LCD Module

Product Specification

□ : **APPROVAL FOR SPECIFICATION**

For Customer：_____ □ : **APPROVAL FOR SAMPLE**

Module No.： TSM1602-20B

Version No.: A

For Customer's Acceptance ：

Approved by	**Comment**

Team Source Display ：

Presented by	**Reviewed by**	**Organized by**

Contents

2.GENERAL SPECIFICATION

Interface with 4-bit or 8-bit MPU (directly connected M6800 serial MPU)

Display Specification

Display Character: 16 character X 2 line Character Font:5X8dors+cursor

Display color-Display background color : STN, YG / YG Backlight

Polarize mode: P Positive,Transflective

Viewing angle: 6:00

Display duty: 1/16 Driving bias: 1/5

Character Generator ROM (CGROM): 8320 bits (192 characterX5X8 dots) &(32 characterX5X10 dots)

Character Generator RAM (CGRAM): 64X8 bits (8 charactersX5X8 dots)

Display Data RAM (DDRAM) :40X8 bits (80 characters max)

Mechanical characteristics (Unit: mm)

Extenal demension: 80.0x36.0x12.6

Veiwing Area: 64.4x14.8

Character font: 5X8 dots + cursor

Character size: 2.9x5.15

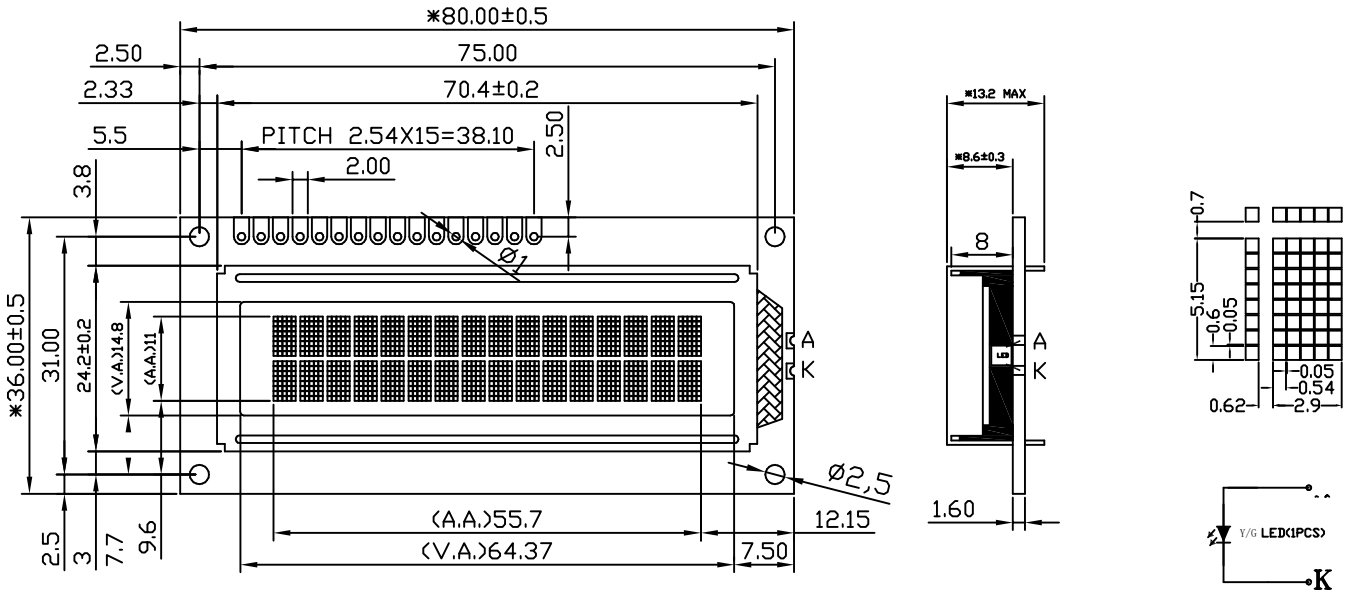
Dots size: 0.60x0.54

Character pitch: 0.352x585

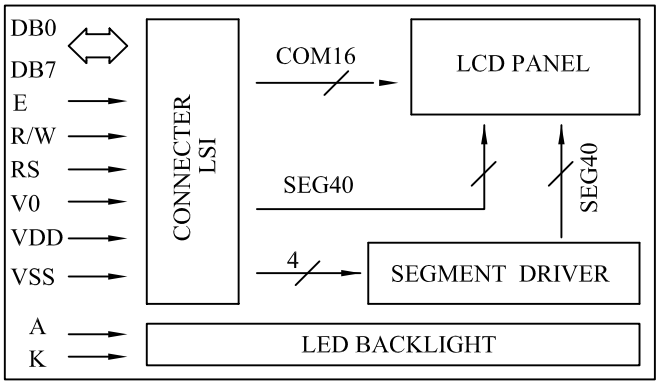
Weight： g

POWER： +5V

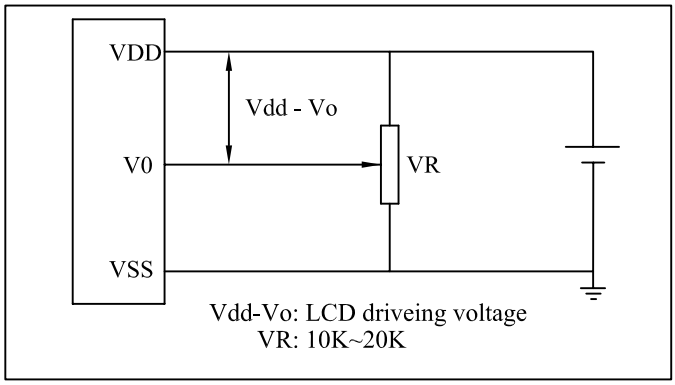
3. OUTLINE DEMENSION:



