POWERTIP TECH. CORP.

DISPLAY DEVICES FOR BETTER ELECTRONIC DESIGN

Specification For Approval

Customer   : _____

Model Type   : <u>LCD Module</u>

Sample Code   : <u>PG12864LRU-JNN-H-P1</u>

Mass Production Code : _____

Edit   : <u>0</u>

Customer Sign	Sales Sign	Approved By	Prepared By

PT-003-2

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1. SPECIFICATIONS

1.1 Features

- Full dot-matrix structure with 128 dots *64 dots
- 1/64 Duty, 1/9 bias
- STN LCD, positive
- Transflective LCD, yellow green
- 6 o'clock viewing direction
- 8 bits parallel data input
- LED Backlight

1.2 Mechanical Specifications

- Outline dimension   :   75.0mm(L)*52.7mm(W)*8.4mm(H)
- Viewing area   :   60.0mm   *32.6mm
- Active area   :   55.01mm   *27.49mm
- Dot size   :   0.39mm   * 0.39mm
- Dot pitch   :   0.43mm   * 0.43mm

1.3 Absolute Maximum Ratings

Item	Symbol	Conditions	Min.	Max.	Unit
Power supply Voltage	VDD	–	0	6.7	V
LCD drive Supply voltage	VDD-VLC	–	0	8.15	V
Input voltage	VIN	–	0	VDD+0.3	V
Operating temperature	TOPR	–	–20	+70	°C
Storage temperature	TSTG	–	–30	+80	°C
Humidity*1	HD	–	–	90	%RH

1.4 DC Electrical Characteristics

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
Logic Supply voltage	VDD	–	4.5	5	5.5	V
"H" input voltage	VIH	–	0.7VDD	–	VDD	V
"L" input voltage	VIL	–	0	–	0.3VDD	V
Supply current	IDD	VDD=5V	–	1.65	–	mA
LCD driving voltage	VOP	VDD-VLC	8.18	–	9.17	V

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1.5 Optical Characteristics

1/64 duty, 1/9 bias, Vopr=8.8V, Ta=25°C

Item	Symbol	Conditions	Min.	Typ.	Max	Reference
Viewing angle	θ	C≥2.0,∅=0°C	30°	–	–	Notes 1 & 2
Contrast	C	θ=5°, ∅=0°	2	3	–	Note 3
Response time(rise)	tr	θ=5°, ∅=0°	–	82ms	–	Note 4
Response time(fall)	tf	θ=5°, ∅=0°	–	163ms	–	Note 4

Note 1: Definition of angles θ and ∅   Note 2: Definition of viewing angles θ1 and θ2

Light (when reflected) z
(θ=0°)

Y'(∅=180°)

Sensor

θ

LCD panel

X'   X(∅=90°)

Z'

∅

Light (when Y(∅=70°)
transmitted) (θ=90°)
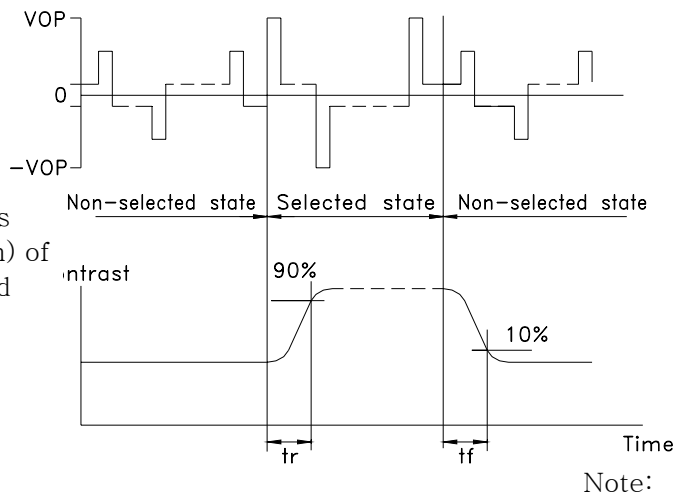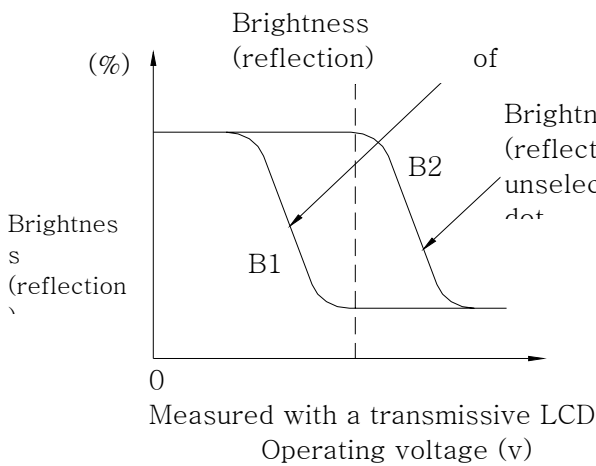
Cmax

