USER'S MANUAL FOR

LCD MODULE EDM12864-116

Dalian Dongfu Color Display Co., Ltd.

Contents

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: Reflective and positive type
STN LCD (Yellow green)

Display color: Display dot: Dark blue
Background: Yellow green

Display format: 128(w)×64 (h) full dots

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

Multiplexing ratio: 1/64 Duty

Viewing direction: 6 O'clock

Back light:: None/LED

Build-in DC/DC converter circuits

3-2. Mechanical features

Item	Specification	Unit
Outline dimensions	93.0 (W)×70.0 (H) ×12.6 Max.(T)	mm
Number of dots	128 (W) ×64 (H) Dots	—
Viewing area	70.5 (W)×38.5 (H)	mm
Image area	66.52 (W)×33.24 (H)	mm
Dot pitch	0.52 (W)×0.52 (H)	mm
Dot size	0.48 (W)×0.48 (H)	mm
Weight	Approx.100	g

3-3. Absolute maximum ratings

Item		Symbol	Min.	Max.	Unit	Note
Supply Voltage	Logic	Vdd	0	6.0	V	
	LCD drive	Vdd – Vee	0	16.0	V	
Input Voltage		Vi	0	Vdd	V	
Operating Temperature		Top	-20	70	℃	
Storage Temperature		Tstg	-25	75	℃	
Humidity		—	—	90	%RH	

3-4. Electrical Characteristics

3-4-1 Electrical Characteristics

Item		Symbol	Conditions	Min.	Typ.	Max.	Unit
Supply Voltage	Logic	Vdd		4.5	5.0	5.5	V
	LCD drive	Vdd–Vee		11.5	12.0	12.5	
Input Voltage	"H" Level	Vih	Vdd=5V±5%	0.8Vdd	—	Vdd	
	"L" Level	Vil		0	—	0.2Vdd	
Frame Frequency		Fflm	Vdd=5V	70	75	80	Hz
Current Consumption	Logic	Idd	Vdd=5V Vdd–Vee= 12.0V Fflm=75Hz	—	—	2.8	mA
	LCD drive	Iee		—	0.15	0.2	
LCD Driving Voltage (Recommended Voltage)		Vdd–Vee	Ta= 0℃ φ=0°, θ=0°	—	12.6	13.0	V
			Ta= 25℃ φ=0°, θ=0°	11.5	12.0	12.5	
			Ta= 50℃ φ=0°, θ=0°	11.0	11.4	—	

Note: <1> Duty =1/64 <2> All dots on static state

3-4-2. Back light specifications for LED

(The users can select the modules with or without backlight according to their own needs.)

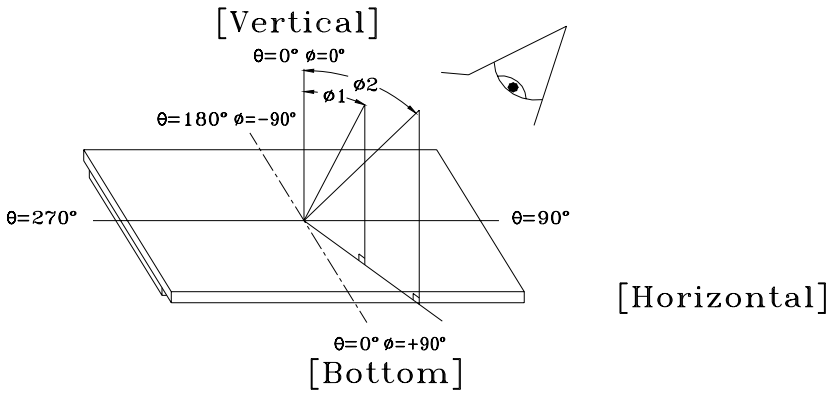
Item	Unit	Standard values			Conditions
		Min.	Typ.	Max.	
Power supply	V	—	4.2	—	—
Brightness	cd/m^2(nit)	—	—	—	DC5.0 Vrms, Dark room
Current	mA	—	—	500	DC5.0 Vrms, Dark room
Life time	Hrs	10000			Note <1>
Luminous color	—	Yellow green			DC5.0 Vrms, Dark room
Operating temperature	℃	-30 ~ 70			—
Storage temperature	℃	-40 ~80			—

