SDEC

DOT MATRIX
LIQUID CRYSTAL DISPLAY
MODULE

USER' MANUAL

MODEL: LMG-SS24D12DLNW-E

PROPOSED BY		APPROVED
Design	Approved	

SDEC TECHNOLOGY CORP.

CONTENTS

1. GENERAL AND CHARACTERISTICS

Model	LMG-SS24D12DLNW-E					
Dot Matrix Format	240 × 128 dots					
Controller IC	LC7981 or equivalent					
Dimensional Outline	144.0W × 104.0H × 13.0D mm					
Viewing Area	114.0W × 61.0H mm					
Active Viewing Area	105.56W × 56.28H mm					
Dot Pitch	0.44W × 0.44H mm					
Dot Size	0.40W × 0.40H mm					
Viewing Direction	6 O'CLOCK					
LCD Mode	STN , Blue , extended temperature					
BACKLIGHT TYPE	LED		USE INVERTER			
BACKLIGHT INPUT	DC +3.5V	V	240	mA		Hz

2. ABSOLUTE MAXIMUM RATINGS:

2.1 Electrical absolute maximum rating

ITEM	SYMBOL	MIN	MAX	UNIT
Logic Circuit Supply Voltage	V_{DD} - V_{SS}	0	7.0	V
LCD Driver Circuit Supply Voltage	V_{DD} - V_{EE}	0	15.0	V
Input Voltage	V_I	V_{SS}	V_{DD}	V
Operating Temperature	T_{OP}	-10	+70	℃
Storage Temperature	T_{ST}	-20	+80	℃

2.2 Environmental absolute maximum ratings

ITEM	OPERATING		STORAGE		COMMENT
	MIN	MAX	MIN	MAX	
Ambient Temperature	0/-20	50/70	-10/-30	60/80	Norm/Extended Note (1)
Humidity	Note (2)		Note (2)		Without condensation
Vibration	--	4.9m/s^2	--	19.6m/s^2	XYZ directions
Shock	--	29.4m/s^2	--	490.0m/s^2	XYZ directions

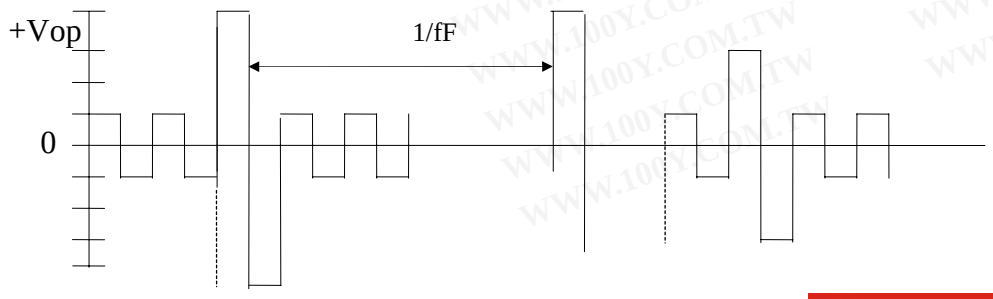
Note (1) Ta at 60℃ : 50 HR MAX

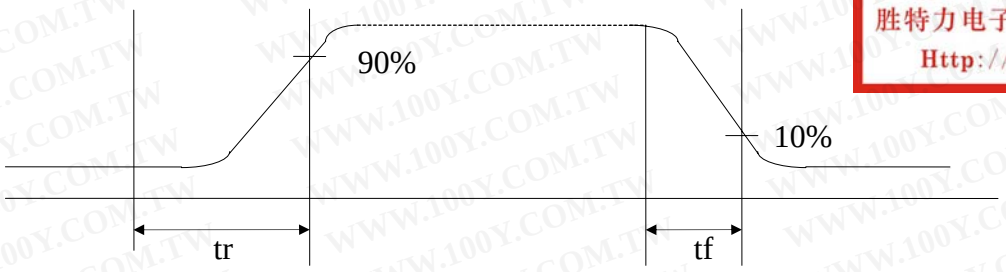
Note (2) Ta ≦40℃ : 90% RH MAX

Ta ＞40℃ : Absolute humidity must be lower than the humidity of 90% at 40℃.

(Note 1) Definition of response time and measuring condition. Response time should be measured at the point of the most smallest response in all segments under the following condition.

