# Low Duty LCD Segment Driver

**BU9795BGUW** **MAX 124 Segments (SEG31×COM4)**

## General Description

BU9795BGUW is a 1/4 Duty General-purpose LCD driver that can be used for consumer / battery operated products.BU9795BGUW can drive up to 124 LCD Segments.
It has integrated display RAM for reducing CPU load. Also, it is designed with low power consumption and no external component needed.
Its small BGA package of BU9795BGUW is well-suited for small footprint applications.

## Features

- Integrated RAM for Display Data (DDRAM) : 31 × 4bit (Max 124 Segments)
- LCD Drive Output : 4 Common output, Max 31 Segment output
- Integrated Buffer AMP for LCD Driving
- Integrated Oscillator Circuit
- No external Components
- Low Power Consumption Design

## Applications

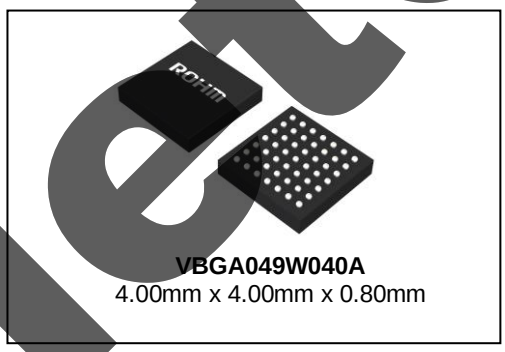
- Metering
- Home Automation Goods
- White Goods
- Small Appliances
- Healthcare Products
- Battery Operated Products

etc.

## Key Specifications

- Supply Voltage Range: +2.5V to +5.5V
- Operating Temperature Range: -40°C to +85°C
- Max Segments: 124 Segments
- Display Duty: 1/4
- Bias: 1/2, 1/3 selectable
- Interface: 3wire serial interface

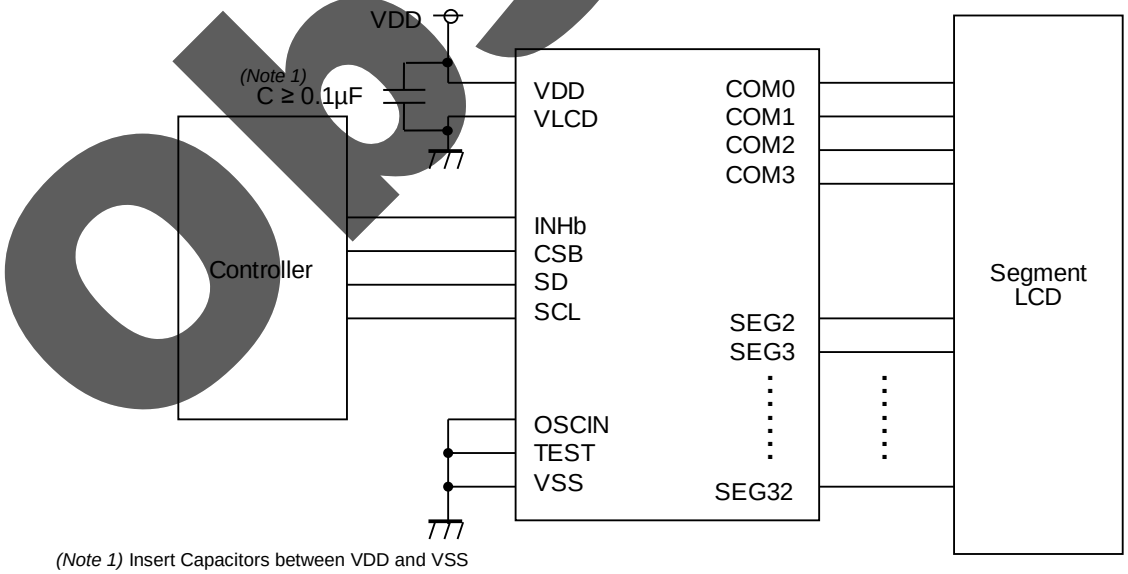
## Package W (Typ) x D (Typ) x H (Max)



**VBGA049W040A**
4.00mm x 4.00mm x 0.80mm



## Typical Application Circuit




*(Note 1)* Insert Capacitors between VDD and VSS

Internal Oscillator Circuit Mode

**Figure 1. Typical Application Circuit**

○Product structure : Silicon monolithic integrated circuit ○This product has no designed protection against radioactive rays.

## Block Diagrams / Pin Configurations / Pin Description

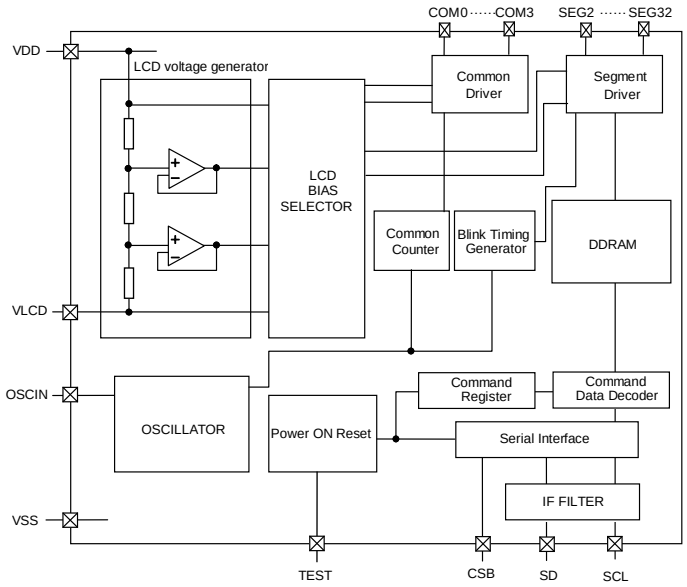



**Figure 3. Block Diagram**

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| A | (NC) | TEST | SCL | OSCIN | VLCD | COM2 | (NC) |
| B | (NC) | INHb | SD | VSS | VDD | COM1 | COM0 |
| C | SEG4 | SEG3 | SEG2 | CSB | COM3 | SEG32 | SEG31 |
| D | SEG7 | SEG6 | SEG8 | SEG5 | SEG30 | SEG28 | SEG29 |
| E | SEG9 | SEG10 | SEG14 | SEG19 | SEG25 | SEG27 | SEG26 |
| F | SEG11 | SEG12 | SEG16 | SEG17 | SEG21 | SEG23 | SEG24 |
| G | (NC) | SEG13 | SEG15 | SEG18 | SEG20 | SEG22 | (NC) |

**Figure 4. Pin Configuration (TOP VIEW)**

Table 1. Pin Description

| Pin Name | I/O | Function | Handling when unused |
|---|---|---|---|
| INHb | I | Input pin for turn off display<br>H : turn on display L : turn off display | VDD |
| TEST | I | POR enable setting<br>VDD: POR disenable *(Note)*<br>VSS: POR enable | VSS |
| OSCIN | I | Input pin for external clock<br>External clock and Internal clock can be changed by command.<br>Must be connected to VSS when using internal oscillation circuit. | VSS |
| SD | I | Serial data input | - |
| SCL | I | Serial data transfer clock | - |
| CSB | I | Chip select : ”L” active | - |
| VSS | - | Ground | - |
| VDD | - | Power supply | - |
| VLCD | I | Power supply for LCD driving | - |
| SEG2 to 32 | O | Segment output for LCD driving | OPEN |
| COM0 to 3 | O | Common output for LCD driving | OPEN |

*(Note)* This function is guaranteed by design, not tested in production process.
Software Reset is necessary to initialize IC in case of TEST=VDD.

### Absolute Maximum Ratings (VSS=0V)

| Parameter | Symbol | Ratings | Unit | Remark |
|---|---|---|---|---|
| Power Supply Voltage1 | VDD | -0.5 to +7.0 | V | Power Supply |
| Power Supply Voltage2 | VLCD | -0.5 to VDD | V | LCD Drive Voltage |
| Power Dissipation | Pd | 0.27*(Note 1)* | W | |
| Input Voltage Range | $V_{IN}$ | -0.5 to VDD+0.5 | V | |
| Operating Temperature Range | Topr | -40 to +85 | °C | |
| Storage Temperature Range | Tstg | -55 to +125 | °C | |

*(Note 1)* Derate by 2.7mW/°C when exceeding above Ta=25°C (when mounted in ROHM's standard board).

**Caution**: Operating the IC over the absolute maximum ratings may damage the IC. The damage can either be a short circuit between pins or an open circuit between pins and the internal circuitry. Therefore, it is important to consider circuit protection measures, such as adding a fuse, in case the IC is operated over the absolute maximum ratings.

**Caution2:** Should by any chance the maximum junction temperature rating be exceeded the rise in temperature of the chip may result in deterioration of the properties of the chip. In case of exceeding this absolute maximum rating, design a PCB boards with power dissipation taken into consideration by increasing board size and copper area so as not to exceed the maximum junction temperature rating.

### Recommended Operating Conditions (Ta=-40°C to +85°C, VSS=0V)

| Parameter | Symbol | Ratings | | | Unit | Remark |
|---|---|---|---|---|---|---|
| | | Min | Typ | Max | | |
| Power Supply Voltage1 | VDD | 2.5 | - | 5.5 | V | Power Supply |
| Power Supply Voltage2 | VLCD | 0 | - | VDD-2.4 | V | LCD Drive Voltage, VDD-VLCD ≥ 2.4V |

### Electrical Characteristics

DC Characteristics (VDD=2.5V to 5.5V, VSS=0V, Ta=-40°C to +85°C, unless otherwise specified)

| Parameter | | Symbol | Limit | | | Unit | Conditions |
|---|---|---|---|---|---|---|---|
| | | | Min | Typ | Max | | |
| "H" Level Input Voltage | | $V_{IH}$ | 0.7VDD | - | VDD | V | SD, SCL, CSB, INHb, OSCIN |
| "L" Level Input Voltage | | $V_{IL}$ | VSS | - | 0.3VDD | V | SD, SCL, CSB, INHb, OSCIN |
| "H" Level Input Current | | $I_{IH}$ | - | - | 1 | µA | SD, SCL, CSB, INHb, OSCIN*(Note 2)*, TEST |
| "L" Level Input Current | | $I_{IL}$ | -1 | - | - | µA | SD, SCL, CSB, INHb, OSCIN*(Note 2)*, TEST |
| LCD Driver ON-Resistance | SEG | $R_{ON}$ | - | 3.5 | - | kΩ | Iload=±10µA |
| | COM | $R_{ON}$ | - | 3.5 | - | kΩ | |
| VLCD Supply Voltage | | VLCD | 0 | - | VDD -2.4 | V | VDD-VLCD ≥ 2.4V |
| Standby Current | | Ist | - | - | 5 | µA | Display off, Oscillator off |
| Power Consumption 1 | | $I_{DD1}$ | - | 12.5 | 30 | µA | VDD=3.3V, VLCD=0V, Ta=25°C, Power save mode1, FR=70Hz, 1/3 bias, Frame inverse |
| Power Consumption 2 | | $I_{DD2}$ | - | 20 | 40 | µA | $V_{DD}$=3.3V, VLCD=0V, Ta=25°C, Normal mode, FR=80Hz, 1/3 bias, Line inverse |

