

# POWERTIP TECH. CORP.

## Specification For Approval

Customer : \_\_\_\_\_

Model Type : LCD Module

Sample Code : \_\_\_\_\_

Mass Production Code : PG12864LRS-HNN-B

Edit : 0

| Customer Sign | Sales Sign | Approved By | Prepared By |
|---------------|------------|-------------|-------------|
|               |            |             |             |

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DISPLAY DEVICES FOR BETTER ELECTRONIC DESIGN

# 1. SPECIFICATIONS

## 1.1 Features

- Full dot-matrix structure with 128 dots \*64 dots
- 1/64 Duty, 1/9 bias
- STN LCD, positive, gray display
- Transflective LCD
- 6 o'clock viewing angle
- 8 bits parallel data input ,with controller IC T6963C
- Built-in negative voltage and LED backlight

## 1.2 Mechanical Specifications

- Outline dimension : 87.0mm(L) \*71.0mm(W)\*14.3mm max.(H)
- Viewing area : 62.0mm \*44.0mm
- Active area : 56.27mm \*38.35mm
- Dot size : 0.39mm \*0.55mm
- Dot pitch : 0.44mm \*0.6mm

## 1.3 Absolute Maximum Ratings

| Item                     | Symbol  | Conditions | Min. | Max.    | Unit |
|--------------------------|---------|------------|------|---------|------|
| Power supply Voltage     | VDD     | -          | 4.5  | 5.5     | V    |
| LCD drive Supply voltage | VDD-VEE | -          | 12.0 | 17      | V    |
| Input voltage            | VIN     | -          | -0.3 | VDD+0.3 | V    |
| Operating temperature    | TOPR    | -          | 0    | 50      | °C   |
| Storage temperature      | TSTG    | -          | -20  | 60      | °C   |
| Humidity*1               | HD      | -          | -    | 90      | %RH  |

## 1.4 DC Electrical Characteristics

VDD=+5V±10%, VSS=0V, TA=25°C

| Item                 | Symbol | Condition | Min.    | Typ. | Max.   | Unit |
|----------------------|--------|-----------|---------|------|--------|------|
| Logic Supply voltage | VDD    | -         | 4.5     | 5    | 5.5    | V    |
| “H” input voltage    | VIH    | -         | 0.8VDD  | -    | VDD    | V    |
| “L” input voltage    | VIL    | -         | 0       | -    | 0.2VDD | V    |
| “H” output voltage   | VOH    | -         | VDD-0.3 | -    | -      | V    |
| “L” output voltage   | VOL    | -         | -       | -    | 0.3    | V    |
| Supply current       | IDD    | VDD=5V    | -       | -    | 8      | mA   |
| LCD driving voltage  | VOP    | VDD-VO    | -       | 8.4  | -      | V    |



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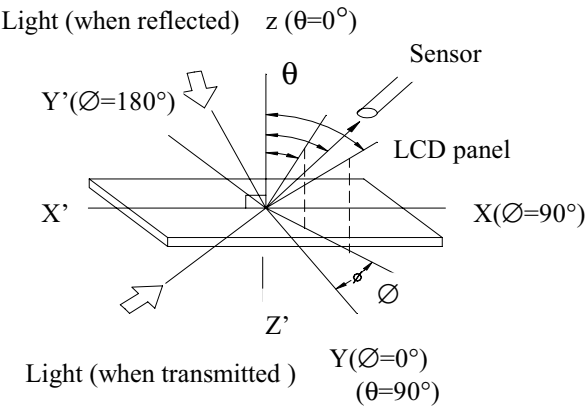
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1.5 Optical Characteristics