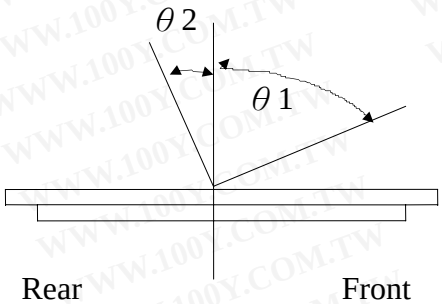
a) Temperature 25℃
b) Frame frequency 64 Hz
c) Viewing angle θ =0°, φ =0°



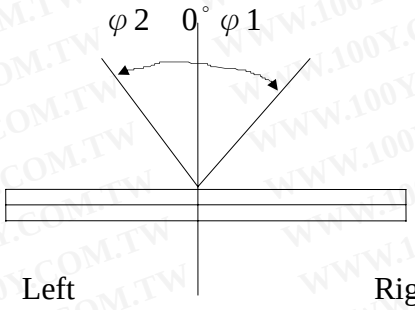


(Note 2) Definition of viewing angle

Front-Rear direction



Right-Left direction



3. ELECTRICAL CHARACTERISTICS

V_{SS} = 0V, Ta = 25℃

ITEM	SYMBOL	CONDITION	MIN	TYP	MAX	UNIT
Logic Circuit Power Supply	V_{DD} - V_{SS}	--	4.75	5.0	5.25	V
LCD Driver Power Supply	V_{DD} - V_{EE}	--	11.75	12.5	13.25	V
Input Voltage	V_{IH}	V_{DD} = 5V ±	0.7*V_{DD}	--	V_{DD}	V
	V_{IL}	0.25	0	--	0.3*V_{DD}	V
Power Supply Current	I_{DD}	V_{DD} = 5V	--	--	15.0	mA
	I_{EE}	V_{EE} = -10V	--	--	2.0	mA

4. ELECTRO-OPTICAL CHARACTERISTICS

ITEM	SYMBOL	CONDITION	MIN	TYP	MAX	UNIT	REF.
Rise Time	Tr	25℃	--	396	--	mS	Note 1
Fall Time	Tf	25℃	--	109	--	mS	Note 1
Contrast	Cr	25℃	--	12.3	--	--	Note 3
Viewing Angle	θ	25℃ &	50	--	--	DEG	Note 2
	φ 1, φ 2	Cr≧3	--	40	--	DEG	Note 2
Frame Frequency	Ff	25℃	--	64	--	Hz	--

Note 1&2: See previous page.

Note 3 : Contrast ration is defined under the following condition.

Cr = reflectance value of non-selected condition ÷ reflectance value of selected condition.

