

**SANYO**

No.2674A

**DM2021**

20 Characters × 2 Lines

Liquid Crystal  
Dot Matrix Display Module**Overview**

The DM2021 is a liquid crystal dot matrix display module that consists of LCD panel LCD-5121, LCD control driver LC7985NA, and driver SED1181 and is capable of providing 20 characters × 2 lines display. It contains a controller, a data RAM, and a character generator ROM required for providing display. Data interfacing is in 4-bit parallel or 8-bit parallel and data can be written in or read from a microprocessor.

**General Specifications**

|                                |  |
|--------------------------------|--|
| 1. Display method              | 1/5 bias 1/16 duty   |
| 2. Display content             | 20 characters × 2 lines  |
| 3. Dots organizing 1 character | 5 × 8 dots   |
| 4. Display data RAM            | 80 × 8 bits  |
| 5. Character generator ROM     | 160-character JIS font set + 32-character<br>Refer to Table 1. |
| 6. Character generator RAM     | 64 × 8 bits 5 × 7 dots 8 characters                            |
| 7. Instruction function        | Refer to Table 2.  |
| 8. Circuit diagram             | Refer to Fig. 3.   |

**Outline**

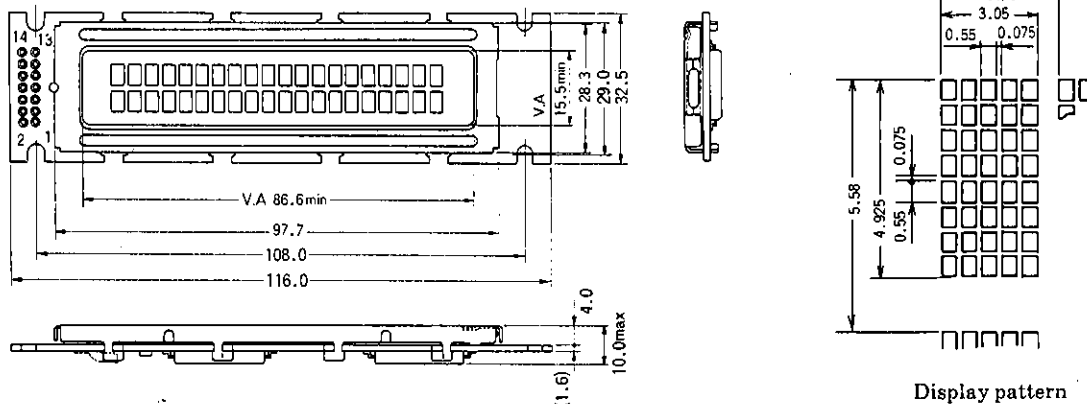
|                                |  |
|--------------------------------|--|
| 1. Module outline              | 116.0 (L) × 32.5 (W) × 10 (T) [mm <sup>3</sup> ] |
| 2. View area                   | 86.0 × 15.5 [mm <sup>2</sup> ]                   |
| 3. Dot size                    | 0.55 × 0.55 [mm <sup>2</sup> ]                   |
| 4. Dot pitch                   | 0.625 × 0.625 [mm <sup>2</sup> ]                 |
| 5. Character size (5 × 8 dots) | 3.05 × 4.925 [mm <sup>2</sup> ]                  |

**Absolute Maximum Ratings at Ta = 25°C**

|                        |                   |                        | unit |
|------------------------|-------------------|------------------------|------|
| Maximum Supply Voltage | $V_{DD} - V_{SS}$ | -0.3 to +7             | V    |
| Input Voltage          | $V_I$             | -0.3 to $V_{DD} + 0.3$ | V    |
| LCD Drive Voltage      | $V_{DD} - V_O$    | -0.3 to +13.3          | V    |
| Operating Temperature  | $T_{opr}$         | 0 to +50               | °C   |
| Storage Temperature    | $T_{stg}$         | -20 to +70             | °C   |

**Module Dimensions 5008**

(unit: mm)



