

# User's Guide

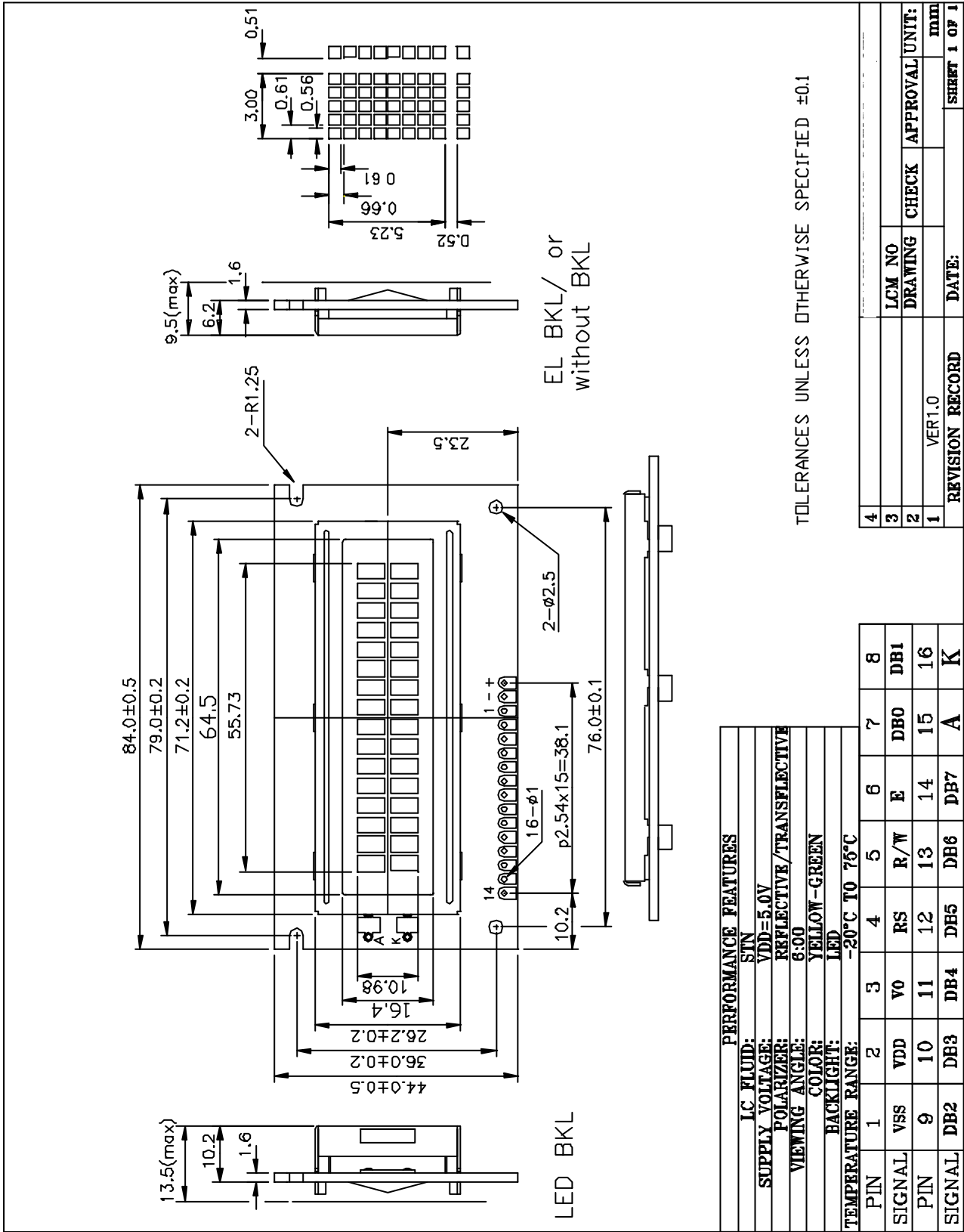
# ATM1602B

Liquid Crystal Display Module

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# Mechanical Diagram



## Absolute Maximum Ratings

| Item                        | Symbol            | Min      | Max      | Unit |
|-----------------------------|-------------------|----------|----------|------|
| Power Voltage               | $V_{DD} - V_{SS}$ | 0        | 7.0      | V    |
| Input Voltage               | $V_{in}$          | $V_{SS}$ | $V_{DD}$ |      |
| Operating Temperature Range | $T_{OP}$          | 0        | +50      |      |
| Storage Temperature Range   | $T_{ST}$          | -20      | +60      |      |

