M0121LB-222LHAR2-I1

Vacuum Fluorescent Display Module

RoHS Compliant

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1. SCOPE

This specification applies to VFD module (Model No: M0121LB-222LHAR2-I1).

2. FEATURES

2.1 This VFD module can be communicated by 8-bit bus systems.

2.2 High quality of display and brightness.

2.3 Compact and flat packed one-chip controller.

2.4 +5V single power supply.

2.5 Brightness adjustment available by software (4 levels).

2.6 8 user definable fonts available (CG-RAM font).

2.7 **ASCII characters and LEVEL-BAR patterns** (CG-ROM font).

3. GENERAL DESCRIPTIONS

3.1 This specification becomes effective after being approved by the purchaser.

3.2 When any conflict is found in the specification, appropriate action shall be taken upon agreement of both parties.

3.3 The expected necessary service parts should be arranged by the customer before the completion of production.

4. PRODUCT SPECIFICATIONS

4.1 Type

Table_1

Type	M0121LB-222LHAR2-I1
Digit Format	5×7 Dot Matrix or 15-Level bar and Icons

4.2 Outer Dimensions, Weight (See Fig-4 for details)

Table_2

Parameter		Specification	Unit
Outer Dimensions	Width	195.0±1.0	mm
	Height	45.0±1.0	mm
	Thickness	Max 25.0	mm
Weight		Typical 160	g

4.3 Specifications of Display Panel (See Fig-5 for details)   Table_3

Parameter	Symbol	Specification	Unit
Display Size	W×H	144.0×18.0	mm
Display Pattern Dimensions		See the Fig-5	-
Display Color		Blue-Green (peak 505 nm) Yellowish-Orange (peak 605 nm) Reddish orange (peak 665 nm)	-

4.4 Environment Conditions   Table_4

Parameter	Symbol	Min.	Max.	Unit
Operating Temperature	Topr	-40	+80	℃
Storage Temperature	Tstg	-50	+95	℃
Humidity (Operating)	Hopr	0	85	％
Humidity (Non-operating)	Hstg	0	90	％
Vibration (10~55Hz)	-	-	4	G
Shock	-	-	40	G

4.5 Absolute Maximum Ratings   Table_5

Parameter	Symbol	Min.	Max.	Unit
Supply Voltage	V_{CC}	-0.5	6.0	V DC
Input Signal Voltage	V_{IS}	-0.5	V_{CC}+0.5	V DC

4.6 Recommend Operating Conditions   Table_6

Parameter	Symbol	Min.	Typ.	Max.	Unit
Supply Voltage	V_{CC}	4.5	5.0	5.5	V DC
Signal (Logic) Input Voltage	V_{IS}	0	-	V_{CC}	V DC
Operating Temperature	T_{OPR}	-20	+25	+70	℃

4.7 DC Characteristics (Ta=+25℃, VCC=+5.0 V DC)   Table_7

Parameter		Symbol	Min.	Typ.	Max.	Unit
Supply Current *)		I_{CC}	-	600	1000	mA
Logic Input Voltage	"H"Level	V_{IH}	0.7×V_{CC}	-	-	V DC
	"L"Level	V_{IL}	-	-	0.3×V_{CC}	V DC
"H" level input current	V_{IN}=V_{CC}	V_{IL}	20	-	500	uA
Brightness	Green	L	100	200	-	ft-L
	Rsh.O		10	20	-	
	Ysh.O		17	35	-	

*) I_{CC} shows the current when all dots are turned on. The surge current can be approx. 3 times the specified supply current at power on. However, the exact peak surge current amplitude and duration are dependent on the characteristics of the host power supply.

