



To: \_\_\_\_\_

# SPECIFICATION



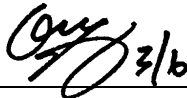
Rev. 2.0

Application: \_\_\_\_\_

## VACUUM FLUORESCENT DISPLAY MODULE

Model No.: 16LF01UA3

| Rev. No.  | Issued Date   | Descriptions  | Remark    |
|-----------|---------------|---|-----------|
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| Rev 1.0   | Oct. 12, 1999 | * Second Edition<br>- Correction of the Reset Pulse Width (100us → 1ms) | Page 8,9  |
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## 1. SCOPE

This specification applies to VFD module (Model No. 16LF01UA3) manufactured by Samsung SSVD (Shanghai Samsung Vacuum Devices).

## 2. FEATURES

- \* Simple connection to the host system data bus via two-wired serial interface.
- \* Since a DC/DC converter is used, only +5V<sub>DC</sub> power source is required to operate the module.
- \* One chip controller offers integral 64×16 bit programmable logic array, low power consumption and high reliability in services.
- \* 32 brightness levels can be selected by brightness control command.
- \* High quality blue-green (505 nm) vacuum fluorescent display provides an attractive and readable medium. Other colors can be achieved by simple wavelength filters.
- \* Characters are provided in an attractive 16-segment starburst format.

## 3. PRECAUTIONS (OPERATING RECOMMENDATIONS)

- \* Avoid applying excessive shock or vibration beyond the specification for the VFD module.
- \* Since VFD is 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.
- \* 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.
- \* Avoid plugging or unplugging the interface connection with the power on, otherwise it may cause the severe damage to input circuitry.
- \* Exceeding any of maximum ratings may cause the permanent damage.
- \* Since the VFD modules contain high voltage source, careful handling is required during powered on.
- \* 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. In other words, the compulsory short-circuit of mounted components on PCB within 30 seconds after power-off may cause damage to the module.
- \* Sending any input signals to the VFD module during power-off condition may cause I/O port damage in VFD circuitry.
- \* The power supply must be capable of providing at least 5 times the rated current, because the inrush current maybe 5 times the specified current consumption when the power is turned on.
- \* 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 15 meters (50 feet).
- \* Since all VFD modules contain C-MOS ICs, anti-static handling procedures are always required.

## 4. PRODUCT SPECIFICATIONS

### 4.1 Type

|              |                                   |
|--------------|-----------------------------------|
| Type         | 16LF01UA3                         |
| Digit Format | 16-Segment & Comma, Decimal Point |

### 4.2 Outer Dimensions, Weight

| Parameters       | Symbols   | Specification       | Unit |
|------------------|-----------|---------------------|------|
| Outer Dimensions | W * H * t | 218.0 * 45.0 * 26.5 | mm   |
| Glass Size       | W * H     | 205.2 * 29.0        | mm   |
| Display Area     | W * H     | 173.6 * 14.25       | mm   |
| Character Size   | CW * CH   | 7.0 * 12.50         | mm   |
| Character Pitch  | CP(x)     | 11.0                | mm   |
| Weight           |           | Approx. 130         | g    |

### 4.3 Environment Conditions

| Parameters               | Symbols          | Min. | Max. | Unit |
|--------------------------|------------------|------|------|------|
| Operating Temperature    | T <sub>OPR</sub> | -20  | +70  | °C   |
| Storage Temperature      | T <sub>STG</sub> | -40  | +85  | °C   |
| Humidity (Operating)     | H <sub>OPR</sub> | 30   | 85   | %    |
| Humidity (Non-operating) | H <sub>STG</sub> | 30   | 90   | %    |
| Vibration (10 ~ 55 Hz)   | -                | -    | 4    | G    |
| Shock                    | -                | -    | 40   | G    |

### 4.4 Absolute Maximum Ratings

| Parameters           | Symbols         | Min. | Max. | Unit            |
|----------------------|-----------------|------|------|-----------------|
| Supply Voltage       | V <sub>CC</sub> | -0.3 | +7.0 | V <sub>DC</sub> |
| Input Signal Voltage | V <sub>IN</sub> | -0.4 | +5.5 | V <sub>DC</sub> |

