To :

SPECIFICATION

Rev 2.0

Application :

VACUUM FLUORESCENT DISPLAY MODULE

Model No. : 16L102DA4

Rev No.	Issued Date	Description	Remark
Tentative	Nov. 25, 1996	First Edition	All Pages
Rev 1.0	Feb. 02, 1998	Second Edition -.Mounting hole size change: Ø3.5→Ø4.0 -.Connector pin assignment change: #10: NC (No connection) → /RST (Reset) #8: NC (No connection) → SCLK (Serial clock) (common to #7)	Page 6/12 Page 5/12
Rev 2.0	May. 29, 1998	Third Edition -.Comma & Decimal point default value change Off → Undefined -.Addition of Recommand initial setting sequence	Page 10/12 Page 11/12

Issued by	Customer Approval
Checked by	
Approved by	

1. SCOPE

This specification applies to VFD module(Model No:16L102DA4) manufactured by Samsung Display Devices.

2. FEATURES

2.1 The MCU can control this module by five control signals, chip select(/SEL), shift clock(SCLK), serial data(SDATA) and reset(/RST).

2.2 Since a DC/DC converter is used, only +12Vdc power source is required to operate the module.

2.3 One chip controller mounted on the module includes the character generator ROM (CG-ROM) of 96 ASCII and 152 European characters.

2.4 Eight brightness levels can be selected by dimming function.

2.5 High quality blue-green(505 nm) vacuum fluorescent display provides an attractive and readable medium. Other colors can be achieved by simple wavelength filters.

2.6 Characters are provided with a 5×7 dot matrix.

2.7 The module has up to 8 user definable characters. (CG-RAM function)

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	16L102DA4
Digit Format	5×7 Dot Matrix with Comma

4.2 Outer Dimensions, Weight (See Fig-4 on Page 6/12 for details)

Table_2

Parameter		Specification	Unit
Outer Dimensions	Width	218.0±1.0	mm
	Height	45.0±1.0	mm
	Thickness	26.5 Max	mm
Weight		Typical 130	g

4.3 Specifications of Display Panel (See Fig-5 on Page 6/12)

Table_3

Parameter	Symbol	Specification	Unit
Display Size (W × H)	-	173.2×13.55	mm
Number of Digit	-	16 Digits	—
Character Size (W × H)	-	6.76×12.50	mm
Character Pitch	Cp(x)	11.0	mm
Display Color	-	Blue-Green (Peak 505nm)	nm

4.4 Environment Conditions

Table_4

Parameter	Symbol	Min.	Max.	Unit
Operating Temperature	Topr	-20	+70	℃
Storage Temperature	Tstg	-40	+85	℃
Humidity (Operating)	Hopr	0	85	%
Humidity (Non-operating)	Hstg	0	90	%
Vibration (10 ~ 55 Hz)	—	—	4	G
Shock	—	—	40	G

4.5 Absolute Maximum Ratings

Table_5

Parameter	Symbol	Min.	Max.	Unit
Supply Voltage	Vcc	-0.3	13.2	Vdc
Input Signal Voltage	Vis	-0.3	5.5	Vdc

4.6 Recommend Operating Conditions

Table_6

Parameter	Symbol	Min.	Typ.	Max.	Unit
Supply Voltage	Vcc	10.8	12.0	13.2	Vdc
H-Level Input Voltage	Vih	3.5	—	5.5	Vdc
L-Level Input Voltage	Vil	—	—	0.8	Vdc

4.7 DC Characteristics (Ta = +25℃, Vcc = +12.0 Vdc)

Table_7

Parameter	Symbol	Min.	Typ.	Max.	Unit
Supply Current ※)	Icc	—	300	400	mA
H-Level Input Current	Iih	-1.0	—	1.0	μA
L-Level Input Current	Iil	-1.0	—	1.0	μA
Luminance	L	100	200	—	ft-L

※) The surge current can be approx. 3 times the specified supply current at power on.

