Noritake itron

RoHS Compliant

Vacuum Fluorescent Display Module

Hardware Specification

Model: GU128X32D-D903S

Specification No.:	DS-1900-0000-01	
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This product complies with RoHS Directive
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Contents

1 General Description

1.1 Scope

This specification covers the hardware aspects of the GU128X32D-D903S vacuum fluorescent graphic display module.

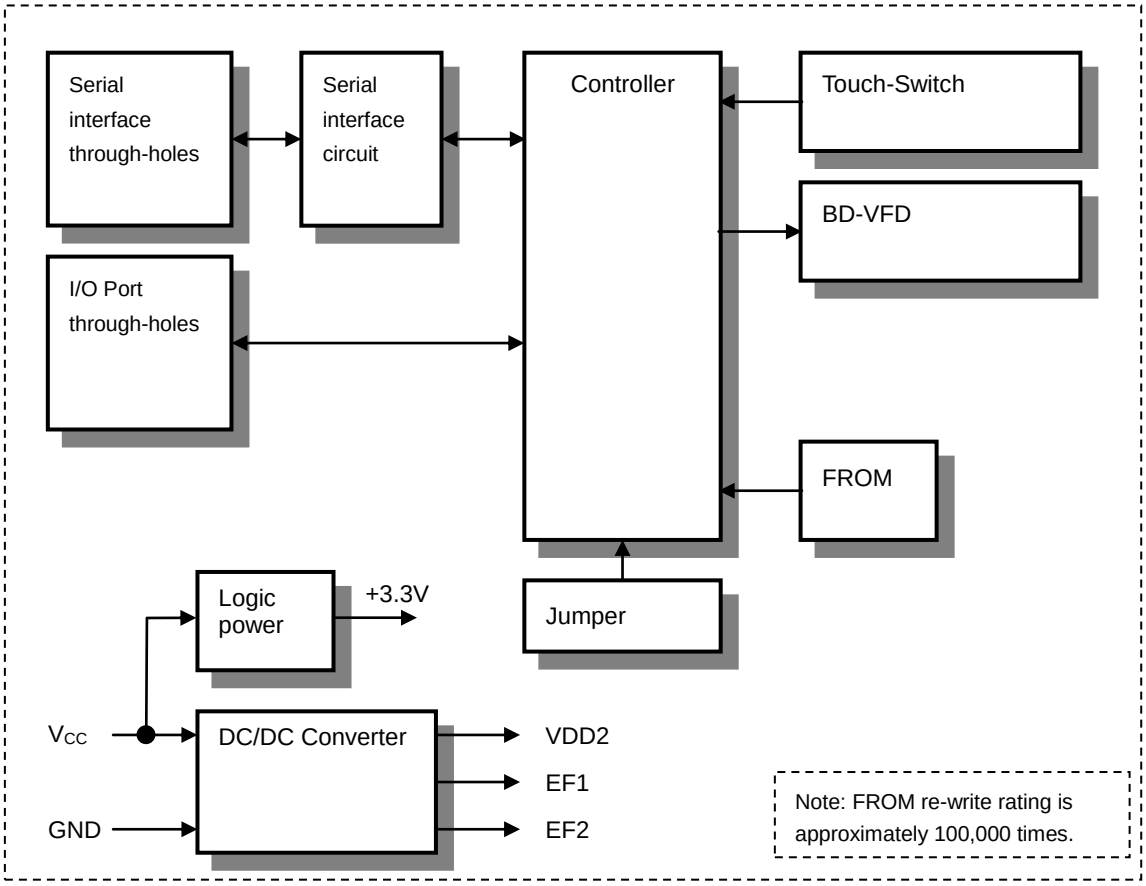
1.2 Outline

- ・Power supply: $+5V_{DC}$ only
- ・Interfaces: Asynchronous serial, SPI, I^2C (All interfaces +3.3V level)
- ・User interface: 8×2 matrix Touch-Switch panel
- ・Function: Character display, Graphic display, Control command, Display action command, Bit Image download function, Window function, Download (user-definable) font, Macro / Program Macro function, Memory SW, I/O port control, Touch information read, Touch sensitivity adjustment

For function details, refer to:

GU-D Series "General Function" Software Specification:	DS-1900-0002-XX
GU-D Series "Program Macro" Software Specification:	DS-1900-0004-XX

1.3 Block Diagram



2 Electrical Specifications

2.1 Absolute Maximum Ratings

Parameter	Symbol	Min.	Typ.	Max.	Unit
Power Supply Voltage	V_{CC}	-0.3	-	6.0	V_{DC}
Logic Input Voltage	V_{IN}	-0.3	-	3.5	V_{DC}

2.2 Electrical Ratings

Parameter	Symbol	Min.	Typ.	Max.	Unit
Power Supply Voltage	V_{CC}	4.75	5.00	5.25	V_{DC}

Driving voltage for the VFD is obtained from the on-board DC/DC converter.