### 4.5 Recommend Operating Conditions

| Parameters            | Symbols         | Min. | Typ. | Max. | Unit            |
|-----------------------|-----------------|------|------|------|-----------------|
| Supply Voltage        | V <sub>CC</sub> | 4.5  | 5.0  | 5.5  | V <sub>DC</sub> |
| H-Level Input Voltage | V <sub>IH</sub> | 3.6  | -    | 5.5  | V <sub>DC</sub> |
| L-Level Input Voltage | V <sub>IL</sub> | -    | -    | 1.0  | V <sub>DC</sub> |

### 4.6 DC Characteristics (V<sub>CC</sub>=+5.0 V<sub>DC</sub>, Ta=+25°C)

| Parameters            | Symbol          | Min.                     | Typ. | Max. | Unit |
|-----------------------|-----------------|--------------------------|------|------|------|
| Supply Current (*)    | I <sub>CC</sub> | -                        | 600  | 800  | mA   |
| H-Level Input Current | I <sub>IH</sub> | -2.0                     | -    | 2.0  | uA   |
| L-Level Input Current | I <sub>IL</sub> | -2.0                     | -    | 2.0  | uA   |
| Brightness            | -               | 100                      | 200  | -    | ft-L |
| Display Color         | -               | Green (x=0.250, y=0.439) |      |      | -    |

\*: The surge current can be approx. 5 times the specified supply current at power on.

4.7 Timing Chart

4.7.1 SCLK and DATA Timing

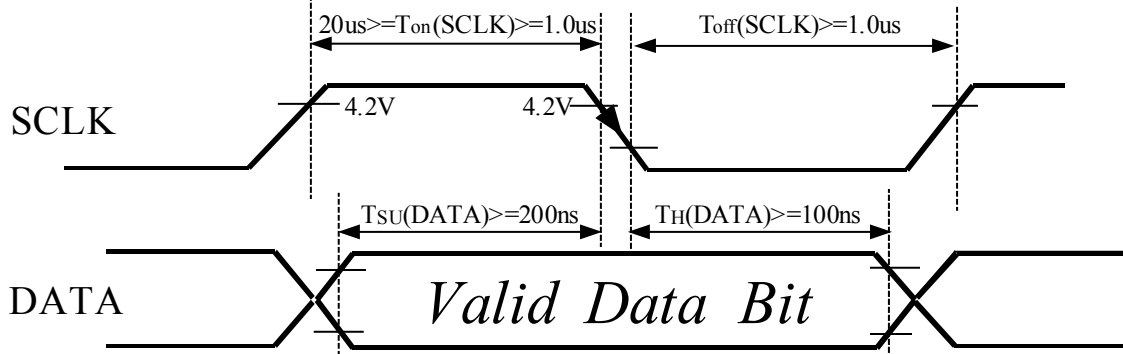


Fig.-1 SCLK and Serial DATA Timing Diagram

4.7.2 Transmit Timing

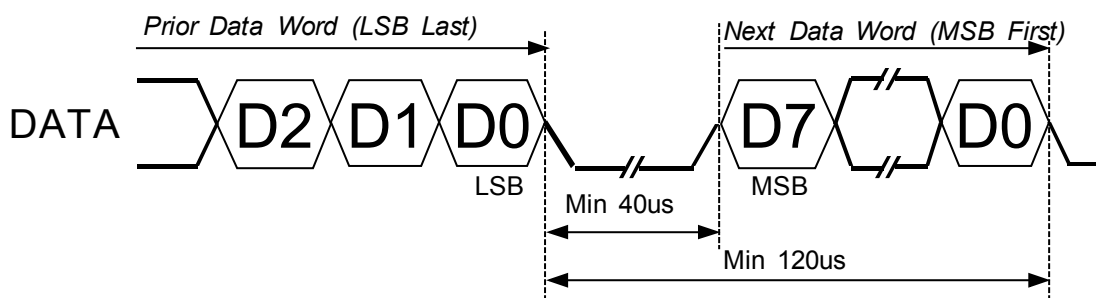


Fig.-2 Data word LSB/MSB Timing Diagram

4.8 Signal Interfacing

Connector: PH-2S06-FG (Aster) or equivalent.