Contrast

2.0

θ1   θ2

viewing angle θ (∅ fixed)
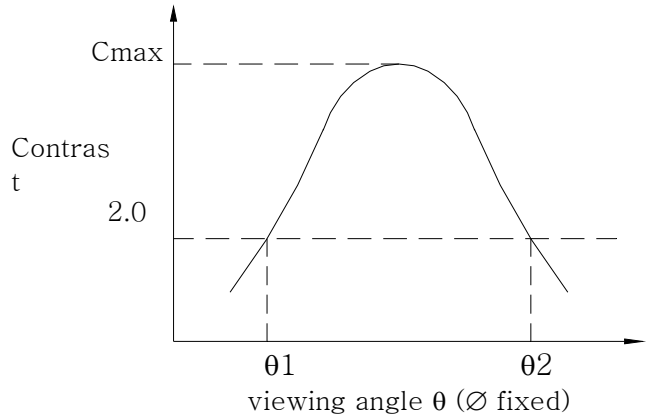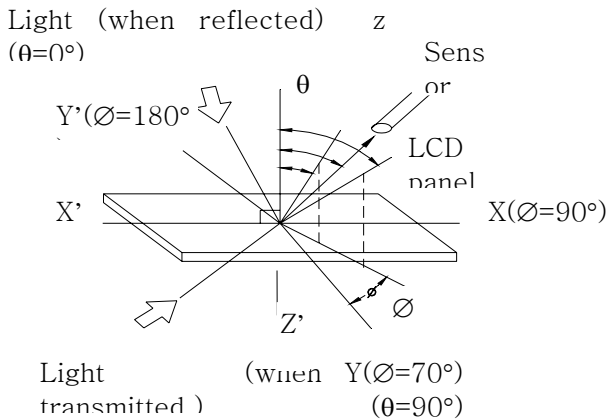
Note： Optimum viewing angle with the
naked eye and viewing angle θ at
Cmax. Above are not always the same.

Note 3: Definition of contrast C   Note 4: Definition of response time

$$C = \frac{\text{Brightness (reflection) of unselected dot (B2)}}{\text{Brightness (reflection) of selected dot (B1)}}$$

(%)

Brightness (reflection) of

Brightness (reflection) of unselected dot

B2

Brightness (reflection)

B1

0

Measured with a transmissive LCD
Operating voltage (v)

VOP

0

−VOP

Non−selected state | Selected state | Non−selected state

Contrast

90%

10%

tr   tf   Time

Note:

panel which is displayed 1 cm²

V_{OPR} : Operating voltage f_{FRM} : Frame frequency

t r : Response time (rise)   t f : Response time

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1.6 Backlight Characteristic

The LCD Module is backlight using a LED panel
•.Maximum Ratings

Item	Symbol	Conditions	Min.	Max.	Unit
Forward current	IF	TA=25°C	–	250	MA
Reverse voltage	VR	TA=25°C	–	8	V
Power dissipation	PO	TA=25°C	–	1.1	W
Operating Temperature	TOPR	–	–20	70	°C
Storage temperature	TSTG	–	–40	80	°C

•.Electrical Ratings

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
Forward voltage	VF	IF=100mA	–	4.1	4.4	V
Reverse current	IR	VR=8V	–	–	0.2	mA
Luminous intensity	IV	IF=100mA	–	16	–	cd/m^2
Wavelength	HUE	IF=100mA	571	–	576	nm
Color	Yellow Green					