4.8 AC Characteristics (Ta=+25℃, Vcc=+5.0 Vdc)

Table_8

Parameter	Symbol	Min.	Max.	Unit
Cycle time of SCLK	t_{CYCLE}	1.0	-	μs
Pulse width of SCLK	t_{CW}	300	-	ns
Set-up time of SDATA	t_{DS}	300	-	ns
Holding time of SDATA	t_{DH}	300	-	ns
Set-up time of /SEL	t_{CSS}	300	-	ns
Holding time of /SEL	t_{CSH}	16	-	μs
Waiting time of /SEL	t_{CSW}	300	-	ns
Processing time of SDATA	t_{DOFF}	8	-	μs
Wating time of SDATA	t_{RSOFF}	300	-	ns
Rising Time of Vcc	t_{PRZ}	-	100	μs
Off time of Vcc	t_{POFF}	5.0	-	ms

4.9 Timing Diagram

4.9.1 Data Input Timing

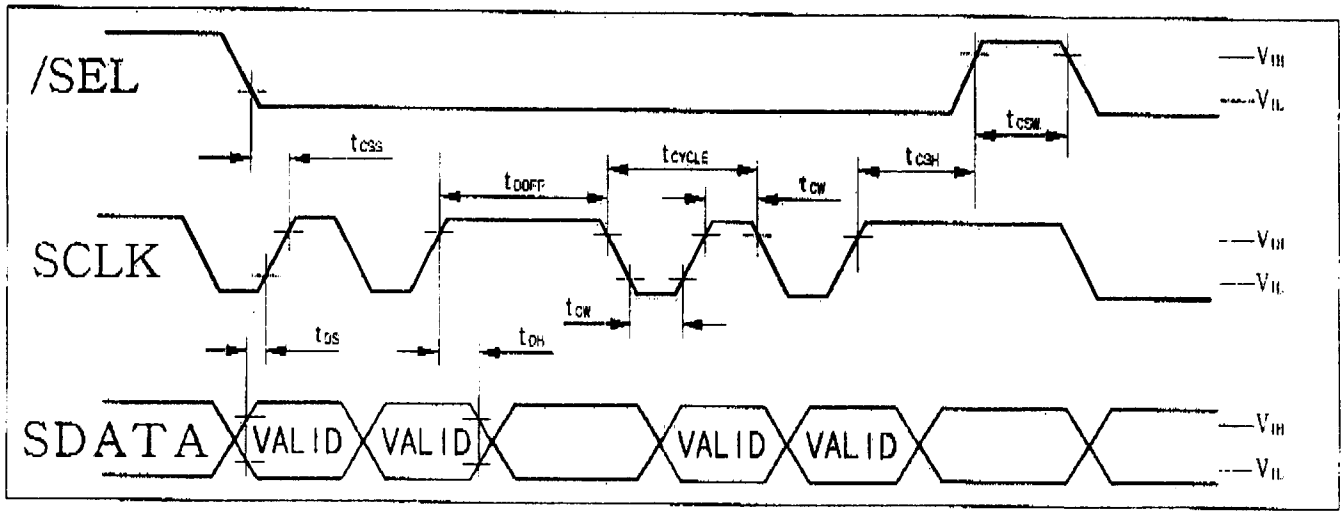


Fig-1. Data Input Timing Diagram

4.9.2 Power On Timing

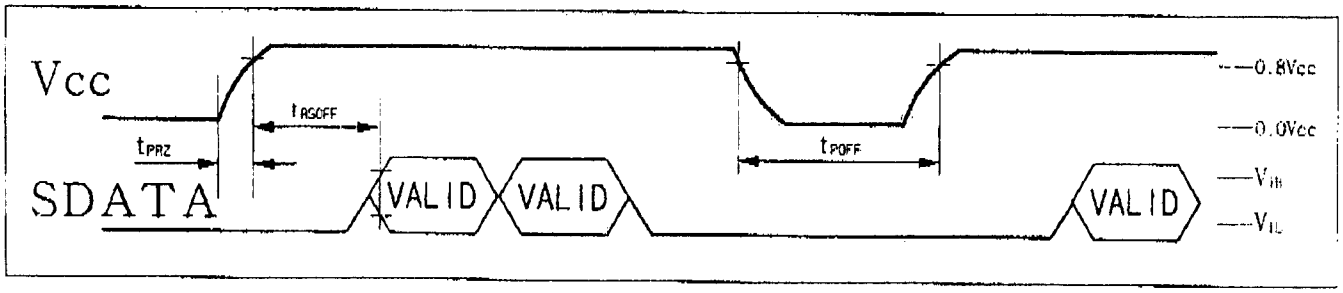


Fig-2. Power On Timing Diagram

4.10 Signal Interfacing

· Connector(Male) : PH-2S06-FG (by Aster) or equivalent
→ Mate Socket(Female) : HIF3B-12D-2.54R (HIROSE) or equivalent

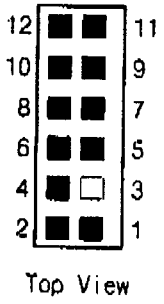


Table_9

Pin No	Symbol	Descriptions
5	/SEL	Chip Select Terminal with 1kΩ Pulled-up. When the pin is High, the serial data transfer is inhibited.
7,8	SCLK	Shift Clock Input Terminal with 1kΩ Pulled-up. The Serial data(Pin #9) is shifted at rising edge of SCLK.
9	SDATA	Serial data Input from LSB with 1kΩ Pulled-up.
10	/RST	Input terminal for reset of VFD Module(Low active)
1,2	Vcc	Power Supply Terminal. (+12Vdc is required.)
11,12	GND	Ground Terminal. (0Vdc is required)
3	N/P	No Pin
4,6	N/C	No Connection

