out of order. It will recover when it returns to the specified temperature range.
5. If the display area is pushed hard during operation, the display may become abnormal, however it will return to normal if it is turned off and then turned back on.
6. Condensation on terminals can cause an electrochemical reaction disrupting the terminal circuit, therefore it must be used under the relative condition of 40°C, 50% RH.
7. When turning the power on, input each signal after the positive/negative voltage becomes stable.



STORAGE

WHEN STORING LCD'S, THE FOLLOWING PRECAUTIONS ARE NECESSARY:

1. Store them in a sealed polyethylene bag. If properly sealed, there is no need for desiccant.
2. Store them in a dark place; do not expose them to sunlight or fluorescent light. Keep the temperature between 0°C and 35°C.
3. The polarizer surface should not come in contact with any other objects. (We advise you to store them in the container in which they were shipped).
4. Environmental conditions:
    A). Do not leave them for more than 160 hours at 70°C
    B). They should not be left for more than 48 hours at -20°C

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

Newhaven Display MAKES NO WARRANTY RESPECTING THE MERCHANTABILITY OF THE PRODUCTS OR THEIR SUITABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE OR USE OR RESPECTING INFRINGEMENT. Newhaven Display's liability arising out of any sale of products to Customer is expressly limited to repair and/or replacement of such Products, at Newhaven Display's election, with such remedies exclusive and in lieu of all others. Newhaven Display will not be responsible for any subsequent or consequential events or injury or damage to any personnel or user including third party personnel and/or user. This warranty is in lieu of any and all other warranties, whether oral, written, expressed, implied or statutory. Implied warranties of fitness for a particular purpose and merchantability are specifically excluded and shall not apply. Customer's obligations and Newhaven Display's remedies with respect to defective or nonconforming products, are solely and exclusively as stated herein. Furthermore, no warranty will apply if the Product has been subject to misuse, static discharge, neglect, accident, modification, or has been soldered or altered in any way or if any of the LCD handling precautions have been disregarded. Broken glass, scratches on polarizer, mechanical damages, as well as defects that are caused by accelerated environment tests are excluded from warranty. In returning products, they must be returned in their original packaging. If the original packaging is not used, the returned product must be properly packaged to prevent damage or warranty will be void. There must be a detailed description of the failures or defect for each returned part.

RETURN LCD MODULES UNDER WARRANTY

The Customer must notify Newhaven Display within one year from date of shipment of any defective product. If Newhaven Display agrees to accept a return, return freight charges may be paid by Newhaven Display. Newhaven Display will not accept COD shipments. Contact a sales representative for a Return Materials Authorization Number and addressing instructions prior to returning product.

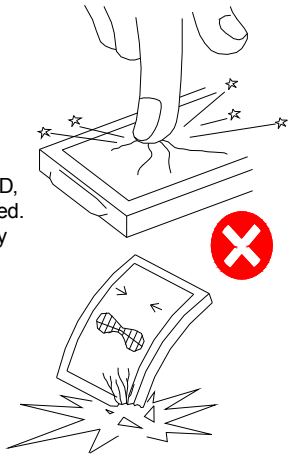
Handling Precautions

1. Limitation of Application:
Newhaven products are designed for use in ordinary electronic devices such as business machines, telecommunications equipment, measurement devices..etc. Please handle the products with care. (See below)
Newhaven products are not designed, intended or authorized for use in any application which the failure of the product could result in a situation where personal injury or death may occur. These applications include, but are not limited to: life-sustaining equipment, nuclear control devices, aerospace equipment, devices related to hazardous or flammable materials...etc. (If Buyer intends to purchase or use the Newhaven products for such unintended or unauthorized applications, Buyer must secure prior written consent to such use by a responsible officer of Newhaven Display). Should Buyer purchase or use Newhaven products for any such unintended or unauthorized application (without such consent), Buyer shall indemnify and hold Newhaven and its officers, employees, subsidaries, affiliates and distributors harmless against all claims, costs, damages and expenses, and reasonable attorney's fees, arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that Newhaven was negligent regarding the design or manufacture of the part.

2. Industrial Rights and Patents
Newhaven shall not be responsible for any infringement of industrial property rights of third parties in any country arising out of the application or use of Newhaven products, except which directly concern the structure or production of such products.

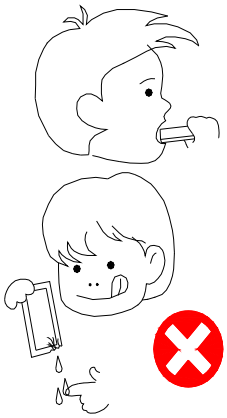
Do Not Press!

If pressure is applied to LCD, orientation may be disturbed. The LCD can be broken by shock!



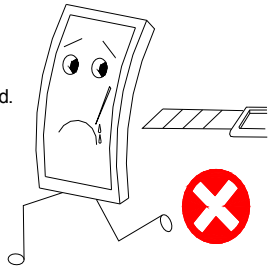
Don't Swallow or Touch Liquid Crystal!