\*Wide Temperature range is available

(operating/storage temperature as wide as -20 ~ +70/-30 ~ +80 )。

## Description Of Terminals

| Pin No.       | Pin Name               | Input/Output | External Connection        | Function   |
|---------------|------------------------|--------------|----------------------------|--|
| 1             | VSS                    | —            | Power Supply               | VSS:GND  |
| 2             | VDD                    | —            |                            | VDD: +5V   |
| 3             | VO                     | —            |                            | $V_{LCD}$ adjustment   |
| 4             | RS                     | INPUT        | MPU                        | Register select signal<br>“0”:Instruction register (when writing)<br>Busy flag & address counter (When reading)<br>“1”:Data register (when writing & reading)                      |
| 5             | R/W                    | Input        | MPU                        | Read/write select signal<br>“0” for writing , “1” for reading  |
| 6             | E                      | Input        | MPU                        | Operation (data read/write) enable signal  |
| 7<br>/<br>10  | DB0-DB3                | Input        | MPU                        | Low-order lines of data bus with 3-state, bi-directional function for use in data transaction with the MPU. These lines are not used when interfacing with a 4-bit microprocessor. |
| 11<br>/<br>14 | DB4-DB7                | Input        | MPU                        | High-order lines of data bus with 3-state, bi-directional function for use in data transactions with the MPU. DB7 may also be used to check the busy flag.                         |
| 15<br>/<br>16 | LED “ + ”<br>LED “ - ” | Input        | LED BACKLIGHT POWER SUPPLY | LED “ + ” VOLTAGE TYPE:4.2V<br>MAX : 4.5V<br>LED “ - ” : GND   |

## Optical Characteristics

for TN Type Display Module ( $T_a=25$  ,  $V_{DD}=5.0V \pm 0.25V$ )

| Item                | Symbol | Condition | Min. | Typ. | Max. | Unit |
|---------------------|--------|-----------|------|------|------|------|
| Viewing angle       |        | $C_r$ 4   | -25  | -    | -    | deg  |
|                     |        |           | -30  | -    | 30   |      |
| Contrast ratio      | $C_r$  |           | -    | 2    | -    | -    |
| Response time(rise) | $T_r$  | -         | -    | 120  | 150  | ms   |
| Response time(fall) | $T_r$  | -         | -    | 120  | 150  | ms   |

for STN Type Display Module ( $T_a=25$  ,  $V_{DD}=5.0V \pm 0.25V$ )

| Item                | Symbol | Condition | Min. | Typ. | Max. | Unit |
|---------------------|--------|-----------|------|------|------|------|
| Viewing angle       |        | $C_r$ 2   | -60  | -    | 35   | deg  |
|                     |        |           | -40  | -    | 40   |      |
| Contrast ratio      | $C_r$  |           | -    | 6    | -    | -    |
| Response time(rise) | $T_r$  | -         | -    | 150  | 250  | ms   |
| Response time(fall) | $T_r$  | -         | -    | 150  | 250  | ms   |

## Electrical Characteristics

### DC Characteristics

| Parameter                | Symbol         | Conditions                  | Min. | Type | Max.     | Unit    |
|--------------------------|----------------|-----------------------------|------|------|----------|---------|
| Supply voltage for LCD   | $V_{DD} - V_O$ | $T_A=25$                    | —    | 4.6  | —        | V       |
| Input voltage            | $V_{DD}$       |                             | 4.7  | —    | 5.5      | V       |
| Supply current           | $I_{DD}$       | $V_{DD}=5.0V; T_A=25$       | —    | 1.5  | 2.5      | mA      |
| Input leakage current    | $I_{LKG}$      |                             | —    | —    | 1.0      | $\mu A$ |
| “H” level input voltage  | $V_{IH}$       |                             | 2.2  | —    | $V_{DD}$ | V       |
| “L” level input voltage  | $V_{IL}$       | Twice initial value or less | 0    | —    | 0.6      | V       |
| “H” level output voltage | $V_{OH}$       | LOH= -0.25MA                | 2.4  | —    | —        | V       |
| “L” level output voltage | $V_{OL}$       | LOL=1.6MA                   | —    | —    | 0.4      | V       |
| Backlight supply power   | $V_F$          |                             | —    | 4.2  | 4.5      | V       |