→ Mate Socket (Female): HIF3B-12D-2.54R (HIROSE) or equivalent.

| Pin No. | Signal | Pin No. | Signal | Signal Name Description                                                                                          |
|---------|--------|---------|--------|------------------------------------------------------------------------------------------------------------------|
| 1       | Vcc    | 2       | Vcc    | Vcc: Power Supply Terminal. (+5Vdc is required)                                                                  |
| 3       | N/P    | 4       | N/C    | N/P: No Pin, N/C: No Connection                                                                                  |
| 6       | N/C    | 6       | N/C    | N/C: No Connection                                                                                               |
| 7       | N/C    | 8       | SCLK   | SCLK: Shift Clock of Shift Register. (Falling Edge Active)                                                       |
| 9       | DATA   | 10      | /RST   | DATA: Input Terminal for Display or Control Codes.<br>/RST: Input Terminal for Reset of VFD Module. (Low Active) |
| 11      | GND    | 12      | GND    | GND: Ground Terminal.                                                                                            |

4.9 System Block Diagram

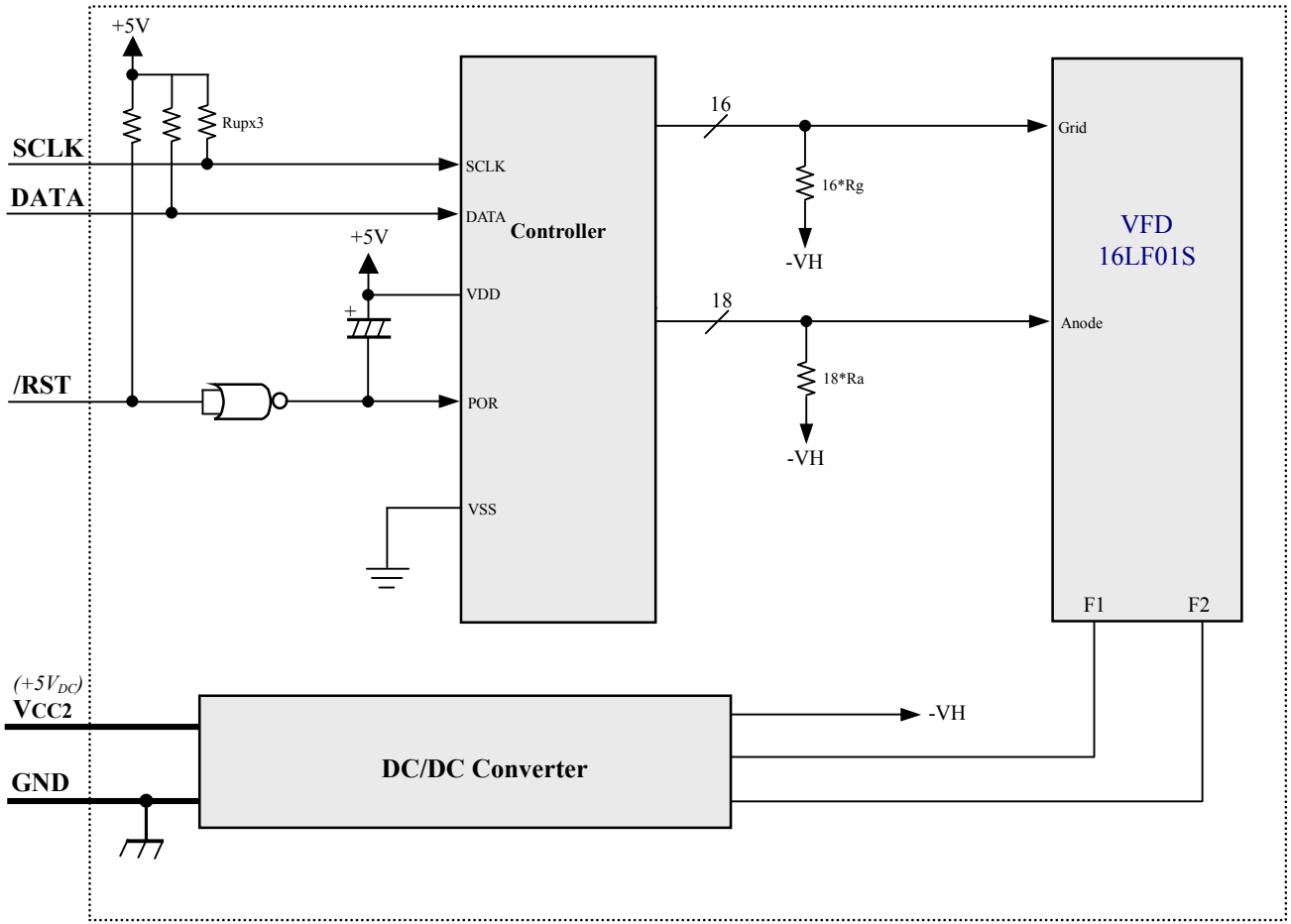


Fig.-3 System Block Diagram

4.10 Outer Dimension