2.3 Electrical Characteristics

Measuring Conditions: Ambient temperature = 25ºC, V_{CC} = 5.0V_{DC}

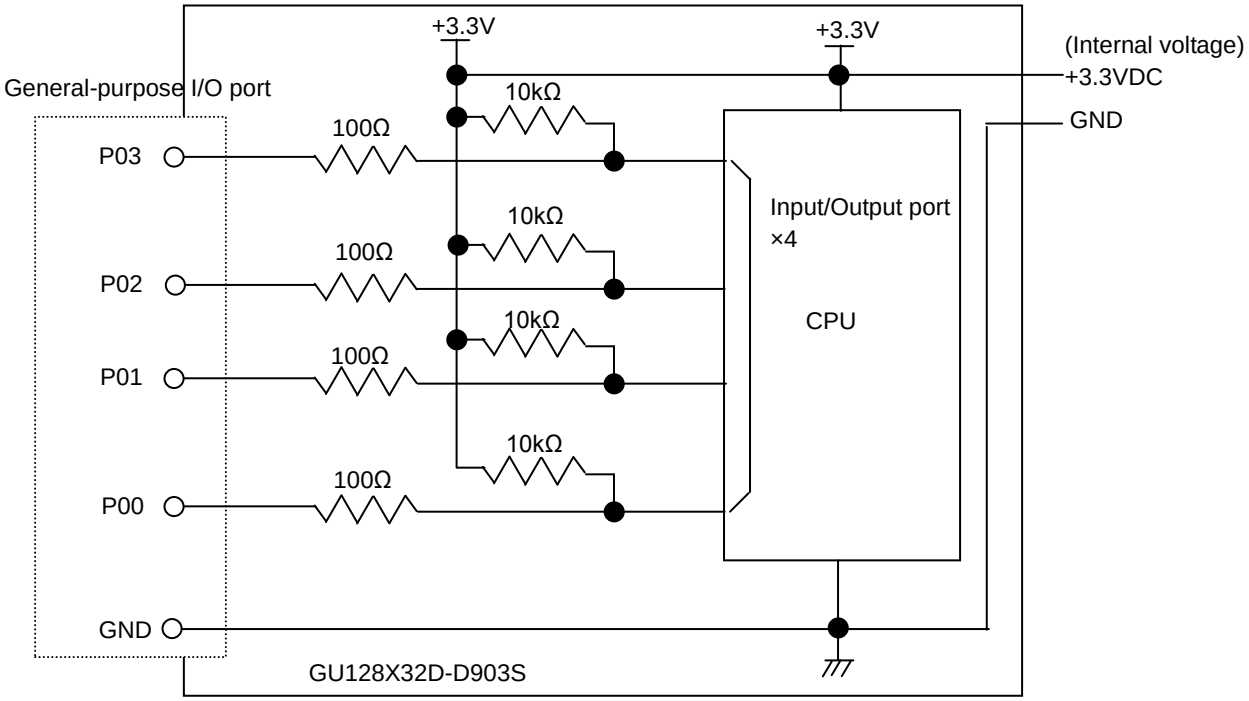
Parameter			Symbol	Min.	Typ.	Max.	Unit	Note
I^2C IF	Logic Input Current SDA,SCL,/RESET	"H"	I_{IH}-1	-	-	1.0	μA_{DC}	V_{IN}=3.3V
		"L"	I_{IL}-1	-	-	-0.5	mA_{DC}	V_{IN}=0V
	Logic Input Voltage SDA,SCL,/RESET	"H"	V_{IH}-1	2.5	-	-	V_{DC}	-
		"L"	V_{IL}-1	-	-	0.6	V_{DC}	-
	Logic Output Voltage SDA,SCL ***1**	"L"	V_{OL}-1	-	-	0.5	V_{DC}	I_{OL}=0.5mA
	Logic Output Voltage MBUSY,/TRDY	"H"	V_{OH}-2	2.6	-	-	V_{DC}	I_{OH}=-0.5mA
		"L"	V_{OL}-2	-	-	0.5	V_{DC}	I_{OL}=0.5mA
Other IF	Logic Input Current RXD,MOSI,SCK,/CS, HBUSY,/RESET	"H"	I_{IH}-2	-	-	1.0	μA_{DC}	V_{IN}=3.3V
		"L"	I_{IL}-2	-	-	-0.5	mA_{DC}	V_{IN}=0V
	Logic Input Voltage RXD,MOSI,SCK,/CS, HBUSY,/RESET	"H"	V_{IH}-2	2.5	-	-	V_{DC}	-
		"L"	V_{IL}-2	-	-	0.6	V_{DC}	-
	Logic Output Voltage TXD,MISO,MBUSY,/TRDY	"H"	V_{OH}-3	2.6	-	-	V_{DC}	I_{OH}=-0.5mA
		"L"	V_{OL}-3	-	-	0.5	V_{DC}	I_{OL}=0.5mA
I/O port	Logic Input Current P00-P03	"H"	I_{IH}-3	-	-	1.0	μA_{DC}	V_{IN}=3.3V
		"L"	I_{IL}-3	-	-	-0.5	mA_{DC}	V_{IN}=0V
	Logic Input Voltage P00-P03	"H"	V_{IH}-3	2.5	-	-	V_{DC}	-
		"L"	V_{IL}-3	-	-	0.6	V_{DC}	-
	Logic Output Voltage P00-P03	"H"	V_{OH}-4	2.6	-	-	V_{DC}	I_{OH}=-0.5mA
		"L"	V_{OL}-4	-	-	0.5	V_{DC}	I_{OL}=0.5mA
	Output permissible Current P00-P03 (per single port) ***2**	"H"	I_{iOH}-1	-	-	3	mA_{DC}	-
		"L"	I_{iOL}-1	-	-	3	mA_{DC}	-
Internal pull-up resistor RXD,TXD,MOSI,MISO,SCK,/CS, SDA,SCL,MBUSY,HBUSY,/TRDY, /RESET,P00-P03			R_p	-	10	-	kΩ	-
Power Supply Current 1			I_{CC}-1	-	230	300	mA_{DC}	All dots ON
Power Supply Current 2			I_{CC}-2	-	140	180	mA_{DC}	All dots OFF
Power Supply Current 3			I_{CC}-3	-	7	9	mA_{DC}	Display power OFF (Power-save mode)
Power Consumption			-	-	1.15	1.50	W	All dots ON

*1: SDA and SCL terminal is set to open-drain output when the used in the output state when I^2C interface is selected (pulled-up by 10kΩ resistor).

*2: Output current should not exceed the values in the above table. If driving LED or other device directly, insert appropriate current limiter into output line.

・The rise time of supply voltage should not exceed 100ms.
・Inrush current at power-on may exceed twice normal current.
・Display power OFF: Refer to "General Function" Software Specification.

2.4 General-purpose I/O port



・Refer to "2.3 Electrical Characteristics", Logic Input/Output Voltage.
・For controlling I/O port, refer to "I/O Port Input / Output setting" command, "I/O Port Output" command, and "I/O Port Input" command in the "General Function" Software Specification.

3 Optical Specifications

Luminance:	350 cd/m^2 Min. (700 cd/m^2 Typ.)
Color of illumination:	Green (Blue Green)

4 Physical Specifications

Number of dots:	4,096 (128×32)
Display area:	57.45 mm × 13.93 mm (X×Y)
Dot size:	0.30 mm × 0.29 mm (X×Y)
Dot pitch:	0.45 mm × 0.44 mm (X×Y)
Weight:	Approximately 38g

5 Environmental Specifications

Operating temperature:	-40 to +85 ºC*
Storage temperature:	-40 to +85 ºC*
Operating humidity:	20 to 80% RH (non-condensing)
Storage humidity:	20 to 80% RH (non-condensing)
Vibration (non-operating):	10-55-10Hz, all amplitude 1.0mm, 30 minutes, X-Y-Z
Shock (non-operating):	392m/s^2 (40G), 9ms, X-Y-Z, 3 times each direction

* Safety standard for bare finger touch to the touch switch area is maximum +70ºC (short touch), or +65ºC (continuous touch).
* If stored or operated for a long time at high temperatures, some parts of the display area may become discolored.

