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# On Screen Display Controller

ASSP for Display Control

## MB90099

## Design Manual



# **On Screen Display Controller**

ASSP for Display Control

## **MB90099**

# **Design Manual**

**FUJITSU LIMITED**



# PREFACE,

## ■ Purpose of this document and intended reader

The MB90099 is an on-screen display controller for displaying text and graphics on the TV screen. The three-channel output control function, compact package and low voltage operation make this device suitable for on-screen displays in portable devices including camera-integrated VTRs and digital still cameras. The MB90099 contains display memory (VRAM), character font ROM, allowing characters and graphics to be displayed with few external components.

This manual is intended for engineers who design products using the MB90099 of microcontrollers. Please read through this manual.

If customer use MB90099 evaluation board, the actual operation should be test on this manual.

## ■ Organization of this document

This book is composed of the following four chapters and an appendix.

### **CHAPTER 1 Specification**

This chapter explains MB90099 design.

### **CHAPTER 2 Display Functions**

This chapter explains display functions of the MB90099.

### **CHAPTER 3 Control Functions**

This chapter explains control functions of the MB90099.

### **CHAPTER 4 Display Control Command**

This chapter explains MB90099 display control commands.

### **APPENDIX**

Appendix contains a package dimensional drawing of the MB90099, the contents of font data, and the procedures of creating a font and releasing data.

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# ***CHAPTER 1***

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# ***Specification***

**This chapter explains MB90099 design.**

1.1 Features

1.2 Configuration

1.3 Pin Assignment

## 1.1 Features

---

**The MB90099 is an on-screen display controller for displaying text and graphics on the TV screen. The three-channel output control function, compact package and low voltage operation make this device suitable for on-screen displays in portable devices including camera-integrated VTRs and digital still cameras.**

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### ■ Features

The feature of MB9099 is shown as follows.

- Screen configuration

28 characters ×12 lines (Max)

- Character types

1024 characters (Built-in ROM, user-settable through the entire area)

- Font configuration

12 dots ×18 dots (Font ROM structure)

Horizontal/vertical display character size can be used.

- Two-type of horizontal size (S/L), setting enable by character
  - Size S: 6 dots
  - Size L: 12 dots
- Two-type of vertical size (A/B), setting enable by line
  - Size A: 18 dots
  - Size B: 12 dots

- Display mode

Character trimming: No/Yes(Set for each line)

Character background:No background/Solid background/Shaded background concaved/Shaded background convexed (Set for each line)

Shadow of the background right and left character combination/independent display (Set for each character)

Shadow of the background over and under line combination/independent display (Set for each line)

Character background extended display to line spacings: ON/OFF (Set for each line)

Line background:No background/Solid background/Shaded background concaved/Shaded background convexed (Set for each line)

(display the left/right of the line area and line spacings)

Character extension: Normal/Double width/Double height/Double width x double height (Set for each line)

Enlarged character dot interpolation function(Set for each line)

- Screen display position control

Horizontal display position: Control in 2-dot units (movable through the entire screen)

Vertical display position: Control in 2-dot units (movable through the entire screen)

Line space: Control in single dot unit (set between 0 to 7 dots for each line, applied simultaneously to two areas above and below the line)

- Sprite character control

Sprite character display: OFF/ON

Sprite character types: 256 character types (character codes 000<sub>H</sub> to 0FF<sub>H</sub>)

Sprite character trimming: OFF/ON

Composing the sprite character: two-type, 1 characters /double height characters

Sprite character horizontal position: Control in single dot unit (movable through the entire screen)

Sprite character vertical position: Control in single dot unit (movable through the entire screen)

- Screen background

Screen background color: OFF/ON

- Display colors

Character color (Setting for each character, selected from among 16 colors)

Character trimming colors: 16 colors (set for each line)

Characters background colors (16 colors, set for each character) \*

Line background color (Setting for each line, selected from among 16 colors)

Screen background color: 16 colors

Sprite characters color: 16 colors

Sprite characters trimming: 16 colors

Shaded background frame highlight color: 16 colors

Shaded background frame shadow color: 16 colors

\*: Character background color (color code) = "0<sub>H</sub>" is transparent (displays lower-layer color).

- Digital signal

Color signal output: 4 bits (support for 16 colors)

Display period signal: 3 systems (with output selection circuit)

- External interface

16-bit serial input

- Chip select
- Serial clock
- Serial data

- Package

SSOP-20

- Supply voltage

2.4V to 3.6V

## 1.2 Configuration

---

The MB90099 consists of the following block:

- Serial input control block
  - Display control block
  - Display memory (VRAM) block
  - Font ROM block
  - Output control block
  - Test control block (Circuits for factory testing of the LSI before delivery)
- 

### ■ Configuration

- Serial input control block

Receives serial commands and data. Decodes commands, and allocates commands and data to the appropriate control blocks.

- Display control block

Performs display control functions synchronized with the input sync signals.

- Display memory (VRAM) block

VRAM memory for character data (24 bits × 28 characters × 12 lines) and line data (24 bits × 12 lines).

- Font ROM block

ROM memory for display character fonts. Configured for 1,024 characters of 12 dots × 18 dots.

- Output control block

Generates output signals by applying display processing to the font data read from the font ROM.