*(Note 2)* For External clock mode only

## Electrical Characteristics – continued

Oscillation Characteristics (VDD=2.5V to 5.5V, VSS=0V, Ta=-40°C to +85°C, unless otherwise specified)

| Parameter | Symbol | Limits | | | Unit | Conditions |
|---|---|---|---|---|---|---|
| | | Min | Typ | Max | | |
| Frame Frequency1 | $f_{CLK1}$ | 56 | 80 | 104 | Hz | FR = 80Hz setting, VDD=2.5V to 5.5V, Ta=-40°C to +85°C |
| Frame Frequency2 | $f_{CLK2}$ | 70 | 80 | 90 | Hz | FR = 80Hz setting, VDD=3.3V, Ta=25°C |
| Frame Frequency3 | $f_{CLK3}$ | 77.5 | 87.5 | 97.5 | Hz | FR = 80Hz setting, VDD=5.0V, Ta=25°C |
| Frame Frequency4 | $f_{CLK4}$ | 67.5 | 87.5 | 108 | Hz | FR = 80Hz setting, VDD=5.0V, Ta=-40°C to +85°C |
| External Clock Rise Time | tr | - | - | 0.3 | µs | External clock mode (OSCIN) *(Note)* |
| External Clock Fall Time | tf | - | - | 0.3 | µs | |
| External Frequency | $f_{EXCLK}$ | 15 | - | 300 | kHz | |
| External Clock Duty | $t_{DTY}$ | 30 | 50 | 70 | % | |

*(Note)* <Frame frequency calculation at External clock mode>
DISCTL 320Hz setting: Frame frequency [Hz] = External clock [Hz] / 128
DISCTL 284Hz setting: Frame frequency [Hz] = External clock [Hz] / 144
DISCTL 213Hz setting: Frame frequency [Hz] = External clock [Hz] / 192
DISCTL 160Hz setting: Frame frequency [Hz] = External clock [Hz] / 256
DISCTL 80Hz setting: Frame frequency [Hz] = External clock [Hz] / 512
DISCTL 71Hz setting: Frame frequency [Hz] = External clock [Hz] / 576
DISCTL 64Hz setting: Frame frequency [Hz] = External clock [Hz] / 648
DISCTL 53Hz setting: Frame frequency [Hz] = External clock [Hz] / 768

【Reference Data】

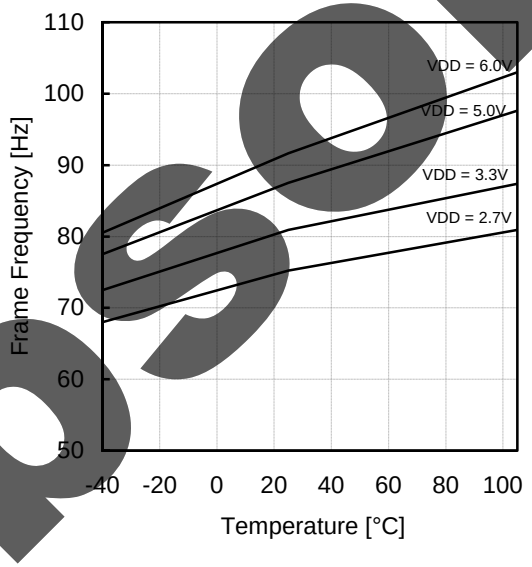



**Figure 4. Frame Frequency Typical Temperature Characteristics**

## Electrical Characteristics – continued

MPU Interface Characteristics (VDD=2.5V to 5.5V, VSS=0V, Ta=-40°C to +85°C, unless otherwise specified)

| Parameter | Symbol | Limit | | | Unit | Conditions |
|---|---|---|---|---|---|---|
| | | Min | Typ | Max | | |
| Input Rise Time | $t_r$ | - | - | 80 | ns | |
| Input Fall Time | $t_f$ | - | - | 80 | ns | |
| SCL Cycle Time | $t_{SCYC}$ | 400 | - | - | ns | |
| “H” SCL Pulse Width | $t_{SHW}$ | 100 | - | - | ns | |
| “L” SCL Pulse Width | $t_{SLW}$ | 100 | - | - | ns | |
| SD Setup Time | $t_{SDS}$ | 20 | - | - | ns | |
| SD Hold Time | $t_{SDH}$ | 50 | - | - | ns | |
| CSB Setup Time | $t_{CSS}$ | 50 | - | - | ns | |
| CSB Hold Time | $t_{CSH}$ | 50 | - | - | ns | |
| “H” CSB Pulse Width | $t_{CHW}$ | 50 | - | - | ns | |

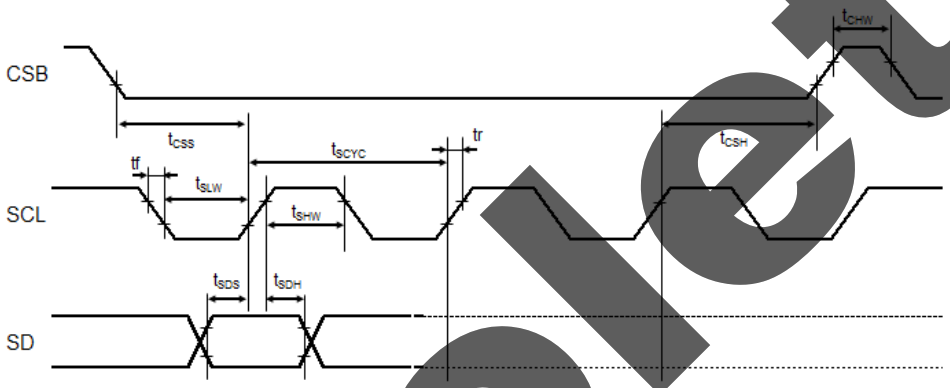



**Figure 5. Interface Timing**

## I/O Equivalent Circuit

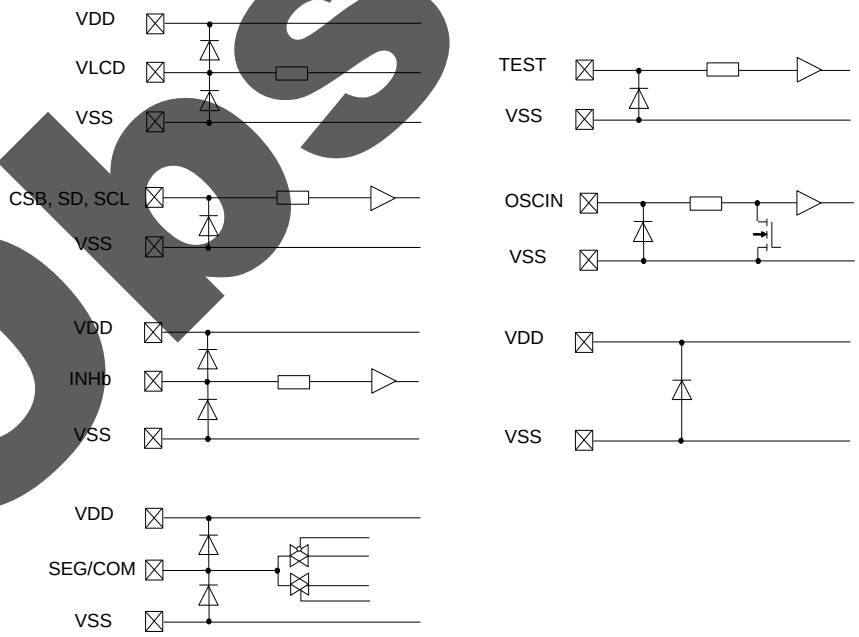
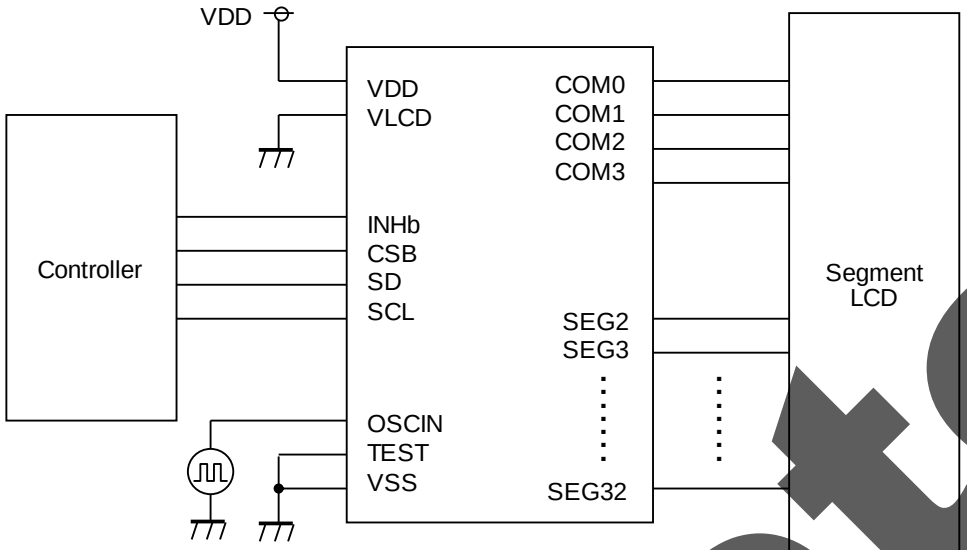
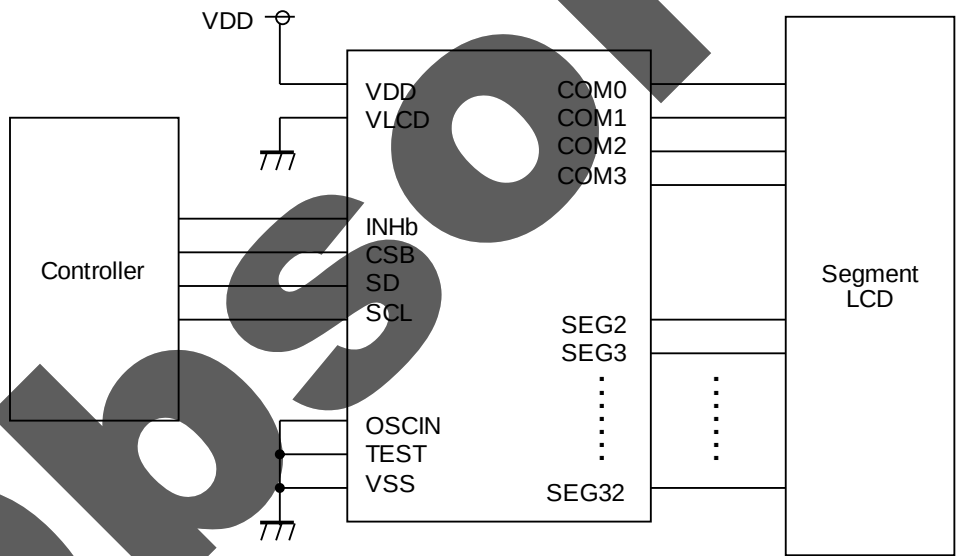



**Figure 6. I/O Equivalent Circuit**

**Application Example**




External clock mode




Internal clock mode

**Figure 7. Example of Application Circuit**

## Function Descriptions

1.Command and Data Transfer Method

1.1 3-SPI (3wire Serial Interface)

BU9795BGUW is controlled by 3-wire signal (CSB, SCL, and SD).
First, Interface counter is initialized with CSB="H", and CSB="L" makes SD and SCL input enable.
The protocol of 3-SPI transfer is as follows.
Each command starts with Command or Data judgment bit (D/C) as MSB data, followed by D6 to D0 during CSB ="L".
(Internal data is latched at the rising edge of SCL, it is converted to 8bits parallel data at the falling edge of 8th CLK.)

