

# Vacuum Fluorescent Display Module Specification

Model: GU160X32-800B

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**This product complies with RoHS Directive 2002/95/EC**

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## 1. General Description

- 1.1 Construction: A 160x32 dot BD-VFD single board display module consisting of an 8 bit micro-computer, and a DC/DC converter.
- 1.2 Features: Simultaneous display of graphic.  
Flexible Display and Editing Functions.  
Compact design due to the application of a BD-VFD tube.
- 1.3 Dimensions: See attached drawings.

## 2. Absolute Maximum Ratings

Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition
Logic Input Voltage	VI	-0.5	—	V <sub>cc</sub> +0.3	V	—
Power Supply Voltage	V <sub>cc</sub>	0	—	6.5	VDC	—

## 3. Electrical Characteristics

Measurement Conditions: 25°C / V<sub>cc</sub>=5.0V

Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition
Logic Input Voltage	"H"	VIH	4.0	—	—	VDC IIH= 2 μA
	"L"	VIL	—	—	1.0	
Logic Output Voltage	"H"	VOH	4.7	—	—	VDC IOH= - 300 μA
	"L"	VOL	—	—	0.3	
Reset Input Voltage	"H"	VRH	4.0	—	—	VDC IRH= 5 μA
	"L"	VRL	—	—	0.6	
Power Supply Voltage	V <sub>cc</sub>	4.75	5.00	5.25	VDC	—
Power Supply Current	I <sub>cc</sub>	—	550	700	mA	V <sub>CC</sub> =+5V, All dots ON
		—	450	600		V <sub>CC</sub> =+5V, All dots OFF

### Notes:

The rise time of **V<sub>cc</sub>** should not exceed **100 ms**.

**I<sub>cc</sub>** may peak at power up may be more than twice the normal operating current

## 4. Optical Specifications

- Number of dots: 5120 (160x32)  
 Display area: 101.45 mm x 20.17 mm (X x Y)  
 Dot size: 0.485 mm x 0.485 mm (X x Y)  
 Dot pitch: 0.635 mm x 0.635 mm (X x Y)  
 Luminance: 350cd/m<sup>2</sup> (Min.)  
 Color of illumination: Green (Blue Green)

## 5. Environmental Specifications

- Operating temperature: -40 to +85°C  
 Storage temperature: -40 to +85°C  
 Storage humidity: 20 to 80 % R.H(Non Condensation)  
 Vibration: 10-55-10Hz, all amplitude 1mm, 30Min., X-Y-Z (Non operating)  
 Shock: 539m/s<sup>2</sup> 10mS (Non operating)

## 6. Description of Bus and Signals

This module has serial and 2 types of parallel interface.

Type of interface can be selected by jumper settings. Refer to 11 on page # 18 for details.

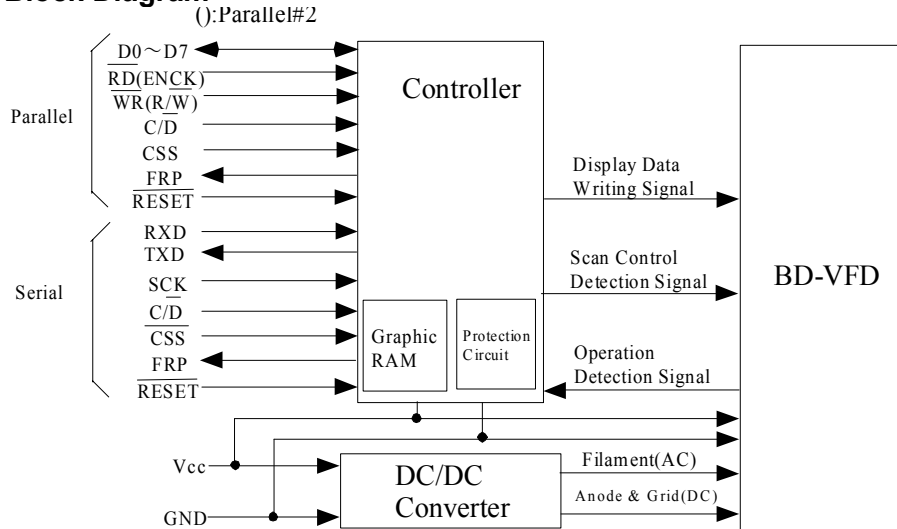
### 6.1 Parallel Interface

Data Line	Function
D0 ~ D7	Data Bus (Input / Output)
WR (R/W)	Parallel #1: Write Signal, Parallel #2: R/W (Input)
RD (ENCK)	Parallel #1: Read Signal, Parallel #2: ENCK (Input)
CSS	Chip Select (Input)
C/D	Command / Data Select Signal (Input) C/D = "1" ... Command C/D = "0" ... Data
FRP	Frame Pulse Signal (Output)
RESET	RESET="0"... Reset (Input)
Vcc	Power Supply
GND	Ground

### 6.2 Serial Interface

Data Line	Function
RXD	Serial Input
TXD	Serial Output
SCK	Clock (Input)
CSS	Chip Select (Input)
C/D	Command / Data Select Signal (Input) C/D = "1" ... Command C/D = "0" ... Data
FRP	Frame Pulse Signal (Output)
RESET	RESET="0"... Reset (Input) Active Low
Vcc	Power Supply
GND	Ground

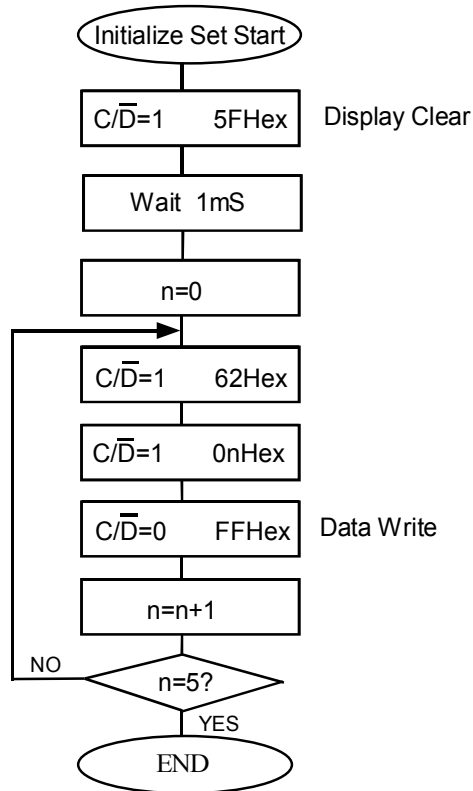
## 7. Block Diagram



### 8. Display Screen and Initialize Set

The Display screen consists of 5,120 dots arranged as 160 by 32 dots. It is divided into 64 display area blocks of 16 by 8 dots each. Each display area block can be assigned to GRAM (Graphic mode) or DDRAM (Character mode) by the Display Area Set command. (9.5 Page #10)