6 Applicable Specifications

Applicable VFD Module reliability specification:	TT-99-3102x
Applicable VFD Module quality specification:	TT-93-3413x
Applicable VFD quality specification:	TT-93-3336x

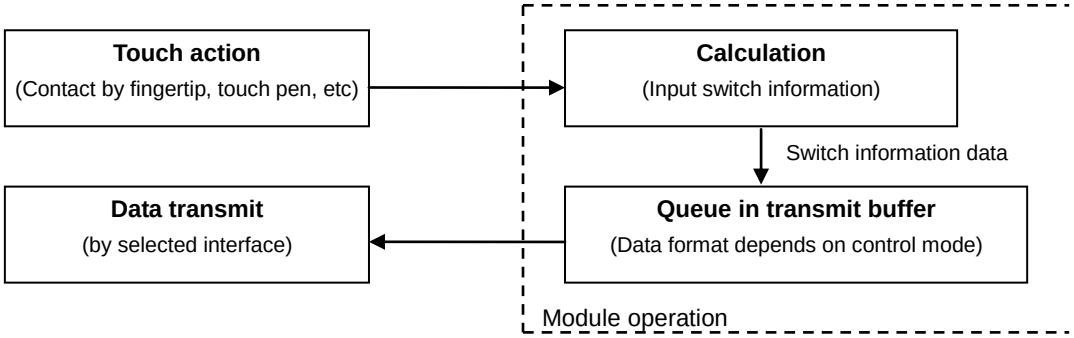
7 Touch-Switch

7.1 Outline

- Detection: Capacitive (multi-touch (multiple-point input) is supported)
- Construction: Glass + Aluminum wiring

7.2 Basic Operation

- The display module features a Touch-Switch panel for handling input by fingertip or touch pen, etc. The switch information data is stored into the transmit buffer in the module.



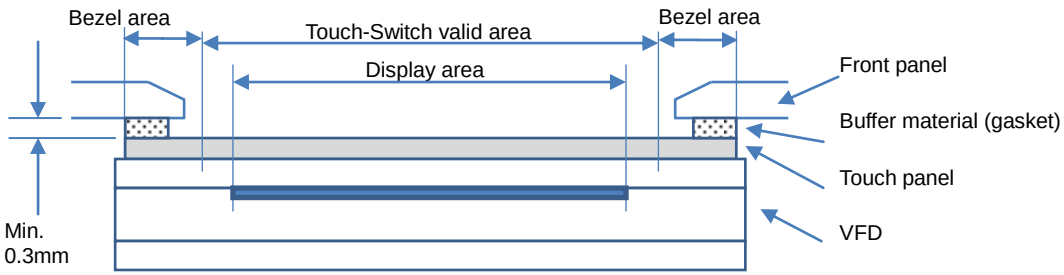
Note: There are various modes for obtaining switch status information. Refer to "General Function" Software Specification for details.

7.2.1 Auto-calibration

- The built-in Touch-Switch is of static-capacitive type, and as such, **it's operation can be affected by the temperature and humidity etc, of the surrounding environment.** An **auto-calibration function** is provided in order to adjust the threshold for touch detection in response to changes in the surrounding environment. This enables stable touch detection, reducing the effects of changes in the surrounding environment. This function can be turned OFF by software command (refer to "General Function" Software Specification).

7.3 Cautions

- For product assembly, ensure mounting such that front panel is within the bezel area. **Ensure a margin within the Bezel area from the Touch-Switch valid area, and adjust while checking the actual touch sensitivity.**



(Refer to 13 Physical Dimensions for position details)

- The Touch-Switch cable (FPC) significantly impacts the operation of the Touch-Switch, so the mounting design should ensure that the FPC does not direct contact the device. Do not hold the Touch-Switch panel cable (FPC), and avoid any assembly or operation that would apply stress to the cable.
- When display power is ON, Touch-Switch panel surface area rises up to around 30 ºC higher than surrounding area, so use caution for operation in high-temperature environments.

8 Interface

8.1 Type of interface

There are three serial interfaces, selected by jumper: Asynchronous, SPI, and I^2C (all CMOS-level).

Refer to "9 Jumper".

8.2 Basic function

- Data received is stored in the internal receive buffer, and processed in order of receipt.
- MBUSY signal changes according to receive buffer state. The host should send data when MBUSY=READY.
- When there is data in the transmit buffer, /TRDY = READY.

○MBUSY signal change timing:

MBUSY	BUSY ("H")	READY ("L")
Condition	Data in receive buffer	No data in receive buffer

○/TRDY signal change timing:

/TRDY	EMPTY ("H")	READY ("L")
condition	No data in transmit buffer	Data in transmit buffer

○Buffer Capacity:

Receive buffer	60 bytes
Transmit buffer	60 bytes

8.2.1 Asynchronous serial interface

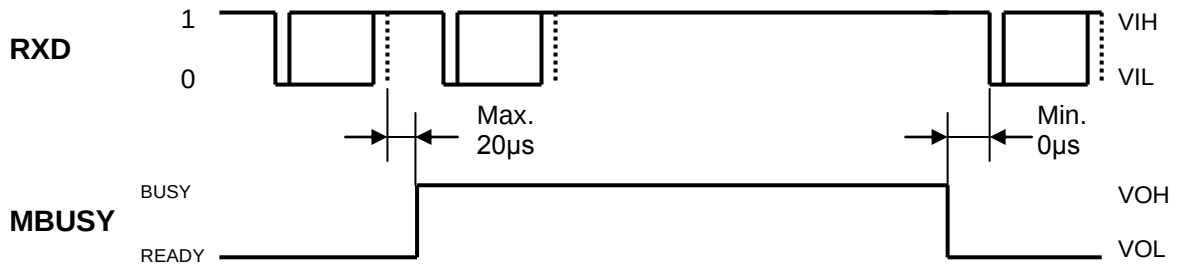
○Interface conditions:

Baud rate	9600 to 115200bps (set by Jumper and Memory SW) **Default setting: 38400bps**
Parity	None, Even, Odd (set by Memory SW) **Default setting: None**
Format	Start (1 bit) + Data (8 bit) + Parity (0 or 1 bit) + Stop (1 bit)
Communication control signal	MBUSY, HBUSY, /TRDY