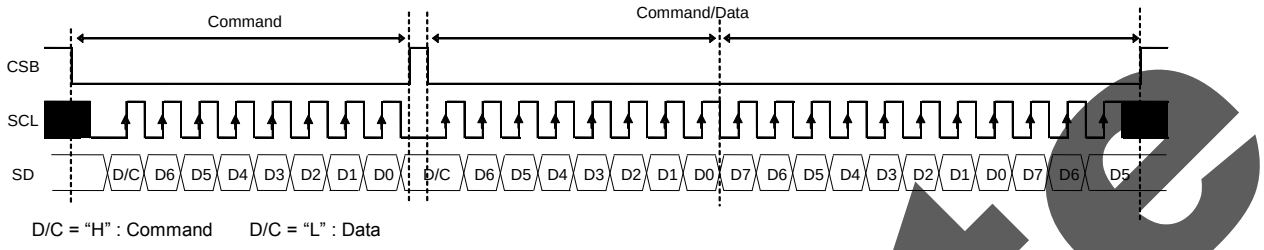



**Figure 8. 3-SPI Command/Data Transfer Format**

1.2 Command Transfer Method

After CSB="H"→"L", 1st byte is always a command input.
MSB of the command input data will be judged that the next byte data, it is a command or Display Data (This bit is called "command or data judgment bit").
When set "command or data judge bit"="1", next byte will be (continuously) command.
When set "command or data judge bit"="0", next byte data is Display Data.


Once it becomes Display Data transfer condition, it will not be back to command input condition even if D/C=1.
So if you want to send command data again, set CSB="L"→"H".
(CSB "L"→"H" will cancel data transfer condition.)
Command transfer is done by 8bits unit, so if CSB="L"→"H" with less than 8bits data transfer, command will be cancelled.
It will be able to transfer command with CSB="L" again.

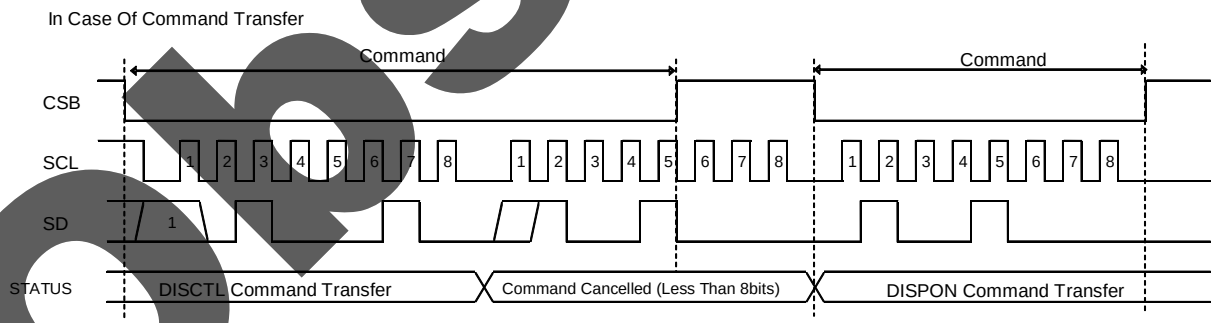
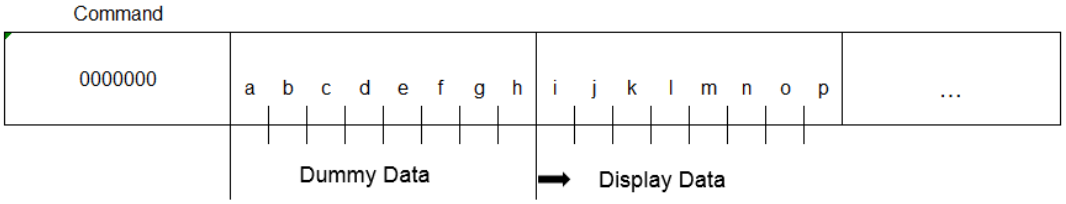



**Figure 9. Command Transfer Format**

1. Command and Data Transfer Method – continued

1.3 Write Display Data and transfer method

BU9795BGUW has Display Data RAM (DDRAM) of 31×4=124bit.
As SEG0, SEG1, SEG33, SEG34 are not output, these address will be dummy address.
The relationship between data input and Display Data, DDRAM data and address are as follows.




8bit data will be stored in DDRAM. The address to be written is the address specified by ADSET command, and the address is automatically incremented in every 4bit data.
Data can be continuously written in DDRAM by transmitting Data continuously.
(When RAM data is written successively after writing RAM data to 22h (SEG34), the address is returned to 00h (SEG0) by the auto-increment function. (Refer to ADSET command for the Address set order.)

| | Dummy data | | DDRAM address | | | | | | | | | Dummy data | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 00h | 01h | 02h | 03h | 04h | 05h | 06h | 07h | ・・・・・・ | 1Eh | 1Fh | 20h | 21h | 22h |
| 0 | a | e | i | m | q | u | | | | | | | | COM0 |
| 1 | b | f | j | n | r | v | | | | | | | | COM1 |
| 2 | c | g | k | o | s | x | | | | | | | | COM2 |
| 3 | d | h | l | p | t | y | | | | | | | | COM3 |
| BIT | SEG 0 | SEG 1 | SEG 2 | SEG 3 | SEG 4 | SEG 5 | SEG 6 | SEG 7 | ・・・・・・ | SEG 30 | SEG 31 | SEG 32 | SEG 33 | SEG 34 |

As data transfer to DDRAM happens every 4bit data, it will be cancelled if it changes CSB="L"→"H" before 4bits data transfer. (Command transfer is done every 8bits)

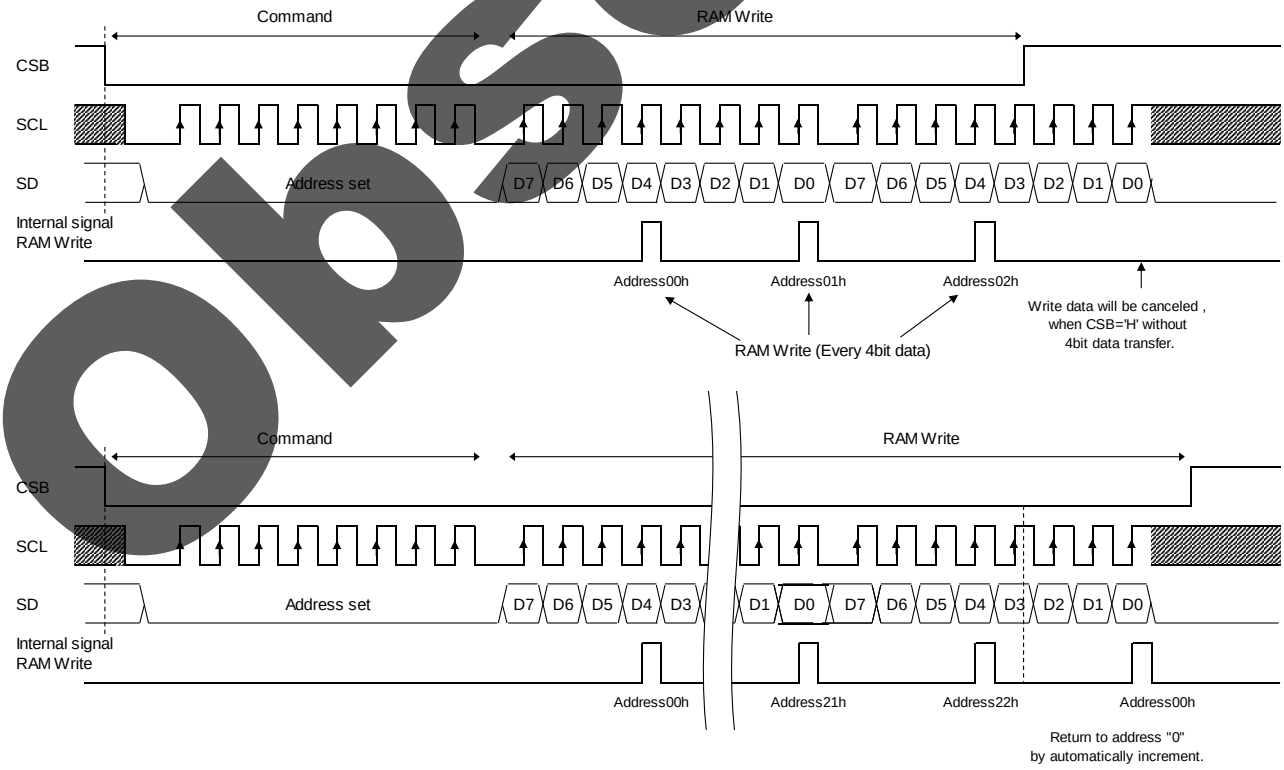



**Figure 10. Data Transfer Format**

## Function Descriptions – continued

2. OSCILLATOR

There are two kinds of clock for logic and analog circuit; from internal oscillator circuit or external clock input. If internal oscillator circuit will be used, OSCIN must be connected to VSS.
When you use external clock, execute ICSET command and connect OSCIN to external clock.

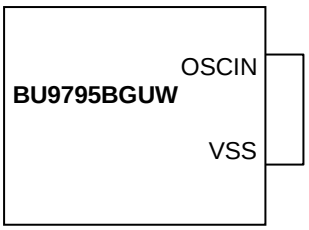



**Figure 11. Internal Oscillator Circuit Mode**

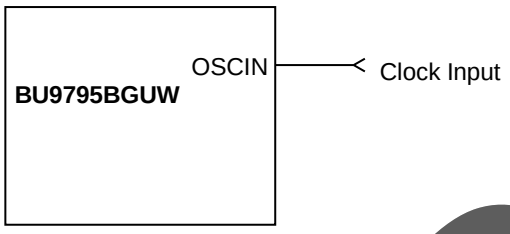



**Figure 12. External clock mode**

3. LCD Driver Bias Circuit

This LSI generates LCD driving voltage with on-chip Buffer AMP.
And it can drive LCD at low power consumption.
1/3 and 1/2Bias can be set in MODESET command.
Line and frame inversion can be set in DISCTL command.
Refer to "LCD Driving Waveform" about each LCD driving waveform.

4. Blink Timing Generator

BU9795BGUW is equipped with Blinking function.
Blink mode is asserted by BLKCTL command.
The Blink frequency varies depending on $f_{CLK}$ characteristics at Internal clock mode.
Refer to Oscillation Characteristics for $f_{CLK}$.

5.Reset (Initial) Condition

Initial condition after executing Software Reset is as follows.
(1)Display is OFF.
(2)DDRAM address is initialized (DDRAM Data is not initialized).
Refer to Command Description about initialize value of register.