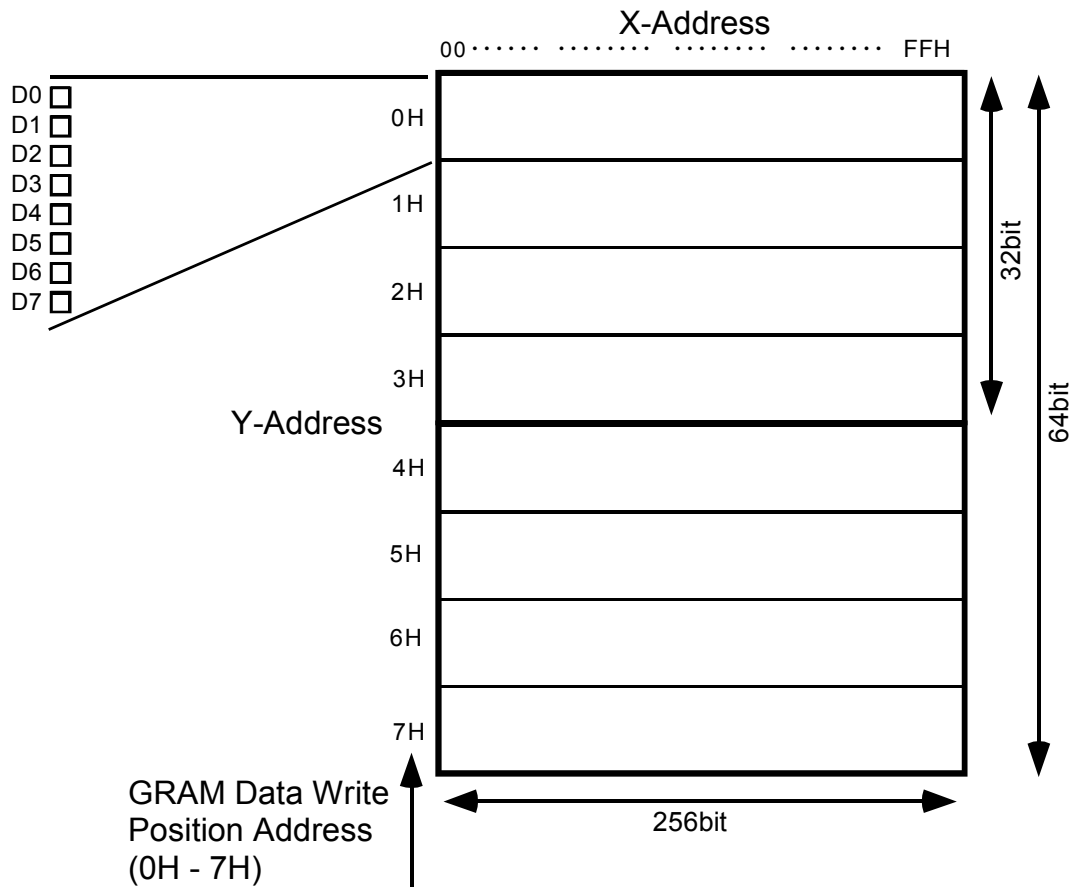
But, this is the version which has no Font ROM. Therefore, DDRAM is not available, all of display area block must be assigned to GRAM as the initialize setting, and this must be done when the module is powered up and also every time the reset is applied, because all display area blocks are set to DDRAM area as default setting. Initialize sequence is as follows;



**8.1 Graphic Display (GRAM)**

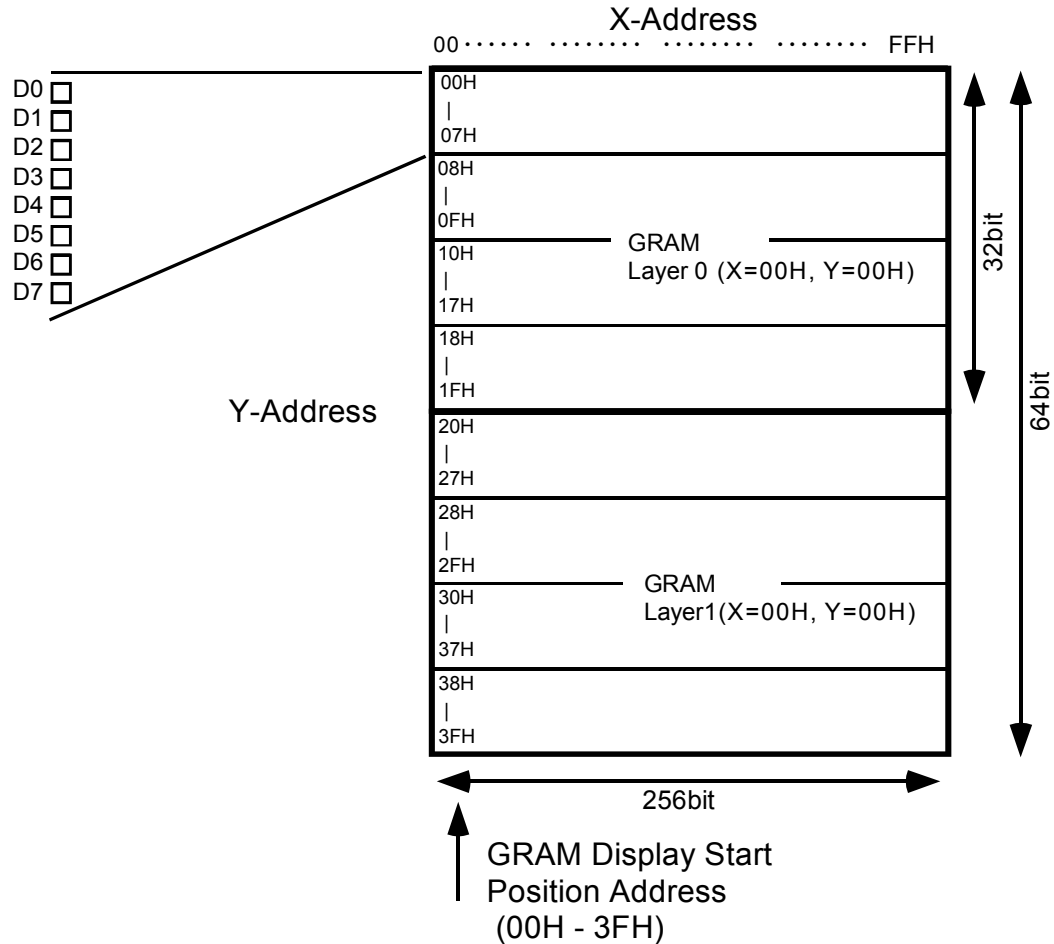
GRAM consists of 16,384 bits arranged in 256 by 64 bit blocks with access is structured as 8 bits of vertical data. The detail of GRAM is as follows:

GRAM Data Write Position Address



8.1 Cont'd

GRAM Display Start Position Address



This module has 2 layers - Layer 0 and Layer 1. Each layer in this display consists of 256 by 32 dots. Display merging using these 2 layers can be done with the Display ON/OFF command. Refer to 9.2 on page # 8 for details.

Layer 0 has an area of 256x32 dots that starts from top left point defined by the GRAM Start Position Address. The area of Layer 1 is the next 256x32 dots.

When the value of the GRAM Start Position Address X overflow = FFH, the next position goes to 00H. When the value of the GRAM Start Position Address Y overflow = 3FH, the next position goes to 00H.

**For example:**

If the GRAM Start Position Address is set as X=02H, Y=08H, the area of Layer 0 is as follows;

X=02H,03H,04H.....FFH,00H,01H  
Y=08H,09H.....26H, 27H

In this case, the area of Layer1 is as follows;

X=02H,03H,04H.....FFH,00H,01H  
Y=28H,29H.....06H,07H

**9. Function**  
**9.1 Commands**

Command	C/D	D7	D6	D5	D4	D3	D2	D1	D0	Comments	
Display ON/OFF	1	0	0	1	0	L1	L0	*	*	1st Byte	Display ON/OFF Control, 2 Byte Command
		0	GS	0	GRV	AND	EXOR	*	*	2nd Byte	
Brightness Set	1	0	1	0	0	BW3	BW2	BW1	BW0	1 Byte	1 Byte Command
Display Clear	1	0	1	0	1	G1C	G0C	1	HM	1 Byte	1 Byte Command
Display Area SET (Initialize)	1	0	1	1	0	0	0	1	0	1st Byte	Display Area is assigned 3 Byte Command
		0	0	0	0	0	(A2 – A0)			2nd Byte	
	0	1	1	1	1	1	1	1	1	3rd Byte	
Data Write Position Address Set	1	0	1	1	0	0	1	0	*	1st Byte	Graphic Display X-Address Set, 2 Byte Command
		GRAM X-Address (GXA7~GXA0)								2nd Byte	
	1	0	1	1	0	0	0	0	*	1st Byte	Graphic Address Y-Address Set, 2-Byte Command
*	*	*	*	0	GYA2	GYA1	GYA0	2nd Byte			
Display Start Position Address Set	1	0	1	1	1	*	*	*	*	1st Byte	Graphic Display Horizontal Shift, 2-Byte Command
		XA7	XA6	XA5	XA4	XA3	XA2	XA1	XA0	2nd Byte	
Display Start Position Address Set	1	1	0	1	1	UD	S1	S0	*	1 Byte	Graphic Display Vertical Shift, 1 Byte Command
Address Mode Set	1	1	0	0	0	*	IGX	IGY	*	1 Byte	Address Increment, 1 Byte Command
Address Read	1	1	1	0	1	0	1	*	*	1st Byte	Graphic Display (GRAM) Horizontal And Vertical Display Start Address, 3 Byte Command
		*	VG6	VG5	VG4	VG3	VG2	VG1	VG0	2nd Byte	
		HG7	HG6	HG5	HG4	HG3	HG2	HG1	HG0	3rd Byte	
Data Write	0	WRITE DATA									Writes Data Graphic Data is 1 Byte