Display pattern

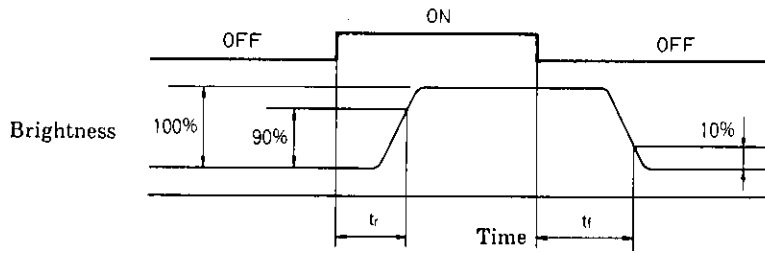
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# DM2021

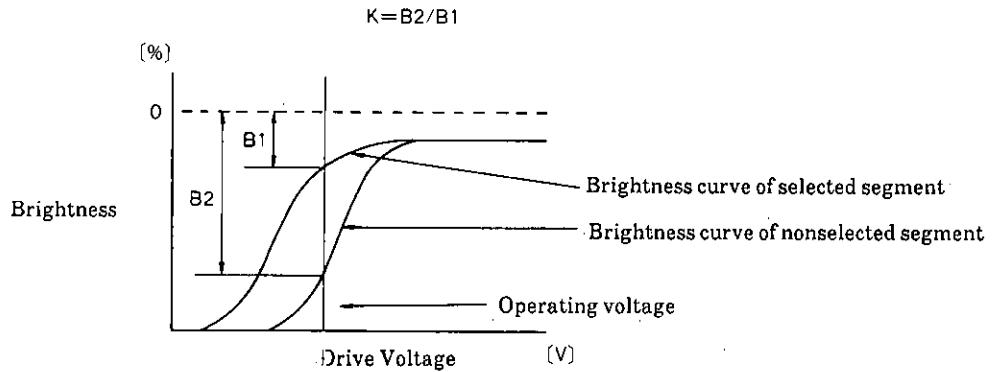
**Electro-optical Characteristics at  $T_a = 25^\circ\text{C}$ ,  $V_{DD} - V_{SS} = 5\text{V}$  unless otherwise specified**

|  |                   |   | min | typ   | max      | unit          |
|--|-------------------|---|-----|-------|----------|---------------|
| Input 'H'-Level Voltage                  | $V_{IH}$          |   | 2.2 |       | $V_{DD}$ | V             |
| Input 'L'-Level Voltage                  | $V_{IL}$          |   | 0   |       | 0.6      | V             |
| Output 'H'-Level Voltage                 | $V_{OH}$          | $DB_0$ to $DB_7$ , $-I_{OH} = 0.2\text{mA}$                           | 2.4 |       | $V_{DD}$ | V             |
| Output 'L'-Level Voltage                 | $V_{OL}$          | $DB_0$ to $DB_7$ , $-I_{OL} = 1.2\text{mA}$                           | 0   |       | 0.4      | V             |
| Pull-up MOS Current                      | $I_P$             | $DB_0$ to $DB_7$ , RS, R/W  | 50  | 125   | 250      | $\mu\text{A}$ |
| Current Dissipation                      | $I_{DD}$          | No input/output current included                                      |     | (1.5) | 3.0      | mA            |
| Oscillation Frequency                    | $F_{OSC}$         |   | 190 | 270   | 350      | kHz           |
| Viewing Angle                            | $\phi_2 - \phi_1$ | $K = 1.4, \theta = 0^\circ$   | 20  | 30    |          | deg.          |
| Contrast Ratio                           | K                 | $\phi = 20^\circ, \theta = 0^\circ$                                   | 3.0 |       |          |               |
| Rise Time                                | $t_r$             | $\phi = 20^\circ, \theta = 0^\circ$                                   |     | 200   | 300      | ms            |
| Fall Time                                | $t_f$             | $\phi = 20^\circ, \theta = 0^\circ$                                   |     | 300   | 450      | ms            |
| LCD Drive Voltage<br>(Recommended Value) | $V_{DD} - V_O$    | $T_a = 0^\circ\text{C}, \phi = 20^\circ, \theta = 0^\circ, K \geq 3$  | 4.4 | 4.5   | 4.6      | V             |
|  |                   | $T_a = 25^\circ\text{C}, \phi = 20^\circ, \theta = 0^\circ, K \geq 3$ | 4.0 | 4.1   | 4.2      | V             |
| 1/16 Duty                                |                   | $T_a = 50^\circ\text{C}, \phi = 20^\circ, \theta = 0^\circ, K \geq 3$ | 3.4 | 3.5   | 3.6      | V             |

