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LCD MODULE SPECIFICATION FOR CUSTOMER'S APPROVAL

CUSTOMER : _____

MODULE TYPE : NMTC-S20200XRGHS

APPROVED BY: (FOR CUSTOMER USE ONLY)

| Approved By | Checked By | Prepared By | MT File No | Date Issued |
|---|---|---|------------|-------------|
|  |  |  | MTC-20200X | 04/26/02 |

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FEATURES of LIQUID CRYSTAL DISPLAY MODULE

MODEL NO. : NMTC-S20200XRGHS

Character Type Dot Matrix LCD Module

Easy interface of 4-bit or 8-bit

Display character pattern : 5 × 7 font with cursor(208 kinds)

The special character pattern can be programmable by Character Generator RAM directly.

A customer character pattern can be programmable by mask option.

Automatically power on reset.

Internal Memory:

- Character Generator ROM (CGROM) : 10,080 bits (204 characters × 5 × 8 dot)

- Character Generator RAM (CGRAM) : 64 × 8 bits (8 characters × 5 × 8 dot)

Low power operation:

- Power supply voltage range : 2.7 ~ 5.5 V (V_{DD})

- LCD drive voltage range : 3.0 ~ 13.0 V (V_{DD} - V_O)

Low power consumption

CMOS process

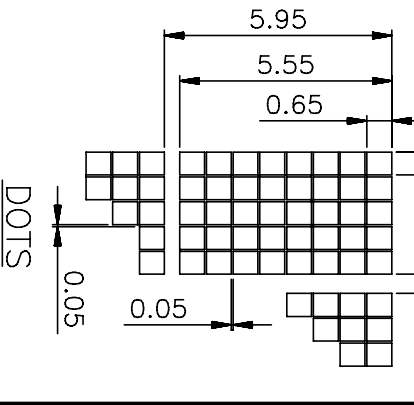
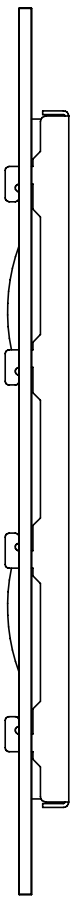
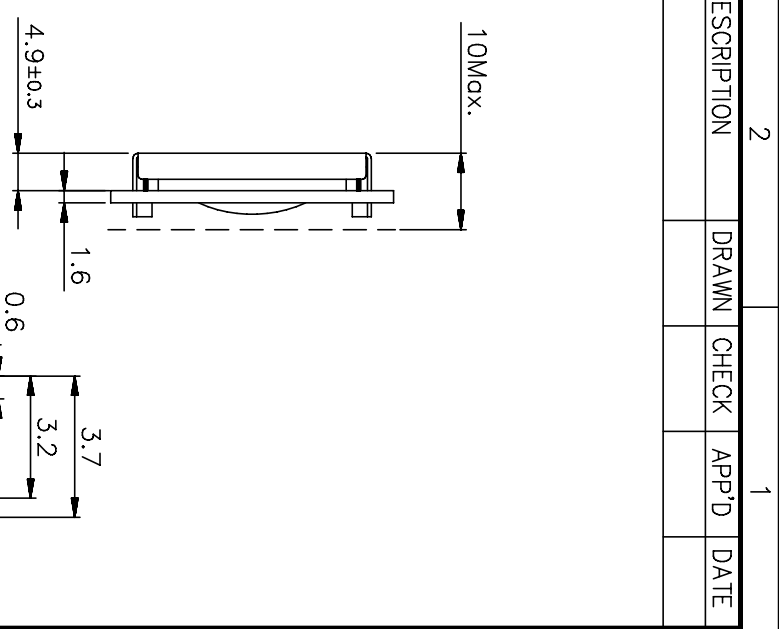
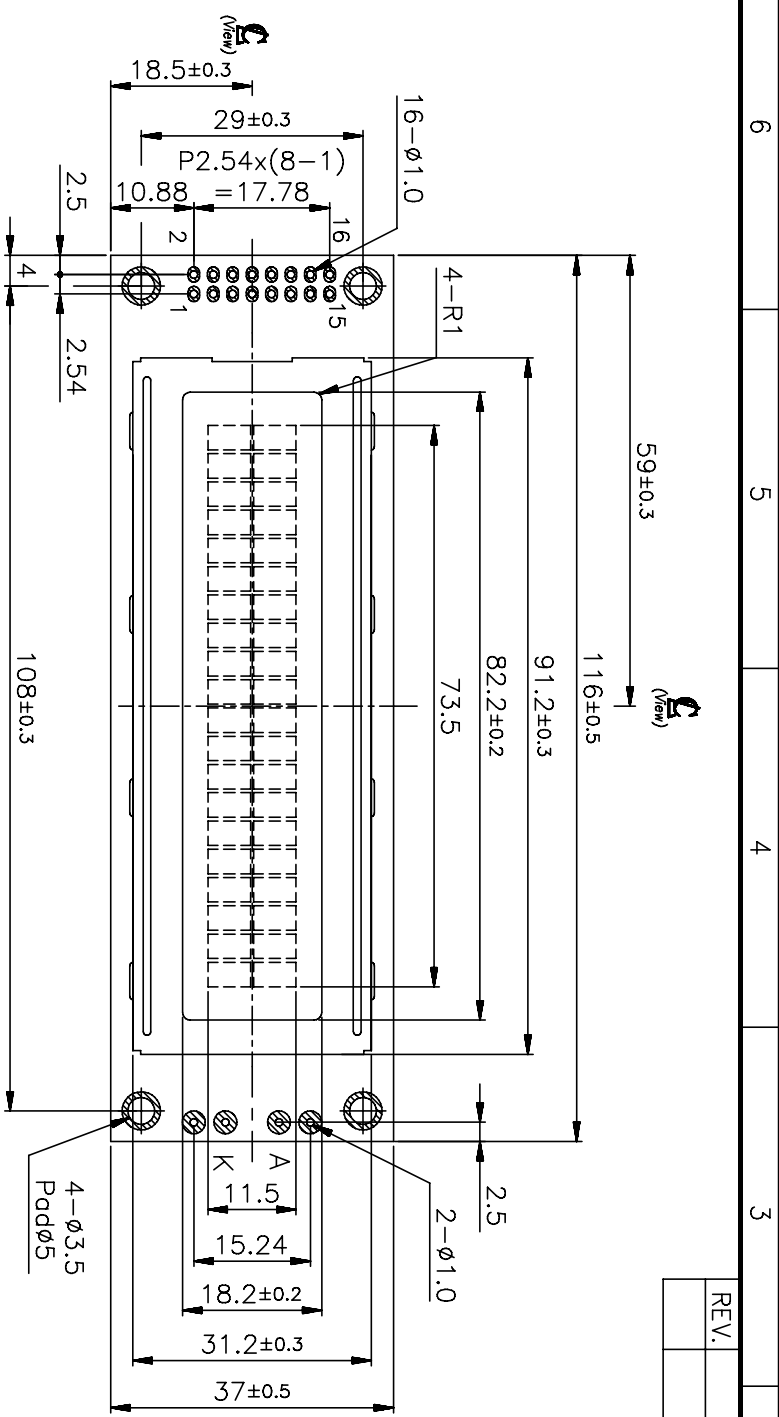
Duty-cycle : 1/16

