Futaba®

AN-E-2222A

APPLICATION NOTE

VACUUM FLUORESCENT DISPLAY MODULE

CHARACTER DISPLAY MODULE

M404SD01BB

GENERAL DESCRIPTION

Futaba Vacuum Fluorescent Display Module M404SD01BB, with Futaba VFD 404-SD-01G display, produces 40 digits on 4 rows.
Each character is displayed in 5×7 dot matrix.
Consisting of a VFD, one chip controller, driver IC, the module can be connected directly to the system bus, thus simplifying interfacing.
The bright and anesthetically pleasing VFD makes the module desirable for application in office equipment's, such as electronics typewriters, computer terminals, measuring equipment, etc.

⚠ Important Safety Notice

Please read this note carefully before using the product.

Warning

- The module should be disconnected from the power supply before handling.
- The power supply should be switched off before connecting or disconnecting the power or interface cables.
- The module contains electronic components that generate high voltages which may cause an electrical shock when touched.
- Do not touch the electronic components of the module with any metal objects.
- The VFD used on the module is made of glass and should be handled with care. When handling the VFD, it is recommended that cotton gloves be used.
- The module is equipped with a circuit protection fuse.
- Under no circumstances should the module be modified or repaired.
  Any unauthorized modifications or repairs will invalidate the product warranty.
- The module should be abolished as the factory waste.

CONTENTS PAGE

1. FEATURES

1-1. One chip controller is equipped on the module and it realized intelligent terminal.
The module can be connected to the system bus directly.

1-2. Two hundred and fifteen character fonts consisting of alphabets, katakanas, numeral and other symbols can be displayed.

1-3. By using dimming function, brightness can be controlled into 4 levels.

1-4. Since a DC/DC converter is included, only 5Vdc power source is required to operate the module.

1-5. High quality and reliability, also long life can be achieved with FUTABA VFD.

1-6. Compact, light weight and thin design by using SMART (Surface Mount And Reflow Technology) provides excellent built-in capability.

1-7. Either parallel or serial input interface can be selected.

1-8. Additionally, original character fonts can be defined and displayed.
Three user definable characters are available.

2. GENERAL SPECIFICATIONS

2-1. OUTER DIMENSIONS, WEIGHT (See FIGURE-1)

Table-1

Item	Specification	Unit
Outer Dimension	(L) 230±1 (W) 60±1 (T) 32 Max.	mm
Weight	Approx. 250	g

2-2. SPECIFICATION OF THE DISPLAY PANEL

Table-2

Item	Specification	Unit
Display Area (H×W)	30.5×170.7	mm
Number of digits (H×W)	40 digits (5×7)×4 rows	dot
Dot Size (H×W)	0.5×0.4	mm
Dot Pitch (H×W)	0.75×0.65	mm
Character Size (H×W)	5.0×3.0	mm
Character Pitch (H×W)	8.5×4.3	mm
Color of Illumination	Green (λp=505nm)	–

2-3. ENVIRONMENT CONDITION

Table-3

Item	Symbol	Min.	Max.	Unit
Operating Temperature	*T*opr	0	+70	°C
Storage Temperature	*T*stg	-20	+70	°C
Operating Humidity	*H*opr	20	85	%
Storage Humidity	*H*stg	20	90	%
Vibration (10 to 55 Hz)	–	–	4	–
Shock	–	–	40	–

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

2-4. ABSOLUTE MAXIMUM RATINGS

Table-4

Item	Symbol	Min.	Max.	Unit
Supply Voltage	*V*cc	–	7.0	V
Input Signal Voltage	V_{IS}	-0.4	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	V
H-Level Input Voltage	V_{IH}	*V*cc=5V	2.0	–	5.25	V
L-Level Input Voltage	V_{IL}	*V*cc=5V	–	–	0.8	V