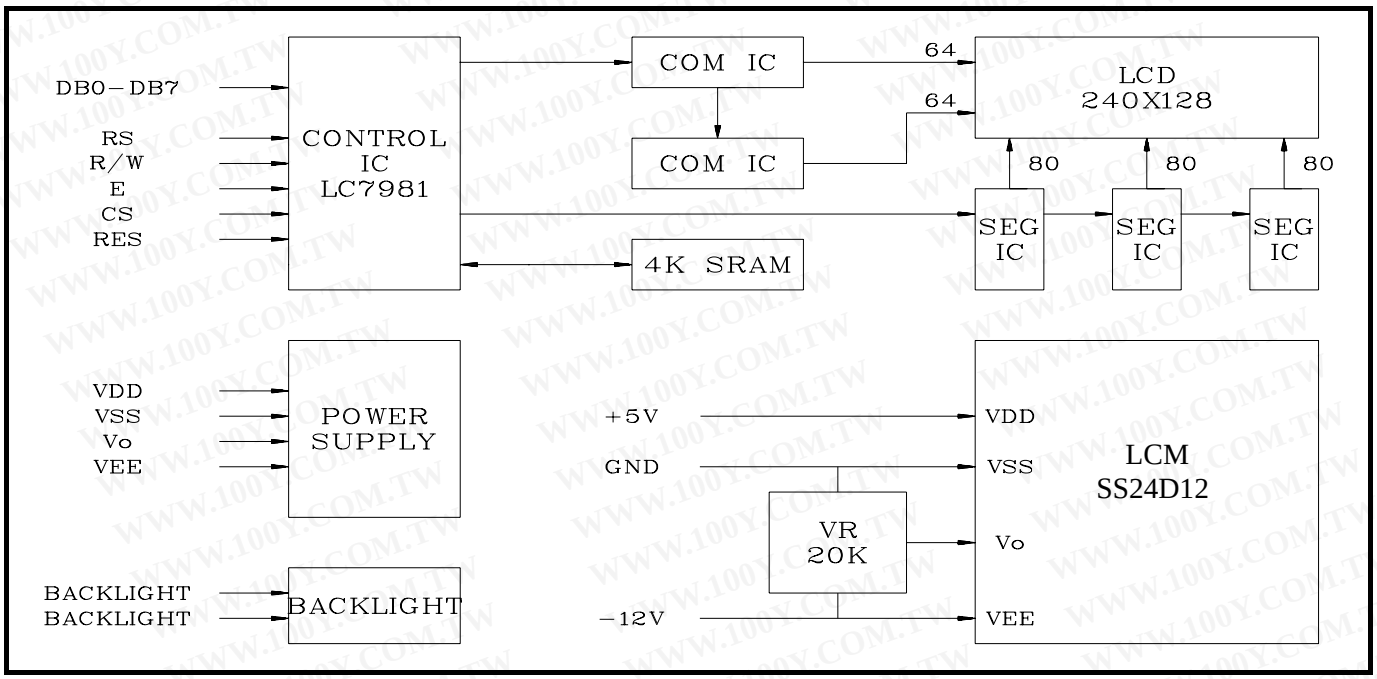
(a) Temperature..... 25℃

(b) Frame frequency..... 64 Hz

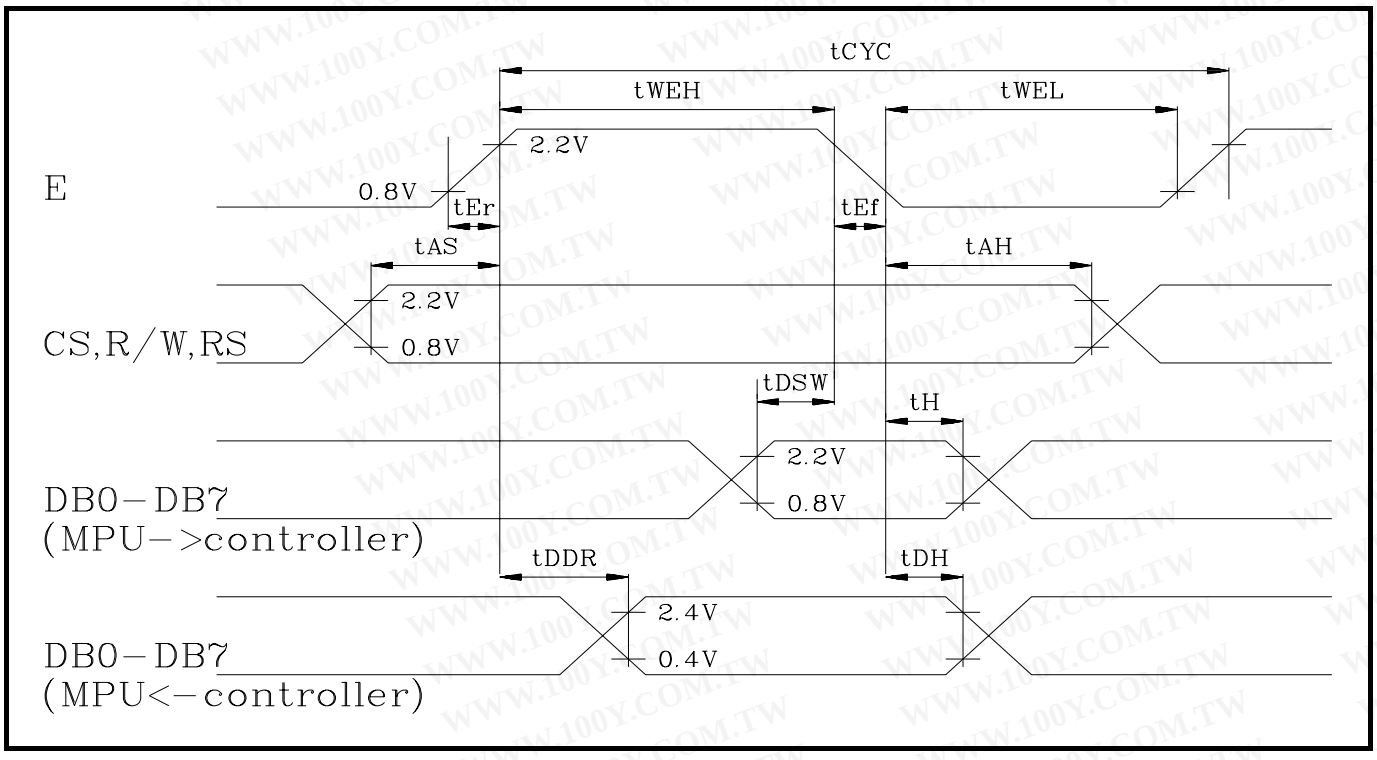
(c) Viewing angle..... θ =0°, φ =0°

(d) Operating voltage.....12.5V

5. BLOCK DIAGRAM AND POWER SUPPLY



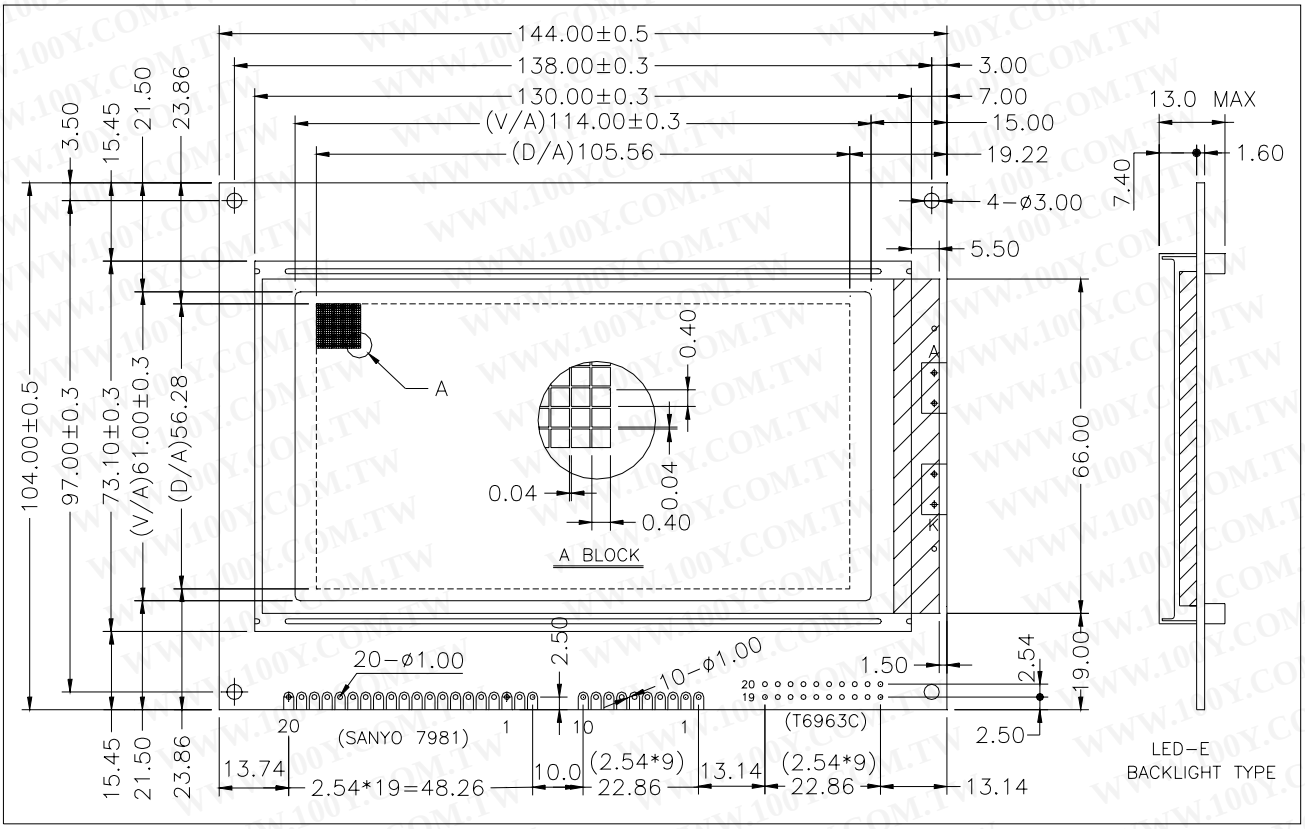
6. TIMING CHARACTERISTICS



ITEM	SYMBOL	MIN	TYP	MAX	UNIT
Enable cycle time	t_{CYC}	1000	--	--	ns
Enable pulse width High/Low level	t_{WEH},t_{WEL}	450	--	--	ns
Enable rise/fall time	t_{Er},t_{Ef}	--	--	25	ns
Setup time	t_{AS}	140	--	--	ns
Data setup time	t_{DSW}	225	--	--	ns
Data delay time	t_{DDR}	--	--	225	ns*
Data hold time	t_{H}	10	--	--	ns
Address hold time	t_{AH}	10	--	--	ns
Output data hold time	t_{DH}	20	--	--	ns

Note: * The following load circuit is connected for specification

7. DIMENSION OUTLINE AND PIN CONNECTIONS



NO.	SYMBOL	FUNCTION	NO.	SYMBOL	FUNCTION
1	V_{SS}	Ground	15	/CS	Chip enable
2	V_{DD}	Power supply for logic circuit	16	/RES	Controller reset
3	V_o	Power supply for LCD circuit	17	V_{EE}	Negative voltage input
4	RS	Instruction / Data	18	N.C	
5	R/W	Read / Write	19	A	
6	E	Enable Signal	20	K	
7~14	DB0~DB7	Data bus line			

8. POWER SUPPLY FOR BACKLIGHT

ITEM	SPECIFICATION	NOTE
Color	White	
CCFL Voltage(INPUT)	—	
CCFL Frequency	—	
Inverter Current Density	—	—
Initial Brightness	—	
Half-Life Time	10,000HR.	

9. DISPLAY CONTROL INSTRUCTIONS

9.1 Description of command

Display is controlled by writing data into the instruction register and 13 data registers. The RS signal distinguishes the instruction register from the data registers. 8-bit data is written into the instruction register with RS=1, and the code of data register is specified. After that, the 8-bit data is written in the data register and the specified instruction is executed with RS=0. During the execution of the instruction, no new instruction can be accepted. Since the busy flag is set during this, read the busy flag and make sure it is 0 before writing the next instruction.