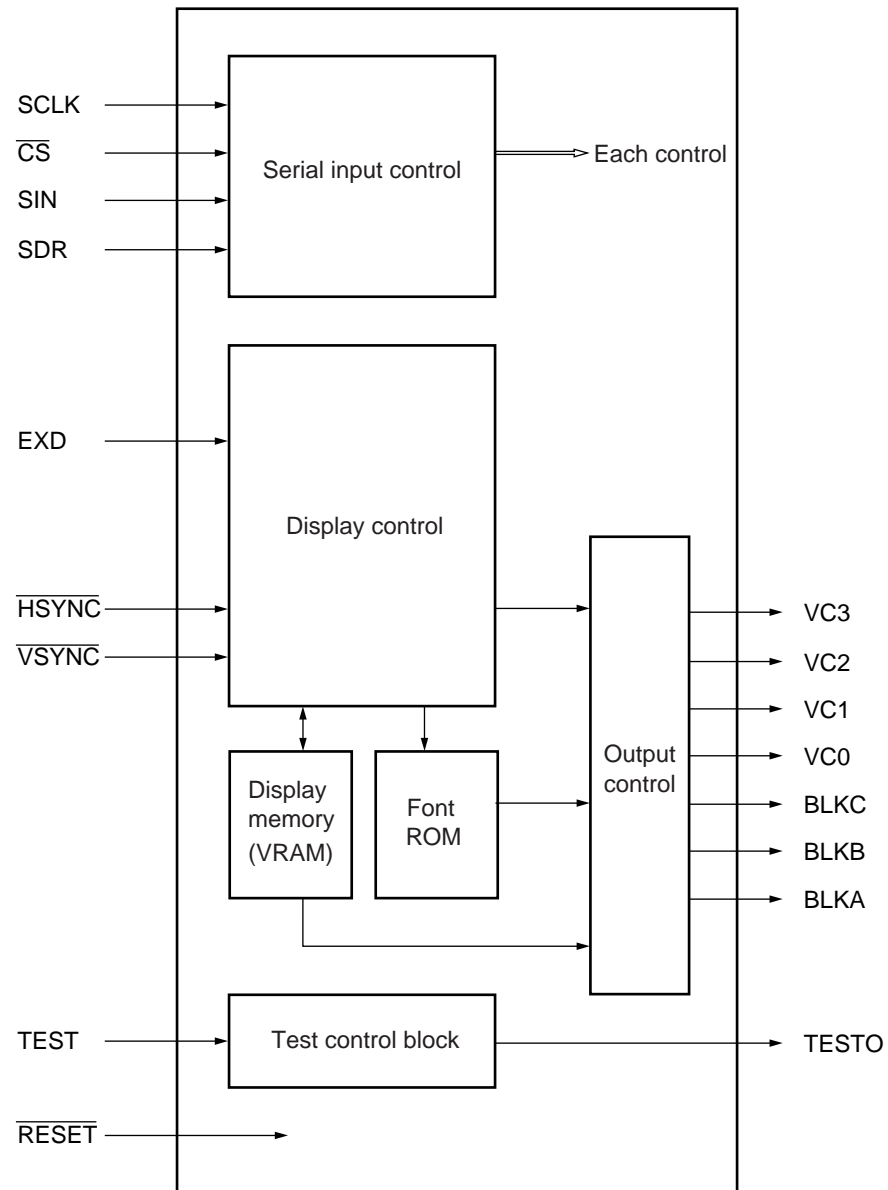
- Test control block

Circuits for factory testing of the LSI before delivery.

## ■ Block Diagram

Figure 1.2-1 shows the block diagram of the MB90099.

**Figure 1.2-1 MB90099 Block diagram**

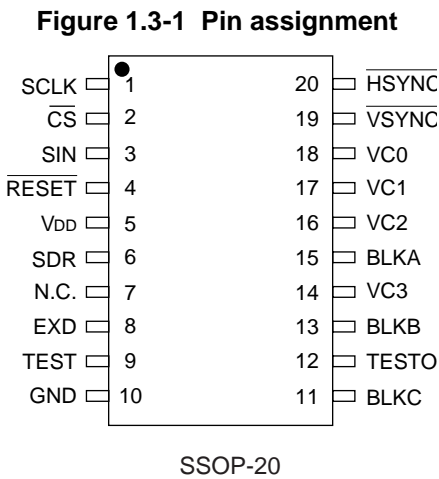


# 1.3 Pin Assignment

This section shows the pin assignment, pin function and I/O circuit type.

## ■ Pin Assignment

Figure 1.3-1 shows the pin assignment.



## ■ Pin Function

Table 1.3-1 shows the pin function.

**Table 1.3-1 Pin Function**

Pin name	Pin Number	I/O	Functional description	Circuit Type
SCLK	1	Input	Shift clock input pin for serial transfer. This pin has an internal pull-up resistor.	A
$\overline{CS}$	2	Input	Chip select pin. Input a low level signal during serial transfer. This pin has an internal pull-up resistor.	A
SIN	3	Input	Serial data input pin. This pin has an internal pull-up resistor.	A
$\overline{RESET}$	4	Input	Reset input pin. Input a low level signal at power-on time.	B
V <sub>DD</sub>	5	-	+3V power supply pin	-
SDR	6	Input	Data input direction select pin for serial transfer. Input a low level signal at LSB-first transfer mode, or a high level signal at MSB-first transfer mode.	C
N.C.	7	-	Not connected. This pin should be left open.	-
EXD	8	Input	Display dot clock input pin.	B
TEST	9	Input	LSI test input pin. Input a low level signal during normal use.	C
GND	10	-	Ground pin	-
$\overline{HSYNC}$	20	Input	Horizontal sync signal input pin	B
$\overline{VSYNC}$	19	Input	Vertical sync signal input pin	B
VC0 VC1 VC2 VC3	18 17 16 14	Output Output Output Output	Color code signal output pins.	D
BLKA	15	Output	Display period signal output pin for output channel A.	D
BLKB	13	Output	Display period signal output pin for output channel B.	D
BLKC	11	Output	Display period signal output pin for output channel C.	D
TEST0	12	Output	LSI test output pin. (Internal: N.C.) This pin should be left open during normal use.	-