•.Light LED Backlight
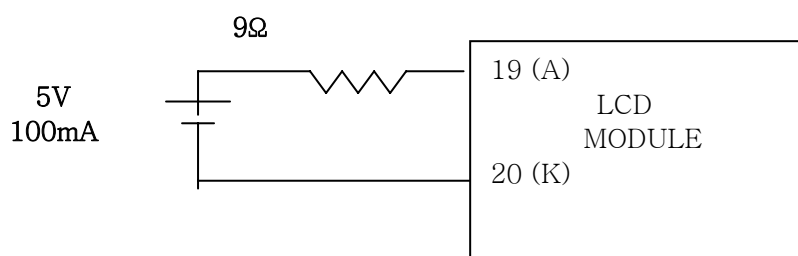
2. MODULE STRUCTURE

2.1 Counter Drawing

*See Appendix

2.2 Interface Pin Description

Pin No.	Symbol	Function
1	VDD	Power supply for logic (+ 5V)
2	VSS	Signal ground (GND)
3	VLC	Operating voltage for LCD (variable)
4 −7	DB0~ DB3	Four low order bi-directional three-state data bus lines. Use for data transfer between the MPU and the LCD module. These four are not used during 4-bit operation.
8 −11	DB4~ DB7	For high order bi-directional three-state data bus lines. Used for data transfer between the MPU and the LCD module. DB7 can be used as a busy flag.
12	/CS1	Chip enable for D2 (segment 1 to segment 64)
13	/CS2	Chip enable for D3 (segment 65 to segment 128)
14	$\overline{RST}$	Reset signal
15	R/$\overline{W}$	R/W signal input is used to select the read/write mode High =Read mode, Low =Write mode
16	D/$\overline{I}$	Register selection input High =Data register Low =Instruction register (for write) Busy flag address counter (for read)
17	E	Start enable signal to read or write the data
18	VSS	Ground
19	A	LED Backlight(+)
20	K	LED Backlight(−)

Contrast Adjust

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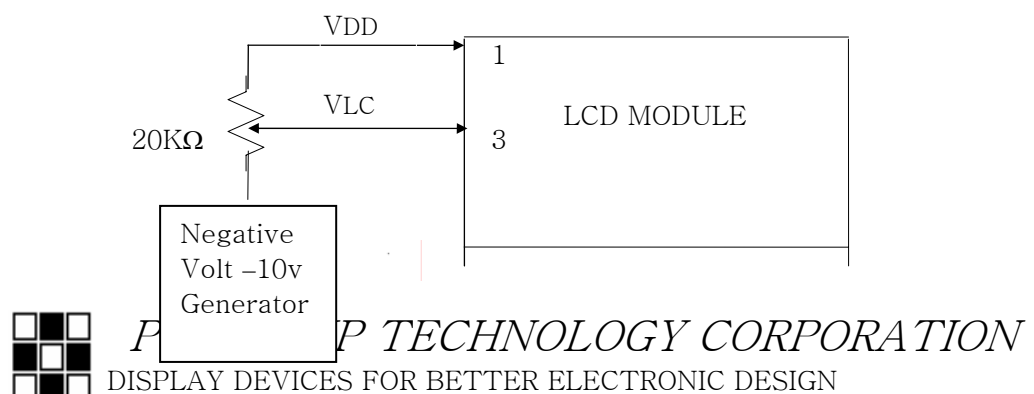
2.3 Timing Characteristics