4.8 Timing Chart and AC Characteristics
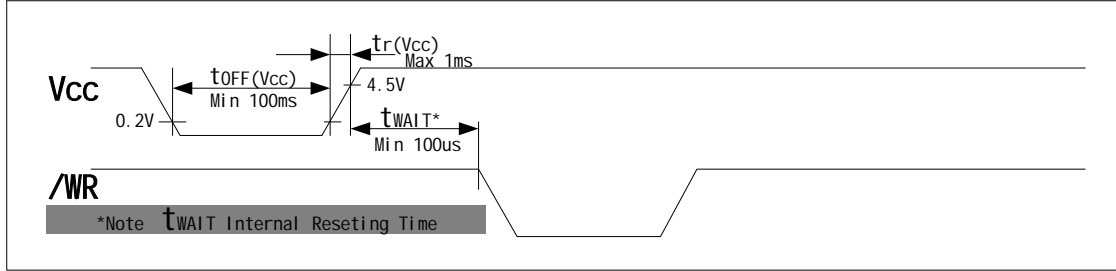
4.8.1 Power-on Reset Timing

Fig-1 Power-on Reset Timing

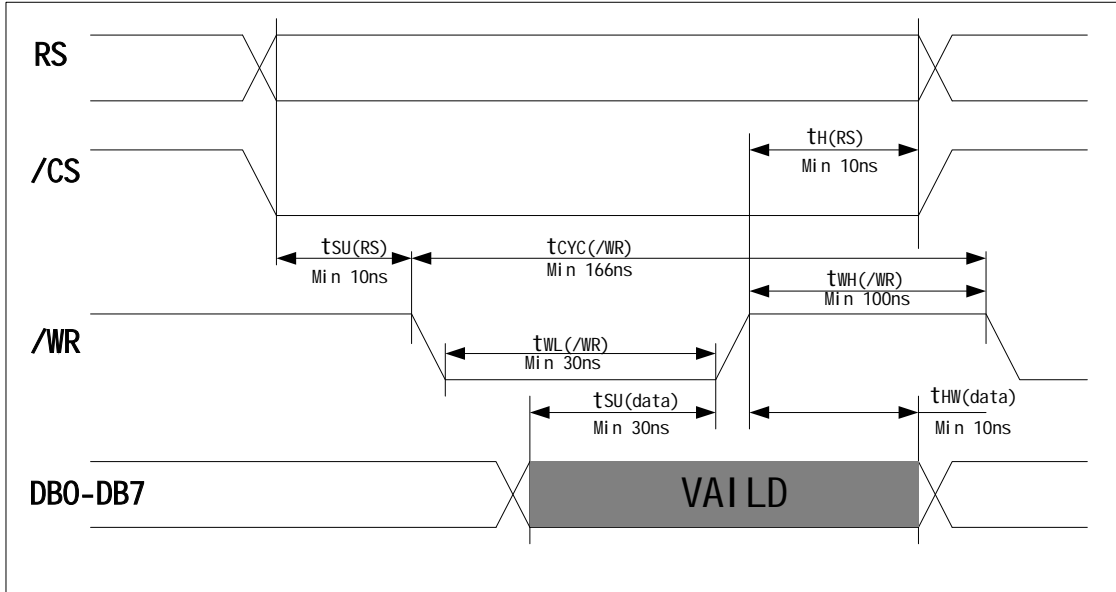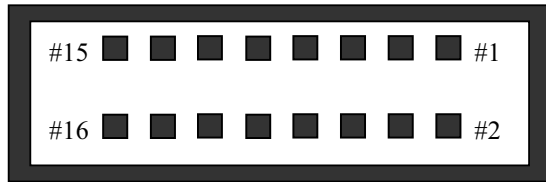### 4.8.2 Data Write-in Timing

Fig-2 Data write-in Timing Diagram

4.9 Connector Pin Assignment

Connector (Male):

BH-S16-FG (by Aster)-16Pin Dual Box Header, Straight

⇢Male Socket(Female):MIL-STD-16P

*NC : No Connection

No	Signal	No	Signal
1	DB7	2	DB6
3	DB5	4	DB4
5	DB3	6	DB2
7	DB1	8	DB0
9	/WR	10	/CS
11	RS	12	*NC
13	Vcc	14	Vcc
15	GND	16	GND