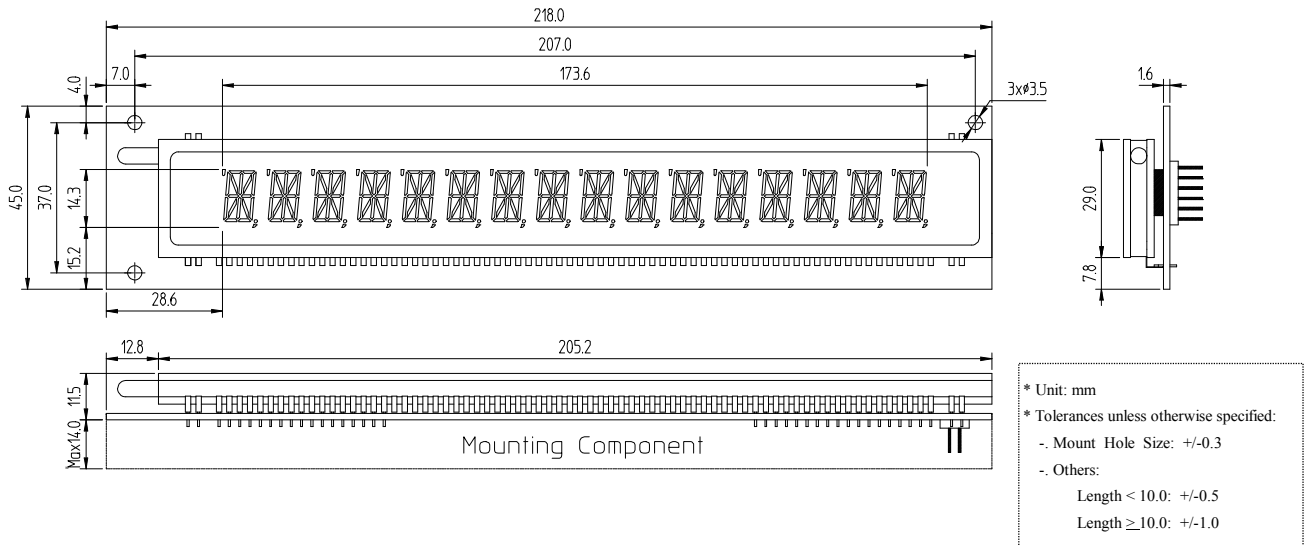


Fig.-4 Outer Dimensions

4.11 Pattern Details

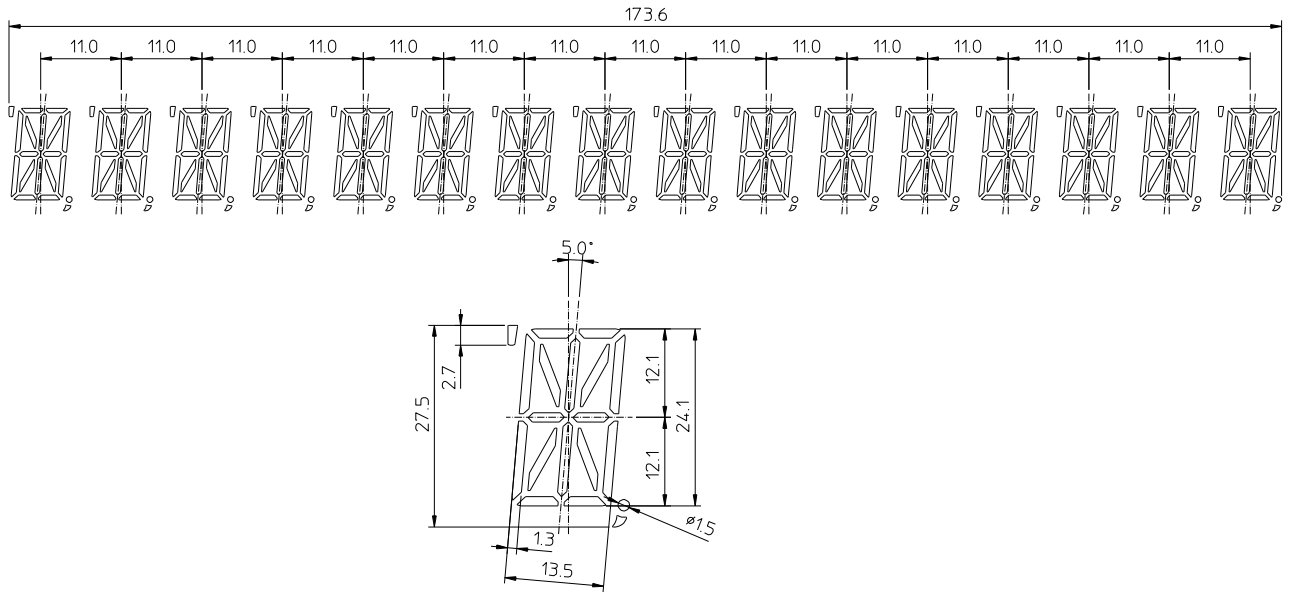


Fig.-5 Pattern Details

## 5. FUNCTIONS

The module has control data and display data write and reset functions.

Input data from the host system is loaded into the module's display buffer via serial data input channel as 8-bit serial data. The MSB value of 8-bit serial data determines whether the input data into this module is control data or display data.

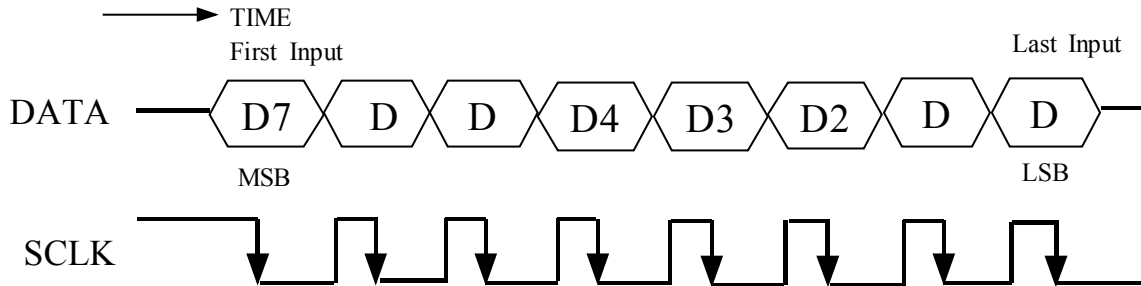


Fig.-6 Synchronous Serial Data Input

### 5.1 Control Data

The control data can be input by setting MSB to "1". In addition, a command type and associated data with the command is determined by the D6~D0.

