USER'S MANUAL FOR

LCD MODULE EDM128128A

Dalian Dongfu Color Display Co., Ltd.

Contents

Dalian Dongfu Color Display Co., Ltd.

1. Scope

This manual defines general provisions as well as inspection standards for standard LCD module supplied by Dalian Dongfu Color Display Co., Ltd.

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

2. Warranty

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

3. Features

3-1. Features

Display Mode:	⌈	Transflective and positive type
	⌊	Yellow green and STN LCD
Display Color:	⌈	Display dot: Black
	⌊	Background: Yellow green

Display Format:　　　　128(w)×128(h) full dots

Input Data:　　　　　　8-bit parallel data interface from a MPU

Multiplexing Ratio:　　1/128 Duty

Viewing Direction:　　6 O'clock

Backlight:　　　　　　E/L

RAM Display capacity:　8k byte S-RAM (built-in)

Controller:　　　　　　Toshiba T6963C (built-in)

CG ROM/RAM capacity:　Built-in 128 words Character Generator (CG) ROM.

3-2. Mechanical features

Item	Specifications	Unit
Dimensional Outline	99.0(W)×100.0(H)　×10.0 Max.(T)	mm
Number of Dots	128(W)　×128(H) Dots	—
Number of Characters	21C×16L(336) in case of 6×8 Fonts 16C×16L(256) in case of 8×8 Fonts	—
Viewing Area	69.0(W)×69.0(H)	mm
Active Area	63.96(W)×63.96(H)	mm
Dot Pitch	0.5(W)×0.5(H)	mm
Dot Size	0.46(W)×0.46(H)	mm
Weight	Approx. 80	g

3-3. Absolute maximum ratings

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	℃	
Storage Temperature		Tstg	-20	70	℃	
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		—	23	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	
	"L" Level	Vol		0	—	0.3	
Frame Frequency		Fflm	Vdd=5V	70	75	80	Hz
Current Consumption	Logic	Idd	Vdd=5V Vdd–Vee=15.0V Fflm=75Hz	—	5.7	10.0	mA
	LCD drive	Iee		—	3.0	6.0	
LCD Driving Voltage (Recommended Voltage)		Vdd–Vee	Ta= -10℃ $\phi=0°$, $\theta=0°$	—	23.8	24.0	V
			Ta= 25℃ $\phi=0°$, $\theta=0°$	—	23.0	—	
			Ta= 60℃ $\phi=0°$, $\theta=0°$	22.0	22.2	—	

3-4-2. Specifications for E/L backlight

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

Item	Unit	Standard Values			Conditions
		Min.	Typ.	Max.	
Supply Voltage	V	—	100	125	—
Supply Frequency	Hz	—	400	400	—
Initial Brightness	cd/m^2(nit)	45	55	—	AC100 Vrms, 400Hz, dark room
Current	mA/cm^2	—	0.12	0.17	AC100 Vrms, 400Hz, dark room
Life time	Hrs	5000			Note <1>
Luminous Color	—	White			AC100 Vrms, 400Hz, dark room
Operating Temp.	℃	-35 ~ 60			—
Storage Temp.	℃	-40 ~ 70			—

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3-5. Electro-optical characteristics

| Item		Symbol	Temp.	Conditions	Min.	Typ.	Max.	Unit	Note
LCD Driving Voltage (Recommended voltage)		Vop	-10℃	ϕ=0°, θ=0°	—	23.8	24.0	V	1,2,5
			25℃		—	23.0	—		
			60℃		22.0	22.2	—		
Response Time	Rise Time	tr	0℃	ϕ=0°, θ=0°	—	1500	2000	mS	1,3,5
			25℃		—	150	200		
	Decay Time	td	0℃		—	3000	3500		
			25℃		—	200	250		
Viewing Angle		$\Delta \phi$	25℃	Vertical	-35	—	35	deg.	1,4,5
				Horizontal	-30	—	30		
Contrast Ratio		K	25℃	ϕ=0°, θ=0°	2.0	5.0	—	—	1,5,6

