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CrystalFontz America, Inc.

SPECIFICATION

CUSTOMER : _____

MODULE NO.: **CFAG240128D-FMI-T**

| SALES BY | APPROVED BY | CHECKED BY | PREPARED BY |
|---------------------|--------------------|-------------------|--------------------|
| | | | |
| ISSUED DATE: | | | |

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1. Module Classification Information

CFA G 240128 D-FMI-T
① ② ③ ④ ⑤ ⑥ ⑦ ⑧

| | | | | | | | | | | | | | | |
|------------------------------|--|---|-------------------------|---------------------------|--------------------------|----------------------------|--------------------------|--------------------------|------------------------------|---------------------------|-----------------------------|----------------------------------|----------------------------|---------------------------|
| ① | Brand: CRYSTALFONTZ AMERICA, INCORPORATED | | | | | | | | | | | | | |
| ② | Display Type : H→Character Type, G→Graphic Type | | | | | | | | | | | | | |
| ③ | Display's logical dimensions: 240 pixels by 128 pixels | | | | | | | | | | | | | |
| ④ | Model serials no. | | | | | | | | | | | | | |
| ⑤ | Backlight Type : | <table border="0"> <tr> <td>N→Without backlight</td> <td>A→LED, Amber</td> </tr> <tr> <td>B→EL, Blue green</td> <td>R→LED, Red</td> </tr> <tr> <td>D→EL, Green</td> <td>O→LED, Orange</td> </tr> <tr> <td>W→EL, White</td> <td>G→LED, Green</td> </tr> <tr> <td>F→CCFL, White</td> <td></td> </tr> <tr> <td>Y→LED, Yellow Green</td> <td></td> </tr> </table> | N→Without backlight | A→LED, Amber | B→EL, Blue green | R→LED, Red | D→EL, Green | O→LED, Orange | W→EL, White | G→LED, Green | F→CCFL, White | | Y→LED, Yellow Green | |
| N→Without backlight | A→LED, Amber | | | | | | | | | | | | | |
| B→EL, Blue green | R→LED, Red | | | | | | | | | | | | | |
| D→EL, Green | O→LED, Orange | | | | | | | | | | | | | |
| W→EL, White | G→LED, Green | | | | | | | | | | | | | |
| F→CCFL, White | | | | | | | | | | | | | | |
| Y→LED, Yellow Green | | | | | | | | | | | | | | |
| ⑥ | LCD Mode : | <table border="0"> <tr> <td>B→TN Positive, Gray</td> <td>T→FSTN Negative</td> </tr> <tr> <td>N→TN Negative,</td> <td></td> </tr> <tr> <td>G→STN Positive, Gray</td> <td></td> </tr> <tr> <td>Y→STN Positive, Yellow Green</td> <td></td> </tr> <tr> <td>M→STN Negative, Blue</td> <td></td> </tr> <tr> <td>F→FSTN Positive</td> <td></td> </tr> </table> | B→TN Positive, Gray | T→FSTN Negative | N→TN Negative, | | G→STN Positive, Gray | | Y→STN Positive, Yellow Green | | M→STN Negative, Blue | | F→FSTN Positive | |
| B→TN Positive, Gray | T→FSTN Negative | | | | | | | | | | | | | |
| N→TN Negative, | | | | | | | | | | | | | | |
| G→STN Positive, Gray | | | | | | | | | | | | | | |
| Y→STN Positive, Yellow Green | | | | | | | | | | | | | | |
| M→STN Negative, Blue | | | | | | | | | | | | | | |
| F→FSTN Positive | | | | | | | | | | | | | | |
| ⑦ | LCD Polarizer Type/ Temperature range/ View direction | <table border="0"> <tr> <td>A→Reflective, N.T, 6:00</td> <td>H→Transflective, W.T,6:00</td> </tr> <tr> <td>D→Reflective, N.T, 12:00</td> <td>K→Transflective, W.T,12:00</td> </tr> <tr> <td>G→Reflective, W. T, 6:00</td> <td>C→Transmissive, N.T,6:00</td> </tr> <tr> <td>J→Reflective, W. T, 12:00</td> <td>F→Transmissive, N.T,12:00</td> </tr> <tr> <td>B→Transflective, N.T,6:00</td> <td>I→Transmissive,W. T, 6:00</td> </tr> <tr> <td>E→Transflective, N.T.12:00</td> <td>L→Transmissive, W.T,12:00</td> </tr> </table> | A→Reflective, N.T, 6:00 | H→Transflective, W.T,6:00 | D→Reflective, N.T, 12:00 | K→Transflective, W.T,12:00 | G→Reflective, W. T, 6:00 | C→Transmissive, N.T,6:00 | J→Reflective, W. T, 12:00 | F→Transmissive, N.T,12:00 | B→Transflective, N.T,6:00 | I→Transmissive,W. T, 6:00 | E→Transflective, N.T.12:00 | L→Transmissive, W.T,12:00 |
| A→Reflective, N.T, 6:00 | H→Transflective, W.T,6:00 | | | | | | | | | | | | | |
| D→Reflective, N.T, 12:00 | K→Transflective, W.T,12:00 | | | | | | | | | | | | | |
| G→Reflective, W. T, 6:00 | C→Transmissive, N.T,6:00 | | | | | | | | | | | | | |
| J→Reflective, W. T, 12:00 | F→Transmissive, N.T,12:00 | | | | | | | | | | | | | |
| B→Transflective, N.T,6:00 | I→Transmissive,W. T, 6:00 | | | | | | | | | | | | | |
| E→Transflective, N.T.12:00 | L→Transmissive, W.T,12:00 | | | | | | | | | | | | | |
| ⑧ | Special Code | T: Built in Negative Voltage & Temperature compensation | | | | | | | | | | | | |



2. Precautions in use of LCD Modules

- (1) Avoid applying excessive shocks to the module or making any alterations or modifications to it.
- (2) Don't make extra holes on the printed circuit board, modify its shape or change the components of LCD module.
- (3) Don't disassemble the LCM.
- (4) Don't operate it above the absolute maximum rating.
- (5) Don't drop, bend or twist LCM.
- (6) Soldering: only to the I/O terminals.
- (7) Storage: please storage in anti-static electricity container and clean environment.