2-6. ELECTRICAL CHARACTERISTICS

Tabpe-6

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
Supply Current	*I*cc	*V*cc=5V All On	–	1.4	1.6	A
Power Consumption	–		–	7	8	W
Luminance	L		340	690	–	cd/m^2
H-Level Input Current	I_{IH}	*V*cc=5.5V	–	–	20	μA
L-Level Input Current	I_{IL}	*V*cc=5.5V	-0.4	–	–	mA
H-Level Input Voltage	V_{OH}	*V*cc=4.5V I_{OH}=-0.5mA	2.4	–	–	V
L-Level Input Voltage	V_{OL}	*V*cc=4.5V I_{OL}=-0.5mA	0.25	–	0.4	V

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

3. FUNCTION

The module has data and control code write, data read, Blanking, SELF-TEST, and hardware reset function.(See Table-7)

Table-7

	$\overline{RESET}$*	$\overline{TEST}$	$\overline{BLANK}$	$\overline{SEL}$	$\overline{WR}$	Functions
Parallel or Serial Interface	↘ –	–	–	–	–	Hardware Reset
	H	L	–	–	–	Self Test
	H	–	L	-	-	Blanking
Parallel Interface	H	H	–	L	L	Data and control code write in
Serial Interface	H	H	–	NC	NC	Data and control code write in

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

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 data.
(When data is under processing, the BUSY signal high “H”.)
The data ore control command is to be written in at the rising edge of $\overline{WR}$ (L→H), When $\overline{SEL}$ = “L”, and $\overline{RESET}$, $\overline{TEST}$ = “H”.
The display character from follows equivalent to ASCII (Alphabets, Numeric and Symbols etc.).
After a character is written in, the write-in position 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 code are available as follows and the details will be explained.

(1)	DEF	: Define Characters UF0 ~ 3	: (03 HEX)
(2)	DIM	: Dimming	: (04 HEX)
(3)	BS	: Back Space	: (08 HEX)
(4)	HM+CLR	: Home Position + Display Clear	: (0B HEX)
(5)	CR+LF	: Carriage Return + Line Feed	: (0D HEX)
(6)	DP	: Display Position	: (10 HEX)
(7)	DC1	: Normal Display Mode	: (11 HEX)
(8)	DC2	: Vertical Scroll Mode	: (12 HEX)
(9)	DC3	: Over Write Mode	: (13 HEX)
(10)	DC4	: Display Off (Blanking) Mode	: (14 HEX)
(11)	DC5	: Display On Mode	: (15 HEX)
(12)	UP	: Up Shift	: (1A HEX)
(13)	DWN	: Down Shift	: (1B HEX)
(14)	RT	: Right Shift	: (1C HEX)
(15)	LT	: Left Shift	: (1D HEX)
(16)	RST	: Reset	: (1F HEX)

(1) DEF (Define UF0 ~ 3)

The DEF command define user definable characters, UF 0 ~ 3.
These fonts are stored in the module as follows.

1 Byte DEF command code, (03 H)	1 Bye Position code (FCH to FEH)	5 Bytes the font data,

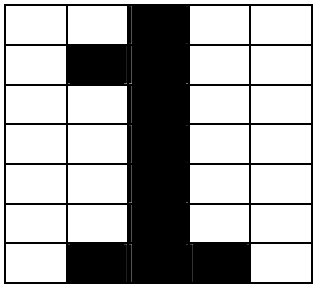
1-1	2-1	3-1	4-1	5-1
1-2	2-2	3-2	4-2	5-2
1-3	2-3	3-3	4-3	5-3
1-4	2-4	3-4	4-4	5-4
1-5	2-5	3-5	4-5	5-5
1-6	2-6	3-6	4-6	5-6
1-7	2-7	3-7	4-7	5-7

(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 "H" in UF 0.
Control and data strings 03H, FCH, 23H, 08H, 42H, 11H, C0H.



(a) Character Font

		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

"H" : Turn On
"L" : Turn Off

FIG.1 Defining User's Font

All these data will be stored into the RAM and it is possible to display the user's original font on the VFD module.
These is no backup system of this RAM, therefore, it is needed to restore these data when power on.

(2) DIM (Dimming)

The brightness can be controlled into four levels by using this function.
After writing 04H, the following dimming data is written to change the brightness out put.

