# DOT MATRIX VFD MODULE M402SD07AA
# INSTRUCTION MANUAL

## GENERAL DESCRIPTION

Futaba Vacuum Fluorescent Display Module M402SD07AA, with Futaba VFD 402-SD-07GK display, produces 40 digits on 2 rows.
Each character is displayed in 5×7 dot matrix with the cursor under it.
Consisting of a VFD, microcomputer, driver IC, the module can be connected directly to the system bus, thus simplifying interfacing.
The bright and aesthetically pleasing VFD makes the module desirable for application in office equipments, such as electronic typewriters, computer terminals, measuring equipment, etc.

CONTENTS

# 1. FEATURES

1-1. Using a one chip computer, the module can be connected to the system bus directly.

1-2. Two hundred nineteen different characters consisting of alpha-numeric and other symbols can be displayed.

1-3. Since a DC/DC converter is included, only a 5V power source is required to operate the module.

1-4. High quality reliability and long life can be achieved with FUTABA VFD.

1-5. Either parallel or serial mode can be selected as the data input form.

1-6. The module's small, light and thin mechanical sizing allows for maximum mounting flexibility.

1-7. The module's surface mount components allow for maximum reliability.

1-8. The module has up to three definable characters, it can be displayed original fonts.

1-9. The cursor located character code can be read from the host system.

1-10. Four levels of brightness control is available.

## 2. GENERAL SPECIFICATIONS

### 2-1. DIMENSIONS, WEIGHT (Refer APPENDIX-1)

TABLE-1

| Item | Specification | Unit |
|---|---|---|
| Outer Dimensions | (W) 240±1<br>(H) 50±1<br>(T) 21 Max<br>(Without connector) | mm |
| Weight | APPROX. 150 | g |

### 2-2. SPECIFICATIONS OF THE DISPLAY PANEL

TABLE-2

| Item | Specification | Unit |
|---|---|---|
| Display area | 186.8×16.4 | mm |
| Number of digits | 40digits(5×7 with cursor)<br>×2rows | — |
| Digits size (H×W) | 5.0×3.5 | mm |
| Digits pitch (H×W) | 10.0×4.7 | mm |
| Color of illumination | Green(λp=505nm) | — |

### 2-3. ENVIRONMENT CONDITIONS

TABLE-3

| Item | Symbol | Min. | Max. | Unit |
|---|---|---|---|---|
| Operating temperature | $T_{opr}$ | -20 | +70 | ℃ |
| Storage temperature | $T_{stg}$ | -40 | +85 | ℃ |
| Operating humidity | $H_{opr}$ | 20 | 85 | % |
| Storage humidity | $H_{stg}$ | 20 | 95 | % |
| Vibration (10 to 55 Hz) | — | — | 4 | G |
| Shock | — | — | 40 | G |

Note) Avoid operations and or storage in moist environmental conditions.

### 2-4. ABSOLUTE MAXIMUM RATINGS

TABLE-4

| Item | Symbol | Min. | Max. | Unit |
|---|---|---|---|---|
| Supply voltage | $V$cc | -0.3 | 6.5 | $V$dc |
| Input signal voltage | $V_{IS}$ | -0.3 | 5.5 | $V$ |

## 2-5. RECOMMENDED OPERATING CONDITIONS

TABLE-5

| Item | Symbol | Condition | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| Supply voltage | $V_{CC}$ | — | 4.5 | 5.0 | 5.5 | Vdc |
| H-level input voltage | $V_{IH}$ | $V_{CC}$=5V | 2.6 | — | — | V |
| L-level input voltage | $V_{IL}$ | $V_{CC}$=5V | — | — | 0.5 | V |

## 2-6. ELECTRICAL CHARACTERISTICS

TABLE-6

| Item | Symbol | Condition | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| Supply current | $I_{CC}$ | $V_{CC}$=5V<br>All on | — | 750 | 1000 | mA |
| Power consumption | — | | — | 3.75 | — | W |
| Luminance | $L$ | | 350 (102) | 700 (204) | — | cd/m$^2$ (fL) |
| H-level input current | $I_{IH}$ | $V_{CC}$=5V | — | — | 20 | $\mu$A |
| L-level input current | $I_{IL}$ | $V_{CC}$=5V | -0.6 | — | — | mA |
| H-level output voltage | $V_{OH}$ | $V_{CC}$=5V<br>$I_{OH}$=-2mA | 3.5 | — | — | V |
| L-level output voltage | $V_{OL}$ | $V_{CC}$=5V<br>$I_{OL}$=6mA | — | — | 0.5 | V |

Note) The surge current can be approx. 10 times the specified supply current at power on.

## 3. FUNCTIONS

The module has data and control code write, data read, Blanking, SELF-TEST, and hardware reset function.