3. General Specification

| Item | Dimension | Unit |
|----------------------|-----------------------------------|-------------|
| Number of Characters | 240 x 128 | — |
| Module dimension | 152.0 x 104.0 x 14.3(MAX) | mm |
| View area | 114.0 x 64.0 | mm |
| Active area | 107.98 x 57.58 | mm |
| Dot size | 0.43 x 0.43 | mm |
| Dot pitch | 0.45 x 0.45 | mm |
| LCD type | STN, Negative, Transmissive, Blue | |
| Duty | 1/128 | |
| View direction | 6 o'clock | |
| Backlight Type | CCFL B/L | |



4. Absolute Maximum Ratings

| Item | Symbol | Min | Typ | Max | Unit |
|--------------------------|-----------------|----------|-----|----------|------|
| Operating Temperature | T_{OP} | -20 | — | +70 | °C |
| Storage Temperature | T_{ST} | -30 | — | +80 | °C |
| Input Voltage | V_I | V_{SS} | — | V_{DD} | V |
| Supply Voltage For Logic | $V_{DD}-V_{SS}$ | -0.3 | — | +7 | V |
| Supply Voltage For LCD | $V_{DD}-V_0$ | 0 | — | 23 | V |
| Negative Voltage Output | V_{EE} | — | 15 | — | V |

5. Electrical Characteristics

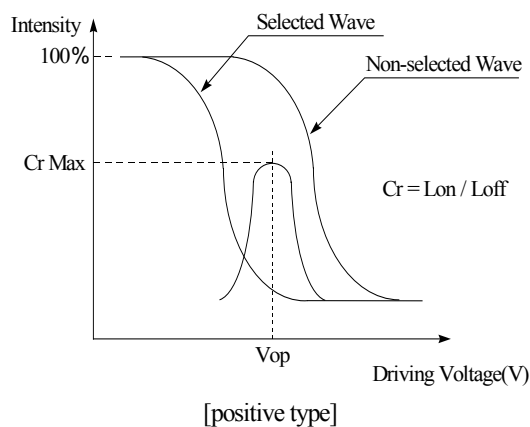
| Item | Symbol | Condition | Min | Typ | Max | Unit |
|--------------------------|-----------------|---------------------------|------|------|----------|------|
| Supply Voltage For Logic | $V_{DD}-V_{SS}$ | — | 4.75 | — | 5.25 | V |
| Supply Voltage For LCD | $V_{DD}-V_0$ | $T_a=-20^{\circ}\text{C}$ | — | — | 20.2 | V |
| | | $T_a=25^{\circ}\text{C}$ | — | 18.2 | — | V |
| | | $T_a=+70^{\circ}\text{C}$ | 16.2 | — | — | V |
| Input High Volt. | V_{IH} | — | 2.2 | — | V_{DD} | V |
| Input Low Volt. | V_{IL} | — | 0 | — | 0.8 | V |
| Output High Volt. | V_{OH} | — | 2.4 | — | V_{DD} | V |
| Output Low Volt. | V_{OL} | — | 0 | — | 0.4 | V |
| Supply Current | I_{DD} | $V_{DD}=5\text{V}$ | — | 15 | — | mA |



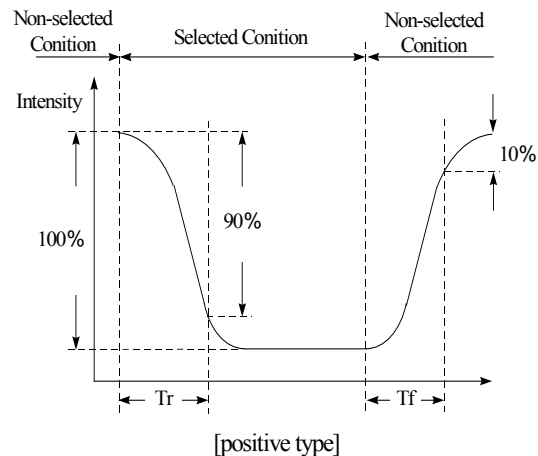
6. Optical Characteristics

| Item | Symbol | Condition | Min | Typ | Max | Unit |
|----------------|---------------|-------------|-----|-----|-----|------|
| View Angle | (V) θ | $CR \geq 2$ | 10 | — | 105 | deg |
| | (H) φ | $CR \geq 2$ | -30 | — | 30 | deg |
| Contrast Ratio | CR | — | — | 3 | — | — |
| Response Time | T rise | — | — | 200 | 300 | ms |
| | T fall | — | — | 200 | 300 | ms |

Definition of Operation Voltage (Vop)



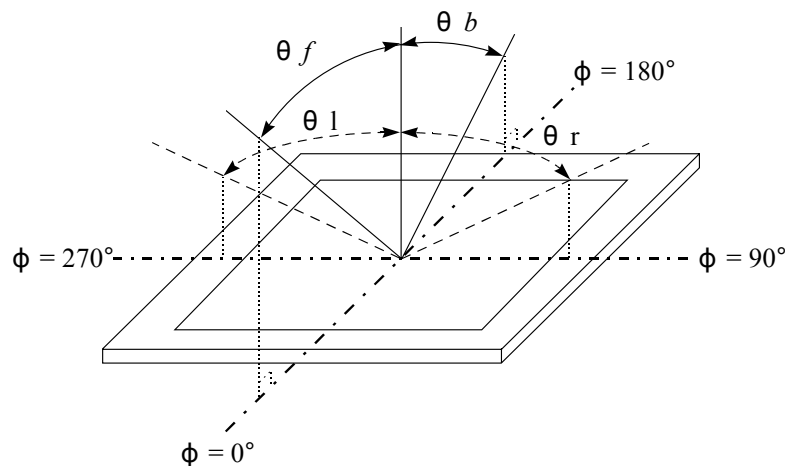
Definition of Response Time (Tr, Tf)



Conditions :

Operating Voltage : Vop Viewing Angle(θ , φ) : 0° , 0°
 Frame Frequency : 64 HZ Driving Waveform : 1/N duty, 1/a bias

Definition of viewing angle($CR \geq 2$)



