TINSHARP Industrial Co., Ltd.

DATA SHEET

ISO 9001:2000 SGS
SYSTEM CERTIFICATION

LCM MODULE

TC1602D-01A

Specification for Approval

APPROVED BY	CHECKED BY	PREPARED BY

ISSUED: V00 2019-01-10

CONTENTS

FUNCTIONS & FEATURES

- Construction : COB(Chip-on-Board)
- Display Format : 16x2 Characters
- Display Type : STN, Transflective, Positive, Y-G
- Controller : SPLC780C or equivalent controller
- Interface : 8-bit parallel interface
- Backlight : yellow-green\bottom lights
- Viewing Direction : 6 O'clock
- Driving Scheme : 1/16 Duty Cycle, 1/5 Bias
- Power Supply Voltage : 5.0 V
- V_{LCD} Adjustable For Best Contrast : 4.2 V (V_{OP}.)
- Operation temperature : -20℃ to +70℃
- Storage temperature : -30℃ to +80℃

BLOCK DIAGRAM

MODULE OUTLINE DRAWING

DESCRIPTION :

C/D

TINSHARP ELECTRONICS CO.,LTD.

SERIAL NUMBER   CTJ0142

SCALE: FIT	MODEL	TC1602D-01A
SHEET: 1 OF 1		
PROJECTION	CHK:	DATE:
UNIT: mm	APP:	DATE:
	DWN:	DATE:

PIN	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
NAME	VSS	VDD	V0	RS	R/W	E	DB0	DB1	DB2	DB3	DB4	DB5	DB6	DB7	LED+	LED−

NOTE:

SPECIFICATIONS
1. DISPLAY TYPE: STN/TRANSFLECTIVE/POSITIVE/Y-G
2. LCD DRIVING VOLTAGE: 4.2V
3. LOGIC VOLTAGE: 5.0V
4. VIEWING DIRECTION: 6 O'CLOCK
5. OPERATING TEMP: -20°C~70°C
6. STORAGE TEMP: -30°C~80°C
7. DRIVE MODE: 1/16 DUTY,1/5 BIAS
8. BACKLIGHT: YELLOW GREEN/BOTTOM BACKLIGHT/4.2V
9. CONTROL/DRIVE IC:
10. OTHER:
MECHANICAL TOL.±0.2 UNLESS SPECIFIED

TYPE	A	B
LED B/L	13.4	9.4

INTERFACE PIN FUNCTIONS

Pin No.	Symbol	Level	Description
1	VSS	0V	Ground.
2	VDD	+5.0V	Power supply for logic operating.
3	V0	--	Adjusting supply voltage for LCD driving.
4	RS	H/L	A signal for selecting registers: 1: Data Register (for read and write) 0: Instruction Register (for write), Busy flag-Address Counter (for read).
5	R/W	H/L	R/W = "H": Read mode. R/W = "L": Write mode.
6	E	H/L	An enable signal for writing or reading data.
7	DB0	H/L	This is an 8-bit bi-directional data bus.
8	DB1	H/L	
9	DB2	H/L	
10	DB3	H/L	
11	DB4	H/L	
12	DB5	H/L	
13	DB6	H/L	
14	DB7	H/L	
15	LED+	+4.2V	Power supply for backlight.
16	LED-	0V	The backlight ground.

ABSOLUTE MAXIMUM RATINGS (Ta = 25℃)

Parameter	Symbol	Min	Max	Unit
Supply voltage for logic	V_{DD}	-0.3	+7.0	V
Supply voltage for LCD	V_o	0	V_{DD} +0.3	V
Input voltage	V_I	-0.3	V_{DD} +0.3	V
Normal Operating temperature	T_{OP}	-20	+70	℃
Normal Storage temperature	T_{ST}	-30	+80	℃

  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.

DC ELECTRICAL CHARACTERISTICS

Parameter	Symbol	Condition	Min	T_{YP}	Max	Unit
Supply voltage for logic	VDD	--	4.8	5.0	5.2	V
Supply current for logic	IDD	--	--	245	270	mA
Operating voltage for LCD	VLCD	-10℃				V
		25℃	4.0	4.2	4.4	
		+60℃				
Input voltage "H" level	VIH	--	0.7 VDD	--	VDD+0.3	V
Input voltage "L" level	VIL	--	0	--	0.2VDD	V

LED BACKLIGHT CHARACTERISTICS

| COLOR	Wavelength λ p(nm)	Operating Voltage(±0.15V)	Spectral line half width Δλ (nm)	Forward Current (mA)
Yellow-green	--	4.2	--	240

  NOTE: Do not connect +5V directly to the backlight terminals. This will ruin the backlight.