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

3-5. Electro-optical Characteristics

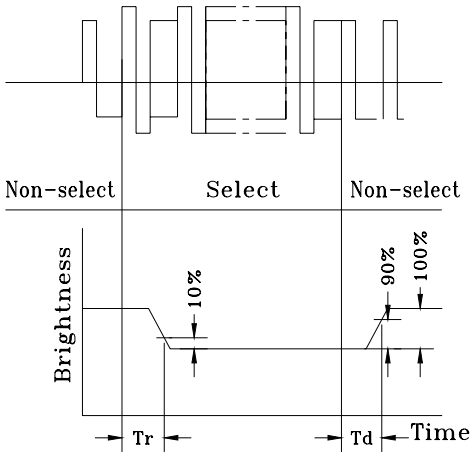
Item		Symbol	Temp.	Conditions	Min.	Typ.	Max.	Unit	Note
LCD Driving Voltage (Recommended voltage)		V_{OP} (VDD-VO)	0℃	φ=0°, θ=0°	—	12.6	13.0	V	1,2,5
			25℃		11.5	12.0	12.5		
			50℃		11.0	11.4	—		
Response Time	Rise Time	tr	0℃	φ=0°, θ=0°	—	1500	2000	Ms	1,3,5
			25℃		—	150	200		
	Decay Time	td	0℃		—	3000	3500		
			25℃		—	200	250		
Viewing angle		Δφ	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.

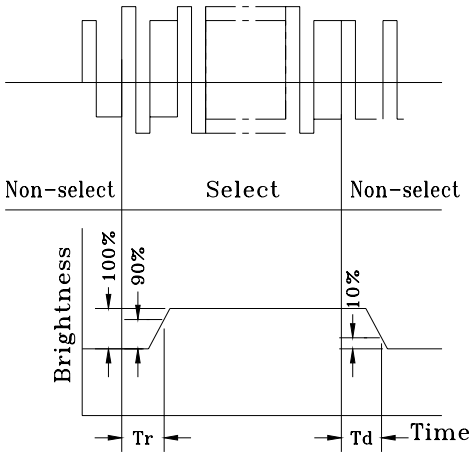


Note: <3>Definition of response time waveform

Positive Display

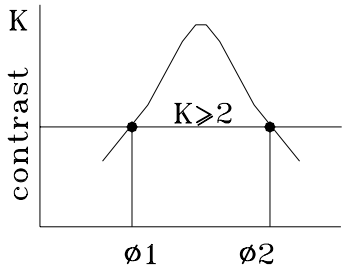


Negative Display



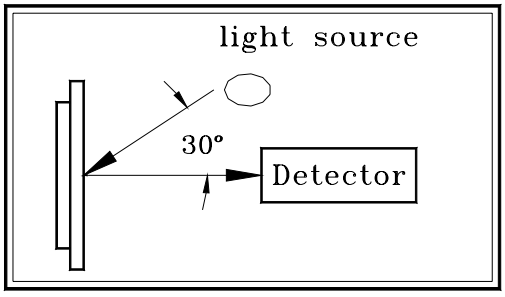
Note: <4>Definition of viewing angle

(Δ Φ) Δ Φ=|Φ1-Φ2|



Viewing angle

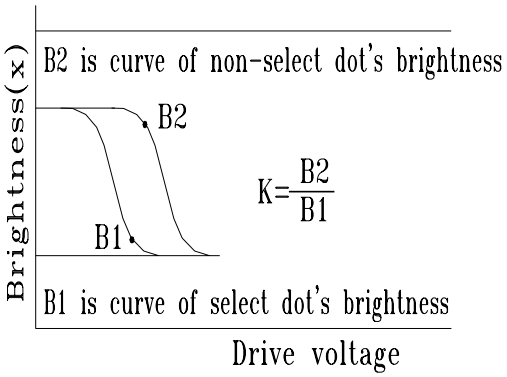
Note: <5> Optical measuring system temperature-regulated chamber



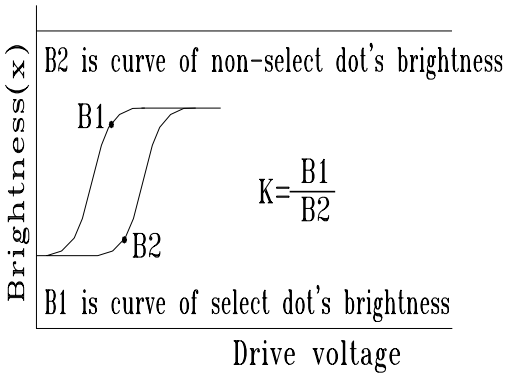
Measuring equipment: DMS (Made in AUTRONIC)