Liquid Crystal may leak if the display breaks. If it accidentally gets on your hands, wash them with soap and water!



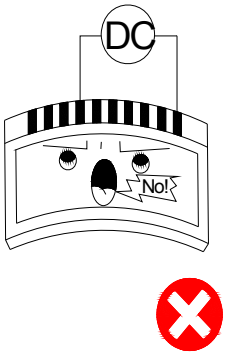
Do Not Scratch!

Polarizer is a soft material and can easily be scratched.



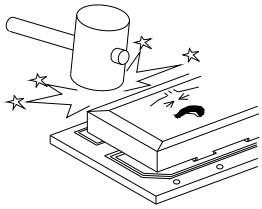
No DC Voltage to LCD!

DC voltage or higher voltage than specified will reduce the lifetime of the LCD.

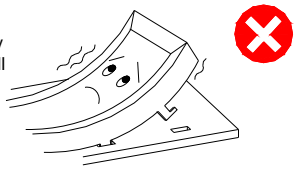


Do Not Put Pressure on the Metallic Frame or Disassemble the LCD Module

Pressure on the metallic frame and PCB may deform the conductive rubber or break the liquid crystal cell and backlight, which will cause defects.

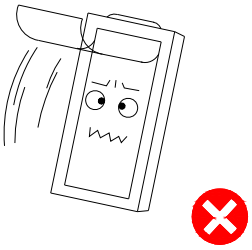


LCD may be shifted or conductive rubber may be reshaped, which will cause defects.



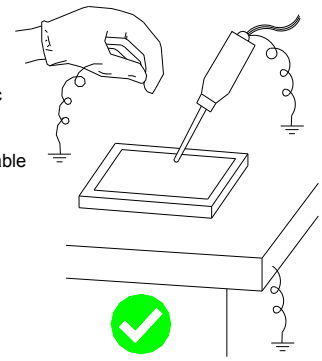
Slowly Peel Off Protective Film!

Avoid static electricity.



Avoid Static Electricity!

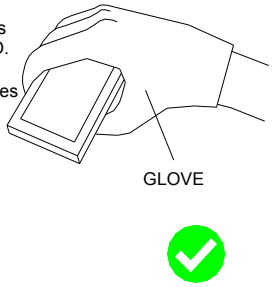
Please be sure to ground human body and electric appliances during work.
It is preferable to use a conductive mat on the table and wear cotton clothes or conduction processed fiber. Synthetic fiber is not recommended.



Wear Gloves While Handing!

It is preferable to wear gloves to avoid damaging the LCD.

Please do not touch electrodes with bare hands or leave any residue.

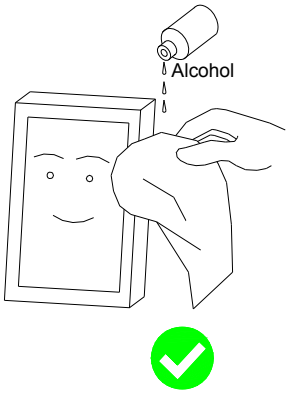


Keep Away From Extreme Heat and Humidity!

LCD deteriorates.

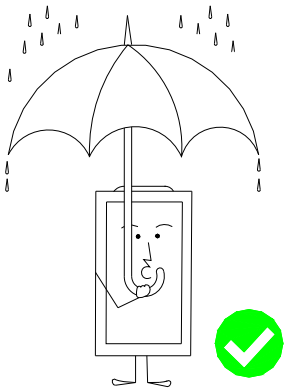
Use Alcohol to Clean Terminals!

When attaching with the heat seal or anisotropically conductive film, wipe off with alcohol before use.



Don't Drop Water on LCD!

Note that the presence of waterdrops or dew in the LCD panel may deteriorate the polarizer or corrode the electrodes.



Precaution in Soldering LCD Module

Basic instructions: Solder I/O terminals only.
Use soldering iron without leakage.
(1)Soldering condition to I/O terminals
Temperature at tip of the iron: 280±10°
Soldering time: 3~4 sec.
Type of solder: Eutectic solder (containing colophony-flux)
*Do not use flux because it may soak into the LCD Module or contaminate it.
*It is preferable to peel off protective film on the display surface after soldering I/O terminals are complete.
(2)Remove connector or cable
*When you remove connector or cable soldered to I/O terminals, please confirm that solder is fully melted. If you remove by force, electrodes at I/O terminals may be damaged(or stripped off).
*It is recommended to use a solder suction machine.

Long-term Storage

If it is necessary to store LCD modules for a period of time, please comply with the following procedures.
If storage conditions are not satisfactory,the display(especially polarizer) or soldering I/O terminals may become difficult(some oxide is generated at I/O terminals plating).
1.Store as delivered by Newhaven.
2.If you store it unpacked, put it in an anti-static bag, seal its opening and store where it is not subjected to direct sunlight or fluorescent light.
3.Store at temperature 0 to +35° and at low humidity.Please refer to our specification sheets for storage temperature range and humidity conditions.

Long-term Storage

Please use power supply with built-in surge protection circuit.