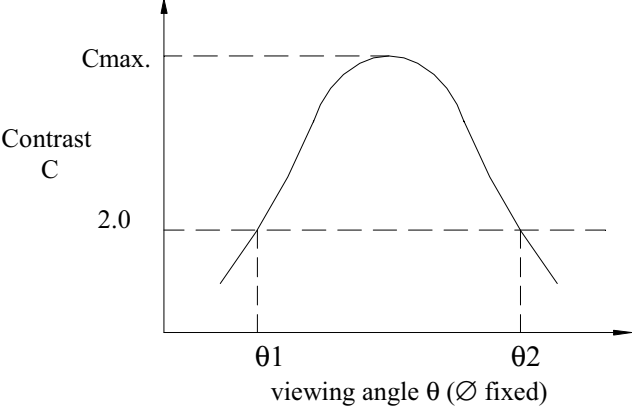
1/64 duty, 1/9 bias, Vopr=10.3V, Ta=25°C

| Item                | Symbol   | Conditions                                | Min.        | Typ.  | Max        | Reference   |
|---------------------|----------|-------------------------------------------|-------------|-------|------------|-------------|
| Viewing angle       | $\theta$ | $C \geq 2.0, \varnothing = 0^\circ$       | $-30^\circ$ | -     | $30^\circ$ | Notes 1 & 2 |
| Contrast            | C        | $\theta = 5^\circ, \varnothing = 0^\circ$ | -           | 3     | -          | Note 3      |
| Response time(rise) | tr       | $\theta = 5^\circ, \varnothing = 0^\circ$ | -           | 150ms | 300ms      | Note 4      |
| Response time(fall) | tf       | $\theta = 5^\circ, \varnothing = 0^\circ$ | -           | 300ms | 500ms      | Note 4      |

Note 1: Definition of angles  $\theta$  and  $\varnothing$



Note 2: Definition of viewing angles  $\theta_1$  and  $\theta_2$

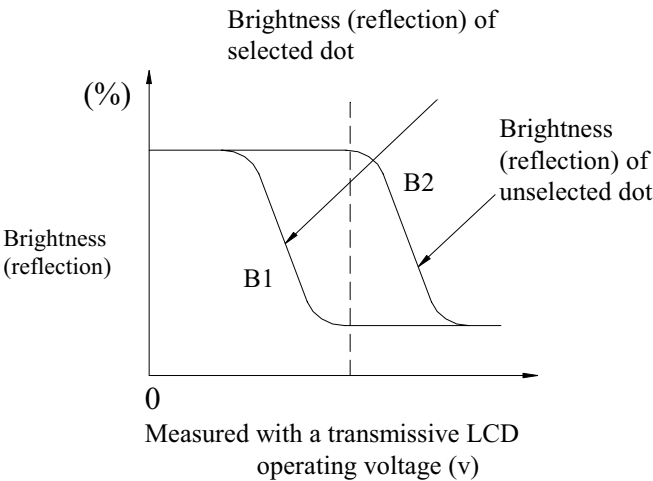


Note : Optimum viewing angle with the naked eye and viewing angle  $\theta$  at Cmax. Above are not always the same

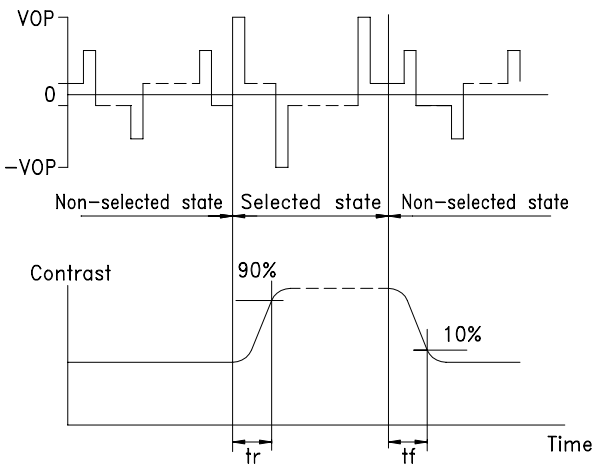
Note 3: Definition of contrast C

Brightness (reflection) of unselected dot (B2)

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



Note 4: Definition of response time



Note:  
panel which is displayed 1 cm<sup>2</sup>

V<sub>OPR</sub> : Operating voltage  
t<sub>r</sub> : Response time (rise)  
f<sub>FRM</sub> : Frame frequency  
t<sub>f</sub> : Response time (fall)