4. BLOCK DIAGRAM:



POWER SUPPLY



5.Absolute Maximum Ratings

Item	Symbol	Condition	Standard Value		Unit
			Min	Max	
Supply Voltage for logic	Vdd		-0.3	7.0	V
Supply Voltage for LCD	V5		Vdd-10.0	Vdd+0.3	V
Input Voltage	Vi		-0.3	Vdd+0.3	V
Operating Temperature(T)	Top	-	-20	70	℃
Storage Temperature(T)	Tstg	-	-30	80	℃

6.ELECTRICAL SPECIFICATIONS(Ta=25 ℃,Vdd=5.0V)

Item	Symbol	Condition	Standard Value			Unit
			Min	Type	Max	
Supply Voltage for logic	Vdd-GND	-	4.5	5.0	5.5	V
Supply Current for logic	Idd	Vdd=5V	-	1.0	-	mA
Driving Current for LCD	Iee		-	0.6	-	mA
Driving Voltage for LCD	Vdd-V5		-	4.5	-	V
Input Voltage H level	Vih		0.7Vdd	-	Vdd	V
Input Voltage L level	Vil		-0.3	-	0.6	V
Output Voltage H	Voh	Ioh=-0.205mA	0.9Vdd	-	-	V
Output Voltage L	Vol	Io1=1.2mA	-	-	0.1Vdd	V

7.Absolute Maximum Ratings For Bottom LED Backlight

Parameter	Symbol	Test condition	Min	Type	Max	Unit
LED Forward Consumption Current	I_f	Ta=25^{0}C	-	15	20	mA
LED Allowable Dissipation	P_d	Vf=2.8V	-	42	60	mW

8. Pin assignment

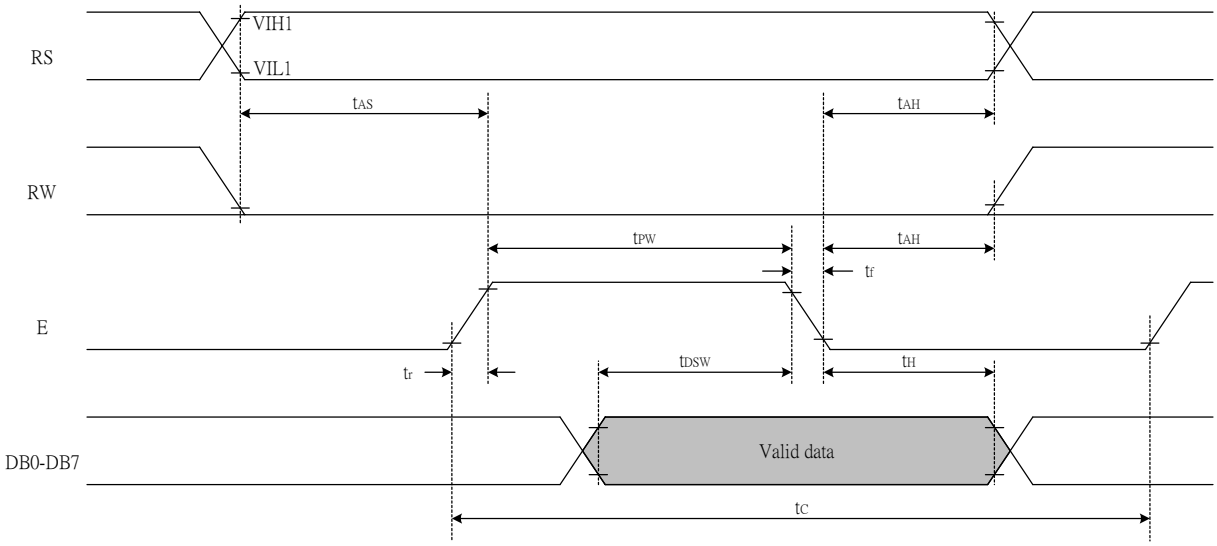
Pin No.	symbel	lever	Function
1	Vss	---	0V
2	Vdd	---	+5V
3	Vo	---	---
4	RS	H/L	L:Instruction code input H:Data input
5	R/W	H/L	L:Data write H:Data read
6	E	H.H-L	Enable singal
7	D0	H/L	Data bus line
8	D1	H/L	
9	D2	H/L	
10	D3	H/L	
11	D4	H/L	
12	D5	H/L	
13	D6	H/L	
14	D7	H/L	
15	LED+	A	Power supply for LED
16	LED−	K	Power supply for LED