1 Byte (DIM command code), 04H	+	1 Byte Dimming level data

Table-8

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

(3) BS (Back Space)

The write-in position is shifted to the left one digit.

When the write-in position is on the most significant of the second to fourth row, the write-in position moves to the least significant digit of the upper row.

When the write-in position is on the most significant digit of the first row, the write-in position moves to the least significant digit of the fourth row.

(4) HM+CLR (Home Position + Display Clear)

The write-in position moves to the most significant digit of the first row and clearing displayed characters.

(5) CR+LF (Carriage Return + Line Feed)

When the write-in position is in the first to third rows, the write-in position moves to the most significant digit of the under row.

When the write-in position is in the fourth row, the character displayed second to fourth rows are shifted to the upper row, and the write-in position moves to the most significant digit of the fourth row.

(6) 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 10 HEX to prepare the 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
3rd row	50 HEX	77 HEX
4th row	78 HEX	9F HEX

(7) DC1 (Normal Display Mode)

After writing a character, the write-in position is shifted to the right one digit automatically.

When the write-in position is on the least significant digit of the first to third rows, the write-in position moves to the most significant digit of the under row.

When the character is displayed on the least significant digit of the fourth row, the display will be not changed.

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 write-in position moves to the next digit.

When the power is turn on, thisDC1 Mode is selected, and will be held until another mode is selected.

(8) DC2 (Vertical Scroll Mode)

After writing a character, the write-in position is shifted to the right one digit automatically.

When the character is displayed on the least significant digit of the fourth row, the display will be not changed.

And the character code is written in the module next, all the characters display in the second to fourth rows are shifted to the upper row, clearing the fourth row, and the write-in position moves to the most significant digit of the fourth row.

(9) DC3 (Over Write Mode)

After writing a character, the writing position is shifted to the right one digit automatically.
When the write-in position is on the least significant digit of the first to third rows, the write-in position moves to the most significant digit of the under row.
When the character is displayed on the least significant digit of the fourth row, the display will be not changed.
And the character code is written in the module next, the character is displayed on the most significant digit of the first row and the write-in position moves to next digit.
The character is not changed till a character is written in.

(10) DC4 (Display Off Mode)

The all digits is disappeared.
But the character data is not cleared.

(11) DC5 (Display On Mode)

The all digits is displayed.
When power is turned on, this mode is selected automatically.

(12) UP (Write-in Position Down Shift)

When write-in position is on the second to fourth row, the write-in position are shifted to the upper row.
When write-in position is the first row, this code is ignored.

(13) DWN (Write-in Position Down Shift)

When write-in position is on the first to third row, the write-in position are shifted to the down row.
When write-in position is on the fourth row, this code is ignored.

(14) RT (Write-in Position Right Shift)

The write-in position is shifted to the right.
When the write-in position is on the least significant digit, this code is ignored.

(15) LT (Write-in Position Left Shift)

The write-in position is shifted to the left.
When the write-in position is on the most significant digit, this code is ignored.

(16) RST (Reset)

Resetting the module.
All the characters displayed are erased, then the write-in position is set on the most significant digit of the first row.
The displaying status is the same as the Power on Reset.
The display mode is set for DC1 and DC5.

3-3. SELF-TEST

$\overline{\text{TEST}}$ = "L" (Signal connector pin #2 is connected to GND.) starts the SELF-TEST. Then the display shows all characters, Alphabet, Numeric and symbols, in that order.
One hundred sixty (4×40) character are displayed at a time.
Using this mode, neither data write-in nor control code write-in is allowed.
To release this mode, $\overline{\text{TEST}}$ must be set to "H".

3-4. HARDWARE RESET

When the module is turned on, or the RESET is set to "Low", the display and the memory are cleared an the module is initialized.
The display mode is set for DC1, DC5.

3-5. BLANKING OF THE DISPLAY

The BLANK signal is set into low "L", all digit will be put out.
But the character data is not cleared, therefore, when the BLANK signal is set into high "H", all digit will be displayed again.