TABLE-7

| | $\overline{RESET}$ | $\overline{TEST}$ | $\overline{BLANK}$ | $\overline{SEL}$ | A0/$\overline{RTS}$ | $\overline{WR}$ | $\overline{RD}$ | FUNCTION |
|---|---|---|---|---|---|---|---|---|
| Parallel or Serial Interface | L | — | — | — | — | — | — | Hardware reset |
| | H | L | — | — | — | — | — | Self test |
| | H | — | L | — | — | — | — | Blanking |
| Parallel Interface | H | H | — | L | L | L→H | H | Data and control code write in |
| | H | H | — | L | L | H | L | Data read |
| | H | H | — | L | H | H | L | Status read |
| Serial Interface | H | H | — | NC | H | NC | NC | Data and control code write in |
| | H | H | — | NC | H | NC | NC | Data read |

NC : No Connection
L : Low Level (0V)
H : High Level (5V)
— : Irrelevant included
No. connection

TABLE-7 THE BASIC FUNCTIONS

### 3-1. DATA AND CONTROL CODE WRITE IN

When the data is being written in, the BUSY signal is active which indicates that the module is processing the data.
(When the data is under processing, the BUSY signal is high "H".)
The display character from follows equivalent to ASCII (Alphabet, Numerics and Symbols etc).
After a character is written in, the cursor will be shifted to the right one digit automatically.
The above action can be executed, only when the BUSY signal is low "L".

## 3-2. CONTROL CODE

The control codes are available as follows.
The details will be explained on the next page.

(1) DEF : Define Characters UF0～2 : (03HEX)
(2) DIM : Dimming : (04HEX)
(3) DDR : Displayed Data Read : (05HEX)
(4) BS : Back Space : (08HEX)
(5) LF : Line Feed : (0AHEX)
(6) HM : Cursor Home Position : (0BHEX)
(7) CL : Carriage Return & Line Feed : (0CHEX)
(8) CR : Carriage Return : (0DHEX)
(9) DP : Display Position : (10HEX)
(10) DC1 : Normal Display Mode : (11HEX)
(11) DC2 : Vertical Scroll Mode : (12HEX)
(12) DC3 : Horizontal Scroll Mode : (13HEX)
(13) DC4 : Over Write Mode : (14HEX)
(14) DC5 : Cursor ON Mode : (15HEX)
(15) DC6 : Cursor OFF Mode : (16HEX)
(16) DC7 : Cursor Blink Mode : (17HEX)
(17) DC8 : Display OFF (Blanking) Mode : (18HEX)
(18) DC9 : Display ON Mode : (19HEX)
(19) RT : Cursor Right Shift : (1CHEX)
(20) LT : Cursor Left Shift : (1DHEX)
(21) UD : Cursor Up Down : (1EHEX)
(22) RST : Reset : (1FHEX)

(1) DEF (Define UF0～2)

The DEF command defines user definable characters, UF0～2.
These fonts are stored in the module as follows.

| 1 byte<br>DEF command code,<br>(03 H) | 1 byte<br>Position code<br>(FCH to FEH) | 5 bytes<br>The font data |
|---|---|---|

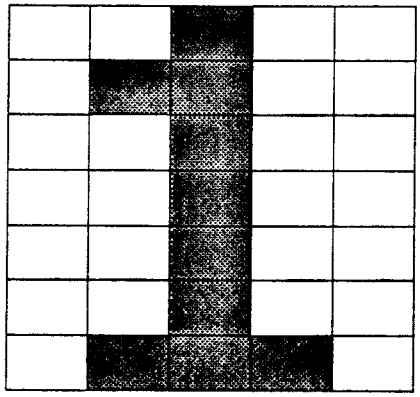
| | | | | | | |
|---|---|---|---|---|---|---|
| 1-1 | 2-1 | 3-1 | 4-1 | 5-1 | | |
| 1-2 | 2-2 | 3-2 | 4-2 | 5-2 | | |
| 1-3 | 2-3 | 3-3 | 4-3 | 5-3 | | |
| 1-4 | 2-4 | 3-4 | 4-4 | 5-4 | | |
| 1-5 | 2-5 | 3-5 | 4-5 | 5-5 | | |
| 1-6 | 2-6 | 3-6 | 4-6 | 5-6 | | |
| 1-7 | 2-7 | 3-7 | 4-7 | 5-7 | | |

(a) Character font

| | | Bit | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Byte | 1st | 1-1 | 2-1 | 3-1 | 4-1 | 5-1 | 1-2 | 2-2 | 3-2 |
| | 2nd | 4-2 | 5-2 | 1-3 | 2-3 | 3-3 | 4-3 | 5-3 | 1-4 |
| | 3rd | 2-4 | 3-4 | 4-4 | 5-4 | 1-5 | 2-5 | 3-5 | 4-5 |
| | 4th | 5-5 | 1-6 | 2-6 | 3-6 | 4-6 | 5-6 | 1-7 | 2-7 |
| | 5th | 3-7 | 4-7 | 5-7 | "L" | "L" | "L" | "L" | "L" |

(b) Font data

Example of write-in character "1" in UF0.
Control and data strings 03H, FCH, 23H, 08H, 42H, 11H, C0H.