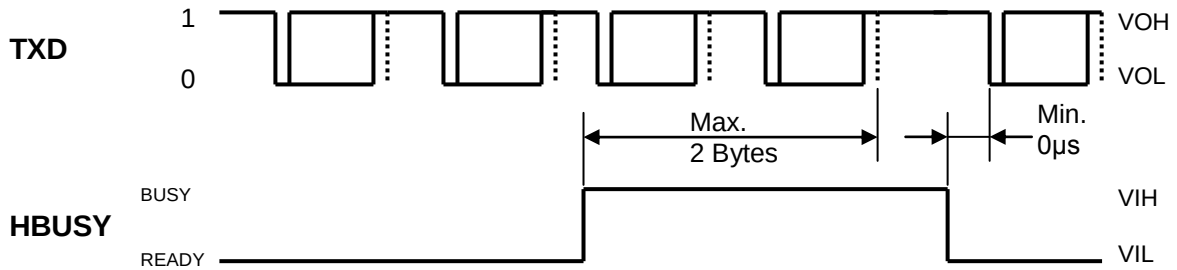
- Data transmitted from the display is placed in the internal transmit buffer and sent, in order, when HBUSY=READY.

○Timing

[Data write]



[Data read]



8.2.2 SPI

○Interface conditions:

・ Display module operates as SPI slave; data is sent and received in response to host (master) operations. /CS = High → Low → High is one command sequence.

1st byte	Operation mode
44h	Data write (Host → Module)
54h	Data read (Host → Module)
58h	Status read

[Data write]

・ When 44h is input as the first byte, the module receives as data the 2nd and subsequent bytes.

	1st byte	2nd byte	3rd byte	---	n byte
MOSI	44h	Data(1)	Data(2)	---	Data(n-1)
MISO	-	-	-	---	-

[Data read]

・ When 54h is input as the first byte, the module outputs valid data on the 3rd and subsequent bytes.

・ The host must read the number of bytes reported by the immediately preceding Status Read command. (**The number of bytes reported by the Status read command will be transmitted, with any unread bytes discarded.**)

	1st byte	2nd byte	3rd byte	---	n byte
MOSI	54h	-	-	---	-
MISO	-	00h	Data(1)	---	Data(n-2)

[Status read]

・ When 58h is input as the first byte, the module outputs status data. **For the 3rd and any subsequent bytes, the most recent status data is provided.**

	1st byte	2nd byte	3rd byte	---	n byte
MOSI	58h	-	-	---	-
MISO	-	Status	Status	---	Status

Status bit assignment

bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
MBUSY	0 *	TL(bit 5)	TL(bit 4)	TL(bit 3)	TL(bit 2)	TL(bit 1)	TL(bit 0)

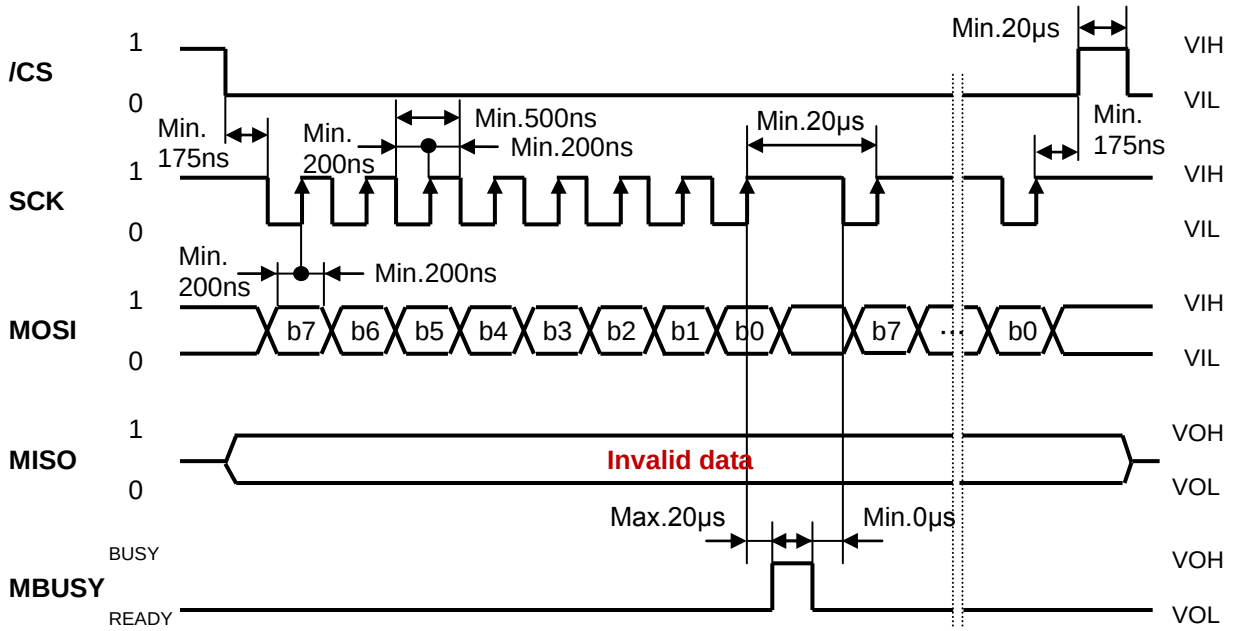
・ MBUSY: MBUSY signal status (MBUSY = 0: Low(READY), MBUSY = 1: High(BUSY))

・ TL: Number of Transmit data bytes available (maximum 63 bytes)

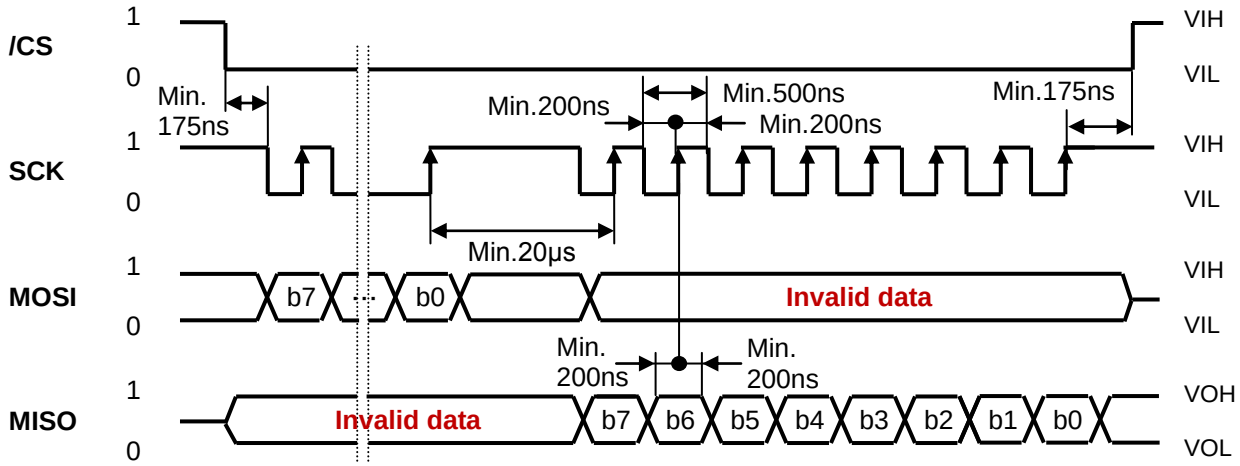
*: If bit 6 = 1, the Status data is invalid.