3-6. 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 is selected, J5 (chip jumper) must be open. (internally pulled up.)
When the serial input is selected, J5 must be short.
Baud rate is selected by J1 ~ J3 as shown below.

J1, J2, J3 } Baud rate selection (J3 : chip jumper)

Table-9

J1		Short	Open	Short	Open
J2		Short	Short	Open	Open
J3	Short	1200 (bps)	2400	4800	9600
	Open	7812.5	15625	31250	62500

BAUD RATE SELECTION

Note) When the module is shipped, interface selection is set for parallel. (J1, J2, J3 and J5 are open)

4. INTERFACE CONNECTION

4-1. CONNECTOR PIN CONNECTION

Connector : HIF3FB-26PA-2.54DSA (HIROSE) or equivalent
Socket : 3399-6500SC or equivalent

Table-10

Pin No.	Signal	Parallel In	Serial In	Pin No.	Signal	Parallel In	Serial
1	$\overline{\text{BLANK}}$	○	○	2	$\overline{\text{TEST}}$	○	○
3	NC	NC	NC	4	$\overline{\text{WR}}$	○	NC
5	$\overline{\text{SEL}}$	○	NC	6	NC	NC	NC
7	RXD	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	Vcc	○	○	22	Vcc	○	○
23	Vcc	○	○	24	Vcc	○	○
25	GND	○	○	26	GND	○	○

NC : NO-CONNECTION
○ : CONNECTION

CONNECTOR PIN CONNECTION

4-2. WRITE-IN TIMING

4-2-1. PARALLEL INPUT

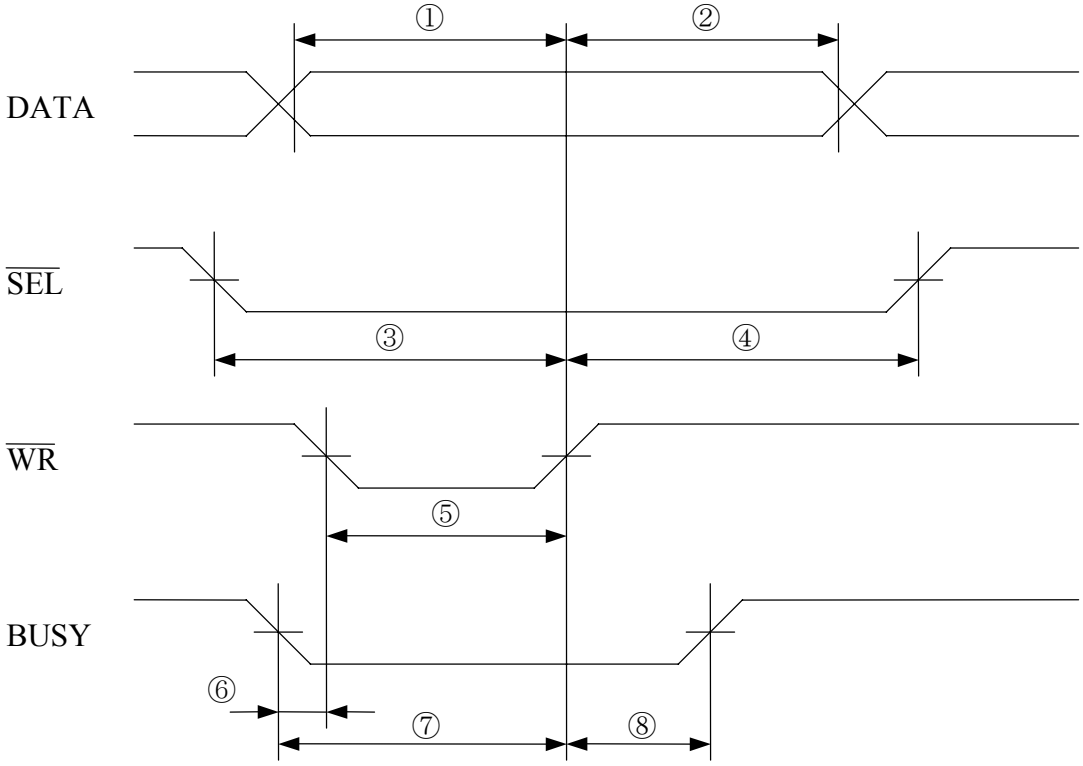
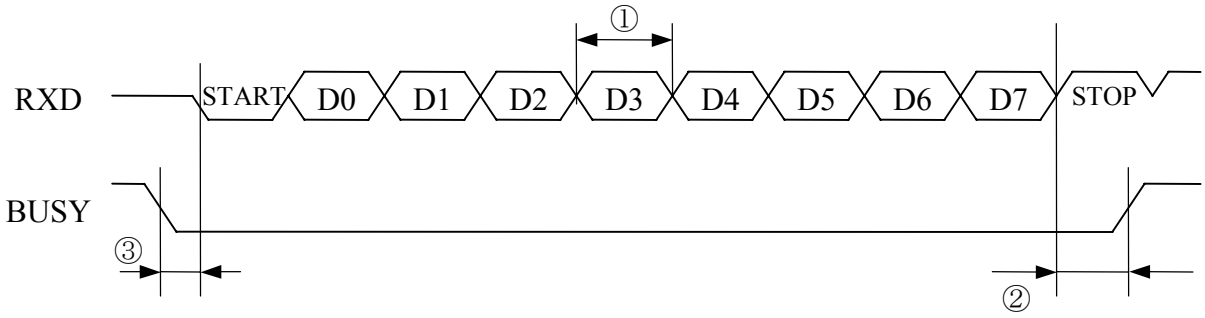