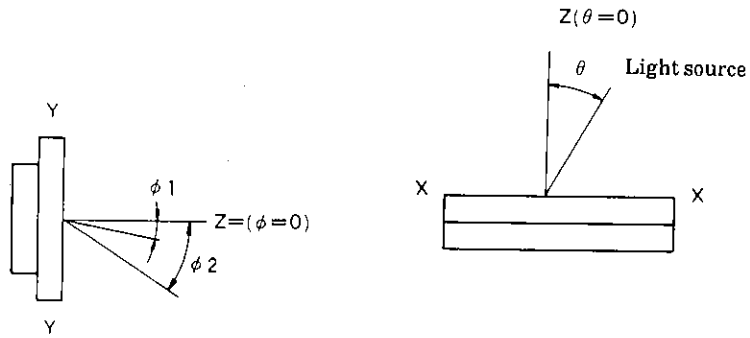
**(1) Test Condition for Response Time ( $t_r, t_f$ )**



**(2) Definition of Contrast Ratio [K]**



## (3) Contrast Ratio Measuring Method



Angles  $\phi$  and  $\theta$  are defined as shown above.

The light source is placed in the  $\theta$  direction at an angle of  $30^\circ$  and the sensor is placed in the  $\phi$  direction to measure the contrast.

## Pin Description

| No. | Pin Name        | Function                                |
|-----|-----------------|---|
| 1   | V <sub>SS</sub> | (-) power supply pin 0V                 |
| 2   | V <sub>DD</sub> | (+) power supply pin +5V                |
| 3   | V <sub>O</sub>  | Pin for applying LCD drive voltage      |
| 4   | RS              | Input pin, HI = Data, LOW = Instruction |
| 5   | R/W             | Input pin, HI = Read, LOW = Write       |
| 6   | E               | Input pin, Enable signal                |
| 7   | DB <sub>0</sub> | } Data bus line                         |
| 8   | DB <sub>1</sub> |   |
| 9   | DB <sub>2</sub> |   |
| 10  | DB <sub>3</sub> |   |
| 11  | DB <sub>4</sub> |   |
| 12  | DB <sub>5</sub> |   |
| 13  | DB <sub>6</sub> |   |
| 14  | DB <sub>7</sub> |   |

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| Timing Characteristics          |                  | min    | typ | max | unit |
|---------------------------------|------------------|--------|-----|-----|------|
| Enable Cycle Time               | $t_{cycE}$       | 1000   |     |     | ns   |
| Enable Pulse Width [High Level] | $P_{WEH}$        | 450    |     |     | ns   |
| Enable Rise/Fall Time           | $t_{Er}, t_{Ef}$ |        |     | 25  | ns   |
| Setup Time [RS/RW-E]            | $t_{As}$         | 140    |     |     | ns   |
| Address Hold Time               | $t_{AH}$         | 10     |     |     | ns   |
| Data Delay Time                 | $t_{DDR}$        |        |     | 320 | ns   |
| Data Setup Time                 | $t_{DSW}$        | 195    |     |     | ns   |
| Data Hold Time                  | $t_H(t_{DHR})$   | 10(20) |     |     | ns   |