(a) Character

| | | Bit | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Byte | 1st | L | L | H | L | L | L | H | H |
| | 2nd | L | L | L | L | H | L | L | L |
| | 3rd | L | H | L | L | L | L | H | L |
| | 4th | L | L | L | H | L | L | L | H |
| | 5th | H | H | L | L | L | L | L | L |

(b) Font data "L":Turn ON "H":Turn OFF

FIG. 1 Defining User's font

It is recommended to store these definable characters at the initializing of module.
All these data will remain into the RAM and the client can display user's original font on VFD module.
There is no back-up system of this RAM, therefore, it is needed to restore these data when power off.

(2) DIM (Dimming)

Brightness can be controled into four level by using this function.
After writing 04H, another HEX byte mentioned under is written to change the brightness out put.

| 1 byte | + | 1 byte |
|---|---|---|
| (DIM command code), 04H | | Dimming level data |

TABLE-8

| Dimming Level | Data |
|---|---|
| 100% | FFH |
| 60% | 60H |
| 40% | 40H |
| 20% | 20H |

(3) DDR (Displayed Data Read)

This command makes possible to read the character code that is located a cursor. (Refer 3-3. Data and status Read.)

(4) BS (Back Space)

The cursor position (write-in position) is shifted to the left one digit. (beyond this point, the position of cursor is identical with write-in position of the display, unless otherwise specified. Under DC8 MODE, the cursor will not show up.)
When the cursor is on the most significant digit of the second row, the cursor moves to the least significant digit of the first row.
When the cursor is on the most significant digit of the first row, this code is ignored.

(5) LF (Line Feed)

When the cursor is in the second row, the character displayed there, is shifted up to the first row, leaving the cursor at its present position, then the second row is cleared.
When the cursor is in the first row, the cursor moves down to another row staying on the same line.

(6) HM (Home Position)

The cursor moves to the most significant digit of the first row without clearing displayed characters.

(7) CL (Carriage Return & Line Feed)

When the cursor is in the second row, the character displayed there is shifted up to the first row, and the cursor moves to the most significant digit of the second row.

When the cursor is in the first row, the cursor moves to the most significant digit of the second row.

(8) CR (Carriage Return)

The cursor to the most significant digit of the same row.

(9) DP (Display Position)

Instead of writing the character from the first digit, the write-in starting position can be pointed by using this function.

After writing 10HEX to module for this command, another HEX byte is written to specify the position desired.

A third byte representing data is then sent.

| | The most significant digit | The least significant digit |
|---|---|---|
| 1st row | 00 HEX | 27 HEX |
| 2nd row | 28 HEX | 4F HEX |

(10) DC1 (Normal Display Mode)

After writing a character, the cursor is shifted to the right one digit automatically.

When the cursor is on the least significant digit of the first row, the cursor moves to the most significant digit of the second row.

When the character is displayed on the least significant digit of the second row, cursor moves to the most significant digit of the first row.

And the character code is written in the module next, first, all digits are cleared, second, the character is displayed on the most significant digit of the first row and the cursor moves to the digit.

When the power is turn on, this DC1 MODE is selected, and will be held until another mode is selected.

(11) DC2 (Vertical Scroll Mode)

After writing the characters up to the least significant digit of the second row, all the characters displayed in the second row are shifted to the upper row (first row), clearing the second row.

(12) DC3 (Horizontal Scroll Mode)

When the character is on the least significant digit of the second row, the cursor is on the same digit.

The character is written in the module next, all digits shifted to the left, the one n the most significant digit of the second row moves on the least digit of the upper row, the character is displayed on the least digit of the lower.

(13) DC4 (Over Write Mode)

After writing a character, the cursor is shifted to the right one digit automatically.

When the cursor is on the least significant digit of the second row, the cursor moves to the significant digit of the second row.

When the cursor is on the least significant digit of the first row, the cursor moves to the most significant digit of the first row.

The character is not change till a new character is written in.

(14) DC5 (Cursor ON Mode)

The cursor is displayed.

(15) DC6 (Cursor OFF Mode)

The cursor won't be displayed.

(16) DC7 (Cursor Blink Mode)

The cursor is blinked.

When the power is turned on, this DC7 MODE is selected and will be held until DC5 or DC6 MODE is selected.

(17) DC8 (Display OFF Mode)

The all digits is disappeared.

(18) DC9 (Display ON Mode)

The all digits is displayed.

When the power is turned on, this mode is selected automatically.

(19) RT (Cursor Right Shift)

The cursor is shifted to the right.

When the cursor is on the least significant digit of the first row, the cursor moves to the most significant digit of the second row.

When the cursor is on the least significant digit of the second row, the cursor moves to the most significant digit of the first row.

The all digits aren't changed.