9. MPU Interface (Vdd=4.5V~5.5V, Ta=-30~+85℃)

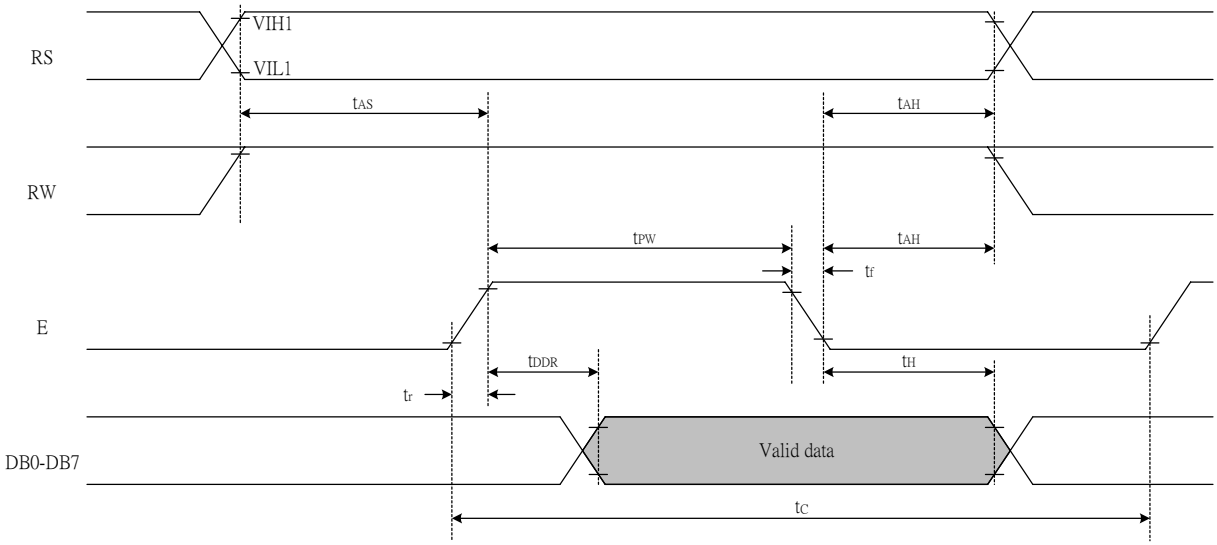
Mode	Characteristic	Symbol	Min.	Type	Max	Unit
Write Mode	E Cycle Time	t_C	500	-	-	ns
	E Rise/Fall Time	t_R,t_F	-	-	20	
	E Pulse Width (High, Low)	t_{PW}	230	-	-	
	R/W and RS Setup time	t_{SP1}	40	-	-	
	R/W and RS Hold Time	t_{HD1}	10	-	-	
	Data Setup Time	t_{SP2}	80	-	-	
	Data Hold Time	t_{HD2}	10	-	-	

Read Mode	E Cycle Time	t_C	500	-	-	ns
	E Rise/Fall Time	t_R,t_F	-	-	20	
	E Pulse Width(High, Low)	t_{PW}	230	-	-	
	R/W and RS Setup Time	t_{SP1}	40	-	-	
	R/W and RS Hold Time	t_{HD2}	10	-	-	
	Data Output Delay Time	t_D	-	-	120	
	Data Hold Time	t_{HD2}	5	-	-	

- **Writing data from MPU to ST7066U**



- **Reading data from ST7066U to MPU**



10. Reflector of Screen and Display RAM

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

-1 means first character of line 1 on screen

11. Instructions

- **Designate ST7066U functions, such as display format, data length, etc.**
- **Set internal RAM addresses**
- **Perform data transfer with internal RAM**
- **Others**

Instruction Table:

Instruction	Instruction Code										Description	Description Time (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	1.52 ms
Return Home	0	0	0	0	0	0	0	0	1	x	Set DDRAM address to "00H" from AC and return cursor to its original position if shifted. The contents of DDRAM are not changed.	1.52 ms
Entry Mode Set	0	0	0	0	0	0	0	1	I/D	S	Sets cursor move direction and specifies display shift. These operations are performed during data write and read.	37 us
Display ON/OFF	0	0	0	0	0	0	1	D	C	B	D=1:entire display on C=1:cursor on B=1:cursor position on	37 us
Cursor or Display Shift	0	0	0	0	0	1	S/C	R/L	x	x	Set cursor moving and display shift control bit, and the direction, without changing DDRAM data.	37 us
Function Set	0	0	0	0	1	DL	N	F	x	x	DL:interface data is 8/4 bits N:number of line is 2/1 F:font size is 5x11/5x8	37 us
Set CGRAM address	0	0	0	1	AC5	AC4	AC3	AC2	AC1	AC0	Set CGRAM address in address counter	37 us
Set DDRAM address	0	0	1	AC6	AC5	AC4	AC3	AC2	AC1	AC0	Set DDRAM address in address counter	37 us
Read Busy flag and address	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.	0 us
Write data to RAM	1	0	D7	D6	D5	D4	D3	D2	D1	D0	Write data into internal RAM (DDRAM/CGRAM)	37 us
Read data from RAM	1	1	D7	D6	D5	D4	D3	D2	D1	D0	Read data from internal RAM (DDRAM/CGRAM)	37 us

Note:
Be sure the ST7066U is not in the busy state (BF = 0) before sending an instruction from the MPU to the ST7066U. If an instruction is sent without checking the busy flag, the time between the first instruction and next instruction will take much longer than the instruction time itself. Refer to Instruction Table for the list of each instruction execution time.

■ Instruction Description

- **Clear Display**

	RS	RW	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
Code	0	0	0	0	0	0	0	0	0	1

Clear all the display data by writing "20H" (space code) to all DDRAM address, and set DDRAM address to "00H" into AC (address counter). Return cursor to the original status, namely, bring the cursor to the left edge on first line of the display. Make entry mode increment (I/D = "1").

- **Return Home**

	RS	RW	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
Code	0	0	0	0	0	0	0	0	1	x

Return Home is cursor return home instruction. Set DDRAM address to "00H" into the address counter. Return cursor to its original site and return display to its original status, if shifted. Contents of DDRAM does not change.