FIG.2

Table-11

		Min.	Max.	Note
①	tsu(DATA)	65ns	—	
②	th(DATA)	55ns	—	
③	tsu($\overline{\text{SEL}}$)	75ns	—	
④	th($\overline{\text{SEL}}$)	0ns	—	
⑤	tpw($\overline{\text{WR}}$)	75ns	—	
⑥	twait	0ns	—	
⑦	twait	250ns	—	For Min 250ns, $\overline{\text{WR}}$ shroud not be active (positive H), after BUSY is "0"
⑧	tlelay	—	50ns	

4-2-2. SERIAL INPUT



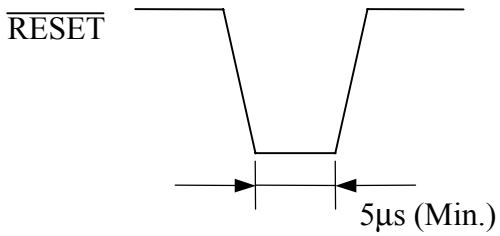
① t (DATA) = 10^6 / baud rate [μs] (This depends on the selection of the baud rate.)

② t(DATA) / 2 [μs] (Busy becomes "H" at the center of stop bit.)

③ t (WAIT) : 0 (Min.) [μs]

FIG.3 WRITE-IN TIMING

4-2-3. $\overline{\text{RESET}}$ TIMING (When external reset function is used.)



4-3. INTERFACE TO CPU

Since this module is designed to be directly connected to the bus line, the interface can be simplified.