CONNECTION WITH MCU
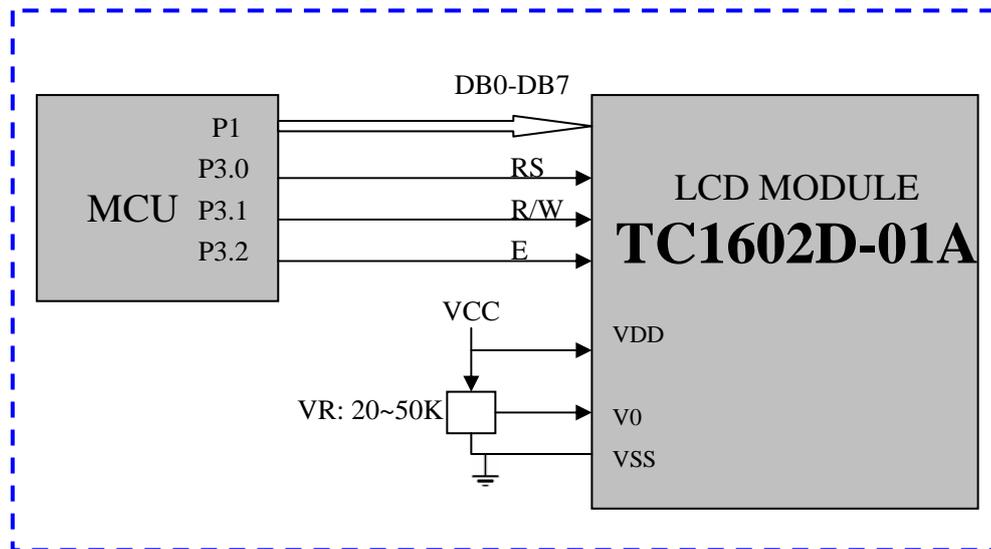
(1) Typical V0 connections for display contrast

Adjust V0 to +5.0V (VLCD=+4.7V) as an initial setting. When the module is operational, readjust V0 for optimal display appearance.
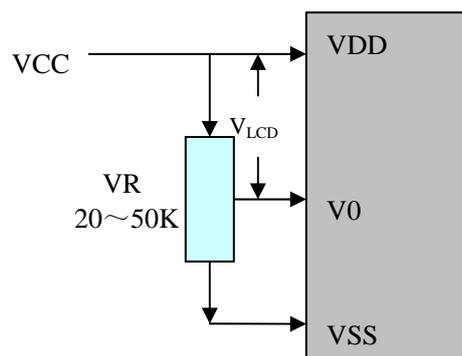
We recommend allowing field adjustment of V0 for all designs. The optimal value for V0 will change with temperature, variations in VDD, and viewing angle. V0 will also vary module-to-module and batch-to-batch due to normal manufacturing variations.

Ideally, adjustment to V0 should be available to the end user so each user can adjust the display to the optimal contrast for their required viewing conditions. As a minimum, your design should allow V0 to be adjusted as part of your product's final test.

Although a potentiometer is shown as a typical connection, V0 can be driven by your microcontroller, either by using a DAC or a filtered PWM. Displays that require V0 to be negative may need a level-shifting circuit. Please do not hesitate to contact Tinsharp application support for design assistance on your application.

(2) MPU Interface 4-bit/8-Bit

There are tow 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~DB7). Thus, DB0 to DB3 bus lines are not used. Using 4-bit MPU to interface 8-bit data requires tow times transferring. First, the higher 4-bit data is transferred by 4-busline (for 8-bit operation, DB7~DB4). Secondly, the lower 4-bit data is transferred by 4-busline (for 8-bit operation, DB3~DB0). For 8-bit MPU, the 8-bit data is transferred by 8-busline (DB0~DB7).

AC CHARACTERISTICS

(1) Write Mode (Writing data from MPU to SPLC780C)