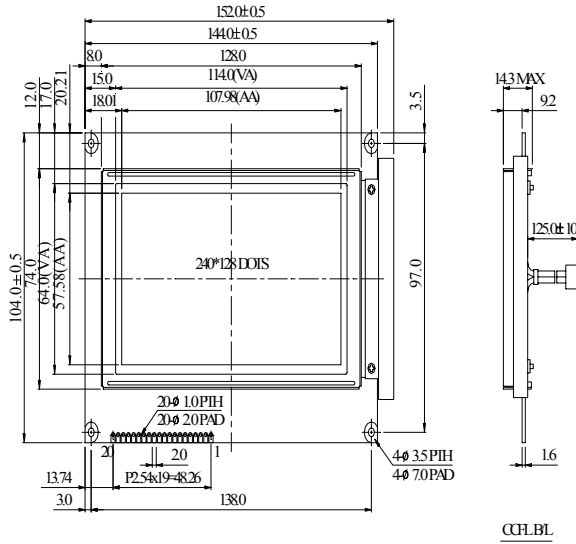


7. Interface Description

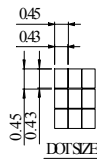
| Pin No. | Symbol | Level | Description |
|---------|-----------------|-------|--------------------------------|
| 1 | V _{SS} | | Ground |
| 2 | V _{DD} | | Power supply for logic circuit |
| 3 | V _O | | Power supply for LCD |
| 4 | RS | H / L | H : Instruction , L : Data |
| 5 | R / W | H / L | H : read , L : write |
| 6 | E | H / L | Enable |
| 7 | DB0 | H / L | Data bus line |
| 8 | DB1 | H / L | Data bus line |
| 9 | DB2 | H / L | Data bus line |
| 10 | DB3 | H / L | Data bus line |
| 11 | DB4 | H / L | Data bus line |
| 12 | DB5 | H / L | Data bus line |
| 13 | DB6 | H / L | Data bus line |
| 14 | DB7 | H / L | Data bus line |
| 15 | CS | L | Chip enable active “ L “ |
| 16 | RESET | L | Reset active “ L “ |
| 17 | V _{ee} | | Negative voltage output |
| 18 | NC | | |
| 19 | A | | NC |
| 20 | K | | NC |



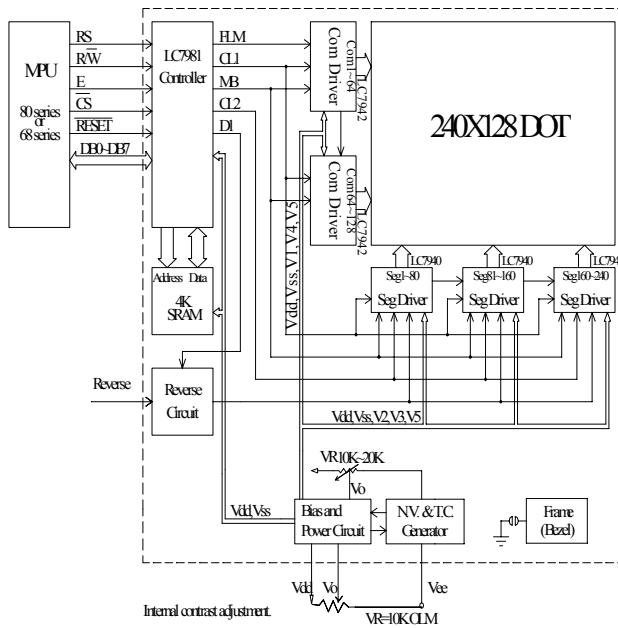
8. Contour Drawing & Block Diagram



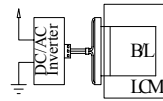
| PIN NO. | SYMBOL |
|---------|-----------------|
| 1 | V _{SS} |
| 2 | V _{H1} |
| 3 | V ₀ |
| 4 | RS |
| 5 | RW |
| 6 | E |
| 7 | DB0 |
| 8 | DB1 |
| 9 | DB2 |
| 10 | DB3 |
| 11 | DB4 |
| 12 | DB5 |
| 13 | DB6 |
| 14 | DB7 |
| 15 | CS |
| 16 | RESET |
| 17 | V _{EE} |
| 18 | NC |
| 19 | A |
| 20 | K |



The non-specified tolerance of dimension is ±0.3mm



CFLBL drive directly from connector.



Internal contrast adjustment

VR=10KΩM



9. Display control instruction

The LCM has built-in a LC7981 LSI Controller, it stores display data sent from the 8 bit microcomputer in the display RAM attached externally and generates dot matrix LC drive signal. The LC7981 has two modes-the graphic mode, in which each bit of data from the external RAM either lights or doesn't light a dot in the LCD, and the character mode in which character codes stored in the external RAM generate dot patterns through the built-in character-generator ROM (CGROM)

below is its block diagram

Description of each block

• Register

The LC7981 has 5 types of registers-the instruction register, data input register, data output register, dot register, and mode control register.

The instruction register stores such instruction codes as the start address, cursor address specification, etc. It consists of 4 bits, and the lower 4 bits of the data bus, DB0 to DB3, are written into it.

The data input register temporarily stores data to be written into the external RAM, dot register, and mode control register. It consists of 8 bits.

The data output register temporarily stores data to be read from external RAM, and consists of 8 bits. What the cursor address is written into the cursor address counter via the data input register and the memory read instruction is set in the instruction register, data in external RAM is read into the data output register by internal operation. With the next instruction, the MPU reads the data output register, and completes data transfer to the MPU.

The dot register stores dot information such as the character pitch, the number of vertical dots, etc. Data sent from the MPU is written into the dot register via the data input register.

The mode control register stores LCD status information such as display on/off and cursor on/off/blink. It consists of 6 bits. Data sent from the MPU is written into this register via the data input register.

• Busy flag

When the Busy flag is "1", the LC7981 is operating internally. At this time, the next instruction cannot be accepted. The Busy flag is output to DB7 when RS=1, RW=1. The next instruction must be written after ensuring that the Busy flag is "0". When the maximum value of the read cycle time or write cycle time has been passed after the execution of the preceding data read instruction or data write instruction, the next instruction can be executed without checking the Busy flag.