MPU Write timing

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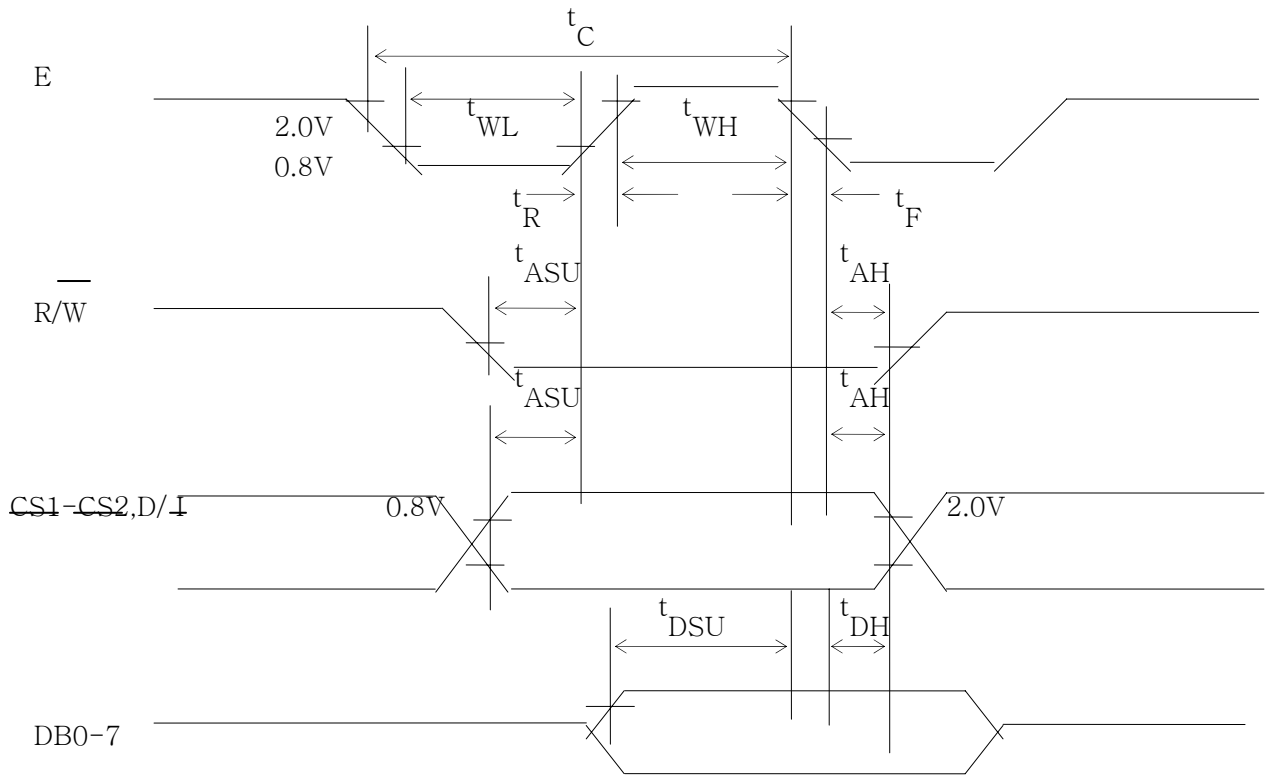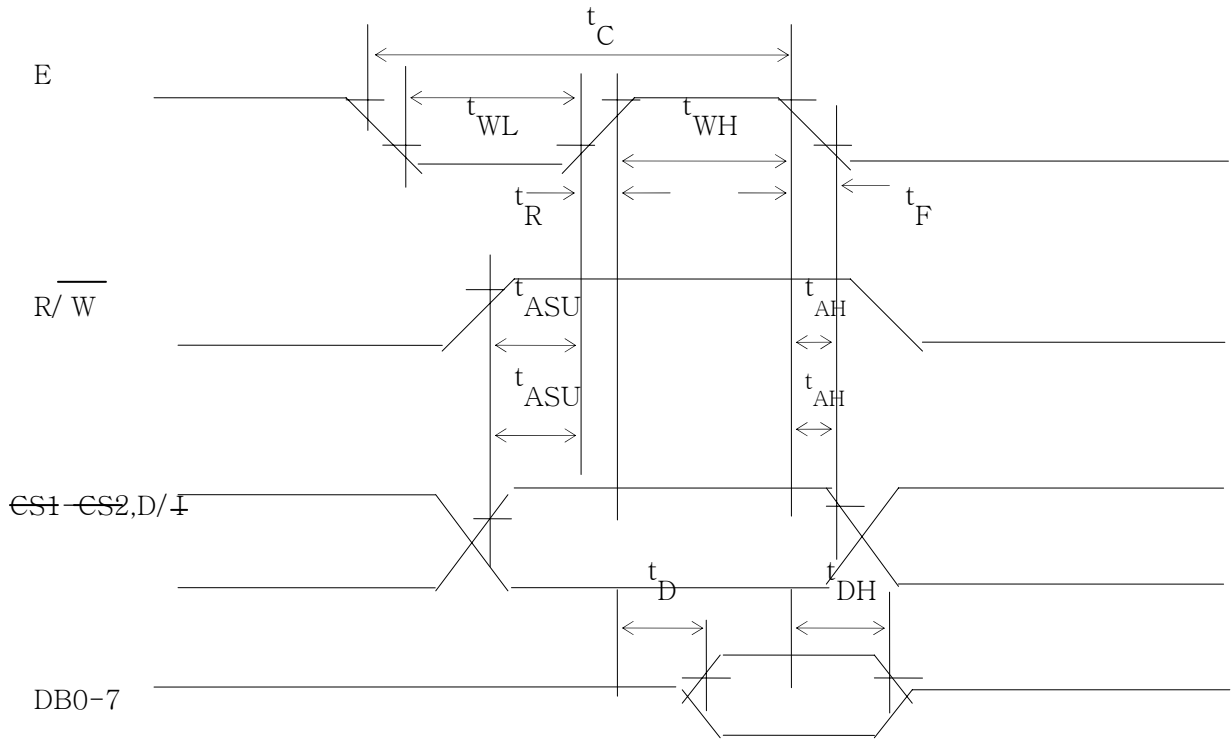
MPU Read timing