4.11 System Block Diagram

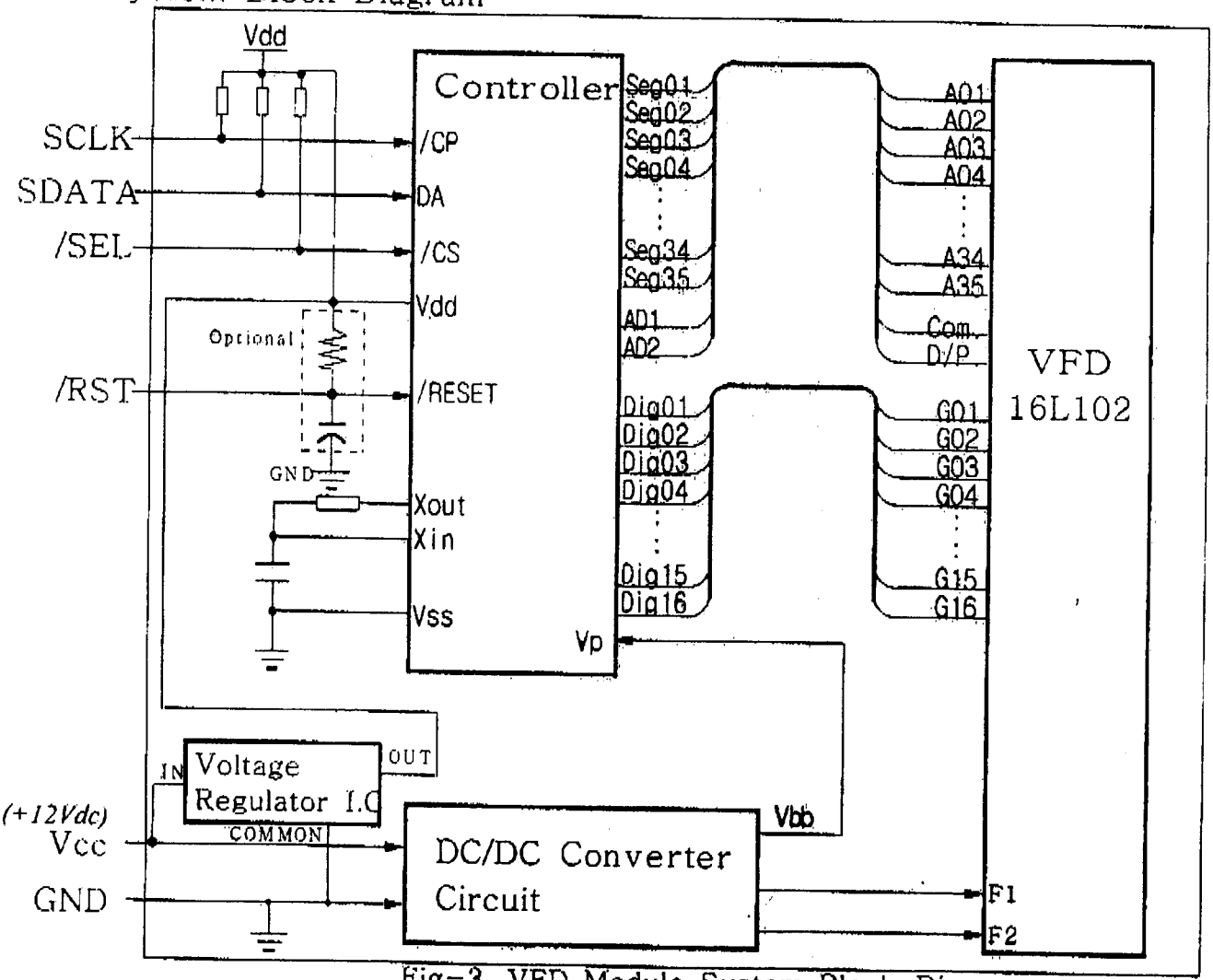


Fig-3. VFD Module System Block Diagram