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

Positive Display



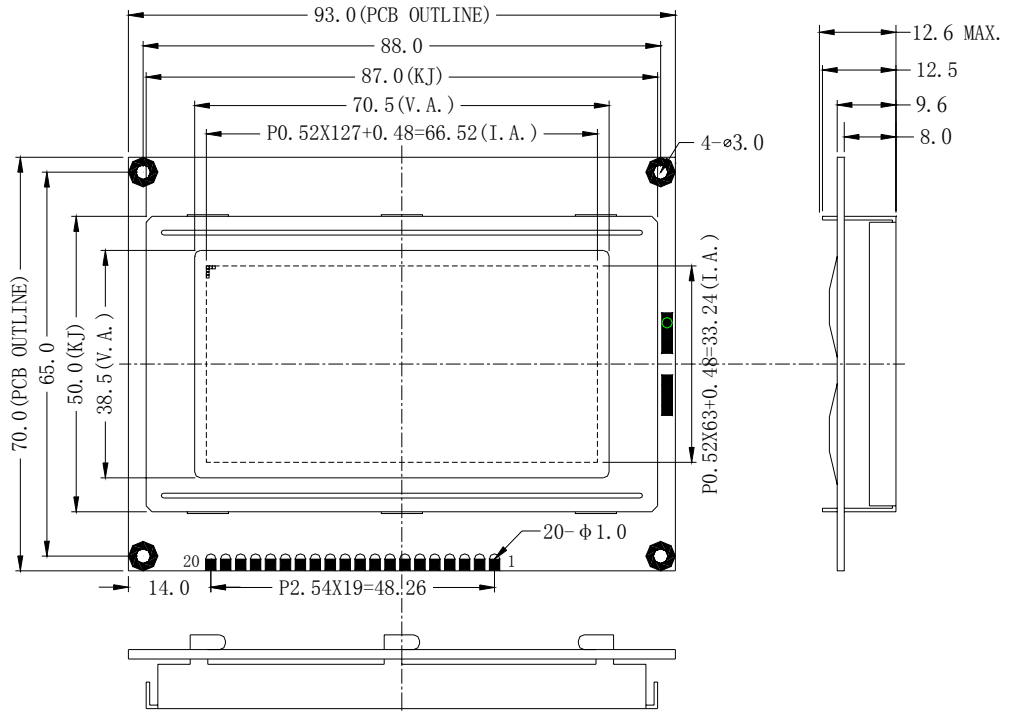
Negative Display



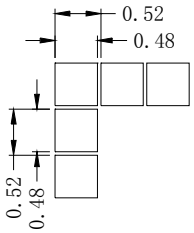
Positive display Contrast (K)= Brightness of non-selected dot (B2) / Brightness of selected dot (B1)

Negative display Contrast (K)= Brightness of non-selected dot (B1) / Brightness of selected dot (B2)