Characteristic	Symbol	Min.	Typ	Max	Unit
E Cycle	tC	1000	–	–	ns
E High Level Width	tWH	450	–	–	ns
E Low Level Width	tWL	450	–	–	ns
E Rise Time	tR	–	–	25	ns
E Fall Time	tF	–	–	25	ns
Address Set-Up time	tASU	140	–	–	ns
Address Hold Time	tAH	10	–	–	ns
Data Set-Up Time	tSU	200		–	ns
Data Delay Time	tD	–	–	320	ns
Data Hold Time (Write)	tDHW	10	–	–	ns
Data Hold Time (Read)	tDHR	20	–	–	ns

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2.4 Display command

Instructions	Code										Functions	
	R/W	D/I	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0		
Display on/off	0	0	0	0	1	1	1	1	1	1/0	Controls display on/off. RAM data and internal status are not affected. (0:OFF,1:ON)	
Display start line	0	0	1	1	Display start line (0-63)						Specifies the RAM line displayed at the top of the screen.	
Set Page (x address)	0	0	1	0	1	1	1	Page (0-7)			Sets the page (X address) of RAM at the page (X address) register.	
Set Y address	0	0	0	1	Y address (0-63)						Sets the Y address in the Y address counter.	
Status read	1	0	Busy	0	ON/OFF	Reset	0	0	0	0	Reads the status. Reset 1: Reset 0: Normal ON/OFF 1: Display off 0: Display on Busy 1: Internal operation 0: Ready	
Write display data	0	1	Write data								Writes data DB0 (LSB) to DB7 (MSB) on the data bus into display RAM.	Has access to the address of the display RAM specified in advance. After the access, Y address is increased by 1.
Read display data	1	1	Read data								Reads data DB0 (LSB) to DB7 (MSB) from the display RAM to the data bus.	

Detailed Explanation
Display On/Off

R/W D/I   DB7.......................................DB0

Code	0	0	0	0	1	1	1	1	1	D
	MSB								LSB	

The display data appears when D is 1 and disappears when D is 0. Though the data is not on the screen with D=0, it remains in the display data RAM. Therefore, you can make it appear by changing D=0 into D=1.

Display Start Line

R/W D/I   DB7.......................................DB0

Code	0	0	1	1	A	A	A	A	A	A
	MSB								LSB	

Z address AAAAAA (binary) of the display data RAM is set in the display start line register and displayed at the top of the screen. Figure 1 shows examples of display (1/64 duty cycle) when the start line=0-3. When the display duty cycle is 1/64 or more (ex. 1/32, 1/24 etc.), the data of

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Set page (X address)

```
        R/W D/I  DB7.......................................DB0
Code  | 0 | 0 | 1 | 0 | 1 | 1 | 1 | A | A | A |
        MSB                        LSB
```

X address AAA (binary) of the display data RAM is set in the X address register. After that,
writing or reading to or from MPU is executed in this specified page until the next page is set.
See figure 2.