4.12 Outer Dimensions

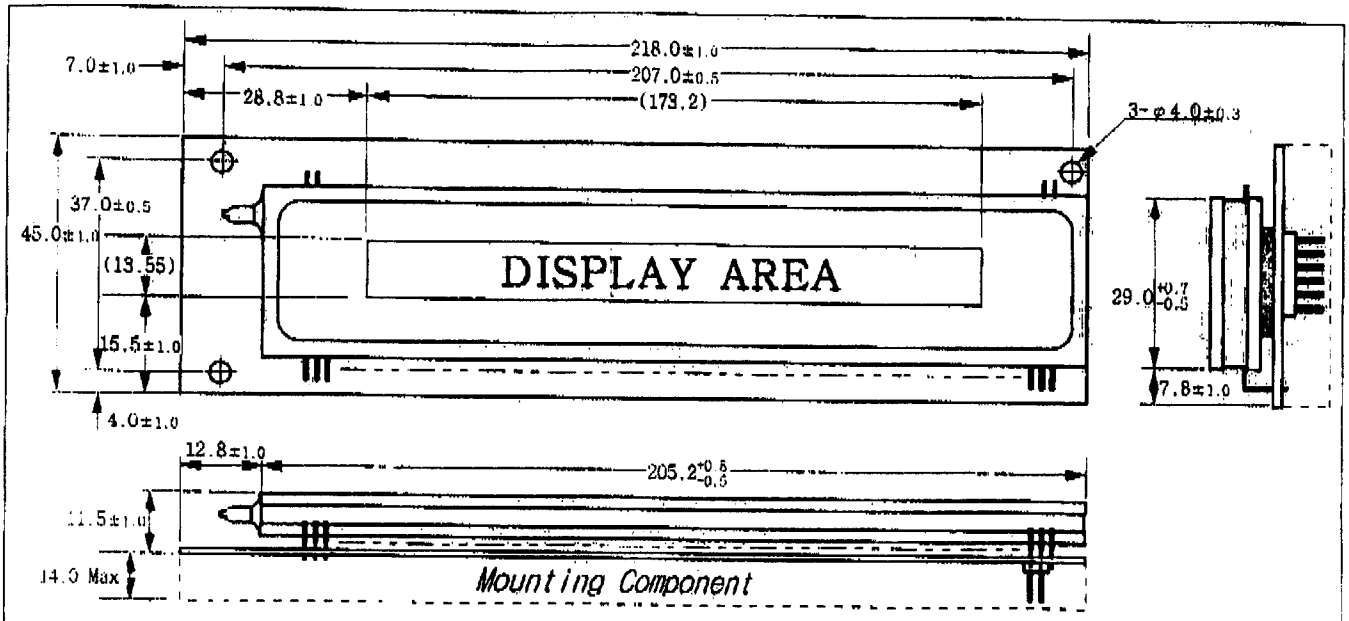


Fig-4. Outer Dimensions (Unit : mm)

