

## User's Guide

# M0116LD-161LDA1

# VFD-

(Vacuum Fluorescent Display Module)

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## 1. INTRODUCTION

The M0116LD Vacuum Fluorescent Display module consists of a 1 row x 16 digit display with one chip controller on board.

## 2. FEATURES

- 2.1 The MCU can control this module by three control signals, chip select (/SEL), shift clock (SCLK) and serial data (SDATA).
- 2.2 Since a DC/DC convert is used, only +5Vdc 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 (505nm) 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

<b>TYPE</b>	<b>M0116LD-161LSA1</b>
Digit Format	5×7 Dot Matrix with Comma

### 4.2 Outer Dimensions, Weight (See Fig-4 on page 5/13 for details)

Table\_2

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

#### 4.3 Specification of Display Panel (See Fig-5 on Page 5/13) Table\_3

Parameter	Symbol	Specification	Unit
Display Size(W×H)	—	174.0×16.0	mm
Number of Digit	—	16 Digits	
Character Size(W×H)	—	7.1×14.7	mm
Character Pitch	Cp(x)	11.0	mm
Display Color	—	Blue-Green (Peak 505nm)	

#### 4.4 Environment Conditions Table\_4

Parameter	Symbol	Min.	Max.	Unit
Operating Temperature	Topr	-40	+85	°C
Storage Temperature	Tstg	-50	+95	°C
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	Vcc	-0.3	5.5	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	4.5	5.0	5.5	Vdc
H-Level Input Voltage	Vih	3.5	—	5.5	Vdc
L-Level Input Voltage	Vil	—	—	1.5	Vdc

#### 4.7 DC Characteristics(Ta=+25°C, Vcc=+5.0Vdc) Table\_7

Parameter	Symbol	Min.	Typ.	Max.	Unit
Supply Current ※)	Icc	—	850	1000	mA
H-Level Input Current	Iih	-1.0	—	1.0	uA
L-Level Input Current	Iil	-1.0	—	1.0	uA
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 ( $T_a = +25^\circ\text{C}$ ,  $V_{cc} = +5.0\text{Vdc}$ )