## Write Operation

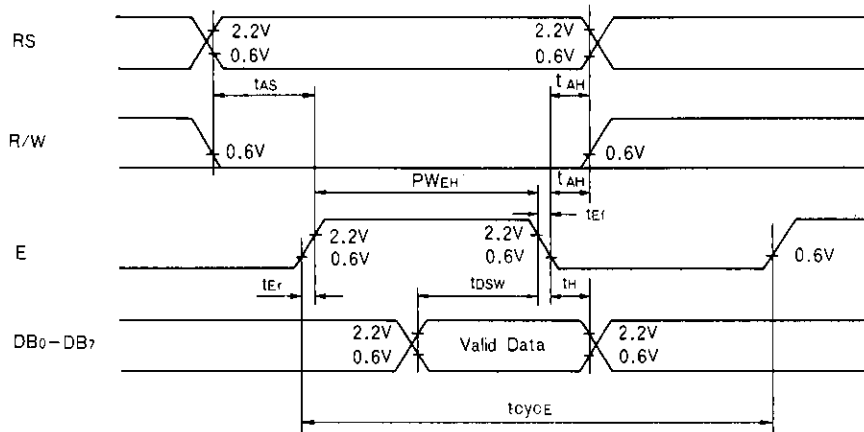


Fig.1 Interface Timing (Data Write)

## Read Operation

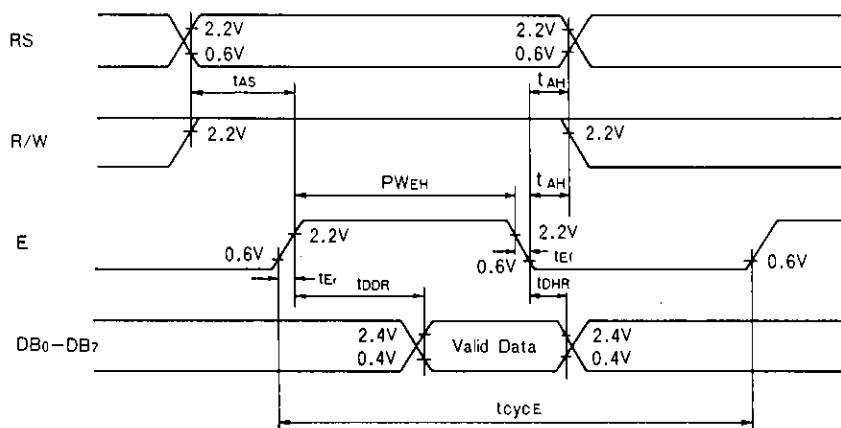


Fig.2 Interface Timing (Data Read)

Table 1 Character Code

| Low-order 4bits \ Hi-order 4 bits | 0000       | 0010 | 0011 | 0100 | 0101 | 0110 | 0111 | 1010 | 1011 | 1100 | 1101 | 1110 | 1111 |
|-----------------------------------|------------|------|------|------|------|------|------|------|------|------|------|------|------|
| xxxx0000                          | CG RAM (1) |      | 0    | a    | P    | `    | P    | -    | 9    | E    | e    | p    |      |
| xxxx0001                          | (2)        | !    | 1    | A    | Q    | a    | q    | a    | 7    | +    | 4    | a    | q    |
| xxxx0010                          | (3)        | "    | 2    | B    | b    | r    | r    | 4    | 9    | x    | p    | e    |      |
| xxxx0011                          | (4)        | #    | 3    | C    | c    | s    | s    | 4    | 7    | e    | e    | e    |      |
| xxxx0100                          | (5)        | \$   | 4    | D    | d    | t    | t    | \    | 1    | 1    | P    | a    |      |
| xxxx0101                          | (6)        | %    | 5    | E    | e    | u    | u    | .    | *    | 1    | e    | o    |      |
| xxxx0110                          | (7)        | &    | 6    | F    | f    | v    | v    | 9    | 1    | a    | p    | z    |      |
| xxxx0111                          | (8)        | '    | 7    | G    | g    | w    | w    | 7    | +    | x    | g    | π    |      |
| xxxx1000                          | (1)        | (    | 8    | H    | h    | x    | x    | 4    | 9    | *    | 1    | π    | π    |
| xxxx1001                          | (2)        | )    | 9    | I    | i    | y    | y    | e    | 7    | 1    | 1    | 1    | 1    |
| xxxx1010                          | (3)        | *    | 0    | J    | j    | z    | z    | x    | 3    | 1    | 1    | 1    | 1    |
| xxxx1011                          | (4)        | +    | 1    | K    | k    | l    | l    | 4    | 9    | 1    | 1    | 1    | 1    |
| xxxx1100                          | (5)        | ,    | <    | L    | l    | 1    | 1    | 1    | 9    | 7    | 7    | 1    | 1    |
| xxxx1101                          | (6)        | -    | =    | M    | m    | 1    | 1    | 1    | z    | 1    | 1    | 1    | 1    |
| xxxx1110                          | (7)        | .    | >    | N    | n    | 1    | 1    | 1    | a    | 1    | 1    | 1    | 1    |
| xxxx1111                          | (8)        | /    | ?    | O    | o    | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1    |