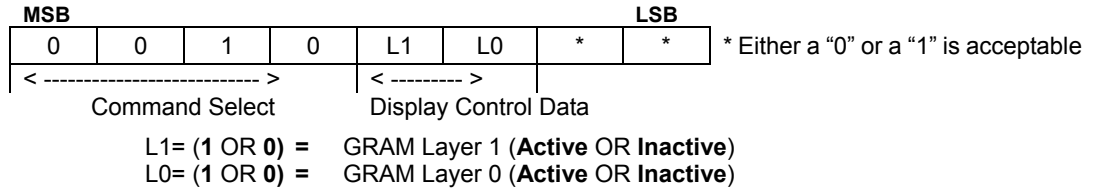
\* Either a "0" or a "1" is acceptable



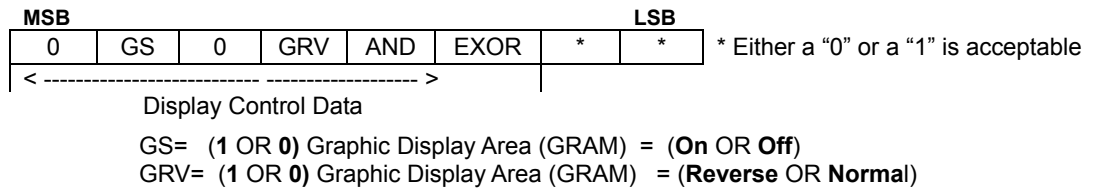
**9.2 Display On/Off (C/D= "1")**

The GRAM Layer is selected with the 1st Byte of data. DDRAM (**On/Off**), GRAM (**On/Off**), DDRAM (**reverse** or **normal** modes), GRAM (**reverse** or **normal** modes) and display merge are selected by the 2nd Byte. Reverse mode toggles the representation of green in the foreground and black in the background to the exact opposite - green to black and black to the foreground. This is similar to the concept of reverse video.

1st Byte:



2nd Byte:



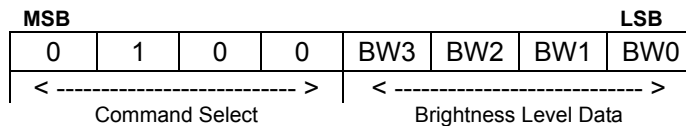
DS="0", GS= "0": Stand-by mode

1st Byte		2nd Byte		Action
L1	L0	AND	EXOR	
*	*	1	*	AND Display of Layer 1& 0
*	*	0	1	EXOR Display of Layer 1& 0
1	1	0	0	OR Display of Layer 1& 0
1	0	0	0	Only Layer1 selected for display
0	1	0	0	Only Layer0 selected for display
0	0	0	0	Graphic Display Off

\* Either a "0" or a "1" is acceptable

**9.3 Brightness Set (C/D= "1")**

The Brightness level of the display screen can be scaled by the following four bit control. Please note that the brightness is consistent across the illuminated pixels. There is no scaling of individual pixels. The display self-initializes to 100% brightness.



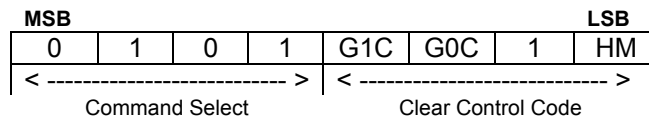
### 9.3 Cont'd

Brightness levels are set by the following:

BW3	BW2	BW1	BW0	Brightness Level
0	0	0	0	100%(Light)
0	0	0	1	94%
0	0	1	0	87%
0	0	1	1	81%
0	1	0	0	75%
0	1	0	1	69%
0	1	1	0	62%
0	1	1	1	56%
1	0	0	0	50%
1	0	0	1	44%
1	0	1	0	37%
1	0	1	1	31%
1	1	0	0	25%
1	1	0	1	19%
1	1	1	0	12%
1	1	1	1	6%(Dark)

### 9.4 Display Clear ( $\overline{C/D}$ = "1") This command clears the GRAM.

This command should always be applied at power on or reset. In the period of 1mS following the issue of this command, the module requires internal processing and does not accept any commands.



To clear the GRAM area, G1C or G0C bit must be asserted. By asserting HM bit, both data write position address and display start position address which selected by G1C, G0C, DC also be reset.

HM = (1 or 0) equals (Initialize data write position address and display start position address or Not initialize).

G1C= (1 or 0) equals (GRAM area 1 is cleared or GRAM area 1 not cleared)

G0C= (1 or 0) equals (GRAM area 0 cleared or GRAM area 0 not cleared)

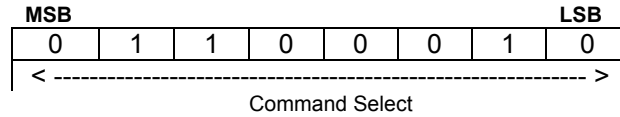
GRAM area 1: X= 00H-FFH, Y=0H – 3H (Display data write position address)

GRAM area 2: X= 00H-FFH, Y=4H – 7H (Display data write position address)

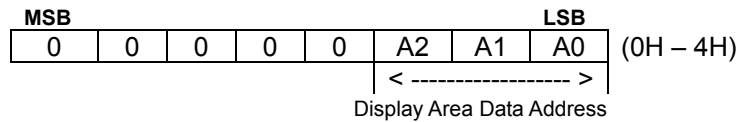
### 9.5 Display Area Set ( $\overline{C/D}$ ="1", only used for Initialize Set)

This command sets the display area block as Graphic Display (GRAM) or Character display (DDRAM). But, this is version which has no Font ROM. Therefore, DDRAM is not available, all of display area block must be assigned to GRAM as the initialize setting, and this must be done when the module is powered up and also every time the reset is applied. Setup is performed by 3-byte command.

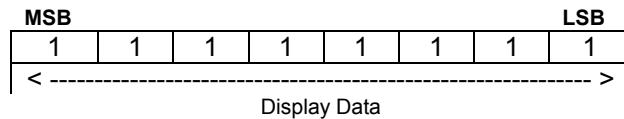
1st Byte: ( $\overline{C/D}$ ="1") Command Select



2nd Byte: ( $\overline{C/D}$ ="1") Display Area Data Address Select

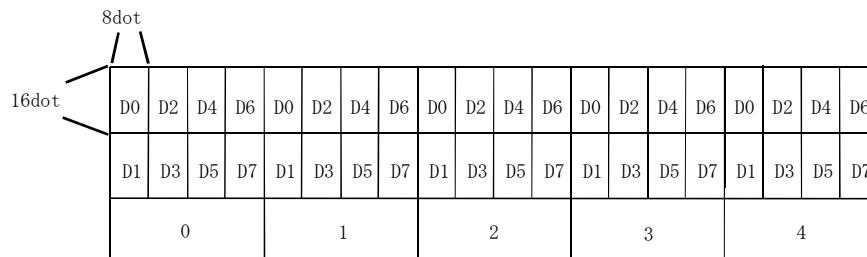


3rd Byte: ( $\overline{C/D}$ ="0") Display Area Block Select



- D0 to D7 = "1":      Graphic Display (GRAM)
- D0 to D7 = "0":      Character Display (DDRAM, **Not available**)

Display area block is assigned as follows on a screen.