Table\_8

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

## 4.9 Timing Diagram

## 4.9.1 Data Input Timing

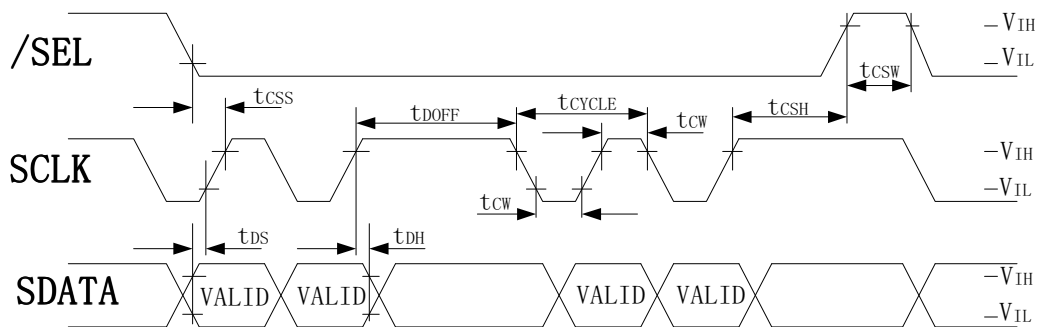


Fig-1. Data Input Timing Diagram

## 4.9.2 Power On Timing

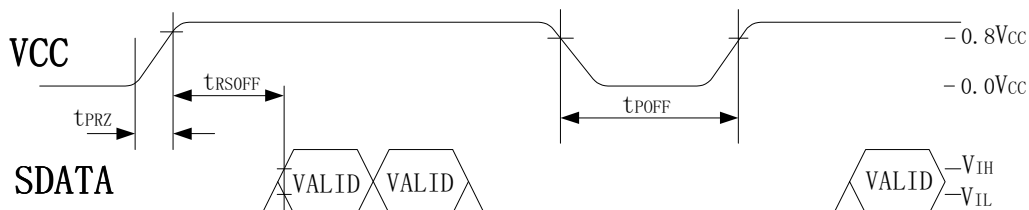


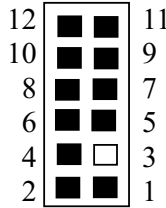
Fig-2. Power On Timing Diagram

#### 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	<b>/SEL</b>	Chip select Terminal with 1K Pulled-up. When the pin is High, the serial data transfer is inhibited
7	<b>SCLK</b>	Shift Clock Input Terminal with 1K Pulled-up. The serial data (pin#9) is shifted at rising edge of SCLK.
9	<b>SDATA</b>	Serial data Input from LSB with 1K Pulled-up.
1,2	<b>VCC</b>	Power Supply Terminal. (+5Vdc is required.)
11,12	<b>GND</b>	Ground Terminal. (0Vdc is required)
3	<b>N/P</b>	No Pin
4,6,8,10	<b>N/C</b>	No Connection

#### 4.11 System Block Diagram

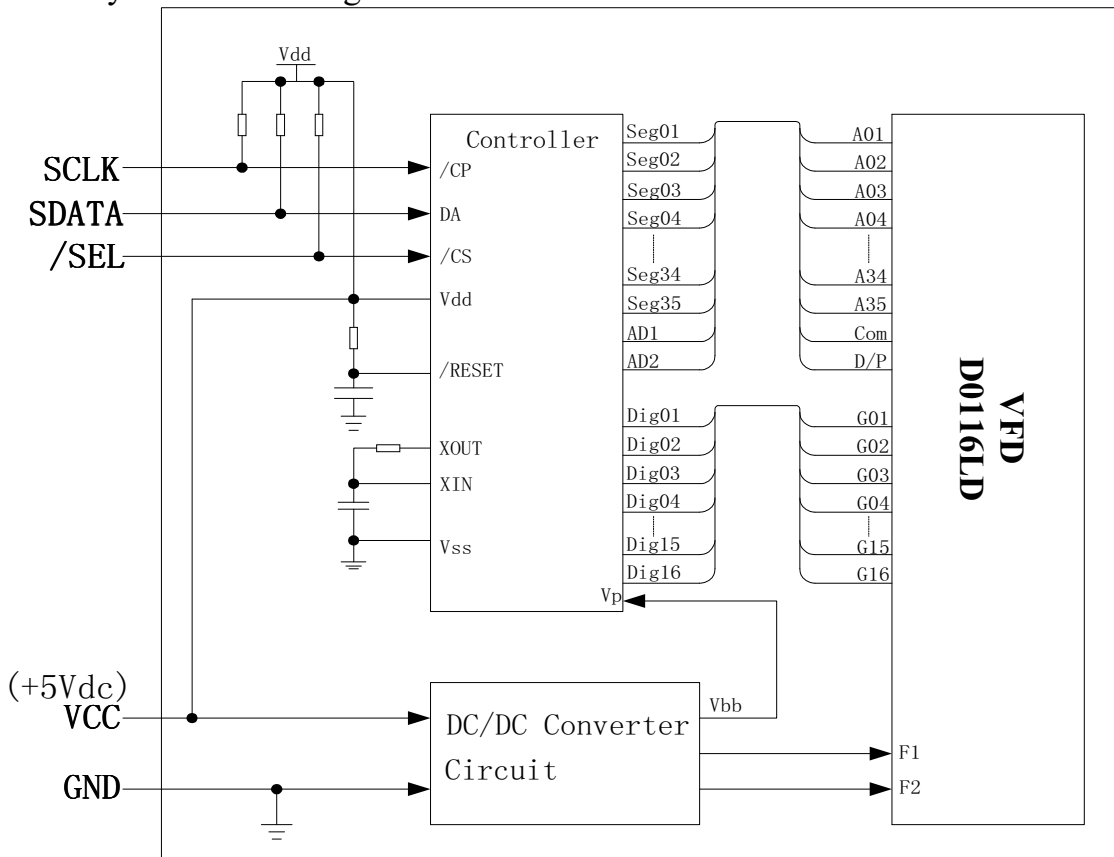


Fig-3 VFD Module System Block Diagram



## 5. FUNCTION DESCRIPTIONS

A display control command or character data is written by the 8-bit serial synchronous transfer mode. The Figure\_6 shows the write timing chart.