| | | | | | |
|-------------------|--|---|--|---------------------------------------|-------------------------------------|
| View Direction | <input checked="" type="checkbox"/> 6 O'clock | | <input type="checkbox"/> 12 O'clock | | |
| LCD Type | <input type="checkbox"/> FSTN Positive | | <input type="checkbox"/> FSTN Negative | | |
| | <input checked="" type="checkbox"/> STN Gray | <input type="checkbox"/> STN Yellow Green | <input type="checkbox"/> STN Blue | | |
| Rear Polarizer | <input checked="" type="checkbox"/> Reflective | <input type="checkbox"/> Transflective | | <input type="checkbox"/> Transmissive | |
| Backlight Type | <input type="checkbox"/> LED | <input type="checkbox"/> Internal Power | <input type="checkbox"/> EL | | <input type="checkbox"/> 5V input |
| | | <input type="checkbox"/> External Power | <input type="checkbox"/> CCFL | | <input type="checkbox"/> 12V input |
| Backlight Color | <input type="checkbox"/> White | <input type="checkbox"/> Amber | <input type="checkbox"/> Blue Green | <input type="checkbox"/> Yellow Green | <input type="checkbox"/> Other |
| Temperature Range | <input type="checkbox"/> Normal | | <input checked="" type="checkbox"/> Wide | | <input type="checkbox"/> Super Wide |
| CCFL Inverter | <input type="checkbox"/> Build-in | | <input checked="" type="checkbox"/> Not Build-in | | |
| EL Driver IC | <input type="checkbox"/> Build-in | | <input checked="" type="checkbox"/> Not Build-in | | |
| Touch Screen | <input type="checkbox"/> With | | <input checked="" type="checkbox"/> Without | | |

TO BE VERY CAREFUL !

The LCD driver ICs are made of CMOS process, which is very easy to be damaged by static charge, make sure the user is grounded when handling the LCM.

| REV. | DESCRIPTION | DRAWN | CHECK | APP'D | DATE |
|------|-------------|-------|-------|-------|------|
| | | | | | |



| PIN ASSIGNMENT | |
|----------------|-----------|
| 1. VSS | 5. R/W |
| 2. VDD | 6. E |
| 3. VEE | 7. DE0 |
| 4. RS | 8. DB1 |
| 9. DB2 | 10. DB3 |
| 11. DB4 | 12. DB5 |
| 13. DB6 | 14. DB7 |
| 15. BKL A | 16. BKL K |

| | | | | | |
|-----------|------------|------------|-----------|---|-------------|
| NO. | M-20200X | Q'TY | 10-21-99' | MATERIAL | FINISH |
| PART NAME | | DATE: | | | |
| DRAWN | Henry | CHECK | Chris | APP'D | Sunny |
| UNIT:MM | | SCALE: 1/1 | | UNLESS OTHERWISE SPECIFIED TOLERANCE ON FRACTIONS DECIMALS ANGLES 0.10 0.5° | |
| PRODUCT: | MTC-20200X | DWG NO.: | C20200X0 | FILE: DWG\MTC20\C20200X | SHEET 1 / 1 |
| Rev: | A | | | | |

6 5 4 3 2 1

A B C D A B C D

GENERAL SPECIFICATION

| Item | Content |
|-------------------------|----------------------------------|
| Display Resolution | 20 Characters×2 lines |
| Dimensional Outline(mm) | 116.0(W)×37.0(H)×10.0 max(D) |
| Display mode | Reflective/ Positive Type |
| Circuit | Controller IC, Segment-driver IC |
| Interface | Data (DB0~DB7), RS, R/W, E |

ABSOLUTE MAXIMUM RATING

(1) Electrical Absolute Ratings

| Item | Symbol | Min. | Max. | Unit | Note |
|----------------------------------|-----------------|------|--------------|------|------|
| Power Supply for Logic | $V_{DD}-V_{SS}$ | -0.3 | 7.0 | Volt | |
| Power Supply for LCD | $V_{DD}-V_O$ | 0 | 15.0 | Volt | |
| Input Voltage | V_{IN} | -0.3 | $V_{DD}+0.3$ | Volt | |
| Supply Current for LED backlight | I_{LED} | - | 420 | mA | |

Note: Operator should be grounded during handling LCM.

(2) Environmental Absolute Maximum Ratings

| Item | Normal Temperature | | | | Wide Temperature | | | |
|--------------------------------|--------------------|-------|----------|-------|------------------|-------|----------|-------|
| | Operating | | Storage | | Operating | | Storage | |
| | Max, | Min. | Max, | Min. | Max, | Min. | Max, | Min. |
| Ambient Temperature | 0°C | +50°C | -20°C | +70°C | -20°C | +70°C | -30°C | +80°C |
| Humidity(without condensation) | Note 2,4 | | Note 3,5 | | Note 4,5 | | Note 4,6 | |

Note 2 $T_a \leq 50^\circ\text{C}$: 80% RH max

$T_a > 50^\circ\text{C}$: Absolute humidity must be lower than the humidity of 85%RH at 50°C

Note 3 T_a at -20°C will be <48hrs at 70°C will be <120hrs when humidity is higher than 70%.

Note 4 Background color changes slightly depending on ambient temperature. This phenomenon is reversible.

Note 5 $T_a \leq 70^\circ\text{C}$: 75RH max

$T_a > 70^\circ\text{C}$: absolute humidity must be lower than the humidity of 75%RH at 70°C

Note 6 T_a at -30°C will be <48hrs, at 80°C will be <120hrs when humidity is higher than 70%.

ELECTRICAL CHARACTERISTICS

| Item | Symbol | Condition | Min. | Typ. | Max. | Unit | note |
|--|--------------------------------------|---|--------------|--------------|------|------|------|
| Power Supply for Logic | $V_{DD}-V_{SS}$ | - | 2.7 | 4.5 | 5.5 | Volt | |
| Input Voltage | V_{IL} | L level | V_{SS} | $0.2 V_{DD}$ | - | Volt | |
| | V_{IH} | H level | $0.8 V_{DD}$ | V_{DD} | - | Volt | |
| LCM Recommend LCD Module Driving Voltage | $V_{DD}=5.0V$ $V_{DD}-V_{O}=4.0V$ | $T_a=-20^{\circ}C$ | - | - | - | Volt | |
| | | $T_a=0^{\circ}C$ | - | - | - | | |
| | | $T_a=25^{\circ}C$ | 3.8 | 4.0 | 4.4 | | |
| | | $T_a=50^{\circ}C$ | - | - | - | | |
| Power Supply Current for LCM | I_{DD} (B/L OFF) | $V_{DD}=5.0V$ $V_{DD}-V_{O}=4.0V$ $T_a=25^{\circ}C$ | - | 1.5 | 2.0 | mA | |
| | I_{LED} | | 130 | 210 | 315 | | |

OPTICAL CHARACTERISTICS

| Item | Symbol | Condition | Min. | Typ | Max. | Unit | note |
|---------------------|-----------------------|--|------|-----|------|--------|------|
| Viewing angle range | Φf (12 o'clock) | When $Cr \geq 2$ | - | 40 | - | Degree | 9,10 |
| | Φb (6 o'clock) | | - | 50 | - | | |
| | Φl (9 o'clock) | | - | 40 | - | | |
| | Φr (3 o'clock) | | - | 40 | - | | |
| Rise Time | T_r | $V_{DD}-V_{O}=4.0V$ $T_a=25^{\circ}C$ | | 150 | 200 | mS | |
| Fall Time | T_f | | | 200 | 250 | | |
| Contrast | Cr | | - | 4.5 | - | | |