4.10 System Block Diagram
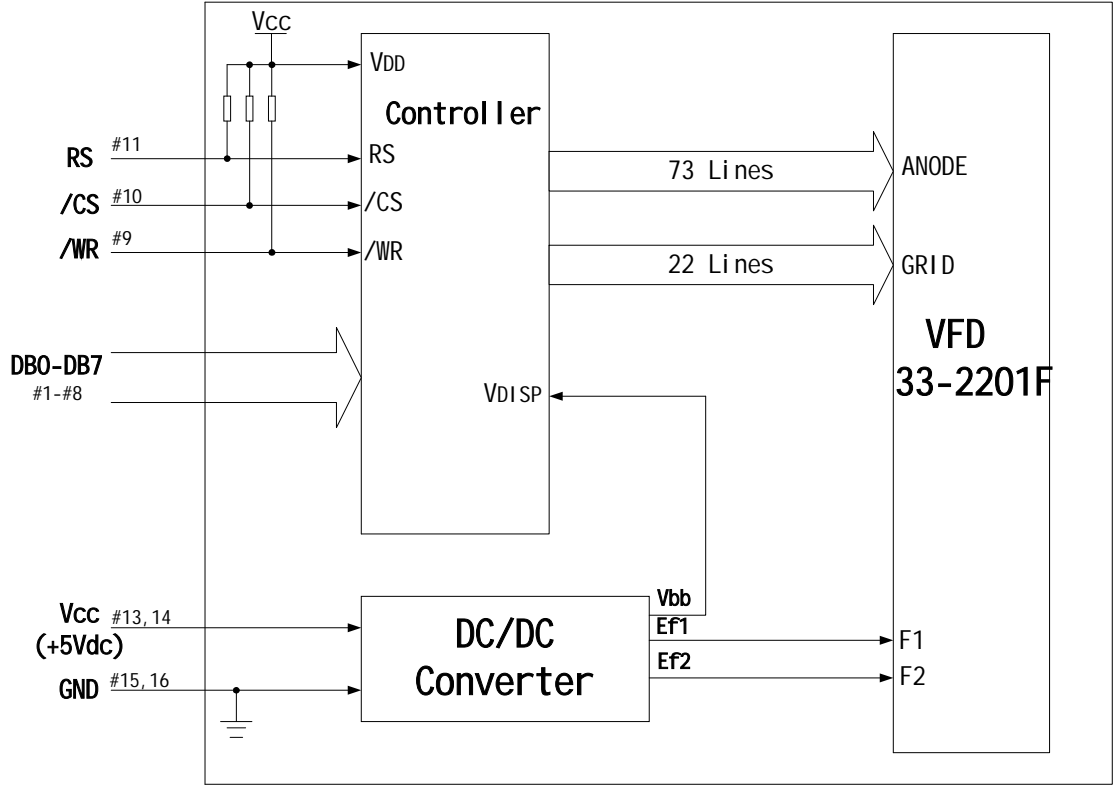
Fig-3 System Block Diagram of this VFD Module

4.11 Outer Dimensions
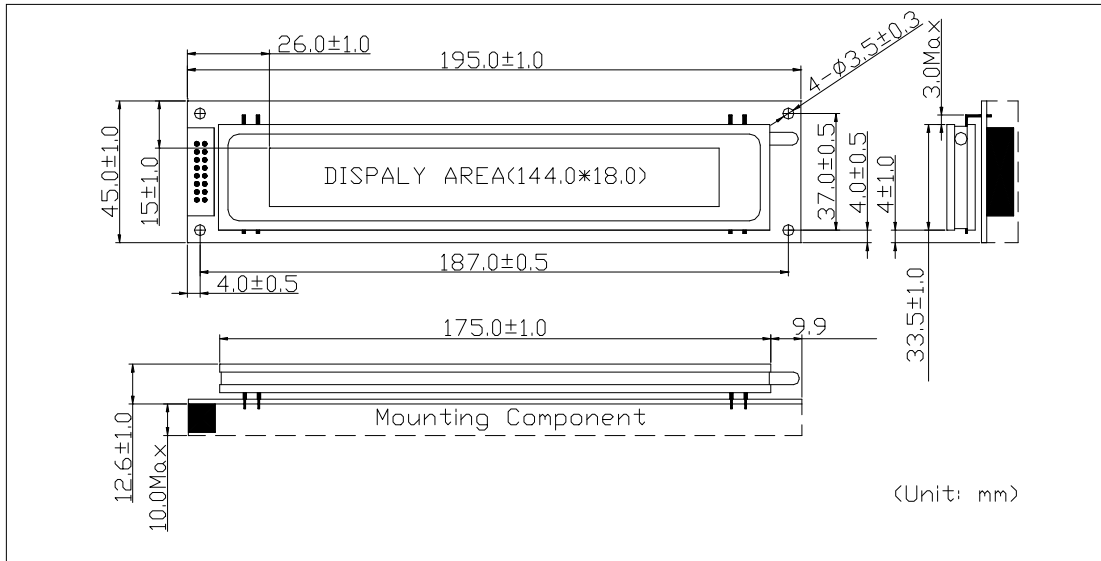
Fig-4 Outer Dimensions

4.12 Pattern Details
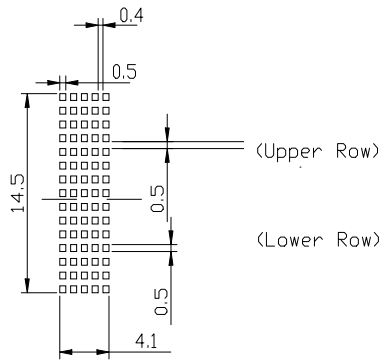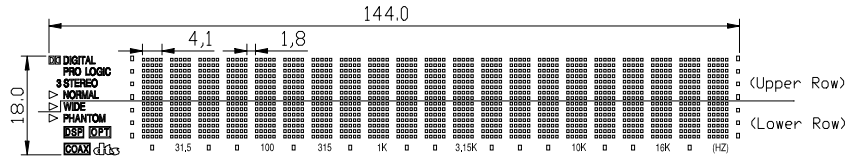
Fig-5 Pattern Details
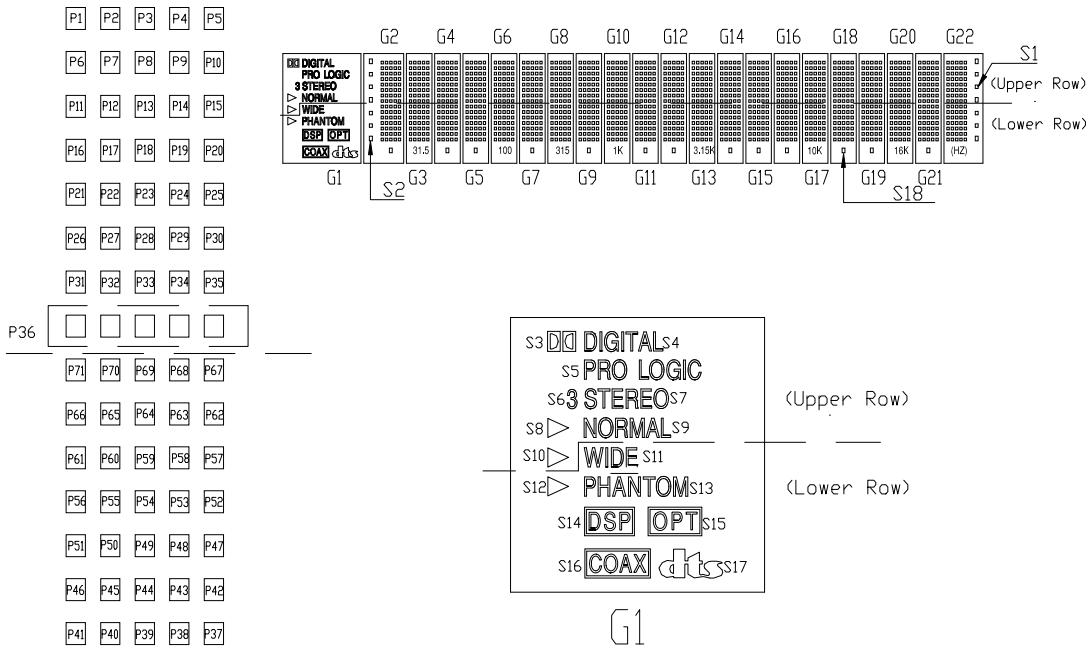
Fig-6 Grid Assignment