Note: <1> Definition of ϕ and θ <2> Contrast ratio higher than 2 (k≥2) can be obtained in this voltage range.
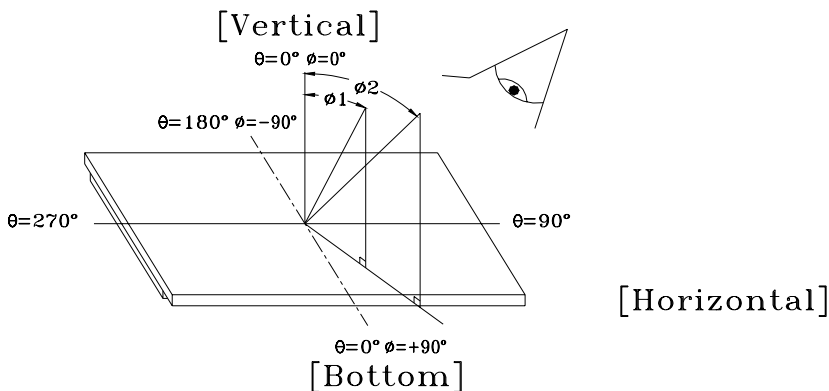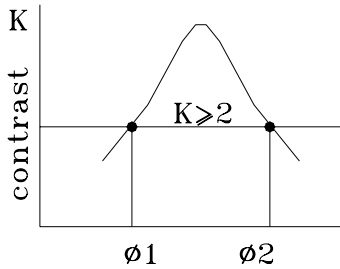

Note: <3>Definition of response time waveform
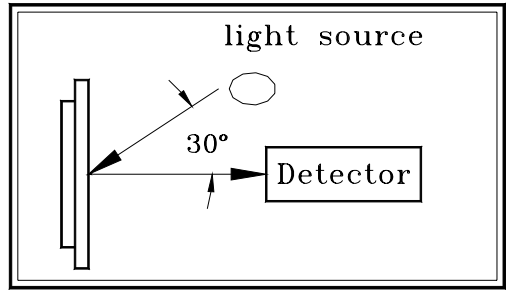
Positive Display   Negative Display

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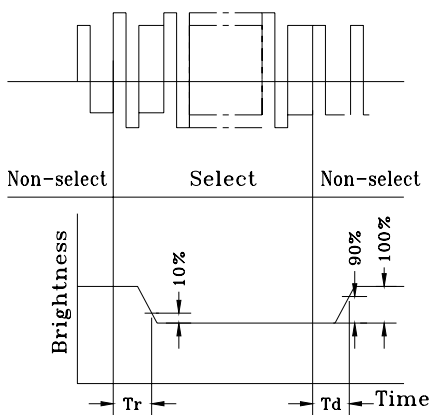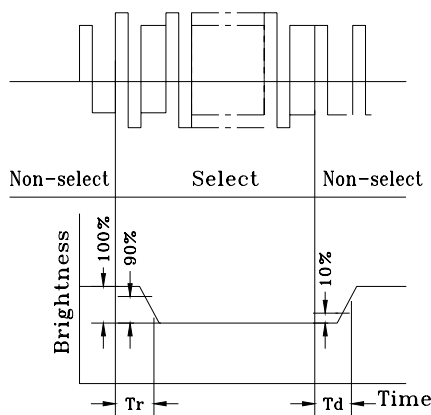
Note: <4>Definition of viewing angle
$(\Delta\Phi)$ $\Delta\Phi=|\Phi1-\Phi2|$

Note: <5> Optical measuring system
temperature regulated chamber

K

contrast

K≥2

Ø1   Ø2
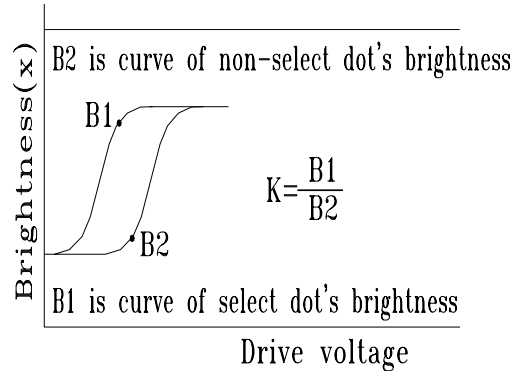
Viewing angle

light source

30°

Detector

Measuring equipment: DMS
(Made in AUTRONIC)