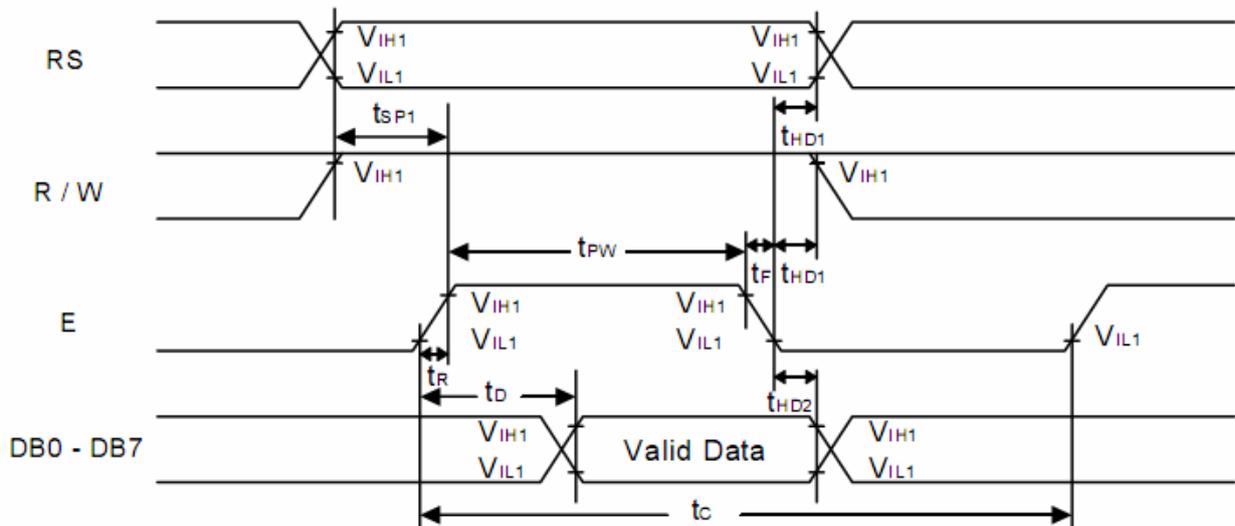| Characteristics	Symbol	Limit			Unit	Test Condition
		Min.	Typ.	Max.		
E Cycle Time	t_C	1000	-	-	ns	Pin E
E Pulse Width	t_{PW}	450	-	-	ns	Pin E
E Rise/Fall Time	t_R, t_F	-	-	25	ns	Pin E
Address Setup Time	t_{SP1}	60	-	-	ns	Pins: RS, R/W, E
Address Hold Time	t_{HD1}	20	-	-	ns	Pins: RS, R/W, E
Data Setup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

Write Mode Timing Diagram (Writing data from MPU to SPLC780C)
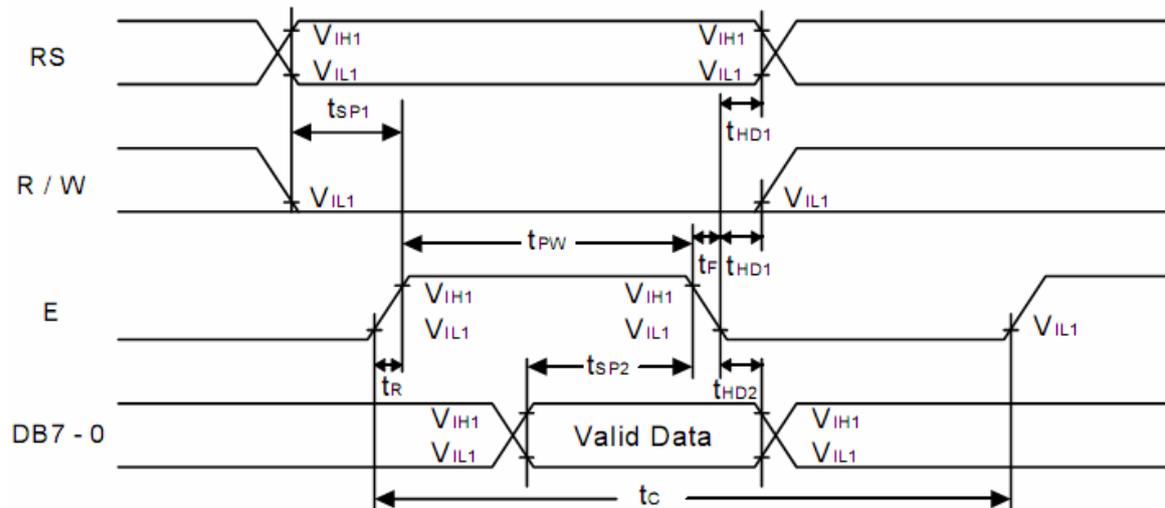
(2) Read Mode (Reading data from SPLC780C to MPU)