4.13 Pattern Details

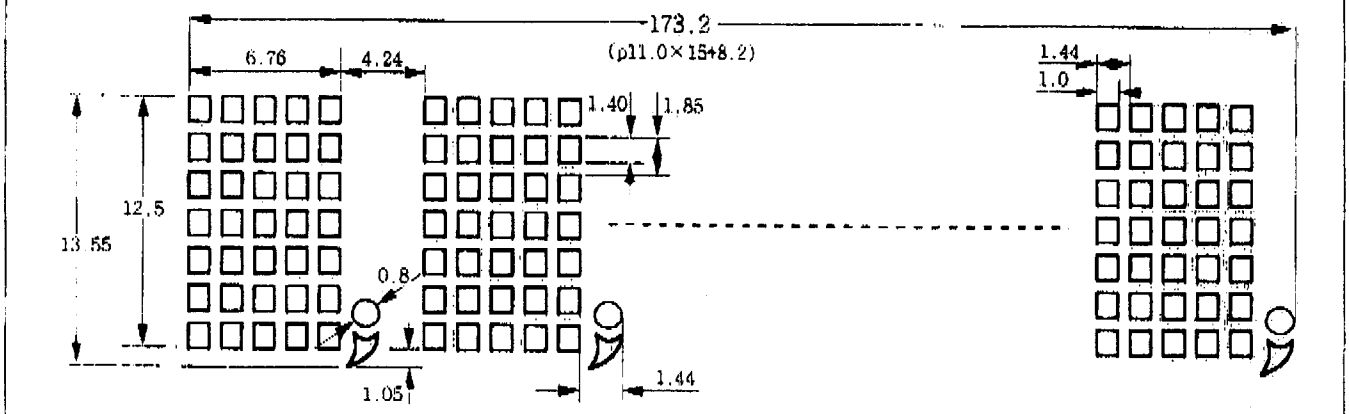


Fig-5. Pattern Details (Unit : mm)

5. FUNCTIONAL DESCRIPTIONS

A display control command or character data is written by the 8-bit serial synchronous transfer mode. The Figure_6 on the next page shows the write timing chart.
When the /SEL pin is low(Logic "0"), data can be transferred. Data with 8 bits length is input into the SDATA pin sequentially from LSB. (LSB First, MSB Last)

Data is shifted at the rising edge of a shift clock pulse which is input to the SCLK pin as shown in the Figure_6. When data with 8 bits length is entered, an inner LOAD signal is automatically generated, and data is written into the register and RAM. Accordingly, there is no need to input an external LOAD signal.
If the /SEL pin is changed from LOW to HIGH, the serial transfer is inhibited, and

data, which is entered after the /SEL pin is changed from HIGH to LOW, is recognized in unit of 8-bits.