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

Positive Display

Negative Display

Brightness(x)

B2 is curve of non-select dot's brightness

B2

$K=\dfrac{B2}{B1}$

B1

B1 is curve of select dot's brightness

Drive voltage

Brightness(x)

B2 is curve of non-select dot's brightness

B1
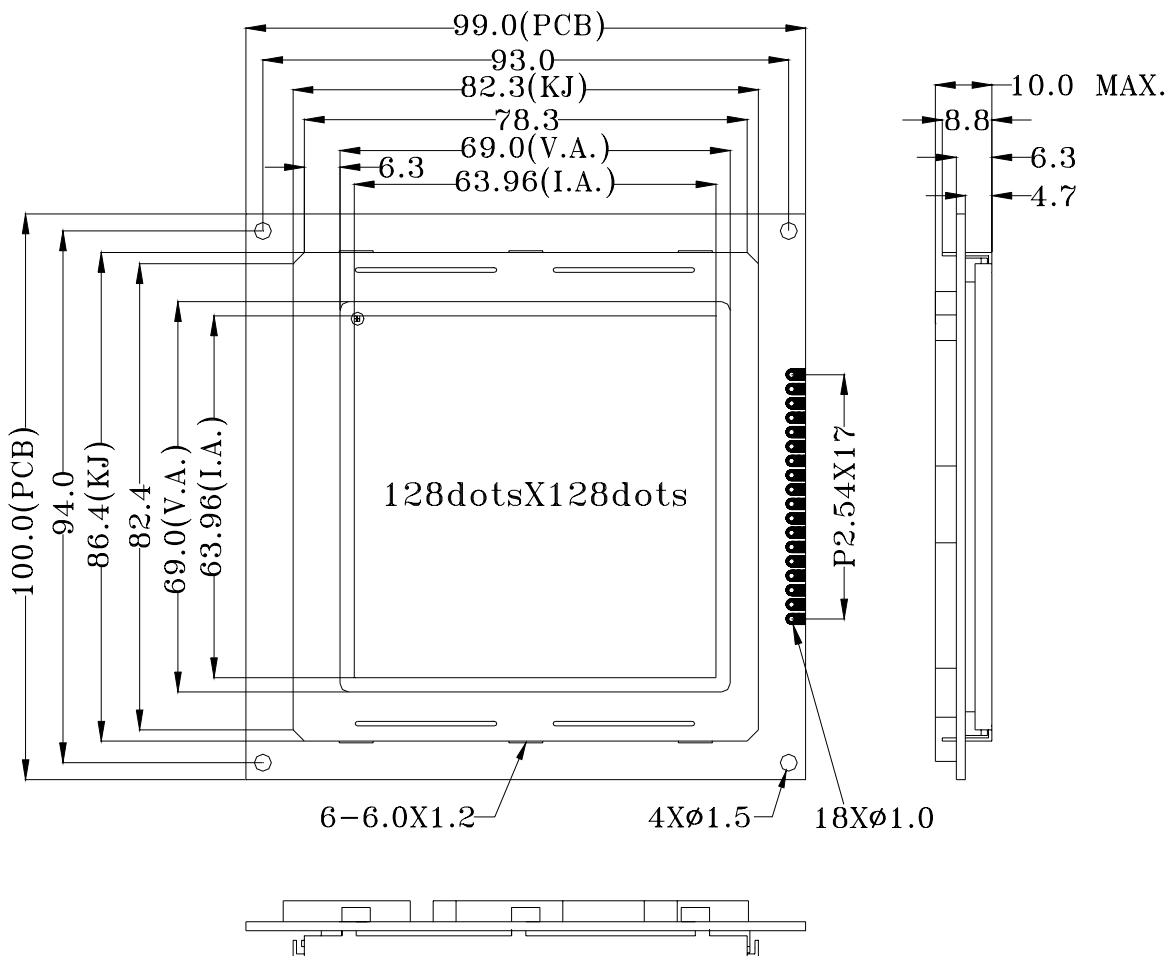
$K=\dfrac{B1}{B2}$

B2

B1 is curve of select dot's brightness

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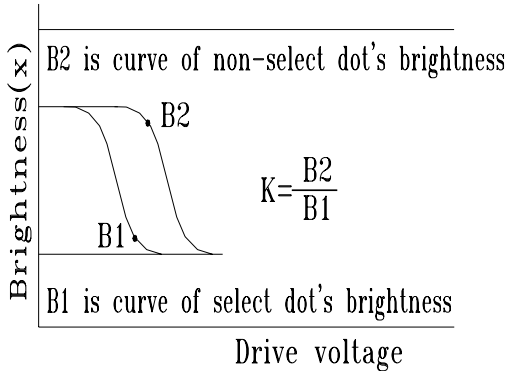
Contrast Ratio (K) = $\dfrac{\text{Brightness of non-selected dot (B2)}}{\text{Brightness of selected dot (B1)}}$

4. Dimensional outline

(See the next page)

99.0(PCB)
93.0
82.3(KJ)
78.3
69.0(V.A.)
6.3
63.96(I.A.)

10.0 MAX.
8.8
6.3
4.7

100.0(PCB)
94.0
86.4(KJ)
82.4
69.0(V.A.)
63.96(I.A.)

128dotsX128dots

P2.54X17

6-6.0X1.2   4XØ1.5   18XØ1.0

PIN#	NAME	PIN#	NAME
P1	FG	P10	FS
P2	GND	P11	DB0
P3	VCC	P12	DB1
P4	VEE	P13	DB2
P5	WR	P14	DB3
P6	RD	P15	DB4
P7	CE	P16	DB5
P8	C/D	P17	DB6
P9	RST	P18	DB7

0.46   0.04
0.46
0.04
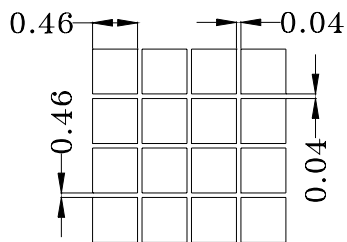
5. I/O terminals