(20) LT (Cursor left shift)

The cursor is shifted to the left.
When the cursor is on the most significant digit of the first row, the cursor moves to the least significant digit of the second row.
When the cursor is on the most significant digit of the second row, the cursor moves to the least significant digit of the first row.
The all digits aren't changed.

(21) UD (Cursor Up Down)

The cursor moves to anothe row on the same column.
The all digits aren't changed.

(22) RST (Reset)

Resetting the module.
All the characters displayed are erased, then the write-in position (cursor position) is set on the most significant digit of the first row.
The displaying status is the same as the hardware Reset, but the font data of UF0～2 is kept.
The display mode is set for DC1, DC7, and DC9.

3-3. DATA AND STATUS READ

(1) Status Read (Parallel)

The module can be read the status when control signals are set as follows.
$\overline{SEL}$ and RD ="L"
A0, $\overline{WR}$, $\overline{TEST}$ and $\overline{RESET}$ ="H"
and BUSY signal is indicated on the data line D7.

(2) DATA READ

The character code located with the cursor will be desired to read, firstly the DDR command should be written in and after that, the control signals should be set the followed condition.

a) Parallel

$\overline{SEL}$, $\overline{RD}$ and A0 ="L"
$\overline{WR}$, $\overline{TEST}$ and A0 ="H"
Then, the character data will be set on the data bus.

b) Serial

When the $\overline{RTS}$ signal is turn "L", the module starts to send a data.
The $\overline{RTS}$ signal must be turned "H" after reading the one byte data.

3-4. SELF-TEST

$\overline{TEST}$="L" (Connector pin #2 is connected to GND.) status the SELF-TEST.
Then the display shows characters as follows.

I) Displaying full dot in all digits
II) Clearing all digits
III) Displaying the character of F4H in all digits
IV) Displaying the character of FBH in all digits
V) Displaying alphabet and other one after another

Eighty (2×40) character are displayed at a time.
Using this mode, neither data write-in nor control code write-in is allowed.
To release this mode, $\overline{TEST}$ must be set to "H".

3-5. HARDWARE RESET

When the module is turned on, or the $\overline{RESET}$ is set to "L" the display and the mmemory are cleared and the module is initialized.
The display mode is set for DC1, DC7, DC9.

3-6. BLANKING OF THE DISPLAY

The $\overline{BLANK}$ signal is set into "L", all digits will be put out.
But the character data is not cleared, therefore, when the BLANK signal is set into high "H", all digits will be displayed again.

3-7. SELECTION OF INPUT MODE

TABLE-10 shows the combinations of the signal lines for the parallel or serial input.
Users must choose one of the combinations.
Unused signal lines are to be open (internally pulled up).
When parallel input, output is selected, J6 must be open.
When serial input, output is selected, J6 must be short.
Then A0/$\overline{RTS}$ signal is defined a request to send signal of a serial line, "$\overline{RTS}$".
Baud rate is selected by J1～J3.

J1
J2 ├ Baud rate select
J3

TABLE-9

| J1 | short | open | short | open |
|---|---|---|---|---|
| J2 | short | short | open | open |
| J3 short | 7812.5 bps | 15625 | 31250 | 62500 |
| J3 open | 1200 | 2400 | 4800 | 9600 |

When the module was shaped J, J2, J3 and J6 is opened.

## 4. INTERFACE CONNECTION

### 4-1. CONNECTOR PINCONNECTION

Connector : HIF3FC-26PA-2.54DSA (HIROSE) or equivalent

Socket : 3399-6500SC (3M) or equivalent

TABLE-10

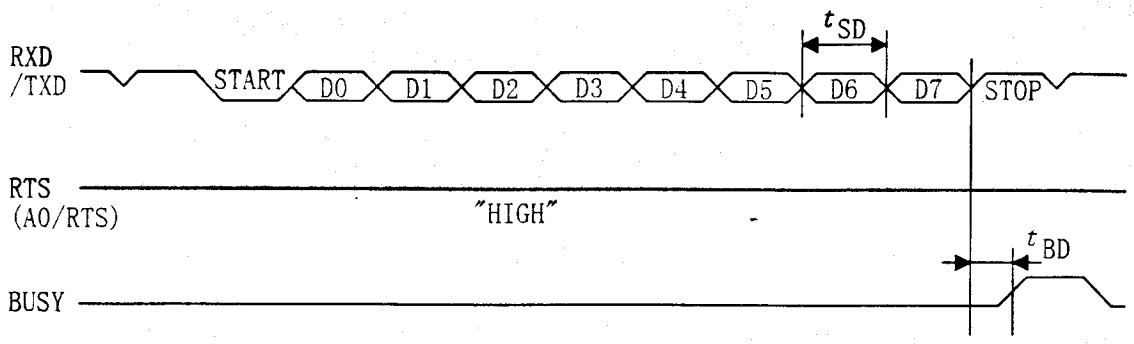
| Pin No. | Signal Name | Serial Mode | Parallel Mode |
|---|---|---|---|
| 1 | $\overline{\text{BLANK}}$ | ○ | ○ |
| 2 | $\overline{\text{TEST}}$ | ○ | ○ |
| 3 | A0/$\overline{\text{RTS}}$ | ○ | ○ |
| 4 | $\overline{\text{WR}}$ | NC | ○ |
| 5 | $\overline{\text{SEL}}$ | NC | ○ |
| 6 | $\overline{\text{RD}}$ | NC | ○ |
| 7 | RXD/TXD | ○ | NC |
| 8 | D0 | NC | ○ |
| 9 | D1 | NC | ○ |
| 10 | D2 | NC | ○ |
| 11 | D3 | NC | ○ |
| 12 | D4 | NC | ○ |
| 13 | D5 | NC | ○ |
| 14 | D6 | NC | ○ |
| 15 | D7 | NC | ○ |
| 16 | $\overline{\text{RESET}}$ | ○ | ○ |
| 17 | BUSY | ○ | ○ |
| 18 | GND | ○ | ○ |
| 19 | GND | ○ | ○ |
| 20 | GND | ○ | ○ |
| 21 | *V*cc | ○ | ○ |
| 22 | *V*cc | ○ | ○ |
| 23 | *V*cc | ○ | ○ |
| 24 | *V*cc | ○ | ○ |
| 25 | GND | ○ | ○ |
| 26 | GND | ○ | ○ |