- **Entry Mode Set**

	RS	RW	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
Code	0	0	0	0	0	0	0	1	I/D	S

Set the moving direction of cursor and display.

- **I/D : Increment / decrement of DDRAM address (cursor or blink)**
  When I/D = "High", cursor/blink moves to right and DDRAM address is increased by 1.
  When I/D = "Low", cursor/blink moves to left and DDRAM address is decreased by 1.
  * CGRAM operates the same as DDRAM, when read from or write to CGRAM.
- **S: Shift of entire display**
  When DDRAM read (CGRAM read/write) operation or S = "Low", shift of entire display is not performed. If S = "High" and DDRAM write operation, shift of entire display is performed according to I/D value (I/D = "1" : shift left, I/D = "0" : shift right).

S	I/D	Description
H	H	Shift the display to the left
H	L	Shift the display to the right

- **Display ON/OFF**

	RS	RW	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
Code	0	0	0	0	0	0	1	D	C	B

Control display/cursor/blink ON/OFF 1 bit register.

- **D : Display ON/OFF control bit**
  When D = "High", entire display is turned on.
  When D = "Low", display is turned off, but display data is remained in DDRAM.
- **C : Cursor ON/OFF control bit**
  When C = "High", cursor is turned on.
  When C = "Low", cursor is disappeared in current display, but I/D register remains its data.
- **B : Cursor Blink ON/OFF control bit**
  When B = "High", cursor blink is on, that performs alternate between all the high data and display character at the cursor position.
  When B = "Low", blink is off.

- **Cursor or Display Shift**

	RS	RW	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
Code	0	0	0	0	0	1	S/C	R/L	x	x

Without writing or reading of display data, shift right/left cursor position or display. This instruction is used to correct or search display data. During 2-line mode display, cursor moves to the 2nd line after 40th digit of 1st line. Note that display shift is performed simultaneously in all the line. When displayed data is shifted repeatedly, each line shifted individually. When display shift is performed, the contents of address counter are not changed.

S/C	R/L	Description	AC Value
L	L	Shift cursor to the left	AC=AC-1
L	H	Shift cursor to the right	AC=AC+1
H	L	Shift display to the left. Cursor follows the display shift	AC=AC
H	H	Shift display to the right. Cursor follows the display shift	AC=AC

- **Function Set**

	RS	RW	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
Code	0	0	0	0	1	DL	N	F	x	x

- **DL : Interface data length control bit**
  When DL = "High", it means 8-bit bus mode with MPU.
  When DL = "Low", it means 4-bit bus mode with MPU. So to speak, DL is a signal to select 8-bit or 4-bit bus mode.
  When 4-bit bus mode, it needs to transfer 4-bit data by two times.
- **N : Display line number control bit**
  When N = "Low", it means 1-line display mode.
  When N = "High", 2-line display mode is set.
- **F : Display font type control bit**
  When F = "Low", it means 5 x 8 dots format display mode
  When F = "High", 5 x11 dots format display mode.

N	F	No. of Display Lines	Character Font	Duty Factor
L	L	1	5x8	1/8
L	H	1	5x11	1/11
H	x	2	5x8	1/16

- **Set CGRAM Address**

	RS	RW	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
Code	0	0	0	1	AC5	AC4	AC3	AC2	AC1	AC0

Set CGRAM address to AC.
This instruction makes CGRAM data available from MPU.

- **Set DDRAM Address**

	RS	RW	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
Code	0	0	1	AC6	AC5	AC4	AC3	AC2	AC1	AC0

Set DDRAM address to AC.
This instruction makes DDRAM data available from MPU.
When 1-line display mode (N = 0), DDRAM address is from "00H" to "4FH".
In 2-line display mode (N = 1), DDRAM address in the 1st line is from "00H" to "27H", and DDRAM address in the 2nd line is from "40H" to "67H".

- **Read Busy Flag and Address**

	RS	RW	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
Code	0	1	BF	AC6	AC5	AC4	AC3	AC2	AC1	AC0

When BF = “High”, indicates that the internal operation is being processed.So during this time the next instruction cannot be accepted.

The address Counter (AC) stores DDRAM/CGRAM addresses, transferred from IR.

After writing into (reading from) DDRAM/CGRAM, AC is automatically increased (decreased) by 1.

- **Write Data to CGRAM or DDRAM**

	RS	RW	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
Code	1	0	D7	D6	D5	D4	D3	D2	D1	D0

Write binary 8-bit data to DDRAM/CGRAM.

The selection of RAM from DDRAM, CGRAM, is set by the previous address set instruction : DDRAM address set, CGRAM address set. RAM set instruction can also determine the AC direction to RAM.

After write operation, the address is automatically increased/decreased by 1, according to the entry mode.

- **Read Data from CGRAM or DDRAM**

	RS	RW	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
Code	1	1	D7	D6	D5	D4	D3	D2	D1	D0

Read binary 8-bit data from DDRAM/CGRAM.

The selection of RAM is set by the previous address set instruction. If address set instruction of RAM is not performed before this instruction, the data that read first is invalid, because the direction of AC is not determined. If you read RAM data several times without RAM address set instruction before read operation, you can get correct RAM data from the second, but the first data would be incorrect, because there is no time margin to transfer RAM data.

In case of DDRAM read operation, cursor shift instruction plays the same role as DDRAM address set instruction : it also transfer RAM data to output data register. After read operation address counter is automatically increased/decreased by 1 according to the entry mode. After CGRAM read operation, display shift may not be executed correctly.

* In case of RAM write operation, after this AC is increased/decreased by 1 like read operation. In this time, AC indicates the next address position, but you can read only the previous data by read instruction.