Note: There are two types of this module. One is with built-in DC-DC converter and the other is without DC-DC converter. The following explanation is only applied for the module without built-in DC-DC converter. For the module with DC-DC converter, please leave Vee open and only supply the +5V power for Vdd, and ignore the following part about negative voltage.

5-1. I/O connection table

Pin No.	Symbol	Function
1	FG	Frame ground (connected to metal bezel)
2	GND	Ground
3	VCC	Power supply (+5V)
4	VEE	Power supply (negative, variable)
5	/WR	Data write (active at low level)
6	/RD	Data read (active at low level)
7	/CE	Chip enable (active at low level)
8	C/D	/WR="L";C/D="H": Command write, C/D="L": Data write /WR="H";C/D="H": Command read, C/D="L": Data read
9	/RESET	Reset control (module resets, active at low level)
10	FS	Font selection. Connect to Vdd: 6×8 dots font Connect to Vss: 8×8 dots font
11~18	D0~D7	Data bus (D0 is LSB, and D7 is MSB)

5-2. Timing and timing diagram

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

Bus timing
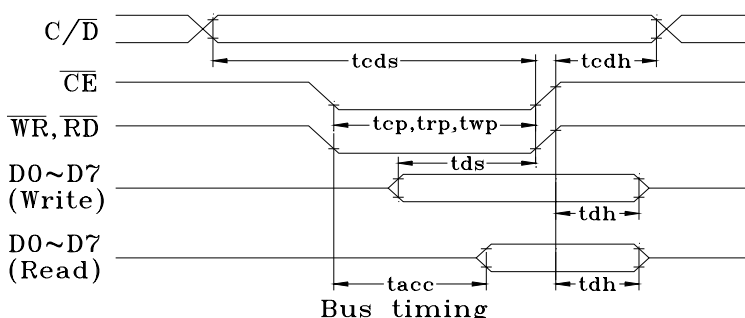
5-3. Power supply connection diagram