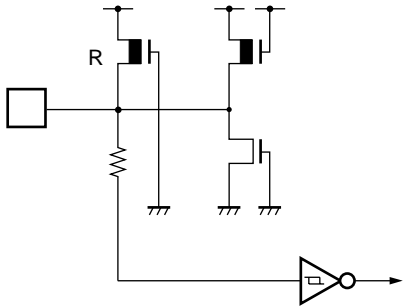
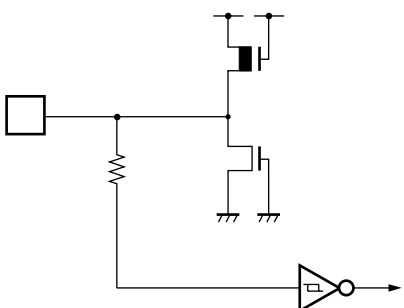
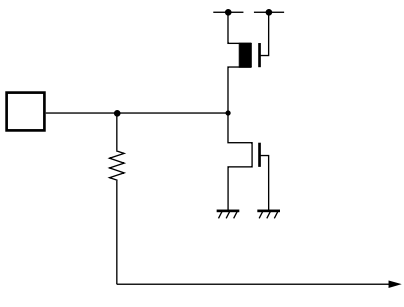
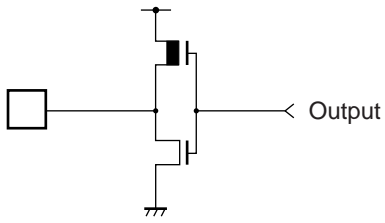
Note: For the circuit type detail, see Classification in Table1.3-2.



■ I/O Circuit

Table 1.3-2 shows the I/O circuit types about Table 1.3-1.

Table 1.3-2 I/O Circuit

Classification	Circuit	Remark
A		CMOS level, hysteresis input, pull-up resistance (25 kΩ to 200 kΩ) .
B		CMOS level, hysteresis input.
C		CMOS level input.
D		CMOS level output.

# **CHAPTER 2**

---

## ***Display Functions***

**This chapter explains display functions of the MB90099.**

- 2.1 Screen configuration
- 2.2 Font ROM configuration
- 2.3 Display memory (VRAM) configuration
- 2.4 Display memory (VRAM) programming
- 2.5 Display Characters
- 2.6 Character background display
- 2.7 Line background display
- 2.8 Display background color control
- 2.9 Sprite character display

## 2.1 Screen configuration

The display screen consists of the individual display screen elements stacked in the following order from the bottom layer. Each display screen element has a different display configuration and display position control.

- (Screen background) Screen background color
- (Line background) Line background color
- (Characters background) Characters background colors
- Characters + trimming
- Sprite characters+ trimming

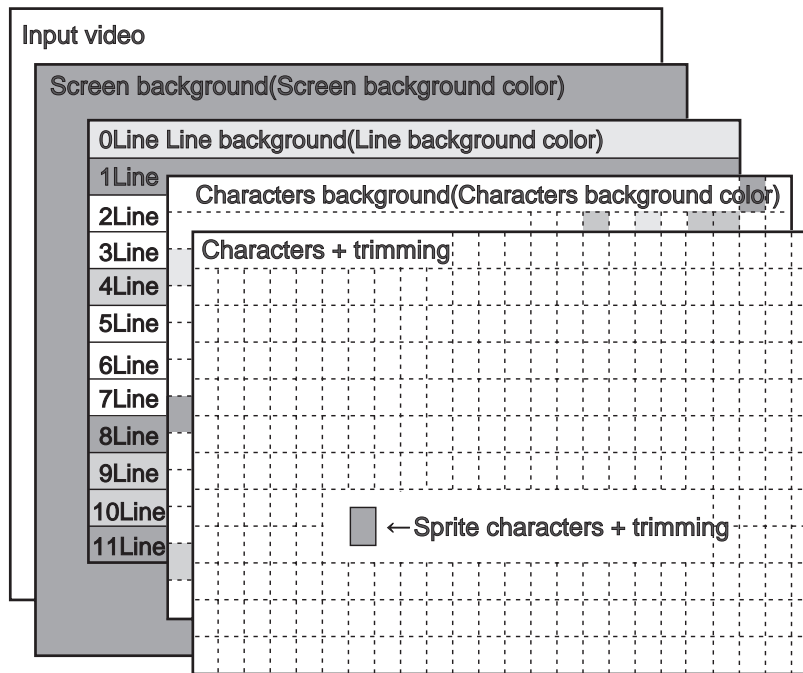
### ■ Screen configuration

Table 2.1-1 shows the relationship between display configuration and display position control of display screen element. Figure 2.1-1 shows the screen configuration.

**Table 2.1-1 Display configuration and display position control of display screen element**

	Display screen element name	Display configuration	Display position control
High layer ↑	Sprite characters (+trimming)	1 (Font configuration of 2 characters high)	Horizontal/Vertical: Control in 1-dot units
	characters (+trimming)	28 characters x 12 lines	Horizontal/Vertical: Control in 2-dot units
	Characters background	28 characters x 12 lines	(Synchronized with character control)
	Line background	12 lines	(Synchronized with character control)
↓ Low layer	Screen background	Full screen display in single color	(None)

Figure 2.1-1 Screen configuration



Note: When a character is displayed on a line, the display of the shaded background shadow frame for the line background overrides the character (character + trimming) display. The display of the shaded background shadow frame for the character background overrides the character display and the shaded background shadow frame for the line background.