5. FUNCTION DESCRIPTIONS

5.1 Registers in VFD Controller

The VFD controller has two 8-bit registers, an instruction register (IR) and a data register (DR).

IR stores instruction codes, such as display clear and address information for DD-RAM and CG-RAM. The IR can only be written from the host MPU. DR temporarily stores data to be written into DD-RAM or CG-RAM.

Data written into the DR from the MPU is automatically written into DD-RAM or CG-RAM by an internal operation.

By the register selector (RS) signal, these two registers can be selected (See Table_8).

Table_8 Register Selection

RS	/CS	/WR	Operation
0	0	0 to 1	IR write as an internal operation (display clear, etc.)
1	0	0 to 1	DR write as an internal operation (DR to DDRAM or CGRAM)

×: Don't care

5.1.1 Address Counter (ACC)

The address counter (ACC) assigns addresses to both DD-RAM and CG-RAM. When an address Of an instruction is written into the IR, the address information is sent from the IR to the ACC. Selection of either DD-RAM or CG-RAM is also determined concurrently by the instruction. After writing into DD-RAM or CG-RAM, the ACC is automatically incremented by 1 (decremented by 1).

5.1.2 Display Data RAM (DD-RAM)

Display data RAM (DD-RAM) stores display data represented in 8-bit character codes. The area in DD-RAM that is not used for display can be used as general data RAM. See Table_9 for the relationships between DD-RAM addresses and positions on the VFD.

Table_9 Relation between Digit Position and DD-RAM data

Digit	G1	G2	G3	....	G21	G22
Upper Row code	00Hex	01Hex	02Hex	....	14Hex	15Hex
Lower Row code	40Hex	41Hex	42Hex	....	54Hex	55Hex

5.1.3 Character Generator ROM (CG-RAM)

The character generator ROM (CG-ROM) generates character patterns of 5×7 dots from 8-bit Character codes (Table-10). It can generate 112 kinds of 5×7 dot character patterns and 64 kinds of level bar patterns.

The character fonts are shown on the following page. The character coders 00Hex to 0Fhex are allocated to the CG-RAM.

Table_10 Character and Level bar Font Table (CG-ROM) and CG-RAM codes

ICON(S1,S2,S18) On (80Hex-BFHex)

ICON(S1,S2,S18) Off (C0Hex-FFHex)

Upper bits DB7				0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
DB6				0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1
DB5				0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1
Lower bits DB4				0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1
DB3	DB2	DB1	DB0		0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0	0	0	0	0	CG-RAM (1)															
0	0	0	1	1	CG-RAM (2)															
0	0	1	0	2	CG-RAM (3)															
0	0	1	1	3	CG-RAM (4)															
0	1	0	0	4	CG-RAM (5)															
0	1	0	1	5	CG-RAM (6)															
0	1	1	0	6	CG-RAM (7)															
0	1	1	1	7	CG-RAM (8)															
1	0	0	0	8	CG-RAM (1)															
1	0	0	1	9	CG-RAM (2)															
1	0	1	0	A	CG-RAM (3)															
1	0	1	1	B	CG-RAM (4)															
1	1	0	0	C	CG-RAM (5)															
1	1	0	1	D	CG-RAM (6)															
1	1	1	0	E	CG-RAM (7)															
1	1	1	1	F	CG-RAM (8)															

Table_11 Relationship between CG-RAM Addresses, Character Codes (DD-RAM) and 5×7 (with Cursor) Dot Character Patterns (CG-RAM data)