4. Dimensional outline



PIN	SYM.
1	GND
2	VDD
3	VLCD
4	RS
5	RWL
6	CE
7-14	D0-D7
15	CS1
16	CS2
17	RST
18	VADJ
19	BL+
20	BL-



5. I/O terminal

5-1. I/O terminal table

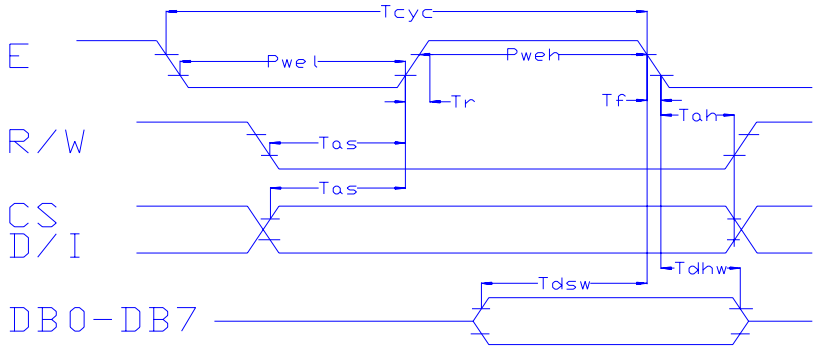
Pin No.	Pin name	Level	Functions
1	GND	--	Ground (0V)
2	VDD	--	Power supply for logic circuit:+5V
3	VLCD	--	Operating voltage for LCD driving
4	D/I	H/L	When D/I="H", it indicates that DB7~DB0 is display data; When D/I="L", it indicates that DB7~DB0 is instruction data.
5	R/W	H/L	While R/W="H" and E="H" , data is read to DB7~DB0 While R/W="L" and E="H->L" , data is written to DB7~DB0
6	E	H.H→ L	Enable signal. While R/W="L", data of DB7~DB0 is latched at falling edge of E While R/W="H" and E="H" , data of DD RAM appears at DB7~DB0
7~14	DB0~DB7	H/L	Data bus line.
15	CS1	H/L	Chip selection. Selects the chip that controls the left half screen.(active at high level, CS1=1,CS2=0)
16	CS2	H/L	Chip selection. Selects the chip that controls the right half screen.(active at high level, CS1=0,CS2=1)
17	/RST	H/L	Controller reset at low level
18	VADJ	--	Negative voltage output
19	BL+	--	Power Supply for LED
20	BL-	--	Power Supply for LED

*******Frame Ground must be soldering+

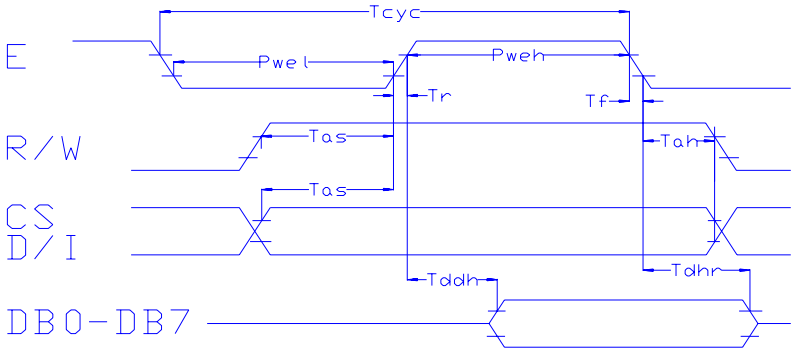
+

5-2. Timing and timing diagram

5-2-1. Timing diagram for write operation



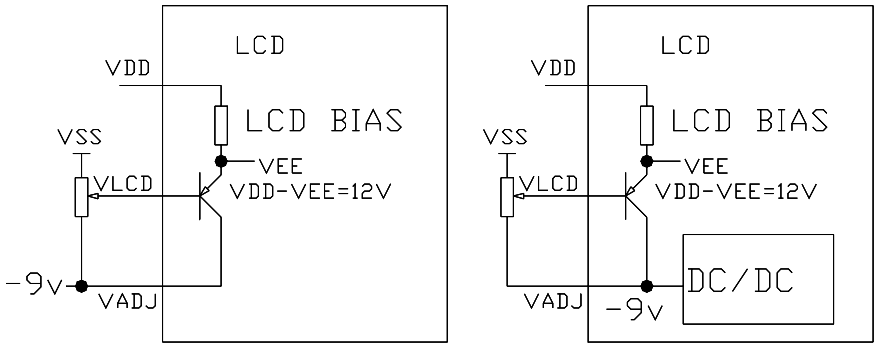
5-2-2. Timing diagram for read operation



5-2-3. Timing characteristics

Name	Symbol	Min.	Typ.	Max.	Unit
E cycle	Tcyc	1000	-	-	ns
E High Level Width	Pweh	450	-	-	ns
E Low Level Width	Pwel	450	-	-	ns
E rise time	Tr	-	-	25	ns
E fall time	Tf	-	-	25	ns
Address setup time	Tas	140	-	-	ns
Address hold time	Tah	10	-	-	ns
Data set-up time	Tdsw	200	-	-	ns
Data delay time	Tddr	-	-	320	ns
Write data hold time	Tdhw	10	-	-	ns
Read data hold time	Tdhr	20	-	-	ns