9.1.1 Mode Control

Code $"00" (hexadecimal) written into the instruction register specifies the mode control register.

REGISTER	R/W	RS	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
Instruction Register	0	1	0	0	0	0	0	0	0	0
Mode Control Register	0	0	0	0	Mode Data					

DB5	DB4	DB3	DB2	DB1	DB0	Cursor/blink	CG	Graphic/Character
		0	0			Cursor OFF		
		0	1			Cursor ON	Internal	
		1	0		0	Cursor OFF, Character blink	CG	
		1	1			Cursor blink		
1/0	1/0	0	0	0		Cursor OFF		Character Mode
		0	1			Cursor ON	Internal	
		1	0		1	Cursor OFF, Character blink	CG	
		1	1			Cursor blink		
		0	0	1	0			Graphic Mode

1: Master Mode 0: Slave Mode *Normal is set Master Mode

1: Display ON 0: Display OFF

9.1.2 Set Character Pitch

REGISTER	R/W	RS	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
Instruction Register	0	1	0	0	0	0	0	0	0	1
Character Pitch Register	0	0	(Vp -1) Binary				0	(Hp -1) Binary		

Vp indicates the number of vertical dots per character. The space between the vertically-displayed characters is considered for determination. This value is meaningful only during character display (in the character mode) and becomes invalid in the graphic mode. The Hp indicates the number of horizontal dots per character in display including the space between horizontally-displayed characters. In the graphic mode, the Hp indicates the number of bits of 1 byte display data to be displayed. Three Hp values:

Hp	DB2	DB1	DB0	
6	1	0	1	Horizontal character pitch 6
7	1	1	0	Horizontal character pitch 7
8	1	1	1	Horizontal character pitch 8

9.1.3 Set Number of Characters

REGISTER	R/W	RS	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
Instruction Register	0	1	0	0	0	0	0	0	1	0
Number of Character Register	0	0	0	(Hn -1) Binary						

Hn indicates the number of horizontal characters in the character mode r the number of horizontal bytes in the graphic mode. If the total sum of horizontal dots on the screen is taken as n, n = Hp x Hn.
Hn can be set with an even number of 2 to 128 (decimal).

9.1.4 Set Number of Time Division (inverse of display duty ratio)

REGISTER	R/W	RS	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
Instruction Register	0	1	0	0	0	0	0	0	1	1
Character Pitch Register	0	0	(Nx -1) Binary							

Nx indicates the number of time division in multiplex display. 1/Nx is a display duty ration.
A value of 1 to 128 (decimal) can be set to Nx.

9.1.5 Set Cursor Position

REGISTER	R/W	RS	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
Instruction Register	0	1	0	0	0	0	0	1	0	0
Cursor Position Register	0	0	0	0	0	0	(Cp -1) Binary			

Cp indicates the position in a character where the cursor is displayed in the character mode. For example, in 5x7 dot font, the cursor is displayed under a character by specifying Cp=8 (decimal). The cursor

horizontal length is equal to the horizontal character pitch Hp. A value of 1 to 16 (decimal) can be set to Cp. If a smaller value than the number of vertical character pitches Vp is set (Cp≦Vp), and a character is overlapped with the cursor, the cursor has higher priority of display (at cursor display ON). If Cp is greater than Vp, no cursor is displayed. The cursor horizontal length is equal to Hp.

9.1.6 Set Display Start Low Order Address

REGISTER	R/W	RS	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
Instruction Register	0	1	0	0	0	0	1	0	0	0
Display Start Address Register (low order byte)	0	0	(Start low order address) Binary							

9.1.7 Set Display start High Order Address

REGISTER	R/W	RS	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
Instruction Register	0	1	0	0	0	0	1	0	0	1
Display Start Address Register (high order byte)	0	0	(Start high order address) Binary							

These instructions cause display start addresses to be written in the display start address registers. The display start address indicates a RAM address at which the data displayed at the top left end on the screen is stored. In the graphic mode, the start address is composed of high/low order 16 bits. In the character display, it is composed of he lower 4 bits of high order address (DB3 - DB4) and 8 bits of low order address. The upper 4 bits of high order address are ignored.

9.1.8 Set Cursor Address (low order) (RAM write low order address)

REGISTER	R/W	RS	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
Instruction Register	0	1	0	0	0	0	1	0	1	0
Cursor Address Counter (low order byte)	0	0	(Cursor low order address) Binary							

9.1.9 Set Cursor Address (high order) (RAM write high address)

REGISTER	R/W	RS	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
Instruction Register	0	1	0	0	0	0	1	0	1	1
Cursor Address Counter (high order byte)	0	0	(Vp -1) Binary				0	(Hp -1) Binary		

These instructions cause cursor addresses to be written in the cursor address counters. The cursor address indicates and address for sending or receiving display data and character codes to or from the RAM. Namely, data at address specified by the cursor address are read/written. In the character mode, the cursor is displayed at the digit specified by the cursor address. A cursor address consists of the low-order address (8 bits) and the high-order address (8 bits). Satisfy the following requirements.

