

APPROVAL SHEET

Customer : _____
Part Name : LCD MODULE
Model NO. : GDM240128A
Drawing NO. : _____
Approved by : _____
Date : 2005.06.03

Approved by	Checked by	Prepared by	Sheet code
			2005-06-03

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1. Scope

This manual defines general provisions as well as inspection standards for LCD module supplied by Worldtech LCD LTD

If the event of unforeseen problem or unspecified items may occur, please contact the nearest supplier or our company for solution.

2. Warranty

If module is not stored or used as specified in this manual, it will be void the 12 months warranty.

3. Features

3-1. Features:

Display Mode:	{	Transflective and Positive type STN LCD
Display Color:	{	Display Dots: Black Background: Light Gray
Display Format:		240(w)×128(h) full dots
Input Data:		8-bits parallel data interface from a MPU
Multiplexing Ratio:		1/128 Duty
Viewing Angle:		6 o'clock
Back Light:		LED backlight White
Display RAM Capacity:		32k byte S-RAM (built-in)
Controller Type:		T6963C (built-in)
CG ROM/RAM Capacity:		Built-in 128 words character generator (CG) ROM.

3-2. Mechanical Specifications:

Item	Specifications	Unit
Dimensional Outline	144.0(W)×104.0(H) ×16.0 Max.	mm
Number of Dots	240(W) ×128(H) Dots	—
Number of Characters	40C×16L(640) in case of 6×8 Fonts 30C×16L(480) in case of 8×8 Fonts	—
Viewing Area	114.0(W)×64.0(H)	mm
Active Area	107.95(W)×57.55(H)	mm
Dot Pitch	0.45(W)×0.45(H)	mm
Dot Size	0.40(W)×0.40(H)	mm
Weight	Approx. 180	g

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3-3. Absolute Maximum Rating

Item		Symbol	Min.	Max.	Unit	Note
Supply Voltage	Logic	Vdd	-0.3	7.0	V	Vss=0V
	LCD drive	Vdd - Vee	0	28	V	
Input Voltage		Vi	-0.3	Vdd+0.3	V	Vss=0V
Operating Temperature		Top	-10	60	°C	
Storage Temperature		Tstg	-20	70	°C	
Humidity		—	—	90	%RH	

3-4. Electrical Characteristics:

3-4-1. Electrical Characteristics

Note: <1> Duty =1/128 <2> All dots on static state

Item		Symbol	Conditions	Min.	Typ.	Max.	Unit
Supply Voltage	Logic	Vdd		4.5	5.0	5.5	V
	LCD drive	Vdd-Vee		—	20	25.0	
Input Voltage	"H" Level	Vih	Vdd=5V ± 5%	Vdd-2.2	—	Vdd	V
	"L" Level	Vil		0	—	0.8	
Output Voltage	"H" Level	Voh	Vdd=5V ± 5%	Vdd-0.3	—	Vdd	V
	"L" Level	Vol		0	—	0.3	
Frame Frequency		Fflm	Vdd=5V	70	75	80	Hz
Current Consumption	Logic	Idd	Vdd=5V Vdd-Vee=20.0V	—	5.7	10.0	mA
	LCD drive	Iee	Fflm=75Hz	—	5.4	9.8	
LCD Driving Voltage (Recommended Voltage)		Vdd-Vee	Ta= -10°C φ=0°, θ=0°	—	20.8	—	V
			Ta= 25°C φ=0°, θ=0°	—	20.0	—	
			Ta= 60°C φ=0°, θ=0°	—	19.5	—	

3-4-2 Specifications for E/L backlight

Item	Unit	Standard Values			Conditions
		Min.	Typ.	Max.	
Supply Voltage	V	—	5.0	—	—
Supply Frequency	mA	—	72	—	DC5.0 Vrms, Dark room
Lifetime	Hrs	10000			Note <1>
Luminous Color	—	White			DC5.0Vrms, Dark room
Operating Temperature	°C	-30~70			—
Storage Temperature	°C	-40 ~ 85			—

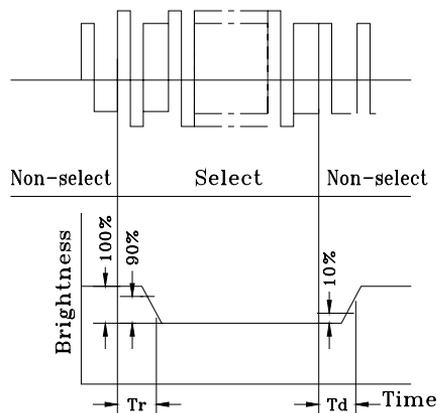
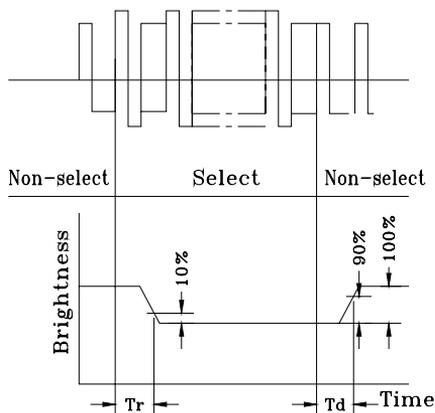
Note<1>: Half value of initial brightness at 20°C 60%RH

3-5. Electro-optical Characteristics:

Item	Symbol	Temp.	Conditions	Min.	Typ.	Max.	Unit	Note
LCD Driving Voltage (Recommended voltage)	Vop	-10°C	$\phi = 0^\circ, \theta = 0^\circ$	—	20.8	24.0	V	1,2,5
		25°C		—	20.0	—		
		60°C		—	19.5	—		
Response Time	Rise Time	0°C	$\phi = 0^\circ, \theta = 0^\circ$	—	1500	2000	mS	1,3,5
		25°C		—	150	200		
	Decay Time	0°C		—	3000	3500		
		25°C		—	200	250		
Viewing Angle	$\Delta \phi$	25°C	Vertical	-35	—	35	deg.	1,4,5
			Horizontal	-30	—	30		
Contrast Ratio	K	25°C	$\phi = 0^\circ, \theta = 0^\circ$	2.0	5.0	—	—	1,5,6

Note: <1> Definition of ϕ and θ

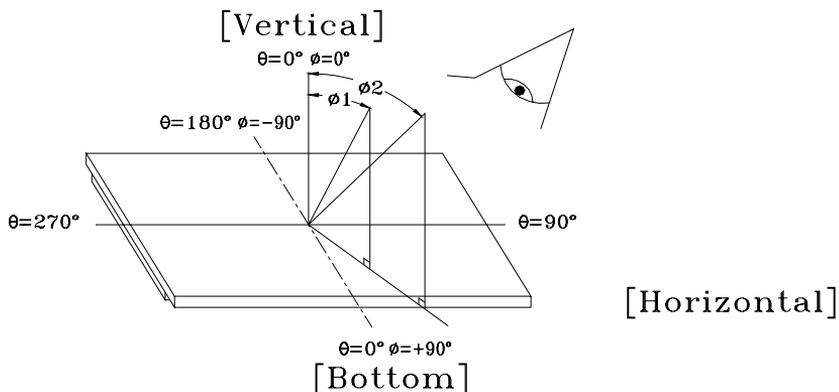
<2> Contrast ratio higher than 2 ($k \geq 2$) can be obtained in this voltage range.