## 2.1.1 Screen display type

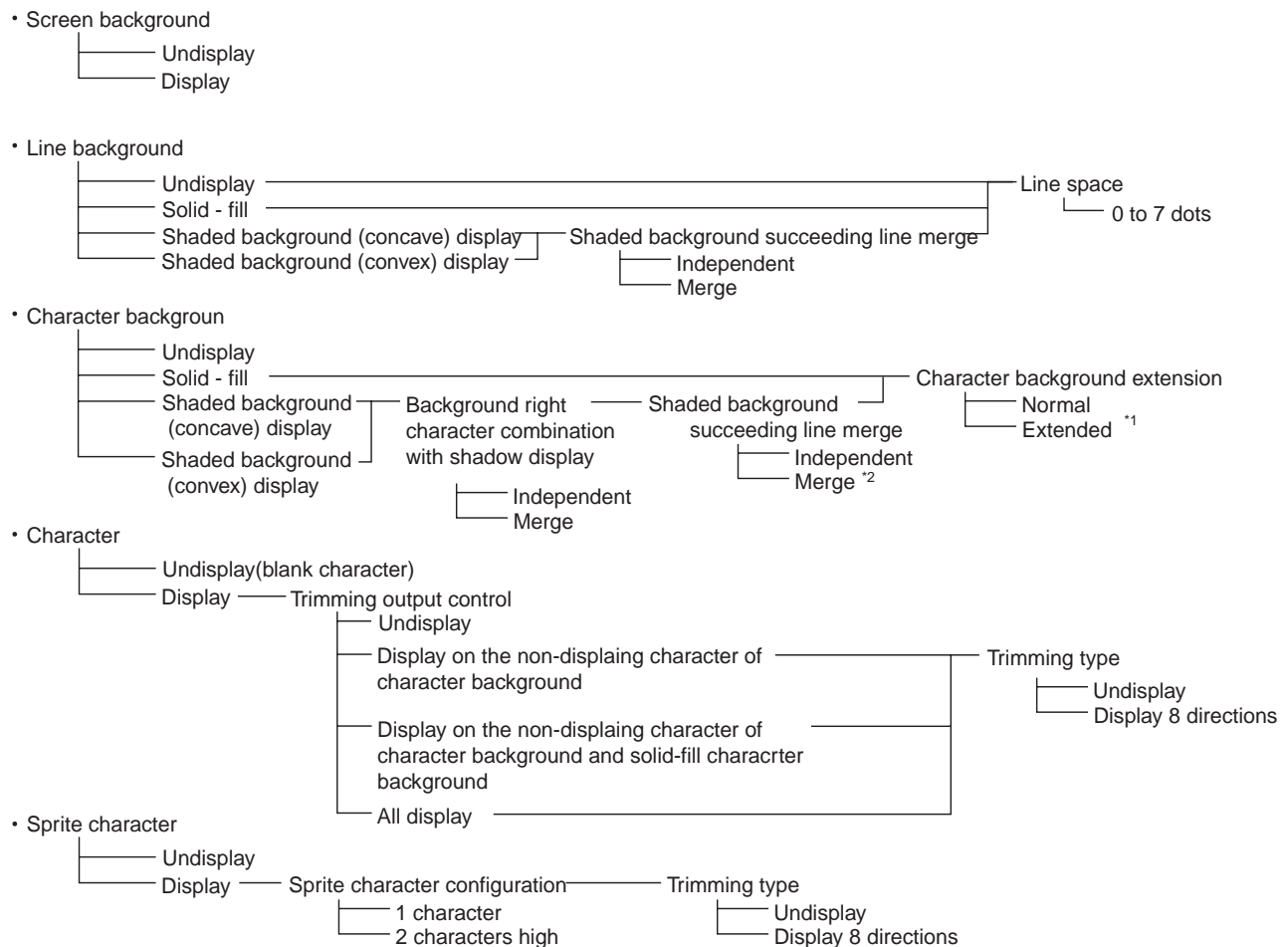
This section shows the display format for each display screen element.

- Screen background
- Line background
- Characters background
- Characters
- Sprite characters

### ■ Screen display type

Figure 2.1-2 shows the screen display types.

**Figure 2.1-2 Screen display type**



\*1: This can be set when line spacing is not set "0".

\*2: This can be set during character background extended display.

## 2.1.2 Screen output control

The display output control can control 3 systems (output A, output B, output C) independently. Each system output the output enable period signal to BLKA/BLKB/BLKC pin. Each system control (output A/output B/output C) can set the character attributes display OFF/the line background display OFF/the screen background display OFF, and can output 3 screen independently.

The layer construction of output display only exists on standard screen display. If any part are set OFF, the lower layers display should not be displayed and they are displayed transparently on each output control A/B/C.

### ■ Screen output control

Table 2.1-2 shows the screen output control command.

**Table 2.1-2 Screen output control**

Standard screen display control				Three-channel output control		
Controlled elements/Control bit name		(control unit)	Output A control	Output B control	Output C control	
Characters + trimming + characters background + line background		DSP (screen unit)	←	←	←	
Characters + trimming + characters background		LDS (line unit)	←	←	←	
characters		M9-MO (character unit)	OA2-OA0 (screen unit) × MO1,MO0 *1 (character unit)	OB2-OB0 (screen unit) × MO1,MO0 *1 (character unit)	OC2-OC0 (screen unit) × MO1,MO0 *1 (character unit)	
characters trimming		LFD-LFA (line unit)				
Characters background		MM1,MMO (character unit)				
Line background		LM1,LMO (line unit)	←	BLB*2 (screen unit)	BLC*2 (screen unit)	
Screen background color		UDS (screen unit)	←	BGB (screen unit)	BGC (screen unit)	
Sprite characters		SDS (screen unit)	←	SOB*3 (screen unit)	SOC*3 (screen unit)	
Sprite characters trimming		SFB,SFA (screen unit)	←			

\*1: If the display of character is turned off on overlapped the characters /trimming/character background with the line or screen background, the lower layer should not be displayed and the area should be shown transparently.

