

# AZ DISPLAYS, INC.

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*COMPLETE LCD SOLUTIONS*

## **SPECIFICATIONS FOR LIQUID CRYSTAL DISPLAY**

PART NUMBER:  
DATE:

ACM 4002E SERIES  
September 22, 1999

# ACM4002E SERIES LCD MODULE

## 1.0 MECHANICAL SPECS

|                              |                                                                                                                                  |
|------------------------------|----------------------------------------------------------------------------------------------------------------------------------|
| 1. Overall Module Size       | 182.0mm(W) x 33.5mm(H) x max 14.5mm(D) for LED backlight version<br>182.0mm(W) x 33.5mm(H) x max 9.5mm(D) for reflective version |
| 2. Dot Size                  | 0.60mm(W) x 0.65mm(H)                                                                                                            |
| 3. Dot Pitch                 | 0.65mm(W) x 0.70mm(H)                                                                                                            |
| 4. Duty                      | 1/16                                                                                                                             |
| 5. Controller IC             | KS0066                                                                                                                           |
| 6. LC Fluid Options          | TN, STN                                                                                                                          |
| 7. Polarizer Options         | Reflective, Transflective, Transmissive                                                                                          |
| 8. Backlight Options         | LED                                                                                                                              |
| 9. Temperature Range Options | Standard(0°C ~ 50°C), Wide(-20°C ~ 70°C)                                                                                         |

## 2.0 ABSOLUTE MAXIMUM RATINGS

| Item                                     | Symbol   | Min | Typ | Max | Unit |
|------------------------------------------|----------|-----|-----|-----|------|
| Operating temperature (Standard)         | Top      | 0   | -   | 50  | °C   |
| Storage temperature (Standard)           | Tst      | -10 | -   | 60  | °C   |
| Operating temperature (Wide temperature) | Top      | -20 | -   | 70  | °C   |
| Storage temperature (Wide temperature)   | Tst      | -30 | -   | 80  | °C   |
| Input voltage                            | Vin      | Vss |     | Vdd | V    |
| Supply voltage for logic                 | Vdd- Vss | 2.7 | -   | 5.5 | V    |
| Supply voltage for LCD drive             | Vdd- Vo  | 3.0 | 4.6 | 6.5 | V    |

## ACM4002E SERIES LCD MODULE

### 3.0 ELECTRICAL CHARACTERISTICS

| Item                                           | Symbol                           | Condition                                          | Min | Typ | Max             | Unit |
|------------------------------------------------|----------------------------------|----------------------------------------------------|-----|-----|-----------------|------|
| Input voltage (high)                           | V <sub>ih</sub>                  | H level                                            | 2.2 | -   | V <sub>dd</sub> | V    |
| Input voltage (low)                            | V <sub>il</sub>                  | L level                                            | 0   | -   | 0.6             | V    |
| Recommended LC Driving Voltage (Standard Temp) | V <sub>dd</sub> - V <sub>o</sub> | 0°C                                                | -   | 4.8 | 5.4             | V    |
|                                                |                                  | 25°C                                               | 4.2 | 4.6 | -               |      |
|                                                |                                  | 50°C                                               | 3.9 | 4.3 | -               |      |
| Recommended LC Driving Voltage (Wide Temp)     | V <sub>dd</sub> - V <sub>o</sub> | -20°C                                              | -   | 6.4 | 7.2             | V    |
|                                                |                                  | 0°C                                                | -   | 4.8 | -               |      |
|                                                |                                  | 50°C                                               | -   | 4.3 | -               |      |
|                                                |                                  | 70°C                                               | 3.7 | 4.2 | -               |      |
| Power Supply Current                           | I <sub>dd</sub>                  | V <sub>dd</sub> =5.0V,<br>f <sub>osc</sub> =270kHz | -   | 0.5 | 1.0             | mA   |
| LED Power Supply Voltage                       | V <sub>fled</sub>                | R=6.8Ω                                             | -   | 4.6 | 5.0             | V    |
| LED Power Supply Current                       | I <sub>fled</sub>                | R=6.8Ω                                             | -   | 210 | 420             | mA   |