Display Area Data Address (0 ~ 4H)

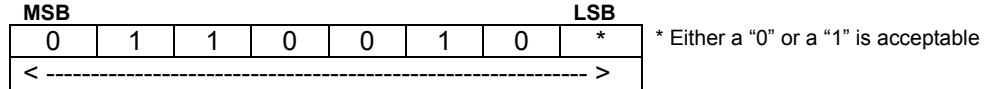
**9.6 GRAM Data Write position Address Set (Graphic Display) (C/D="1")**

This command specifies both X & Y data write position address.

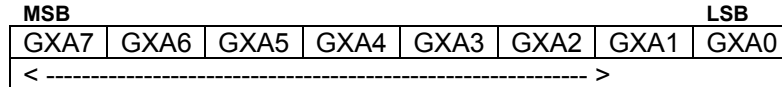
**9.6.1 GRAM Data Write Position X Address Set**

Data write position X address of GRAM expressed with 8 bits (00Hex-FFHex) is specified. Refer to 8.1 Graphic Display (GRAM) on Page #5.

1st Byte: Command Select



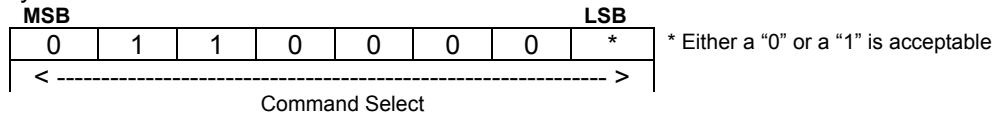
2nd Byte: GRAM Data Write Position X Address



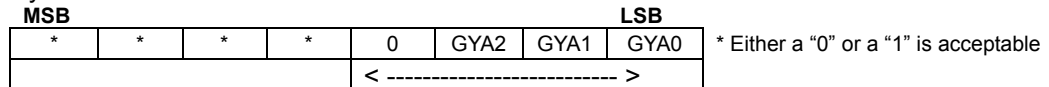
**9.6.2 GRAM Data Write Position Y Address Set**

Data write position Y address of GRAM expressed with 4 bits (0Hex-7Hex) is specified.

1st Byte:



2nd Byte:

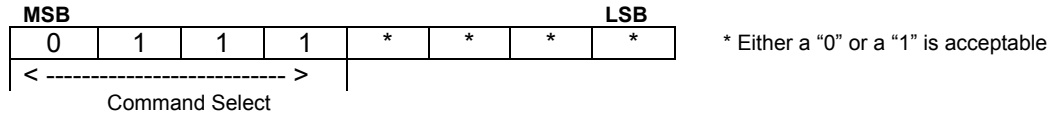


**9.7 GRAM Display Start Position Address Set (C/D="1")**

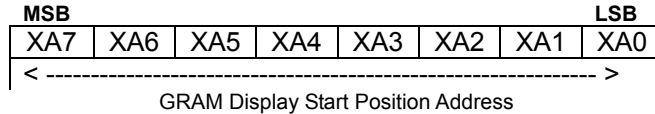
**9.7.1 Horizontal Shift**

This command specifies the address that a display pattern can be positioned to by **8 bits (00Hex to FFHex)**. This is equivalent to an offset in the X-axis.

1st Byte:

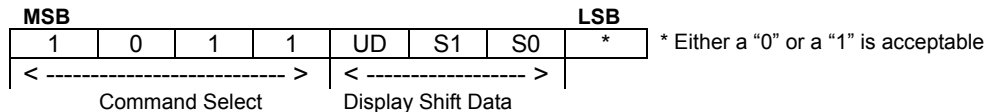


2nd Byte:



**9.7.2 Vertical Shift**

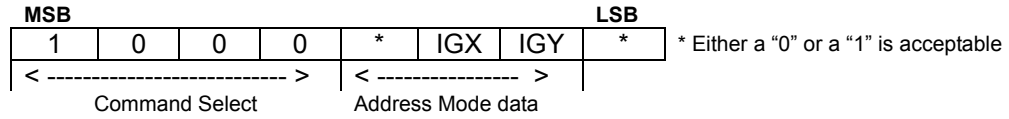
This is equivalent to an offset Y-axis.



- UD= "1": Display scrolled up.
- UD= "0": Display scrolled down.
- S1= "0", S0= "1": Display shift by 8 dots.
- S1= "1", S0= "0": Display shift by 1 dot.
- S1= "1", S0= "1": Display shift by 2 dots.

**9.8 Address Mode Set (C/D="1")**

This command specifies the GRAM data write position address auto increment mode.

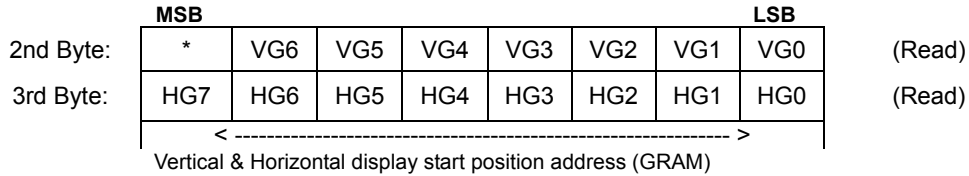
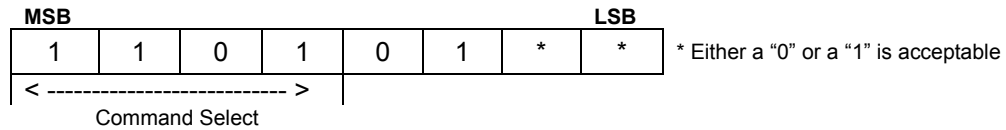


IGX = "1" : X-Address +1(increment) when writing to GRAM.(It not affect to Y-Address.)  
 IGX = "0" : GRAM X address fixed mode  
 IGY = "1" : Y-Address +1(increment) when writing to GRAM.(It not affect to X-Address)  
 IGY = "0" : GRAM Y address fixed mode.

**9.9 Address Read (C/D="1")**

This command reads both vertical and horizontal display start position addresses of GRAM (Refer to sect. 8 - Display Screen and Initialize set on Page # 4). On the parallel interface, the data bus outputs the address until  $\overline{CSS}$  goes high after the READY signal goes active (Parallel #1:  $\overline{RD}$ =LOW, Parallel #2:  $\overline{R/W}$ =HIGH). The Data bus becomes an input when other. On the serial interface, TXD outputs the data from SCK rising after command is issued until the  $\overline{CSS}$  goes high. Refer to 10.Interface on Page #15.