Note: <3> Definition of response time waveform

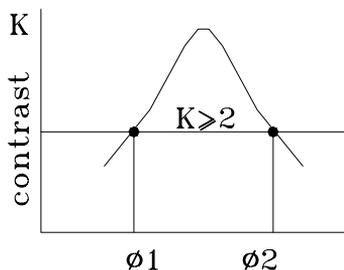
Positive Display

Negative Display



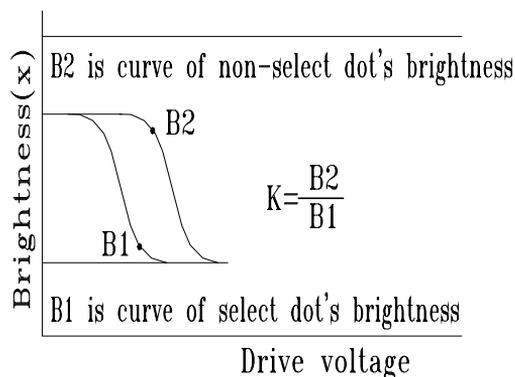
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Note: <4> Definition of viewing angle
 $(\Delta \Phi) \Delta \Phi = |\Phi 1 - \Phi 2|$

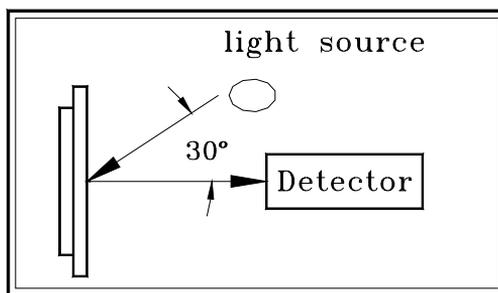


Viewing angle

Note: <6> Definition of Contrast Ratio (K)
 Positive Display

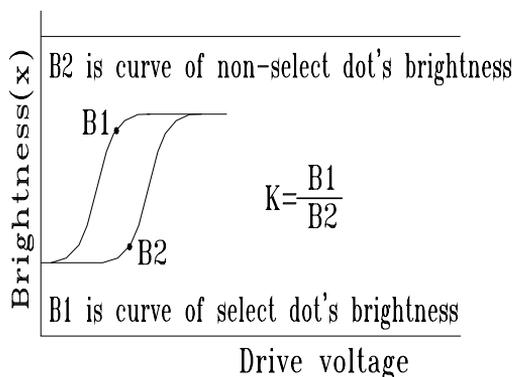


Note: <5> Optical measuring system
 temperature regulated chamber



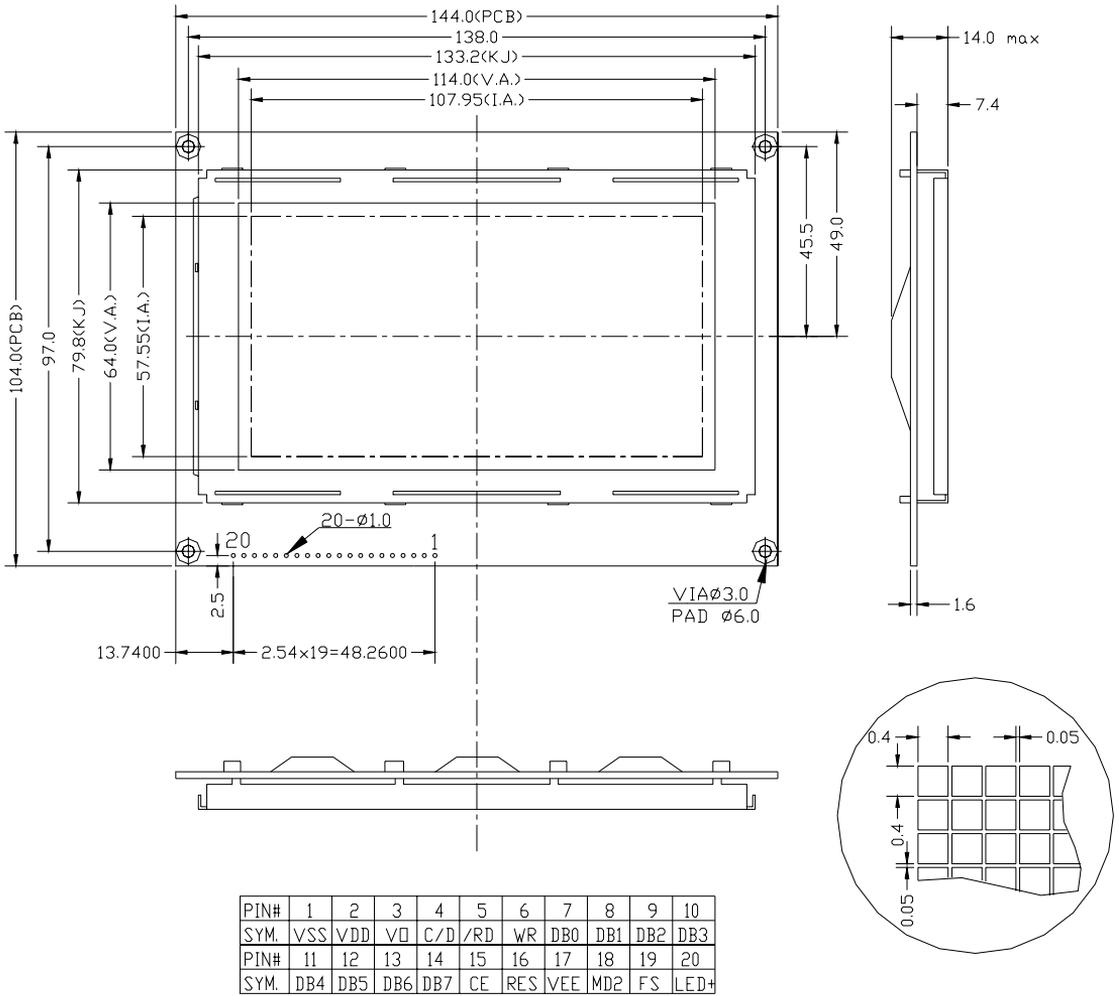
Measuring equipment: DMS
 (Made in AUTRONIC)

Negative Display



$$\text{Contrast Ratio (K)} = \frac{\text{Brightness of non-selected dot (B2)}}{\text{Brightness of selected dot (B1)}}$$

4. Dimensional Outline



5. I/O terminals

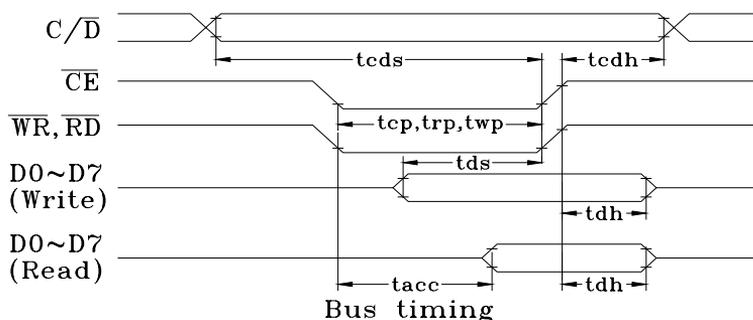
Note: The following explanation is applied for the module without built-in voltage converter.