Character Codes (DD-RAM data)									CG-RAM Address							Character Patterns (CG-RAM data)								
D7	D6	D5	D4	D3	D2	D1	D0		A5	A4	A3	A2	A1	A0		D7	D6	D5	D4	D3	D2	D1	D0	
0	0	0	0	×	0	0	0		0	0	0	0	0	0		×	×	×	1	2	3	4	5	Character
												0	0	1		×	×	×	6	7	8	9	10	or Level
												0	1	0		×	×	×	11	12	13	14	15	bar Pattern
												0	1	1		×	×	×	16	17	18	19	20	(1)
												1	0	0		×	×	×	21	22	23	24	25	
												1	0	1		×	×	×	26	27	28	29	30	
												1	1	0		×	×	×	31	32	33	34	35	
												1	1	1		×	×	×	36	37	38	×	×	
0	0	0	0	×	0	0	1		0	0	1	0	0	0		×	×	×	1	2	3	4	5	Character
												0	0	1		×	×	×	6	7	8	9	10	or Level
												0	1	0		×	×	×	11	12	13	14	15	bar
												0	1	1		×	×	×	16	17	18	19	20	Pattern
												1	0	0		×	×	×	21	22	23	24	25	(2)
												1	0	1		×	×	×	26	27	28	29	30	
												1	1	0		×	×	×	31	32	33	34	35	
												1	1	1		×	×	×	36	37	38	×	×	
0	0	0	0	×	1	1	1		1	1	1	0	0	0		×	×	×	1	2	3	4	5	Character
												0	0	1		×	×	×	6	7	8	9	10	or Level
												0	1	0		×	×	×	11	12	13	14	15	bar
												0	1	1		×	×	×	16	17	18	19	20	Pattern
												1	0	0		×	×	×	21	22	23	24	25	(8)
												1	0	1		×	×	×	26	27	28	29	30	
												1	1	0		×	×	×	31	32	33	34	35	
												1	1	1		×	×	×	36	37	38	×	×	

Notes: 1. Character code bits 0 to 2 correspond to CG-RAM address bits 3 to 5 (3 bits: 8 types)

2. CG-RAM address bits 0 to 2 designate the character pattern line position. The 8th line is composed of the Center Level bar (36: Center Bar), Icons (37: S1+S2 38: S18).

3. Character pattern row positions correspond to CG-RAM data bits 0 to 4 (bit 4 being at the left).

4. As shown Table_11, CG-RAM character patterns are selected when character codes bits 4 to 7 are all 0. However, since character codes bit 3 has no effect, the display example above can be selected by either character code 00H or 08H.

5. 1 for CG-RAM data corresponds to display selection and 0 to non-selection.

"×" Indicates no effect (Don't care)

5.1.4 Character Generator RAM (CG-RAM)

In the character generator RAM (CG-RAM), the user can rewrite character patterns by program.

Indicator icons of G1 must be written CG-RAM.

Also 5×7 dots or level bars patterns can be written CG-RAM.

Write into DD-RAM the character codes at the addresses shown as the left column of Table-10

to show the character patterns shored in CG-RAM.

See Table-11 for the relationship between CG-RAM addresses and data and display patterns

and refer to Fig-6 for dot assignment of VFD.

Areas that are not used for display can be used as general data RAM.

1) CG-RAM Assignment for G1

G1
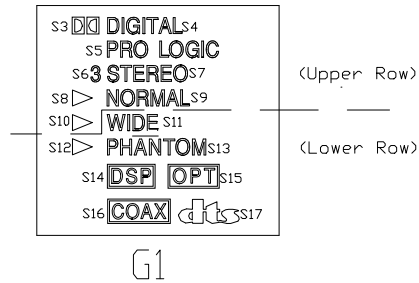
1	2	3	4	5
(S3)	×	×	×	×
6	7	8	9	10
×	×	×	×	×
11	12	13	14	15
(S4)	×	×	×	×
16	17	18	19	20
(S5)	×	×	×	(S6)
21	22	23	24	25
×	×	×	×	(S7)
26	27	28	29	30
(S8)	(S9)	×	×	×
31	32	33	34	35
×	×	×	×	×
36	37	38	39	40
(S10)	×	×	×	×

1	2	3	4	5
×	×	×	×	×
6	7	8	9	10
×	×	×	×	×
11	12	13	14	15
×	×	(S16)	×	×
16	17	18	19	20
×	×	×	×	×
21	22	23	24	25
×	×	×	×	×
26	27	28	29	30
(S15)	(S14)	(S13)	×	×
31	32	33	34	35
×	×	×	(S12)	(S11)
36	37	38	39	40
×	×	(S17)	×	×

[Upper Row]　　　Fig-7 Icons Assignment　　　[Lower Row]

2) CG-RAM for 5×7 Dot and S1, S2, S18 icons

Refer to Table_11

5.2 Interfacing to the MPU

This VFD module can interface in 8-bit operation.

5.3 Power-on reset

An internal reset circuit automatically initializes the module when the power is turned on.

The following instructions are executed during the initialization.