1st Byte:



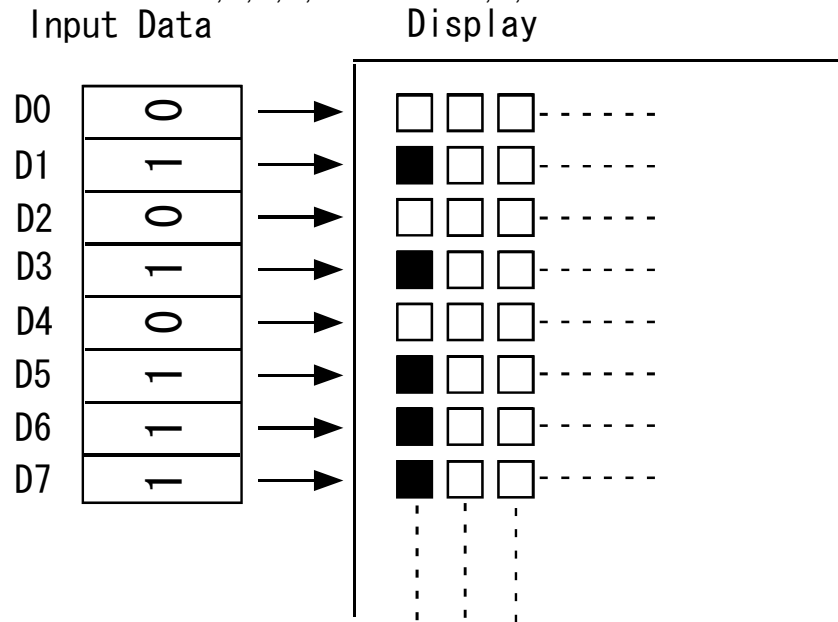
VG0 to VG6: Vertical display start position address  
 HG0 to HG7: Horizontal display start position address

**9.10 Data Write to Graphic Display (GRAM) (C/D="0")**

Can be written into GRAM by setting GRAM X or Y data write position address.

**Example:**

Writing "EA Hex" sets "D1, 3, 5, 6, 7 =1" and "D0, 2, 4 =0".



■ : Display ON

**9.11 Default Status at Reset**

When the reset is applied, the display self-initializes into the following status:

GRAM Layer:	Layer ( 0 )
Display ON/OFF:	Display ( Off )
Display Area:	All DDRAM (Character display area)

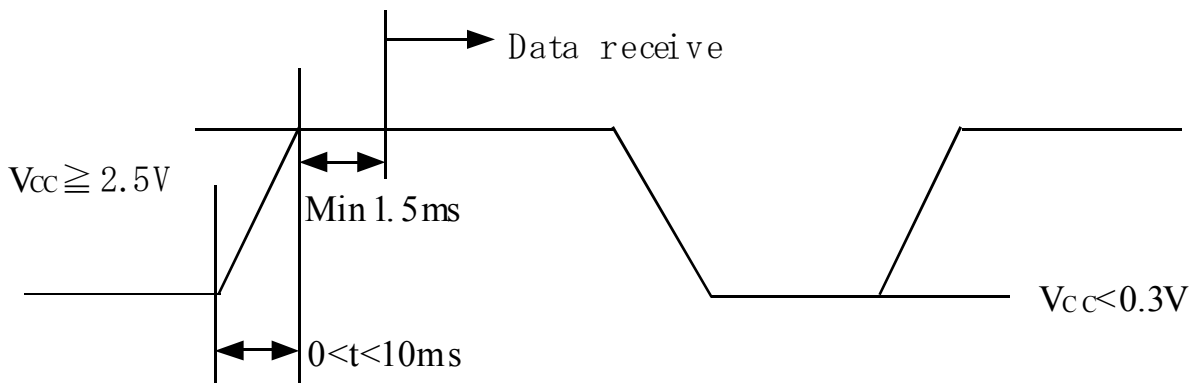
**All of display area block must be assigned to GRAM again as the initialize setting after reset is applied because DDRAM is not available.**

GRAM X-address:	Fixed mode
GRAM Y-address:	Fixed mode
Brightness Level:	100% Brightness

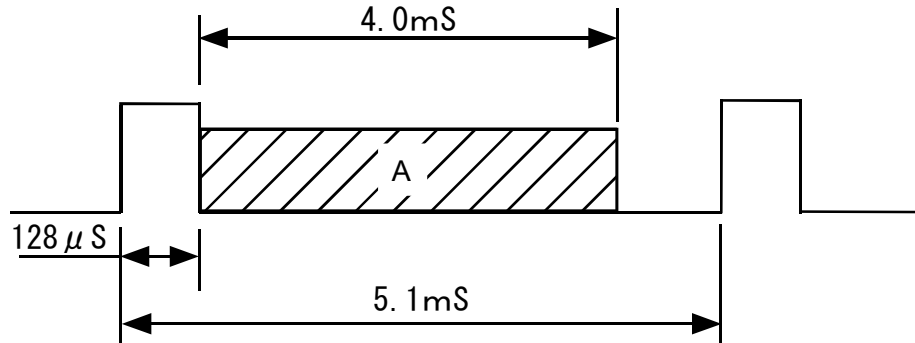
**The following precautions should be observed at power on, and after a reset:**

**External Reset:** After Vcc reaches 2.5V, the Reset level is "Low" for more than 1.5mS.

**Power-Up:** The following sequence occurs:



**9.12 FRP (Frame Pulse)**

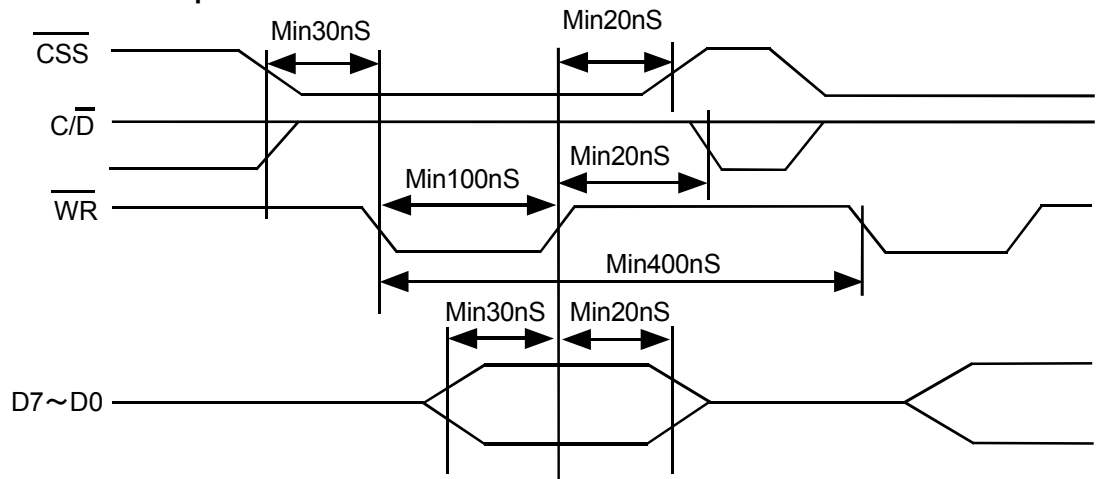


An FRP signal is triggered each time the display is refreshed by the module from its own memory. Smooth scrolling can be achieved by synchronizing the change of display start address with of the FRP signal from module. The area marked as "A" is optimal for writing commands.