NC : NO CONNECTION

TABLE-10 CONNECTOR PINCONNECTION

4-2. WRITE-IN AND READ TIMING

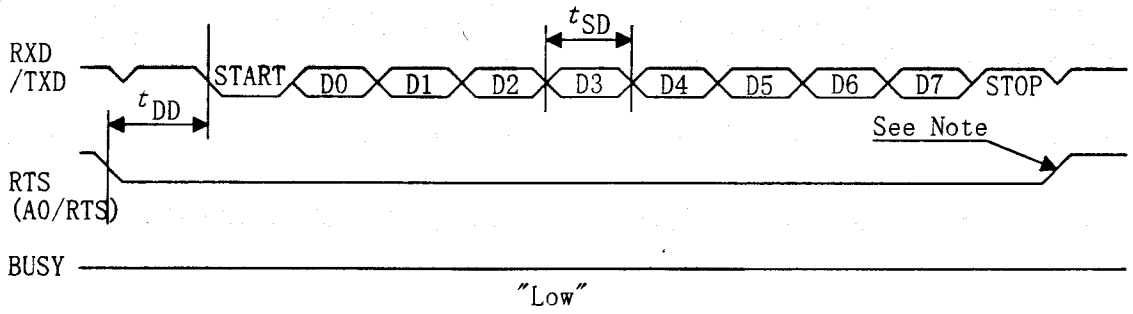
See FIG. 5, FIG. 6, FIG. 7, FIG8.




$^{t}SD=10^{6}/Baud\ rate\ [\mu s]$

$^{t}BD=^{t}SD/2\ [\mu s]$

FIG. 5 SERIAL INPUT TIMING




$^{t}SD=10^{6}/Baud\ rate\ [\mu s]$

$^{t}DD=^{t}SD\ [\mu s\ min]$

Note : RTS signal must be tuned to "HIGH" level after reading the data. Otherwise, the next input data can't be written in.