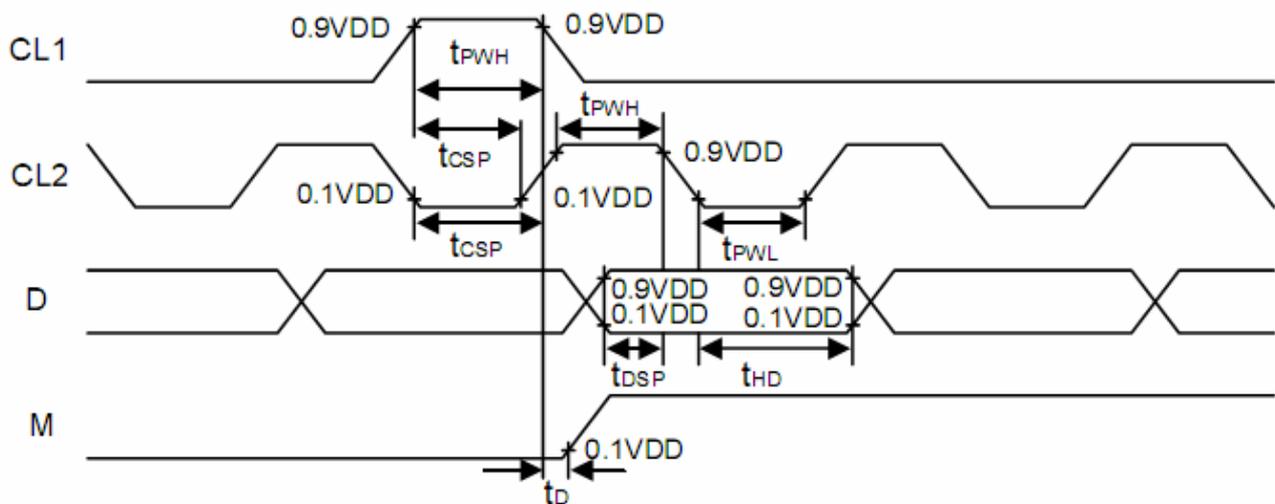| Characteristics	Symbol	Limit			Unit	Test Condition
		Min.	Typ.	Max.		
E Cycle Time	t_C	1000	-	-	ns	Pin E
E Pulse Width	t_W	450	-	-	ns	Pin E
E Rise/Fall Time	t_R, t_F	-	-	25	ns	Pin E
Address Setup Time	t_{SP1}	60	-	-	ns	Pins: RS, R/W, E
Address Hold Time	t_{HD1}	20	-	-	ns	Pins: RS, R/W, E
Data Output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

Read Mode Timing Diagram (Reading data from SPLC780C to MCU)

(3) Interface mode with LCD driver (SPLC100B1)

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

Interface mode with SPLC100B1 Timing Diagram

OPTICAL CHARACTERISTICS

Note1: Definition Operation Voltage (V_OP)