(Note) The CG RAM is a character generator RAM used to store the character patterns that can be program-rewritten, as desired, by the user.

Table 2 Instruction Function

| Instruction              | Code   |     |            |     |     |     |     |  |  |  | Contents  | Execution Time<br>( $f_{OSC} = 250\text{kHz}$ )   |                           |
|--------------------------|--|-----|------------|-----|-----|-----|-----|--|--|--|---|---|---------------------------|
|                          | RS   | R/W | DB7        | DB6 | DB5 | DB4 | DB3 | DB2                                    | DB1  | DB0  |   |   |                           |
| Display clear            | 0  | 0   | 0          | 0   | 0   | 0   | 0   | 0                                      | 0  | 1  | Clears all display and returns the cursor to the home position (address 0).   | 82 $\mu\text{s}$ to 1.64ms  |                           |
| Cursor home              | 0  | 0   | 0          | 0   | 0   | 0   | 0   | 0                                      | 0  | 1  | *   | Returns the cursor to the home position address 0). Also returns the display being shifted to the original position. The DD RAM contents remain unaffected.   | 40 $\mu\text{s}$ to 1.6ms |
| Entry mode set           | 0  | 0   | 0          | 0   | 0   | 0   | 0   | 1                                      | I/D  | S  | Sets the cursor move direction and specifies whether or not the shift the display. These operations are performed during data write and read.   | 40 $\mu\text{s}$  |                           |
| Display ON/OFF control   | 0  | 0   | 0          | 0   | 0   | 0   | 1   | D                                      | C  | B  | Sets all display ON/OFF (D), cursor ON/OFF (C), cursor position character blink (B).  | 40 $\mu\text{s}$  |                           |
| Cursor/display shift     | 0  | 0   | 0          | 0   | 0   | 1   | S/C | R/L                                    | *  | *  | Moves the cursor and shifts the display without affecting the DD RAM contents.  | 40 $\mu\text{s}$  |                           |
| Function set             | 0  | 0   | 0          | 0   | 1   | DL  | N   | F                                      | *  | *  | Sets the interface data length (DL), number of display lines (L), and character font (F).   | 40 $\mu\text{s}$  |                           |
| CG RAM address set       | 0  | 0   | 0          | 1   | ACG |     |     |  |  | Sets the CG RAM address. RAM data is sent/received after this setting. |   | 40 $\mu\text{s}$  |                           |
| DD RAM address set       | 0  | 0   | 1          | ADD |     |     |     |  | Sets the DD RAM address. DD RAM data is sent/received after this setting   |  | 40 $\mu\text{s}$  |   |                           |
| Busy flag/address read   | 0  | 1   | BF         | AC  |     |     |     |  | Reads the contents of busy flag (BF) indicating internal operation is in progress and reads the contents of address counter. |  | 1 $\mu\text{s}$   |   |                           |
| CG RAM/DD RAM data write | 1  | 0   | Write data |     |     |     |     | Writes data into the DD RAM or CG RAM. |  | 40 $\mu\text{s}$   |   |   |                           |
| CG RAM/DD RAM data read  | 1  | 1   | Read data  |     |     |     |     | Reads data from the DD RAM or CG RAM.  |  | 40 $\mu\text{s}$   |   |   |                           |
|                          | I/D=1: Increment (+1)<br>I/D=0: Decrement (-1)<br>S=1: Accompanied by display shift<br>S/C=1: Display shift<br>S/C=0: Cursor move<br>R/L=1: Right-shift<br>R/L=0: Left-shift<br>DL=1: 8 bits                      DL=0: 4 bits<br>N=1: 2 lines                      N=0: 1 line<br>F=1: 5 $\times$ 10 dots                  F=0: 5 $\times$ 7 dots<br>BF=1: Internally operating<br>BF=0: Possible to accept instruction |     |            |     |     |     |     |  |  |  | DD RAM: Display data RAM<br>CG RAM: Character generator RAM<br>ACG: CG RAM address<br>ADD: DD RAM address<br>Corresponds to cursor address.<br>AC: Address counter used for both DD RAM and CG RAM. | The change in the frequency ( $f_{OSC}$ ) also causes the execution time to be changed.<br>(Example)<br>When<br>$f_{OSC} = 270\text{kHz}$ ,<br>$40\mu\text{s} \times \frac{250}{270} = 37\mu\text{s}$ |                           |