| Command                | Function                 | Binary Code |    |    |                |                |                |                |                |
|------------------------|--------------------------|-------------|----|----|----------------|----------------|----------------|----------------|----------------|
|                        |                          | D7          | D6 | D5 | D4             | D3             | D2             | D1             | D0             |
| Buffer Pointer control | Specify the RAM address  | 1           | 0  | 1  | 0              | 2 <sup>3</sup> | 2 <sup>2</sup> | 2 <sup>1</sup> | 2 <sup>0</sup> |
| Digit Counter Control  | Set the number of digits | 1           | 1  | 0  | 0              | 2 <sup>3</sup> | 2 <sup>2</sup> | 2 <sup>1</sup> | 2 <sup>0</sup> |
| Brightness Control     | Set the brightness       | 1           | 1  | 1  | 2 <sup>4</sup> | 2 <sup>3</sup> | 2 <sup>2</sup> | 2 <sup>1</sup> | 2 <sup>0</sup> |

#### 5.1.1 Buffer Pointer Control

This command changes the display contents only at an arbitrary digit. (The RAM write address is set.) The digit position to be modified is represented by the value of D3~D0. If the most significant digit (left-end digit) is to be selected, each of D3~D0 are set to a value of "1" and if the second digit is to be selected each of D3~D0 are set to a value of "0", otherwise a decimal value of from "1" to "14" should be entered.

The set value of D3~D0 is lower than the decimal value of the specified position by 2.

| Digit    | Binary Code |    |    |    |    |    |    |    |
|----------|-------------|----|----|----|----|----|----|----|
|          | D7          | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
| Left End | 1           | 0  | 1  | 0  | 1  | 1  | 1  | 1  |
| 2nd      | 1           | 0  | 1  | 0  | 0  | 0  | 0  | 0  |
| 3rd      | 1           | 0  | 1  | 0  | 0  | 0  | 0  | 1  |
| 4th      | 1           | 0  | 1  | 0  | 0  | 0  | 1  | 0  |
| 5th      | 1           | 0  | 1  | 0  | 0  | 0  | 1  | 1  |
| 6th      | 1           | 0  | 1  | 0  | 0  | 1  | 0  | 0  |
| 7th      | 1           | 0  | 1  | 0  | 0  | 1  | 0  | 1  |
| 8th      | 1           | 0  | 1  | 0  | 0  | 1  | 1  | 0  |

| Digit     | Binary Code |    |    |    |    |    |    |    |
|-----------|-------------|----|----|----|----|----|----|----|
|           | D7          | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
| 9th       | 1           | 0  | 1  | 0  | 0  | 1  | 1  | 1  |
| 10th      | 1           | 0  | 1  | 0  | 1  | 0  | 0  | 0  |
| 11th      | 1           | 0  | 1  | 0  | 1  | 0  | 0  | 1  |
| 12th      | 1           | 0  | 1  | 0  | 1  | 0  | 1  | 0  |
| 13th      | 1           | 0  | 1  | 0  | 1  | 0  | 1  | 1  |
| 14th      | 1           | 0  | 1  | 0  | 1  | 1  | 0  | 0  |
| 15th      | 1           | 0  | 1  | 0  | 1  | 1  | 0  | 1  |
| Right End | 1           | 0  | 1  | 0  | 1  | 1  | 1  | 0  |





**5.1.2 Digit Counter Control**

This command is used to define the number of display digits. The code is normally used only during initialization routine of the host system.

If all 16 characters are to be controlled, each of D3~D0 are set to a value of “0”, otherwise a decimal value from “1” to “15” is entered, corresponding to the actual number of characters to be controlled.