5-1. I/O Connection

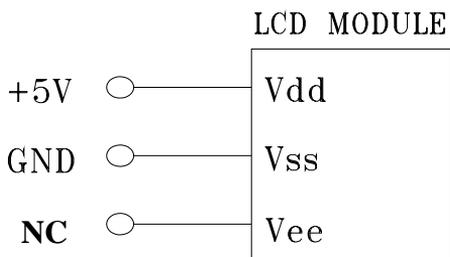
Pin No.	Symbol	Function
1	VSS	Signal ground(GND)
2	VDD	power supply for logic(+5V)
3	V0	Contrast adjustment
4	C/D	H/L Register select signal
5	RD	Data read (Active at "L")
6	WR	Data write (Active at "L")
7~14	D0~D7	Data Bus(D0=LSB,D7=MSB)
15	CE	Data read (Active at "L")
16	RES	Reset signal
17	VEE	Power supply for LCD drive
18	MD2	H=32,L=40
19	FS	Font Select: Connected to Vdd: 6×8 dots font Connected to Vss: 8×8 dots font
20	LED+	Power supply for backlight

5-2. Signal Timing Diagram:

Item	Symbol	Condition	Min.	Max.	Unit
C/D set-up time	tcds	Vdd=5V±5% Vss=0V Ta=25°C	100	—	ns
C/D hold time	tcdh		10	—	
CE,RD,WR pulse width	tcp,trp,twp		80	—	
Data set-up time	tds		80	—	
Data hold time	tdh		40	—	
Access time	tacc		—	150	
Output hold time	toh		10	50	



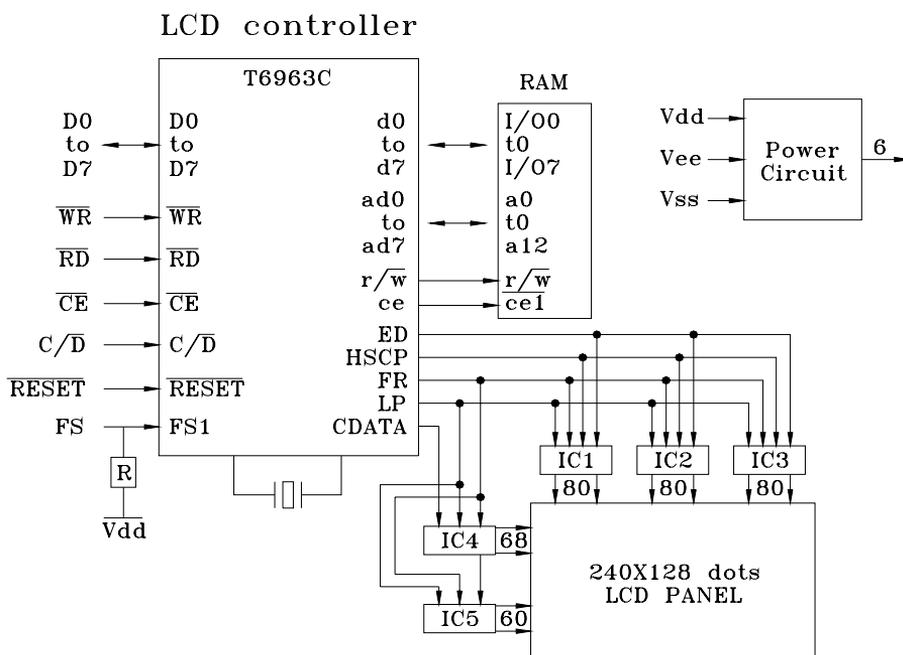
5-3. Example of Power Supply



Note: There is an end on the potentiometer for regulating contrast ratio.

5-4. Circuit Block Diagram

The circuit block diagram is shown in the following figure. The LCD module needs



Block diagram

two power sources: V_{dd} for logic and V_{ee} for LCD drive.

Note: It is necessary to guard all signals from external noise as signal lines are directly connected to C-MOS and are not pull-up or pull-down internally.

5-5. Application features of module:

- (1) This module can be directly connected to 8080MPU or Z80MPU.
- (2) This module can be set to display in combined display of graphic and text

- (Contents of the text area and of the graphic area are displayed on the screen simultaneously by mode set.) and in attribute display of text mode.
- (3) MPU can access the DDRAM at any time in the mode of byte / bit operation.
 - (4) Character Font: 6×8 dots or 8×8 dots
 - (5) A status check must be performed before data or command are read or written.
 - (6) Both the column/line counter and display register are cleared by RESET. (Other registers are not cleared.) DDRAM is kept intact. Disable the display using the clear-display register. After power on, it is necessary to reset by software.
 - (7) By the hardware setting, display columns are defined 40 characters long, maximum transferable amount of data every line.
 - (8) Display lines are defined 128 by hardware setting.
 - (9) This module has a 128-word character generator ROM (see appendix), and allocation of external character generator RAM can be made easily in DDRAM.
 - (10) DDRAM can be allocated to text area, graphic area and external character area. The text home address and the graphic home address correspond to the display bit on the top left corner of the LCD panel. In 6×8 dot matrix, one byte in the text area corresponds to a character on the screen. One byte in graphic area corresponds to 6×1 dot matrix on the screen (The lower 6 bits of a byte are valid).
 - (11) Cursor display mode is on only in the text mode and what is displayed is the logic OR of cursor and the character where the cursor is.
 - (12) For some commands that need operand data, it is important to send the operand data first and then the command code.
 - (13) Text Attribute mode is only applicable in text mode. (In this case, text mode and graphic mode should both be on.)
 - (14) The relationship between Text Area and display position in LCD panel is shown below:

TH	TH+1	...	TH+CL
TH+TA	TH+TA+1	...	TH+TA+CL
$(TH+TA) +TA$	$(TH+TA) +TA+1$	...	TH+2TA+CL
$(TH+2TA) +TA$	$(TH+2TA) +TA+1$	...	TH+3TA+CL
...
TH+15TA	TH+15TA+1	...	TH+15TA+CL

Note: TH: the text home address

TA: the width of text area (number of characters /line), to be defined by user.

CL: number of characters/line set by hardware, the CL of this module is 40.

- (15) The relationship between Graphic Area and display position in LCD panel is shown below:

GH (<i>DB7-DB0</i>)	GH+1	...	GH+CL
GH+TA	GH+TA+1	...	GH+TA+CL
(GH+TA) +TA	(GH+TA) +TA+1	...	GH+2TA+CL
(GH+2TA) +TA	(GH+2TA) +TA+1	...	GH+3TA+CL
...
GH+127TA	GH+127TA+1	...	GH+127TA+CL

Note:

GH: the graphic home address

TA: the width of graphic area (number of characters /line), to be defined by user.

CL: number of characters/line set by hardware, the CL of this module is 40.

Note: In Text mode or Graphic mode, when $TA \neq CL$, the relationship between the valid display area of the LCD panel and DDRAM address is detailed in 5-6-2.

5-6. Commands

The command of this module may have one operand datum, or two operand data or none). It is important to send the data first, and then to send the command code. If the number of the operand data is more than specified, the last are valid. The status check must be performed every time before the data and commands are read or written.