$$CR = L_{on} / L_{off}$$

$L_{on} =$ Luminance of ON segments
$L_{off} =$ Luminance of OFF segments
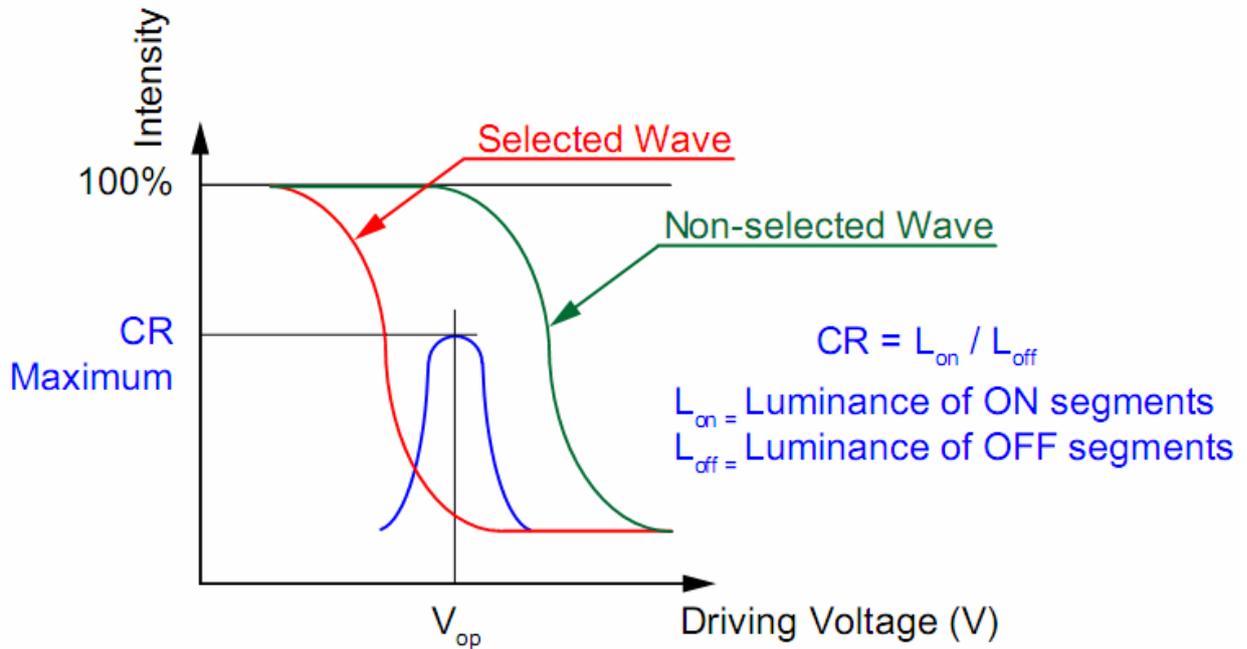
Note2: Response time
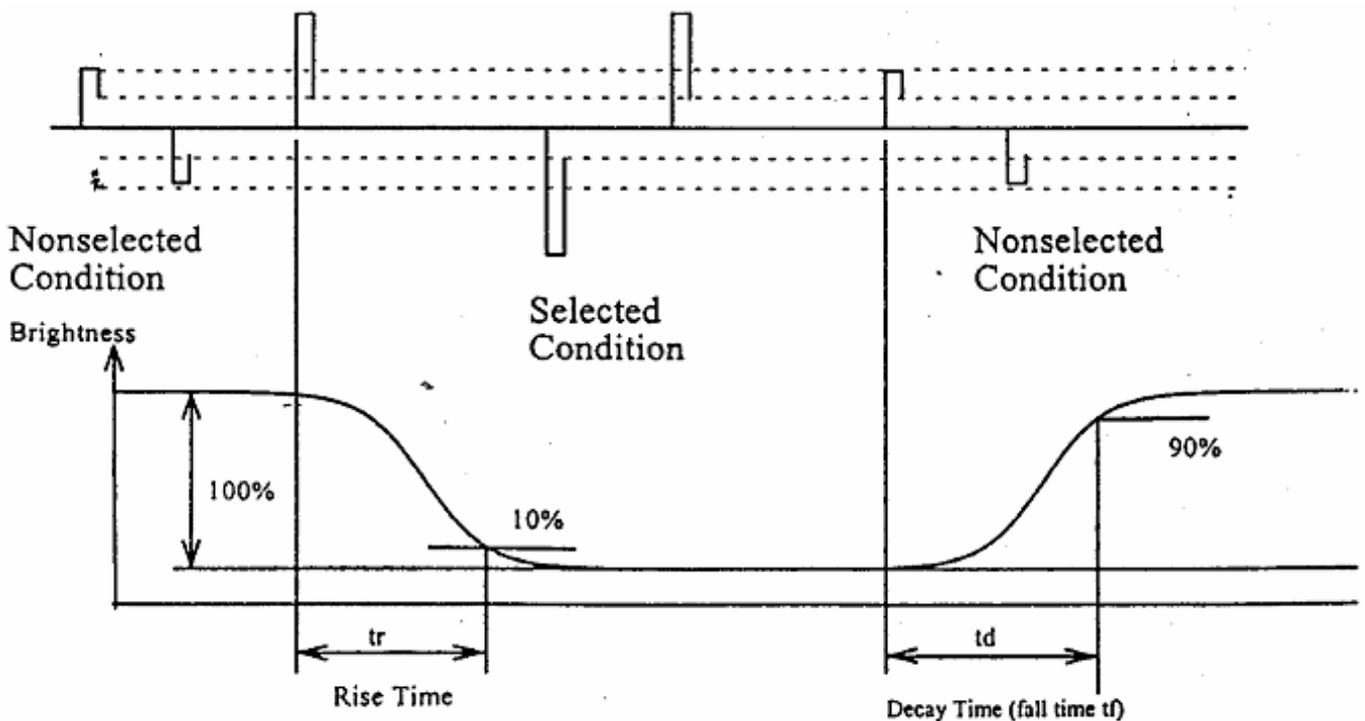
Note3: Viewing angle
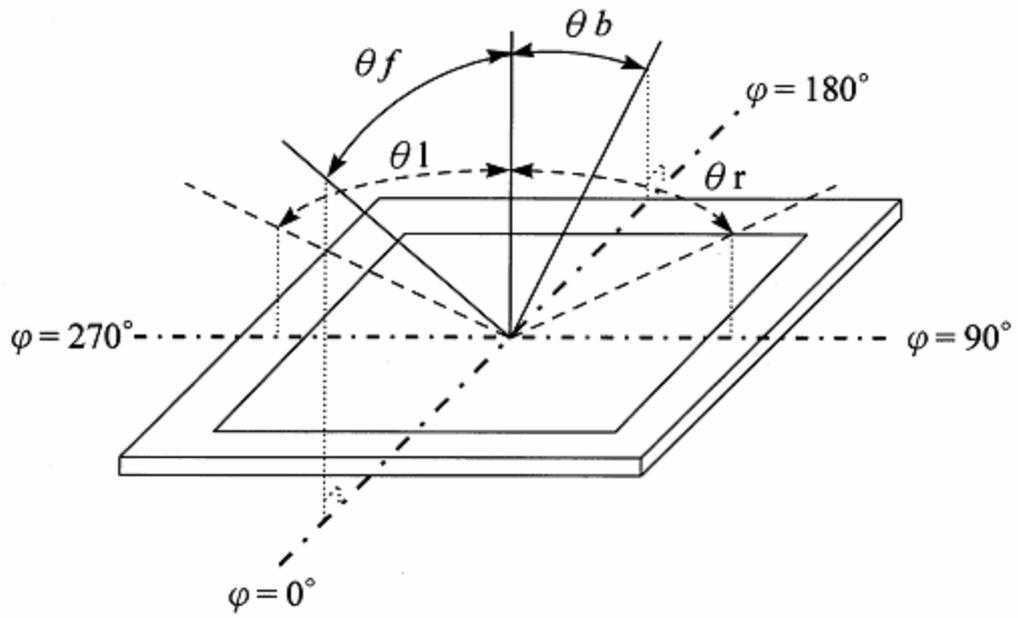
COMMAND TABLE