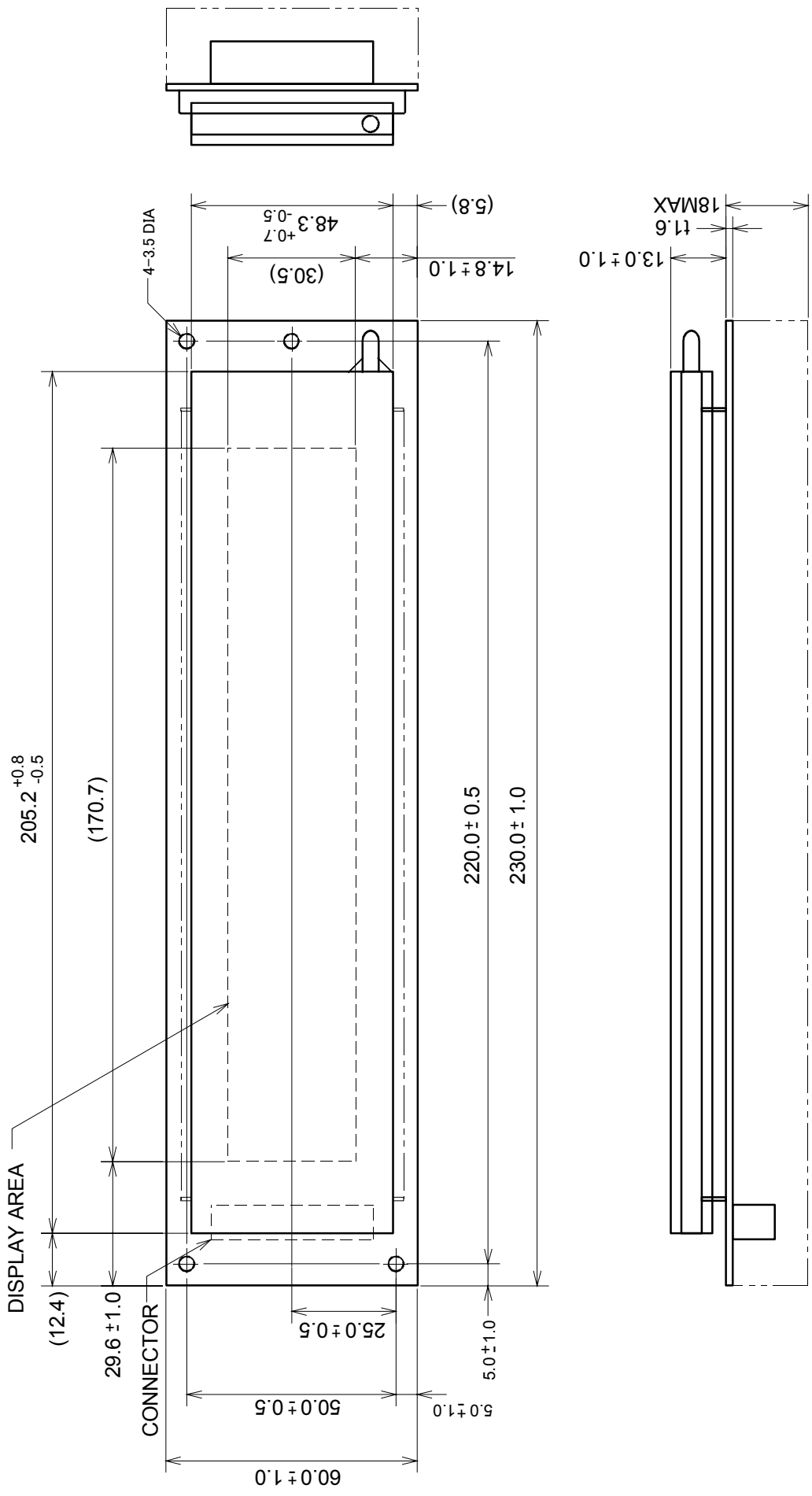
4-4. CONNECTION TO I/O DEVICE

FIG.6 show the example for connecting to typical I/O device.