When the /CS pin is low (logic"0"), data can be transferred. Data with 8bits length is input into the DA 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 /CP 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 /CS pin is changed from LOW to HIGH, the serial transfer is inhibited, and data, which is entered after the /CS pin is changed from HIGH to LOW, is recognized in unit of 8-bits.

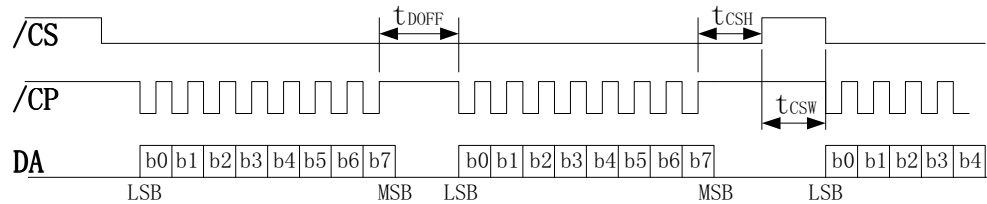


Figure-6. 3-Wired Synchronous Serial Input Timing

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

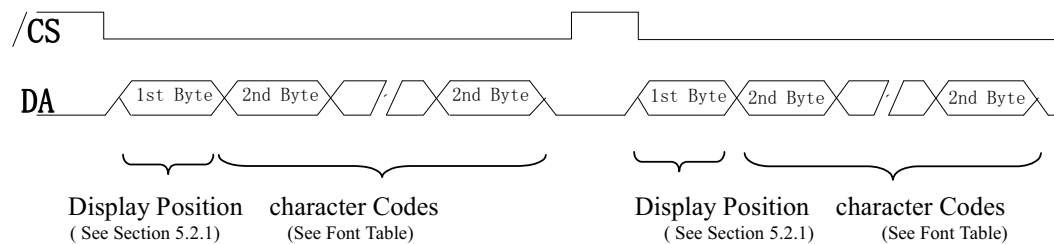


Figure-7 Character Codes Write-in diagram

#### 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\_11 ) is display at current address (write-in position)

## Font Table

MSB LSB	b7	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1		
	b6	0	0	0	0	1	1	1	1	0	0	0	1	1	1	1		
	b5	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1		
	b4	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0		
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	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0 0 0 1	1	CG-RAM1	!	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0 0 1 0	2	CG-RAM2	"	2	3	4	5	6	7	8	9	A	B	C	D	E	F	
0 0 1 1	3	CG-RAM3	#	3	4	5	6	7	8	9	A	B	C	D	E	F		
0 1 0 0	4	CG-RAM4	\$	4	5	6	7	8	9	A	B	C	D	E	F			
0 1 0 1	5	CG-RAM5	%	5	6	7	8	9	A	B	C	D	E	F				
0 1 1 0	6	CG-RAM6	&	6	7	8	9	A	B	C	D	E	F					
0 1 1 1	7	CG-RAM7	'	7	8	9	A	B	C	D	E	F						
1 0 0 0	8		(	8	9	A	B	C	D	E	F							
1 0 0 1	9		)	9	A	B	C	D	E	F								
1 0 1 0	A		,	A	B	C	D	E	F									
1 0 1 1	B		.	B	C	D	E	F										
1 1 0 0	C		/	C	D	E	F											
1 1 0 1	D		-	D	E	F												
1 1 1 0	E		_	E	F													
1 1 1 1	F		:	F														



## 5.2 Control Command write-in

The control commands should be written-in first after the /CS pin is changed from HIGH to LOW. The control commands are listed up 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

### 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\_11

Binary								HEX	Digit
b7	b6	b5	b4	b3	b2	b1	b0		
0	0	0	1	0	0	0	0	10	Left End 2nd Digit 3rd Digit 4th Digit 5th Digit 6th Digit 7th Digit 8th Digit
				0	0	0	1	11	
				0	0	1	0	12	
				0	0	1	1	13	
				0	1	0	0	14	
				0	1	0	1	15	
				0	1	1	0	16	
				0	1	1	1	17	

Binary								HEX	Digit
b7	b6	b5	b4	b3	b2	b1	b0		
0	0	0	1	1	0	0	0	18	9th Digit 10th Digit 11th Digit 12th Digit 13th Digit 14th Digit 15th Digit Last Digit
				1	0	0	1	19	
				1	0	1	0	1A	
				1	0	1	1	1B	
				1	1	0	0	1C	
				1	1	0	1	1D	
				1	1	1	0	1E	
				1	1	1	1	1F	