MECHANICAL SPECIFICATION

| | | |
|----------------------|-----------------|---|
| Product No. | | NMTC-S20200XRGHS |
| Module Size | | 116.0(W)mm×37.0(H)mm×10.0(D)mm Max |
| Display Format | | 20 characters×2 lines |
| Character Size | | 3.2 mm×5.55 mm |
| Character Pitch | | 3.7 mm×5.95 mm |
| Dot Size | | 0.60(W)mm×0.65(H)mm |
| Dot Pitch | | 0.65(W)mm×0.70(H)mm |
| Duty Ratio | | 1/16 Duty |
| Character Font Table | | <input checked="" type="checkbox"/> English <input type="checkbox"/> European <input type="checkbox"/> Other_____ |
| LCD Display Mode | STN | <input type="checkbox"/> Gray Mode <input checked="" type="checkbox"/> Yellow Mode <input type="checkbox"/> Blue Mode |
| | FSTN | <input type="checkbox"/> Black & White(Normally White/Positive Image) <input type="checkbox"/> Black & White(Normally White/Negative Image) |
| | Rear Polarizer: | <input checked="" type="checkbox"/> Reflective <input type="checkbox"/> Transflective <input type="checkbox"/> Transmissive |
| Viewing Direction | | <input checked="" type="checkbox"/> 6 O'clock <input type="checkbox"/> 12 O'clock <input type="checkbox"/> 3 O'clock <input type="checkbox"/> 9 O'clock |
| Backlight | | <input checked="" type="checkbox"/> Without <input type="checkbox"/> CCFL <input type="checkbox"/> EL <input type="checkbox"/> LED |
| Controller | | KS0066 or compatible |
| DC/DC Converter | | Without |
| CCFL Inverter | | Without |
| EL Driver | | Without |

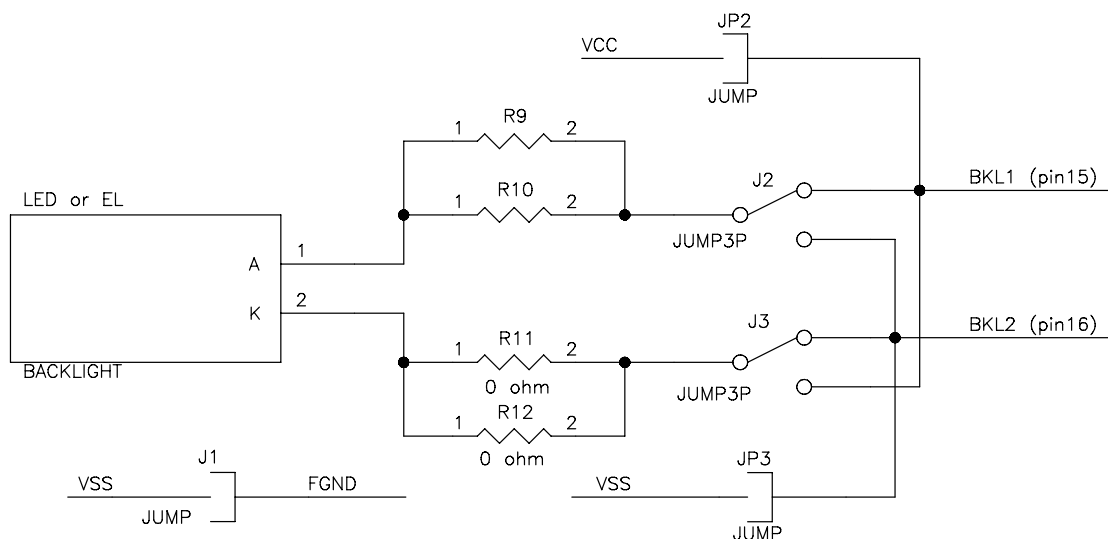
INTERFACE PIN ASSIGNMENT

| PIN NO. | PIN OUT | DESCRIPTION |
|--------------|-----------------|---|
| 1 | V _{SS} | Ground |
| 2 | V _{DD} | Logic Circuit Power Supply |
| 3 | V _O | Power Supply For LCD Panel, please refer to page 11 for connection. |
| 4 | RS | Data/ Instruction Register Select |
| 5 | R/W | Read/ Write Select |
| 6 | E | Enable Signal |
| 7 14 | DB0 DB7 | 3-State I/O Data Bus |
| 15 | BKL1 | Power Supply for Backlight. 100V/400Hz AC for EL, 4.2V or 210~ 315 mA DC for LED backlight |
| 16 | BKL2 | Don't care if no backlight |

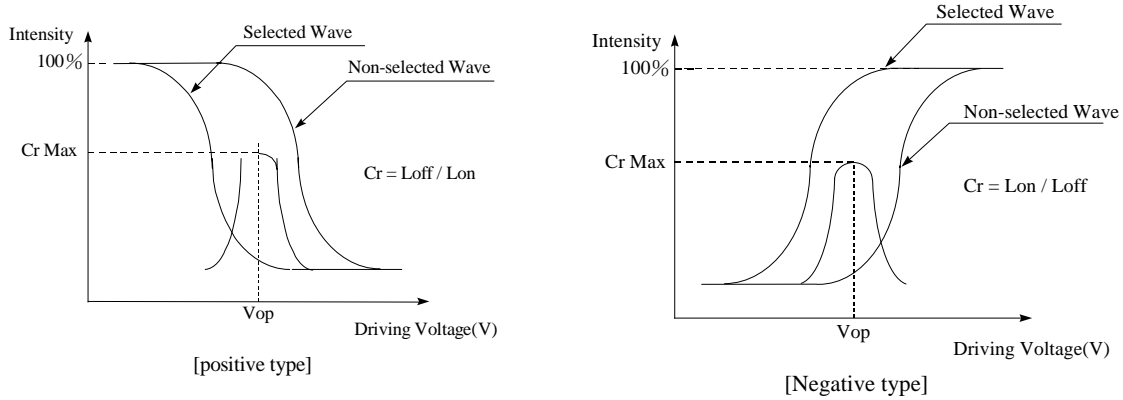
JUMPER EXPLANATION

1. JP2 and JP3 are both short: Pin15 is short with pin2 and pin16 is short with pin1. Backlight powered up via V_{DD} (pin2) and V_{SS} (pin1). Customer does not need to supply power to pin15 and pin16.
2. JP2 short and JP3 open: Pin 15 is short with Pin2 and pin16 is NOT short with pin1. Backlight is powered with V_{DD} (same as logic circuit) and customer should keep pin 15 floating or connected to V_{DD}. Customer could control the backlight independently ON or OFF with pin16 L or H.
3. JP2 open and JP3 short: Pin 15 is NOT short with pin 2 and pin16 is short with pin1. Backlight is common V_{SS} with logic and customer should keep pin16 floating or connected to ground (V_{SS}). Customer could control the backlight ON or OFF with pin15 H or L
4. JP2 and JP3 are both open: The backlight is fully independent with the logic, control the backlight via pin15/pin16 or A/K.
5. J1 short: Bezel and screw holes connected to GND. J1 open: Bezel and screw holes floating
6. Never change the J2 and J3, it may burn off your system.

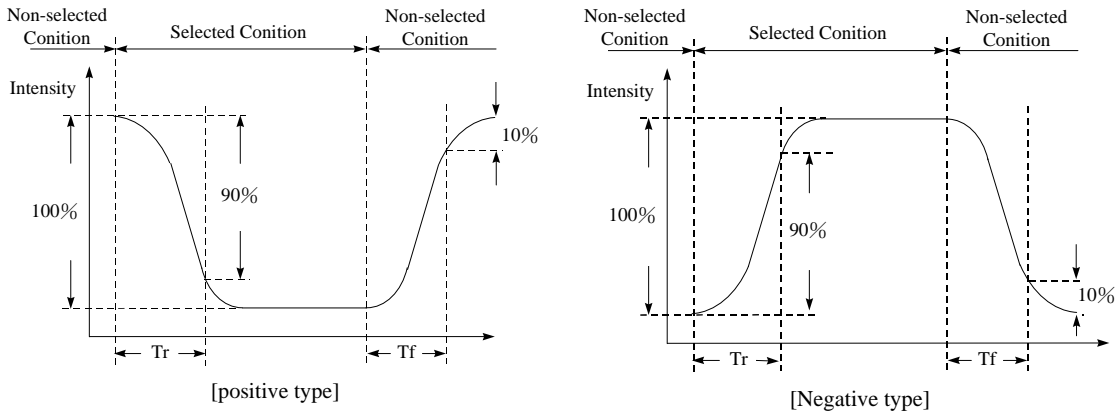
Note: J1, JP2 and JP3 are #0805 0 ohm resistors on the rear side of the PCB.