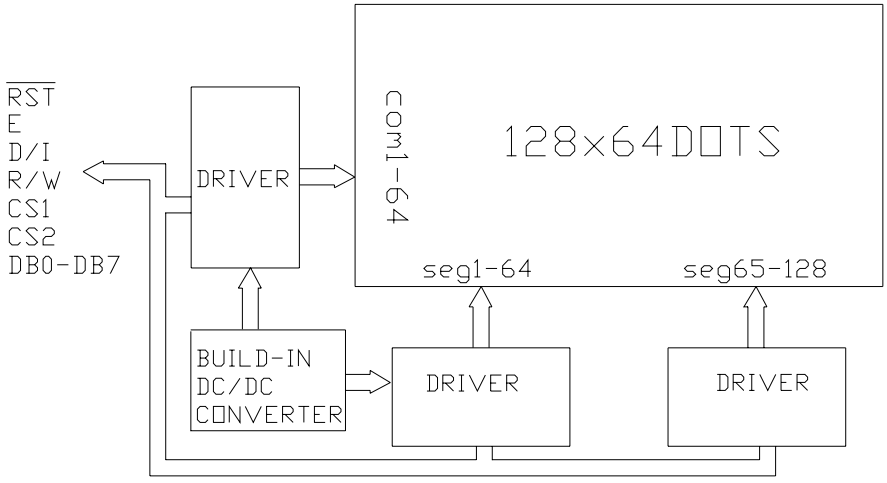
5-3. Power supply connection diagram



Without DC/DC converter　　Built-in DC/DC converter

5-4. Logic block diagram

The LCD module needs power sources: Vdd for logic



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. Description for software and hardware

5-5-1. The internal structure of module

From the above diagram, we may find that the module is mainly composed of LCD panel, controllers and segment drivers.

The control circuit mainly consists of Instruction Register (IR), Data Register (DR), Busy Flag (BF), Display On/Off flip-flop (DFF) and XY Counter.

- Instruction Register (IR)

  IR stores instruction code. When D/I=0, the instruction is written into IR on the falling edge of E.

- Data Register (DR)

  DR stores data. When DR=1, graphic display data are written into DR or are read into DB7 to DB0 data buses under the action of E. The data transfer between DR and DDRAM are executed by internal operation automatically.

- Busy Flag (BF)

  Busy flag indicates that the module is operating or not operating. When BF=1, the module is in the internal operation and does not receive any external instruction and data. When BF=0, the module is in the ready status and can accept the data or instruction at any time.

- Display on/off flip-flop (DFF)

  The display on/off flip-flop makes on/off the liquid crystal display. When DFF=1, display on. The contents of DDRAM are on the screen. When DFF=0, display off.

- XY address counter

  XY address counter is a 9-bit counter. X address counter is higher 3 bits. Y address counter is lower 6 bits. In fact, XY address counter is used as the address pointer of DDRAM. X address counter is page address pointer of DDRAM. Y address counter is Y address pointer of DDRAM.

- Display Data RAM (DDRAM)

  DDRAM stores a display data for liquid crystal display. To express on state dot matrix of liquid crystal display, write data 1. The other way, off state writes 0. (See also DDRAM Address Table for the relation between the DDRAM address and the display position)

- Z Address Counter

  Z address counter is a 6-bit counter. It has cycle-count function, which is used to display with synchronous column scanning. When one column scanning is completed, the address counter is increased by 1 automatically and points to the next column scanning data. After reset, Z address counter is 0.

  Z address counter can be preset by DISPLAY START LINE instruction. Therefore, the display start line is controlled by this instruction. That is to say, where the DDRAM data start is the first line on the screen. There are 64 lines in DDRAM, which can be cycle-displayed on the screen.

5-5-2 Control instructions

1. Display ON/OFF

R/W	D/I	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	1	1	1	1	1	D

D=1 DISPLAY ON

D=0 DISPLAY OFF. Internal status and display RAM data is not affected.

When the value of D is changed from 0 into 1, the former display is on the screen.

2. Display Start Line

R/W	D/I	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	1	1	A5	A4	A3	A2	A1	A0

As explained above in Z address counter, the display start line is controlled by Z address counter. A5~A0 are automatically put into Z address counter. The address of start line can be any line of line 0 to line 63.

For example:

A5~A0 is selected 62, and the correspondence of the first line and DDRAM column is as follows:

DD RAM Column: 62 63 0 1 2 3 …… 60 61

Display column on the screen: 1 2 3 4 5 6 …… 63 64

3. Set Page (X ADDRESS)

R/W	D/I	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	1	0	1	1	1	A2	A1	A0

Page address is line address of DDRAM. There are 8 lines in one page. There are 64 lines in DDRAM (8 pages). A2~A0 represent page 0 to page 7.