The status word format is as follows:

STA7	STA6	STA5	STA4	STA3	STA2	STA1	STA0
------	------	------	------	------	------	------	------

STA0: check command execution capability 1: enable 0: disable

STA1: check data read/write capability 1: enable 0: disable

STA2: check auto mode data read capability 1: enable 0: disable

STA3: check auto mode data write capability 1: enable 0: disable

STA4: not used

STA5: check controller operation capability 1: enable 0: disable

STA6: error flag. Used for screen peek and screen copy commands

1: error 0: no error

STA7: check the blink condition 1: normal display 0: display off

Note:

1. It is necessary to check STA0 and STA1 at the same time. There is a possibility of erroneous operation due to a hardware interrupt.
2. For most modes STA0/STA1 are used at a status check.

3. STA2 and STA3 are valid in auto mode; STA0 and STA1 are invalid.
4. STA6 is valid in screen peek and screen copy mode.
5. STA5 and STA7 mirror the interior operational status.

5-6-1. Registers Setting, the format is as follows: D1,D2

0	0	1	0	0	N2	N1	N0
---	---	---	---	---	----	----	----

D1, D2 is the first and the second parameters respectively, and the last byte is command code. According to the values of N0, N1, N2, this command has three meanings.

D1	D2	Code	Function
X Address (lower 7 bits are valid)	Y Address (lower 5 bits are valid)	21H (N0=1)	Set cursor pointer
Address (lower 5 bits are valid)	00H	22H (N1=1)	Set offset register
Low address	High address	24H (N2=1)	Set address pointer

- A、 Set cursor pointer: D1 stands for the horizontal distance (number of characters) of cursor to the top left corner of the real LCD panel. D2 stands for the vertical distance (number of character lines). Setting and changing the cursor position must be performed through resetting the cursor pointer. The cursor pointer is not related to address pointer and has no auto change function.
- B、 Set CGRAM offset register: Set the high 5 bits of CGRAM's 16 bit address in DDRAM. The actual address of CGRAM is:
- Offset Adrs: C4 C3 C2 C1 C0
- Char. Code: D7 D6 D5 D4 D3 D2 D1 D0
- Line Adrs : +) R2 R1 R0
-
- Actual.Adrs.: A15 A14 A13 A12 A11 A10 A9 A8 A7 A6 A5 A4 A3 A2 A1 A0
- R2~R0: represent one line of the self-designed 8X8 dots characters.
- When the internal CGROM mode is set in mode set, the character code allocated to external character generator is 80H~FFH. When the external CGROM mode is set in mode set, the character code allocated to the external character generator is 00H~FFH.
- For example: when allocate the units of 1800H~1FFFH (2K) in DDRAM to CGRAM, the offset register could be set to #03H. Thus, the address of character whose code is 80H in DDRAM is 1C00H~1C07H.
- B、 Set address pointer: set the unit address of DDRAM to be accessed. D1 and D2 are the low address and high address of the unit address respectively.

5-6-2. Control word setting, the command format is as follows: D1, D2

0	1	0	0	0	0	N1	N0
---	---	---	---	---	---	----	----

According to different values of N1 and N0, this command has four functions:

N1	N0	D1	D2	Code	Function
0	0	Low adrs.	High adrs.	40H	Set text home address
0	1	Columns	00H	41H	Set text area (number of characters/line)
1	0	Low adrs.	High adrs.	42H	Set graphic home address
1	1	Columns	00H	43H	Set graphic area (number of characters/line)

The text home address corresponds to the character position on the top left corner of display panel. The graphic home address corresponds to the byte position on the top left corner of display panel. The text area (number of characters/line) set and graphic area (number of characters/line) set are used to adjust the width (column) of valid display screen. The width indicates the number of character or the number of bytes can be validly displayed.

Define the width of display screen to be CL by hardware and the width of display screen to be TA by this command, then the relationship between text area and its corresponding position on LCD panel is shown as follows:

(a) when $TA \leq CL$: (TH stands for the text home address)

TH	TH+TA-1	Blank
TH+TA	.....	TH+2TA-1
.....	
.....	

←----- TA valid display screen -----→

←----- CL -----→

(b) when $TA > CL$:

TH	.....	TH+CL-1	.....	TH+TA-1
TH+TA	.....	TH+TA+CL-1	.....	TH+2TA-1
.....	.....	.....	do not transfer	
.....		

←----- CL valid display screen -----→

←----- TA -----→

The way in which the graphic area corresponds to its position in display screen is similar to the way in which the text area corresponds to its position in display screen. The only difference is that in graphic area one byte corresponds to 8 bits graphic data.

If the graphic area is defined to be the same number of characters/line of LCD, the home address of every line equals to end address of the previous line +1.

5-6-3. Mode setting, the format of command is as follows: no parameter

1	0	0	0	N3	N2	N1	N0
---	---	---	---	----	----	----	----

N3: select character generator mode

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N3=1, select CGRAM and the character code is 00~FFH.

N3=0, select internal CGROM. Since the character code of CGROM is 00~7FH, when take 80H~FFH as character code, CGRAM is automatically selected.

N2~N0: Combined-display mode setting. The functions are shown below:

N2	N1	N0	Means of Combination
0	0	0	"OR" mode
0	0	1	"EXOR" mode
0	1	1	"AND" mode
1	0	0	Text attribute mode

Only when the text mode and graphic mode are both on, the combined display mode and text attribute mode settings are valid. After the text attribute setting, the graphic area will be converted into text attribute area and store the text attribute codes. The text attribute area is of the same size as text area. In addition, the text attribute codes of the character codes in text area are stored in the same address of graphic area. Every byte in the graphic area determines the feature of its corresponding character, including the normal display, reverse display, inhibit display, blink of normal display, blink of reverse display and blink of reverse display of characters. In the text attribute area, the text attribute codes of characters are made up with a byte's low four bits.

D7	D6	D5	D4	D3	D2	D1	D0
*	*	*	*	d3	d2	d1	d0

d3: blink control. 1-blink, 0-no blink

d2~d0 :

d2	d1	d0	Function
0	0	0	Normal display
1	0	1	Reverse display
0	1	1	Inhibit display

To work in the text attribute mode, the user could build an independent area in the DDRAM as text attribute area. In this case, the graphic home address should be converted into the text attribute home address, and thus keep the data in the previous graphic area. DDRAM could be divided as follows:

Graphic area
Text attribute area
Text area
CGRAM (2K)

5-6-4. Display mode setting, the format of command is as follows: no parameter

1	0	0	1	N3	N2	N1	N0
---	---	---	---	----	----	----	----

- N0: 1/0, cursor blink on/off
- N1: 1/0, cursor display on/off
- N2: 1/0, text display on/off
- N3: 1/0, graphic display on/off

5-6-5. Cursor pattern select, format is shown as below: no parameter

1	0	1	0	0	N2	N1	N0
---	---	---	---	---	----	----	----

The cursor pattern in 8 dots(segment)×N(line). The value of N is in the range of 1 line to 8 lines (00H~07H).