LCD MODULE

+5V ──○─── Vdd

GND ──○─── Vss

−18V ──○─── Vee
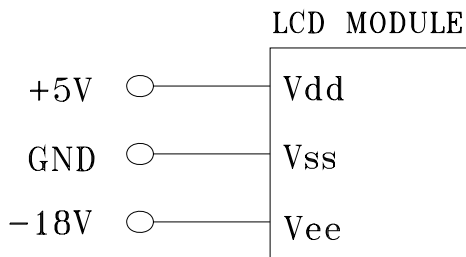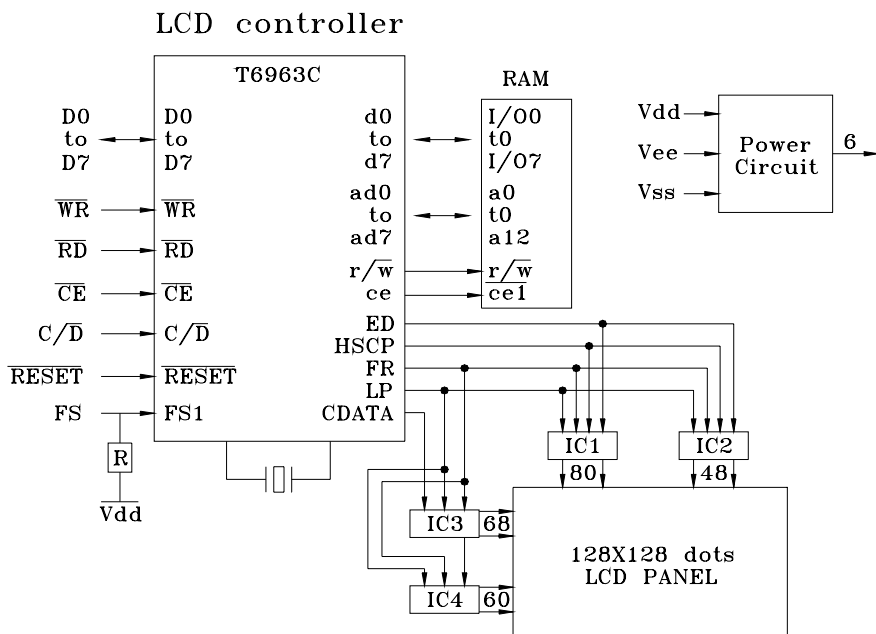
5-4. Circuit block diagram

The circuit block diagram is shown in the following figure. The LCD module needs two power sources: Vdd for logic and Vee for LCD drive.

Block diagram

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. Module application features

（1） This module can be directly connected to 8080MPU or Z80MPU.

（2） This module can be set to display in combination of graphic and text modes (Contents of the text area and of the graphic area are displayed simultaneously on the screen by mode set.), in attribute display of text

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mode and screen copy can be executed.

（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 commands are read or written.

（6） The column/line counter and display register are cleared by RESET. Disable the display using the clear-display register. After power on, it is necessary to reset by software. After reset, use DISPLAY ON instruction to restore the former contents displayed on the screen.

（7） By the hardware setting, display columns (CL) are defined 40 characters long, maximum transferable amounts of data every line.

（8） Display lines are defined 128 by hardware setting.

（9） This module has a 128-word character generator ROM (see also 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 CGRAM area. The text home address and the graphic home address SAD correspond to the display bit on the top left corner of the LCD panel. In text area, one byte corresponds to a character on the screen. In 6×8 dot matrix, one byte in graphic area corresponds to 6×1 dot matrix on the screen (The lower 6 bits of a byte are valid). In 8×8 dot matrix, one byte in graphic area corresponds to 8×1 dot matrix on the screen.

（11） Cursor display mode is on only in the text mode. At this time, what is displayed is the logical 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, both text mode and graphic mode should 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（DB7~DB0）	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≠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 is valid. The status check must be performed every time before the data and commands are read or written.

The format of status word 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

Because the functions of status bits are different, different status bit should be checked when different command is executed.

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. (Seldom used)

5-6-1 Setting registers

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. (Among N0, N1, N2, any two of them can not be 1 at the same time.)