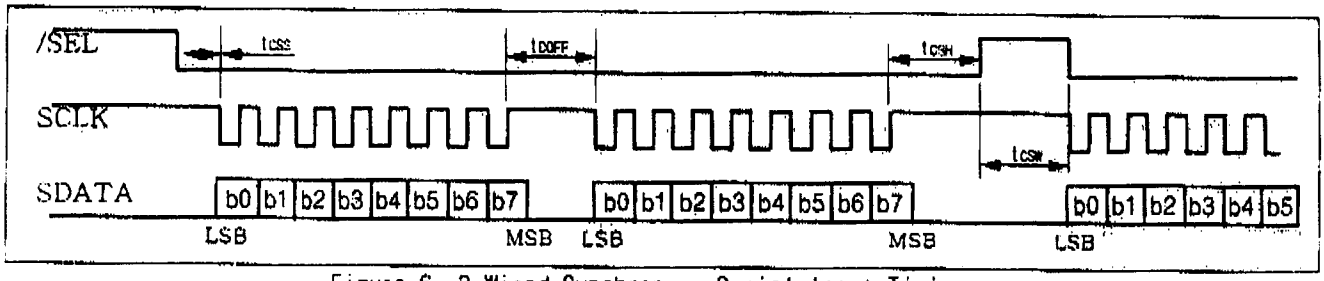


Figure_6. 3-Wired Synchronous Serial Input Timing

5.1 Character Code Write-in

When the first 8-bits data is a command of "DP"(Refer to section 5.2.1) after the /SEL pin is changed from HIGH to LOW, the following codes are treated as display character data. At this time, the display address (Write-in Position) is shifted to the right one digit automatically.

If a user wants to move the write-in position, the user should make a positive pulse on /SEL pin and re-enter a "DP" command.

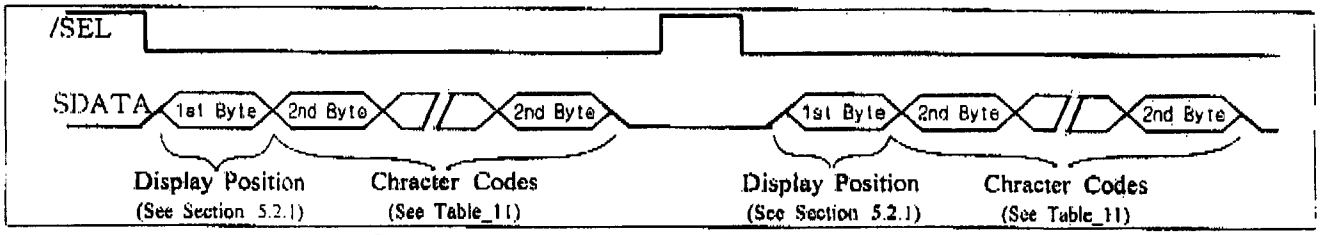


Figure_7. Character Codes Write-in Diagram

5.1.1 CG-RAM Character (00 Hex ~ 07 Hex)

A user should define the CG-RAM font by UDF function (Refer to section 5.2.2), before entering the CG-RAM code into VFD module.

5.1.2 CG-ROM Character (08 Hex ~ FF Hex)

When the CG-ROM character data code is written-in the module, the corresponding character font (Refer to Table_12 on next page) is displayed at current address (write-in position).

5.2 Control Command Write-in

The control commands should be written-in first after the /SEL pin is changed from HIGH to LOW. The control commands are listed up at Table_10 and details will be explained.

Table_10

Symbol	Description	Hex Code	Binary Code							
			b7	b6	b5	b4	b3	b2	b1	b0
DP	Display Position (Address Set)	10~1F Hex	0	0	0	1	*	*	*	*
UDF	User Definable Font (Save CG-RAM Data)	20~27 Hex	0	0	1	0	×	*	*	*
CMDP	Comma and/or Decimal Point ON/OFF	30~3F Hex	0	0	1	1	*	*	*	*
DIM	Dimming (Luminance Control)	50~57 Hex	0	1	0	1	×	*	*	*
DLNG	Digit Length Set	60~67 Hex	0	1	1	0	×	*	*	*
ALL	All Segments ON/OFF	70~73 Hex	0	1	1	1	×	×	*	*

× : Don't Care, * : Selection Bits, 0 : Low Level, 1 : High Level

Font Table

Table_11

MSB / LSB	b7	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
	b6	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1
	b5	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1
	b4	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1
b3 b2 b1 b0		0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0 0 0 0	0	CG-RAM0															
0 0 0 1	1	CG-RAM1															
0 0 1 0	2	CG-RAM2															
0 0 1 1	3	CG-RAM3															
0 1 0 0	4	CG-RAM4															
0 1 0 1	5	CG-RAM5															
0 1 1 0	6	CG-RAM6															
0 1 1 1	7	CG-RAM7															
1 0 0 0	8																
1 0 0 1	9																
1 0 1 0	A																
1 0 1 1	B																
1 1 0 0	C																
1 1 0 1	D																
1 1 1 0	E																
1 1 1 1	F																

5.2.1 DP (10 Hex ~ 1F Hex) : Set Display Position (Write-in Address)

This command is used to select a digit to display a character instead of writing the character from the first digit, the write-in starting position can be pointed out by using this command.