## AC Characteristics

Read Cycle ( $V_{DD}=5.0V+10\%$ ,  $V_{SS}=0V$ ,  $T_a=25$  )

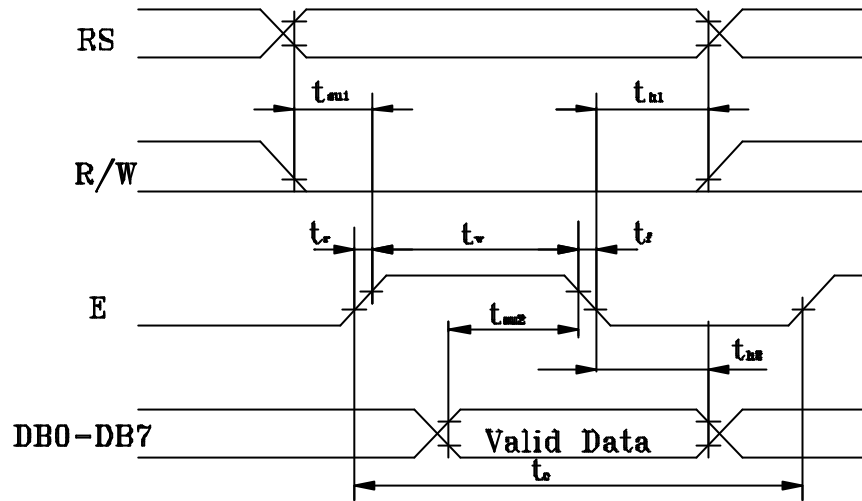
| Parameter                | Symbol     | Test pin | Min. | Type | Max. | Unit |
|--------------------------|------------|----------|------|------|------|------|
| Enable cycle time        | $t_c$      | E        | 500  | -    | -    | ns   |
| Enable pulse width       | $t_w$      | E        | 300  | -    | -    |      |
| Enable rise/fall time    | $t_r, t_f$ | E        | -    | -    | 25   |      |
| RS,R/W setup time        | $t_{su}$   | RS; R/W  | 100  | -    | -    |      |
| RS,R/W address hold time | $t_h$      | RS; R/W  | 10   | -    | -    |      |
| Read data output delay   | $t_D$      | DB0-DB7  | 60   | -    | 190  |      |
| Read data hold time      | $t_{DH}$   | DB0-DB7  | 20   | -    | -    |      |