## 1.6 Backlight Characteristic

The LCD Module is using a CCFL panel backlight

### •.Maximum Ratings

| Item                  | Symbol | Condition | Min. | Max. | Unit |
|-----------------------|--------|-----------|------|------|------|
| Forward current       | IF     | TA=25°C   | -    | 875  | mA   |
| Reverse voltage       | VR     | TA=25°C   | -    | 8    | V    |
| Power dissipation     | PO     | TA=25°C   | -    | 4.02 | 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=350mA  | 3.8  | 4.2  | 4.6  | V                 |
| Reverse current    | IR           | VR=8V     | -    | -    | 0.2  | mA                |
| Luminous intensity | PO           | IF=350mA  | 220  | 270  | -    | cd/m <sup>2</sup> |
| Wavelength         | $\lambda_p$  | IF=350mA  | 565  | -    | 571  | mArms             |
| Color              | Yellow Green |           |      |      |      |                   |



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## 2. MODULE STRUCTURE

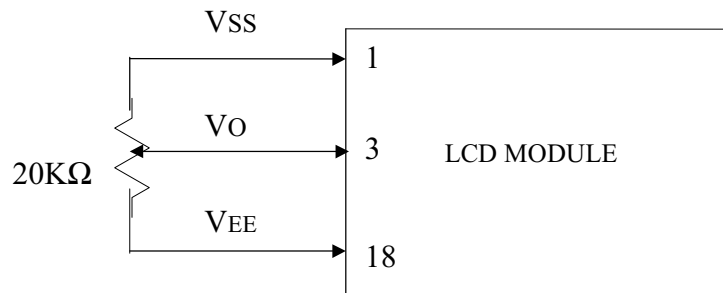
### 2.1 Counter Drawing

\*See Appendix

### 2.2 Interface Pin Description

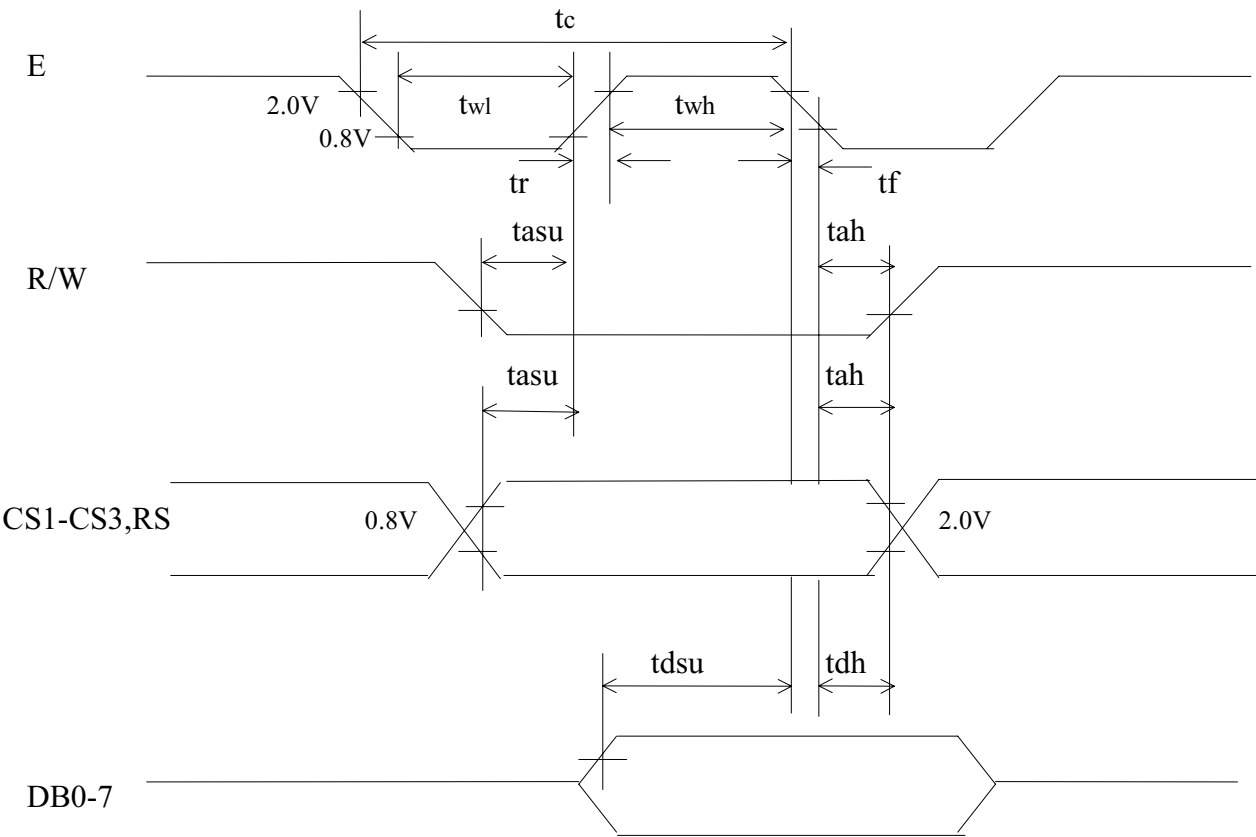
| Pin No. | Symbol           | Function                                                                                                                                                                |
|---------|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1       | VSS              | Signal ground (GND)                                                                                                                                                     |
| 2       | VDD              | Power supply for logic (+5V)                                                                                                                                            |
| 3       | V0               | Operating voltage for LCD (variable)                                                                                                                                    |
| 4       | $\overline{D/I}$ | Register selection input<br>High = Data register<br>Low = Instruction register (for write)<br>Busy flag address counter (for read)                                      |
| 5       | $\overline{R/W}$ | R/W signal input is used to select the read/write mode<br>High = Read mode, Low = Write mode                                                                            |
| 6       | E                | Start enable signal to read or write the data                                                                                                                           |
| 7~10    | DB0~DB3          | Four low order bi-directional three-state data bus lines. Used for data transfer between the MPU and the LCD module.<br>These four are not used during 4-bit operation. |
| 11~14   | DB4~DB7          | For high order bi-directional three-state data bus lines. Used for data transfer between the MPU and the LCD module.<br>DB7 can be used as a busy flag.                 |
| 15      | $\overline{CS1}$ | Chip enable for D2 (segment 1 to segment 64)                                                                                                                            |
| 16      | $\overline{CS2}$ | Chip enable for D3 (segment 1 to segment 64)                                                                                                                            |
| 17      | RST              | Reset signal                                                                                                                                                            |
| 18      | Vee              | Negative voltage power supply                                                                                                                                           |
| 19      | NC               | Non-connection                                                                                                                                                          |
| 20      | NC               | Non-connection                                                                                                                                                          |