Set Y Address

```
        R/W D/I  DB7.......................................DB0
Code  | 0 | 0 | 0 | 1 | A | A | A | A | A | A |
        MSB                        LSB
```

Y address AAAAAA (binary) of the display data RAM is set in the Y address Counter. After that,
Y address counter is increased by 1 every time the data is written or read to or from MPU.

Status Read

```
        R/W D/I  DB7.................................    ....DB0
Code  | 1 | 0 | Busy | 0 | ON/OFF | Reset | 0 | 0 | 0 | 0 |
        MSB                              LSB
```

• Busy
When busy is 1, the LSI is executing internal operations. No instructions are accepted while busy
is 1, so you should make sure that busy is 0 before writing the next instruction.

• ON/OFF
Shows the liquid crystal display conditions: on condition or off condition.

When on/off is 1, the display is in off condition.
When on/off is 0, the display is in on condition.

• RESET
RESET=1 shows that the system is being initialized. In this condition, no instructions except
status read can be accepted.
RESET=0 shows that initializing has finished and the system is in the usual operation condition.

Write Display Data

```
        R/W D/I  DB7.......................................DB0
Code  | 0 | 1 | D | D | D | D | D | D | D | D |
        MSB                        LSB
```

Write 8-bit data DDDDDDDD (binary) into the display data RAM. Then Y address is increased by
1 automatically.

Read Display Data

```
        R/W D/I  DB7.......................................DB0
```

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Code	1	1	D	D	D	D	D	D	D

MSB   LSB

Reads out 8-bit data DDDDDDD (binary) from the display data RAM. Then Y address is increased by 1 automatically.

One dummy read is necessary right after the address setting. For details, refer to the explanation of output register in "Function of Each Block".
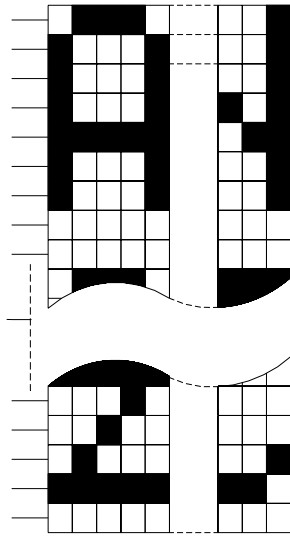
COM1
COM2
COM3
COM4
COM5
COM6
COM7
COM8
COM9

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Start line = 0

Start line = 1

COM1
COM2
COM3
COM4
COM5
COM6
COM7
COM8
COM9

COM60
COM61
COM62
COM63
COM64

Start line = 2

COM1
COM2
COM3
COM4
COM5
COM6
COM7
COM8
COM9

COM60
COM61
COM62
COM63
COM64
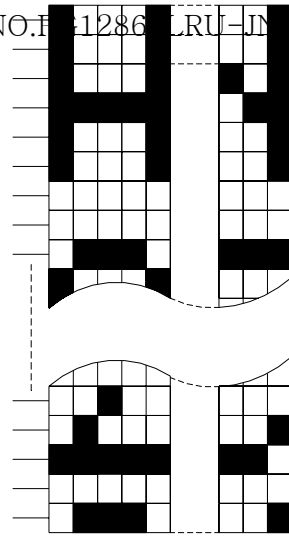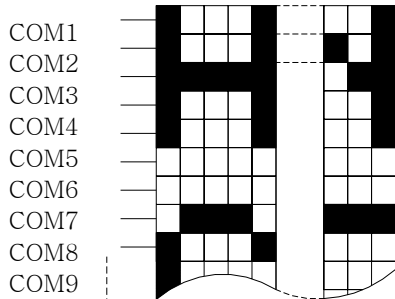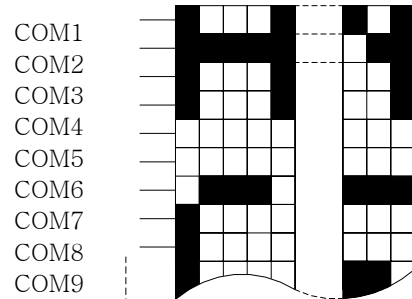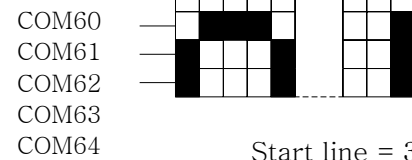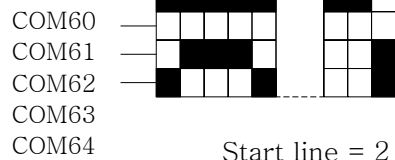
Start line = 3