[Note 7] Definition of Operation Voltage (Vop)



[Note 8] Definition of Response Time (Tr, Tf)



Conditions:

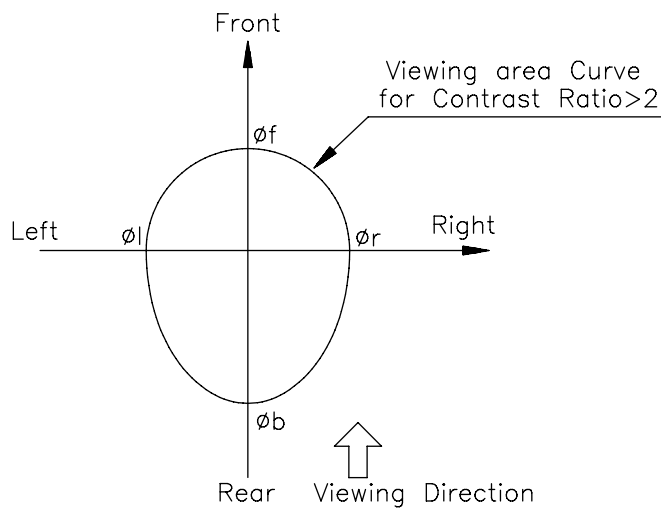
Operating Voltage : Vop

Frame Frequency : 64 Hz

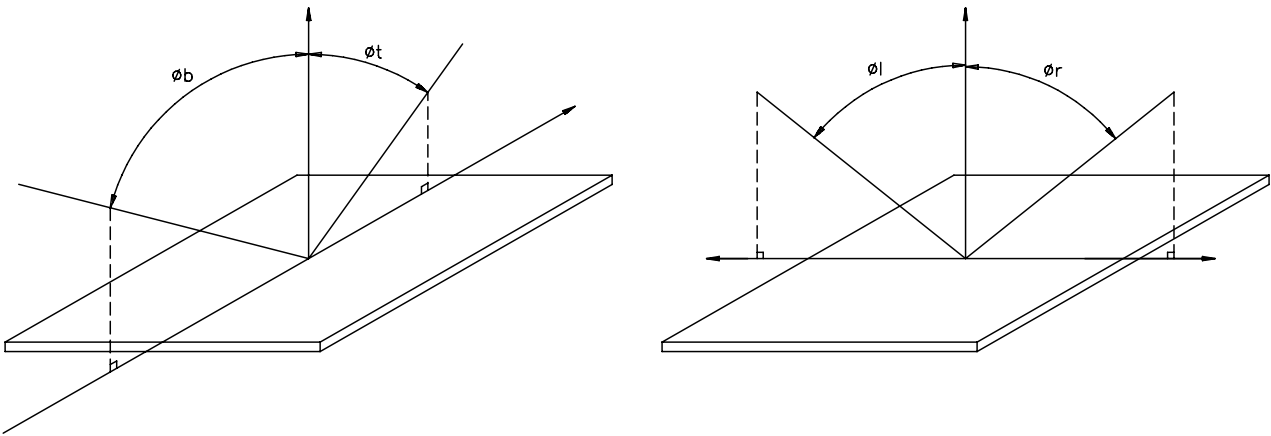
Viewing Angle (θ, φ): $0^\circ, 0^\circ$

Driving Wave form : 1/N duty, 1/a bias

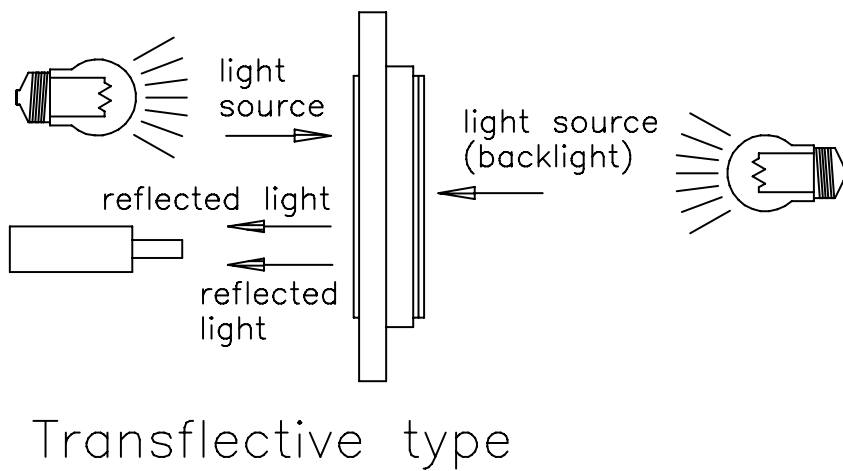
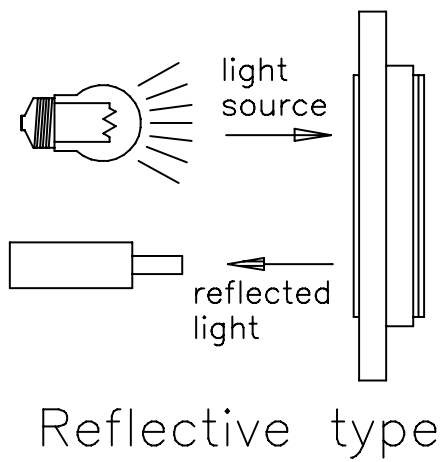
[Note 9] Definition of Viewing Direction