5-6-6. Data auto read/write mode: no parameter

1	0	1	1	0	0	N1	N0
---	---	---	---	---	---	----	----

Using this command, MPU could continuously read/write the data in DDRAM without inputting the read/write command every time. The address pointer is automatically increased by 1 after each datum. The Auto reset command must be sent after all data have been sent, to clear Auto mode. N1 and N0 function as below:

N1	N0	Code	Function
0	0	B0H	Set data auto write
0	1	B1H	Set data auto read
1	*	B2H/B3H	Auto reset

5-6-7. Data read/write mode, the format is shown below: D1,

1	1	0	0	0	N2	N1	N0
---	---	---	---	---	----	----	----

D1	N2	N1	N0	Code	function
Data	0	0	0	C0H	Data write, ADP+1
Data	0	0	1	C1H	Data read, ADP+1
Data	0	1	0	C2H	Data write, ADP-1
—	0	1	1	C3H	Data read, ADP-1
Data	1	0	0	C4H	Date write, same ADP
—	1	0	1	C5H	Date read, same ADP

5-6-8. Screen peek, the format of command is as follows: no parameter

1	1	1	0	0	0	0	0
---	---	---	---	---	---	---	---

This command is used to transfer 1 byte of displayed data positioned by current address pointer to the data stack; this byte can then be read from the MPU by data access. The logical combination of text and graphic display data on the LCD screen can be read by this command. The address pointer should be set in graphic area.

5-6-9. Screen copy, the format of command is as follows: no parameter

1	1	1	0	1	0	0	0
---	---	---	---	---	---	---	---

The command copies a single raster line of data positioned by the address pointer (in graphic area) to the corresponding area in the graphic area. If the

attribute function is being used, this command is not available.

5-6-10. Bit set/reset: no parameter

1	1	1	1	N3	N2	N2	N0
---	---	---	---	----	----	----	----

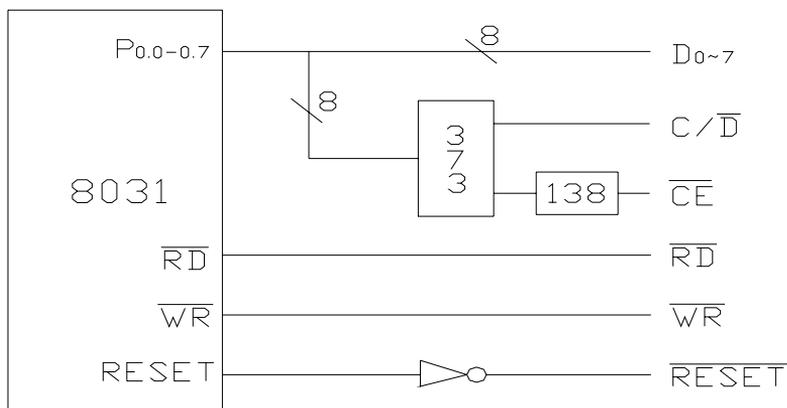
This command is used to set or reset a bit of the byte specified by the address pointer.

N3=1, set; N3=0, reset. N2~N0 corresponds to the D0~D7 bit.

5-7. Module and MPU connection

MPU uses data bus and control lines to control the module by means of direct storage access or I/O access. Interface circuit is shown in following diagram:

MPU: 8031



Data bus of 8031 is connected directly to the data bus of module. RD and WR of 8031 act as the read/write control signal of module. CE can be decoded by address bus. For example: output Y0 of IC 138 as CE. (When test the module independently, CE could be grounded directly.) Output A0 of 8031 address bus as C/D. A0=1 stands for the address of command; A0=0 stands for address of data. Each Subprogram is as follows:

(1) Status read

```

Registers to be used: R0, A;           output register: A  store status
BF:  MOV R0, #01H                    ; address of command
      MOVX A, @ R0                     ; read status
      RET
    
```

Relevant subprograms could be derived from above-mentioned program:

- a. Subprogram of STA0 and STA1 status check, Before the command write and data write and read, STA0 and STA1 should both be defined to be "1":

```
BF1:  LCALL BF
      JNB ACC.0, BF1      ; STA0 status check
      JNB ACC.1, BF1      ; STA1 status check
      RET
```

- b. Subprogram of STA2 status check, STA2 should be checked between reading of each datum. STA2=1 should be confirmed before each reading during the continuous reading.

```
BF2:  LCALL BF
      JNB ACC.2, BF2      ;STA2 status check
      RET
```

Similarly, subprogram of STA3 status check is listed as follows:

```
BF3:  LCALL BF
      JNB ACC.3, BF3      ; STA3 status check
      RET
```

- c. After the screen peek and screen copy commands, the STA6 status should be checked. STA6=0 indicates that the commands are correctly performed.

For example:

```
BF6:  LCALL BF
      JB ACC.6, ERR      ; STA6 status check
      RET
ERR:  .....            ; error disposal program
```

(2) subprogram of writing command and data

register to be used: R0, R2, R3, R4, A:

input register: R2 is the first parameter, R3 is the second parameter, R4 is the command code

```
WR:   LCALL BF1          : entrance of double parameter command
      MOV A, R2
      LCALL WR4
WR1:  LCALL BF1          ; entrance of single parameter command
      MOV A, R3
      LCALL WR4
WR2:  LCALL BF1          ; entrance of no parameter command
```

```
MOV A, R4
SJMP WR5
WR4:  MOV R0, #00H      ; entrance of writing data
WR5:  MOVX @ R0, A
      RET
```

This program is generally used. When entering data and single parameter commands, the data and commands should be sent into R3. The entrance of subprogram is WR4 and WR1 respectively. The entrance of no parameter command is WR2.

(3) subprogram of data writing
register to be used: R0, A; output register: A store data

```
RD:   LCALL BF1
      MOV R0, #00H
      MOVX A, @ R0
      RET
```

5-8. Example of Application Program

The precondition is FS=0, that is, choose the 8X8dots.

5-8-1. Subprogram of clearing DDRAM

```
CLR:  MOV R2, #00H      ; RAM address=0000H
      MOV R3, #00H
      MOV R4, #24H     ; set address pointer
      LCALL WR
      MOV R4, #0B0H   ; set data auto write
      LCALL WR2
      MOV R2, #1FH    ; auto write 8K byte
CLR1: MOV R3, #0FFH
CLR2:  LCALL BF3      ; check status STA3
      CLR A
      LCALL WR4      ; write 00H
      DJNZ R3, CLR2
      DJNZ R2, CLR1
      MOV R4, #0B3H   ; auto reset
      LCALL WR2
      RET
```

5-8-2. Subprogram of Initialization

```
INI:  LCALL CLR
      MOV R2, #00H    ; set text area
```

```

MOV R3, #00H
MOV R4, #40H
LCALL WR
MOV R2, #1EH
MOV R3, #00H
MOV R4, #41H
LCALL WR
MOV R2, #00H           ; set graphic area
MOV R3, #08H
MOV R4, #42H
LCALL WR
MOV R2, #1EH
MOV R3, #00H
MOV R4, #43H
LCALL WR
MOV R4, #80H           ; set display mode
LCALL WR2
MOV R4, #94H           ; text on
LCALL WR2
RET
    
```

The following is an example which is to display “!” in the top left corner of the screen.

```

LCALL INI
MOV R2, #00H
MOV R3, #00H
MOV R4, #24H
LCALL WR
MOV R3, #01H
MOV R4, #0C0H
LCALL WR1
RET
    
```