Figure 1 Relation between Start Line and Display

Y address
0 1 2............................61 62 63

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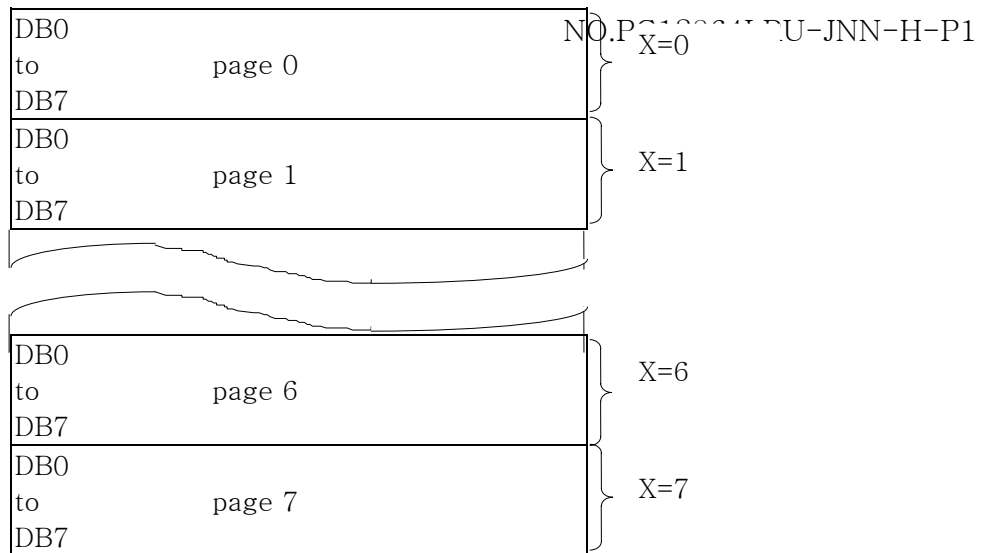| DB0 to DB7 | page 0 | X=0 |
DB0 to DB7	page 1	X=1
...		
DB0 to DB7	page 6	X=6
DB0 to DB7	page 7	X=7

Figure 2 Address Configuration of Display Data RAM

3. RELIABILITY

3.1 Content of Reliability Test

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		Environmental Test	
NO	Test Item	Content of Test	Test Condition
1	High temperature storage	Endurance test applying the high storage temperature for a long time.	70℃ 100 hrs
2	Low temperature storage	Endurance test applying the high storage temperature for a long time.	−30℃ 100 hrs
3	High temperature operation	Endurance test applying the electric stress (Voltage & Current) and the thermal stress to the element for a long time.	70℃ 100 hrs
4	Low temperature operation	Endurance test applying the electric stress under low temperature for a long time.	−20℃ 100 hrs
5	High temperature /Humidity Storage	Endurance test applying the high humidity storage for a long time.	70℃,90%RH 50 hrs
6	High temperature /Humidity Operation	Endurance test applying the electric stress (Voltage & Current) and temperature / humidity stress to the element for a long time.	70℃,90%RH 50 hrs
7	Temperature Cycle	Endurance test applying the low and high temperature cycle. 　−25℃ → 25℃ → 75℃ 30min ← 5min ← 30min ←————————→ 　　　1 cycle	−25℃ / 75℃ 10 cycle

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