### 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 12

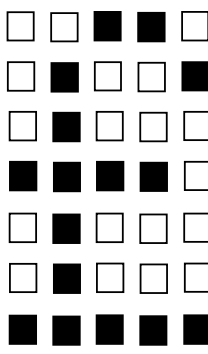
	b7	b6	b5	b4	b3	b2	b1	b0	Location	Description
1st byte	0	0	1	0	×	0	0	0	CG-RAM0	Specify UDF command and character code location (CG-RAM0~CG-RAM7)
						0	0	1	CG-RAM1	
						0	1	0	CG-RAM2	
						0	1	1	CG-RAM3	
						1	0	0	CG-RAM4	
						1	0	1	CG-RAM5	
						1	1	0	CG-RAM6	
						1	1	1	CG-RAM7	
2nd byte	×	A31	A26	A21	A16	A11	A6	A1	Specify ON or OFF of 35 dots position. Table_13.1 shows the relation between segment position and data formation. Table_13.2 shows the example of “£” font designing procedure.	
3rd byte	×	A32	A27	A22	A17	A12	A7	A2		
4th byte	×	A33	A28	A23	A18	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 13.1

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

Table 13.2

Pattern Example	Coding Example																																																												
	<table border="1" style="width:100%; border-collapse: collapse;"> <thead> <tr> <th style="width:10%;"></th> <th style="width:5%;">b7</th> <th style="width:5%;">b6</th> <th style="width:5%;">b5</th> <th style="width:5%;">b4</th> <th style="width:5%;">b3</th> <th style="width:5%;">b2</th> <th style="width:5%;">b1</th> <th style="width:5%;">b0</th> <th style="width:10%;">Hex Code</th> </tr> </thead> <tbody> <tr> <td>2nd byte</td> <td style="text-align: center;">0</td> <td style="text-align: center;">1</td> <td style="text-align: center;">0</td> <td style="text-align: center;">0</td> <td style="text-align: center;">1</td> <td style="text-align: center;">0</td> <td style="text-align: center;">0</td> <td style="text-align: center;">0</td> <td style="text-align: center;">48 Hex</td> </tr> <tr> <td>3rd byte</td> <td style="text-align: center;">0</td> <td style="text-align: center;">1</td> <td style="text-align: center;">1</td> <td style="text-align: center;">1</td> <td style="text-align: center;">1</td> <td style="text-align: center;">1</td> <td style="text-align: center;">1</td> <td style="text-align: center;">0</td> <td style="text-align: center;">7E Hex</td> </tr> <tr> <td>4th byte</td> <td style="text-align: center;">0</td> <td style="text-align: center;">1</td> <td style="text-align: center;">0</td> <td style="text-align: center;">0</td> <td style="text-align: center;">1</td> <td style="text-align: center;">0</td> <td style="text-align: center;">0</td> <td style="text-align: center;">1</td> <td style="text-align: center;">49 Hex</td> </tr> <tr> <td>5th byte</td> <td style="text-align: center;">0</td> <td style="text-align: center;">1</td> <td style="text-align: center;">0</td> <td style="text-align: center;">0</td> <td style="text-align: center;">1</td> <td style="text-align: center;">0</td> <td style="text-align: center;">0</td> <td style="text-align: center;">1</td> <td style="text-align: center;">49 Hex</td> </tr> <tr> <td>6th byte</td> <td style="text-align: center;">0</td> <td style="text-align: center;">1</td> <td style="text-align: center;">0</td> <td style="text-align: center;">0</td> <td style="text-align: center;">0</td> <td style="text-align: center;">0</td> <td style="text-align: center;">1</td> <td style="text-align: center;">0</td> <td style="text-align: center;">42 Hex</td> </tr> </tbody> </table>		b7	b6	b5	b4	b3	b2	b1	b0	Hex Code	2nd byte	0	1	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	1	0	0	0	0	1	0	42 Hex
	b7	b6	b5	b4	b3	b2	b1	b0	Hex Code																																																				
2nd byte	0	1	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	1	0	0	0	0	1	0	42 Hex																																																				