### 4.0 OPTICAL CHARACTERISTICS (T<sub>a</sub>=25°C, V<sub>dd</sub>= 5.0V±0.25V, TN LC fluid)

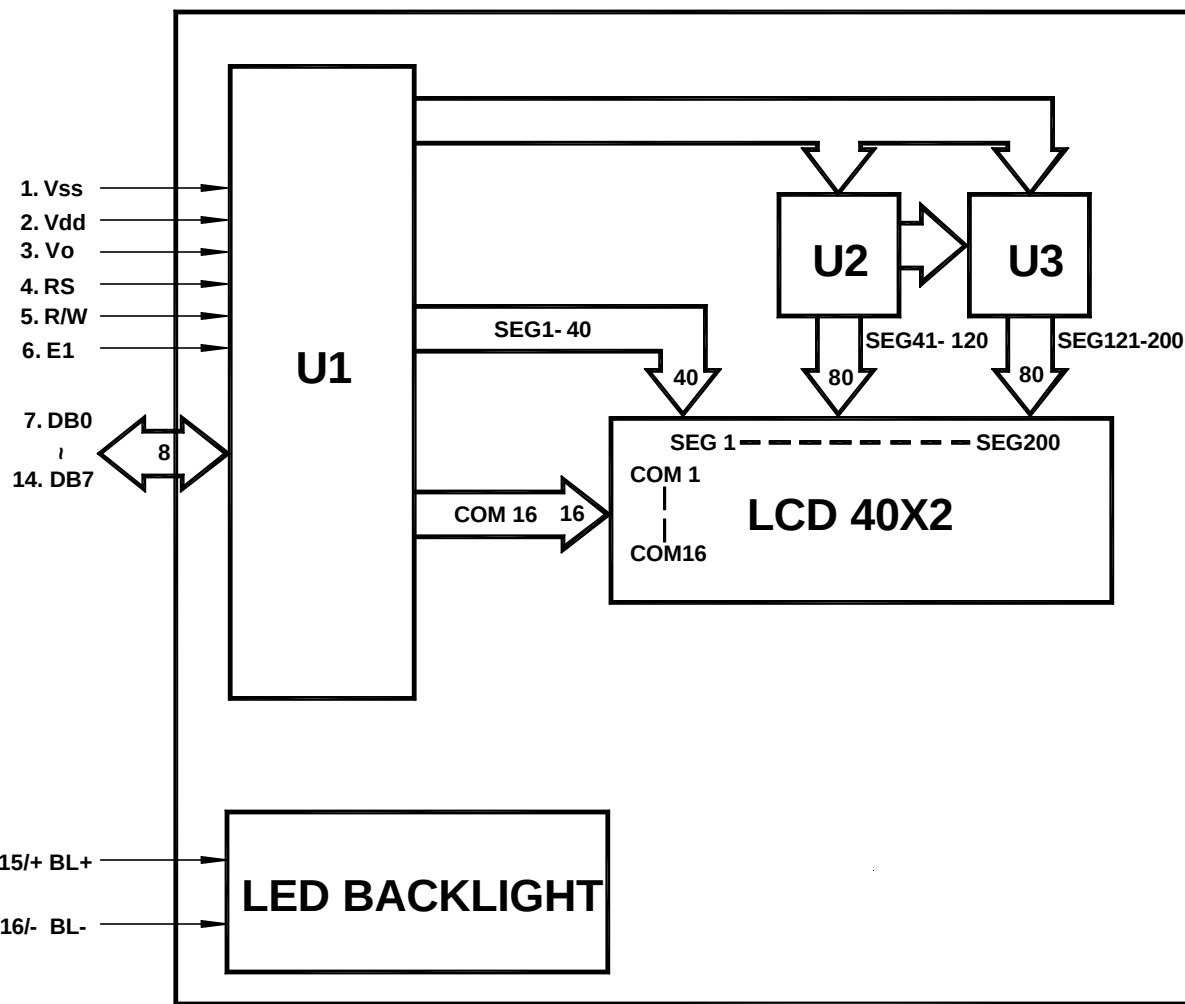
| Item                       | Symbol         | Condition  | Min | Typ | Max | Unit |
|----------------------------|----------------|------------|-----|-----|-----|------|
| Viewing angle (horizontal) | θ              | Cr ≥ 4.0   | -25 | -   | -   | deg  |
| Viewing angle (vertical)   | φ              | Cr ≥ 4.0   | -30 | -   | 30  | deg  |
| Contrast Ratio             | Cr             | φ=0°, θ=0° | -   | 2   | -   |      |
| Response time (rise)       | T <sub>r</sub> | φ=0°, θ=0° | -   | 120 | 150 | ms   |
| Response time (fall)       | T <sub>f</sub> | φ=0°, θ=0° | -   | 120 | 150 | ms   |