## Write Cycle

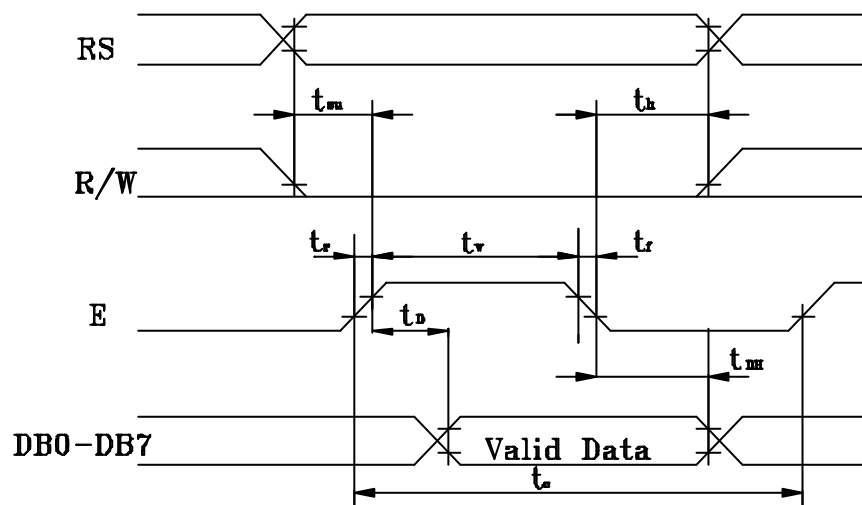
| Parameter                | Symbol     | Test pin | Min. | Type | Max. | Unit |
|--------------------------|------------|----------|------|------|------|------|
| Enable cycle time        | $t_c$      | E        | 500  | -    | -    | ns   |
| Enable pulse width       | $t_w$      | E        | 300  | -    | -    |      |
| Enable rise/fall time    | $t_r, t_f$ | E        | -    | -    | 25   |      |
| RS,R/W setup time        | $t_{su1}$  | RS; R/W  | 100  | -    | -    |      |
| RS,R/W address hold time | $t_{h1}$   | RS; R/W  | 10   | -    | -    |      |
| Data setup time          | $t_{su2}$  | DB0-DB7  | 60   | -    | -    |      |
| Data hold time           | $t_{h2}$   | DB0-DB7  | 10   | -    | -    |      |

## Timing Characteristics

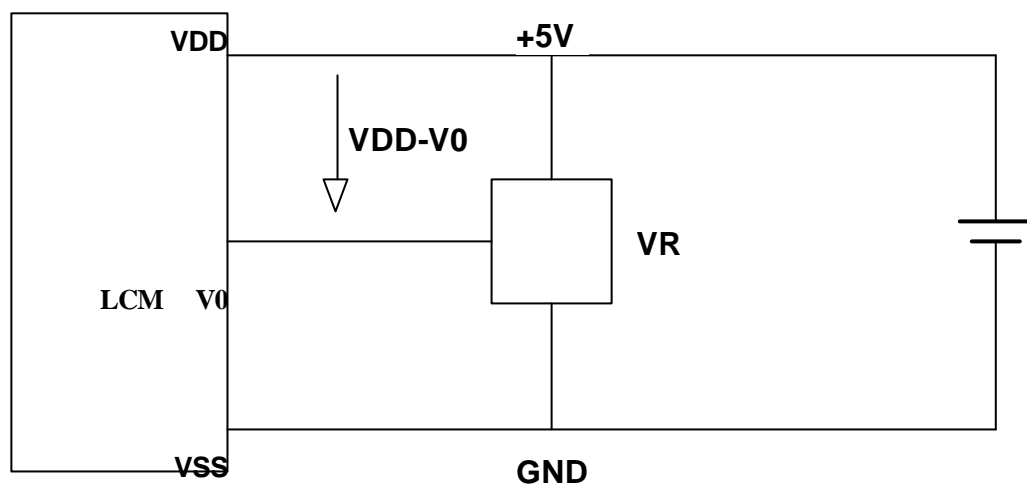
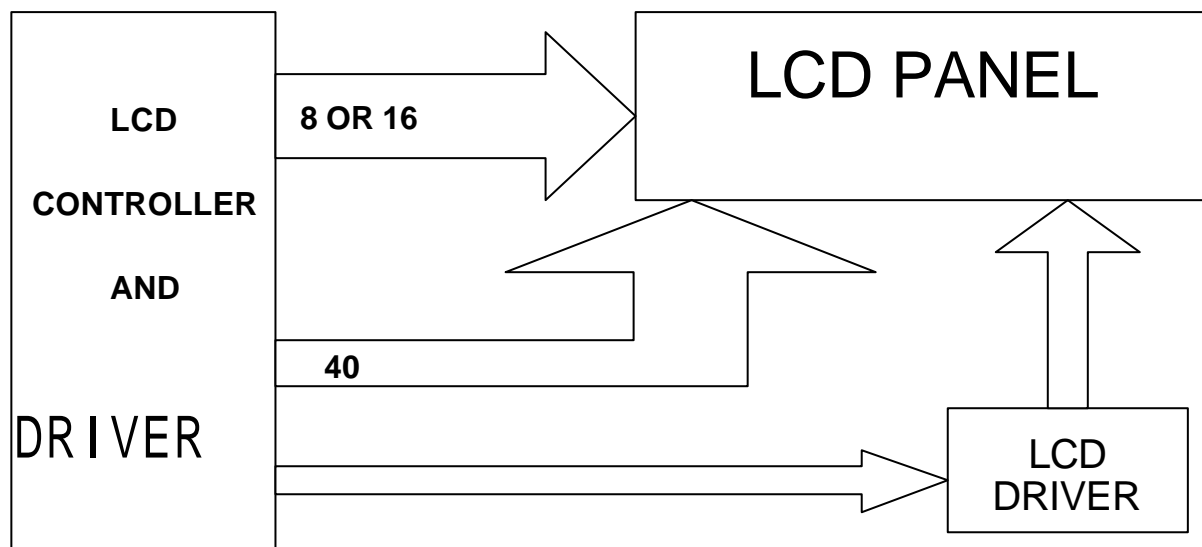
### Write Timing