• Character generator ROM

The character generator ROM has a total of 7360 bits and stores data on 192 kinds of characters. Character codes from the external RAM and row codes from the row address counter are added to address signals, and ROM outputs 5-bit dot data.

There are 192 kinds of character fonts, of which 160 are 5×7 and 32 are 5×11. With extended ROM, character fonts can be increased to 256 kinds sized 8×16.



- **Cursor address counter**

The cursor address counter is a 16-bit counter which can be preset by instruction.. When data is read from or written into external RAM (i. e., read/write of display dot data or character codes), the counter retains the addresses. The value indicated on the cursor address counter is automatically incremented by 1 when instructions to read/write display data and to perform bit set/clear are issued.

- **Cursor signal generator**

In the character mode, the cursor can be displayed by means of instructions. The cursor is generated automatically when the cursor address counter and the row address counter reach the specified value.

- **Display control instruction**

Display is controlled by writing data into the instruction register and 13 data registers. The instruction register and the data register are distinguished by the RS signal. First, write 4-bit data in the instruction register when RS=1, then specify the code of the data register. Next, with RS=0, write 8-bit data in the data register, which executes the specified instruction.

A new instruction cannot be accepted while an old instruction is being executed. As the Busy flag is set under this condition, write an instruction only after reading the Busy flag and making sure that it is 0.

However, the next instruction can be executed without checking the Busy flag when the maximum read cycle time or the write cycle time has been exceeded after execution of the previous data read instruction or the data write instruction. The Busy flag does not change when data is written into the instruction register (RS=1). Therefore, the Busy flag need not be checked immediately after writing data into the instruction register.

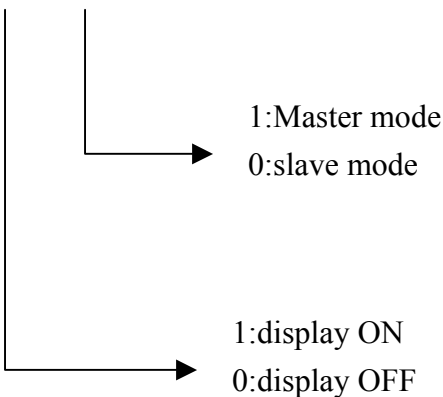


1) Mode control

Write code "00H" (in hexadecimal notation) in the instruction register and specify the mode control register.

| Register | R/W | RS | DB7 | DB6 | DB5 | DB4 | DB3 | DB2 | DB1 | DB0 |
|-------------------|-----|----|-----|-----|-----------|-----|-----|-----|-----|-----|
| Instruction Reg. | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Mode control Reg. | 0 | 0 | 0 | 0 | MODE Data | | | | | |

| DB5 | DB4 | DB3 | DB2 | DB1 | DB0 | Cursor/blink | CG | Graphic/character display | | | | |
|-----|-----|-----|-----|-----|-----|-------------------------------|-------------|---------------------------|---|-----------------------|------------------------|--------------|
| 1/0 | 1/0 | 0 | 0 | 0 | 0 | Cursor OFF | Built-in CG | Character display | | | | |
| | | 0 | 1 | | | Cursor ON | | | | | | |
| | | 1 | 0 | | | Cursor OFF character blink | | | | | | |
| | | 1 | 1 | | | Cursor blink | | | | | | |
| | | 0 | 0 | | 1 | Cursor OFF | External CG | | | | | |
| | | 0 | 1 | | | Cursor ON | | | | | | |
| | | 1 | 0 | | | Cursor OFF character blink | | | | | | |
| | | 1 | 1 | | | Cursor blink | | | | | | |
| | | 0 | 0 | | | 1 | | | 0 | Cursor OFF | External CG | Graphic mode |
| | | 0 | 0 | | | 1 | | | 0 | Cursor ON | External CG | |





2)Setting the character pitch

| Register | R/W | RS | DB7 | DB6 | DB5 | DB4 | DB3 | DB2 | DB1 | DB0 |
|----------------------|-----|----|---------------|-----|-----|-----|-----|---------------|-----|-----|
| Instruction Reg. | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Character pitch Reg. | 0 | 0 | (Vp-1) Binary | | | | 0 | (Hp-1) Binary | | |

Vp is the number of vertical dots per character. Determine Vp with the pitch between two vertically placed characters taken into consideration. This value is meaningful only in the character display mode: It is invalid in the graphic mode.

In character mode. Hp indicates the number of horizontal dots per character, from the leftmost part of one character to the leftmost part of the next. In the graphic mode, Hp indicates how many bits (or dots) from RAM appear in a 1-byte display.

Hp must take one of the following three values.

| Hp | DB2 | DB1 | DB0 | |
|----|-----|-----|-----|------------------------------|
| 6 | 1 | 0 | 1 | Horizontal character pitch 6 |
| 7 | 1 | 1 | 0 | Horizontal character pitch 7 |
| 8 | 1 | 1 | 1 | Horizontal character pitch 8 |

3)Setting the number of characters

| Register | R/W | RS | DB7 | DB6 | DB5 | DB4 | DB3 | DB2 | DB1 | DB0 |
|-----------------------|-----|----|----------------------------|-----|-----|-----|-----|-----|-----|-----|
| Instruction Reg. | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| Character number Reg. | 0 | 0 | (H _N -1) Binary | | | | | | | |

in the character display mode, H_N indicates the number of characters in the horizontal direction. In the graphic mode, it indicates the number of bytes in the horizontal direction. The total number of dots positioned horizontally on the screen n is given by the formula

$$n = H_p \times H_N$$

Even numbers in the range 2 to 256 (decimal) can be set as H_N.



4)Setting the time division number (display duty)

| Register | R/W | RS | DB7 | DB6 | DB5 | DB4 | DB3 | DB2 | DB1 | DB0 |
|--------------------|-----|----|---------------|-----|-----|-----|-----|-----|-----|-----|
| Instruction Reg. | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| Time division Reg. | 0 | 0 | (Nx-1) Binary | | | | | | | |

Consequently, $1/N_x$ is the display duty.