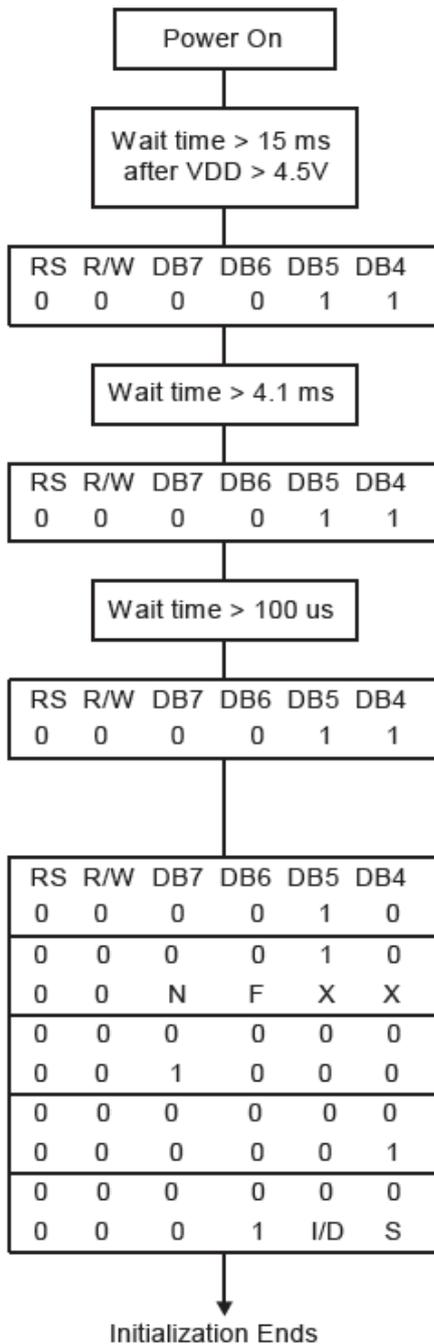| Instruction	Instruction Code										Description	Execution time (fosc=270KHz)
	RS	RW	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0		
Clear Display	0	0	0	0	0	0	0	0	0	1	Write "20H" to DDRAM and set DDRAM address to "00H" from AC	1.52ms
Return Home	0	0	0	0	0	0	0	0	1	-	Set DDRAM address to "00H" from AC and return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