1	When you want to rewrite (set) both the low order address and the high order address.	Set the low order address and then set the high order address.
2	When you want to rewrite only the low order address.	Don‘t fail to set the high order address again after setting the low order address.
3	When you want to rewrite only the high order address.	Set the high order address. You don‘t have to set the low order address again.

The cursor address counter is a 16 bit up-count with SET and RESET functions. When the bit N Changes from 1 to 0, the bit N+1 is added by 1. When setting the low order address, the LSB (bit 1) of the high order address is added by 1 if the MSB (bit *) of the low order address changes from 1 to 0. Therefore, set both the low order address and the high order address as shown in above table.

9.1.10 Write Display Data

REGISTER	R/W	RS	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
Instruction Register	0	1	0	0	0	0	1	1	0	0
RAM	0	0	MSB (pattern data, character code) LSB							

After the code $“OC” is written into the instruction register with RS=1, 8 bit data with RS=0 should be written into the data register. This data is transferred to the RAM specified by the cursor address as display data or character code. The cursor address is increased by 1 after this operation.

9.1.11 Read Display Data

REGISTER	R/W	RS	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
Instruction Register	0	1	0	0	0	0	1	1	0	1
RAM	0	0	MSB (pattern data, character code) LSB							

Data can be read from the RAM with RS=0 after writing code $“0D” into the instruction register. The read procedure is as follows:

This instruction outputs the contents of data output register on Data Bus (DB0 to DB7) and then transfers RAM data specified by a cursor address to the data output register, also increasing the cursor address by 1. After setting the cursor address, correct data is not output at the first read but at the second time. Thus, make one dummy read when reading data after setting the cursor address.

9.1.12 Set Bit

REGISTER	R/W	RS	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
Instruction Register	0	1	0	0	0	0	1	1	1	1
Bit Set Register	0	0	0	0	0	0	0			

The Clear/Set bit instruction sets 1 bit in a byte of display data RAM to 0 or 1, respectively. The position of the bit in a byte is specified by NB and RAM address is specified by cursor address. After the execution of the instruction, the cursor address is automatically increased by 1. NB is a value of 1 to 8. NB=1 and NB=8 indicates LSB and MSB, respectively.

9.1.13 Read Busy Flag

REGISTER	R/W	RS	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
Busy Flag	0	1	1/0	*						

When the read mode is set with RS=1, the busy flag is output to DB7. The busy flag is set to 1 during the execution of any of instructions (1) to (13). After the execution, it is set to 0. The next instruction can be accepted. No instruction can be accepted when busy flag=1. Before executing an instruction or writing data, perform a busy flag check to make sure that busy flag is 0. When data is written in the register (RS=1), no busy flag changes. Thus, no busy flag check is required just after the write operation into the instruction register with RS=1. The busy flag can be read without specifying any instruction register.

9.2 Display variables

Symbol	Name	Meaning	Value
Hp	Horizontal character pitch	Lateral character pitch	6 to 8 dots
Hn	Number of horizontal characters	Number of lateral characters per line (number of digits) in the character mode or number of bytes per line in the graphic mode.	2 to 128 digits (an even number)
Vp	Vertical character pitch	Longitudinal character pitch.	1 to 16 dots
Cp	Cursor position	Line number on which the cursor can be displayed.	
nx	Number of time division	Inverse of display duty ratio	1 to 128 lines

Note: If the number of vertical dots on screen is taken as m, and the number of horizontal dots as n,