1) Display clear

     Fill the DD-RAM with 20H(Space Code)

2) Set the address counter to 00H

     Set the address counter (ACC) to point DD-RAM.

3) Display on/off control:

     $D = 0$: Display off

     $B = 0$: Blinking off

4) Entry mode set:

     $I/D = 1$: Increment by 1

     $S = 0$: No shift

5) Function Set

     $IF = 1$: 8-bit interface data

     $N = 1$: 2-line display

     $BR0 = BR1 = 0$; Brightness $= 100\%$

6. INSTRUCTIONS

6.1 Outline

Only the instruction register (IR) and the data register (DR) of the VFD controller can be controlled by the user's MPU. Before starting the internal operation of the controller, control information is temporarily stored into these registers to allow interfacing with various MPUs, which operate at different speeds, or various peripheral control devices. The internal operation of the controller is determined by signals sent from the MPU. These signals, which include register selection signal (RS), write signal (/WR) and the data bus (DB0 to DB7), make up the controller instructions (See Table_13).

These are four categories of instructions that:

     .Designate controller functions, such as display format, data length, etc.

     .Set internal RAM addresses

     .Perform data transfer with internal RAM

     .Perform miscellaneous functions

Normally, instructions that perform data transfer with internal RAM are used the most.

However, auto-incrementation by 1 (or auto-decrementation by 1) of internal RAM addresses after each data write can lighten the program load of the MPU. Since the display shift instruction can perform concurrently with display data write, the user can minimize system development time with maximum programming efficiency.

Table _13 Instruction Set

Instruction	CODE										Description
	RS	/WR	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	
Display Clear	0	↑	0	0	0	0	0	0	0	1	Clear all display and sets DD-RAM address 0 in address counter
Cursor Home	0	↑	0	0	0	0	0	0	1	×	Sets DD-RAM address 0 in ACC. Also returns the display being shifted to the original position. DD-RAM contents remain unchanged
Entry Mode Set	0	↑	0	0	0	0	0	1	I/D	S	Specify display shift. These operations are performed during writing data.
Display ON/OFF Control	0	↑	0	0	0	0	1	D	C	B	Sets all display ON/OFF (D), cursor ON/OFF(C), Cursor blink of character position (B).
Cursor or Display Shift	0	↑	0	0	0	1	S/C	R/L	×	×	Shifts display keeping DD-RAM contents.
Function Set	0	↑	0	0	1	1	N	×	BR1	BR0	Sets number of display lines (N), Set Brightness level (BR1, BR0)
CGRAM Address Setting	0	↑	0	1	ACG						Sets the CG-RAM address.
DDRAM Address Setting	0	↑	1	ADD							Sets the DD-RAM address.
Data Writing to CG or DDRAM	1	↑	Data writing								Writes data into CG-RAM or DD-RAM.
*NOTE	I/D =1 : Increment I/D =0 : Decrement S = 1 : Display shift enabled S = 0 : Display shift disabled S/C = 1: Display shift S/C = 0: Ignore R/L = 1: Shift to the right R/L = 0: Shift to the left IF = 1: 8bits IF = 0: 4bits N = 1 : 2 lines display N = 0 : 1 line display BR1, BR0 = 00 : 100% 01: 75% 　　　　　　 10 :　50%　 11: 25% ×: Don't Care										[Abbreviation] DD-RAM : Display Data RAM CG-RAM : Character Generator RAM ACG : CG-RAM Address ADD : DD-RAM Address ACC : Address Counter

6.2 Instruction Descriptions

6.2.1 Display Clear

DB7 DB6 DB5 DB4 DB3 DB2 DB1 DB0

0	0	0	0	0	0	0	1

01H

RS=0, /CS= 0, /WR= 0 to 1

This instruction

(1) Fills all locations in the display data RAM (DD-RAM) with 20H (Blank-character).

(2) Clear the contents of the address counter (ACC) to 00H.

(3) Sets the display for zero character shift (returns original position).

(4) Sets the address counter (ACC) to point to the DD-RAM.

(5) Sets the address counter (ACC) to increment on the each access of DD-RAM or CG-RAM.

6.2.2 Cursor Home

DB7 DB6 DB5 DB4 DB3 DB2 DB1 DB0

0	0	0	0	0	0	1	×

02H to 03H

× : Don't care

RS=0, /CS= 0, /WR= 0 to 1

This instruction

(1) Clear the contents of the address counter (ACC) to 00H.

(2) Sets the address counter (ACC) to point to the DD-RAM.

(3) Sets the display for zero character shift (returns original position).

6.2.3 Entry Mode Set

DB7 DB6 DB5 DB4 DB3 DB2 DB1 DB0

0	0	0	0	0	1	I/D	S

04H to 07H

RS=0, /CS= 0, /WR= 0 to 1

The I/D bit selects the way in which the contents of the address counter (ACC) are modified after every access to DD-RAM or CG-RAM.

I/D = 1 : The address counter (ACC) is incremented.

I/D = 0 : The address counter (ACC)is decremented.