[Note 10] Definition of viewing angle



[Note 11] Description of Measuring Equipment



TIMING CHARACTERISTICS

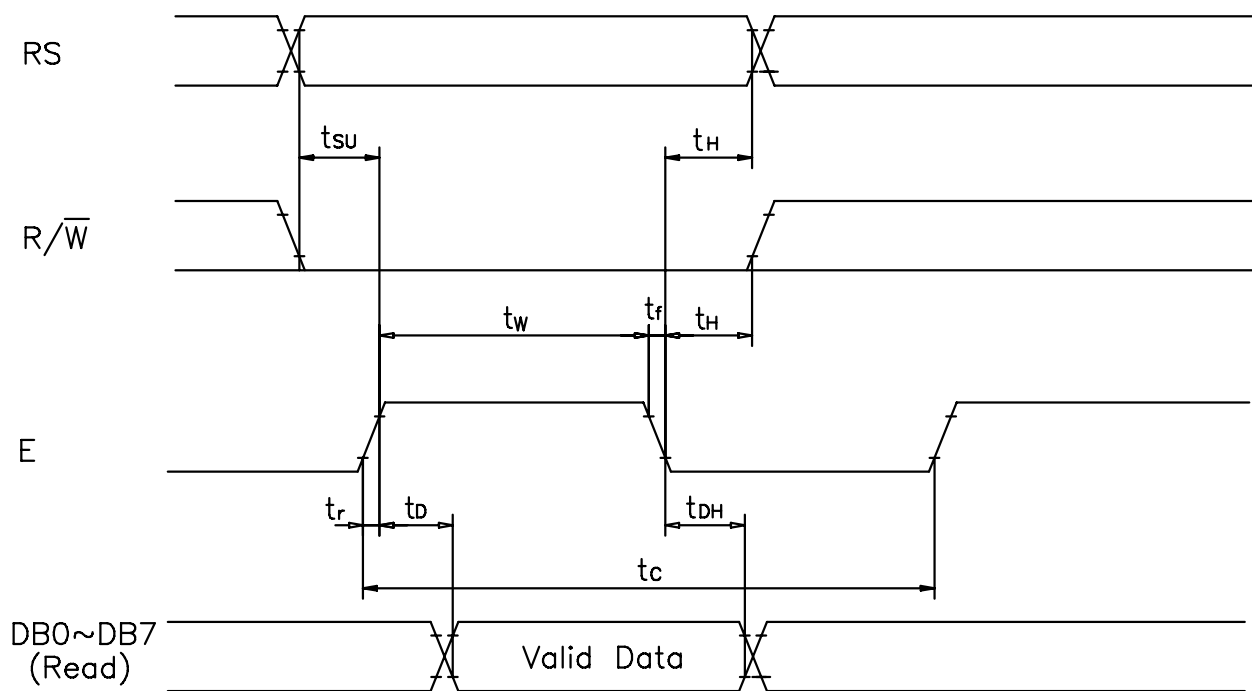
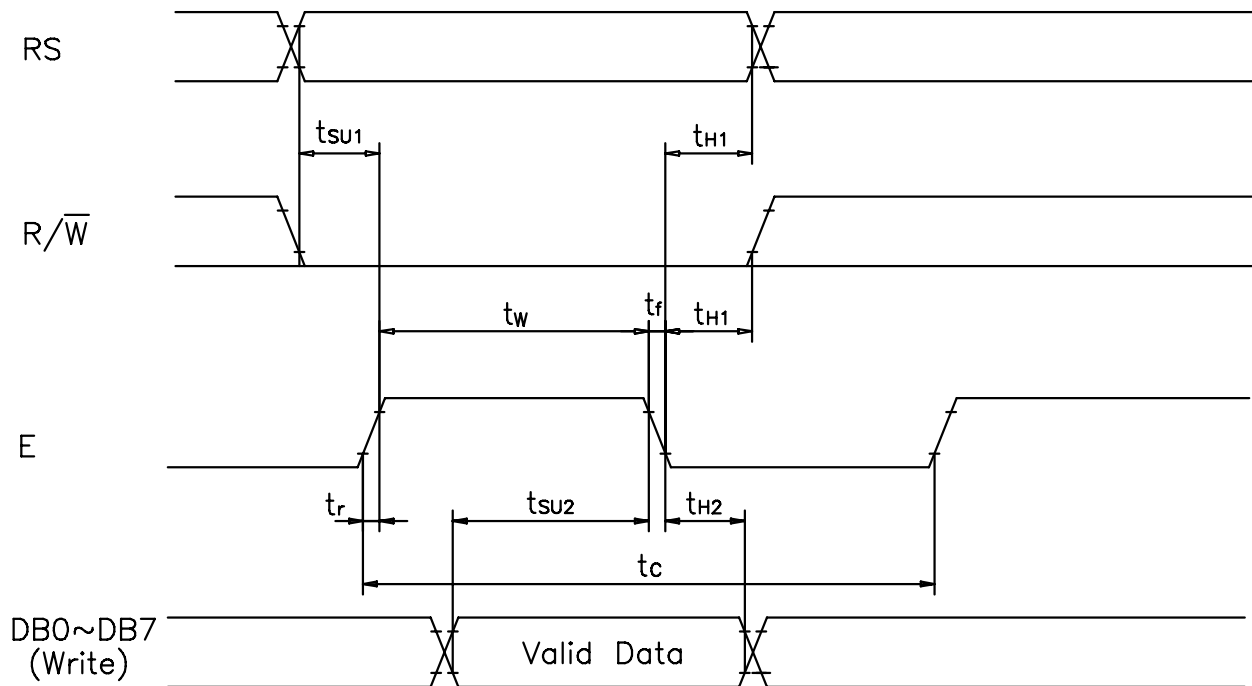
AC Characteristics ($V_{SS}=0V$, $V_{DD}=4.5V$ to $5.0V$, $T_a=0$ to $50^{\circ}C$)

| Mode | Characteristic | Symbol | Min. | Typ. | Max. | Unit |
|------------|--------------------------|------------|------|------|------|------|
| Write Mode | E Cycle Time | t_C | 500 | - | - | ns |
| | E Rise/Fall Time | t_R, t_F | - | - | 20 | ns |
| | E Pulse Width(High, Low) | t_W | 230 | - | - | ns |
| | R/W And RS Setup Time | t_{SU1} | 40 | - | - | ns |
| | R/W And RS Hold Time | t_{H1} | 10 | - | - | ns |
| | Data Setup Time | t_{SU2} | 80 | - | - | ns |
| | Data Hold Time | t_{H2} | 10 | - | - | ns |
| Read Mode | E Cycle Time | t_C | 500 | - | - | ns |
| | E Rise/Fall Time | t_R, t_F | - | - | 20 | ns |
| | E Pulse Width(High, Low) | t_W | 230 | - | - | ns |
| | R/W And RS Setup Time | t_{SU} | 40 | - | - | ns |
| | R/W And RS Hold Time | t_H | 10 | - | - | ns |
| | Data Setup Time | t_D | - | - | 120 | ns |
| | Data Hold Time | t_{DH} | 5 | - | - | ns |

AC Characteristics ($V_{SS}=0V$, $V_{DD}=2.7V$ to $4.5V$, $T_a=0$ to $50^{\circ}C$)

| Mode | Characteristic | Symbol | Min. | Typ. | Max. | Unit |
|------------|--------------------------|------------|------|------|------|------|
| Write Mode | E Cycle Time | t_C | 1000 | - | - | ns |
| | E Rise/Fall Time | t_R, t_F | - | - | 25 | ns |
| | E Pulse Width(High, Low) | t_W | 450 | - | - | ns |
| | R/W And RS Setup Time | t_{SU1} | 60 | - | - | ns |
| | R/W And RS Hold Time | t_{H1} | 20 | - | - | ns |
| | Data Setup Time | t_{SU2} | 195 | - | - | ns |
| | Data Hold Time | t_{H2} | 10 | - | - | ns |
| Read Mode | E Cycle Time | t_C | 1000 | - | - | ns |
| | E Rise/Fall Time | t_R, t_F | - | - | 25 | ns |
| | E Pulse Width(High, Low) | t_W | 450 | - | - | ns |
| | R/W And RS Setup Time | t_{SU} | 60 | - | - | ns |
| | R/W And RS Hold Time | t_H | 20 | - | - | ns |
| | Data Setup Time | t_D | - | - | 360 | ns |
| | Data Hold Time | t_{DH} | 5 | - | - | ns |