5-8-3. Set CGRAM

Set offset register content

- (1) Set the matrix data and character codes of the characters. For example, the Chinese character “北”, choose the character codes between 80H and FFH, then the matrix data and character codes of the character “北” are defined as follows:

Structure of “北”	matrix data	character code
Top left	04H, 04H, 04H, 04H, 04H, 7CH, 04H, 04H	80H
Bottom left	04H, 04H, 04H, 04H, 1CH, E4H, 44H, 00H	81H
Top right	80H, 80H, 88H, 98H, A0H, C0H, 80H, 80H	82H

Write into CGRAM

```

WRCG: MOV R2, #03H
      MOV R3, #00H
      MOV R4, #22H           ; set offset register
      LCALL WR
      MOV DPTR, #TAB1       ; matrix data home address
      MOV R2, #00H
      MOV R3, #1CH          ; CGRAM address
      MOV R4, #24H          ; set address pointer
      LCALL WR
      MOV R4, #0B0H         ; set auto write
      LCALL WR2
      MOV R2, #20H          ; number of matrix data
WRCG1: LCALL BF3            ; check status STA3
      CLR A
      MOVC A, @A+DPTR       ; read matrix data
      LCALL WR4             ; write into CGRAM
      INC DPTR
      DJNZ R2, WRCG1
      MOV R4, #0B2H         ; auto reset
      LCALL WR2
      RET
TAB1:  DB  04H, 04H, 04H, 04H, 04H, 7CH, 04H, 04H
      DB  04H, 04H, 04H, 04H, 1CH, 0E4H, 44H, 00H
      DB  80H, 80H, 88H, 98H, 0A0H, 0C0H, 80H, 80H
      DB  80H, 80H, 80H, 80H, 82H, 82H, 7EH, 00H
    
```

5-8-4. Chinese Characters Display

Matrix data of Chinese character are in the sequence of top left corner (8 bytes from top to bottom) → left bottom left corner (8 bytes from top to bottom) → top right corner (8 bytes from top to bottom) → bottom right corner (8 bytes from top to bottom) .

(1) Display of Chinese Character in Text Mode

In this mode, only 64 Chinese characters with 16X16 dots can be entered as a maximum. (4 character codes for a Chinese character).

The address pointer is already positioned on the top left corner of the character to be entered.

Register to be used: R2, R3, R4, A; input register: R3 (store Chinese character codes)

```

WRHZT:  MOV R4, #0C0H           ; data write, address+1
        LCALL WR1              ; R3 set in the main program, for
                                example R3=80H

        INC R3
        INC R3
        LCALL WR1              ; R3=82H
        DEC R3                 ; R3=81H
        MOV R2, #1CH
        MOV R4, #0C1H         ; data read, address+1
WRHZT1: LCALL WR2
        DJNZ R2, WRHZT1       ; move the address pointer to the
                                left bottom corner of the
                                Chinese character

        MOV R4, #0C0H
        LCALL WR1
        INC R3
        INC R3                 ; R3=83H
        LCALL WR1
        RET
    
```

(2) Display of Chinese character in the graphic mode

This method is to build a Chinese character storage area in the ROM of MPU system, the Chinese character matrix should be input byte by byte in graphic mode.

Register to be used: A, R2, R3, R4

DPTR is a home address of one Chinese character matrix array and will be assigned in the main program.

```

WRHZG:  MOV R2, #10H           ; number of cycles
        MOV A, #00H
WRHZG1: PUSH ACC              ; push code into stack
        MOVC A, @A+DPTR       ; read character matrix
        MOV R3, A
        MOV R4, #0C0H
        LCALL WR1
        POP ACC               ; pop code from stack
        PUSH ACC              ; push code into stack
        ADD A, #10H           ; locate the pointer to the matrix of
                                the byte on the right
        MOVC A, @A+DPTR       ; read character matrix
        MOV R3, A
        LCALL WR1
    
```

```
MOV A, R2
MOV R3, A           ; R3=R2
MOV R2, #1CH       ; number of cycles
MOV R4, #0C1H
WRHZG2: LCALL WR2   ; change the address pointer
DJNZ R2, WRHZG2
MOV A, R3
MOV R2, A           ; recover R2
POP ACC             ; pop code of stack
INC A               ; code+1
DJNZ R2, WRHZG1
RET
```

5-8-5. Application of Text Attribute Mode

Display the character string "WELCOME!" on the top left corner of the screen: "WELCOME", blink of reverse display; "!", normal display. The subprogram is TCR, in which TAB2 acts as character code and TAB3 as corresponding text attribute code.

```
TCR:  MOV R4, #9CH           ;start the text and graphic mode
      LCALL WR2
      MOV R4, #84H          ; text attribute mode set
      LCALL WR2
      MOV R2, #00H
      MOV R3, #00H
      MOV R4, #24H          ; address pointer set
      LCALL WR
      MOV R2, #00H          ; number of characters
TCR1: MOV DPTR, #TAB2       ; table of characters
      MOV A, R2
      MOVC A, @A+DPTR
      MOV R3, A
      MOV R4, #0C0H
      LCALL WR1
      INC R2
      CJNE R2, #08H, TCR1
      MOV R2, #00H
      MOV R3, #08H
      MOV R4, #24H          ; address pointer set
      LCALL WR
      MOV R2, #00H          ; number of characters
TCR2: MOV DPTR, #TAB3       ; table of characters
      MOV A, R2
```

```
MOVC A, @A+DPTR
MOV R3, A
MOV R4, #0C0H
LCALL WR1
INC R2
CJNE R2, #08H, TCR2
RET
```

```
TAB2: DB 37H, 25H, 2CH, 23H, 2FH, 2DH, 25H, 01H
```

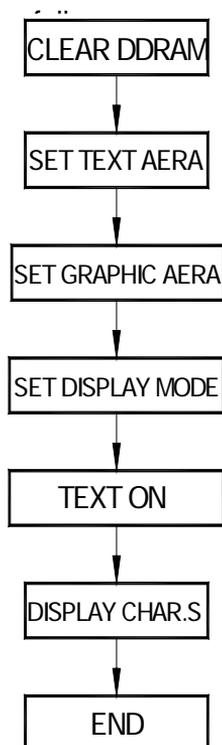
```
TAB3: DB 0DH, 0DH, 0DH, 0DH, 0DH, 0DH, 0DH, 08H
```

5-8-6. Application Program

For example, to display “!” on the top left corner of the screen, the program is:

```
ORG 0000H
STAR: LCALL INI           ; initialize
      MOV R2, #00H       ; display “ !”
      MOV R3, #00H
      MOV R4, #24H
      LCALL WR
      MOV R3, #01H
      MOV R4, #0C0H
      LCALL WR1
      RET
```

The flow chart of this program is



6. Quality level

6-1. Inspection conditions

6-1-1. The environmental conditions for inspection shall be as follows:

Room temperature: $20 \pm 3^{\circ}\text{C}$

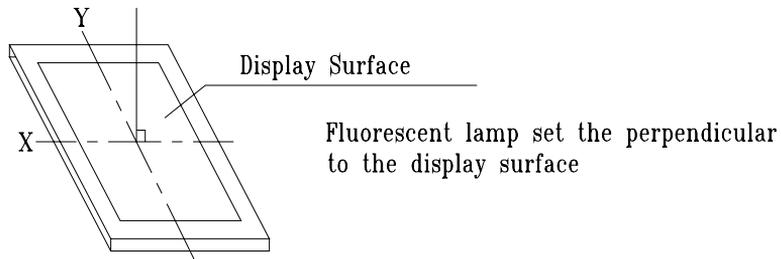
Humidity: $65 \pm 20\% \text{ RH}$

6-1-2. The external visual inspection:

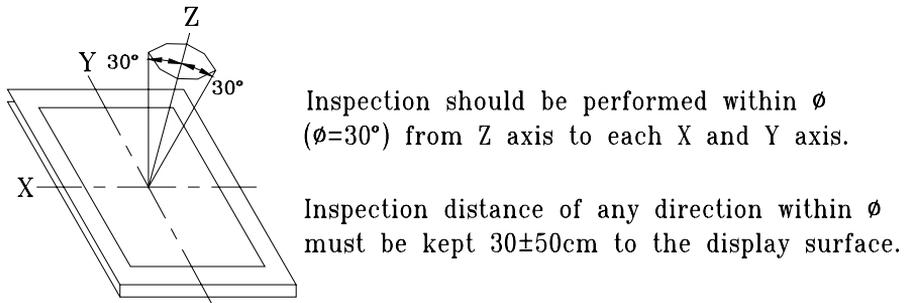
Using a 20W fluorescent lamp for illumination shall perform the inspection.

The distance between LCD and the inspector's eyes should be at least 30cm.

6-1-3. (1) Light method



(2) Inspection distance and angle



6-2. Sampling procedures for each item's acceptance level table

Defect type	Sampling procedure	AQL
Major defect	MIL-STD-105D Inspection Level I	Q/ED-01-98(II)
	Normal inspection Single sample inspection	
Minor defect	MIL-STD-105D Inspection Level I	Q/ED-01-98(II)
	Normal inspection Single sample inspection	

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6-3. Classification of defects

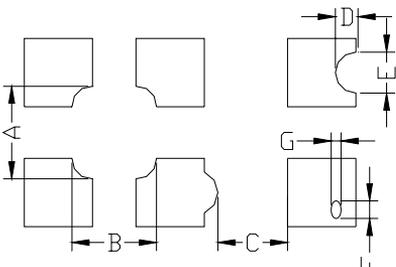
6-3-1. Major defect

A major defect refers to a defect that may substantially degrade usability for product applications.

6-3-2. Minor defect

A minor defect refers to a defect that deviates from existing standards almost unrelated to the effective use of the product or its operation.

6-4 .Inspection standards

Item	Criterion for defects	Defect type																					
1) Display on inspection	(1) Non display (2) Vertical line is deficient (3) Horizontal line is deficient (4) Cross line is deficient	Major																					
2) Black / White spot	<table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>Size Φ (mm)</th> <th>Acceptable number</th> </tr> </thead> <tbody> <tr> <td>$\Phi \leq 0.3$</td> <td>Ignore (note)</td> </tr> <tr> <td>$0.3 < \Phi \leq 0.45$</td> <td>3</td> </tr> <tr> <td>$0.45 < \Phi \leq 0.6$</td> <td>1</td> </tr> <tr> <td>$0.3 < \Phi$</td> <td>0</td> </tr> </tbody> </table> <p style="text-align: center;">(Note) Not allowed if four more spots crowd together</p>	Size Φ (mm)	Acceptable number	$\Phi \leq 0.3$	Ignore (note)	$0.3 < \Phi \leq 0.45$	3	$0.45 < \Phi \leq 0.6$	1	$0.3 < \Phi$	0	Minor											
Size Φ (mm)	Acceptable number																						
$\Phi \leq 0.3$	Ignore (note)																						
$0.3 < \Phi \leq 0.45$	3																						
$0.45 < \Phi \leq 0.6$	1																						
$0.3 < \Phi$	0																						
3) Black / White line	<table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>Length (mm)</th> <th>Width (mm)</th> <th>Acceptable number</th> </tr> </thead> <tbody> <tr> <td>$L \leq 10$</td> <td>$W \leq 0.03$</td> <td>Ignore</td> </tr> <tr> <td>$5.0 \leq L \leq 10$</td> <td>$0.03 < W \leq 0.04$</td> <td>3</td> </tr> <tr> <td>$5.0 \leq L \leq 10$</td> <td>$0.04 < W \leq 0.05$</td> <td>2</td> </tr> <tr> <td>$1.0 \leq L \leq 10$</td> <td>$0.05 < W \leq 0.06$</td> <td>2</td> </tr> <tr> <td>$1.0 \leq L \leq 10$</td> <td>$0.06 < W \leq 0.08$</td> <td>1</td> </tr> <tr> <td>$L \leq 10$</td> <td>$0.08 < W$</td> <td>follows 2) point defect</td> </tr> </tbody> </table> <p style="text-align: center;">Defects separate with each other at an interval of more than 20mm.</p>	Length (mm)	Width (mm)	Acceptable number	$L \leq 10$	$W \leq 0.03$	Ignore	$5.0 \leq L \leq 10$	$0.03 < W \leq 0.04$	3	$5.0 \leq L \leq 10$	$0.04 < W \leq 0.05$	2	$1.0 \leq L \leq 10$	$0.05 < W \leq 0.06$	2	$1.0 \leq L \leq 10$	$0.06 < W \leq 0.08$	1	$L \leq 10$	$0.08 < W$	follows 2) point defect	Minor
Length (mm)	Width (mm)	Acceptable number																					
$L \leq 10$	$W \leq 0.03$	Ignore																					
$5.0 \leq L \leq 10$	$0.03 < W \leq 0.04$	3																					
$5.0 \leq L \leq 10$	$0.04 < W \leq 0.05$	2																					
$1.0 \leq L \leq 10$	$0.05 < W \leq 0.06$	2																					
$1.0 \leq L \leq 10$	$0.06 < W \leq 0.08$	1																					
$L \leq 10$	$0.08 < W$	follows 2) point defect																					
4) Display pattern	 <p style="text-align: center;">[Unit: mm]</p> $\frac{A+B}{2} \leq 0.45 \quad \quad 0 < C \quad \quad \frac{D+E}{2} \leq 0.35 \quad \quad \frac{F+G}{2} \leq 0.35$ <p>Note: 1) Up to 3 damages acceptable 2) Not allowed if there are two or more pinholes every three-fourths inch.</p>	Minor																					