The S bit enables display shift, instead of cursor shift, after each write or read to the DD-RAM.

S = 1 : Display shift enabled.

S = 0 : Cursor shift enabled.

The direction in which the display is shifted is opposite in sense to that of the cursor.

For example, if S=0 and I/D=1,the cursor would shift one character to the right after a MPU writes to DD-RAM.   However if S=1 and I/D=1, the display would shift one character to the left and the cursor would maintain its position on the panel.

The cursor will already be shifted in the direction selected by I/D during reads of DD-RAM,

Irrespective of the value of S. Similarly reading and writing the CG-RAM always shift the cursor.

Also both lines are shifted simultaneously.

Table_14 Cursor move and Display shift by the "Entry Mode Set"

I/D	S	After writing DD-RAM data	After Reading DD-RAM data
0	0	The cursor moves one character to the left.	The cursor moves one character to the left.
1	0	The cursor moves one character to the right.	The cursor moves one character to the right.
0	1	The display shifts one character to the right without cursor's move.	The cursor moves one character to the left.
1	1	The display shifts one character to the left without cursor's move.	The cursor moves one character to the right.

6.2.4 Display ON/OFF

DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	
0	0	0	0	1	D	C	B	08H to 0FH

RS=0, /CS=0, /WR=0 to 1

This instruction controls various features of display.

D = 1 : Display on,   D = 0 : Display off.

C = 1 : Cursor on,   C = 0 : Cursor off.

B = 1 : Blinking on，   B = 0 : Blinking off.

(Blinking is achieved by alternating between a normal and all on display of a character.

The cursor blinks with a frequency of about 1.0 HZ and DUTY 50%.)

6.2.5 Display Shift

DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	
0	0	0	1	S/C	R/L	×	×	10H to 1FH

× : Don't care

RS=0, /CS=0, /WR=0 to 1

This instruction shifts the display moves one character to the left or right, without writing DD-RAM.

The S/C bit selects movement of the display.

S/C = 1 : Shift display

S/C = 0 : No shift display

The R/L bit selects left ward or right ward movement of the display and/or cursor.

R/L = 1 : Shift one character right

R/L = 0 : Shift one character left

Table_15 Cursor/Display shift

S/C	R/L	Cursor shift	Display shift
0	0	Move one character to the left	No shift
0	1	Move one character to the right	No shift
1	0	Shift one character to the left with display	Shift one character to the left
1	1	Shift one character to the right with display	Shift one character to the right

6.2.6 Function Set

DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	1	1	N	×	BR1	BR0

20H to 3FH

× : Don't care

RS=0, /CS=0, /WR=0 to 1

This instruction initializes the system, and must be the first instruction executed after power-on.

The N bit selects between 1-line or 2-line display.

N = 1 : Select 2 line display(Using anode output A1 to A80)

N = 0 : Select 1 line display (Using anode output A1 to A40. A41 to A80 fixed Low level.)

BR1, BR0 flag is control to brightness of VFD to modulate pulse width of Anode output as follows.

BR1	BR0	Brightness
0	0	100%
0	1	75%
1	0	50%
1	1	25%

6.2.7 Set CG-RAM Address

DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	1	ACG					

40H to 7FH

RS=0, /CS=0, /WR=0 to 1

This instruction

(1) Load a new 6-bit address into the address counter (ACC).

(2) Sets the address counter (ACC) to address CG-RAM.

Once "Set CG-RAM Address" has been executed, the contents of the address counter (ACC) will be automatically modified after every access of CG-RAM, as determined by the "Entry Mode Set" instruction. The active width of the address counter (ACC), when it is addressing CG-RAM, is 6 bits, so the counter will wrap around to 00H from 3FH if more than 64 bytes of data are written to CG-RAM.

6.2.8 Set DD-RAM Address

DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
1	ADD						

80H to AFH (1-line)

C0H to E7H (2-line)

RS=0, /CS=0, /WR=0 to 1

This instruction

(1) Loads a new 7-bit address into the address counter (ACC).

(2) Sets the address counter (ACC) to point to the DD-RAM.

Once the "Set DD-RAM Address" instruction has been executed. The contents of the address counter (ACC) will be automatically modified after each access of DD-RAM, as selected by the "Entry Mode Set" instruction.

Table_16 Valid DD-RAM address Ranges

	Number of character	Address Range
1st line	40	00H to 27H
2nd line	40	40H to 67H

6.2.9 Write Data to CG or DD-RAM

DB7　DB6　DB5　DB4　DB3　DB2　DB1　DB0

Data Write	00H to FFH
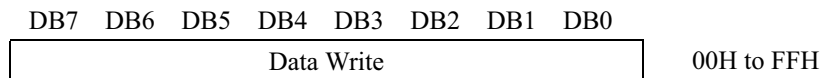
RS=1, /CS=0, /WR=0 to 1

This instruction writes 8-bit binary data (DB7 to DB0) into CG-RAM or DD-RAM.