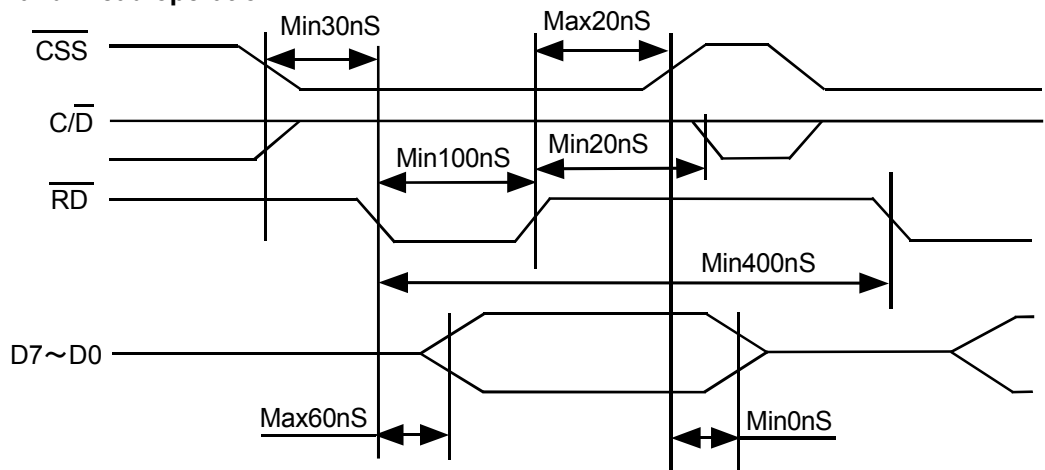
10. Interface

10.1 Parallel Interface (Parallel #1)

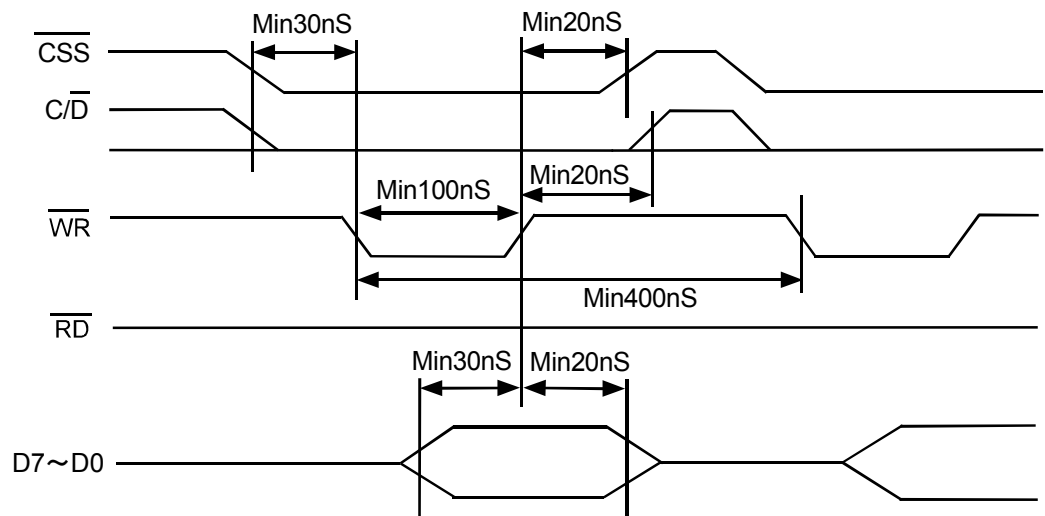
10.1.1 Command Write operation



10.1.2 Command Read operation



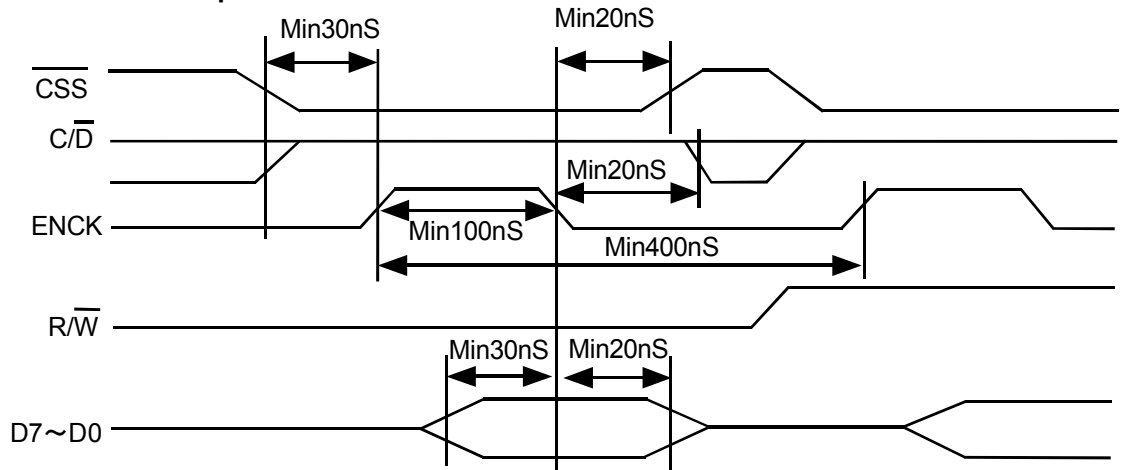
10.1.3 Data Write operation



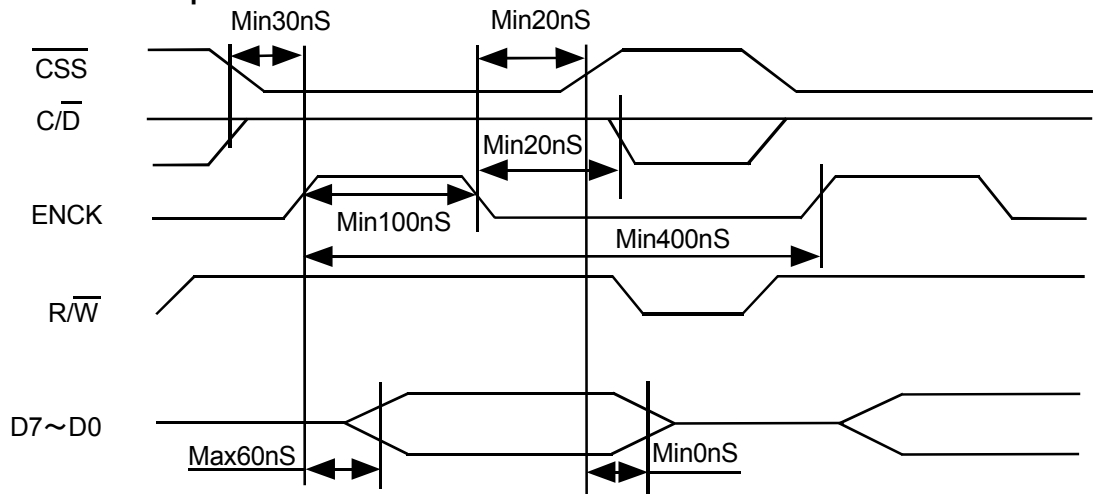


**10.2 Parallel Interface(Parallel #2)**

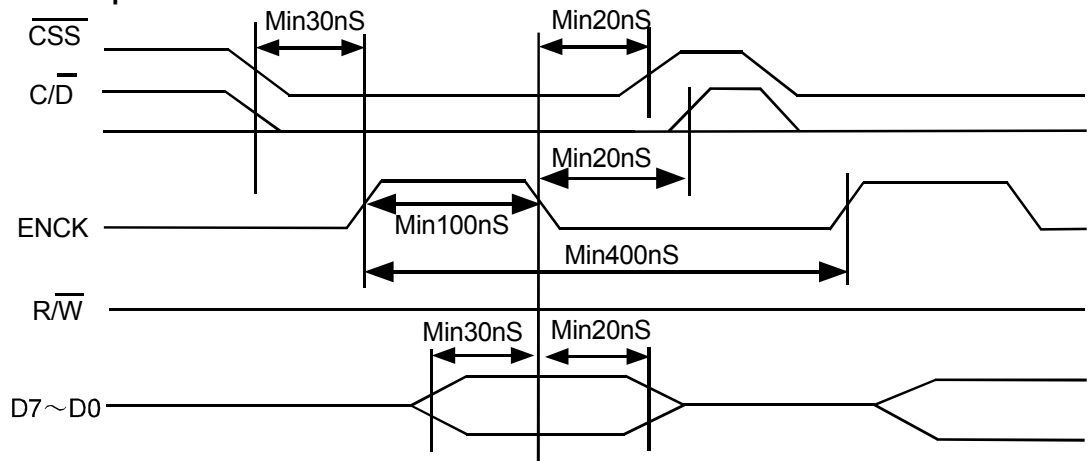
**10.2.1 Command Write operation**



**10.2.2 Command Read operation**

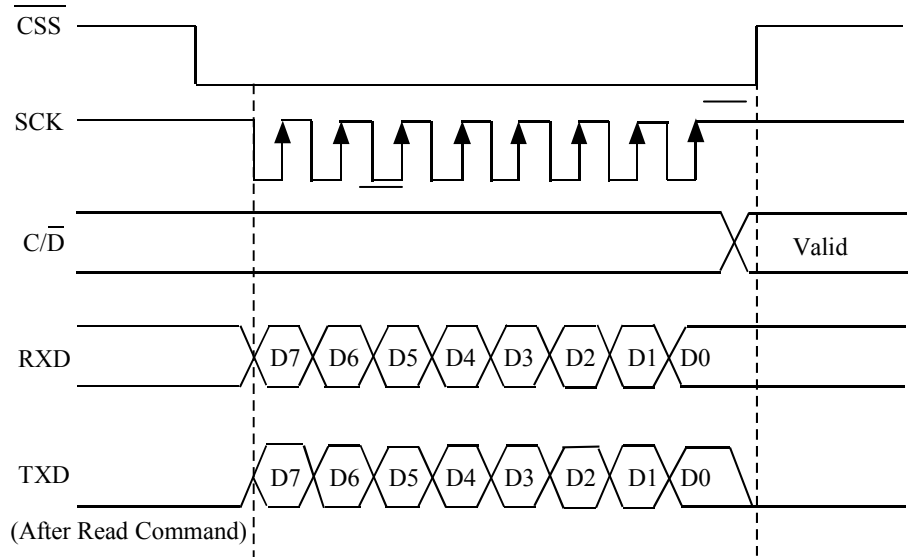


**10.2.3 Data Write operation**

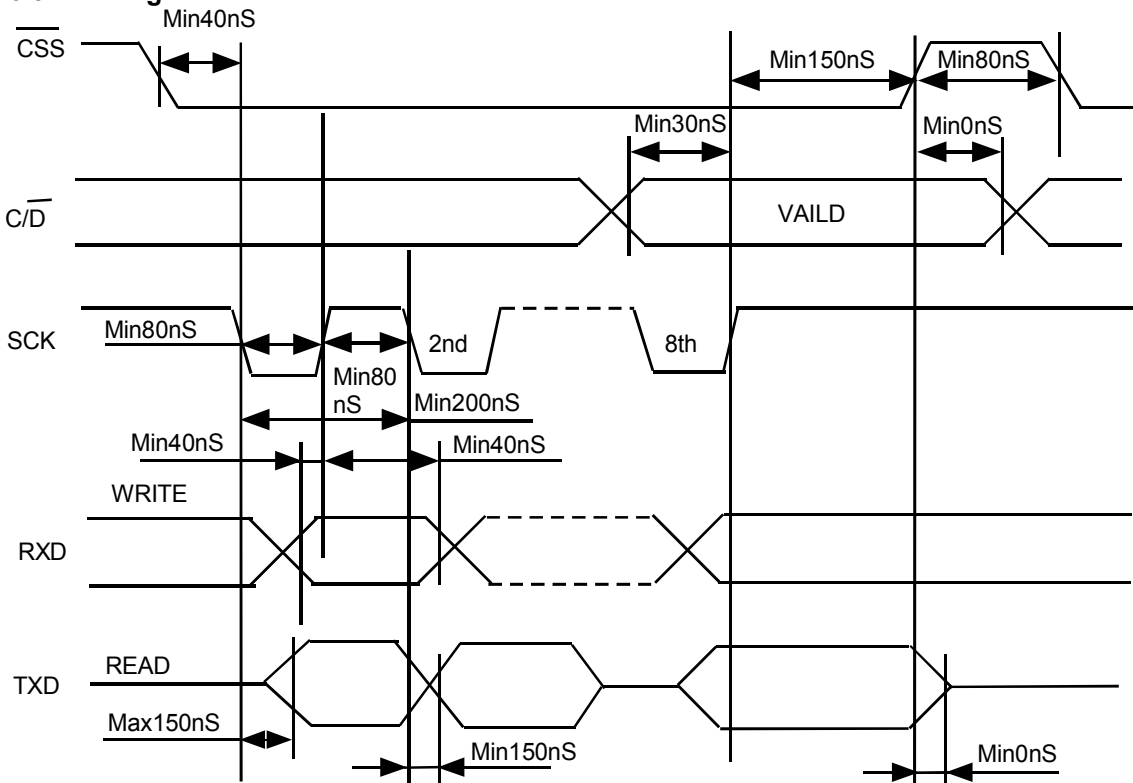


### 10.3 Serial Interface

To use the serial interface of this module, (RXD, TXD and SCK) will be activated by CSS= "L". The internal shift registers and counters will be reset by CSS= "H". Serial data is transferred from MSB to LSB (D7->D0) on the rising edge of SCK. After the 8th clock edge, the data stream is converted to 8 bit parallel data. Recognition of the RXD input as either data or command is determined by C/D on the 8<sup>th</sup> pulse SCK.



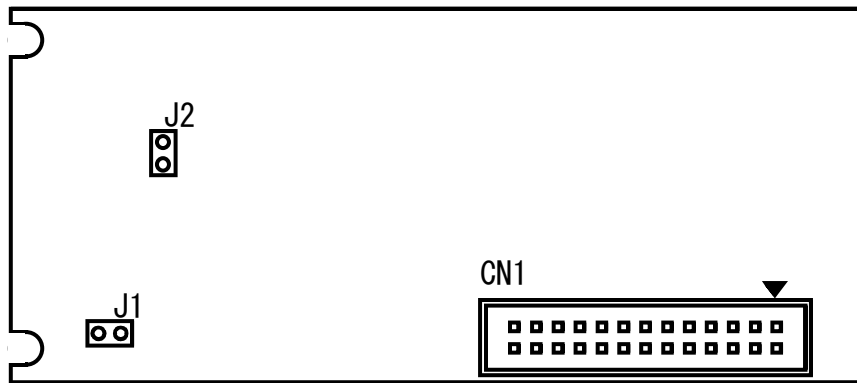