Read/Write Timing Chart



Commands

| Instruction | Instruction Code | | | | | | | | | | Description | Execution time(f_{OSC} is 270kHz) | |
|----------------------------|------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-------------|---|------------|
| | RS | R/W | DB7 | DB6 | DB5 | DB4 | DB3 | DB2 | DB1 | DB0 | | | |
| Clear Display | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | Write "20H" to DDRAM. and set DDRAM address to "00H" from AC | 1.53mS |
| Return Home | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | * | Set DDRAM address to "00H" from AC and return cursor to its original position if shifted. The contents of DDRAM are not changed. | 1.53mS |
| Entry Mode | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | I/D | SH | Assign cursor moving direction and make shift of entire display enable. | 39 μ S |
| Display ON/OFF | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | D | C | B | Set display(D), cursor(C), and blinking of cursor(B) on/off control bit. | 39 μ S |
| Cursor or Display Shift | 0 | 0 | 0 | 0 | 0 | 0 | 1 | S/C | R/L | * | * | Set cursor moving and display shift control bit, and the direction, without changing DDRAM data. | 39 μ S |
| Function Set | 0 | 0 | 0 | 0 | 0 | 1 | DL | N | F | * | * | Set interface data length (DL : 4-bit/8-bit), numbers of display line (N : 1-line/2-line), display font type(F : 5 X 8 dots/ 5 X 11 dots) | 39 μ S |
| Set CG RAM Address | 0 | 0 | 0 | 1 | AC5 | AC4 | AC3 | AC2 | AC1 | AC0 | | Set CGRAM address in address counter. | 39 μ S |
| Set DD RAM Address | 0 | 0 | 1 | AC6 | AC5 | AC4 | AC3 | AC2 | AC1 | AC0 | | Set DDRAM address in address counter. | 39 μ S |
| Read Busy Flag and Address | 0 | 1 | BF | AC6 | AC5 | AC4 | AC3 | AC2 | AC1 | AC0 | | Whether during internal operation or not can be known by reading BF. The contents of address counter can also be read. | 0 μ S |
| Write Data to RAM | 1 | 0 | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | | Write data into internal RAM (DDRAM/CGRAM). | 43 μ S |
| Read Data from RAM | 1 | 1 | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | | Read data from internal RAM (DDRAM/CGRAM). | 43 μ S |

* means don't care

COMMANDS DESCRIPTION

Clear Display

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

Clear all the display data by writing "20H" (space code) to all DDRAM address, and set DDRAM address to "00H" into AC (address counter). Return cursor to the original status. namely, bring the cursor to the left edge on first line of the display. Make entry mode increment (I/D = "1").

Return Home

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

Return Home is cursor return home instruction. Set DDRAM address to "00H" into the address counter. Return cursor to its original site and return display to its original status, if shifted. Content of DDRAM is not changed.

Entry Mode Set

| RS | R/W | DB7 | DB6 | DB5 | DB4 | DB3 | DB2 | DB1 | DB0 |
|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | I/D | SH |

Set the moving direction of cursor and display.

I/D : Increment / decrement of DDRAM address (cursor or blink)

When I/D = "High", cursor/blink moves to right and DDRAM address is increased by 1.

When I/D = "Low", cursor/blink moves to left and DDRAM address is decreased by 1.

* CGRAM operates the same as DDRAM, when read from or write to CGRAM.

SH: Shift of entire display

When DDRAM read (CGRAM read/write) operation or SH = "Low", shift of entire display is not performed. If SH = "High" and DDRAM write operation, shift of entire display is performed according to I/D value (I/D = "1" , shift left, I/D = "0" : shift right).

Display ON/OFF Control

| | | | | | | | | | |
|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| RS | R/W | DB7 | DB6 | DB5 | DB4 | DB3 | DB2 | DB1 | DB0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 | D | C | B |

Control display/cursor/blink ON/OFF 1 bit register.

D : Display ON/OFF control bit

When D = "High", entire display is turned on.

When D = "Low", display is turned off, but display data is remained in DDRAM.

C : Cursor ON/OFF control bit

When C = "High", cursor is turned on.

When C = "Low", cursor is disappeared in current display, but I/D register remains its data.

B : Cursor Blink ON/OFF control bit

When B = "High", cursor blink is on, that performs alternate between all the high data and display character at the cursor position.

When B = "Low", blink is off.

Cursor or Display Shift

| | | | | | | | | | |
|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| RS | R/W | DB7 | DB6 | DB5 | DB4 | DB3 | DB2 | DB1 | DB0 |
| 0 | 0 | 0 | 0 | 0 | 1 | S/C | R/L | * | * |

Without writing or reading of display data, shift right/left cursor position or display.

This instruction is used to correct or search display data. (Refer to Table 4)

During 2-line mode display, cursor moves to the 2nd line after 40th digit of 1st line.

Note that display shift is performed simultaneously in all the line.

When displayed data is shifted repeatedly, each line shifted individually.

When display shift is performed, the contents of address counter are not changed.

| S/C | R/L | Operation |
|-----|-----|---|
| 0 | 0 | Shift cursor to the left, AC is decreased by 1. |
| 0 | 1 | Shift cursor to the right, AC is increased by 1. |
| 1 | 0 | Shift all of the display to the left, cursor moves according to the display. |
| 1 | 1 | Shift all of the display to the right, cursor moves according to the display. |

Function Set

| RS | R/W | DB7 | DB6 | DB5 | DB4 | DB3 | DB2 | DB1 | DB0 |
|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 00 | 0 | 0 | 0 | 1 | DL | N | F | * | * |

DL : Interface data length control bit

When DL = "High", it means 8-bit bus mode with MPU.

When DL = "Low", it means 4-bit bus mode with MPU. So to speak, DL is a signal to select 8-bit or 4-bit bus mode. When 4-bit bus mode, it needs to transfer 4-bit data by two times.

N : Display line number control bit

When N = "Low", it means 1-line display mode.

When N = "High", 2-line display mode is set.

F : Display font type control bit

When F = "Low", it means 5 X 8 dots format display mode

When F = "High", 5 x11 dots format display mode.

Set CG RAM Address

| RS | R/W | DB7 | DB6 | DB5 | DB4 | DB3 | DB2 | DB1 | DB0 |
|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 0 | 0 | 0 | 1 | AC5 | AC4 | AC3 | AC2 | AC1 | AC0 |

Set CGRAM address to AC.

This instruction makes CGRAM data available from MPU.

Set DD RAM Address

| RS | R/W | DB7 | DB6 | DB5 | DB4 | DB3 | DB2 | DB1 | DB0 |
|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 0 | 0 | 1 | AC6 | AC5 | AC4 | AC3 | AC2 | AC1 | AC0 |

Set DDRAM address to AC.

This instruction makes DDRAM data available from MPU.

When 1-line display mode (N = 0), DDRAM address is from "00H" to "4FH".

In 2-line display mode (N = 1), DDRAM address in the 1st line is from "00H" to "27H", and DDRAM address in the 2nd line is from "40H" to "67H".

Read Busy Flag and Address

| RS | R/W | DB7 | DB6 | DB5 | DB4 | DB3 | DB2 | DB1 | DB0 |
|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 0 | 1 | BF | AC6 | AC5 | AC4 | AC3 | AC2 | AC1 | AC0 |

This instruction shows whether KS0066U is in internal operation or not. If the resultant BF is High, it means the internal operation is in progress and you have to wait until BF to be Low, and then the next instruction can be performed. In this instruction you can read also the value of address counter.

Write Data to RAM

| RS | R/W | DB7 | DB6 | DB5 | DB4 | DB3 | DB2 | DB1 | DB0 |
|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 1 | 0 | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |

Write binary 8-bit data to DDRAM/CGRAM.

The selection of RAM from DDRAM, CGRAM, is set by the previous address set instruction : DDRAM address set, CGRAM address set. RAM set instruction can also determine the AC direction to RAM. After write operation, the address is automatically increased/decreased by 1, according to the entry mode.

Read Data to RAM

| RS | R/W | DB7 | DB6 | DB5 | DB4 | DB3 | DB2 | DB1 | DB0 |
|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 1 | 0 | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |

Read binary 8-bit data from DDRAM/CGRAM.

The selection of RAM is set by the previous address set instruction. If address set instruction of RAM is not performed before this instruction, the data that read first is invalid, because the direction of AC is not determined. If you read RAM data several times without RAM address set instruction before read operation, you can get correct RAM data from the second, but the first data would be incorrect, because there is no time margin to transfer RAM data.