## Command / Function List

Table of Functions Description

| No. | Command | Function |
|---|---|---|
| 1 | Mode Set (MODESET) | Set LCD Drive Mode |
| 2 | Address Set (ADSET) | Set LCD Display Mode 1 |
| 3 | Display Control (DISCTL) | Set LCD Display Mode 2 |
| 4 | Set IC Operation (ICSET) | Set IC Operation |
| 5 | Blink Control (BLKCTL) | Set Blink Mode |
| 6 | All Pixel Control (APCTL) | Set All Pixels ON/OFF Display |

## Detailed Command Description

D7 (MSB) is bit for command or data judgment.
Refer to Command and data transfer method.

C : 0 : Next byte is RAM Write data.
1 : Next byte is command.

1.Mode Set (MODE SET)

MSB LSB

| D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
|---|---|---|---|---|---|---|---|
| C | 1 | 0 | * | P3 | P2 | * | * |

(* : Don't care)

Set Display on and off

| Setting | P3 | Reset initial condition |
|---|---|---|
| Display off (DISPOFF) | 0 | ○ |
| Display on (DISPON) | 1 | - |

Display off : Regardless of DDRAM data, all Segment and Common output will be stopped after 1 frame of data write. Display off mode will be finished by Display on.
Display on : Segment and Common output will be active and start to read the Display Data from DDRAM.

(Note) When Display on/off is controlled by INHb terminal, it is not synchronized with display frame period.

Set bias level

| Setting | P2 | Reset initial condition |
|---|---|---|
| 1/3 Bias | 0 | ○ |
| 1/2 Bias | 1 | - |

Refer to LCD driving waveform(Example of SEG and COM output waveform by Bias level setting.).

2.Address Set (ADSET)

MSB LSB

| D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
|---|---|---|---|---|---|---|---|
| C | 0 | 0 | P4 | P3 | P2 | P1 | P0 |

Address data is specified in P[4 : 0] and P2 (ICSET command) as follows.

| | MSB | | | LSB |
|---|---|---|---|---|
| Internal register | Address [5] | Address [4] | ・・・ | Address [0] |
| Bit of each command | ICSET [P2] | ADSET [P4] | ・・・ | ADSET [P0] |

The address is 00h in reset condition. The valid address is 00h to 22h.
Another address is invalid, (otherwise address will be set to 00h.)
The ICSET command is only to define the register setting ("0" or "1") of MSB of the address and does not set the address. Address counter will be set only when ADSET command is executed. When ICSET[P2] is set, the previous state is maintained until ICSET command is executed again or when Software Reset is executed.

## Detailed Command Description – continued

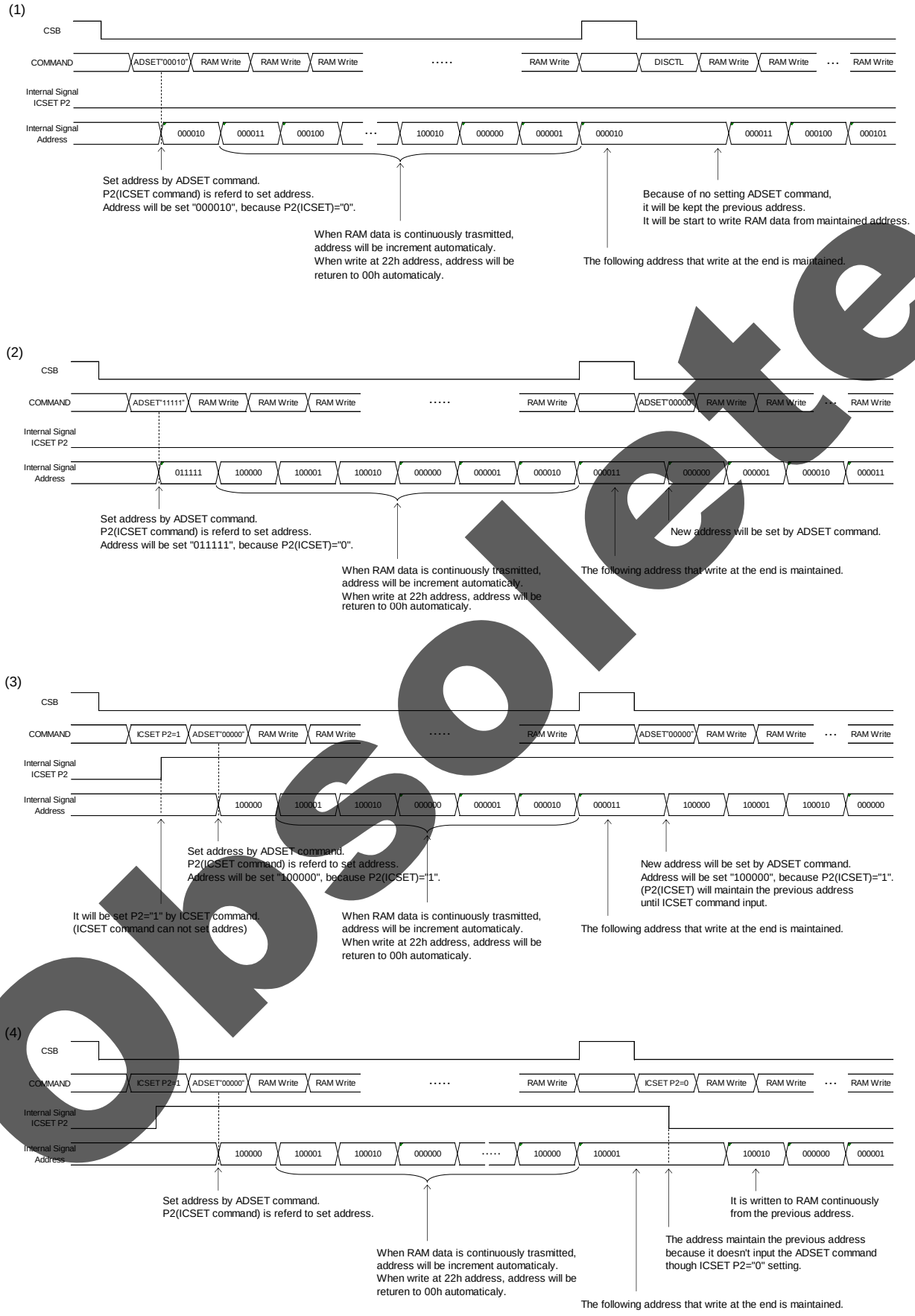



**Figure 13. Address Set Sequence**

## Detailed Command Description – continued

3.Display Control (DISCTL)

MSB LSB

| D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
|---|---|---|---|---|---|---|---|
| C | 0 | 1 | P4 | P3 | P2 | P1 | P0 |

Set Frame Frequency

| Setting*(Note 1)* | P4 | P3 | FRSEL*(Note 2)* | Reset initial condition |
|---|---|---|---|---|
| 80Hz | 0 | 0 | 0 | ○ |
| 71Hz | 0 | 1 | 0 | - |
| 64Hz | 1 | 0 | 0 | - |
| 53Hz | 1 | 1 | 0 | - |
| 160Hz | 0 | 0 | 1 | - |
| 213Hz | 1 | 1 | 1 | - |
| 284Hz | 0 | 1 | 1 | - |
| 320Hz | 1 | 0 | 1 | - |

*(Note 1)* The frame frequency varies according to the characteristics of $f_{CLK}$ when internal oscillation circuit is used.
(Refer to Oscillation Characteristics for $f_{CLK}$ properties).
*(Note 2)* Refer to BLKCTL for FRSEL

Set LCD Drive Waveform

| Setting | P2 | Reset initial condition |
|---|---|---|
| Line Inversion | 0 | ○ |
| Frame Inversion | 1 | - |

Power consumption is reduced in the following order:
Line inversion > Frame inversion
Typically, when driving large capacitance LCD, Line inversion will increase the influence of crosstalk.
Regarding driving waveform, refer to LCD Driving Waveform.

Set Power Save Mode (low current consumption mode)

| Setting | P1 | P0 | Reset initial condition |
|---|---|---|---|
| Power Save Mode 1 | 0 | 0 | - |
| Power Save Mode 2 | 0 | 1 | - |
| Normal Mode | 1 | 0 | ○ |
| High Power Mode | 1 | 1 | - |

Power consumption is increased in the following order:
Power save mode 1 < Power save mode 2 < Normal mode < High power mode
Use VDD- VLCD ≥ 3.0V in High power mode condition.

(Reference Current Consumption data)

| Setting | Reset initial condition |
|---|---|
| Power Save Mode 1 | ×0.5 |
| Power Save Mode 2 | ×0.67 |
| Normal Mode | ×1.0 |
| High Power Mode | ×1.8 |

The data above is for reference only. Actual consumption depends on Panel load.

## Detailed Command Description – continued

4.Set IC Operation (ICSET)

MSB LSB

| D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
|---|---|---|---|---|---|---|---|
| C | 1 | 1 | 0 | 1 | P2 | P1 | P0 |

P2 : Set MSB data of DDRAM address.
Execute ADSET command for it to take effect on an address.
Refer to "ADSET" command for details.

| Setting | P2 | Reset initial condition |
|---|---|---|
| Address MSB"0" | 0 | ○ |
| Address MSB"1" | 1 | - |

Set Software Reset Condition

| Setting | P1 |
|---|---|
| No Operation | 0 |
| Software Reset | 1 |

When "Software Reset" is executed, BU9795BGUW will be reset to initial condition.
If software reset is executed, the value of P2 and P0 will be ignored and they will be reset to initial condition. (Refer to "Reset initial condition")

Switch between Internal oscillator operating mode and external clock mode.

| Setting | P0 | Reset initial condition |
|---|---|---|
| Internal oscillator operating mode | 0 | ○ |
| External Clock Input mode | 1 | - |

Internal oscillator operating mode: OSCIN must be connected to VSS level.
External Clock mode: Input external clock from OSCIN terminal.