#### 10.3.1 Timing



## 11. Jumper

### 11.1 Jumper Position

Component side of board



### 11.2 Jumper Setting (Must be done when power is OFF)

	J1	J2	Function
Interface	0	X	Serial Interface
	1	1	Parallel #1 Interface (Default)
	1	0	Parallel #2 Interface

1:Open

0:Short

X: Open or Short

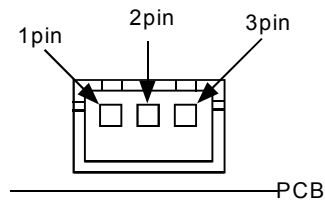
**12. Pin Assignment** (See connector diagrams below)

**12.1 Signal Connection**

Pin No.	Description		
	Parallel #1	Parallel #2	Serial
1	D7	D7	×
3	D6	D6	×
5	D5	D5	×
7	D4	D4	×
9	D3	D3	×
11	D2	D2	×
13	D1	D1	TXD
15	D0	D0	RXD
17	$\overline{WR}$	$\overline{R/W}$	×
19	$\overline{C/D}$	$\overline{C/D}$	$\overline{C/D}$
21	$\overline{RD}$	ENCK	SCK
23	$\overline{CSS}$	$\overline{CSS}$	$\overline{CSS}$
25	FRP	FRP	FRP

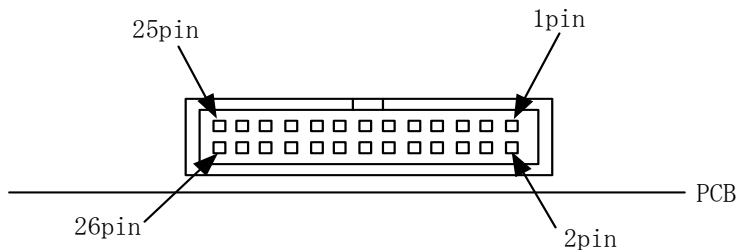
Pin No.	Description		
	Parallel #1	Parallel #2	Serial
2	GND	GND	GND
4	GND	GND	GND
6	GND	GND	GND
8	GND	GND	GND
10	GND	GND	GND
12	GND	GND	GND
14	GND	GND	GND
16	GND	GND	GND
18	GND	GND	GND
20	GND	GND	GND
22	GND	GND	GND
24	GND	GND	GND
26	$\overline{RESET}$	$\overline{RESET}$	$\overline{RESET}$