FIG. 6 SERIAL OUTPUT TIMING

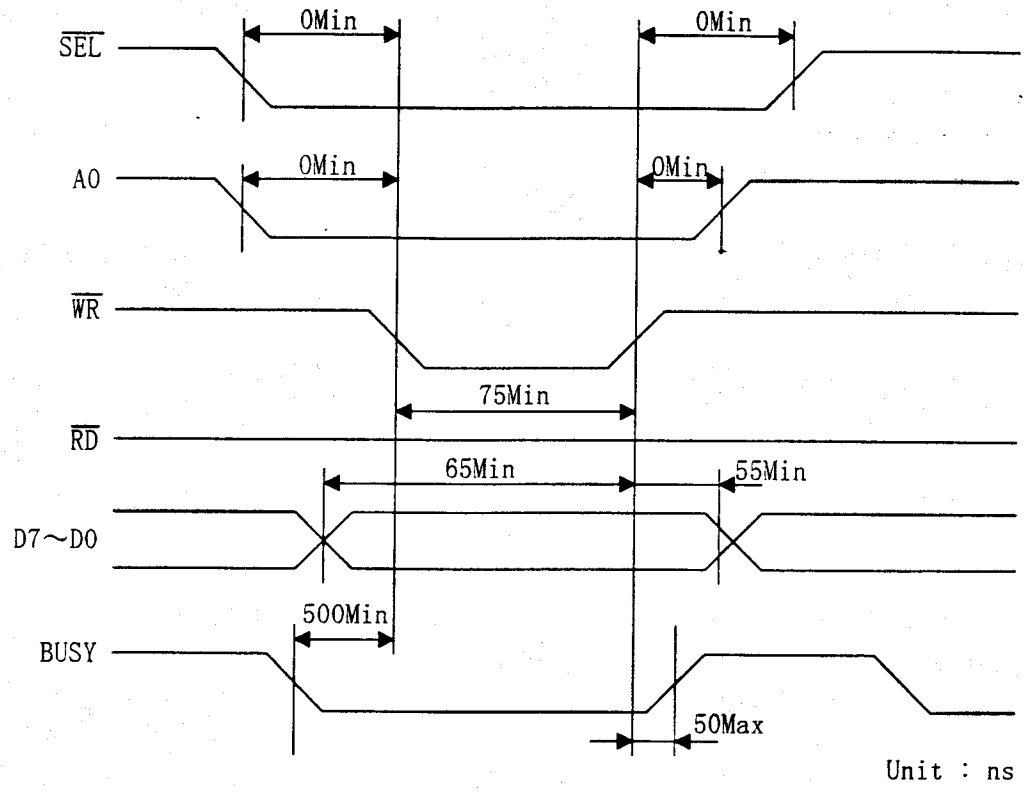



FIG.7 PARALLEL INPUT TIMING