## ACM4002E SERIES LCD MODULE

### 4.1 OPTICAL CHARACTERISTICS (Ta=25°C, Vdd= 5.0V±0.25V, STN LC fluid)

| Item                       | Symbol   | Condition                      | Min | Typ | Max | Unit |
|----------------------------|----------|--------------------------------|-----|-----|-----|------|
| Viewing angle (horizontal) | $\theta$ | $Cr \geq 2.0$                  | -60 | -   | 35  | deg  |
| Viewing angle (vertical)   | $\phi$   | $Cr \geq 2.0$                  | -40 | -   | 40  | deg  |
| Contrast Ratio             | Cr       | $\phi=0^\circ, \theta=0^\circ$ | -   | 6   | -   |      |
| Response time (rise)       | Tr       | $\phi=0^\circ, \theta=0^\circ$ | -   | 150 | 250 | ms   |
| Response time (fall)       | Tf       | $\phi=0^\circ, \theta=0^\circ$ | -   | 150 | 250 | ms   |

### 5.0 BLOCK DIAGRAM

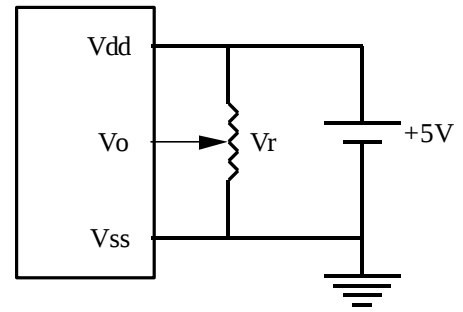


# ACM4002E SERIES LCD MODULE

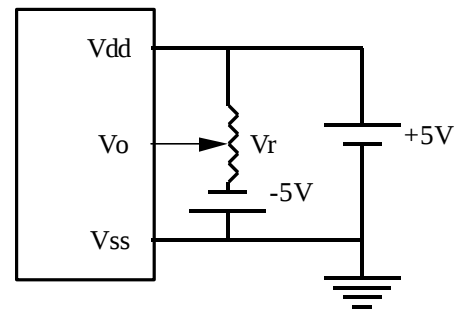
## 6.0 PIN ASSIGNMENT

| Pin No. | Symbol | Function             |
|---------|--------|----------------------|
| 1       | Vss    | Ground               |
| 2       | Vdd    | +5V                  |
| 3       | Vo     | LCD contrast adjust  |
| 4       | RS     | Register select      |
| 5       | R/W    | Read / write         |
| 6       | E      | Enable               |
| 7       | DB0    | Data bit 0           |
| 8       | DB1    | Data bit 1           |
| 9       | DB2    | Data bit 2           |
| 10      | DB3    | Data bit 3           |
| 11      | DB4    | Data bit 4           |
| 12      | DB5    | Data bit 5           |
| 13      | DB6    | Data bit 6           |
| 14      | DB7    | Data bit 7           |
| 15/+    | BL+    | Power Supply for BL+ |
| 16/-    | BL-    | Power Supply for BL- |

## 7.0 POWER SUPPLY



STANDARD TEMP RANGE



WIDE TEMP RANGE

$V_R = 10K\Omega \sim 20K\Omega$

## 8.0 TIMING CHARACTERISTICS

| Item                  | Symbol     | Test Condition | Min. | Typ. | Max. | Unit |
|-----------------------|------------|----------------|------|------|------|------|
| Enable cycle time     | $t_c$      | Fig. a, Fig. b | 500  | -    | -    | ns   |
| Enable pulse width    | $t_w$      | Fig. a, Fig. b | 220  | -    | -    | ns   |
| Enable rise/fall time | $t_r, t_f$ | Fig. a, Fig. b | -    | -    | 25   | ns   |
| RS, R/W set up time   | $t_{su}$   | Fig. a, Fig. b | 40   | -    | -    | ns   |
| RS, R/W hold time     | $t_h$      | Fig. a, Fig. b | 10   | -    | -    | ns   |
| Data delay time       | $t_d$      | Fig. b         | -    | -    | 120  | ns   |
| Data set up time      | $t_{dsu}$  | Fig. a         | 60   | -    | -    | ns   |
| Data hold time        | $t_{dh}$   | Fig. a, Fig. b | 20   | -    | -    | ns   |