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Item	Criterion for defects	Defect type										
5) Spot-like contrast irregularity	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: center;">Size Φ(mm)</th> <th style="text-align: center;">Acceptable Number</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">$\Phi \leq 0.7$</td> <td style="text-align: center;">Ignore (note)</td> </tr> <tr> <td style="text-align: center;">$0.7 < \Phi \leq 1.0$</td> <td style="text-align: center;">3</td> </tr> <tr> <td style="text-align: center;">$1.0 < \Phi \leq 1.5$</td> <td style="text-align: center;">1</td> </tr> <tr> <td style="text-align: center;">$1.5 < \Phi$</td> <td style="text-align: center;">0</td> </tr> </tbody> </table>	Size Φ (mm)	Acceptable Number	$\Phi \leq 0.7$	Ignore (note)	$0.7 < \Phi \leq 1.0$	3	$1.0 < \Phi \leq 1.5$	1	$1.5 < \Phi$	0	Minor
	Size Φ (mm)	Acceptable Number										
$\Phi \leq 0.7$	Ignore (note)											
$0.7 < \Phi \leq 1.0$	3											
$1.0 < \Phi \leq 1.5$	1											
$1.5 < \Phi$	0											
<p>Note: 1) Conformed to limit samples. 2) Intervals of defects are more than 30mm.</p>												
7) Scratches and dent on the polarizer	Scratches and dent on the polarizer shall be in the accordance with "2) Black/white spot", and "3) Black/White line".	Minor										
8) Stains on the surface of LCD panel	Stains which cannot be removed even when wiped lightly with a soft cloth or similar cleaning.	Minor										
9) Rainbow color	No rainbow color is allowed in the optimum contrast on state within the active area.	Minor										
10) Viewing area encroachment	Polarizer edge or line is visible in the opening viewing area due to polarizer shortness or sealing line.	Minor										
11) Bezel appearance	Rust and deep damages that are visible in the bezel are rejected.	Minor										
12) Defect of land surface contact	Evident crevices that are visible are rejected.	Minor										
13) Parts mounting	<ul style="list-style-type: none"> (1) Failure to mount parts (2) Parts not in the specifications are mounted (3) For example: Polarity is reversed, HSC or TCP falls off. 	Major										
14) Part alignment	<ul style="list-style-type: none"> (1) LSI, IC lead width is more than 50% beyond pad outline. (2) More than 50% of LSI, IC leads is off the pad outline. 	Minor										
15) Conductive foreign matter (solder ball, solder hips)	(1) $0.45 < \Phi, N \geq 1$	Major										
	(2) $0.3 < \Phi \leq 0.45, N \geq 1$ Φ : Average diameter of solder ball (unit: mm)	Minor										
	(3) $0.5 < L, N \geq 1$ L: Average length of solder chip (unit: mm)	Minor										
16) PCB pattern damage	(1) Deep damage is found on copper foil and the pattern is nearly broken.	Major										
	(2) Damage on copper foil other than 1) above	Minor										
17) Faulty PCB correction	(1) Due to PCB copper foil pattern burnout, the pattern is connected, using a jumper wire for repair; 2 or more places are corrected per PCB.	Minor										
	(2) Short-circuited part is cut, and no resist coating has been performed.											
18) Bezel flaw	Bezel claw missing or not bent	Minor										

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Item	Criterion for defects	Defect type
19) Indication on name plate (sampling indication label)	(1) Failure to stamp or label error, or not legible (all acceptable if legible). (2) The separation is more than 1/3 for indication discoloration, in which the characters can be checked.	Minor

7. Reliability

7-1 Lifetime

50,000 hours (25°C in the room without ray of sun)

7-2 Items of reliability (See the next page)

Item	Condition	Criterion
1) High Temperature Operating	60°C 96hrs	No cosmetic failure is allowable. Contrast ratio should be between initial value $\pm 10\%$. Total current consumption should be below double of initial value.
2) Low Temperature Operation	-20°C 96hrs	
3) Humidity	40°C, 90%RH, 96hrs	No cosmetic failure is allowable. Contrast ratio should be between initial value $\pm 20\%$. Total current consumption should be below double of initial value.
4) High Temperature	70°C 96hrs	
5) Low Temperature	-30°C 96hrs	
6) Thermal shock	25°C→30°C→25°C→70°C 5(min) 30(min) 5(min) 30(min) 5 cycle, 55~60%RH	
7) Vibration	10~55~10hz amplitude: 1.5mm 2hrs for each direction (X,Y,Z)	

8. Handling precautions

8-1 Mounting method

A panel of LCD module made by Dalian Eastern Display Co., Ltd. consists of two thin glass plates with polarizers that easily get damaged.

And since the module is constructed and fixed by utilizing fitting holes in the Printed Circuit Board (PCB), extreme care should be used when handling the LCD modules.

8-2 Cautions of LCD handling and cleaning

When cleaning the display surface, wipe lightly with soft cloth with solvents (recommended below).

- Isopropyl alcohol
- Ethyl alcohol
- Trichlorotrifluoroethane

Do not wipe the display surface with dry or hard materials that may damage the polarizer surface.

Do not use the following solvents:

- Water
- Ketene
- Aromatics

8-3 Caution against static charge

The LCD module uses C-MOS LSI drivers. So we recommend you:

Connect any unused input terminal to V_{dd} or V_{ss} . Do not input any signals before power turns on, and ground your body, work/assembly areas, and assembly equipment to protect against static electricity.

8-4 Packaging

- A module employs LCD elements, and must be treated as such. Avoid intense shock and falls from a height.
- To prevent modules from degradation, do not operate or store them exposed direct to sunshine or high temperature/humidity.

8-5 Caution for operation

- It is an indispensable condition to drive LCD module within the limits of the specified voltage since the higher voltage over the limits may cause the shorter life of LCD module.
An electrochemical reaction due to DC (direct current) causes LCD undesirable deterioration so that the uses of DC (direct current) drive should be avoided.
- Response time will be extremely delayed at lower temperature than the operating temperature range and on the other hand at higher temperature LCD module may show dark color in them. However those phenomena do not mean malfunction or out of order of LCD module, which will come back in the specified operating temperature.

-

8-6 Storage

In the case of long time storage, the following ways are recommended:

- To be stored in polyethylene bag with the opening sealed so as to prevent fresh air out. Do not put desiccant into the bag.
- To be placed in a dark place where there is neither exposure to direct sunlight nor light. Keep within the storage temperature range.
- To be stored with no touch on polarizer surface by any thing else.

8-7 Safety

- It is recommended to crash damaged or unnecessary LCD into pieces and to wash off liquid crystal by either of solvents such as acetone and ethanol, which should be burned up later.
- When any liquid leaked out of a damaged glass cell comes in contact with your hands, please wash it off with soap and water at once.

9. Precaution for use

9-1 Both parties should provide a limit sample on an occasion when both parties agree to its necessity.

The judgement by a limit sample shall take effect after the limit sample has been established and confirmed by both parties

9-2 On the following occasions, the handling of problem should be decided through discussion and agreement between responsible of the both parties.

- When a question is arisen in this manual.
- When a new problem is arisen which is not specified in this manual.
- Some problem is arisen due to the change of inspection and operating conditions in users.
- When a new problem is arisen at the customer's operating set for sample evaluation in the customer site.

10. Appendix

Character Code Table

LSB MSB \	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0		!	"	#	\$	%	&	'	()				-	.	/
1	0	1	2	3	4	5	6	7	8	9	:	;	<	=	>	?
2	a	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
3	P	Q	R	S	T	U	V	W	X	Y	Z	[\]	^	_
4	`	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o
5	p	q	r	s	t	u	v	w	x	y	z	{	|	}	~	
6	ç	ü	ë	ä	å	ä	ä	ä	ö	ë	ë	ë	ï	ï	ï	Ä
7	É	Æ	Œ	ö	ö	ö	ö	ü	ü	ü	ö	ö	ö	ö	Æ	Œ