| Number of Display Digit | Binary Code |    |    |    |    |    |    |    |
|-------------------------|-------------|----|----|----|----|----|----|----|
|                         | D7          | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
| 1                       | 1           | 1  | 0  | 0  | 0  | 0  | 0  | 1  |
| 2                       | 1           | 1  | 0  | 0  | 0  | 0  | 1  | 0  |
| 3                       | 1           | 1  | 0  | 0  | 0  | 0  | 1  | 1  |
| 4                       | 1           | 1  | 0  | 0  | 0  | 1  | 0  | 0  |
| 5                       | 1           | 1  | 0  | 0  | 0  | 1  | 0  | 1  |
| 6                       | 1           | 1  | 0  | 0  | 0  | 1  | 1  | 0  |
| 7                       | 1           | 1  | 0  | 0  | 0  | 1  | 1  | 1  |
| 8                       | 1           | 1  | 0  | 0  | 1  | 0  | 0  | 0  |

| Number of Display Digit | Binary Code |    |    |    |    |    |    |    |
|-------------------------|-------------|----|----|----|----|----|----|----|
|                         | D7          | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
| 9                       | 1           | 1  | 0  | 0  | 1  | 0  | 0  | 1  |
| 10                      | 1           | 1  | 0  | 0  | 1  | 0  | 1  | 0  |
| 11                      | 1           | 1  | 0  | 0  | 1  | 0  | 1  | 1  |
| 12                      | 1           | 1  | 0  | 0  | 1  | 1  | 0  | 0  |
| 13                      | 1           | 1  | 0  | 0  | 1  | 1  | 0  | 1  |
| 14                      | 1           | 1  | 0  | 0  | 1  | 1  | 1  | 0  |
| 15                      | 1           | 1  | 0  | 0  | 1  | 1  | 1  | 1  |
| 16                      | 1           | 1  | 0  | 0  | 0  | 0  | 0  | 0  |

**5.1.3 Brightness Control**

This command sets the brightness of the VFD. This command allows the brightness to be adjusted by 1/32 step. As shown in the table below, the test value ranges from 0 to 31.

| Level        | Binary Code |    |    |    |    |    |    |    |
|--------------|-------------|----|----|----|----|----|----|----|
|              | D7          | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
| 0/31(0.0%)   | 1           | 1  | 1  | 0  | 0  | 0  | 0  | 0  |
| 1/31(3.2%)   | 1           | 1  | 1  | 0  | 0  | 0  | 0  | 1  |
| 2/31(6.4%)   | 1           | 1  | 1  | 0  | 0  | 0  | 1  | 0  |
| 3/31(9.7%)   | 1           | 1  | 1  | 0  | 0  | 0  | 1  | 1  |
| 4/31(12.9%)  | 1           | 1  | 1  | 0  | 0  | 1  | 0  | 0  |
| 5/31(16.1%)  | 1           | 1  | 1  | 0  | 0  | 1  | 0  | 1  |
| 6/31(19.4%)  | 1           | 1  | 1  | 0  | 0  | 1  | 1  | 0  |
| 7/31(22.6%)  | 1           | 1  | 1  | 0  | 0  | 1  | 1  | 1  |
| 8/31(25.8%)  | 1           | 1  | 1  | 0  | 1  | 0  | 0  | 0  |
| 9/31(29.0%)  | 1           | 1  | 1  | 0  | 1  | 0  | 0  | 1  |
| 10/31(32.3%) | 1           | 1  | 1  | 0  | 1  | 0  | 1  | 0  |
| 11/31(35.5%) | 1           | 1  | 1  | 0  | 1  | 0  | 1  | 1  |
| 12/31(38.7%) | 1           | 1  | 1  | 0  | 1  | 1  | 0  | 0  |
| 13/31(41.9%) | 1           | 1  | 1  | 0  | 1  | 1  | 0  | 1  |
| 14/31(45.2%) | 1           | 1  | 1  | 0  | 1  | 1  | 1  | 0  |
| 15/31(48.4%) | 1           | 1  | 1  | 0  | 1  | 1  | 1  | 1  |