○Timing

[Write operation] Data write



[Read operation] Data read / Status read



8.2.3 I²C interface

○Interface conditions:

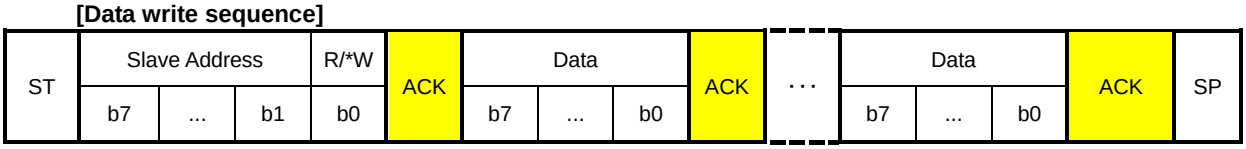
・ Display module operates as I²C slave, sending and receiving data in response to host (master) operation.

Clock frequency	Max.400kHz
Format	Conforms to the I²C Standard
Slave address	08h to 77h (set by Jumper and Memory SW) **Default setting: 50h**
Supported functions	ACK response, Clock stretch
Communication control signals	MBUSY, /TRDY

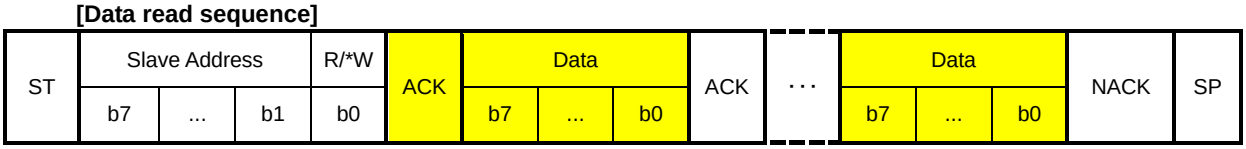
***Note:** **If Clock stretch is applied during processing of a command, the host (master) will not be able to send or receive any more data until command processing has finished.**

- **In addition to the configured Slave address, the VFD module also responds to the General call address (00h), however "second byte" functions (06h and 04h) are not supported (the second, and any subsequent bytes, are treated as ordinary data).**
- If /TRDY = EMPTY, FFh is transmitted from the VFD module in response to a read sequence.
- In addition to the Clock stretch function, flow can also be controlled by monitoring the MBUSY signal. MBUSY signal changes according to receive buffer state. The host should send data when MBUSY=READY (refer to "8.2 Basic function").

[Data write sequence]



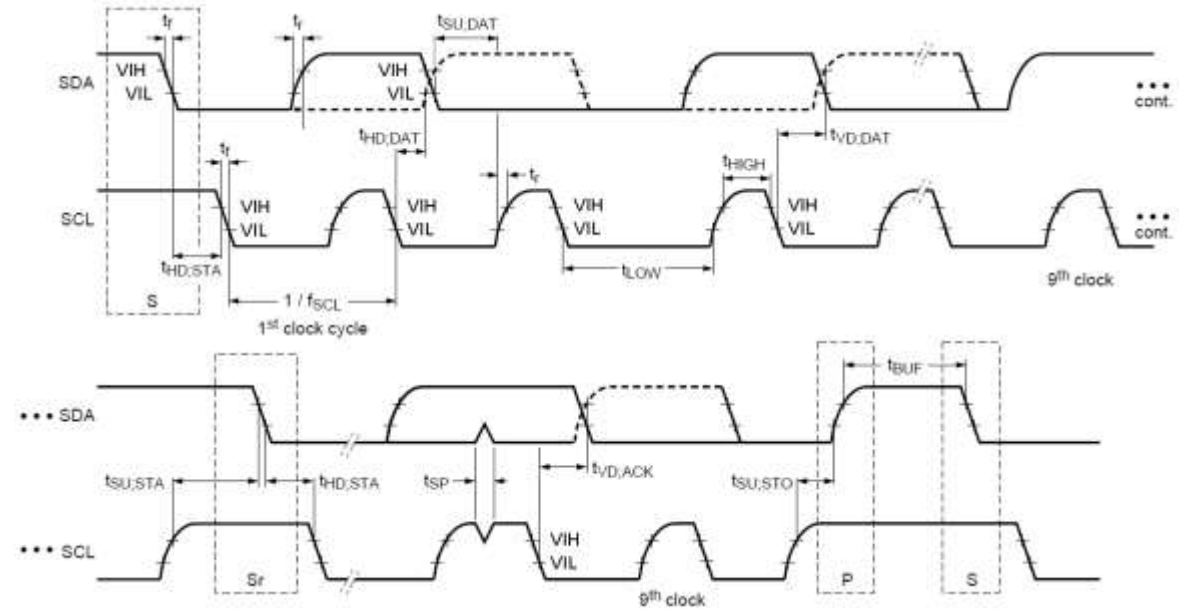
[Data read sequence]