\*2: If the display of line is turned off on overlapped the line background with the screen background, the screen background should not be displayed and the area should be shown transparently.

\*3: If the display of sprite is turned off on overlapped the sprite characters /trimming with the character, character background, line background or screen background, the lower layer should not be displayed and the area should be shown transparently.

Note: Three-channel output control for each character serves as output control within the character area. When trimming dots for a character are displayed protruding to the area for an adjacent character, the output of the trimming dots is controlled by the character output control of that adjacent character. If there are trimming dots to the left of the leftmost character on a line, they cannot be controlled by three-channel output control. In this case, place a blank character at the left end of the line. When trimming dots are displayed to the right of the rightmost character on a line, the three-channel output control of the trimming dots depends on the character output control of the rightmost character.

## 2.1.3 Screen display position control

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**MB90099 can control the display position of character display and the display position of sprite character separately.**

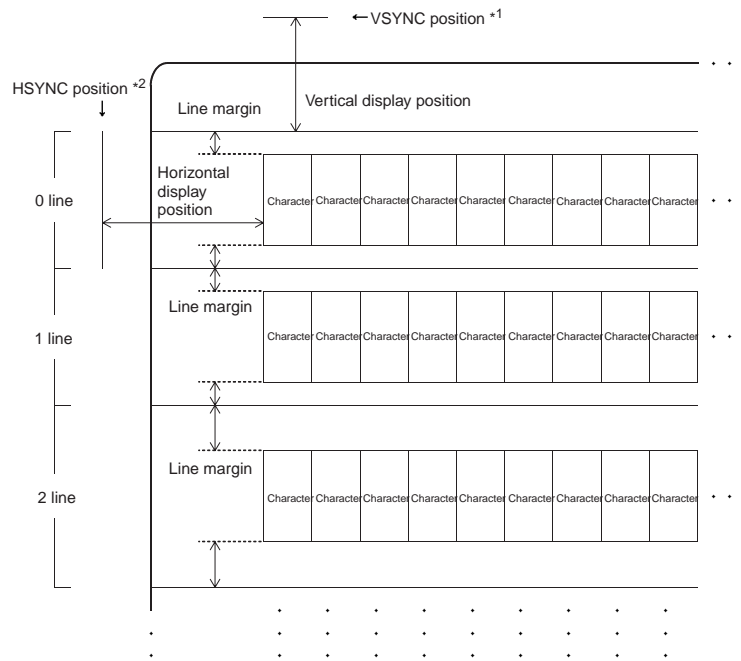
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### ■ Display position control

The MB90099 determines the display position of the screen by controlling the vertical display position, horizontal display position, and line spacing.

It also controls the display positions of characters, character trimmings, character backgrounds, and line backgrounds at the same time.

- Vertical display position: Set the position relative to the VSYNC by the vertical display position<sup>\*</sup> control bit Y8-YO (command 5-2). Setting between 0 and 1022 dots in 2-dot units.  
\*: The actual vertical display position is offset from the set value by several dots from the reference position.
- Horizontal display position: Set the position relative to the HSYNC by the horizontal display position<sup>\*</sup> control bit X8-XO (command 5-3). Setting between 0 and 1022 dots in 2-dot units.  
\*: The actual horizontal display position is offset from the set value by several tens of dots from the reference position.
- Line margin: Set the dot number for the size of the margin to be kept above and below the characters on each line by the line control data setting 1 bit LW2-LW0 (command 3). The spacing specified by the set value will be kept both above and below each character. Setting each line between 0 and 7 dots in 1-dot units. When line height enlarged display is on, the line spacing is enlarged as well.

**Figure 2.1-3 Screen display position control**

\*1: You can select VSYNC position at the leading or trailing edge of the vertical sync pulse.

(For details, see "3.3 Vertical sync control".)

\*2: You can select HSYNC position at the leading or trailing edge of the horizontal sync pulse.

(For details, see "3.4 Horizontal sync control".)



## ■ Sprite Character Display Position Control

The display position of sprite character and the sprite character trimming can be control.

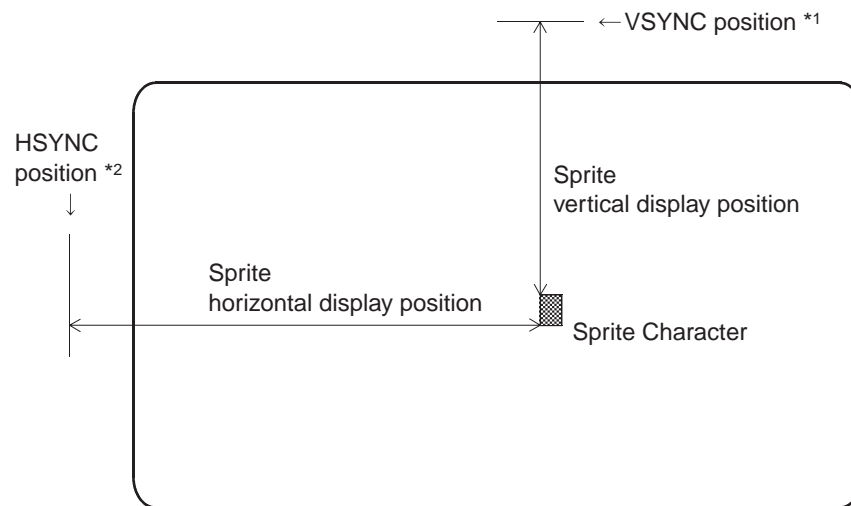
- Vertical display position of sprite character: Set the position relative to the VSYNC by the vertical display position\* control 4 (command 9-0) SY9-SY0 bit. Setting between 0 and 1023 dots in 1-dot units.