Decimal numbers with the range 1 to 256 can be set as N_x . please set $N_x=64$

5)Setting the cursor position

| Register | R/W | RS | DB7 | DB6 | DB5 | DB4 | DB3 | DB2 | DB1 | DB0 |
|----------------------|-----|----|-----|-----|-----|-----|---------------|-----|-----|-----|
| Instruction Reg. | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| Cursor position Reg. | 0 | 0 | 0 | 0 | 0 | 0 | (Cp-1) Binary | | | |

In the character display mode, C_p indicates the line at which the cursor is displayed. For example, when $C_p=8$ (decimal) is specified, the cursor is displayed beneath the character of the 5x7 dot-font. The horizontal length of the cursor equals H_p (the horizontal character pitch). Decimal values in the range 1 to 16 can be assigned to C_p . When the value is less than the vertical character pitch V_p ($C_p \leq V_p$), display priority is given to the cursor (provided the cursor display is ON). The cursor is not displayed when $C_p > V_p$. The horizontal length of the cursor equals H_p .

6)Setting the display start lower address

| Register | R/W | RS | DB7 | DB6 | DB5 | DB4 | DB3 | DB2 | DB1 | DB0 |
|---|-----|----|-----------------------------------|-----|-----|-----|-----|-----|-----|-----|
| Instruction Reg. | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| Display start address Reg. (lower byte) | 0 | 0 | (start address lower byte) binary | | | | | | | |

7)Setting the display start upper address

| Register | R/W | RS | DB7 | DB6 | DB5 | DB4 | DB3 | DB2 | DB1 | DB0 |
|---|-----|----|-----------------------------------|-----|-----|-----|-----|-----|-----|-----|
| Instruction Reg. | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| Display start address Reg. (upper byte) | 0 | 0 | (start address upper byte) binary | | | | | | | |



This instruction writes the display start value in the display start address register. The display start address in the RAM address at which data to be displayed at the leftmost position of the top line of the screen is stored. The start address consists of 16 bits (upper and lower).

8) Setting the cursor (lower) address (RAM read/write lower address)

| Register | R/W | RS | DB7 | DB6 | DB5 | DB4 | DB3 | DB2 | DB1 | DB0 |
|-------------------------------------|-----|----|------------------------------------|-----|-----|-----|-----|-----|-----|-----|
| Instruction Reg. | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| Cursor address counter (lower byte) | 0 | 0 | (cursor address lower byte) binary | | | | | | | |

9) Setting the cursor (upper) address (RAM read/write upper address)

| Register | R/W | RS | DB7 | DB6 | DB5 | DB4 | DB3 | DB2 | DB1 | DB0 |
|-------------------------------------|-----|----|------------------------------------|-----|-----|-----|-----|-----|-----|-----|
| Instruction Reg. | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 |
| Cursor address counter (upper byte) | 0 | 0 | (cursor address upper byte) binary | | | | | | | |

This instruction writes the cursor address value in the cursor address counter. The cursor address indicates the address for exchanging display data and character codes with RAM. In other words, data at the address specified by the cursor address is read from or written into RAM. In character display, the cursor is displayed at the position specified by the cursor address.

The cursor address is divided into a lower address (8 bits) and an upper address (8 bits). It should be set in accordance with the following rules.

| | | |
|---|--|--|
| 1 | To rewrite (set) both lower and upper addresses. | First set the lower address, then the upper. |
| 2 | To rewrite the lower address: | Always reset the upper address after setting the lower address. |
| 3 | To rewrite the upper address only: | Set the upper address. It is necessary to reset the lower address. |

The cursor address counter is a 16-bit up-counter with set/reset functions: when the Nth bit goes from 1 to 0, the count of the (N+1)th bit increments by one. Accordingly, when the lower address is set so that the lower MSB (8th bit) changes from 1 to 0, the LSB (1st bit) of the upper counter must increment by one. When setting the cursor address, set the lower and upper addresses as a 2-byte continuous instruction.



10) Writing display data

| Register | R/W | RS | DB7 | DB6 | DB5 | DB4 | DB3 | DB2 | DB1 | DB0 |
|------------------|-----|----|------------------------------------|-----|-----|-----|-----|-----|-----|-----|
| Instruction Reg. | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |
| RAM | 0 | 0 | MSB (pattern data, character code) | | | | | | LSB | |

Write code “0CH” in the instruction register. Then, write 8-bit data with RS=0, and the data is written into RAM as display data or character codes at the address specified by the cursor address counter. After writing, the count of the cursor address counter increments by 1.

11) Reading display data

| Register | R/W | RS | DB7 | DB6 | DB5 | DB4 | DB3 | DB2 | DB1 | DB0 |
|------------------|-----|----|------------------------------------|-----|-----|-----|-----|-----|-----|-----|
| Instruction Reg. | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 |
| RAM | 1 | 0 | MSB (pattern data, character code) | | | | | | LSB | |

Write “0DH” in the instruction register. Then, establish the read status with RS=0, and data in the RAM can be read. The procedure for reading data is as follows.

This instruction outputs the contents of the data output register to DB0 to 7, then transfers the RAM data indicated by the cursor address to the data output register. It then increments the cursor address by 1, which means that correct data cannot be read in the first read operation. The specified value is output in the second read operation. Accordingly, a dummy read operation must be performed once when reading data after setting the cursor address.

12) Bit clear

| Register | R/W | RS | DB7 | DB6 | DB5 | DB4 | DB3 | DB2 | DB1 | DB0 |
|------------------|-----|----|-----|-----|-----|-----|-----|----------------------------|-----|-----|
| Instruction Reg. | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 |
| Bit clear | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (N _B -1) Binary | | |



13)Bit set

| Register | R/W | RS | DB7 | DB6 | DB5 | DB4 | DB3 | DB2 | DB1 | DB0 |
|-----------------|-----|----|-----|-----|-----|-----|-----|----------------------------|-----|-----|
| Instruction Reg | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |
| Bit set | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (N _B -1) Binary | | |

As the bit-clear or bit-set instruction, 1 bit of a 1 byte of data in display RAM is set to 0 or 1. The bit specified by N_B is set to 0 for the bit-clear instruction and 1 for the bit-set instruction. The RAM address is specified by the cursor address, which is automatically incremented by 1 at the completion of the instruction. N_B is a value in the range from 1 to 8. The LSB is indicated by N_B=1, and the MSB by N_B=8.