Contrast Adjust



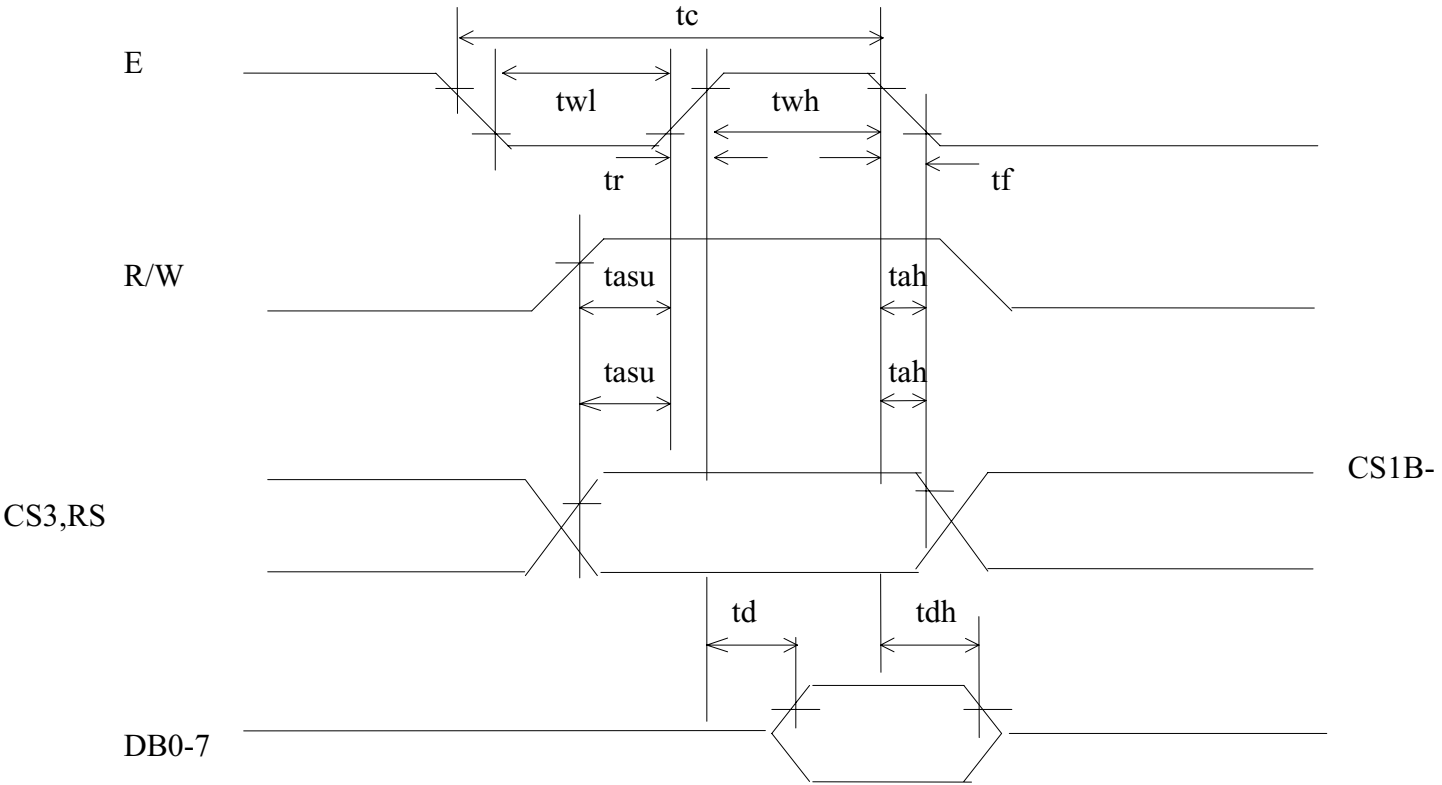
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2.3 Timing Characteristics



MPU write timing





MPU read timing

| Characteristic         | Symbol | Min. | Typ | Max | Unit |
|------------------------|--------|------|-----|-----|------|
| E cycle time           | 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   |



## 2.4 Display command

|                      | Code |     |            |    |                           |       |    |                                                                         |    |     |                                                                                                                                                                             |
|----------------------|------|-----|------------|----|---------------------------|-------|----|-------------------------------------------------------------------------|----|-----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                      | R/   | D/I | DB7        | DB | DB5                       | DB    | DB | DB                                                                      | DB | DB0 |                                                                                                                                                                             |
| Instructions         | W    |     |            | 6  |                           | 4     | 3  | 2                                                                       | 1  |     | Functions                                                                                                                                                                   |
| 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.                                                                                                     |
| 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 in the counter.                                                                                                                         |
| Status read          | 1    | 0   | Busy       | 0  | ON/<br>OFF                | Reset | 0  | 0                                                                       | 0  | 0   | Reads the status.<br><br>Reads           1: Reset<br>0: Normal<br><br>ON/OFF        1: Display off<br>0: Display on<br><br>Busy           1: Internal operation<br>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. |    |     |                                                                                                                                                                             |

Note: Busy time varies with the frequency ( $f_{CLK}$ ) of  $\varnothing 1$ , and  $\varnothing 2$ .  
 $(1/f_{CLK} \leq T_{BUSY} \leq 3/f_{CLK})$

### Detailed Explanation

#### Display On/Off

| Code | R/W | D/I | DB7.....DB0 |   |   |     |   |   |   |   |
|------|-----|-----|-------------|---|---|-----|---|---|---|---|
|      | 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.