The host is transmitter, VFD module is receiver

The host is receiver, VFD module is transmitter

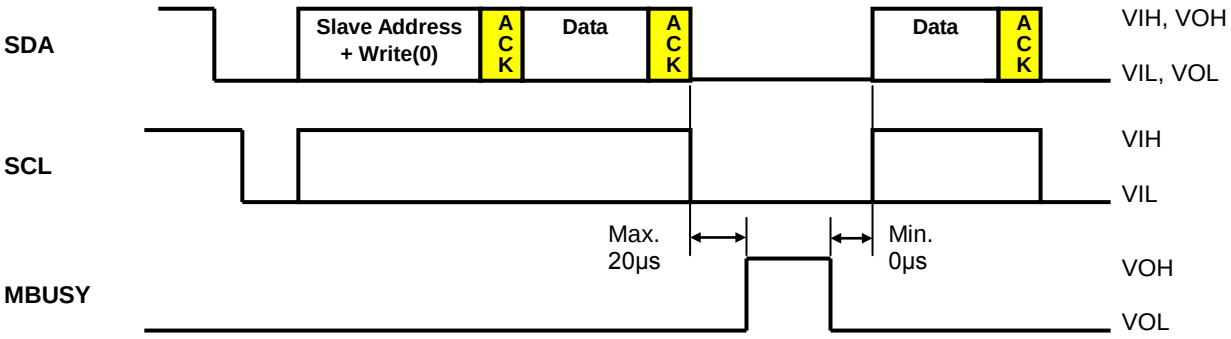
○Timing



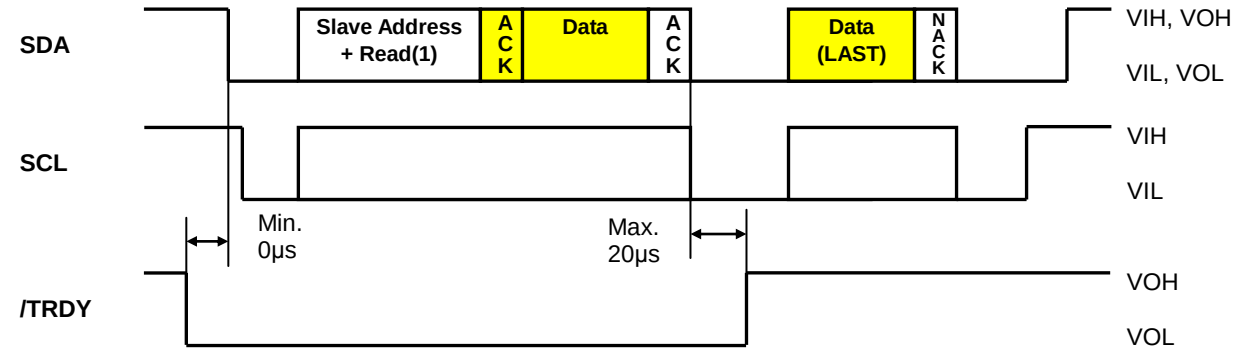
Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Pulse width of spikes that must be suppressed by the input filter	t_{SP}	-	0	-	50	ns
SCL clock frequency	f_{SCL}	-	0	-	400	kHz
(Repeat)Start condition hold time	$t_{HD;STA}$	-	0.6	-	-	μs
SCL LOW time	t_{LOW}	-	1.3	-	-	μs
SCL HIGH time	t_{HIGH}	-	0.6	-	-	μs
Repeat Start condition setup time	$t_{SU;STA}$	-	0.6	-	-	μs
Data hold time	$t_{HD;DAT}$	-	10	-	-	ns
Data setup time	$t_{SU;DAT}$	-	100	-	-	ns
SCL, SDA rise time	t_r	-	20	-	300	ns
SCL, SDA fall time	t_f	V_{IN}=5.5V	20	-	300	ns
Stop condition setup time	$t_{SU;STO}$	-	0.6	-	-	μs
Stop condition - Sart condition bus idle time	t_{BUF}	-	20	-	-	μs
Data valid time	$t_{VD;DAT}$	-	-	-	0.9	μs
Data valid acknowledge valid time	$t_{VD;ACK}$	-	-	-	0.9	μs

***: When selecting the external resistor(s), ensure the requirements in the above table are satisfied. (Refer to "2.3 Electrical Characteristics", for internal pull-up resistor details)**

MBUSY timing



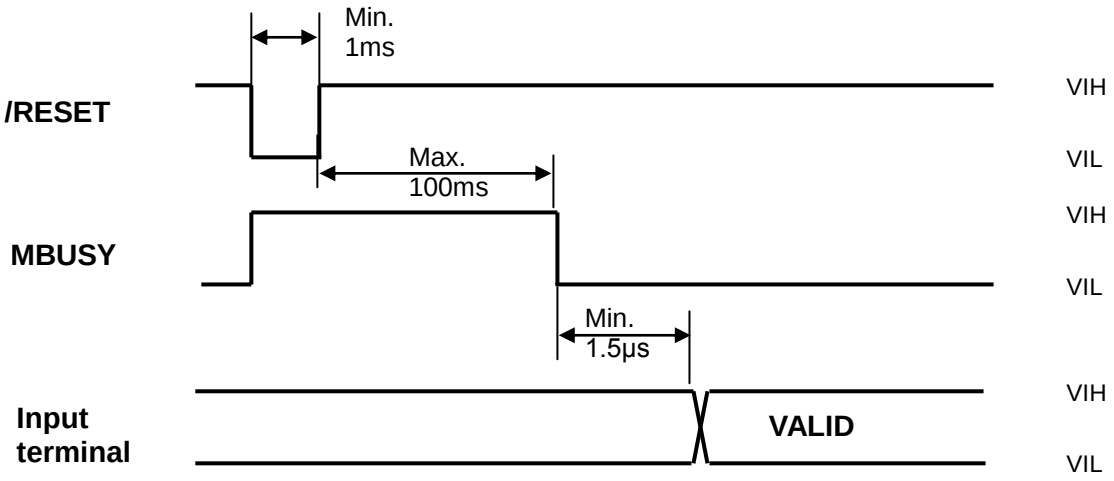
/TRDY timing



8.3 Reset timing

Reset pulse (active low) should be longer than 1ms.

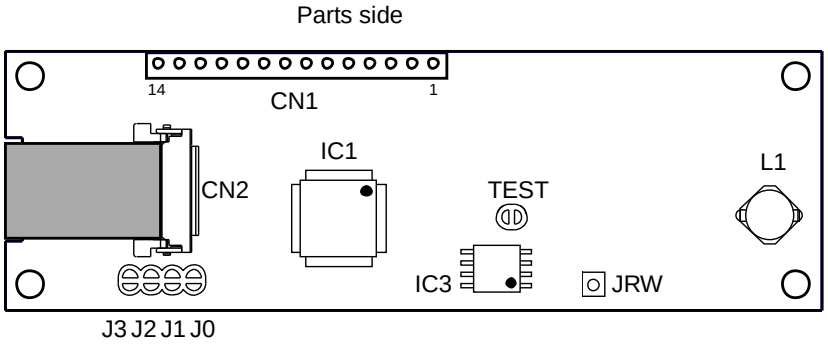
The module sets the MBUSY line upon receipt of /RESET signal and clears the line when ready to receive data.