14)Reading the BUSY flag

| Register | R/W | RS | DB7 | DB6 | DB5 | DB4 | DB3 | DB2 | DB1 | DB0 |
|-----------|-----|----|-----|-----|-----|-----|-----|-----|-----|-----|
| busy flag | 1 | 1 | 1/0 | * | | | | | | |

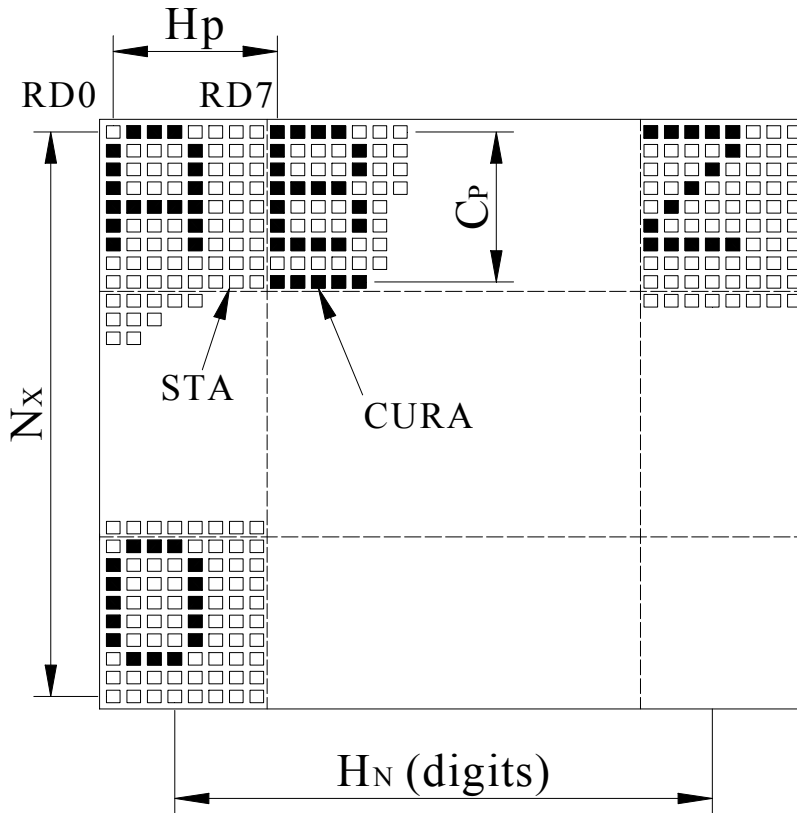
The Busy flag is output to DB7 when read mode is established with RS=1. The Busy flag is set to 1 while any of the instructions 1) through 13) is being executed. It is set to 0 at the completion of the execution, allowing the next instruction to be accepted. No other instruction can be accepted when the Busy flag is 1. Accordingly, before writing an instruction and data, it is necessary to ensure that the Busy flag is 0. However, the next instruction can be executed without checking the Busy flag when the maximum read cycle time or the write cycle time has been exceeded after execution of the previous data read instruction or the data write instruction.

The Busy flag does not change when data is written into the instruction register (RS=1). Therefore, the Busy flag need not be checked immediately after writing data into the instruction register.

Specification of the instruction register is unnecessary to read the Busy flag.



The relation between the LCD panel display and H_p , H_N , C_p , V_p , and N_x



$$C_p \leq V_p$$

| Symbol | Description | Contents | Value |
|--------|--|---|-----------------------------------|
| H_p | Horizontal character pitch | Character pitch in the horizontal direction | 6 to 8 dots |
| H_N | Number of characters in the horizontal direction | Number of characters (digits) per horizontal line or the number of words per line (graphic) | Even digits in the range 2 to 256 |
| V_p | Vertical character pitch | character pitch in the vertical direction | 1 to 16 dots |
| C_p | Cursor position | The line number at which the cursor is to be displayed | 1 to 16 lines |
| N_x | Number of lines in the vertical direction | Display duty | 1 to 256 lines |

Note)

When the number of vertical dots on the screen is m and that of horizontal dots is n ,

$$1/m = 1/N_x = \text{display duty (nx=64)}$$

$$n = H_p \times H_N$$

$$m/V_p = \text{number of display lines, } C_p \leq V_p$$



Display mode

| Display mode | Display data from the MPU | RAM | LCD Panel |
|-------------------|-------------------------------|-----|-----------|
| Character display | Display pattern (8 Bits) | | |
| Graphic | Character code (8 Bits) | | |