### Read Timing



## Block Diagram



VDD-V<sub>0</sub>: LCD DRIVING VOLTAGE

VR: 10K-20K



## Display command

| Parameter                      | RS | R/W | DB7        | DB6   | DB5  | DB4 | DB3 | DB2 | DB1 | DB0   | Note  | Executing time<br>fosc=250kHz |
|--------------------------------|----|-----|------------|---|--|-----|-----|-----|-----|---|---|-------------------------------|
| Clear Display                  | 0  | 0   | 0          | 0   | 0  | 0   | 0   | 0   | 0   | 1   |   | 1.64ms                        |
| Cursor home                    | 0  | 0   | 0          | 0   | 0  | 0   | 0   | 0   | 1   | *   |   | 1.64ms                        |
| Entry Mode Set                 | 0  | 0   | 0          | 0   | 0  | 0   | 0   | 1   | 1/D | S   | DB1=1:Increment<br>DB1=0:Decrement<br>DB0=1:The display is shifted<br>DB0=0:The display is not shifted  | 40 μs                         |
| Display on/off                 | 0  | 0   | 0          | 0   | 0  | 0   | 1   | D   | C   | B   | DB2=1:Display on<br>DB2=0: Display off<br>DB1=1:Cursor on<br>DB1=0: Cursor off<br>DB0=1:Brinking on<br>DB0=0: Brinking off                                | 40 μs                         |
| Cursor / Display Shift         | 0  | 0   | 0          | 0   | 0  | 1   | S/C | R/L | *   | *   | DB3=1:Shifts display one character<br>DB2=1:Right shift<br>DB2=0:Left shift   | 40 μs                         |
| System Set                     | 0  | 0   | 0          | 0   | 1  | DL  | N   | F   | *   | *   | DB4=1:8 bits<br>DB4=0:4 bits<br>DB3=1:2 lines display (1/16 duty)<br>DB3=0:1 line display<br>DB2=1:5 × 10 dots , 1/11 duty<br>DB2=1:5 × 7 dots , 1/8 duty | 40 μs                         |
| Set CG RAM Address             | 0  | 0   | 0          | 1   | CG RAM address corresponds to cursor address |     |     |     |     |   | The address length that can be set is 64 address  | 40 μs                         |
| Set DD RAM Address             | 0  | 0   | 1          | DD RAM address                                  |  |     |     |     |     | The address length that can be set is 80 address                      | 40 μs   |                               |
| Read Busy Flag/Address Counter | 0  | 1   | BF         | Address counter used for both DD&CG RAM address |  |     |     |     |     | DB7=1:Busy (instruction not accepted)<br>DB7=0:Ready(for instruction) | 0 μs  |                               |
| Write Data                     | 1  | 0   | Write data |   |  |     |     |     |     |   |   | 46 μs                         |
| Read Data                      | 1  | 1   | Read data  |   |  |     |     |     |     |   |   | 46 μs                         |

### DD RAM Address:

|                    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|--------------------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
|                    | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| Address for line 1 | 00 | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | A  | B  | C  | D  | E  | F  |
| Address for line 2 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 4A | 4B | 4C | 4D | 4E | 4F |