Relationship between Character Code and CGRAM

Character code	CGRAM Address	CGRAM Data	Pattern number
D7 D6 D5 D4 D3 D2 D1 D0	A5 A4 A3 A2 A1 A0	P7 P6 P5 P4 P3 P2 P1 P0	
0 0 0 0 x 0 0 0	0 0 0 0 0 0	x x x 0 1 1 1 0	Pattern1
	0 0 1	x x x 1 0 0 0 0	
	0 1 0	x x x 1 0 0 0 0	
	0 1 1	x x x 0 1 1 1 0	
	1 0 0	x x x 0 0 0 0 1	
	1 0 1	x x x 0 0 0 0 1	
	1 1 0	x x x 0 1 1 1 0	
	1 1 1	x x x 0 0 0 0 0	
⋮	⋮	⋮	⋮
0 0 0 0 x 1 1 1	0 0 0 0 0 0	x x x 0 1 1 1 0	Pattern8
	0 0 1	x x x 1 0 0 0 1	
	0 1 0	x x x 1 0 0 0 1	
	0 1 1	x x x 1 1 1 1 1	
	1 0 0	x x x 1 0 0 0 1	
	1 0 1	x x x 1 0 0 0 1	
	1 1 0	x x x 1 0 0 0 1	
	1 1 1	x x x 0 0 0 0 0	

Display Data RAM(DDRAM)

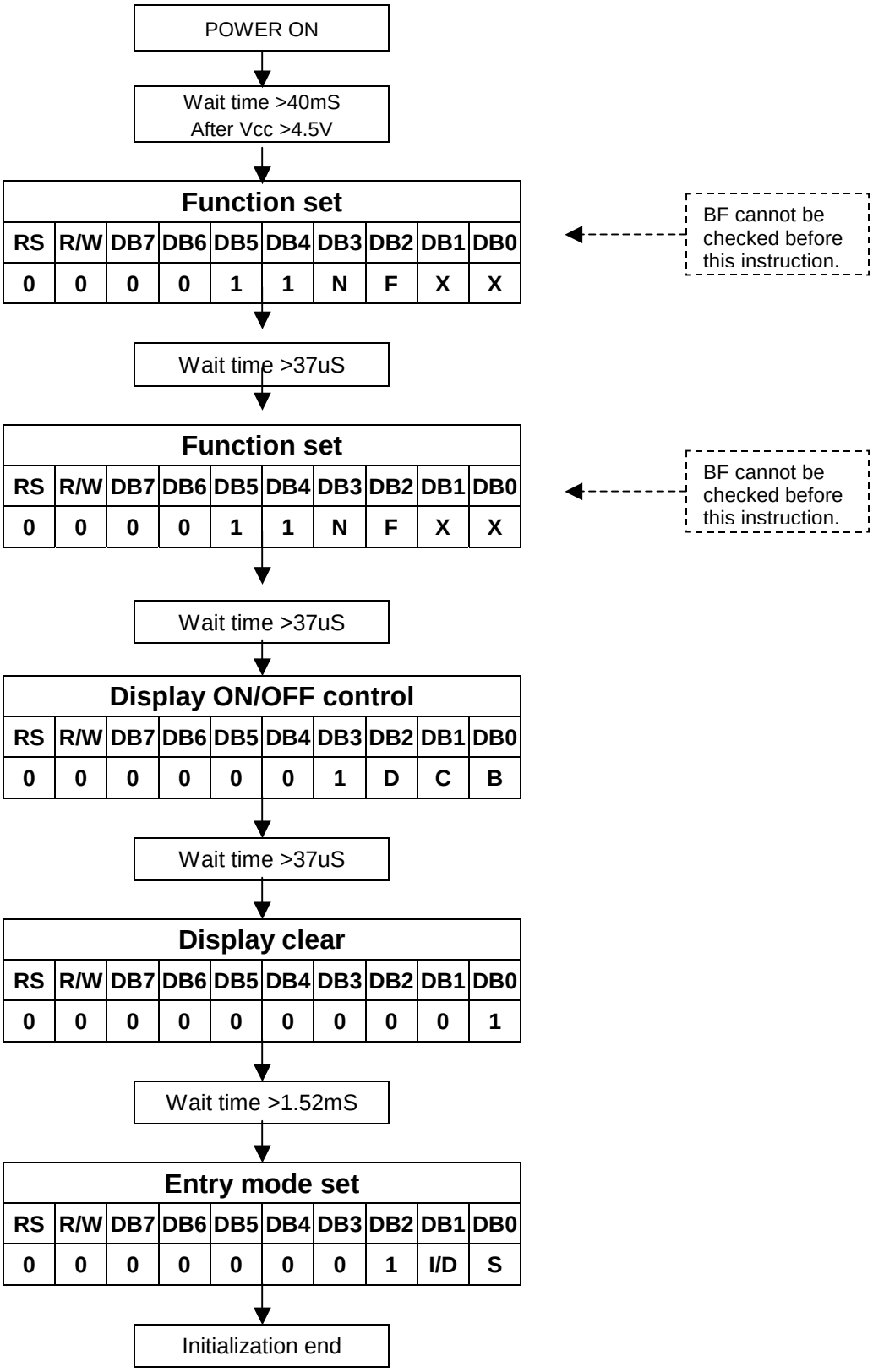
DDRAM stores display data of maximum 80x8bits (80 characters). DDRAM address is set in the address counter (AC) as a hexadecimal number