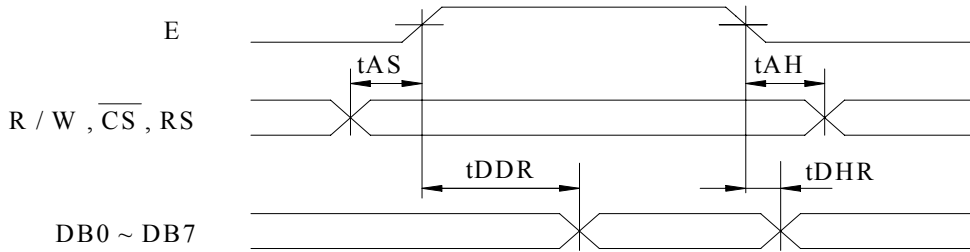
Built-in Character generator

| Upper 4 bit Lower 4 bit | LLLL | LLLH | LLHL | LLHH | LHLL | LHLH | LHHL | LHHH | HLLL | HLLH | HLHL | HLHH | HHLL | HHLH | HHHL | HHHH |
|----------------------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| LLLL | | | | 0 | 1 | 2 | 3 | 4 | | | | 5 | 6 | 7 | 8 | 9 |
| LLLH | | . | ! | 0 | 1 | 2 | 3 | 4 | | | | 5 | 6 | 7 | 8 | 9 |
| LLHL | | | " | 2 | 3 | 4 | 5 | 6 | | | 7 | 8 | 9 | 0 | 1 | 2 |
| LLHH | | | # | 3 | 4 | 5 | 6 | 7 | | | 8 | 9 | 0 | 1 | 2 | 3 |
| LHLL | | | \$ | 4 | 5 | 6 | 7 | 8 | | | 9 | 0 | 1 | 2 | 3 | 4 |
| LHLH | | | % | 5 | 6 | 7 | 8 | 9 | | | 0 | 1 | 2 | 3 | 4 | 5 |
| LHHL | | | & | 6 | 7 | 8 | 9 | 0 | | | 1 | 2 | 3 | 4 | 5 | 6 |
| LHHH | | | ' | 7 | 8 | 9 | 0 | 1 | | | 2 | 3 | 4 | 5 | 6 | 7 |
| HLLL | | | (| 8 | 9 | 0 | 1 | 2 | | | 3 | 4 | 5 | 6 | 7 | 8 |
| HLLH | | |) | 9 | 0 | 1 | 2 | 3 | | | 4 | 5 | 6 | 7 | 8 | 9 |
| HLHL | | | * | 0 | 1 | 2 | 3 | 4 | | | 5 | 6 | 7 | 8 | 9 | 0 |
| HLHH | | | + | 1 | 2 | 3 | 4 | 5 | | | 6 | 7 | 8 | 9 | 0 | 1 |
| HHLL | | | , | 2 | 3 | 4 | 5 | 6 | | | 7 | 8 | 9 | 0 | 1 | 2 |
| HHLH | | | - | 3 | 4 | 5 | 6 | 7 | | | 8 | 9 | 0 | 1 | 2 | 3 |
| HHHL | | | . | 4 | 5 | 6 | 7 | 8 | | | 9 | 0 | 1 | 2 | 3 | 4 |
| HHHH | | | / | 5 | 6 | 7 | 8 | 9 | | | 0 | 1 | 2 | 3 | 4 | 5 |

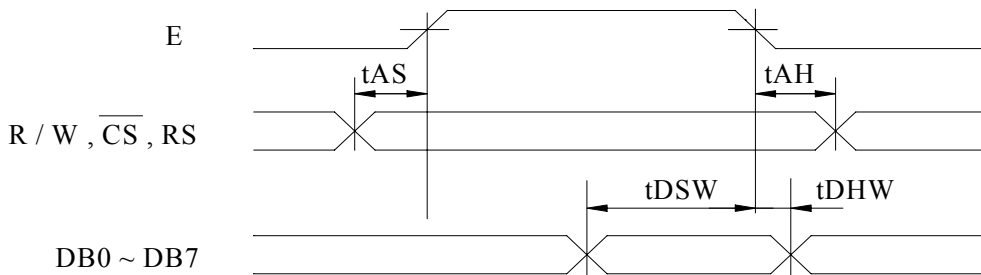


10. Timing Characteristics

Read cycle



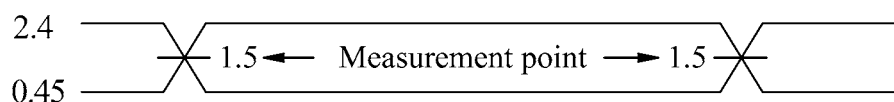
Write cycle



($V_{SS} = 0\text{ V}$, $V_{DD} = 5\text{ V}$)

| Item | Symbol | Min | Typ | Max | Unit |
|----------------------------|--------|-----|-----|-----|------|
| Address set-up time | tAS | 90 | — | — | ns |
| Address hold time | tAH | 10 | — | — | ns |
| Data delay time (read) | tDDR | — | — | 140 | ns |
| Data hold time (read) | tDHR | 10 | — | — | ns |
| Data set-up time (write) | tDSW | 220 | — | — | ns |
| Data hold time (write) | tDHW | 20 | — | — | ns |

Note : Definition of the test waveform



The input terminals are driven at 2.4V and 0.45V. Timming is measured at 1.5V.