Table_12

Binary								HEX	Digit
b7	b6	b5	b4	b3	b2	b1	b0		
0	0	0	1	0	0	0	0	10	Left End
				0	0	0	1	11	2nd Digit
				0	0	1	0	12	3rd Digit
				0	0	1	1	13	4th Digit
				0	1	0	0	14	5th Digit
				0	1	0	1	15	6th Digit
				0	1	1	0	16	7th Digit
				0	1	1	1	17	8th Digit
0	0	0	1	1	0	0	0	18	9th Digit
				1	0	0	1	19	10th Digit
				1	0	1	0	1A	11th Digit
				1	0	1	1	1B	12th Digit
				1	1	0	0	1C	13th Digit
				1	1	0	1	1D	14th Digit
				1	1	1	0	1E	15th Digit
				1	1	1	1	1F	Last Digit

5.2.2 UDF (20 Hex ~ 27 Hex) : User Definable Font (Save CG-RAM Font Data)

The characters can be designed by using this command. These font data are memorized in the CG-RAM of the module. Any 5×7 dots pattern can be stored in the character code location specified by the b0~b2 of 1st byte.

Table_13

	b7	b6	b5	b4	b3	b2	b1	b0	Location	Description
1st byte	0	0	1	0	×	0	0	0	CG-RAM0	Specify UDF command and character code location(CG-RAM0 ~ CG-RAM7).
						0	0	1	CG-RAM1	
						0	1	0	CG-RAM2	
						0	1	1	CG-RAM3	
						1	0	0	CG-RAM4	
						1	0	1	CG-RAM5	
						1	1	0	CG-RAM6	
						1	1	1	CG-RAM7	
2nd byte	×	A31	A26	A21	A16	A11	A6	A1		Specify ON or OFF of 35 dots position. Table_14.1 shows the relation between segment position and data formation. Table_14.2 shows the example of "£" font designing procedure.
3rd byte	×	A32	A27	A22	A17	A12	A7	A2		
4th byte	×	A33	A28	A23	A17	A13	A8	A3		
5th byte	×	A34	A29	A24	A19	A14	A9	A4		
6th byte	×	A35	A30	A25	A20	A15	A10	A5		

× : Don't Care

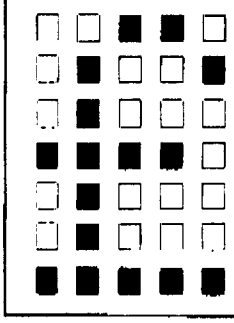
Table_14.1

A1	A2	A3	A4	A5
A6	A7	A8	A9	A10
A11	A12	A13	A14	A15
A16	A17	A18	A19	A20
A21	A22	A23	A24	A25
A26	A27	A28	A29	A30
A31	A32	A33	A34	A35

Bit Map of 5×7 Dot Matrix

Table_14.2

Pattern Example



Coding Example

	b7	b6	b5	b4	b3	b2	b1	b0	Hex Code
2nd byte	0	0	0	0	1	0	0	0	48 Hex
3rd byte	0	1	1	1	1	1	1	0	7E Hex
4th byte	0	1	0	0	1	0	0	1	49 Hex
5th byte	0	1	0	0	1	0	0	1	49 Hex
6th byte	0	0	1	0	0	0	1	0	42 Hex

5.2.3 CMDP (30 Hex ~ 3F Hex) : Comma and/or Decimal Point On/OFF

This command is useful for comma and/or decimal point display ON/OFF.