\*: The actual vertical display position is offset from the set value by several dots from the reference position.

- Horizontal display position of sprite character: Set the position relative to the HSYNC by the horizontal display position\* control 5 (command 9-1) SX9-SX0 bit. Setting between 0 and 1023 dots in 1-dot units.

\*: The actual horizontal display position is offset from the set value by several tens of dots from the reference position.

**Figure 2.1-4 Sprite character display position control**



\*1: You can select VSYNC position at the leading or trailing edge of the vertical sync pulse.  
(For details, see "3.3 Vertical sync control".)

\*2: You can select HSYNC position at the leading or trailing edge of the horizontal sync pulse.  
(For details, see "3.4 Horizontal sync control".)

## 2.2 Font ROM configuration

The MB90099 font ROM allows the user to set a total of 1024 different characters (12-by-18 dots per character).

- The user can set a total of 1024 characters freely.

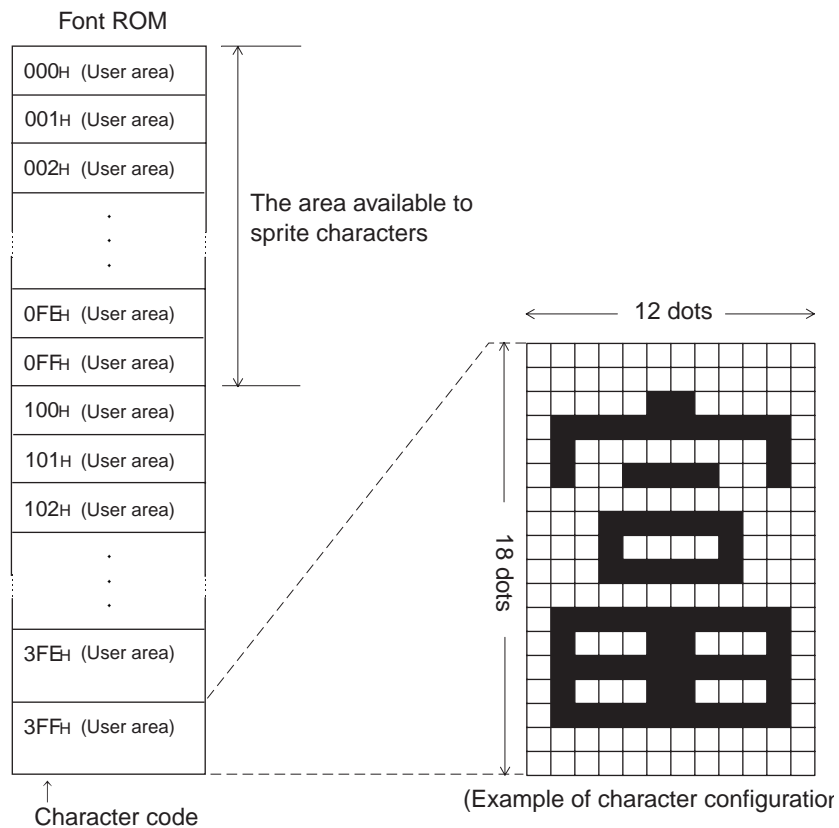
**Note:** Initially, even the blank character is not set as a reserved character.

- The area available to sprite characters is from 000<sub>H</sub> to 0FF<sub>H</sub>.

### ■ Font RAM configuration

Figure 2.2-1 shows the font ROM configuration.

**Figure 2.2-1 Font ROM configuration**



## 2.3 Display memory (VRAM) configuration

The display memory consists of the character RAM for setting character unit and the line RAM for setting line unit.

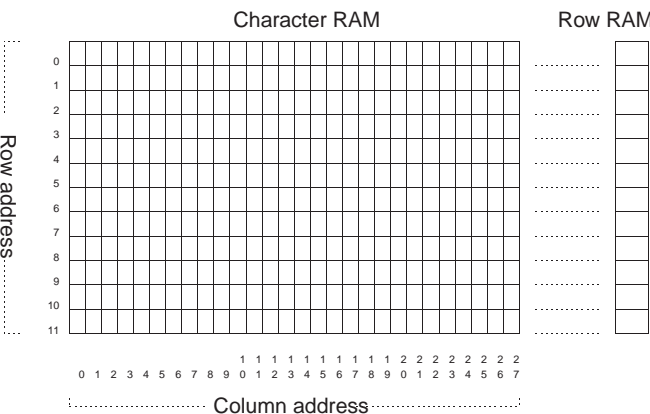
- Character RAM: 28 characters x 12 lines (a total of 336 characters)
- line RAM: 12 lines

### ■ Display memory and display screen

Areas of character RAM correspond to displayed characters on a one-to-one basis. Areas of line RAM correspond to displayed lines on a one-to-one basis. (see Figure 2.3-1 .)

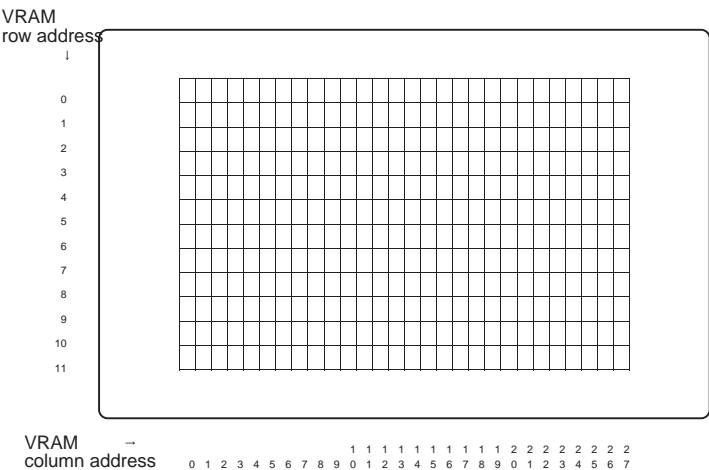
- Display memory (VRAM) configuration

Figure 2.3-1 Display memory (VRAM) configuration



- Screen display configuration example (character size: all typical)