In case of DDRAM read operation, cursor shift instruction plays the same role as DDRAM address set instruction : it also transfers RAM data to output data register. After read operation address counter is automatically increased/decreased by 1 according to the entry mode. After CGRAM read operation, display shift may not be executed correctly.

NOTE: In case of RAM write operation, after this AC is increased/decreased by 1 like read operation. In this time, AC indicates the next address position, but you can read only the previous data by read instruction.

DD RAM ADDRESSING

For 16×1 or 8×1 Display

| | | | | | | | | | | | | | | | | |
|----------------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Character | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| DD RAM Address | 00 | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 |

For 16×2 or 8×2 Display

| | | | | | | | | | | | | | | | | |
|----------------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Character | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| DD RAM Address | 00 | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 0A | 0B | 0C | 0D | 0E | 0F |
| | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 4A | 4B | 4C | 4D | 4E | 4F |

For 16×4 Display

| | | | | | | | | | | | | | | | | |
|----------------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Character | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| DD RAM Address | 00 | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 0A | 0B | 0C | 0D | 0E | 0F |
| | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 4A | 4B | 4C | 4D | 4E | 4F |
| | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 1A | 1B | 1C | 1D | 1E | 1F |
| | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 5A | 5B | 5C | 5D | 5E | 5F |

For 20×2 Display

| | | | | | | | | | | | | | | | | |
|----------------|----|----|----|----|----|----|----|----|----|----|-----|-----|----|----|----|----|
| Character | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | ... | ... | 17 | 18 | 19 | 20 |
| DD RAM Address | 00 | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | ... | ... | 10 | 11 | 12 | 13 |
| | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | ... | ... | 50 | 51 | 52 | 53 |

For 20×4 Display

| | | | | | | | | | | | | | | | | |
|----------------|----|----|----|----|----|----|----|----|----|----|-----|-----|----|----|----|----|
| Character | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | ... | ... | 17 | 18 | 19 | 20 |
| DD RAM Address | 00 | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | ... | ... | 10 | 11 | 12 | 13 |
| | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | ... | ... | 50 | 51 | 52 | 53 |
| | 14 | 15 | 16 | 17 | 18 | 19 | 1A | 1B | 1C | 1D | ... | ... | 24 | 25 | 26 | 27 |
| | 54 | 55 | 56 | 57 | 58 | 59 | 5A | 5B | 5C | 5D | ... | ... | 64 | 65 | 66 | 67 |

For 40×2 Display

| | | | | | | | | | | | | | | | | |
|----------------|----|----|----|----|----|----|----|----|----|----|-----|-----|----|----|----|----|
| Character | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | ... | ... | 37 | 38 | 39 | 40 |
| DD RAM Address | 00 | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | ... | ... | 24 | 25 | 26 | 27 |
| | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | ... | ... | 64 | 65 | 66 | 67 |

For 40×4 Display

| | | | | | | | | | | | | | | | | | |
|----------------|----|----|----|----|----|----|----|----|----|----|----|-----|-----|----|----|----|----|
| Character | E | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | ... | ... | 37 | 38 | 39 | 40 |
| DD RAM Address | E1 | 00 | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | ... | ... | 24 | 25 | 26 | 27 |
| | | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | ... | ... | 64 | 65 | 66 | 67 |
| DD RAM Address | E2 | 00 | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | ... | ... | 24 | 25 | 26 | 27 |
| | | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | ... | ... | 64 | 65 | 66 | 67 |

CG RAM MAPPING

| Character Code (DD RAM data) | | | | | | | | CG RAM Address | | | | | | Character Patterns (CG RAM data) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---------------------------------|---|---|---|-----|---|---|---|----------------|---|---|-----|---|---|---|---|---|---|-----|---|---|---|---------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|--------------------|---|---|---|---|--------------------|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | 5 | 4 | 3 | 2 | 1 | 0 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| High | | | | Low | | | | High | | | Low | | | High | | | | Low | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0 0 0 0 * 0 0 0 | | | | | | | | 0 0 0 | | | | | | <table border="1"> <tr><td>0</td><td>1</td><td>1</td><td>0</td><td>0</td></tr> <tr><td>1</td><td>0</td><td>0</td><td>1</td><td>0</td></tr> <tr><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td></tr> <tr><td>0</td><td>1</td><td>1</td><td>0</td><td>0</td></tr> <tr><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td></tr> <tr><td>1</td><td>1</td><td>1</td><td>1</td><td>0</td></tr> <tr><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr> <tr><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr> <tr><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr> </table> | | | | | | | | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ←Character Pattern |
| 0 | 1 | 1 | 0 | 0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1 | 0 | 0 | 1 | 0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0 | 0 | 1 | 0 | 0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0 | 1 | 1 | 0 | 0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0 | 1 | 0 | 0 | 0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1 | 1 | 1 | 1 | 0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0 | 0 | 0 | 0 | 0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0 | 0 | 0 | 0 | 0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0 | 0 | 0 | 0 | 0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | ←Cursor | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0 0 0 0 * 0 0 1 | | | | | | | | 0 0 1 | | | | | | <table border="1"> <tr><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td></tr> <tr><td>1</td><td>0</td><td>0</td><td>0</td><td>1</td></tr> <tr><td>1</td><td>0</td><td>1</td><td>0</td><td>1</td></tr> <tr><td>1</td><td>0</td><td>1</td><td>1</td><td>1</td></tr> <tr><td>1</td><td>0</td><td>1</td><td>0</td><td>1</td></tr> <tr><td>1</td><td>0</td><td>0</td><td>0</td><td>1</td></tr> <tr><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td></tr> <tr><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr> </table> | | | | | | | | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | ←Character Pattern | | | | | |
| 1 | 1 | 1 | 1 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1 | 0 | 0 | 0 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1 | 0 | 1 | 0 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1 | 0 | 1 | 1 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1 | 0 | 1 | 0 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1 | 0 | 0 | 0 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1 | 1 | 1 | 1 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0 | 0 | 0 | 0 | 0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | ←Cursor | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0 0 0 0 * 1 1 1 | | | | | | | | 1 1 1 | | | | | | <table border="1"> <tr><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td></tr> <tr><td>1</td><td>0</td><td>0</td><td>0</td><td>1</td></tr> <tr><td>1</td><td>1</td><td>1</td><td>0</td><td>1</td></tr> <tr><td>1</td><td>0</td><td>0</td><td>0</td><td>1</td></tr> <tr><td>1</td><td>0</td><td>1</td><td>1</td><td>1</td></tr> <tr><td>1</td><td>0</td><td>0</td><td>0</td><td>1</td></tr> <tr><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td></tr> <tr><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr> </table> | | | | | | | | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | ←Character Pattern | | | | | |
| 1 | 1 | 1 | 1 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1 | 0 | 0 | 0 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1 | 1 | 1 | 0 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1 | 0 | 0 | 0 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1 | 0 | 1 | 1 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1 | 0 | 0 | 0 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1 | 1 | 1 | 1 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0 | 0 | 0 | 0 | 0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | ←Cursor | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