9 Jumper

***: Memory SW (MSW) details: Refer to "General Function" Software Specification.**

No.	Function	Default
J0	Asynchronous serial baud rate setting / I^2C slave address setting	OPEN
J1		OPEN
J2	Serial interface setting	OPEN
J3		OPEN
TEST	Operating Mode select	OPEN
JRW		OPEN



9.1 Serial interface setting

J2	J3	Interface type at power-on
-	OPEN	Asynchronous serial Interface
OPEN	SHORT	I^2C Interface
SHORT	SHORT	SPI

9.2 I^2C slave address setting

I^2C slave address setting at power-on is set by a combination of Memory SW and Jumper.

J0	J1	Slave address
OPEN	OPEN	50h *1
SHORT	OPEN	51h *1
OPEN	SHORT	70h *1
SHORT	SHORT	**MSW47 setting** *2

*1: Also responds to General call address.

*2: Response to General call address can be enabled / disabled.

9.3 Asynchronous serial baud rate setting

Asynchronous serial baud rate setting at power-on is set by a combination of Memory SW and Jumper.

J0	J1	Baud rate
OPEN	OPEN	38400bps
SHORT	OPEN	19200bps
OPEN	SHORT	9600bps
SHORT	SHORT	**MSW48 setting**

10 Connector

10.1 Serial interface & I/O port 14 through-holes (CN1)

※IC: Leave unconnected

10.1.1 Interface type: Asynchronous serial

Pin No.	Signal name	Function	Direction	Pin No.	Signal name	Function	Direction
1	V_{CC}	Power supply	Input	8	TXD	Data send	Output
2	RXD	Data receive	Input	9	/TRDY	Transmit ready	Output
3	GND	Ground	Input	10	GND	Ground	Input
4	MBUSY	Module busy	Output	11	P00	I/O port0_bit0	Input/ Output
5	IC	Internal connection	-	12	P01	I/O port0_bit1	Input/ Output
6	/RESET	Reset	Input	13	P02	I/O port0_bit2	Input/ Output
7	HBUSY	Host busy	Input	14	P03	I/O port0_bit3	Input/ Output

10.1.2 Interface type: SPI

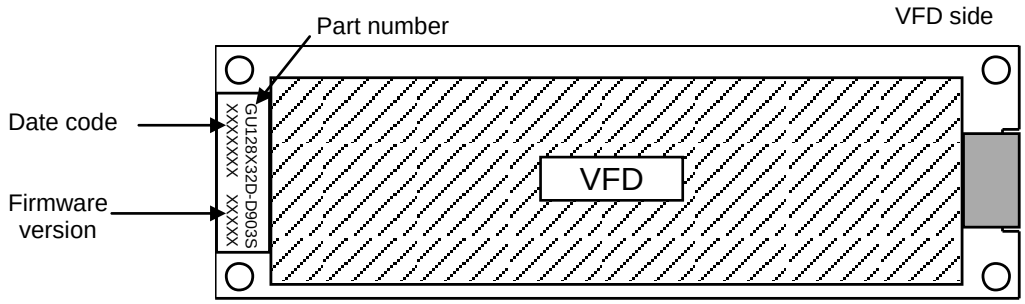
Pin No.	Signal name	Function	Direction	Pin No.	Signal name	Function	Direction
1	V_{CC}	Power supply	Input	8	MISO	Data send	Output
2	MOSI	Data receive	Input	9	/TRDY	Transmit ready	Output
3	GND	Ground	Input	10	GND	Ground	Input
4	MBUSY	Module busy	Output	11	P00	I/O port0_bit0	Input/ Output
5	SCK	Serial clock	Input	12	P01	I/O port0_bit1	Input/ Output
6	/RESET	Reset	Input	13	P02	I/O port0_bit2	Input/ Output
7	/CS	Chip select	Input	14	P03	I/O port0_bit3	Input/ Output

10.1.3 Interface type: I^2C interface

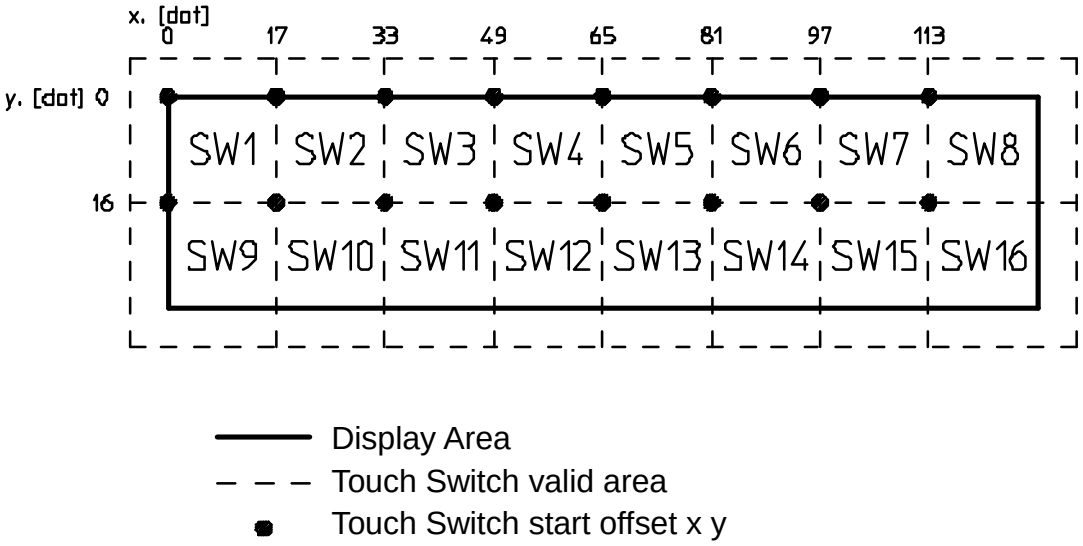
Pin No.	Signal name	Function	Direction	Pin No.	Signal name	Function	Direction
1	V_{CC}	Power supply	Input	8	IC	Internal connection	-
2	SDA	Data receive / send	Input/ Output	9	/TRDY	Transmit ready	Output
3	GND	Ground	Input	10	GND	Ground	Input
4	MBUSY	Module busy	Output	11	P00	I/O port0_bit0	Input/ Output
5	SCL	Serial clock	Input/ Output	12	P01	I/O port0_bit1	Input/ Output
6	/RESET	Reset	Input	13	P02	I/O port0_bit2	Input/ Output
7	IC	Internal connection	-	14	P03	I/O port0_bit3	Input/ Output