11. Quality Assurance

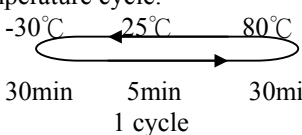
Screen Cosmetic Criteria

| Item | Defect | Judgment Criterion | Partition | | | | | | | | | | | | | | | | | | | | |
|--------------------|--------------------------------------|--|-------------------|--------------------------------------|--------------|-----------|--------------------|---|--------------------|---|-----------|---|-------------------|--------------------------------------|--------------|-----------|--------------------|---|--------------------|---|-----------|---|-------|
| 1 | Spots | <p>A)Clear</p> <table border="0"> <tr> <td><u>Size: d mm</u></td> <td><u>Acceptable Qty in active area</u></td> </tr> <tr> <td>$d \leq 0.1$</td> <td>Disregard</td> </tr> <tr> <td>$0.1 < d \leq 0.2$</td> <td>6</td> </tr> <tr> <td>$0.2 < d \leq 0.3$</td> <td>2</td> </tr> <tr> <td>$0.3 < d$</td> <td>0</td> </tr> </table> <p>Note: Including pin holes and defective dots which must be within one pixel size.</p> <p>B)Unclear</p> <table border="0"> <tr> <td><u>Size: d mm</u></td> <td><u>Acceptable Qty in active area</u></td> </tr> <tr> <td>$d \leq 0.2$</td> <td>Disregard</td> </tr> <tr> <td>$0.2 < d \leq 0.5$</td> <td>6</td> </tr> <tr> <td>$0.5 < d \leq 0.7$</td> <td>2</td> </tr> <tr> <td>$0.7 < d$</td> <td>0</td> </tr> </table> | <u>Size: d mm</u> | <u>Acceptable Qty in active area</u> | $d \leq 0.1$ | Disregard | $0.1 < d \leq 0.2$ | 6 | $0.2 < d \leq 0.3$ | 2 | $0.3 < d$ | 0 | <u>Size: d mm</u> | <u>Acceptable Qty in active area</u> | $d \leq 0.2$ | Disregard | $0.2 < d \leq 0.5$ | 6 | $0.5 < d \leq 0.7$ | 2 | $0.7 < d$ | 0 | Minor |
| <u>Size: d mm</u> | <u>Acceptable Qty in active area</u> | | | | | | | | | | | | | | | | | | | | | | |
| $d \leq 0.1$ | Disregard | | | | | | | | | | | | | | | | | | | | | | |
| $0.1 < d \leq 0.2$ | 6 | | | | | | | | | | | | | | | | | | | | | | |
| $0.2 < d \leq 0.3$ | 2 | | | | | | | | | | | | | | | | | | | | | | |
| $0.3 < d$ | 0 | | | | | | | | | | | | | | | | | | | | | | |
| <u>Size: d mm</u> | <u>Acceptable Qty in active area</u> | | | | | | | | | | | | | | | | | | | | | | |
| $d \leq 0.2$ | Disregard | | | | | | | | | | | | | | | | | | | | | | |
| $0.2 < d \leq 0.5$ | 6 | | | | | | | | | | | | | | | | | | | | | | |
| $0.5 < d \leq 0.7$ | 2 | | | | | | | | | | | | | | | | | | | | | | |
| $0.7 < d$ | 0 | | | | | | | | | | | | | | | | | | | | | | |
| 2 | Bubbles in Polarize | <table border="0"> <tr> <td><u>Size: d mm</u></td> <td><u>Acceptable Qty in active area</u></td> </tr> <tr> <td>$d \leq 0.3$</td> <td>Disregard</td> </tr> <tr> <td>$0.3 < d \leq 1.0$</td> <td>3</td> </tr> <tr> <td>$1.0 < d \leq 1.5$</td> <td>1</td> </tr> <tr> <td>$1.5 < d$</td> <td>0</td> </tr> </table> | <u>Size: d mm</u> | <u>Acceptable Qty in active area</u> | $d \leq 0.3$ | Disregard | $0.3 < d \leq 1.0$ | 3 | $1.0 < d \leq 1.5$ | 1 | $1.5 < d$ | 0 | Minor | | | | | | | | | | |
| <u>Size: d mm</u> | <u>Acceptable Qty in active area</u> | | | | | | | | | | | | | | | | | | | | | | |
| $d \leq 0.3$ | Disregard | | | | | | | | | | | | | | | | | | | | | | |
| $0.3 < d \leq 1.0$ | 3 | | | | | | | | | | | | | | | | | | | | | | |
| $1.0 < d \leq 1.5$ | 1 | | | | | | | | | | | | | | | | | | | | | | |
| $1.5 < d$ | 0 | | | | | | | | | | | | | | | | | | | | | | |
| 3 | Scratch | In accordance with spots cosmetic criteria. When the light reflects on the panel surface, the scratches are not to be remarkable. | Minor | | | | | | | | | | | | | | | | | | | | |
| 4 | Allowable Density | Above defects should be separated more than 30mm each other. | Minor | | | | | | | | | | | | | | | | | | | | |
| 5 | Coloration | Not to be noticeable coloration in the viewing area of the LCD panels. Back-light type should be judged with back-light on state only. | Minor | | | | | | | | | | | | | | | | | | | | |



12. Reliability

Content of Reliability Test

| Environmental Test | | | |
|--------------------------------------|--|---|---------------------|
| Test Item | Content of Test | Test Condition | Applicable Standard |
| High Temperature storage | Endurance test applying the high storage temperature for a long time. | 80°C 200hrs | — |
| Low Temperature storage | Endurance test applying the high storage temperature for a long time. | -30°C 200hrs | — |
| High Temperature Operation | Endurance test applying the electric stress (Voltage & Current) and the thermal stress to the element for a long time. | 70°C 200hrs | — |
| Low Temperature Operation | Endurance test applying the electric stress under low temperature for a long time. | -20°C 200hrs | — |
| High Temperature/ Humidity Storage | Endurance test applying the high temperature and high humidity storage for a long time. | 80°C,90%RH 96hrs | — |
| High Temperature/ Humidity Operation | Endurance test applying the electric stress (Voltage & Current) and temperature / humidity stress to the element for a long time. | 70°C,90%RH 96hrs | — |
| Temperature Cycle | Endurance test applying the low and high temperature cycle.  -30°C 25°C 80°C 30min 5min 30min 1 cycle | -30°C/80°C 10 cycles | — |
| Mechanical Test | | | |
| Vibration test | Endurance test applying the vibration during transportation and using. | 10~22Hz→1.5mmp-p 22~500Hz→1.5G Total 0.5hrs | — |
| Shock test | Constructional and mechanical endurance test applying the shock during transportation. | 50G Half sign wave 11 msdc 3 times of each direction | — |
| Atmospheric pressure test | Endurance test applying the atmospheric pressure during transportation by air. | 115mbar 40hrs | — |
| Others | | | |
| Static electricity test | Endurance test applying the electric stress to the terminal. | VS=800V,RS=1.5kΩ CS=100pF 1 time | — |

***Supply voltage for logic system=5V. Supply voltage for LCD system =Operating voltage at 25°C



13. Backlight Information

No.2 3 4 5 shall be lighted at constant lamp current (IL : 5.0 mA) and shall be measured 3 minutes after the table below. The measurement shall be conducted on the condition that ambient temperature : 25 ± 2 °C
humidity : 30 ~ 85%, with no wind.

| NO | Items | Requirements | Remarks |
|----|-------------------------------------|---|---------|
| 1 | Lamp Current (IL) | 5.0 ± 0.5 (mArms) | |
| 2 | Lamp Voltage (VL) | 205 ± 20 (Vrms) | |
| 3 | Lamp Power (P) (Reference Value) | 1.03 (Wrms) | VL * IL |
| 4 | Luminance | 250 min (cd/m) | Note 1 |
| 5 | Chromaticity (X) (Y) | 0.308 ± 0.01 0.330 ± 0.01 | Note 2 |
| 6 | Starting Voltage (VS) | 400 MAX (25°C) (Vrms) 600 MAX (0°C) (Vrms) | Note 3 |
| 7 | Life time | 10000 min (h) | Note 4 |

Note 1. The average value is measured though the glass.

Note 2. The tube center / center point shall be measured.

Note 3. All the tubes shall be lighted. Slide in method shall be used for voltage application.

Note 4. Life

Judgment conditions.

- A The luminance becomes 50% of the initial luminance.
- B Not normal lighting.
- C When a severe appearance failure is found.