Table_15

	b7	b6	b5	b4	b3	b2	b1	b0	Digit	Description
1st byte	0	0	1	1	0	0	0	0	Left End	Specify CMDP command and display address.
					0	0	0	1	2nd Digit	
					0	0	1	0	3rd Digit	
					:	:	:	:	:	
					1	1	0	1	14th Digit	
					1	1	1	0	15th Digit	
					1	1	1	1	Last Digit	
2nd byte	×	×	×	×	×	×	0	0	Comma Off, Decimal Point Off	
							0	1	Comma Off, Decimal Point On	
							1	0	Comma On, Decimal Point Off	
							1	1	Comma On, Decimal Point On	

× : Don't Care

This command is similar to DP function.
When a user want to display comma and/or decimal point continously, it isn't needed to re-enter this command. i.e the write-in position is incresed automatically after input of 2nd byte. Consequently, if a user doesn't want to display more comma and/or decimal point, the user should make a positive pulse of /SEL and write-in DP or another command code.

5.2.4 DIM (50 Hex ~ 57 Hex) : Dimming

Brightness can be controlled into 8 levels by using this function.

Table_16

b7	b6	b5	b4	b3	b2	b1	b0	Dimming Level
0	1	0	1	×	0	0	0	50% (8/16), Default Value
					0	0	1	56 % (9/16)
					0	1	0	62 % (10/16)
					0	1	1	69 % (11/16)
					1	0	0	75 % (12/16)
					1	0	1	81 % (13/16)
					1	1	0	87 % (14/16)
					1	1	1	94 % (15/16), Maximum Value

5.2.5 DLNG (60 Hex ~ 67 Hex) : Set Display Length

This command is used to define the number of display digit. (9 to 16 Digits)

Table_17

b7	b6	b5	b4	b3	b2	b1	b0	Dimming Level
0	1	1	0	×	0	0	0	1~16 Digit, Default Value
					0	0	1	1~ 9 Digit
					0	1	0	1~10 Digit
					0	1	1	1~11 Digit
					1	0	0	1~12 Digit
					1	0	1	1~13 Digit
					1	1	0	1~14 Digit
					1	1	1	1~15 Digit

5.2.6 ALL (70 Hex ~ 73 Hex) : All Segments ON/OFF

All segments can be displayed or non-displayed by using this command. This command is useful for testing of VFD module, blinking of display or obviating erroneous display pattern at power on.

Table_18

b7	b6	b5	b4	b3	b2	b1	b0	Description
0	1	1	1	×	×	0	0	Maintain current state
						0	1	All segs are OFF. (Default state)
						1	0	All segs are ON.
						1	1	All segs are ON. (All ON is higher priority.)

5.4 Reset

The reset function allows the users to re-initialize the display controller, while the power is still applied to the module, by applying a logical "0" to pin #10(/RST) of the connector.
When the controller is initialized, the display status are shown in Table_19.

Table_19

Initial Status after reset	
Display digit	16 digits
Dimming adjustment	8/16
All display lights ON or OFF	OFF mode
Display position & data	Undefined
Comma & Decimal Point	Undefined
Use definable font	Undefined

5.4. Recommend Initial Setting Sequence

After power on, next (Table_20) command codes are recommanded.

Table_20

No	Initial setting items	Hex-code	Operation Result
1	Number of digit setting	60H	Display length is 16
2	Dimming adjustment setting	57H	Dimming level is set to 100%
3	Use definable font setting	Arbitrary	Design the user definable fonts
4	Comma & Decimal point setting	30H + 00H	Comma & Decimal point OFF
5	Display position & character data setting	10H + Arbitrary	Display position is set to 1G
6	All display lights ON mode setting.	70H	All outputs maintain current states

6. OPERATING RECOMMENDATIONS

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

6.2 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.

6.3 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 of the PCB.

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

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

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

6.7 Since the VFD modules contain high voltage source, careful handling is required while power is on.

6.8 When the power is turned off, the capacitor does not discharge immediately. So the high voltage applied to the VFD must not get in contact with ICs. In other words, short-circuit of mounted components on PCB within 30 seconds after power-off may cause damage the module.

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

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

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