Read/write data does not affect page address. Page address is changed by this instruction or RST signal. After reset, page address is 0.

See also the address table for correspondence of page address and DDRAM.

4. Set Y Address

R/W	D/I	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	1	A5	A4	A3	A2	A1	A0

The function of this instruction is to send A5~A0 to Y address counter. They are used as Y address pointer of DDRAM. Y address pointer is automatically incremented by 1 and points to the next unit of DDRAM after write/read is made to DDRAM.

Table 4-4 DDRAM Address Table

	CS1=1, CS2=0							CS1=0, CS2=1							
Y=	0	1	2	3	..	062	63	0	1	2	3	..	62	63	Line No.
X=0	DB0 ↓ DB7						DB0 ↓ DB7	DB0 ↓ DB7						DB0 ↓ DB7	0 ↓ 7
↓	DB0 ↓ DB7						DB0 ↓ DB7	DB0 ↓ DB7						DB0 ↓ DB7	8 ↓ 55
X=7	DB0 ↓ DB7						DB0 ↓ DB7	DB0 ↓ DB7						DB0 ↓ DB7	56 ↓ 63

5. STATUS READ

R/W	D/I	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
1	0	BF	0	ON/OFF	RST	0	0	0	0

When R/W=1 and D/I=0, status read is output into the corresponding bits of data buses (DB7~DB0) (E in "H" level).

BF: (See also BF part)

ON/OFF: It means the status of Display On/Off flip-flop (See also Display On/Off flip-flop part)

RST: When RST=1, it indicates that the system are in the initialization and any instruction and data except status read may not be accepted.

6. Write Display Data

R/W	D/I	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	1	D7	D6	D5	D4	D3	D2	D1	D0

D7-D0 is display data. This instruction writes 8-bit data (D7-D0) into D7-D0 to the corresponding units of DDRAM. The Y address is incremented by 1 automatically.

7. Read Display Data

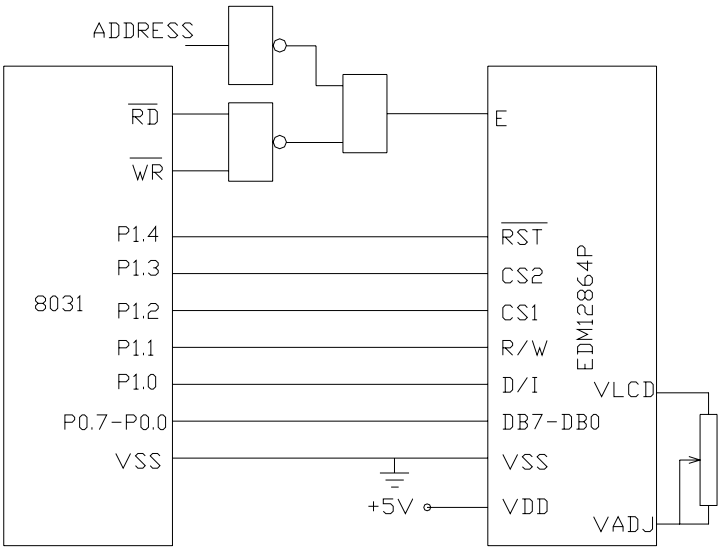
R/W	D/I	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
1	1	D7	D6	D5	D4	D3	D2	D1	D0

Reads out 8-bit data (D7~D0) from the DD RAM. Then Y address is increased by 1 automatically.
The instruction reads out the contents of DDRAM (D7-D0) to the data buses D7-D0. The Y address is incremented by 1 automatically

Note: After the setting of DDRAM address, the dummy read is made at the time of reading data.

5-5-3 Method of interfacing module to MPU

The interface circuit is as follows:



The data bus P0 of 8031 is directly connected to the data bus of module. RD and WR of 8031 act as read/write control signal, interfaced to E signal terminal of module by NAND gate.

5-5-4. Application Example

The following is to explain some instructions using the above circuit application.