M404SD01BB MECHANICAL DIMENSIONS

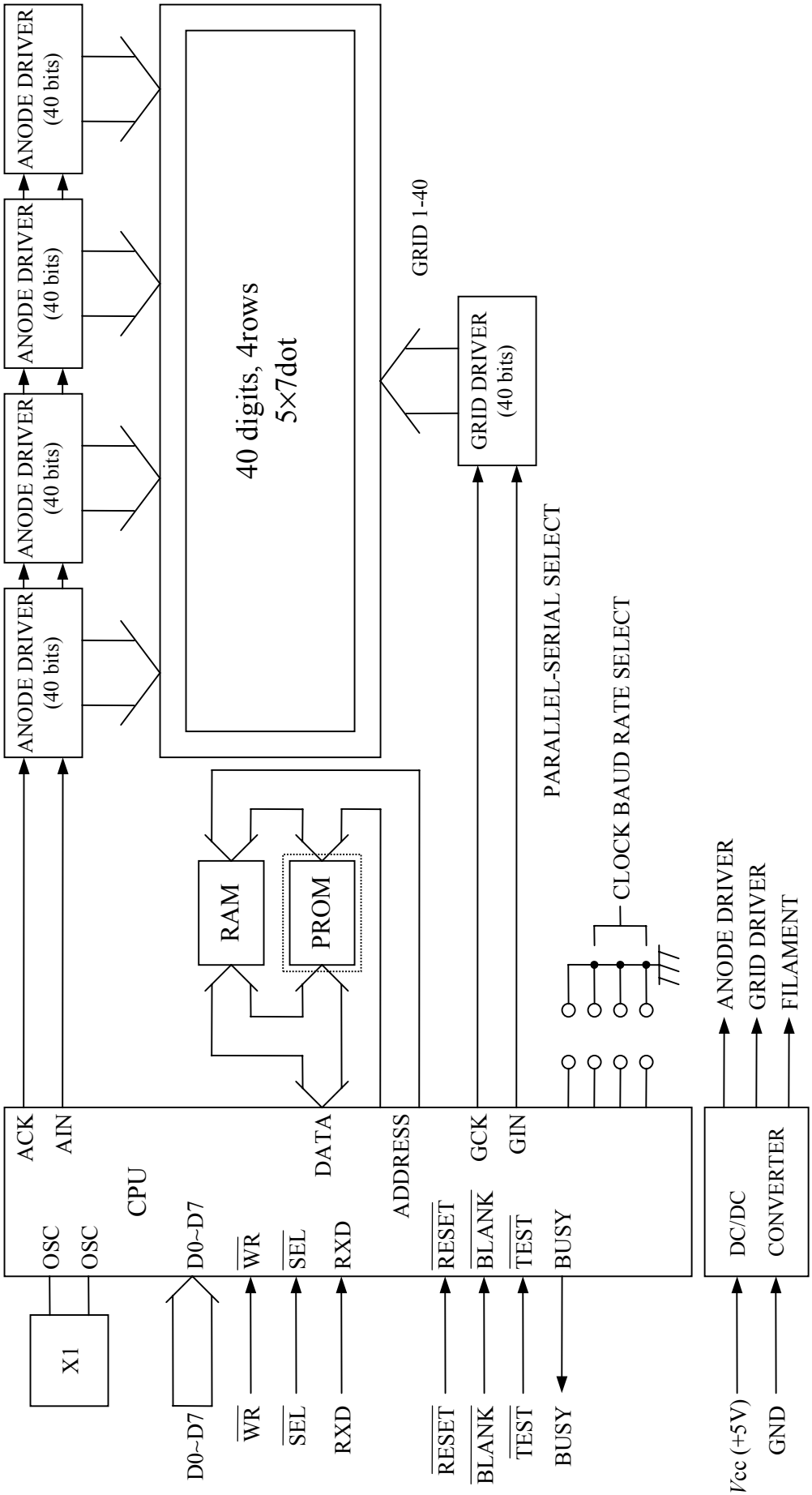
FIGURE-1

UNIT:mm



M404SD01BB　CIRCUIT BLOCK DAIGRAM

FIGURE-2



M404SD01BB DISPLAY CHARACTER CODE

FIGURE-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		DC5													
0 1 1 0	6															
0 1 1 1	7															
1 0 0 0	8	BS														
1 0 0 1	9															
1 0 1 0	A		UP													
1 0 1 1	B	HM CLR	DWN													
1 1 0 0	C		RT													UF0
1 1 0 1	D	HM + LF	LT													UF1
1 1 1 0	E															UF2
1 1 1 1	F		RST													

SP : SPACE

5. WARRANTY

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

6. OPERATING RECOMMENDATIONS

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

6-2. Applying lower voltage 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 show, the controller may not be reset.

6-5. DC/DC converter 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 he module where excessive noise interface is expected.
Noise affects the interface signal and cause 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:

The specification is subject to change without prior notice.
Your consultation with FUTABA sales office is recommended for the use of this module.