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**Display Start Line**

|      | R/W | D/I | DB7..... |   |   |   |     |   | DB0 |
|------|-----|-----|----------|---|---|---|-----|---|-----|
| Code | 0   | 0   | 1        | 1 | 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 total line number of LCD screen, from the line specified by display start line instruction, is displayed.

**Set page (X address)**

|      | R/W | D/I | DB7..... |   |   |   |     |   | DB0 |
|------|-----|-----|----------|---|---|---|-----|---|-----|
| Code | 0   | 0   | 1        | 0 | 1 | 1 | 1   | 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   |
|      | 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 | REST | 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.



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- 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 |
|      | 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 |   |   |   |   |     |   |
| Code | 1   | 1   | D           | D | D | D | D | D   | D |
|      | MSB |     |             |   |   |   |   | LSB |   |

Reads out 8-bit data DDDDDDDD (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”.



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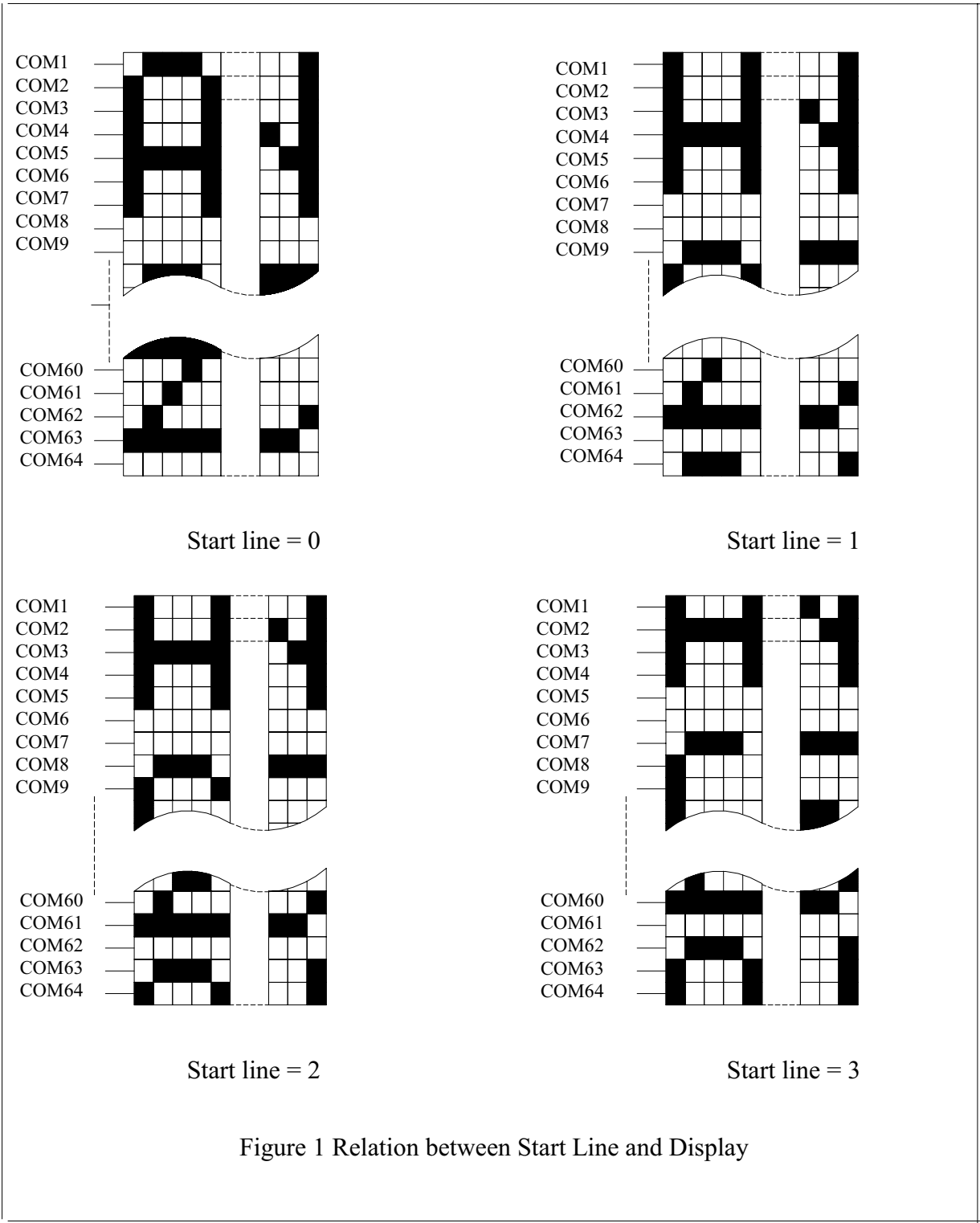