< Frame frequency Calculation at External clock mode >
DISCTL 320Hz select : Frame frequency [Hz] = External clock[Hz] / 128
DISCTL 284Hz select : Frame frequency [Hz] = External clock[Hz] / 144
DISCTL 213Hz select : Frame frequency [Hz] = External clock[Hz] / 192
DISCTL 160Hz select : Frame frequency [Hz] = External clock[Hz] / 256
DISCTL 80Hz select : Frame frequency [Hz] = External clock[Hz] / 512
DISCTL 71Hz select : Frame frequency [Hz] = External clock[Hz] / 576
DISCTL 64Hz select : Frame frequency [Hz] = External clock[Hz] / 648
DISCTL 53Hz select : Frame frequency [Hz] = External clock[Hz] / 768

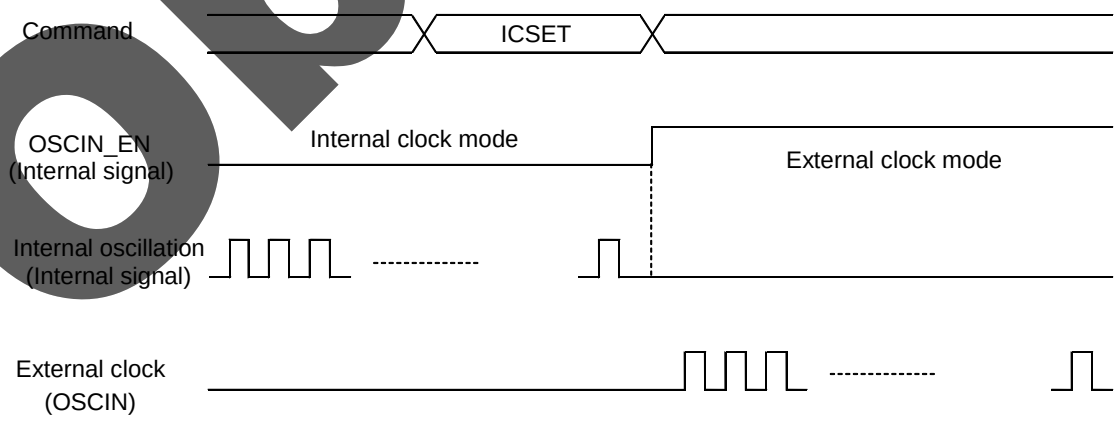



**Figure 14. OSC MODE Switching Timing**

## Detailed Command Description – continued

5.Blink Control (BLKCTL)

MSB LSB

| D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
|---|---|---|---|---|---|---|---|
| C | 1 | 1 | 1 | 0 | P2 | P1 | P0 |

Set Blink Condition

| Setting | P1 | P0 | Reset initial condition |
|---|---|---|---|
| OFF | 0 | 0 | ○ |
| 0.5 (Hz) | 0 | 1 | - |
| 1 (Hz) | 1 | 0 | - |
| 2 (Hz) | 1 | 1 | - |

The Blink frequency varies depending on $f_{CLK}$ characteristics at Internal oscillator operating mode.
Refer to Oscillation Characteristics for $f_{CLK}$.

Set Frame Frequency Setting(FRSEL)

| Setting | P2 | Reset initial condition |
|---|---|---|
| Normal | 0 | ○ |
| 200Hz mode | 1 | - |

6.All Pixel Control (APCTL)

MSB LSB

| D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
|---|---|---|---|---|---|---|---|
| C | 1 | 1 | 1 | 1 | 1 | P1 | P0 |

All Display Set ON/OFF

| Setting | P1 | Reset initial condition |
|---|---|---|
| Normal | 0 | ○ |
| All Pixel on | 1 | - |

| Setting | P0 | Reset initial condition |
|---|---|---|
| Normal | 0 | ○ |
| All Pixel off | 1 | - |

All pixels on: All pixels are on regardless of DDRAM data.
All pixels off: All pixels are off regardless of DDRAM data.

This command is valid in Display on status. The data of DDRAM is not changed by this command.
If set both P1 and P0 ="1", APOFF will be selected.

## LCD Driving Waveform

(1/3bias)

Line Inversion

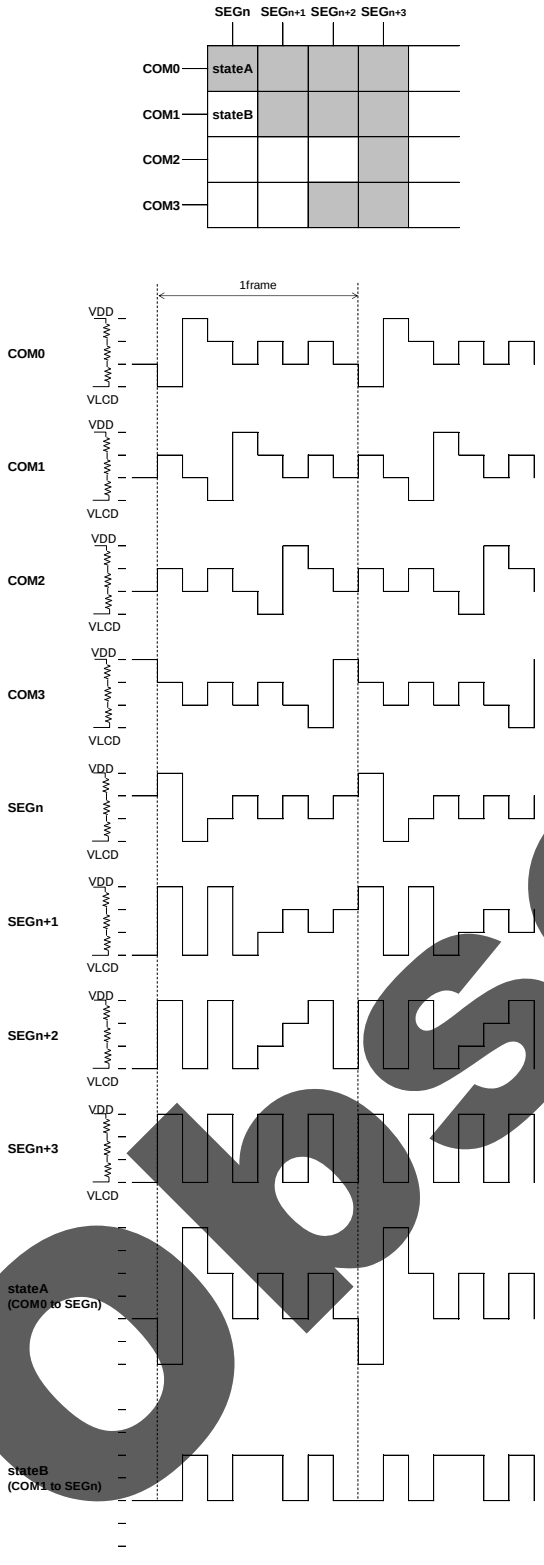



Figure 15. Line Inversion Waveform (1/3bias)

Frame Inversion

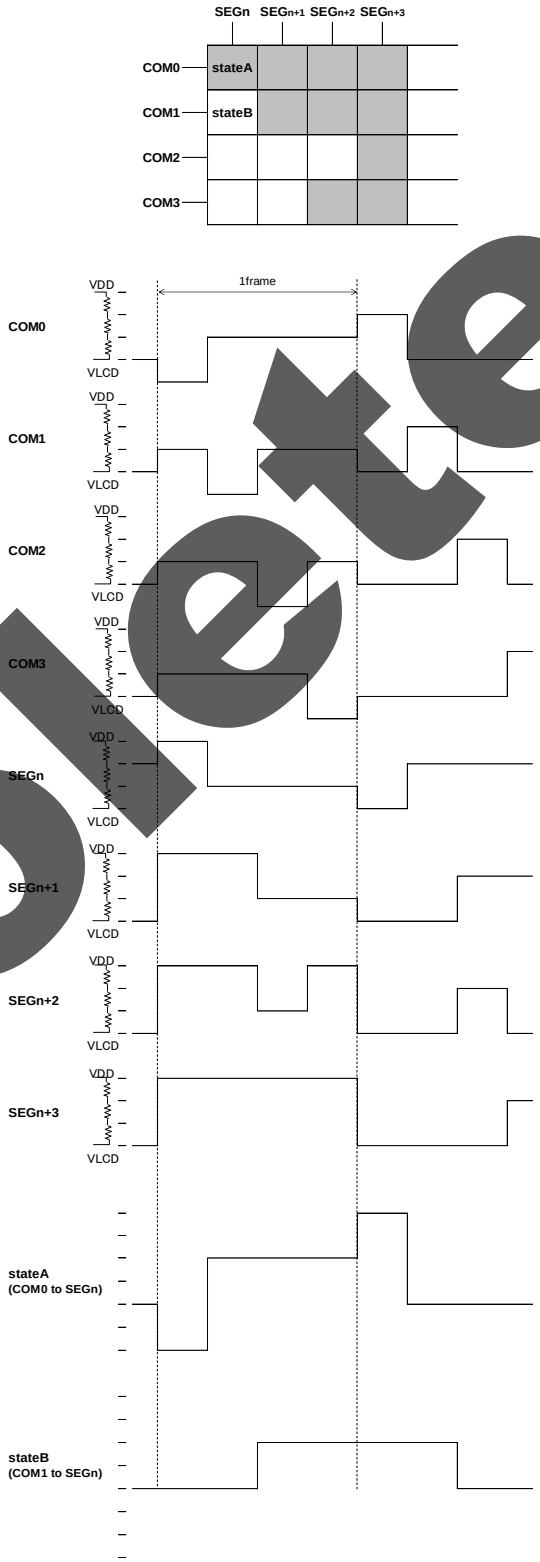



Figure 16. Frame Inversion Waveform (1/3bias)

## LCD Driving Waveform – continued

(1/2bias)

Line Inversion

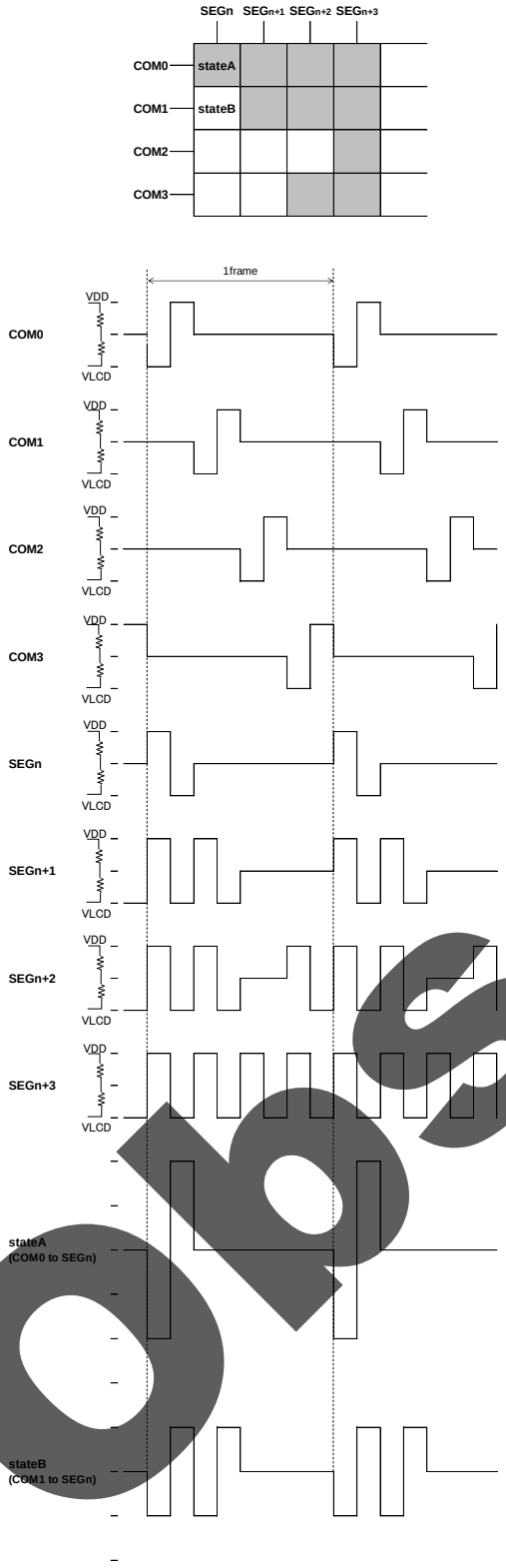



Figure 17. Line Inversion Waveform (1/2bias)