| Level        | Binary Code |    |    |    |    |    |    |    |
|--------------|-------------|----|----|----|----|----|----|----|
|              | D7          | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
| 16/31(51.6%) | 1           | 1  | 1  | 1  | 0  | 0  | 0  | 0  |
| 17/31(54.8%) | 1           | 1  | 1  | 1  | 0  | 0  | 0  | 1  |
| 18/31(58.1%) | 1           | 1  | 1  | 1  | 0  | 0  | 1  | 0  |
| 19/31(61.2%) | 1           | 1  | 1  | 1  | 0  | 0  | 1  | 1  |
| 20/31(64.5%) | 1           | 1  | 1  | 1  | 0  | 1  | 0  | 0  |
| 21/31(67.7%) | 1           | 1  | 1  | 1  | 0  | 1  | 0  | 1  |
| 22/31(71.0%) | 1           | 1  | 1  | 1  | 0  | 1  | 1  | 0  |
| 23/31(74.2%) | 1           | 1  | 1  | 1  | 0  | 1  | 1  | 1  |
| 24/31(77.4%) | 1           | 1  | 1  | 1  | 1  | 0  | 0  | 0  |
| 25/31(80.6%) | 1           | 1  | 1  | 1  | 1  | 0  | 0  | 1  |
| 26/31(83.9%) | 1           | 1  | 1  | 1  | 1  | 0  | 1  | 0  |
| 27/31(87.1%) | 1           | 1  | 1  | 1  | 1  | 0  | 1  | 1  |
| 28/31(90.3%) | 1           | 1  | 1  | 1  | 1  | 1  | 0  | 0  |
| 29/31(93.5%) | 1           | 1  | 1  | 1  | 1  | 1  | 0  | 1  |
| 30/31(96.8%) | 1           | 1  | 1  | 1  | 1  | 1  | 1  | 0  |
| 31/31(100%)  | 1           | 1  | 1  | 1  | 1  | 1  | 1  | 1  |

**5.2 Input Display Data Word**

Display data words are loaded into the display buffer of module as 8-bit codes, with the MSB set to “0”. The 64 available code are shown in Appendix-A display data words must be entered to fully load the display data buffer. The display buffer pointer (write in position) specified by the Buffer Pointer control command is automatically increased by one each time the display data is entered. To set the comma or decimal point, the display data codes of 2C Hex or 2E Hex is entered respectively. Only when 2C Hex and 2E Hex data are entered, the display buffer pointer in the RAM is not automatically increased but stays present location.



**5.3 Reset**

The reset function allows the users to re-initialize the alphanumeric display controller, while the power is still applied to the module, by applying a logical “0” to pin #10(/RST) of the connector.(Pulse Width ≥ 1ms).

When the controller is initialized, the display status is shown in the table below. The RAM data (Display Buffer Data) are the same as the prior data.

| Parameter               | Reset Status   | Binary Code |    |    |    |    |    |    |    |
|-------------------------|----------------|-------------|----|----|----|----|----|----|----|
|                         |                | D7          | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
| Write in Position       | Left End Digit | 1           | 0  | 1  | 0  | 1  | 1  | 1  | 1  |
| Number of Display Digit | 16 Digits      | 1           | 1  | 0  | 0  | 0  | 0  | 0  | 0  |
| Brightness Level        | 0 %            | 1           | 1  | 1  | 0  | 0  | 0  | 0  | 0  |

**5.4 Data Set-up Flow**

1. Power on
  2. /RST signal set to “0” for above 1ms
  3. Digit counter set
  4. Brightness set
  5. Buffer pointer set
  6. Display data set
- Initialization Routine

\* Appendix-A. CG-ROM Character Code Table

| MSB<br>LSB | 0x000 | 0x001 | 0x010 | 0x011 | 0x100 | 0x101 | 0x110 | 0x111 |
|------------|-------|-------|-------|-------|-------|-------|-------|-------|
| 0 0 0      |       |       |       |       |       |       |       |       |
| 0 0 1      |       |       |       |       |       |       |       |       |
| 0 1 0      |       |       |       |       |       |       |       |       |
| 0 1 1      |       |       |       |       |       |       |       |       |
| 1 0 0      |       |       |       |       |       |       |       |       |
| 1 0 1      |       |       |       |       |       |       |       |       |
| 1 1 0      |       |       |       |       |       |       |       |       |
| 1 1 1      |       |       |       |       |       |       |       |       |