MSB LSB

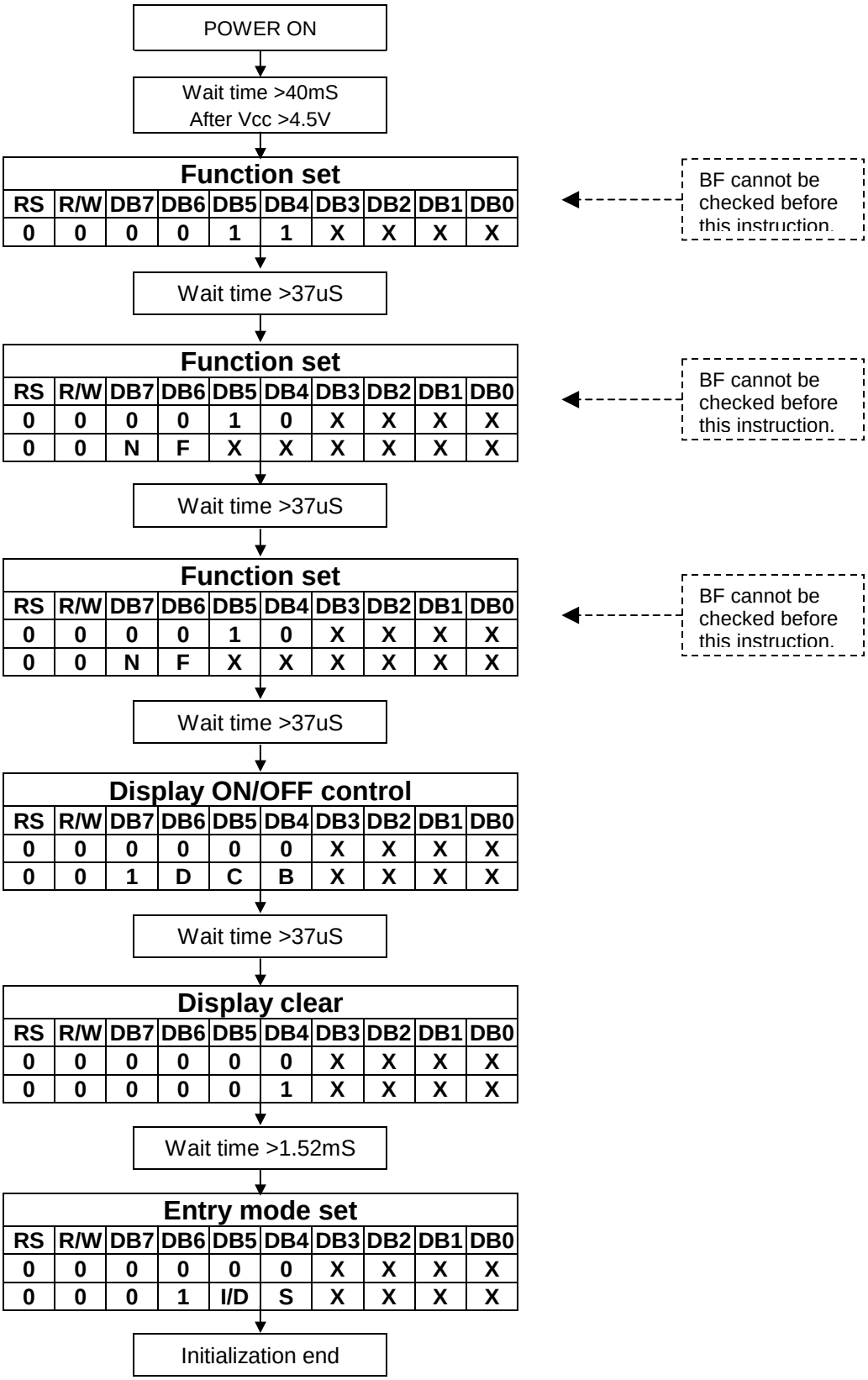
AC6	AC5	AC4	AC3	AC2	AC1	AC0

Initializing by Instruction

- **8-bit Interface (fosc=270KHz)**

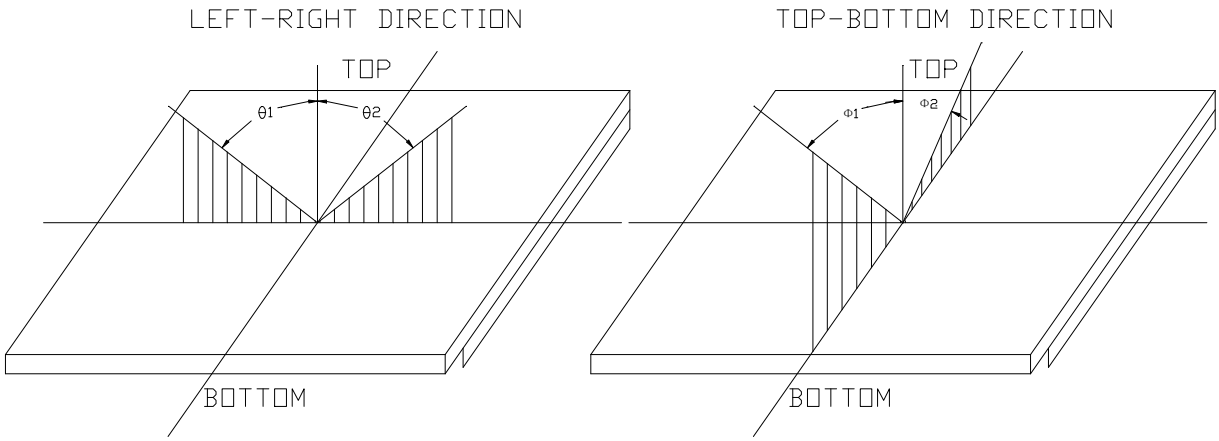


- **4-bit Interface (fosc=270KHz)**



12.OPTICAL CHARACTERISTICS:

(1)Definition of viewing Angle:



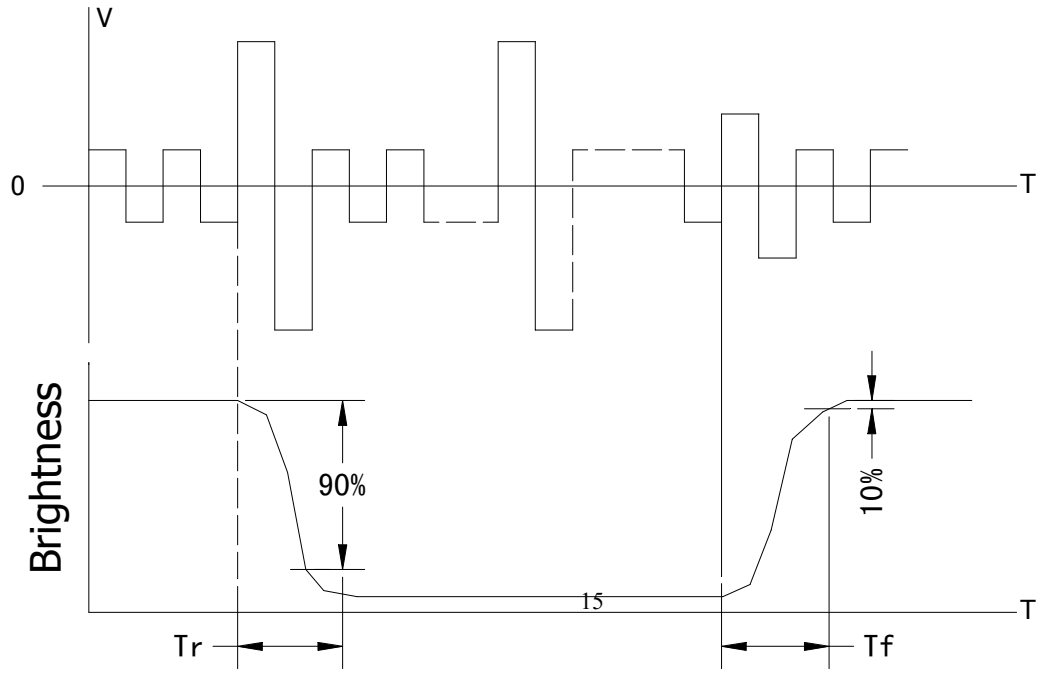
(2)Definition of Contrast Ratio:

$$\text{Contrast Ratio} = \frac{\text{Brightness of non-selected condition}}{\text{Brightness of selected condition}}$$

Test condition: standard A light source

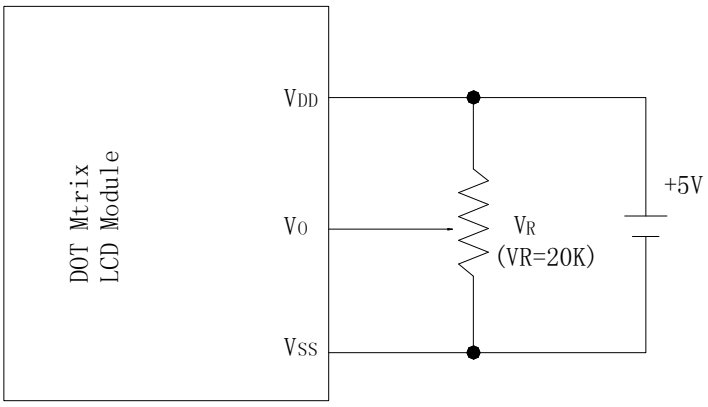
(3)Response Time:

Response time is measured as the shortest period of possible between the change in state of an LCD segments as demonstrated below:



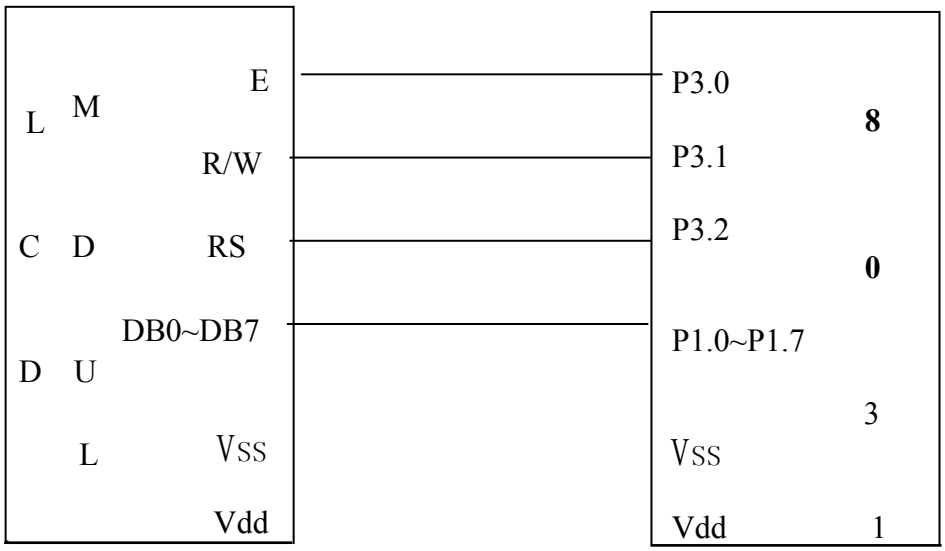
13.POWER SUPPLY SCHEMATICS

For Single Source

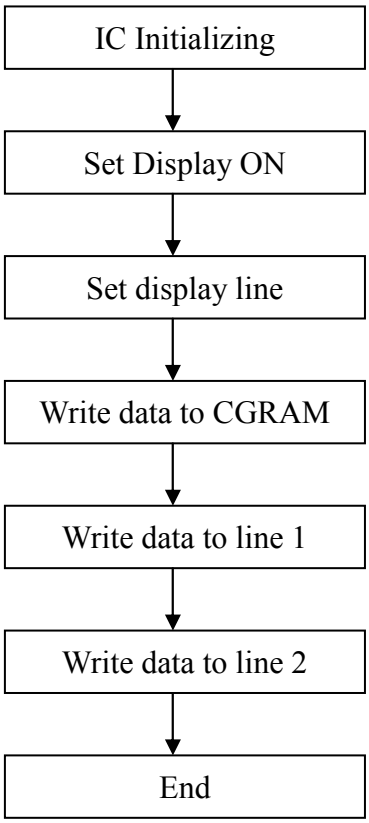


14. APPLICATION EXAMPLE

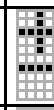
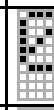
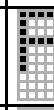
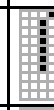
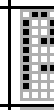
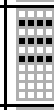
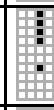
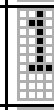
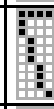
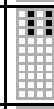
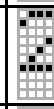
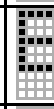
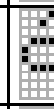
Application Circuit



Application Flowchart



NO.7066-0B

b7-b4 / b3-b0	0000	0001	0010	0011	0100	0101	0110	0111	1000	1001	1010	1011	1100	1101	1110	1111
0000	CG RAM (1)															
0001	(2)															
0010	(3)															
0011	(4)															
0100	(5)															
0101	(6)															
0110	(7)															
0111	(8)															
1000	(1)															
1001	(2)															
1010	(3)															
1011	(4)															
1100	(5)															
1101	(6)															
1110	(7)															
1111	(8)															

15. PRECAUTION FOR USING LCM

1. Liquid Crystal Display (LCD)

LCD is made up of glass, organic sealant, organic fluid, and polymer based polarizers. The following precautions should be taken when handing,

(1). Keep the temperature within range of use and storage. Excessive temperature and humidity could cause polarization degradation, polarizer peel off or bubble.

(2). Do not contact the exposed polarizers with anything harder than an HB pencil lead. To clean dust off the display surface. Wipe gently with cotton. Chamois or other soft material soaked in petroleum benzine.

(3). Wipe off saliva or water drops immediately. Contact with water over a long period of time may cause polarizer deformation or color fading, while an active LCD with water condensation on its surface will cause corrosion of ITO electrodes.

(4). Glass can be easily chipped or cracked from rough handing. especially at corners and edges.

(5). Do not drive LCD with DC voltage.

2. Liquid Crystal Display Modules

2.1 Mechanical Considerations

LCM are assembled and adjusted with a high degree of precision. Avoid excessive shocks and do not make any alterations or modifications. The following should be noted.

(1). Do not tamper in any way with the tabs on the tabs on the metal frame.

(2). Do not modify the PCB by drilling extra holes, changing its outline, moving its components or modifying its pattern.

(3). Do not touch the elastomer connector, especially insert an backlight panel (for example, EL).

(4). When mounting a LCM make sure that the PCB is not under any tress such as bending or twisting. Elastomer contacts are very delicate and missing pixels could result from slight dislocation of any of the elements.

(5). Avoid pressing on the metal bezel, otherwise the elastomer connector could be deformed and lose contact, resulting in missing pie ls.

2.2. Static Electricity

LCM contains CMOS LSI's and the same precaution for such devices should apply, namely

(1). The operator should be grounded whenever he/she comes into contact with the module. Never touch any of the conductive parts such as the LSI pads, the copper leads on the PCB and the interface terminals with any parts of the human body.

(2). The modules should be kept in antistatic bags or other containers resistant to static for storage.

(3). Only properly grounded soldering irons should be used.

(4). If an electric screwdriver is used, it should be well grounded and shielded from commutator sparks.

(5). The normal static prevention measures should be observed for work clothes and working benches; for the latter conductive (rubber) mat is recommended.

(6). Since dry air is inductive to static, a relative humidity of 50-60% is recommended.

2.3. Soldering

(1). Solder only to the I/O terminals.

(2). Use only soldering irons with proper grounding and no leakage.

(3). Soldering temperature: 280 ℃±10℃

(4). Soldering time: 3 to 4 sec.

(5). Use eutectic solder with resin flux fill.

(6). If flux is used, the LCD surface should be covered to avoid flux spatters. Flux residue should be removed after wards.

2.4. Operation

(1). The viewing angle can be adjusted by varying the LCD driving voltage V0.

(2). Driving voltage should be kept within specified range; excess voltage shortens display life.

(3). Response time increases with decrease in temperature.

(4). Display may turn black or dark blue at temperatures above its operational range; this is (however not pressing on the viewing area) may cause the segments to appear "fractured".

(5). Mechanical disturbance during operation (such as pressing on the viewing area) nay cause the segments to appear "fractured".