1/m = 1/Nx = display duty ratio

n = Hp x Hn, m/Vp = Number of display lines

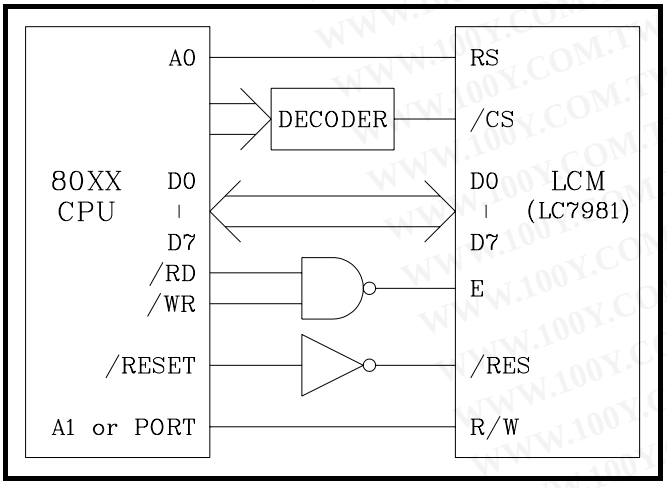
Cp≦Vp

9.3 Initialize LCM register set list

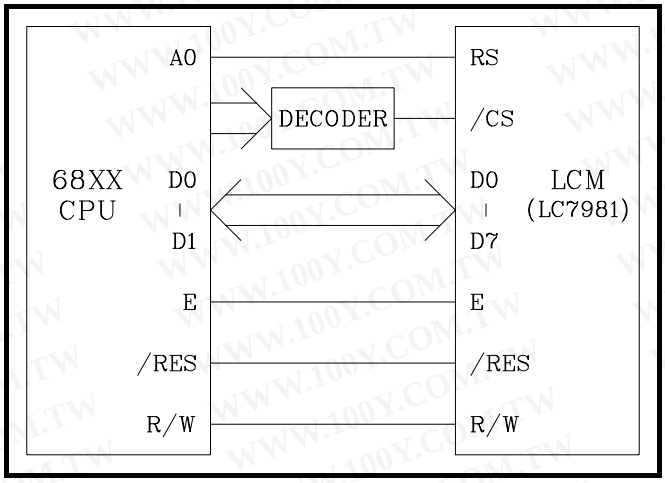
Register number	**0H**	**1H**	**2H**	**3H**	**4H**	**8H**	**9H**	**AH**	**BH**
Character mode	1CH	77H	27H	7FH	07H	00H	00H	00H	00H
Graphics mode	12H	77H	1DH	7FH	07H	00H	00H	00H	00H

10. INTERFACE FOR LCM

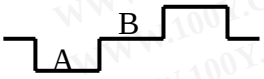
10.1 Interface to 80 family



10.2 Interface to 68 family



11. RELIABILITY CONDITION

			TN Type		STN Type	
			Normal Temp.	Wide Temp.	Normal Temp.	Wide Temp.
Viewing Angle	Horizontal Φ		±30°	±30°	±30°	±30°
	Vertical Θ(mm)		10° to 30°	10° to 30°	-10° to 40°	-10° to 40°
Operating Temperature			-10 to 70℃	-25 to 80℃	0 to 50℃	*-20 to 70℃
Storage Temperature			-20 to 80℃	-35 to 90℃	-20 to 70℃	*-30 to 80℃
High Temperature (Power Off)			240 Hours @70℃	240 Hours @90℃	240 Hours @65℃	240 Hours @75℃
Low Temperature (Power Off)			240 Hours @-20℃	240 Hours @-35℃	240 Hours @-15℃	240 Hours @-25℃
High Temperature (Power On)			240 Hours @70℃	240 Hours @80℃	240 Hours @60℃	240 Hours @70℃
Low Temperature (Power On)			240 Hours @-10℃	240 Hours @-25℃	240 Hours @-10℃	240 Hours @-20℃
High Temperature & High Humidity			55℃/90%RH 240 Hours	75℃/90%RH 240 Hours	45℃/90%RH 240 Hours	65℃/90%RH 240 Hours
Thermal Shock 5 Cycle 		A	60min@-20℃	60min@-35℃	60min@-20℃	60min@-30℃
		B	5min@25℃	5min@25℃	5min@25℃	5min@25℃
		C	60min@70℃	60min@90℃	60min@70℃	60min@80℃
Expected Lift			50,000 Hours	50,000 Hours	50,000 Hours	50,000 Hours

*Wide temp. version may not available for some products, Please consult our sales engineer or respresentative.

12. FUNCTIONAL TEST & INSPECTION CRITERIA

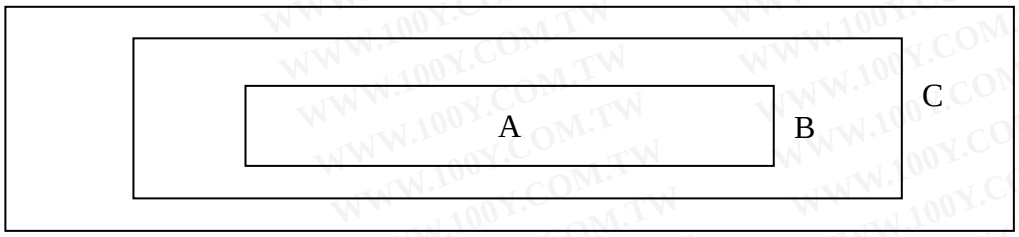
12.1 Sample plan

Sample plan according to MIL-STD-105D level 2, and acceptance/rejection criteria is.
Base on : Major defect : AQL 0.65 Minor defect : AQL 2.5

12.2 Inspection condition

Viewing distance for cosmetic inspection is 30cm with bare eyes, and under an environment of 800 lus (20W) light intensity. All direction for inspecting the sample should be within 45° against perpendicular line.

12.3 Definition of Inspection Zone in LCD



Zone A : Character / Digit area
Zone B : Viewing area except Zone A (Zone A + Zone B = minimum Viewing area)
Zone C : Outside viewing area (invisible area after assembly in customer's product)
Note : As a general rule, visual defects in Zone C are permissible, when it is no trouble for quality and assembly of customer's product.