# ACM4002E SERIES LCD MODULE

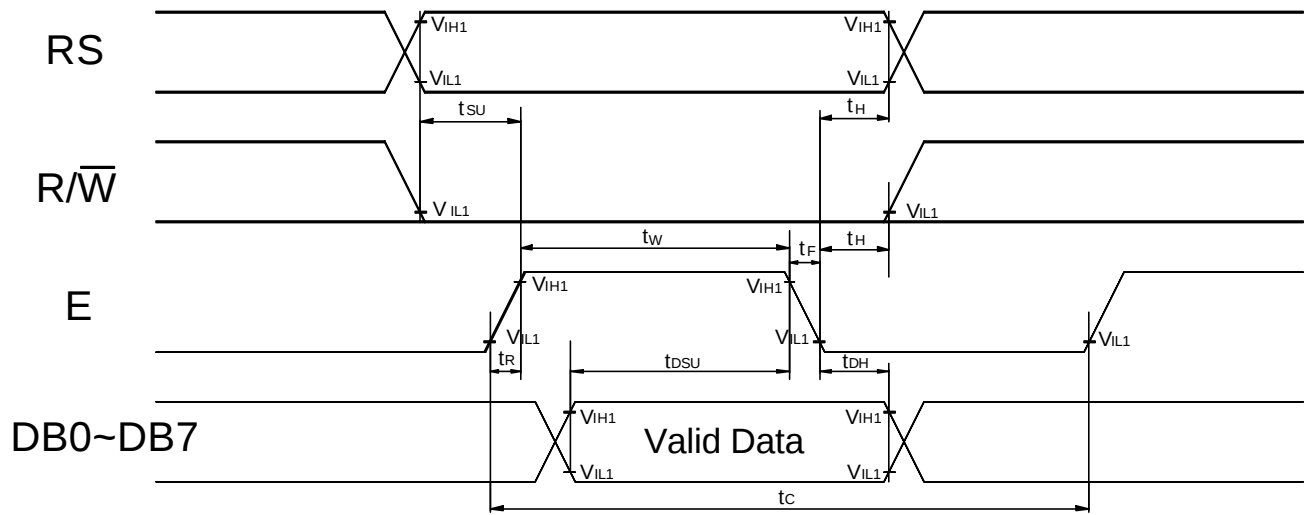


Fig. a Interface timing (data write)