**Bit Map of 5×7 Dot Matrix**

**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 14

	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	
2nd byte	×	×	×	×	×	×	0	0	<b>Comma Off, Decimal Point Off(Default Vaule)</b>	
							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 continuously, it isn't needed to re-enter this command. I.e the write-in position is increased 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 /CS 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\_15

b7	b6	b5	b4	b3	b2	b1	b0	Dimming Level
0	1	0	1	×	0	0	0	<b>50%(8/16) Default Value</b>
					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 defined the number of display digit.(9 to 16 Digits)

Table\_16

b7	b6	b5	b4	b3	b2	b1	b0	Dimming Level
0	1	1	0	×	0	0	0	<b>1~16 Digit Default Value</b>
					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 display 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\_17

b7	b6	b5	b4	b3	b2	b1	b0	Dimming Level
0	1	1	1	×	×	0	0	Maintain current state
						0	1	<b>All Segs are OFF. (Default state)</b>
						1	0	All Segs are ON.
						1	1	All Segs are ON(All ON is higher priority.)

### 5.3 Power On Reset

When the module is turned on, the Micro –Controller on VFD module is initialized automatically. At this time, the displaying statuses are the same as following Table.

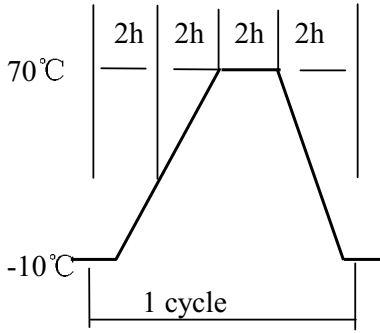
Table 18

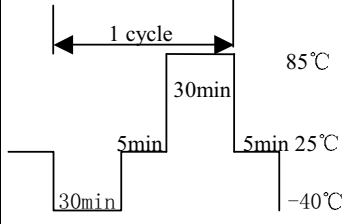
Content	After Power On
Display Characters	All Segments (16 digits * 35 dots) are “OFF”.
Comma and Decimal Point	All commas and Decimal Points are “OFF”.
Digit Length	Every Digit (1~16 digit) is usable.
Dimming Level	Set to 50%(8/16) Dimming.
Write-in Position	Write-in position is set to the first (Left End) Digit.
CG-RAM Data	Not defined.

## 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 hand material to the glass surface (especially exhaust tip) may crack the glass.
- 6.3 When mounting the VFD module to you 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 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.

## 7. Reliability Condition

Item	Condition	Criteria	Remarks
High Temp. (Storage)	Temperature: $85 \pm 2^\circ\text{C}$ Duration : 72 hrs In unlighted state		
High Temp. (Operation)	Temperature: $70 \pm 2^\circ\text{C}$ Duration : 96 hrs In unlighted state		
Low Temp (Storage)	Temperature: $-40 \pm 2^\circ\text{C}$ Duration : 72 hrs In unlighted state		
Low Temp (Operation)	Temperature: $-20 \pm 2^\circ\text{C}$ Duration : 24hrs		
Temperature Cycling	 <p>Number of Repeating : 5 All Segments are lit.</p>	Free of the Major Defects	Measurement shall be done after the specimens are kept at room temperature for an 24 hrs.
Humidity (steady state)	Humidity : 90~95% Temperature : $40 \pm 2^\circ\text{C}$ Duration : 96hrs		
Vibration	Frequency : 10~55Hz Displacement : 1.5mm Direction: $\pm X$ , $\pm Y$ , $\pm Z$ Duration : 4 hrs (2 hrs for each direction) Condition: In unlighted state		

Item	Condition	Criteria	Remarks
Shock	G: 40G Time: 10ms Wave: Half sine wave Direction: $\pm X$ , $\pm Y$ , $\pm Z$ (3 times in each of the direction) Condition: In unlighted state	Free of the Major Defects	Measurement shall be done after the specimens are kept at room temperature for an 24 hrs.
Thermal Sock	 <p>Number of Repeating : 5 Unlighted state.</p>		

## 8. DESIGN CHANGE

8.1 NewHaven reserves the right to change the design of the VFD module without prior notice in order to improve the design and quality.