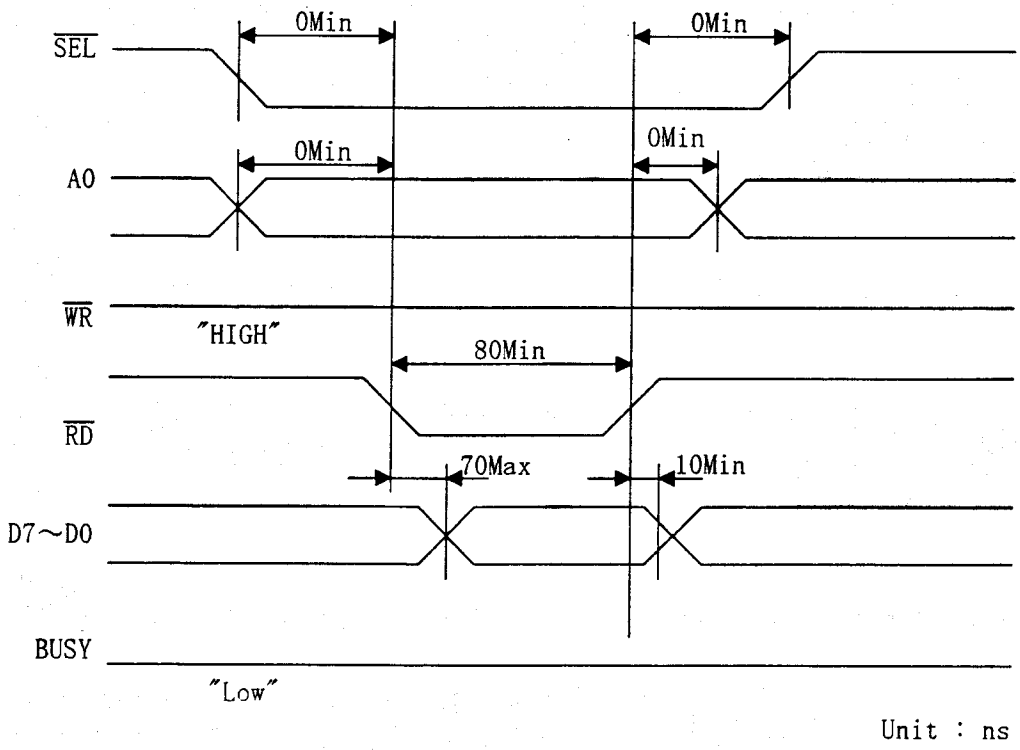
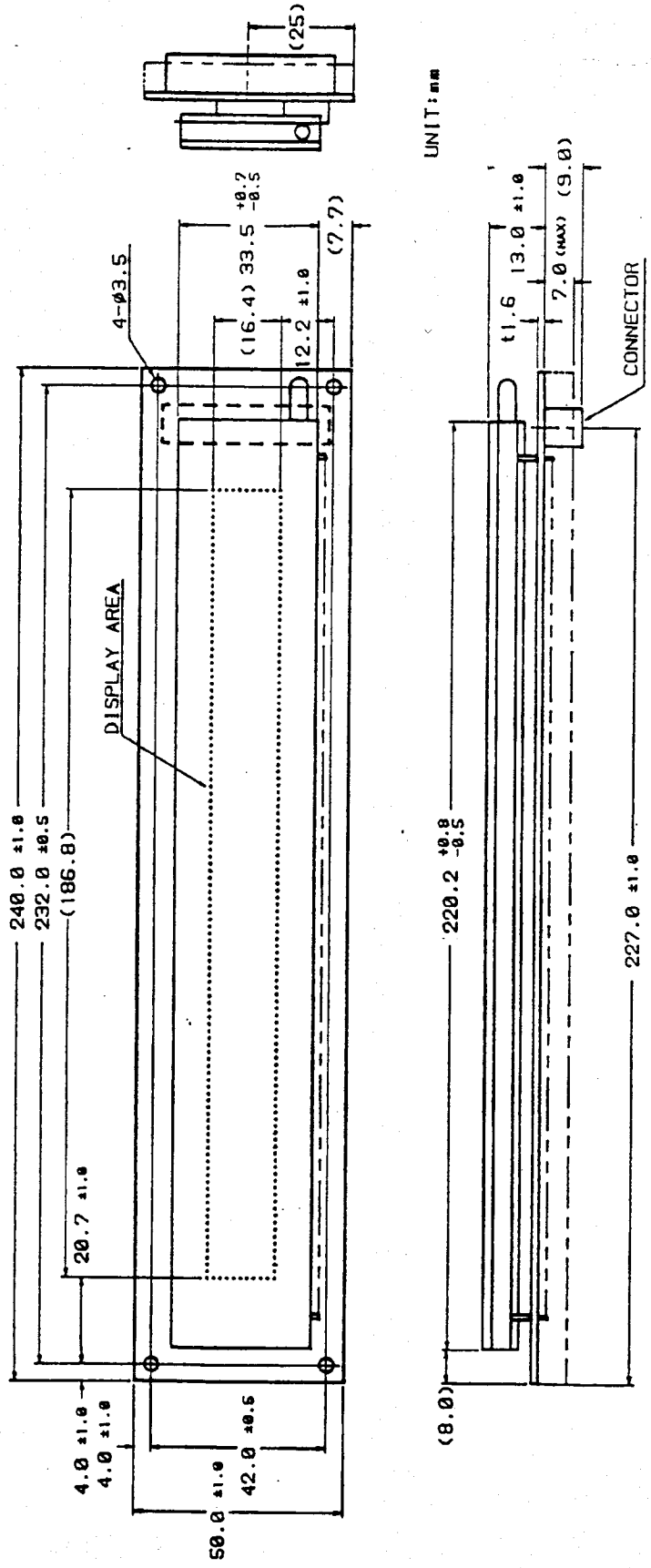