12.4 Major Defect

All functional defects such as open (or missing segment), short, contrast differential, excess power consumption, smearing, leakage, etc. and overall outline dimension beyond the drawing. Are classified as major defects.

12.5 Minor Defect

Except the Major defects above, all cosmetic defects are classified as minor defects.

<table>
<tr><th>Item No.</th><th>Item to be Inspected</th><th colspan="5">Inspection Standard</th><th>Classification of defects</th></tr>
<tr><td rowspan="6">1.</td><td rowspan="6">Spot defect
(Defects in spot from)</td><td rowspan="2">Zone size (mm)</td><td colspan="3">Acceptable Qty</td><td rowspan="6">Minor</td></tr>
<tr><td>A</td><td>B</td><td>C</td></tr>
<tr><td>Φ ≦0.15</td><td colspan="2">Acceptable
(clutering of spot not allowed)</td><td>Accepta-ble</td></tr>
<tr><td>0.15≦ Φ ≦0.20</td><td>1</td><td>2</td><td rowspan="3"></td></tr>
<tr><td>0.20≦ Φ ≦0.25</td><td>0</td><td>1</td></tr>
<tr><td>Φ>0.25</td><td>0</td><td>0</td></tr>
<tr><td colspan="5">Remarks : for dark/white spot, size Φ is defined as Φ=1/2(X+Y)</td></tr>
<tr><td rowspan="8">2.</td><td rowspan="8">Line defect
(Defects in line form)</td><td colspan="2">Size (mm)</td><td colspan="3">Acceptable Qty</td><td rowspan="8">Minor</td></tr>
<tr><td rowspan="2">L
Length</td><td rowspan="2">W
Width</td><td colspan="3">Zone</td></tr>
<tr><td>A</td><td>B</td><td>C</td></tr>
<tr><td>Accep-table</td><td>W≦0.02</td><td colspan="2">Accep-table</td><td>Accep-table</td></tr>
<tr><td>L≦3.0</td><td>W≦0.03</td><td colspan="2">2</td><td rowspan="4"></td></tr>
<tr><td>L>2.5</td><td>W≦0.03</td><td colspan="2">0</td></tr>
<tr><td>L≦3.0</td><td>0.03<W≦0.05</td><td colspan="2">2</td></tr>
<tr><td>L>2.5</td><td>0.03<W≦0.05</td><td colspan="2">0</td></tr>
<tr><td colspan="2">W>0.05</td><td colspan="3">Counted as spot defect (Follows item 12.5.1)</td></tr>
<tr><td colspan="5">Remarks: The total of spot defect and line defect shall not exceed four.</td></tr>
<tr><td>3.</td><td>Orientation defect (such as misalignment of L/C)</td><td colspan="5">Not allowed inside viewing area (Zone A or Zone B)</td><td>Minor</td></tr>
<tr><td rowspan="6">4.</td><td rowspan="6">Polarizing</td><td colspan="5">12.5.4.1 Polarizer Position
1. Shifting in Position Should not exceed the glass outline dimension.
2. Incomplete covering of the viewing area due to Shifting is not allowed.</td><td rowspan="6">Minor</td></tr>
<tr><td colspan="5">12.5.4.2 Seratches, bubble or dent on Glass/ Polarizer/Reflector, Bubble between Polarizer & Reflector/Glass:</td></tr>
<tr><td rowspan="3">Size (mm)</td><td colspan="3">Acceptable Qty</td><td rowspan="5">Accep-table</td></tr>
<tr><td colspan="3">Zone</td></tr>
<tr><td>A</td><td>B</td><td>C</td></tr>
<tr><td>Φ ≦0.20</td><td colspan="2">Acceptable</td></tr>
<tr><td>0.20<Φ ≦0.50</td><td colspan="2">3</td></tr>
<tr><td>0.50<Φ ≦1.00</td><td colspan="2">2</td></tr>
<tr><td>Φ>1.00</td><td colspan="2">0</td></tr>
</table>

13. CG ROM PATTERN

CHARACTER PATTERN CHART (5×7 DOTS +CURSOR)

Higher 4 bit / Lower 4 bit	0000	0010	0011	0100	0101	0110	0111	1010	1011	1100	1101	1110	1111
XXXX0000	CG RAM (1)												
XXXX0001	(2)												
XXXX0010	(3)												
XXXX0011	(4)												
XXXX0100	(5)												
XXXX0101	(6)												
XXXX0110	(7)												
XXXX0111	(8)												
XXXX1000	(1)												
XXXX1001	(2)												
XXXX1010	(3)												
XXXX1011	(4)												
XXXX1100	(5)												
XXXX1101	(6)												
XXXX1110	(7)												
XXXX1111	(8)												