Fig. 3 Circuit Diagram DM2021

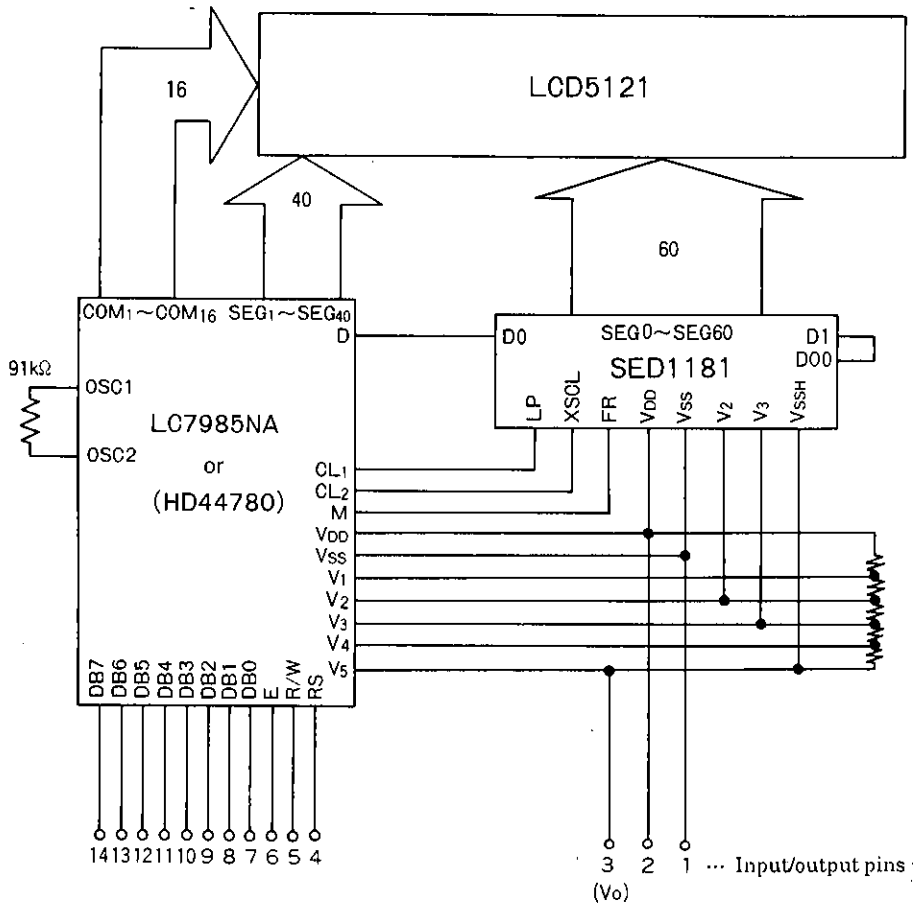
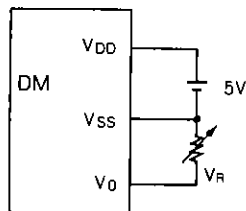


Fig. 4 Sample Power Supply



$V_{DD}-V_0$ : LCD drive voltage  
 The LCD drive voltage can be varied from approximately 3V to 5V by a variable resistor of 5kΩ connected across  $V_{SS}$  and  $V_0$ .

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