Note: "-": don't care

RESET FUNCTION

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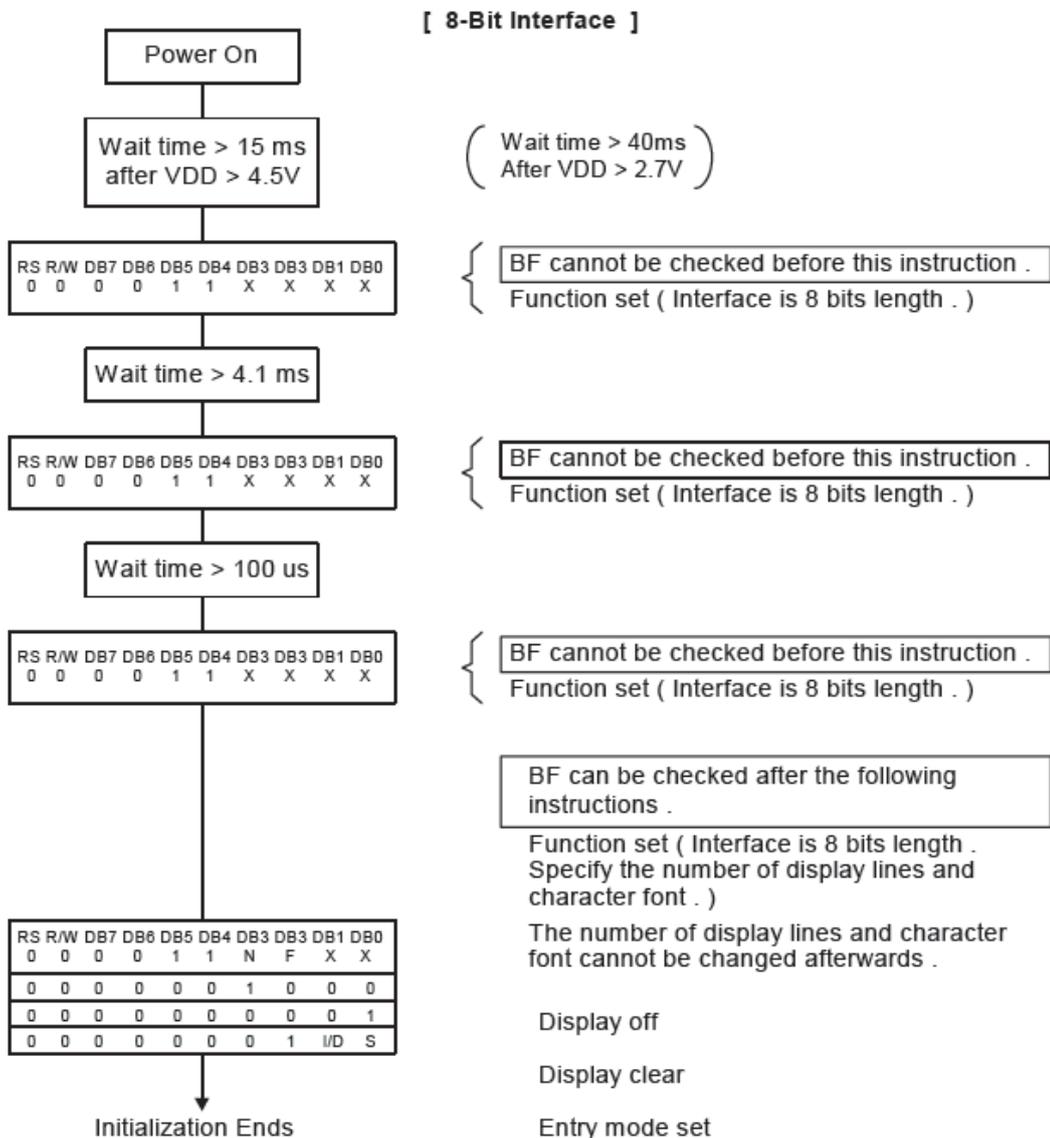
[8-Bit Interface]

Power On

Wait time > 15 ms
after VDD > 4.5V

(Wait time > 40ms
After VDD > 2.7V)

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

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

Wait time > 4.1 ms

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

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

Wait time > 100 us

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

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

BF can be checked after the following instructions .

Function set (Interface is 8 bits length . Specify the number of display lines and character font .)

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

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB3	DB1	DB0
0	0	0	0	1	1	N	F	X	X
0	0	0	0	0	0	1	0	0	0
0	0	0	0	0	0	0	0	0	1
0	0	0	0	0	0	0	1	I/D	S

Display off

Display clear

Entry mode set

Initialization Ends

[4-Bit Interface]

Power On

Wait time > 15 ms
after VDD > 4.5V

(Wait time > 40ms
  After VDD > 2.7V)

RS	R/W	DB7	DB6	DB5	DB4
0	0	0	0	1	1

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

Wait time > 4.1 ms

RS	R/W	DB7	DB6	DB5	DB4
0	0	0	0	1	1

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

Wait time > 100 us

RS	R/W	DB7	DB6	DB5	DB4
0	0	0	0	1	1

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

BF can be checked after the following
instructions .

RS	R/W	DB7	DB6	DB5	DB4
0	0	0	0	1	0
0	0	0	0	1	0
0	0	N	F	X	X
0	0	0	0	0	0
0	0	1	0	0	0
0	0	0	0	0	0
0	0	0	0	0	1
0	0	0	0	0	0
0	0	0	1	I/D	S

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

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

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

Display off

Display clear

Entry mode set

Initialization Ends

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.

2 LINES X 16 CHARACTERS PER LINE

Char.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Line 1	80	81	82	83	84	85	86	87	88	89	8A	8B	8C	8D	8E	8F
Line 2	C0	C1	C2	C3	C4	C5	C6	C7	C8	C9	CA	CB	CC	CD	CE	CF

Timing Generation Circuit

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

LCD Driver Circuit

Total of 16 commons and 40 segments signal drivers are valid in the LCD driver circuit. When a program specifies the character fonts and line numbers, the corresponding common signals output drive-waveforms and the others still output unselected waveforms. The relationships between Display Data RAM Address and LCD′s position are depicted as follows.