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 actual 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 higher 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 the units of 1800H~1FFFH（2K）in DDRAM are allocated to CGRAM, the offset register could be set to #03H. Thus, the address of character whose code is 80H in DDRAM is 1C00H~1C07H.

C. 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	Character Number /Columns	00H	41H	Set text area (number of characters/line)
1	0	Low adrs.	High adrs	42H	Set graphic home address
1	1	Character Number /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. Changing both of addresses may produce the result of scrolling. D1 and D2 represent the low and high bytes. 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, and then the relationship between text area and its corresponding position on LCD panel is shown as follows:

（a）TA<=CL:（TH stands for the text home address）

TH	……	TH+TA-1	
TH+TA	……	TH+2TA-1	Blank
……	……	……	
……	……	……	

←--------------------- TA valid display screen -------------------- →
←-- CL --→

（b）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 the 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

　　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 as 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 above and text attribute mode settings below 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, blank

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）

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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 selections, 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 the need of 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
——	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 (8X1 dots) 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
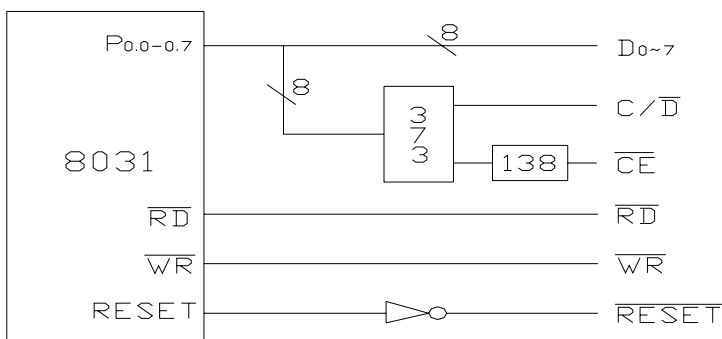
1	1	1	1	N3	N2	N2	N0

This command is used to set or reset a bit of the byte specified by current 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 signals to control the module by means of direct storage access or I/O access. Interface circuit is shown in following diagram:

MPU：8031

Power connection:

Data bus 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:

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（1） Status read subprogram

Registers to be used: R0, A;

Output register: A (store status word)

```
BF:   MOV   R0, #01H      ;address of command
      MOVX  A, @ R0       ;read status word
      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, Both STA0 and STA1 should be defined as "1":

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

b. Subprograms of STA2 status check. STA2 should be checked to replace STA0 and STA1 during the 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. When STA6=0, it 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

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

Input register: R2 is the first byte of parameter, R3 is the second byte of parameter, and 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 data writing, data terminal
                               address
WR5:    MOVX   @ R0, A
             RET
```

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

（3） Data read subprogram

Register to be used: R0, A;   Output register: A stores 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 8X8 dots

5-8-1.   Subprogram for clearing DDRAM

```
       CLR:   MOV   R2, #00H   ;RAM address=0000H
              MOV   R3, #00H
              MOV   R4, #24H   ;Set address command
              LCALL   WR
              MOV   R4, #0B0H  ;set auto write commands
              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 write end commands
              LCALL   WR2
```

RET

5-8-2. Initialization subprogram

```
INI:    LCALL   CLR
        MOV   R2, #00H     ;Set text area
        MOV   R3, #00H
        MOV   R4, #40H
        LCALL   WR
        MOV   R2, #10H
        MOV   R3, #00H
        MOV   R4, #41H
        LCALL   WR
        MOV   R2, #00H     ;Set graphic area
        MOV   R3, #08H
        MOV   R4, #42H
        LCALL   WR
        MOV   R2, #10H
        MOV   R3, #00H
        MOV   R4, #43H
        LCALL   WR
        MOV   R4, #80H     ;Set display mode
        LCALL   WR2
        MOV   R4, #94H     ;Set display on/off, text on
        LCALL   WR2
        RET               ; Initialization ends
```

The following is an example, 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 up CGRAM

Set contents of offset register

（1） Set character pattern data and character codes of the characters. Take an example of the Chinese character "北", choose the character codes between 80H and FFH, then the font data and character codes of the character "北" are defined as follows:

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Structure of "北"	character pattern 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
Bottom right	80H, 80H, 80H, 8CH, 82H, 82H, 7EH, 00H	83H

```
        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 write end command
                 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

   Chinese character patterns 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 in 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, #0EH
        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, and the Chinese character patterns 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 pattern of
                                 the byte on the right
         MOVC   A, @A+DPTR      ;read character pattern
         MOV   R3, A
         LCALL   WR1
         MOV   A, R2
         MOV   R3, A            ;R3=R2
```

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```
                MOV   R2, #0EH            ;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
```

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```
                    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
```
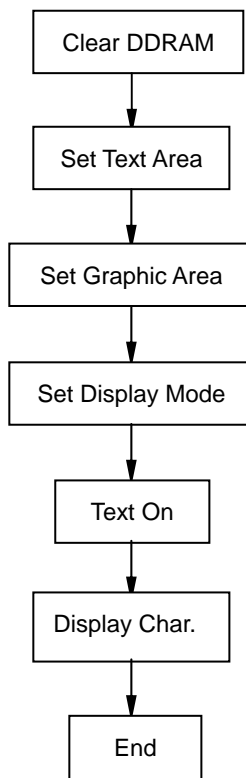
5-8-6.   Application Program

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 following is the flow diagram of the programs:

```
            ┌──────────────────┐
            │   Clear DDRAM    │
            └──────────────────┘
                     │
                     ▼
            ┌──────────────────┐
            │   Set Text Area  │
            └──────────────────┘
                     │
                     ▼
            ┌──────────────────┐
            │  Set Graphic Area │
            └──────────────────┘
                     │
                     ▼
            ┌──────────────────┐
            │  Set Display Mode │
            └──────────────────┘
                     │
                     ▼
            ┌──────────────────┐
            │     Text On      │
            └──────────────────┘
                     │
                     ▼
            ┌──────────────────┐
            │  Display Char.   │
            └──────────────────┘
                     │
                     ▼
            ┌──────────────────┐
            │       End        │
            └──────────────────┘
```

6. Quality level

6-1 Inspection conditions

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

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Room temperature: 20±3℃
Humidity: 65±20% RH

6-1-2 The external visual inspection:

The inspection shall be performed by using a 20W fluorescent lamp for illumination and the distance between LCD and the eyes of the inspector should be at least 30cm.

6-1-3   (1) Light method
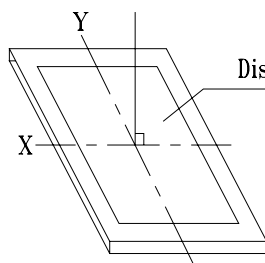
(2) Inspection distance and angle
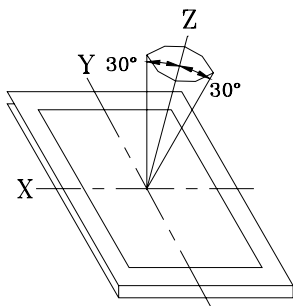
Inspection should be performed within ∅ (∅=30°) from Z axis to each X and Y axis.

Inspection distance of any direction within ∅ must be kept 30±50cm to the display surface.

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

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

6-3 Classification of defects
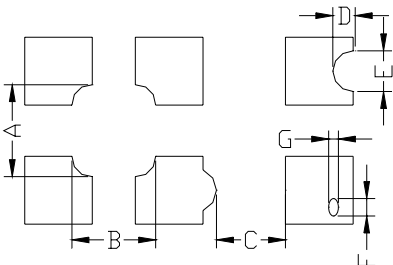
6-3-1 Major defect

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.