Frame Inversion

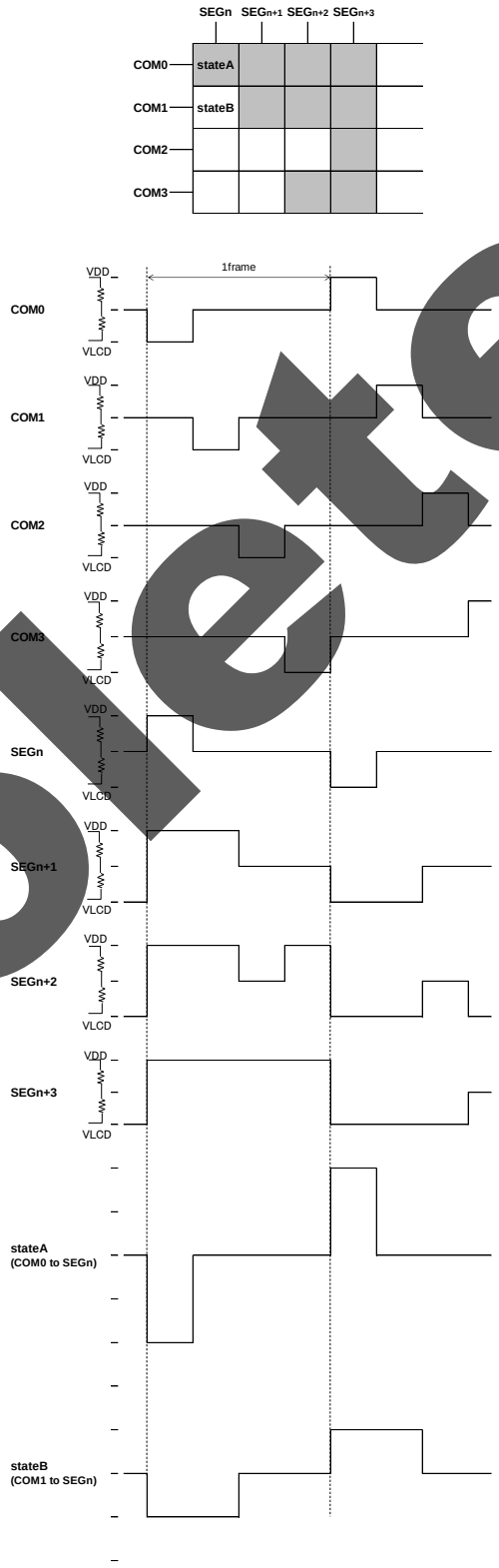



Figure 18. Frame Inversion Waveform (1/2bias)

### Example of Display Data

If COM and SEG line pattern is shown as in Figure 19 and Figure 20, and DDRAM data is shown as in Table 2, display pattern will be shown as in Figure 21.

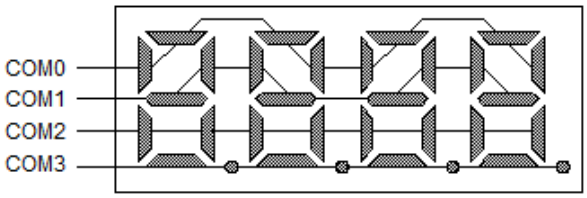



**Figure 19. Example COM Line Pattern**

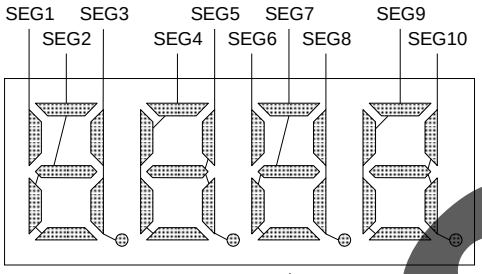



**Figure 20. Example SEG Line Pattern**

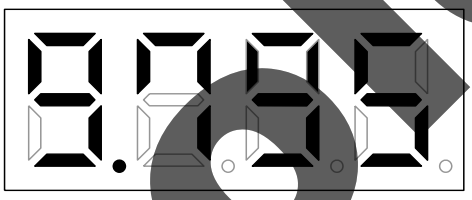


**Figure 21. Example Display Pattern**

Table 2. DDRAM Data Map

| | | SEG0 | SEG1 | SEG2 | SEG3 | SEG4 | SEG5 | SEG6 | SEG7 | SEG8 | SEG9 | SEG10 | SEG11 | SEG12 | SEG13 | SEG14 | SEG15 | SEG16 | SEG17 | SEG18 | SEG19 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| COM0 | D0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| COM1 | D1 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| COM2 | D2 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| COM3 | D3 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Address | | 00h | 01h | 02h | 03h | 04h | 05h | 06h | 07h | 08h | 09h | 0Ah | 0Bh | 0Ch | 0Dh | 0Eh | 0Fh | 10h | 11h | 12h | 13h |

### Initialize Sequence

Follow sequence below after Power ON to set BU9795BGUW to initial condition.

Power ON
↓
CSB ”H” …I/F initialize condition
↓
CSB ”L” …I/F Data transfer start
↓
Execute Software Reset by sending ICSET command (Refer to “ICSET” command)

* Each register value, DDRAM address and DDRAM data are random after Power ON until initialize sequence is executed.

### Start Sequence

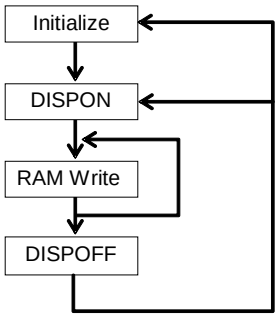
Start Sequence Example 1

| No. | Input | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | Descriptions |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Power ON | | | | | | | | | VDD=0V to 5V (Tr=0.1ms) |
| | ↓ | | | | | | | | | |
| 2 | Wait 100µs | | | | | | | | | Initialize IC |
| | ↓ | | | | | | | | | |
| 3 | CSB ”H” | | | | | | | | | Initialize I/F data |
| | ↓ | | | | | | | | | |
| 4 | CSB ”L” | | | | | | | | | I/F Data transfer start |
| | ↓ | | | | | | | | | |
| 5 | ICSET | 1 | 1 | 1 | 0 | 1 | * | 1 | 0 | Software Reset |
| | ↓ | | | | | | | | | |
| 6 | BLKCTL | 1 | 1 | 1 | 1 | 0 | * | 0 | 1 | |
| | ↓ | | | | | | | | | |
| 7 | DISCTL | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | |
| | ↓ | | | | | | | | | |
| 8 | ICSET | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | RAM Address MSB set |
| | ↓ | | | | | | | | | |
| 9 | ADSET | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | RAM Address set |
| | ↓ | | | | | | | | | |
| 10 | Display Data | * | * | * | * | * | * | * | * | Address 00h to 01h |
| | Display Data | * | * | * | * | * | * | * | * | Address 02h to 03h |
| | ⋮ | | | | | | | | | ⋮ |
| | Display Data | * | * | * | * | * | * | * | * | Address 22h to 00h |
| | ↓ | | | | | | | | | |
| 11 | CSB ”H” | | | | | | | | | I/F Data transfer stop |
| | ↓ | | | | | | | | | |
| 12 | CSB ”L” | | | | | | | | | I/F Data transfer start |
| | ↓ | | | | | | | | | |
| 13 | MODESET | 1 | 1 | 0 | * | 1 | 0 | * | * | Display on |
| | ↓ | | | | | | | | | |
| 14 | CSB ”H” | | | | | | | | | I/F Data transfer stop |

(*: don’t care)

**Start Sequence – continued**

Start Sequence Example 2




Initialize Sequence

DISPON Sequence

RAM Write Sequence

DISPOFF Sequence

BU9795BGUW is initialized with Initialize Sequence, starts to display with “DISPON Sequence”, updates Display Data with “RAM Write Sequence” and stops the display with “DISPOFF sequence”.
If you want to resume to display, BU9795BGUW will resume display with DISPON Sequence.

Initialize Sequence

| Input | DATA | | | | | | | | Description |
|---|---|---|---|---|---|---|---|---|---|
| | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | |
| Power ON | | | | | | | | | |
| Wait 100us | | | | | | | | | IC initialized |
| CSB ”H” | | | | | | | | | I/F initialized |
| CSB ”L” | | | | | | | | | |
| ICSET | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | Software Reset |
| MODESET | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | Display off |
| ADSET | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | RAM Address set |
| Display Data | * | * | * | * | * | * | * | * | Display Data |
| … | | | | | | | | | |
| CSB ”H” | | | | | | | | | |

DISPON Sequence

| Input | DATA | | | | | | | | Description |
|---|---|---|---|---|---|---|---|---|---|
| | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | |
| CSB ”L” | | | | | | | | | |
| DISCTL | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | Display Control |
| BLKCTL | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | BLKCTL |
| APCTL | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | APCTL |
| MODESET | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | Display on |
| CSB ”H” | | | | | | | | | |

RAM Write Sequence

| Input | DATA | | | | | | | | Description |
|---|---|---|---|---|---|---|---|---|---|
| | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | |
| CSB ”L” | | | | | | | | | |
| DISCTL | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | Display Control |
| BLKCTL | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | BLKCTL |
| APCTL | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | APCTL |
| MODESET | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | Display on |
| ADSET | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | RAM Address set |
| Display Data | * | * | * | * | * | * | * | * | Display Data |
| … | | | | | | | | | |
| CSB ”H” | | | | | | | | | |

DISPOFF Sequence

| Input | DATA | | | | | | | | Description |
|---|---|---|---|---|---|---|---|---|---|
| | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | |
| CSB 'L' | | | | | | | | | |
| MODESET | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | Display off |
| CSB 'H' | | | | | | | | | |

Abnormal operation may occur in BU9795BGUW due to the effect of noise or other external factor. To avoid this phenomenon, it is highly recommended to input command according to sequence when the operating of initialize, Display On/Off and the refresh of RAM Data.

### Cautions of “Power ON Condition”

Power supply sequence

Keep Power ON/OFF sequence as below waveform.
To prevent incorrect display, malfunction and abnormal current,
VDD must be turned on before VLCD in power up sequence.
VDD must be turned off after VLCD in power down sequence.
Satisfy VDD-2.4V ≥ VLCD, t1 > 0ns and t2 > 0ns.
To refrain from data transmission is strongly recommended while power supply is rising up or falling down to prevent from the occurrence of disturbances on transmission and reception.