R0 (indirect address register)

ID (instruction code) DATA (display data)

1. DISPLAY ON/OFF

```
CLR P1
SETB RST
SETB CS1
MOV A,#ID
MOVX @R0,A                    ; the left 64 columns
  ↓
CLR CS1
SETB CS2
MOVX @ R0,A                   ; the right 64 columns
```

2. READ STATUS

```
CLR P1
SETB RST
SETB CS1
SETB  R/W
```

```
MOVX A,@R0                    ;Status is read to A.
```

3. WRITE DISPLAY DATA)

Assuming that the addresses of X and Y has been set

```
CLR P1
SETB RST
SETB CS1
SETB D/I
MOV   A, # DATA
MOVX   @R0 , A                ;Data is written into the corresponding units of DDRAM
```

6. Quality level

6-1 Inspection conditions

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

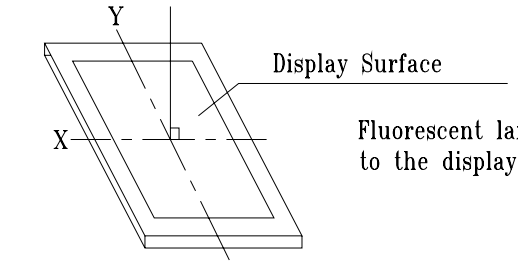
Room temperature: 20±3℃

Humidity: 65±20% RH

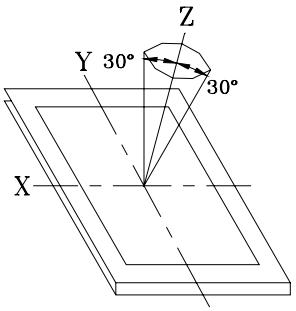
6-1-2 The external visual inspection:

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



Fluorescent lamp set the perpendicular to the display surface



Inspection should be performed within ø (ø=30°) from Z axis to each X and Y axis.

Inspection distance of any direction within ø 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/DF-01-98(II)
Minor defect	MIL-STD-105D Inspection Level I Normal inspection Single sample inspection	Q/DF-01-98(II)

6-3 Classification of defects

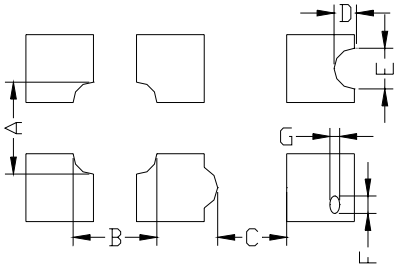
6-3-1 Major defect

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.

6-4 Inspection standards

<table>
<tr><th>Item</th><th>Criterion for defects</th><th>Defect type</th></tr>
<tr><td>1) Display on inspection</td><td>(1) Non display (2) Vertical line is deficient
(3) Horizontal line is deficient (4) Cross line is deficient</td><td>Major</td></tr>
<tr><td>2) Black / White spot</td><td><table><tr><th>Size Φ(mm)</th><th>Acceptable number</th></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</td><td>Minor</td></tr>
<tr><td>3) Black / White line</td><td><table><tr><th>Length (mm)</th><th>Width (mm)</th><th>Acceptable number</th></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.</td><td>Minor</td></tr>
<tr><td>4) Display pattern</td><td> 
[Unit: mm]
$\frac{A+B}{2}\leq 0.45$ | $0<C$ | $\frac{D+E}{2}\leq 0.35$ | $\frac{F+G}{2}\leq 0.35$
Note: 1) Up to 3 damages acceptable
2) Not allowed if there are two or more pinholes every three-fourths inch.</td><td>Minor</td></tr>
<tr><th>Item</th><th>Criterion for defects</th><th>Defect type</th></tr>
<tr><td>5) Spot-like contrast irregularity</td><td><table><tr><th>Size Φ(mm)</th><th>Acceptable Number</th></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.</td><td>Minor</td></tr>
</table>

6) Bubbles in polarizer	Size Φ(mm) / Acceptable Number Φ≤0.4 / Ignore (note) 0.4<Φ≤0.65 / 2 0.65<Φ≤1.2 / 1 1.2<Φ / 0	Minor
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<Φ, N≥1 (2) 0.3<Φ≤0.45, N≥1 Φ: Average diameter of solder ball (unit: mm) (3) 0.5<L, N≥1 L: Average length of solder chip (unit: mm)	Major Minor Minor
16) PCB pattern damage	(1) Deep damage is found on copper foil and the pattern is nearly broken. (2) Damage on copper foil other than 1) above	Major 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
Item	Criterion for defects	Defect type
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	50℃ 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	-10℃ 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	60℃ 96hrs	
5) Low Temperature	-20℃ 96hrs	
6) Thermal shock	25℃→30℃→25℃→60℃ 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 Sanson Infortech 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

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.