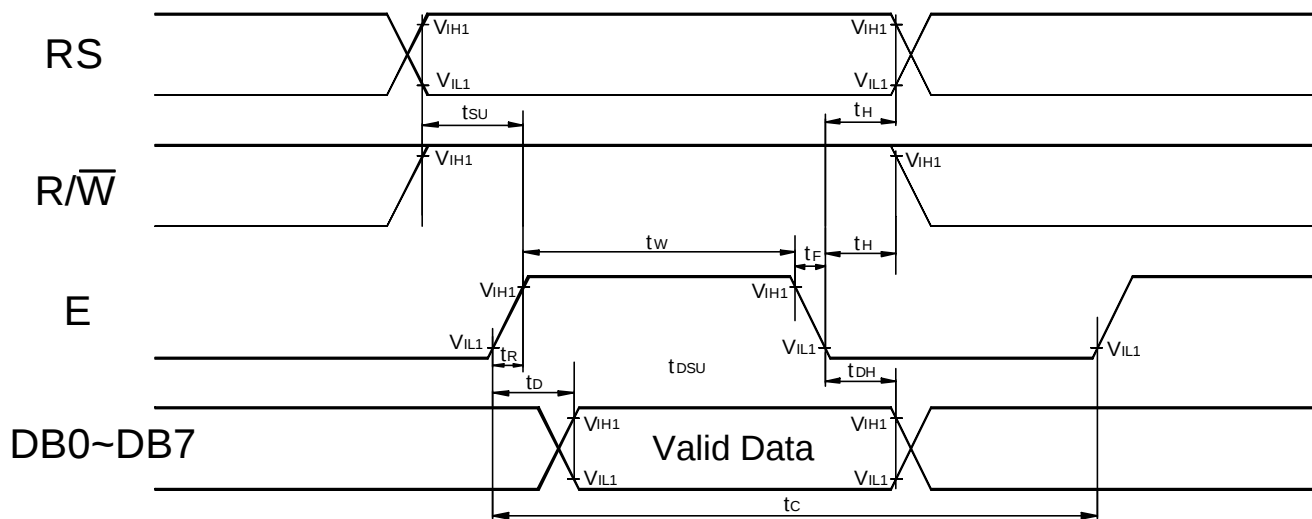
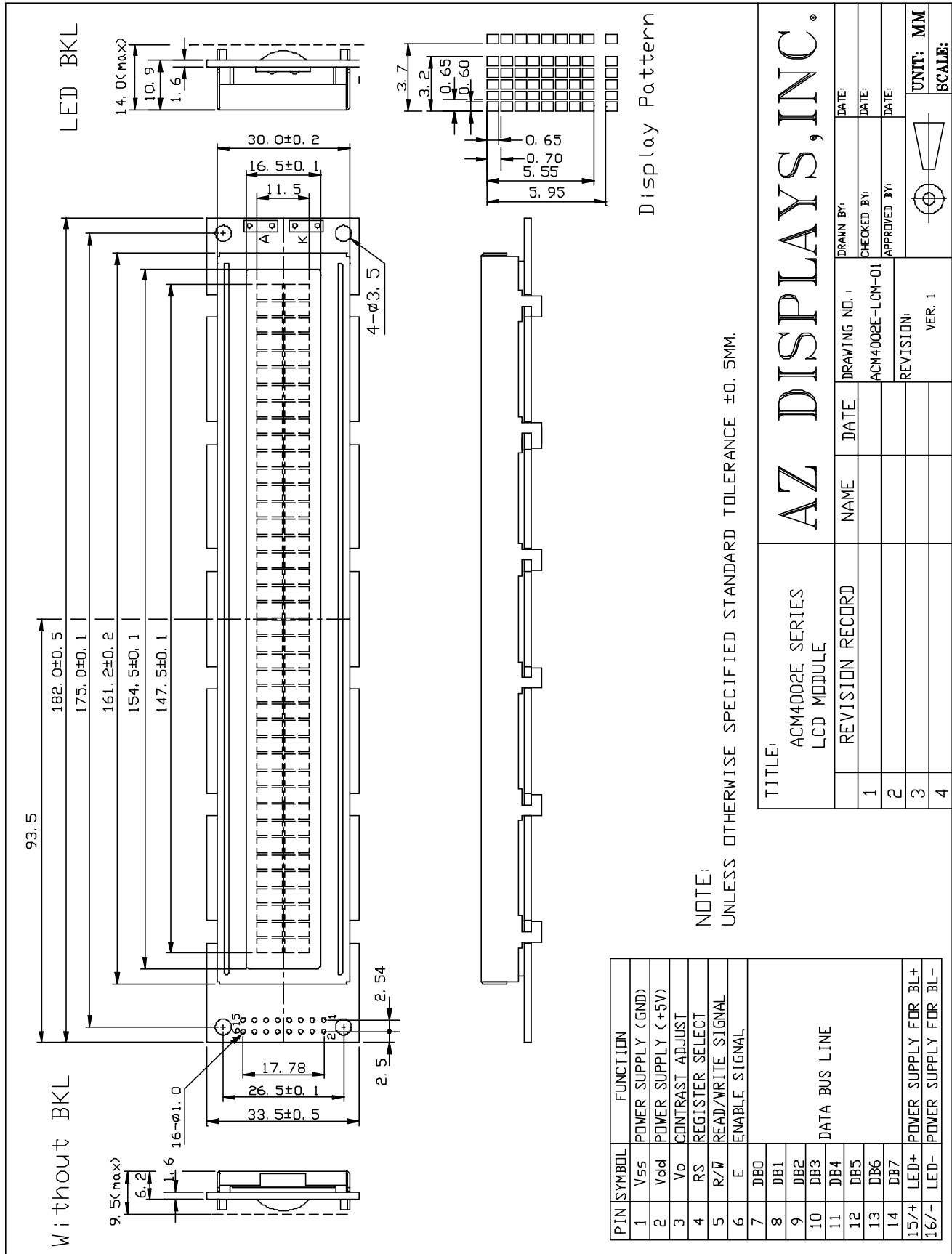


Fig. b Interface timing (data read)

## 9.0 MECHANICAL DIAGRAM



## ACM4002E SERIES LCD MODULE

### 10.0 RELIABILITY TEST

| Storage Condition                          | Content               | Evaluations and Assessment* |        |                                |                   |
|--------------------------------------------|-----------------------|-----------------------------|--------|--------------------------------|-------------------|
|                                            |                       | Current Consumption         | Oozing | Contrast                       | Other Appearances |
| Operation at high temperature and humidity | 40° C, 90% RH, 240hrs | Twice initial value or less | none   | More than 80% of initial value | No abnormality    |
| High temperature storage                   | 60° C, 240hrs         | Twice initial value or less | none   | More than 80% of initial value | No abnormality    |
| Low temperature storage                    | -20° C, 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° C±5° C).