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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><tr><td>Size　Φ(mm)</td><td>Acceptable number</td></tr><tr><td>Φ≤0.3</td><td>Ignore (note)</td></tr><tr><td>0.3<Φ≤0.45</td><td>3</td></tr><tr><td>0.45<Φ≤0.6</td><td>1</td></tr><tr><td>0.3<Φ</td><td>0</td></tr></table>(Note) Not allowed if four more spots crowd together	Minor
3) Black／White line	<table><tr><td>Length (mm)</td><td>Width (mm)</td><td>Acceptable number</td></tr><tr><td>L≤10</td><td>W≤0.03</td><td>Ignore</td></tr><tr><td>5.0≤L≤10</td><td>0.03<W≤0.04</td><td>3</td></tr><tr><td>5.0≤L≤10</td><td>0.04<W≤0.05</td><td>2</td></tr><tr><td>1.0≤L≤10</td><td>0.05<W≤0.06</td><td>2</td></tr><tr><td>1.0≤L≤10</td><td>0.06<W≤0.08</td><td>1</td></tr><tr><td>L≤10</td><td>0.08<W</td><td>follows 2) point defect</td></tr></table>Defects separate with each other at an interval of more than 20mm.	Minor
4) Display pattern	 [Unit: mm] $\dfrac{A+B}{2}\leq0.45$ ∣ $0<C$ ∣ $\dfrac{D+E}{2}\leq0.35$ ∣ $\dfrac{F+G}{2}\leq0.35$ Note: 1) Up to 3 damages acceptable 　　2) Not allowed if there are two or more pinholes every three-fourths inch.	Minor
5) Spot-like contrast irregularity	<table><tr><td>Size　Φ(mm)</td><td>Acceptable Number</td></tr><tr><td>Φ≤0.7</td><td>Ignore (note)</td></tr><tr><td>0.7<Φ≤1.0</td><td>3</td></tr><tr><td>1.0<Φ≤1.5</td><td>1</td></tr><tr><td>1.5<Φ</td><td>0</td></tr></table>Note: 1) Conformed to limit samples. 　　2) Intervals of defects are more than 30mm.	Minor

Item	Criterion for defects			Defect type
6) Bubbles in polarizer		Size Φ(mm)	Acceptable Number		Minor
		$\Phi \leqslant 0.4$	Ignore (note)		
		$0.4 < \Phi \leqslant 0.65$	2		
		$0.65 < \Phi \leqslant 1.2$	1		
		$1.2 < \Phi$	0		
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	(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	(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) $0.45 < \Phi$, $N \geqslant 1$			Major
	(2) $0.3 < \Phi \leqslant 0.45$, $N \geqslant 1$ Φ: Average diameter of solder ball (unit: mm)			Minor
	(3) $0.5 < L$, $N \geqslant 1$ 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. (2) Short-circuited part is cut, and no resist coating has been performed.			Minor
18) Bezel flaw	Bezel claw missing or not bent			Minor
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℃ in the room without ray of sun)

7-2 Items of reliability

Item	Condition	Criterion
1) High Temperature Operating	60℃ 96hrs	No cosmetic failure is allowable. Contrast ratio should be between initial value ±10%. Total current consumption should be below double of initial value.
2) Low Temperature Operation	-20℃ 96hrs	
3) Humidity	40℃, 90%RH, 96hrs	No cosmetic failure is allowable. Contrast ratio should be between initial value ±20%. Total current consumption should be below double of initial value.
4) High Temperature	70℃ 96hrs	
5) Low Temperature	-30℃ 96hrs	
6) Thermal shock	25℃→30℃→25℃→70℃ 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)	No defects in cosmetic and operational function are allowable. Total current consumption should be below double of initial value.

8. Handling precautions

8-1 Mounting method

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

And since the module in so constructed as to be 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, use soft cloth with solvent (recommended below) and wipe lightly.

- □ Isopropyl alcohol
- □ Ethyl alcohol
- □ Trichlorotriflorothane

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

Do not use the following solvent:

- □ Water
- □ Ketene
- □ Aromatics

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8-3 Caution against static charge

The LCD module use 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 is turned on, and ground your body, work/assembly areas, assembly equipment to protect against static electricity.

8-4 Packaging

- 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 storing for a long period of time, the following ways are recommended:

- Storage in polyethylene bag with the opening sealed so as not to enter fresh air outside in it. And with not desiccant.
- Placing in a dark place where neither exposure to direct sunlight nor light is. Keeping the storage temperature range.
- Storing with no touch on polarizer surface by any thing else.

8-7 Safety

- It is recommendable 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 well at once with soap and water.

9. Precaution for use

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

Dalian Dongfu Color Display Co., Ltd.