**12.2 Connectors**



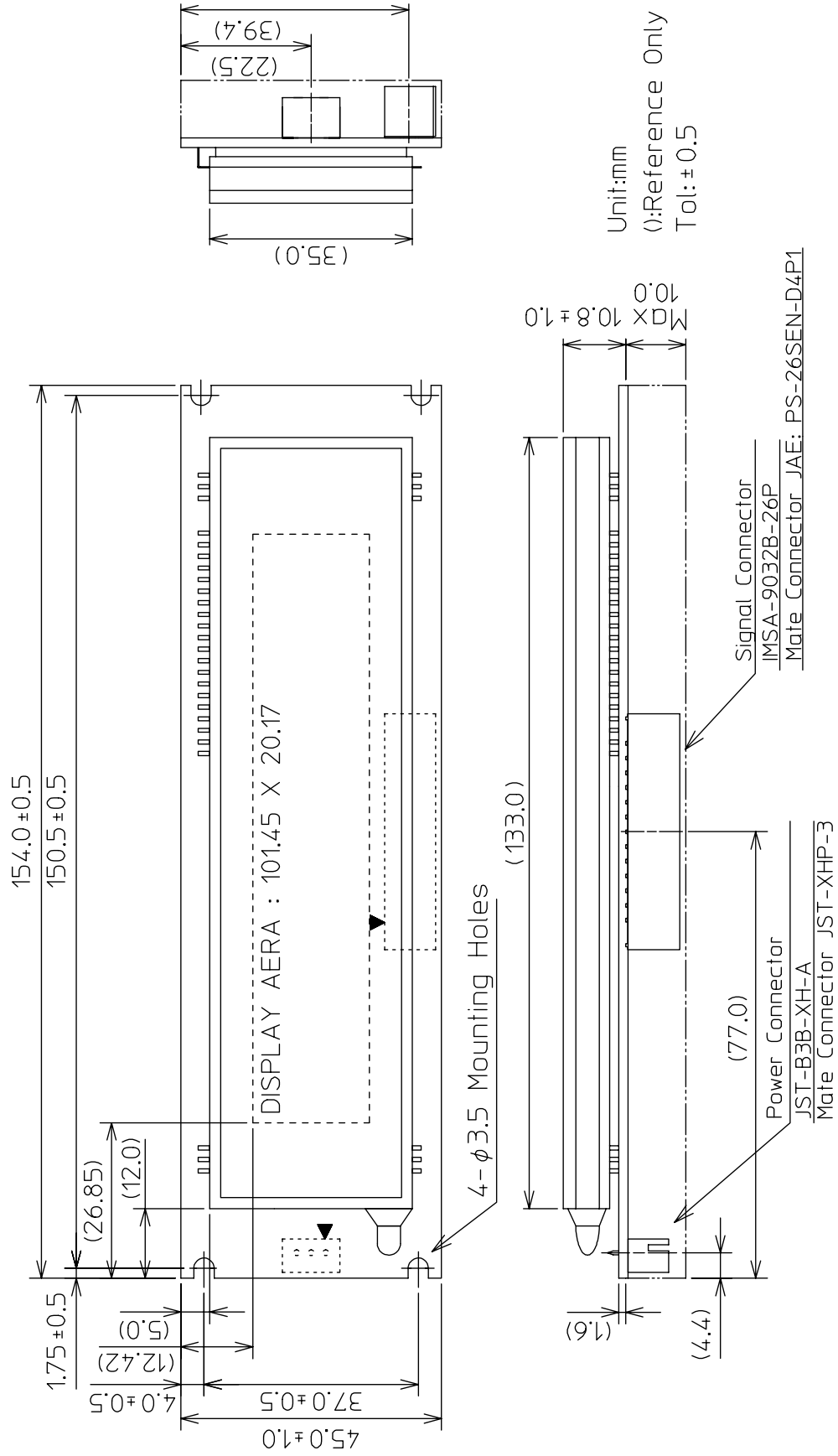
**Power Connector:**  
JST: B3B-XH-A or equivalent

Pin No.	Description
1	Vcc
2	Test (Factory Only)
3	GND



**Data Connector**  
IMSA: 9032B-26Por Equivalent

13. Outline Dimension



## Notice for the Cautious Handling VFD Modules

### Handling and Usage Precautions:

Please carefully follow the appropriate product application notes for proper usage, safety handling, and operation standards for maximum performance.

#### [VFD tubes are made of glass]

- Because the edges of the VFD glass-envelop are not smooth, it is necessary to handle carefully to avoid injuries to your hands
- Please avoid breaking the VFD glass-envelop to prevent injury from sharp glass particles.
- The tip of the exhaust pipe is fragile so avoid shock from impact.
- It is recommended to allow sufficient open space surrounding the exhaust pipe to avoid possible damage.
- Please design the PCB for the VFD-module within 0.3 mm warping tolerance to avoid any forces that may damage the display due to PCB distortion causing a breakdown of the electrical circuit leading to VFD failure.

#### [High voltage]

- Avoid touching conductive electrical parts, because the VFD-module uses high voltage exceeding 30~100 volts.
- Even when electric power is turned off, it may take more than one minute for the electrical current to discharge.

#### [Cable connection]

- Do not unplug the power and/or data cables of VFD-modules during operating condition because unrecoverable damage may result.
- Sending input signals to the VFD-module during a power off condition sometimes causes I/O port damage.
- It is recommended to use a 30 cm or shorter signal cable to prevent functional failures.

#### [Electrostatic charge]

- VFD-modules needs electrostatic free packaging and protection from electrostatic charges during handling and usage.

#### [Structure]

- During operation, VFD and VFD-modules generate heat. Please consider sufficient heat radiation dissipation using heat sink solutions.
- We prefer to use UL grade materials or components in conjunction with VFD-modules.
- Wrap and twist motion causes stress and may break VFDs & VFD modules. Please adhere to allowances within 0.3mm at the point of attachment.

#### [Power]

- Apply regulated power to the VFD-module within specified voltages to protect from failures.
- Because some VFD-modules may consume in rush current equal to twice the typical current at power-on timing, we recommend using a sufficient power capability and quick starting of the power regulator.
- VFD-module needs a specified voltage at the point of connection. Please use an adequate power cable to avoid a decrease in voltage. We also recommend inserting a power fuse for extra protection.

#### [Operating consideration]

- Illuminating phosphor will decrease in brightness during extended operation. If a fixed pattern illuminates for an extended period,( several hours), the phosphor efficiency will decrease compared to the non operating phosphor causing a non uniform brightness among pixels. Please consider programming the display patterns to use all phosphor segments evenly. Scrolling may be a consideration for a period of time to refresh the phosphor condition and improve even illumination to the pixels.
- We recommend using a signal cable 30cm or less to avoid some possible disturbances to the signal.

#### [Storage and operating environment]

- Please use VFD-modules under the recommended specified environmental conditions. Salty, sulfur and dusty environments may damage the VFD-module even during storage.

#### [Discard]

- Some VFDs contain a small amount of cadmium in the phosphor and lead in the solder. When discarding VFDs or VFD-modules, please adhere to governmental related laws or regulations.

#### [Others]

- Although the VFD-module is designed to be protected from electrical noise, please plan your circuitry to exclude as much noise as possible.
- Do not reconstruct or repair the VFD-module without our authorization. We cannot assure the quality or reliability of unauthorized reconstructed VFD-modules.

#### Notice:

- We do not authorize the use of any patents that may be inherent in these specifications.
- Neither whole nor partial copying of these specifications are permitted without our approval.  
If necessary , please ask for assistance from our sales consultant.
- This product is not designed for military, aerospace, medical or other life-critical applications. If you choose to use this product for these applications, please ask us for prior consultation or we cannot take responsibility for problems that may occur.