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

# ACM4002E SERIES LCD MODULE

## 11.0 DISPLAY INSTRUCTION TABLE

| COMMAND                  | R<br>S | R/<br>W | DB<br>7    | DB<br>6                                           | DB<br>5                              | DB<br>4 | DB<br>3 | DB<br>2 | DB<br>1 | DB<br>0 | DESCRIPTION                                                                                                                                                                                             | Executing<br>time<br>fosc=250khz |
|--------------------------|--------|---------|------------|---------------------------------------------------|--------------------------------------|---------|---------|---------|---------|---------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|
| Clear Display            | 0      | 0       | 0          | 0                                                 | 0                                    | 0       | 0       | 0       | 0       | 1       | Clears Display & Returns to Address 0.                                                                                                                                                                  | 1.64ms                           |
| Cursor at Home           | 0      | 0       | 0          | 0                                                 | 0                                    | 0       | 0       | 0       | 1       | x       | Returns Cursor to Address 0. Also returns the display being shifted to the original position. DDRAM contents remain unchanged.                                                                          | 1.64ms                           |
| Entry Mode Set           | 0      | 0       | 0          | 0                                                 | 0                                    | 0       | 0       | 1       | I/D     | S       | I/D: Set Cursor Moving Direction<br>I/D=1: Increment<br>I/D=0: Decrement<br><br>S: Specify Shift of Display<br>S=1: The display is shifted<br>S=0: The display is not shifted                           | 40μs                             |
| Display ON/OFF Control   | 0      | 0       | 0          | 0                                                 | 0                                    | 0       | 1       | D       | C       | B       | Display D=1: Display on<br>D=0: Display off<br>Cursor C=1: Cursor on<br>C=0: Cursor off<br>Brink B=1: Brink on<br>B=0: Brink off                                                                        | 40μs                             |
| Cursor / Display Shift   | 0      | 0       | 0          | 0                                                 | 0                                    | 1       | S/C     | R/L     | x       | x       | Moves cursor or shifts the display w/o changing DD RAM contents<br>S/C=0: Cursor Shift (RAM unchanged)<br>S/C=1: Display Shift (RAM unchanged)<br>R/L=1: Shift to the Right<br>R/L=0: Shift to the Left | 40μs                             |
| Function Set             | 0      | 0       | 0          | 0                                                 | 1                                    | DL      | N       | F       | x       | x       | Sets data bus length (DL), # of display lines (N), and character fonts (F).<br>DL=1: 8 bits F=0: 5x7 dots<br>DL=0: 4 bits F=1: 5x10 dots<br>N=0: 1 line display<br>N=1: 2 lines display                 | 40μs                             |
| Set CG RAM Address       | 0      | 0       | 0          | 1                                                 | Character Generator (CG) RAM Address |         |         |         |         |         | Sets CG RAM address. CG RAM data is sent and received after this instruction.                                                                                                                           | 40μs                             |
| Set DD RAM Address       | 0      | 0       | 1          | Display Data (DD) RAM Address / Cursor Address    |                                      |         |         |         |         |         | Sets DD RAM address. DD Ram data is sent and received after this instruction.                                                                                                                           | 40μs                             |
| Busy Flag / Address Read | 0      | 1       | B<br>F     | Address counter used for both DD & CG RAM address |                                      |         |         |         |         |         | Reads Busy Flag (BF) and address counter contents.                                                                                                                                                      | 40μs                             |
| Write Data               | 1      | 0       | Write Data |                                                   |                                      |         |         |         |         |         | Writes data into DDRAM or CGRAM.                                                                                                                                                                        | 46μs                             |
| Read Data                | 1      | 1       | Read Data  |                                                   |                                      |         |         |         |         |         | Reads data from DDRAM or CGRAM.                                                                                                                                                                         | 46μs                             |

x: Don't Care.

# ACM4002E SERIES LCD MODULE

## 12.0 STANDARD CHARACTER PATTERNS

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

Note: The character generator RAM is the RAM with which the user can rewrite character patterns by program.

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