11 Firmware Version Notation

The firmware version is written in the following position:

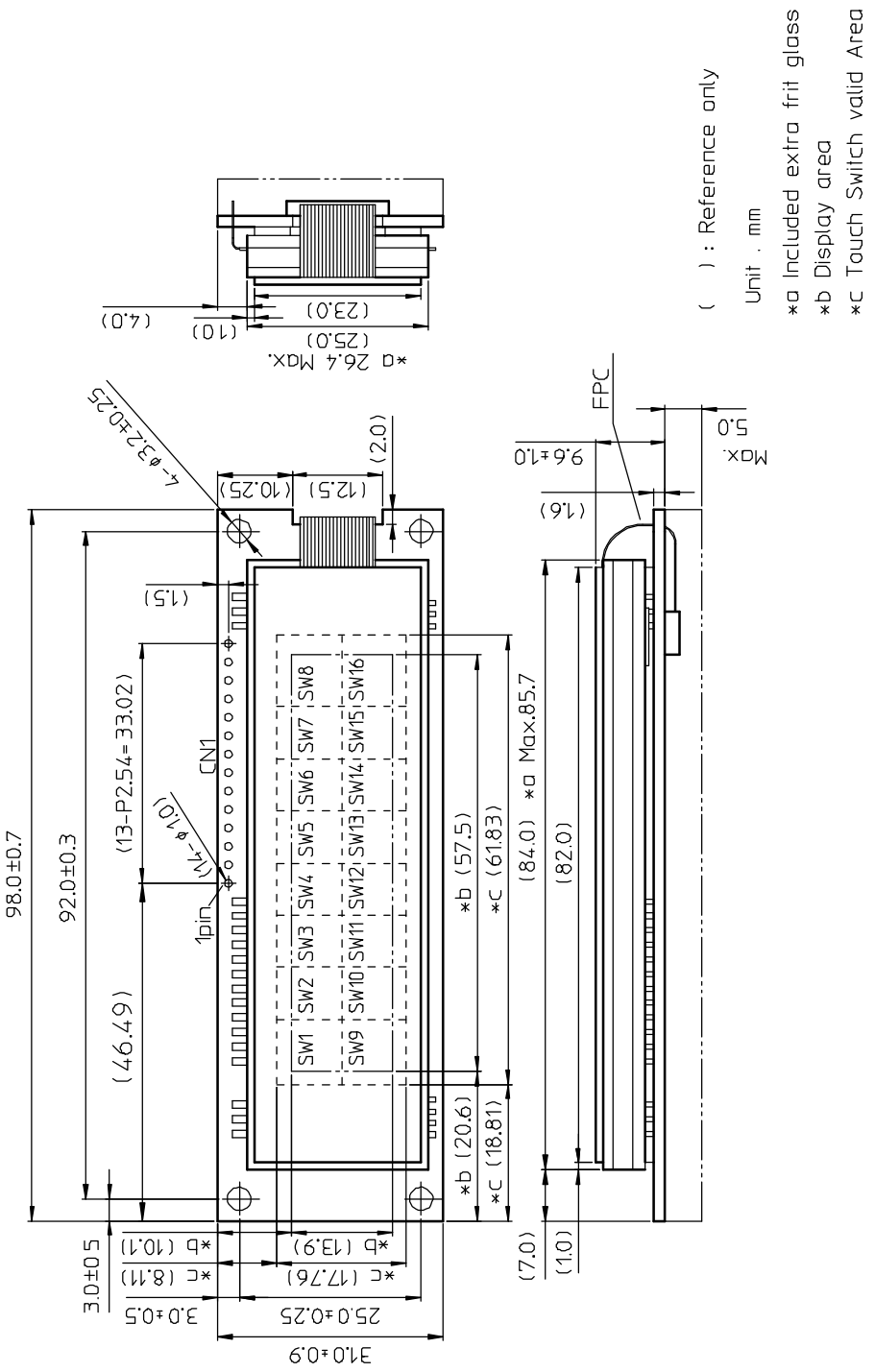


12 Touch Switch position



* Touch-Switch start position may be offset by a number of dots, so an appropriate margin should be incorporated into the display pattern when using adjacent switches.

13 Physical Dimensions



DS-1900-0110-01

Revision Note

Specification No.	Date	Revision
DS-1900-0000-00	Apr. 08, 2015	Initial release.
DS-1900-0000-01	Oct. 01, 2015	8.2.2 SPI MBUSY = 0: Low, MBUSY = 1: High → MBUSY = 0: Low(READY), MBUSY = 1: High(BUSY)

Notice for the Cautious Handling of VFD Modules

Handling and Usage Precautions:
Please carefully follow the appropriate product application notes and operation standards for proper usage, safe handling, and maximum performance.

[VFD tubes are made of glass]
- The edges of the VFD glass envelope are not smooth, so it is necessary to handle carefully to avoid injuries to hands.
- Use caution to avoid breaking the VFD glass envelope, 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 operation, because unrecoverable damage may result.
- Sending input signals to the VFD module when not powered can cause I/O port damage.
- It is recommended to use a 30cm or shorter signal cable to prevent functional failures.

[Electrostatic charge]
- VFD modules need 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.
- Preferably, use UL-grade materials or components in conjunction with VFD modules.
- Warp and twist movement causes stress and may break VFDs and 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.
- VFD modules may draw in-rush current exceeding twice the typical current at power-on, so a power supply with sufficient capacity and quick starting of the power regulator is recommended.
- VFD module needs a specified voltage at the point of connection. Please use an adequate power cable to avoid a decrease in voltage. As a safety measure, a fuse or other over-current protection is recommended.

[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 non-uniform brightness. 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 of the pixels.
- A signal cable 30cm or less is recommended to avoid possible disturbances to the signal.

[Storage and operating environment]
- Please use VFD modules under the recommended specified environmental conditions. Salty, sulfuric and dusty environments may damage the VFD module even during storage.

[Disposal]
- VFD uses lead-containing materials (RoHS directive exempts these lead compounds in the glass for electronic devices). When discarding VFDs or VFD modules, please adhere to applicable laws and regulations.

[Other cautions]
- 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 is 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 accept responsibility for problems that may occur.