FIG.8 parallel output timing

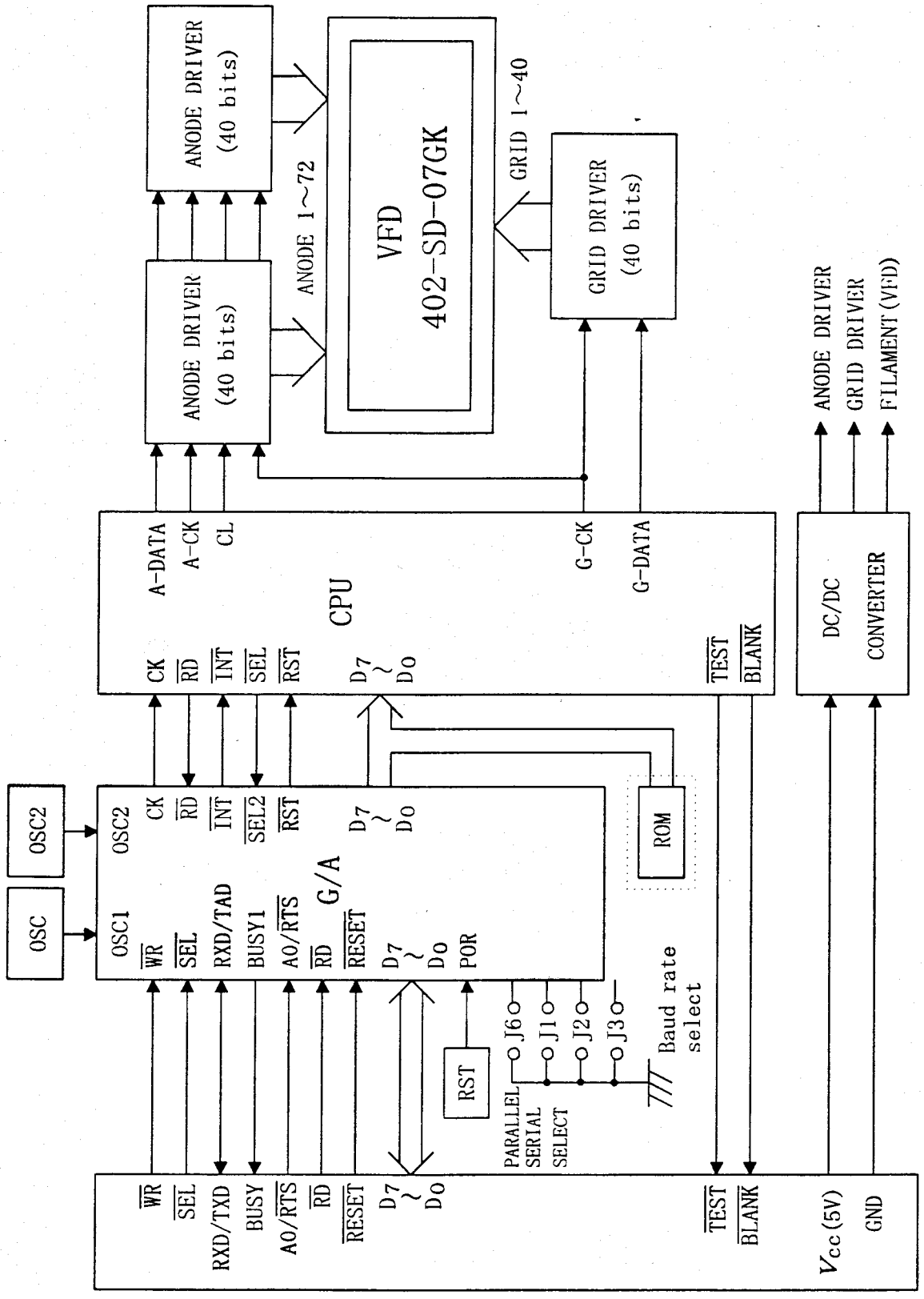
# M402SD07AA MECHANICAL- DRAWING

APPENDIX-1



# M402SD07AA CIRCUIT BLOCK DIAGRAM

APPENDIX-2



# M402SD07AA DISPLAY CHARACTER CODE

APPENDIX-3

| D7 D6 D5 D4 / D3 D2 D1 D0 | | 0 0 0 0 | 0 0 0 1 | 0 0 1 0 | 0 0 1 1 | 0 1 0 0 | 0 1 0 1 | 0 1 1 0 | 0 1 1 1 | 1 0 0 0 | 1 0 0 1 | 1 0 1 0 | 1 0 1 1 | 1 1 0 0 | 1 1 0 1 | 1 1 1 0 | 1 1 1 1 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | A | B | C | D | E | F |
| 0 0 0 0 | 0 | | DP | SP | | | | | | | | | | | | | |
| 0 0 0 1 | 1 | | DC1 | | | | | | | | | | | | | | |
| 0 0 1 0 | 2 | | DC2 | | | | | | | | | | | | | | |
| 0 0 1 1 | 3 | DEF | DC3 | | | | | | | | | | | | | | |
| 0 1 0 0 | 4 | DIM | DC4 | | | | | | | | | | | | | | |
| 0 1 0 1 | 5 | DDR | DC5 | | | | | | | | | | | | | | |
| 0 1 1 0 | 6 | | DC6 | | | | | | | | | | | | | | |
| 0 1 1 1 | 7 | | DC7 | | | | | | | | | | | | | | |
| 1 0 0 0 | 8 | BS | DC8 | | | | | | | | | | | | | | |
| 1 0 0 1 | 9 | | DC9 | | | | | | | | | | | | | | |
| 1 0 1 0 | A | LF | | | | | | | | | | | | | | | |
| 1 0 1 1 | B | HM | | | | | | | | | | | | | | | |
| 1 1 0 0 | C | CL | RT | | | | | | | | | | | | | | UF0 |
| 1 1 0 1 | D | CR | LT | | | | | | | | | | | | | | UF1 |
| 1 1 1 0 | E | | UD | | | | | | | | | | | | | | UF2 |
| 1 1 1 1 | F | | RST | | | | | | | | | | | | | | |

SP : SPACE

5. WARRANTY

This display module is guaranteed for 1 year after shipment from FUTABA.

6. CAUTIONS FOR OPERATION

6-1. Since VFDs are made of glass material.
Avoid applying excessive shock or vibration beyond the specification fot the module.
Careful handing essential.

6-2. Applying lower volatage than the specified may cause non activation for selected pixels.
Conversely, higher voltage may cause non-selected pixel to be activated.
If such phenomenon is observed, check the voltage level of the power supply.

6-3. Avoid plugging or unplugging the interface connection with the power on,

6-4. If the start up time of the supply voltage is slow, the controller may not be reset.

6-5. DC/DC convrtter is equipped on the module, the surge current may be approximately 10 times the specified supply current at the power on.

6-6. Avoid using the module where excessive noise interface is expected.
Noise affects the interface signal and causes improper operation.
Keep the length of the interface cable less than 50cm.
(When the longer cable is required, please confirm there is no noise affection.)

6-7. When power is turned off, the capacitor will not discharge immediately.
Avoid touching IC and others.
(The shorting of the mounted components within 30 sec., after power off, may cause damage.)

6-8. The fuse is mounted on the module as circuit protection.
If the fuse is blown, the problem shall be solved first and change the fuse.

6-9. When fixed pattern is displayed for a long time, you may see uneven luminance.
It is recommended to change the display patterns sometimes in order to keep best display quality.

REMARKS :

This specification is subject to change without prior in order to improve the design and quality.
Your consultation with FUTABA sales office is recommended for the use of this module.