# Reliability and Life Time

## 1. Reliability Test

| Storage Condition                          | Content             | Evaluations and Assessment* |        |                                |                   |
|--|---------------------|-----------------------------|--------|--------------------------------|-------------------|
|  |                     | Current consumption         | Oozing | Contrast                       | Other appearances |
| Operation at high temperature and humidity | 40 , 90% RH, 240hrs | Twice initial value or less | none   | More than 80% of initial value | No abnormality    |
| High temperature storage                   | 60 , 240hrs         | Twice initial value or less | none   | More than 80% of initial value | No abnormality    |
| Low temperature storage                    | -20 , 240hrs        | Twice initial value or less |        | More than 80% of initial value | No abnormality    |

\*Evaluations and assessment to be made two hours after returning to room temperature (25 ± 5 ).

\*The LCDs subjected to the test must not have dew condensation.

## 2. Liquid crystal panel service life

50,000 hours minimum at 25 ± 10 , 45 ± 20%RH.

## Standard Character Pattern

| Lower<br>4 bits | Upper 4<br>bits  | 0000 | 0001 | 0010 | 0011 | 0100 | 0101 | 0110 | 0111 | 1000 | 1001 | 1010 | 1011 | 1100 | 1101 | 1110 | 1111 |
|-----------------|------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| xxxx0000        | CG<br>RAM<br>(1) |      |      | 0    | a    | P    | `    | P    |      |      |      | -    | タ    | ミ    | α    | ρ    |      |
| xxxx0001        | (2)              |      | !    | 1    | A    | Q    | a    | q    |      |      | 。    | ア    | チ    | △    | ü    | q    |      |
| xxxx0010        | (3)              |      | "    | 2    | B    | R    | b    | r    |      |      | 「    | イ    | ツ    | ×    | ρ    | θ    |      |
| xxxx0011        | (4)              |      | #    | 3    | C    | S    | c    | s    |      |      | 」    | ウ    | テ    | ε    | ε    | ε    |      |
| xxxx0100        | (5)              |      | \$   | 4    | D    | T    | d    | t    |      |      | 、    | エ    | ト    | †    | μ    | Ω    |      |
| xxxx0101        | (6)              |      | %    | 5    | E    | U    | e    | u    |      |      | ・    | オ    | ナ    | ∟    | ε    | ü    |      |
| xxxx0110        | (7)              |      | &    | 6    | F    | V    | f    | v    |      |      | ヲ    | カ    | ニ    | ヨ    | ρ    | Σ    |      |
| xxxx0111        | (8)              |      | '    | 7    | G    | W    | g    | w    |      |      | フ    | キ    | ヌ    | ラ    | g    | π    |      |
| xxxx1000        | (1)              |      | (    | 8    | H    | X    | h    | x    |      |      | イ    | ク    | ネ    | リ    | √    | Σ    |      |
| xxxx1001        | (2)              |      | )    | 9    | I    | Y    | i    | y    |      |      | ウ    | ケ    | ル    | ル    | '    | γ    |      |
| xxxx1010        | (3)              |      | *    | :    | J    | Z    | j    | z    |      |      | エ    | コ    | ハ    | レ    | j    | κ    |      |
| xxxx1011        | (4)              |      | +    | :    | K    | [    | k    | [    |      |      | オ    | サ    | ヒ    | ロ    | "    | π    |      |
| xxxx1100        | (5)              |      | ,    | <    | L    | ¥    | l    | l    |      |      | カ    | シ    | フ    | ワ    | φ    | π    |      |
| xxxx1101        | (6)              |      | -    | =    | M    | ]    | m    | ]    |      |      | ユ    | ス    | ハ    | ン    | ε    | ÷    |      |
| xxxx1110        | (7)              |      | .    | >    | N    | ^    | n    | +    |      |      | ヨ    | セ    | ホ    | ハ    | π    |      |      |
| xxxx1111        | (8)              |      | /    | ?    | O    | _    | o    | +    |      |      | リ    | ソ    | マ    | ロ    | ö    | ■    |      |

Note: The user can specify any pattern for character-generator RAM.