Figure 2.3-2 Screen display configuration example (character size: all typical)



## 2.4 Display memory (VRAM) programming

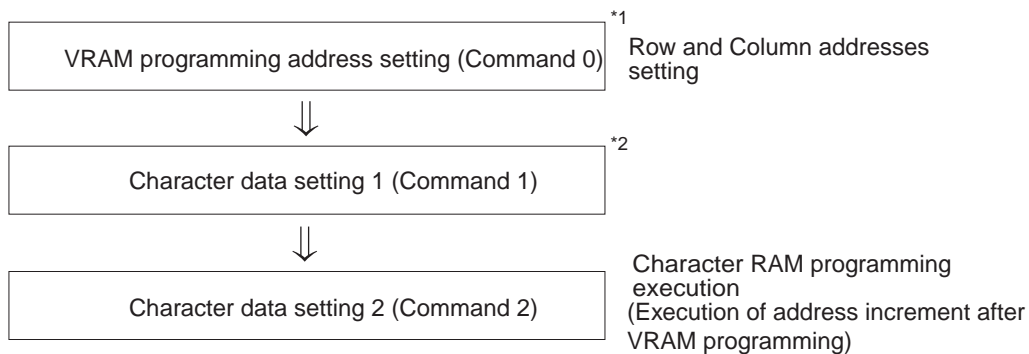
MB90099 has 3-type writing to display memory.

- Writing a single character to character RAM
- Writing multiple characters collectively to character RAM (VRAM fill)
- line RAM programming

### ■ Writing a single character to character RAM

Write an arbitrary character data to an arbitrary address in the character RAM. Figure 2.4-1 shows the procedure.

**Figure 2.4-1 Writing a single character to character RAM 1**



\*1: If writing to continuous address continues after pre-write the character, it can be omitted.

\*2: If the setting 1 contents of the character data does not differ from pre-setting, it can be omitted.

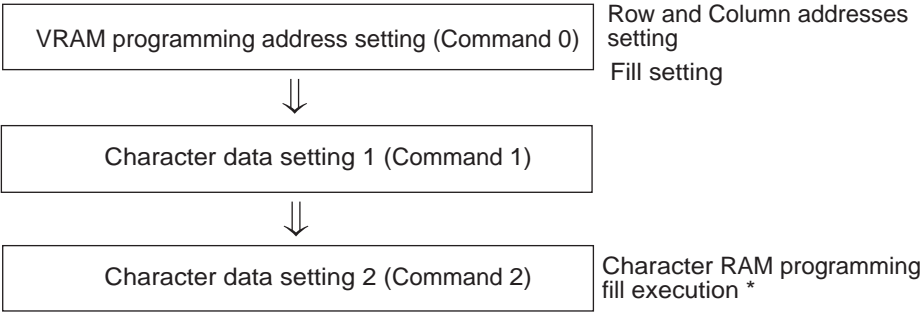
#### Note

Normal writing to VRAM requires input of a Normal horizontal sync signal. Input of an invalid horizontal sync signal may cause VRAM write to fail. The horizontal sync signal pulse width and the VRAM write cycle (the interval between commands 2 and 4 to be issued) should be set such that: horizontal sync signal pulse width < VRAM writing cycle.

■ **Writing multiple characters collectively to character RAM (VRAM fill)**

Write an arbitrary character data from an arbitrary address to the last address in the character RAM. Figure 2.4-2 shows the procedure.

**Figure 2.4-2 Writing multiple characters collectively to character RAM (VRAM fill)**



\*: It takes about 2 ms to execute fill (at all 1 schreen).  
The issue of command 0 to command 4 is not allowed during VRAM fill execution.  
The issue of command 0 (FL=0) during VRAM fill execution stops VRAM fill.  
(After the interruption, it is necessary to reissue command 0 to set the VRAM programming address.)

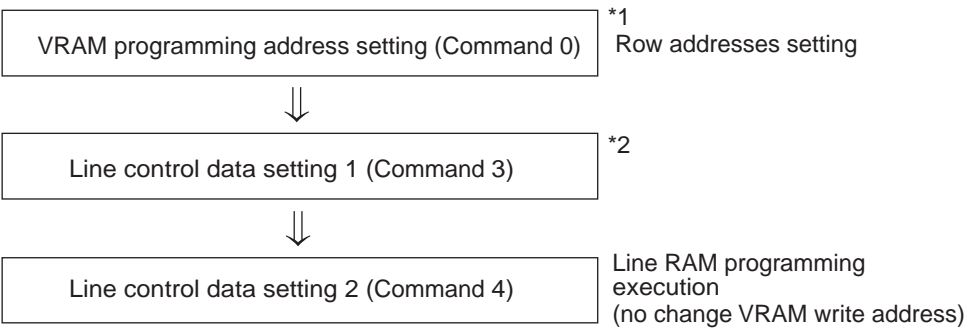
Note

Normal filtering to VRAM requires input of a Normal horizontal sync signal. Input of an invalid horizontal sync signal may cause VRAM write to fail.

■ **Line RAM programming**

Write an arbitrary line data to an arbitrary address in the line RAM. Figure 2.4-3 shows the procedure.

**Figure 2.4-3 Line RAM programming**



\*1: No row RAM function. (Fill specification is prohibited.)  
\*2: It is possible to omit if row data setting 1 contents are not charged since the previous setting.