Figure 1 Relation between Start Line and Display



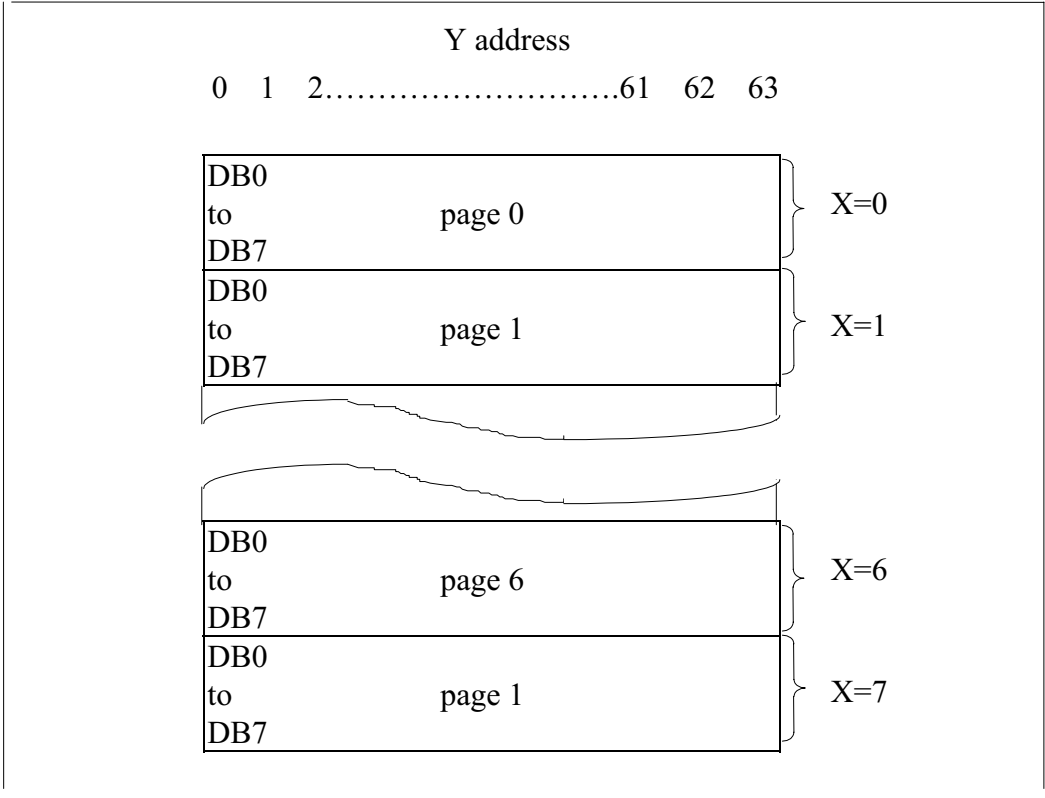


Figure 2 Address Configuration of Display Data RAM



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