CHARACTER FONT TABLE

| Upper 4 bits Lower 4 bits | 0000 | 0001 | 0010 | 0011 | 0100 | 0101 | 0110 | 0111 | 1000 | 1001 | 1010 | 1011 | 1100 | 1101 | 1110 | 1111 |
|------------------------------------|------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 0000 | CG RAM (1) | | | 0 | a | P | ' | P | | | | 一 | ㄱ | ㄷ | ㄹ | ㅍ |
| 0001 | CG RAM (2) | | ! | 1 | A | Q | a | q | | | ㅅ | ㅈ | ㅊ | ㅋ | ㆁ | ㆃ |
| 0010 | CG RAM (3) | | " | 2 | B | R | b | r | | | ㅌ | ㅍ | ㅑ | ㅓ | ㅕ | ㅗ |
| 0011 | CG RAM (4) | | # | 3 | C | S | c | s | | | ㅖ | ㅗ | ㅛ | ㅜ | ㅠ | ㅡ |
| 0100 | CG RAM (5) | | \$ | 4 | D | T | d | t | | | ㅝ | ㅞ | ㅟ | ㅠ | ㅡ | ㅢ |
| 0101 | CG RAM (6) | | % | 5 | E | U | e | u | | | ㅣ | ㅤ | ㅥ | ㅦ | ㅧ | ㅨ |
| 0110 | CG RAM (7) | | & | 6 | F | V | f | v | | | ㅩ | ㅪ | ㅫ | ㅬ | ㅭ | ㅮ |
| 0111 | CG RAM (8) | | ' | 7 | G | W | g | w | | | ㅯ | ㅨ | ㅩ | ㅪ | ㅫ | ㅬ |
| 1000 | CG RAM (1) | | (| 8 | H | X | h | x | | | ㅭ | ㅮ | ㅯ | ㅨ | ㅩ | ㅪ |
| 1001 | CG RAM (2) | |) | 9 | I | Y | i | y | | | ㅫ | ㅬ | ㅭ | ㅮ | ㅯ | ㅨ |
| 1010 | CG RAM (3) | | * | # | J | Z | j | z | | | ㅯ | ㅮ | ㅭ | ㅨ | ㅩ | ㅪ |
| 1011 | CG RAM (4) | | + | # | K | L | k | l | | | ㅯ | ㅮ | ㅭ | ㅨ | ㅩ | ㅪ |
| 1100 | CG RAM (5) | | , | < | L | * | l | l | | | ㅯ | ㅮ | ㅭ | ㅨ | ㅩ | ㅪ |
| 1101 | CG RAM (6) | | - | = | M | N | m | n | | | ㅯ | ㅮ | ㅭ | ㅨ | ㅩ | ㅪ |
| 1110 | CG RAM (7) | | . | > | N | ^ | n | + | | | ㅯ | ㅮ | ㅭ | ㅨ | ㅩ | ㅪ |
| 1111 | CG RAM (8) | | / | ? | O | _ | o | + | | | ㅯ | ㅮ | ㅭ | ㅨ | ㅩ | ㅪ |

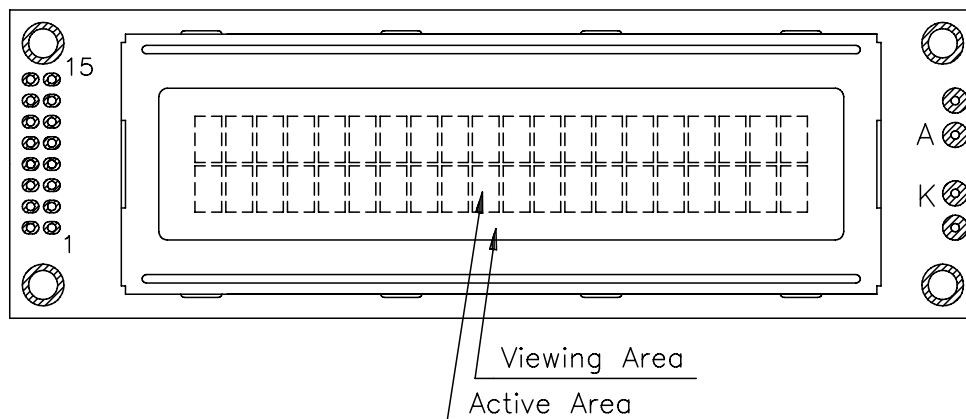
RELIABILITY TEST

| No | Item | Conditions | | Note |
|----|----------------------------------|---|-----------|----------------------|
| 1 | High Temp. Operation | 70°C | 240 HR | |
| 2 | High Temp. Storage | 80°C | 240 HR | |
| 3 | Low Temp. Operation | -20°C | 240 HR | |
| 4 | Low Temp. Storage | -30°C | 240 HR | |
| 5 | High Temp./Humid Storage | 60°C 90%RH | 240 HR | |
| 6 | Thermal Shock | 0°C ,30min +50°C ,30min | 10 cycles | |
| 7 | Vibration Test (IEC-68-2-6) | Frequency : 10~55 Hz Duration : 20 times, 6 min/time Amplitude : 0.75 mm | - | |
| 8 | Shock (IEC 68-2-27) | Duration : 11 mS Acceleration : 100g | - | X, Y, Z direction |

APPEARANCE CHECK

CONDIITON OF APPEARANCE CHECK:

- (1) Specimen shall be checked by eyes in distance of 30cm under 40w-fluorescence lamp.
- (2) Checking direction shall be in 45 degree from perpendicular line op specimen surface.



HANDLING PRECAUTIONS

- (1) Treat polarizer very carefully since it is easy to be damaged.
- (2) When cleaning the display surface, use soft cloth (e.g. gauss) with a solvent (recommended below) and wipe lightly.
 - ◆ ethyl alcohol
 - ◆ iso-procolol

Do not wipe the display surface with dry or hard materials that will damage the polarizer surface.

Do not use the following solvents:

- ◆ water
- ◆ ketone
- ◆ aromatics

- (3) Direct current causes electro-chemical reaction with remarkable degradation of the display quality. Give careful consideration to prevent direct current at ON/OFF timing and during operation.
- (4) Avoid strong shock and drop from the height.
- (5) To prevent LCD panels from degradation, do not operate or store them exposed directly to sunshine or high temperature/humidity.
- (6) Give careful consideration to avoid electrical static discharge with causes uneven contrast.
- (7) Even a small condensation on the contact pads (terminals) causes electro-chemical reaction which makes missing row and column. Give careful attention to avoid condensation. When assembling with zebra connector, clean the surface of the pads with alcohol and keep the air very clean.

LCD PRODUCT QUALITY STANDARD

DISPLAY APPEARANCE

| No | Item | Criteria |
|----|---|--|
| 1 | inclusions (black spot, white spot, dust) | (1)round type diameter mm(a*) no of defect* $a \leq 0.20$ neglect $0.20 < a \leq 0.35$ 5max $0.35 < a$ none (2)linear type length mm(l) width mm(W) no. of defect na $W \leq 0.03$ neglect $1 \leq 3$ $0.03 < W \leq 0.08$ 6 $3 < l$ $0.08 < W$ none |
| 2 | scratch | 1. scratch on protective film is permitted. 2. scratch on polarizer shall be as follow: (1)round type diameter mm(a*) no of defect $a \leq 0.15$ neglect $0.15 < a \leq 0.20$ 2 max $0.20 < a$ none (2)linear type be judged bye 1.-(2) linear type |
| 3 | dent | diameter < 1.5mm |
| 4 | bubble | not exceeding 0.5mm average diameter is acceptable between glass and polarizing film |
| 5 | pin hole | $(a+b)/2 \leq 0.15\text{mm}$ maximum number: ignored $0.15 < (a+b)/2 \leq 0.20\text{mm}$ maximum number: 10 |
| 6 | dot defect | $(a+b)/2 \leq 0.20\text{mm}$ maximum number: ignored $0.20 < (a+b)/2 \leq 0.30\text{mm}$ maximum number: 5 x=width |
| 7 | contrast irregularity(spot) | diameter spec no of defect $a \leq 0.50\text{mm}$ neglect $0.50 < a \leq 0.75$ 5 $0.75 < a \leq 1.00$ 3 $1.00 < a$ none |
| 8 | dot width | design width $\pm 15\%$ |
| 9 | color tone and uniformity | obvious uneven color is not permitted |