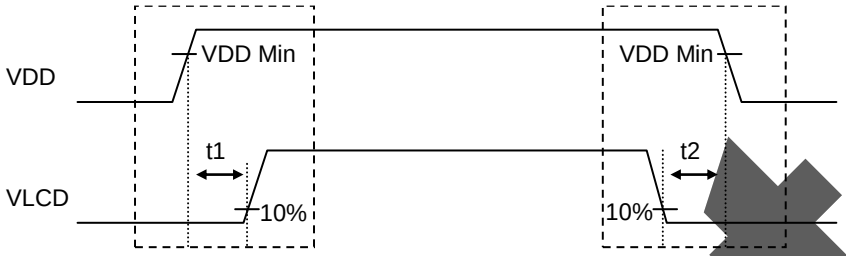
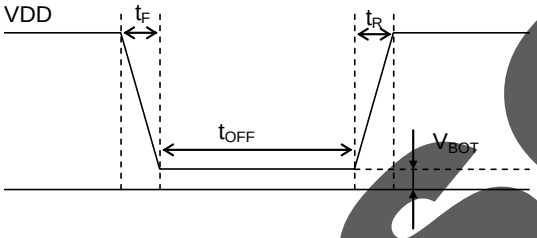



**Figure 22. Power Supply Sequence**

BU9795BGUW has “POR” (Power ON Reset) circuit and Software Reset function.
Keep the following recommended Power ON conditions in order to power up properly.

(1)Set power up conditions to meet the recommended $t_R$, $t_F$, $t_{OFF}$, and $V_{BOT}$ specification below in order to ensure POR operation.
Set pin TEST=”L” to enable POR circuit.




Recommended condition of $t_R$, $t_F$, $t_{OFF}$, $V_{BOT}$ (Ta=+25°C)

| $t_R$(Note) | $t_F$(Note) | $t_{OFF}$(Note) | $V_{BOT}$(Note) |
|---|---|---|---|
| Max 5ms | Max 5ms | Min 20ms | Less than 0.3V |

*(Note)* This function is guaranteed by design, not tested in production process.

**Figure 23. Rising Waveform Diagram**

(2)If it is difficult to meet the above condition, execute the following sequence after Power ON.
Note however that it cannot accept command while supply is unstable or below the minimum supply range.
Note also that software reset is not a complete alternative to POR function.

(a)CSB =“L”→”H” condition

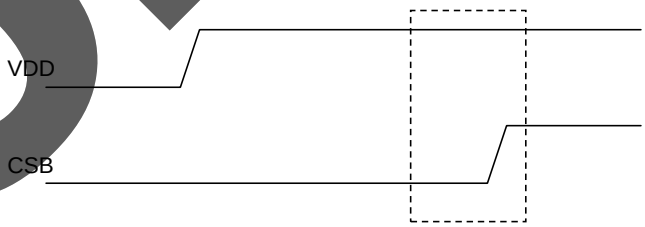



**Figure 24. CSB Timing**

(b)Execute Software Reset in ICSET command after CSB to “L”.
(Refer to “ICSET” command)

### Display off Operation in External clock mode

After receiving MODESET(Display off), BU9795BGUW enter to DISPOFF sequence synchronized with frame then Segment and Common pins output VSS level after 1frame of OFF data write.

Therefore, in External clock mode, it is necessary to input the external clock based on each frame frequency setting after sending MODESET(Display off).
For the required number of clock, refer to Power save mode FR of DISCTL.

Input the external clock as below.
DISCTL 320HZ setting(Frame frequency [Hz] = External clock [Hz] / 128), it needs over 256clk
DISCTL 284HZ setting(Frame frequency [Hz] = External clock [Hz] / 144) , it needs over 288clk
DISCTL 213HZ setting(Frame frequency [Hz] = External clock [Hz] / 192) , it needs over 384clk
DISCTL 160HZ setting(Frame frequency [Hz] = External clock [Hz] / 256) , it needs over 512clk
DISCTL 80HZ setting(Frame frequency [Hz] = External clock [Hz] / 512), it needs over 1024clk
DISCTL 71HZ setting(Frame frequency [Hz] = External clock [Hz] / 576) , it needs over 1152clk
DISCTL 64HZ setting(Frame frequency [Hz] = External clock [Hz] / 648) , it needs over 1296clk
DISCTL 53HZ setting(Frame frequency [Hz] = External clock [Hz] / 768) , it needs over 1536clk

Refer to the timing chart below.

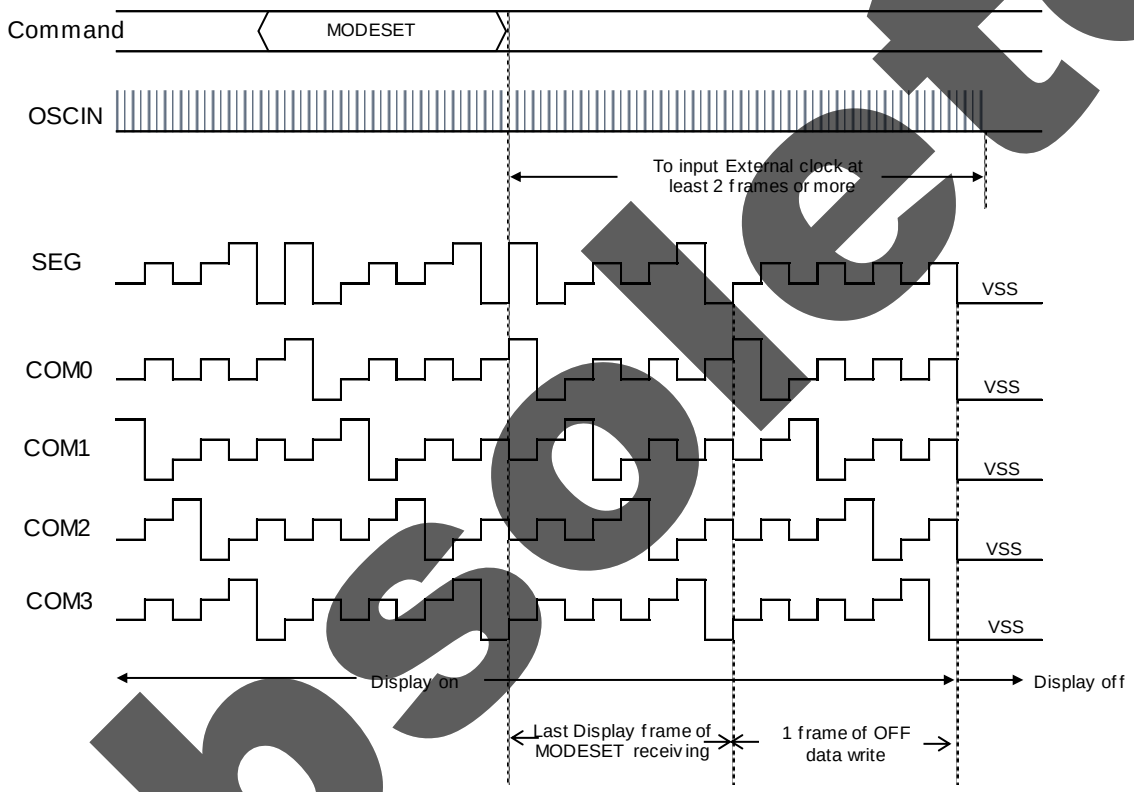



**Figure 25. External Clock Stop Timing**

## Operational Notes

**1. Reverse Connection of Power Supply**

Connecting the power supply in reverse polarity can damage the IC. Take precautions against reverse polarity when connecting the power supply, such as mounting an external diode between the power supply and the IC's power supply pins.

**2. Power Supply Lines**

Design the PCB layout pattern to provide low impedance supply lines. Separate the ground and supply lines of the digital and analog blocks to prevent noise in the ground and supply lines of the digital block from affecting the analog block. Furthermore, connect a capacitor to ground at all power supply pins. Consider the effect of temperature and aging on the capacitance value when using electrolytic capacitors.

**3. Ground Voltage**

Ensure that no pins are at a voltage below that of the ground pin at any time, even during transient condition.

**4. Ground Wiring Pattern**

When using both small-signal and large-current ground traces, the two ground traces should be routed separately but connected to a single ground at the reference point of the application board to avoid fluctuations in the small-signal ground caused by large currents. Also ensure that the ground traces of external components do not cause variations on the ground voltage. The ground lines must be as short and thick as possible to reduce line impedance.

**5. Recommended Operating Conditions**

These conditions represent a range within which the expected characteristics of the IC can be approximately obtained. The electrical characteristics are guaranteed under the conditions of each parameter.

**6. Inrush Current**

When power is first supplied to the IC, it is possible that the internal logic may be unstable and inrush current may flow instantaneously due to the internal powering sequence and delays, especially if the IC has more than one power supply. Therefore, give special consideration to power coupling capacitance, power wiring, width of ground wiring, and routing of connections.

**7. Operation Under Strong Electromagnetic Field**

Operating the IC in the presence of a strong electromagnetic field may cause the IC to malfunction.

**8. Testing on Application Boards**

When testing the IC on an application board, connecting a capacitor directly to a low-impedance output pin may subject the IC to stress. Always discharge capacitors completely after each process or step. The IC's power supply should always be turned off completely before connecting or removing it from the test setup during the inspection process. To prevent damage from static discharge, ground the IC during assembly and use similar precautions during transport and storage.

## Operational Notes – continued

**9. Inter-pin Short and Mounting Errors**

Ensure that the direction and position are correct when mounting the IC on the PCB. Incorrect mounting may result in damaging the IC. Avoid nearby pins being shorted to each other especially to ground, power supply and output pin. Inter-pin shorts could be due to many reasons such as metal particles, water droplets (in very humid environment) and unintentional solder bridge deposited in between pins during assembly to name a few.

**10. Unused Input Pins**

Input pins of an IC are often connected to the gate of a MOS transistor. The gate has extremely high impedance and extremely low capacitance. If left unconnected, the electric field from the outside can easily charge it. The small charge acquired in this way is enough to produce a significant effect on the conduction through the transistor and cause unexpected operation of the IC. So unless otherwise specified, unused input pins should be connected to the power supply or ground line.

**11. Regarding the Input Pin of the IC**

In the construction of this IC, P-N junctions are inevitably formed creating parasitic diodes or transistors. The operation of these parasitic elements can result in mutual interference among circuits, operational faults, or physical damage. Therefore, conditions which cause these parasitic elements to operate, such as applying a voltage to an input pin lower than the ground voltage should be avoided. Furthermore, do not apply a voltage to the input pins when no power supply voltage is applied to the IC. Even if the power supply voltage is applied, make sure that the input pins have voltages within the values specified in the electrical characteristics of this IC.

**12. Ceramic Capacitor**

When using a ceramic capacitor, determine a capacitance value considering the change of capacitance with temperature and the decrease in nominal capacitance due to DC bias and others.