To write into CG-RAM or DD-RAM is determined by the pervious specification of the CG-RAM or DD-RAM address setting. After a write, the address is automatically incremented or decremented by 1 according to the entry mode. The entry mode also determines the display shift.

When data is written to the CG-RAM, the DB7, DB6 and DB5 bits are not displayed as characters.

7. Example of the Display Data Writing

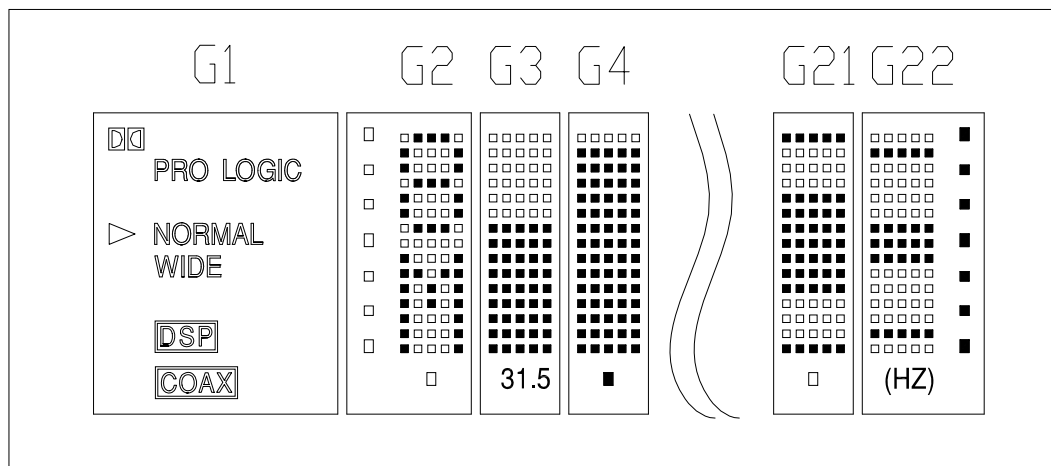Display data sheet of table_14 lists Display pattern of Fig-9

Fig-9 Display pattern Example

If a user wants to display above pattern then please make following procedures.

1. Power on
2. Wait more than 15ms after Vcc rise to 4.5V.
3. Function set (RS=0, Data =38h to assign 2-line display)
4. Display On (RS=0,Data =0Ch to assign Display On, Cursor off and Blinking off)
5. CG-RAM Address Set (RS = 0,Data = 00h to assign the first CG-RAM address)
6. CG-RAM Data Write-in (RS = 1,Data =10h + 00h + 00h + 10h + 18h + 00h + 00h)
7. CG-RAM Address Set (RS=0,Data=01h to assign the second CG-RAM address)
8. CG-RAM Data Write-in (RS = 1,Data = 00h + 00h + 04h + 00h + 00h + 08h + 01h + 00h)
9. DD-RAM Address Set (RS = 0,Data=80h to assign the Upper Icons which are located in G1)
10. CG-RAM data write-in on Upper Icon of G1 (RS=1, Data =00h)
11. DD-RAM Address Set (RS = 0,Data=C0h to assign the Lower Icons which are located in G1)
12. CG-RAM data write-in on Lower Icon of G1 (RS=1,Data=01h)
13. DD-RAM Address Set (RS = 0,DATA=81h to assign the Upper Line of G2)
14. CG-ROM data write-in (RS =1,Data = 38h + 82h + 87h +[16 CG-ROM codes] + E1H + 99h)
15. DD-RAM Address Set (RS = 0,DATA=C1h to assign the Lower Line of G2)
16. CG-ROM data write-in (RS =1,Data = 4Dh + FEh + BEh +[16 CG-ROM codes] + F1H + A8h)

8.OPERATING RECOMMENDATIONS

8.1 Avoid applying excessive shock or vibration beyond the specification for the VFD module.

8.2 Since VFDs are made of glass material, careful handling is required.

   i.e. Direct impact with hard material to the glass surface (especially exhaust tip)may crack the glass.

8.3 When mounting the VFD module to your system, leave a slight gap between the VFD glass and your front panel. The module should be mounted without stress to avoid flexing the PCB.

8.4 Avoid plugging or unplugging the interface connection with the power on, otherwise it may cause the severe damage to input circuitry.

8.5 Slow starting power supply may cause non-operation because one chip micom won't be reset.

8.6 Exceeding any of maximum ratings may cause the permanent damage.

8.7 Since the VFD modules contain high voltage source, careful handling is required during powered on.

8.8 when the power is turned off, the capacitor does not discharge immediately.

   The high voltage applied to the VFD must not contact to the ICs. And the short-circuit of mounted Components on PCB within 30 seconds after power-off may cause damage to those.

8.9 The power supply must be capable of providing at least 3 times the rated current, because the surge current can be more than 3 times the specified current consumption when the power is turned on.

8.10 Avoid using the module where excessive noise interference is expected. Noise may affect the interface signal and causes improper operation. And it is important to keep the length of the interface cable less than 50cm.

8.11 Since all VFD modules contain C-MOS ICs, anti-static handling procedures are always required.