Character Generator ROM (CG ROM)

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

Character Generator RAM (CG RAM)

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

CHARACTER GENERATOR ROM

SPLC780C-002:

RELIABILITY TEST CONDITION

No.	TEST Item	Content of Test	Test Condition	Applicable Standard
1	High temperature storage	Endurance test applying the high storage Temperature for a long time.	80°C 96hrs	------
2	Low temperature storage	Endurance test applying the low storage Temperature for a long time	-30°C 96hrs	-----
3	High temperature operation	Endurance test applying the electric stress (Voltage & current)and the thermal stress to the element for a long time	70°C 96hrs	------
4	Low temperature operation	Endurance test applying the electric stress Under low temperature for a long time	-20°C 96hrs	------
5	High temperature/ Humidity storage	Endurance test applying the electric stress(Voltage & current) and Temperature/ Humidity stress to the element for a long time	40°C 90%RH 96hrs	
6	High temperature/ Humidity operation	Endurance test applying the electric stress (voltage & current)and temperature/ humidity stress to the element for a long time	40°C 90%RH 96hrs	
7	Temperature cycle	Endurance test applying the low and high temperature cycle. -20°C →25°C→70°C 30min←5min←30min.(1 cycle)	-20°C/70°C 10 cycle	------

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

Mechanical Test

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

Environmental condition

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

PRECAUTION FOR USING LCM MODULE

■ Please remove the protection foil of polarizer before using.

■ The display panel is made of glass. Do not subject it to a mechanical shock by dropping it from a high place, etc.

■ If the display panel is damaged and the liquid crystal substance inside it leaks out, do not get any in your mouth. If the substance come into contact with your skin or clothes promptly wash it off using soap and water.

■ Do not apply excessive force to the display surface or the adjoining areas since this may cause the color tone to vary.

■ The polarizer covering the display surface of the LCD module is soft and easily scratched. Handle this polarize carefully.

■ To prevent destruction of the elements by static electricity, be careful to maintain an optimum work environment.
 -Be sure to ground the body when handling the LCD module.
 -Tools required for assembly, such as soldering irons, must be properly grounded.
 -To reduce the amount of static electricity generated, do not conduct assembly and other work under dry conditions.
 -The LCD module is coated with a film to protect the display surface. Exercise care when peeling off this protective film since static electricity may be generated.

■ Storage precautions
 When storing the LCD modules, avoid exposure to direct sunlight or to the light of fluorescent lamps.
 Keep the modules in bags designed to prevent static electricity charging under low temperature / normal humidity conditions (avoid high temperature / high humidity and low temperatures below 0℃).Whenever possible, the LCD modules should be stored in the same conditions in which they were shipped from our company.
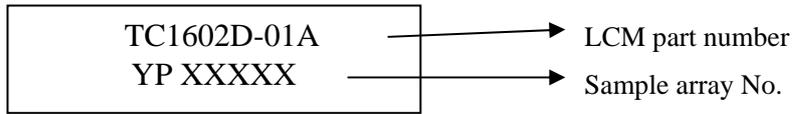
OTHERS

■ Liquid crystals solidify at low temperature (below the storage temperature range) leading to defective orientation of liquid crystal or the generation of air bubbles (black or white). Air bubbles may also be generated if the module is subjected to a strong shock at a low temperature.

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

■ To minimize the performance degradation of the LCD modules resulting from caused by static electricity, etc. exercise care to avoid holding the following   sections when handling the modules :
 - Exposed area of the printed circuit board
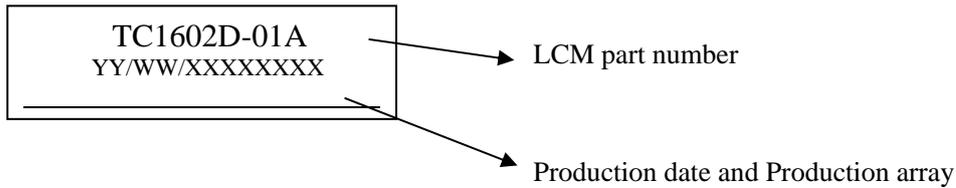 - Terminal electrode sections

A. DATE CODE RULES

A.1. DATE CODE FOR SAMPLE

YP: meaning sample

```
┌─────────────────────────┐
│     TC1602D-01A         │ ──────▶  LCM part number
│     YP XXXXX            │ ──────▶  Sample array No.
└─────────────────────────┘
```

A.2. DATE CODE FOR PRODUCTION

```
┌─────────────────────────┐
│     TC1602D-01A         │ ──────▶  LCM part number
│     YY/WW/XXXXXXXX      │
└─────────────────────────┘
```
Production date and Production array

   A. TC1602D-01A represents LCM part number

   C. YY/WW represents Year, Week

   YY—Year   WW—Week

   XXXXXXXX—Production array No.

B. CHANGE NOTES:

Ver.	Descriptions	Editor	Date
V00	First Issue	ZXQ	2019-01-10