### Ordering Information

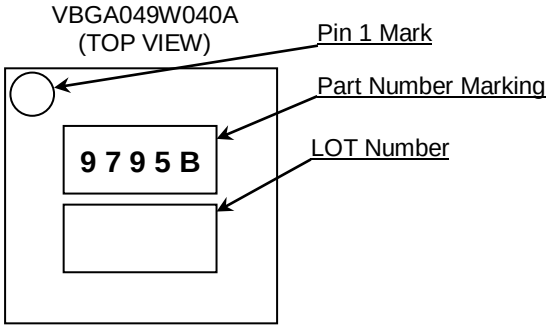
B U 9 7 9 5 B G U W - Z E2

- Part Number
- Package: GUW : VBGA049W040A
- Packaging and forming specification: E2 : Embossed tape and reel
- Z : In-house management code

### Lineup

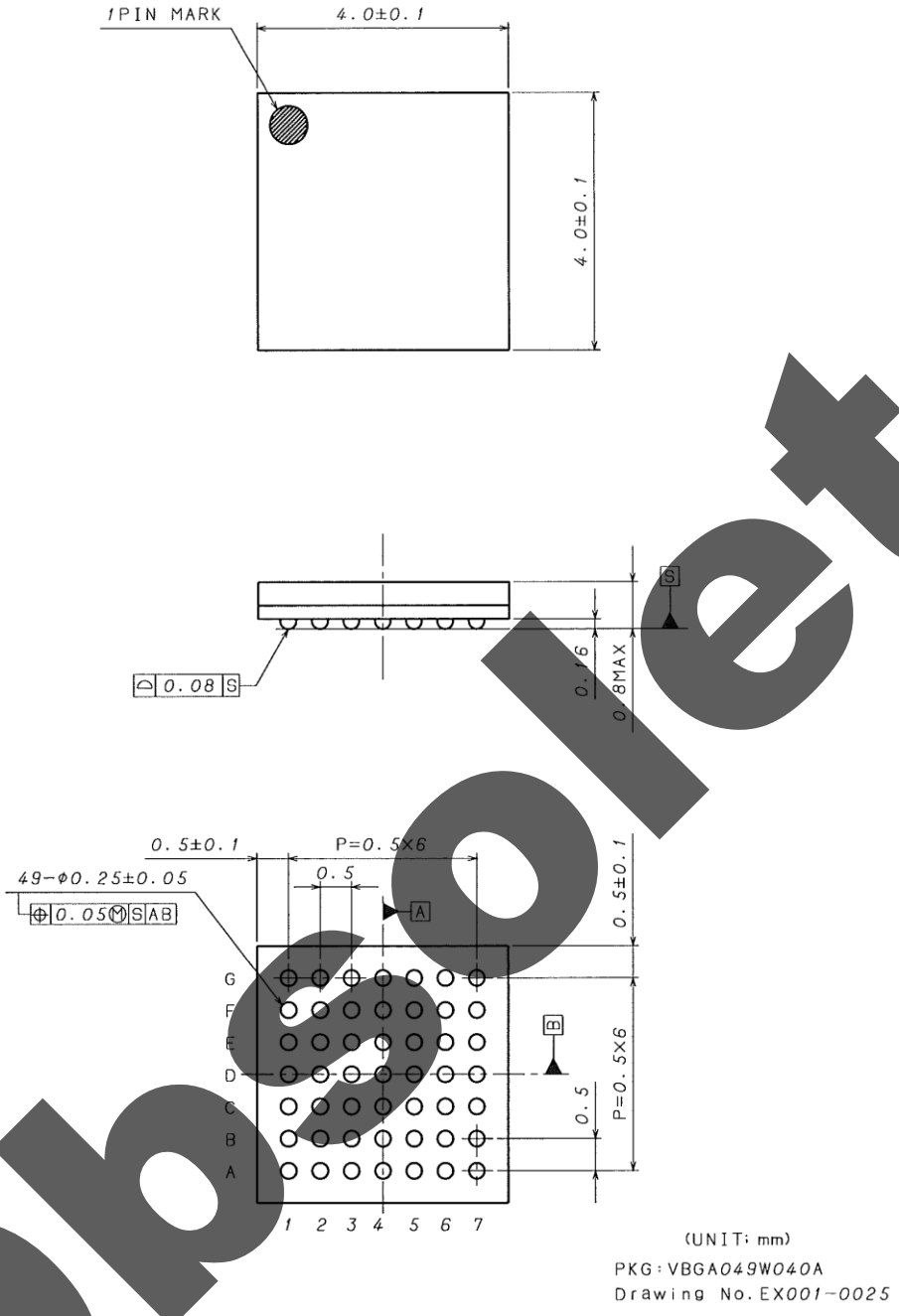
| Package | | Orderable Part Number |
|---|---|---|
| VBGA049W040A | Reel of 2500 | BU9795BGUW-ZE2 |

### Marking Diagram



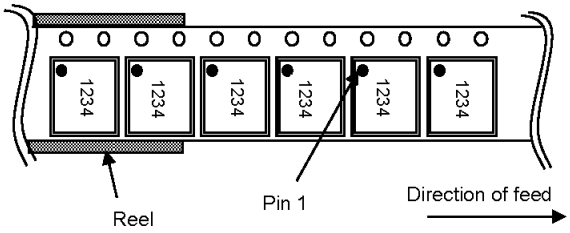
**Physical Dimension and Packing Information**

| Package Name | VBGA049W040A |
|---|---|




< Tape and Reel Information >

| | |
|---|---|
| Tape | Embossed carrier tape with dry pack |
| Quantity | 2500pcs |
| Direction of feed | E2<br>The direction is the pin 1 of product is at the upper left when you hold reel on the left hand and you pull out the tape on the right hand |



**Revision History**

| Date | Revision | Changes |
|---|---|---|
| 01.Apr. 2020 | 003 | Divided BU9795BGUW from the datasheet(TSZ02201-0P4P0D301490-1-2) and new release for Discontinued category product. |

# Notice

## Precaution on using ROHM Products

1. Our Products are designed and manufactured for application in ordinary electronic equipment (such as AV equipment, OA equipment, telecommunication equipment, home electronic appliances, amusement equipment, etc.). If you intend to use our Products in devices requiring extremely high reliability (such as medical equipment (Note 1), transport equipment, traffic equipment, aircraft/spacecraft, nuclear power controllers, fuel controllers, car equipment including car accessories, safety devices, etc.) and whose malfunction or failure may cause loss of human life, bodily injury or serious damage to property ("Specific Applications"), please consult with the ROHM sales representative in advance. Unless otherwise agreed in writing by ROHM in advance, ROHM shall not be in any way responsible or liable for any damages, expenses or losses incurred by you or third parties arising from the use of any ROHM's Products for Specific Applications.

(Note1) Medical Equipment Classification of the Specific Applications

| JAPAN | USA | EU | CHINA |
|---|---|---|---|
| CLASSⅢ | CLASSⅢ | CLASSⅡb | CLASSⅢ |
| CLASSⅣ | | CLASSⅢ | |

2. ROHM designs and manufactures its Products subject to strict quality control system. However, semiconductor products can fail or malfunction at a certain rate. Please be sure to implement, at your own responsibilities, adequate safety measures including but not limited to fail-safe design against the physical injury, damage to any property, which a failure or malfunction of our Products may cause. The following are examples of safety measures:
   [a] Installation of protection circuits or other protective devices to improve system safety
   [b] Installation of redundant circuits to reduce the impact of single or multiple circuit failure

3. Our Products are designed and manufactured for use under standard conditions and not under any special or extraordinary environments or conditions, as exemplified below. Accordingly, ROHM shall not be in any way responsible or liable for any damages, expenses or losses arising from the use of any ROHM's Products under any special or extraordinary environments or conditions. If you intend to use our Products under any special or extraordinary environments or conditions (as exemplified below), your independent verification and confirmation of product performance, reliability, etc, prior to use, must be necessary:
   [a] Use of our Products in any types of liquid, including water, oils, chemicals, and organic solvents
   [b] Use of our Products outdoors or in places where the Products are exposed to direct sunlight or dust
   [c] Use of our Products in places where the Products are exposed to sea wind or corrosive gases, including $Cl_2$, $H_2S$, $NH_3$, $SO_2$, and $NO_2$
   [d] Use of our Products in places where the Products are exposed to static electricity or electromagnetic waves
   [e] Use of our Products in proximity to heat-producing components, plastic cords, or other flammable items
   [f] Sealing or coating our Products with resin or other coating materials
   [g] Use of our Products without cleaning residue of flux (Exclude cases where no-clean type fluxes is used. However, recommend sufficiently about the residue.) ; or Washing our Products by using water or water-soluble cleaning agents for cleaning residue after soldering
   [h] Use of the Products in places subject to dew condensation

4. The Products are not subject to radiation-proof design.

5. Please verify and confirm characteristics of the final or mounted products in using the Products.

6. In particular, if a transient load (a large amount of load applied in a short period of time, such as pulse, is applied, confirmation of performance characteristics after on-board mounting is strongly recommended. Avoid applying power exceeding normal rated power; exceeding the power rating under steady-state loading condition may negatively affect product performance and reliability.

7. De-rate Power Dissipation depending on ambient temperature. When used in sealed area, confirm that it is the use in the range that does not exceed the maximum junction temperature.

8. Confirm that operation temperature is within the specified range described in the product specification.

9. ROHM shall not be in any way responsible or liable for failure induced under deviant condition from what is defined in this document.

## Precaution for Mounting / Circuit board design

1. When a highly active halogenous (chlorine, bromine, etc.) flux is used, the residue of flux may negatively affect product performance and reliability.

2. In principle, the reflow soldering method must be used on a surface-mount products, the flow soldering method must be used on a through hole mount products. If the flow soldering method is preferred on a surface-mount products, please consult with the ROHM representative in advance.

For details, please refer to ROHM Mounting specification

### Precautions Regarding Application Examples and External Circuits

1. If change is made to the constant of an external circuit, please allow a sufficient margin considering variations of the characteristics of the Products and external components, including transient characteristics, as well as static characteristics.

2. You agree that application notes, reference designs, and associated data and information contained in this document are presented only as guidance for Products use. Therefore, in case you use such information, you are solely responsible for it and you must exercise your own independent verification and judgment in the use of such information contained in this document. ROHM shall not be in any way responsible or liable for any damages, expenses or losses incurred by you or third parties arising from the use of such information.

### Precaution for Electrostatic

This Product is electrostatic sensitive product, which may be damaged due to electrostatic discharge. Please take proper caution in your manufacturing process and storage so that voltage exceeding the Products maximum rating will not be applied to Products. Please take special care under dry condition (e.g. Grounding of human body / equipment / solder iron, isolation from charged objects, setting of Ionizer, friction prevention and temperature / humidity control).

### Precaution for Storage / Transportation

1. Product performance and soldered connections may deteriorate if the Products are stored in the places where:
   [a] the Products are exposed to sea winds or corrosive gases, including $Cl_2$, $H_2S$, $NH_3$, $SO_2$, and $NO_2$
   [b] the temperature or humidity exceeds those recommended by ROHM
   [c] the Products are exposed to direct sunshine or condensation
   [d] the Products are exposed to high Electrostatic

2. Even under ROHM recommended storage condition, solderability of products out of recommended storage time period may be degraded. It is strongly recommended to confirm solderability before using Products of which storage time is exceeding the recommended storage time period.

3. Store / transport cartons in the correct direction, which is indicated on a carton with a symbol. Otherwise bent leads may occur due to excessive stress applied when dropping of a carton.

4. Use Products within the specified time after opening a humidity barrier bag. Baking is required before using Products of which storage time is exceeding the recommended storage time period.

### Precaution for Product Label

A two-dimensional barcode printed on ROHM Products label is for ROHM's internal use only.

### Precaution for Disposition

When disposing Products please dispose them properly using an authorized industry waste company.

### Precaution for Foreign Exchange and Foreign Trade act

Since concerned goods might be fallen under listed items of export control prescribed by Foreign exchange and Foreign trade act, please consult with ROHM in case of export.

### Precaution Regarding Intellectual Property Rights

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## General Precaution

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