Note

Normal writing to VRAM requires input of a Normal horizontal sync signal. Input of an invalid horizontal sync signal may cause VRAM write to fail. The horizontal sync signal pulse width and the VRAM write cycle (the interval between commands 2 and 4 to be issued) should be set such that: horizontal sync signal pulse width < VRAM writing cycle.

## 2.5 Display Characters

The display character size can be set vertically and horizontally.

Each character is displayed by clipping the specified size of the specified character data from font ROM, starting at the upper leftmost dot.

### ■ Font configuration

- Characters horizontal size control (set for each character)

Table 2.5-1 shows the character horizontal size control.

**Table 2.5-1 Character horizontal size control (character data setting 2 (command 2): MS bit)**

MS	Characters horizontal size
0	Size S: 6 dots
1	Size L: 12 dots

- Line character vertical size type control (set for each line)

Table 2.5-2 shows the line vertical size control.

**Table 2.5-2 Line vertical size control 1 (line control data setting (command 3): LHS bit)**

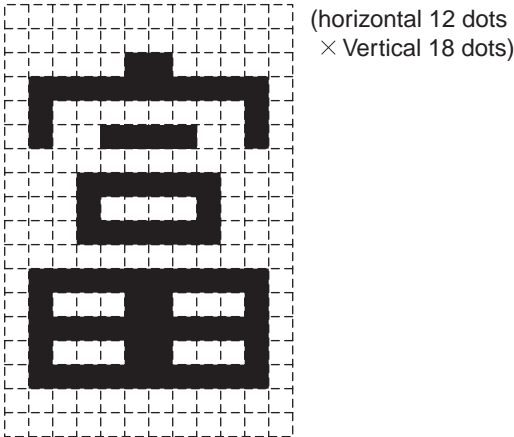
LHS	line character vertical size type
0	Characters vertical size A: 18 dots
1	Characters vertical size B: 12 dots

■ Example of display

About the font ROM data (see Figure 2.5-1 ), Figure 2.5-2 and Figure 2.5-3 show the display example of each character size.

● Font ROM contents

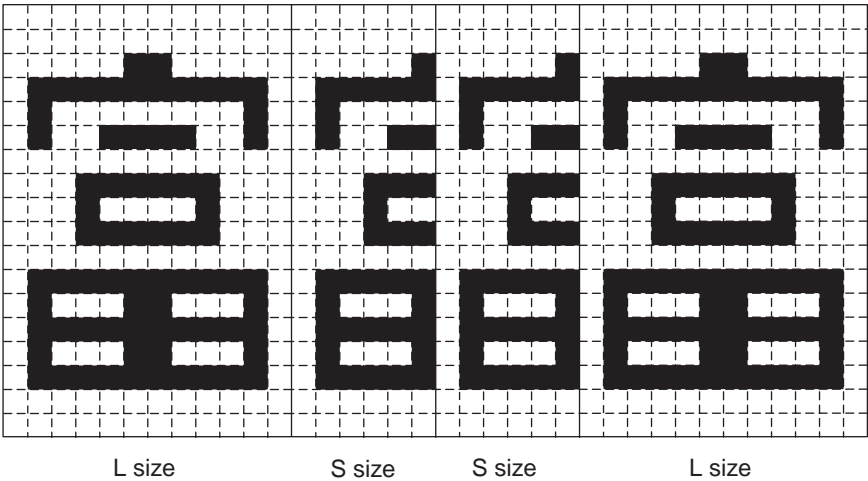
Figure 2.5-1 Font ROM contents



● Display example 1 (character vertical size A:18 dots)

Figure 2.5-2 shows the display example (vertical character size A: 18 dots).

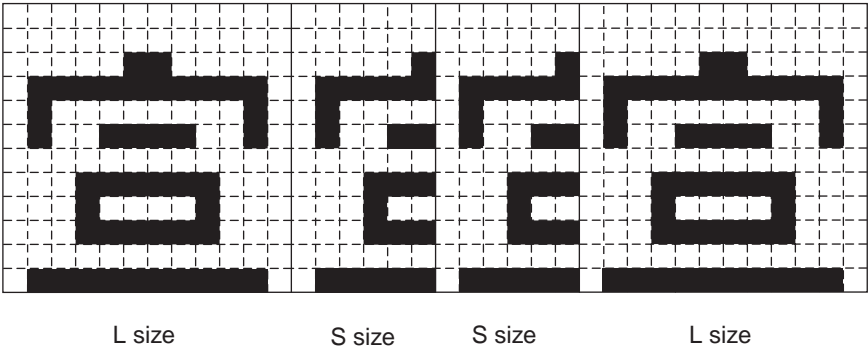
Figure 2.5-2 Display example 1 (vertical character size A:18 dots)



● Display example 2 (character vertical size B:12 dots)

Figure 2.5-3 shows the display example (vertical character size B: 12 dots).

**Figure 2.5-3 Display example 2 (vertical character size B: 12 dots)**





## 2.5.1 Characters trimming

**Character trimming display is the function to display trimming dots around character dots.**

### ■ Trimming output control

The character trimming controls the trimming ON/OFF by character background. 4-type can be set at each line.

Table 2.5-3 shows the character trimming output control.

**Table 2.5-3 Character trimming output control (Line control data setting 1 (command 3): LFD,LFC bit)**

Character trimming output control (set for each line)		characters background type (set for each character)			Trimming output
LFD	LFC	MM1	MM0	Display description	
0	0	0	0	Undisplay	×
		0	1	Solid-fill	×
		1	0	Shaded background (concave)	×
		1	1	Shaded background (convex)	×
0	1	0	0	Undisplay	○
		0	1	Solid-fill	×
		1	0	Shaded background (concave)	×
		1	1	Shaded background (convex)	×
1	0	0	0	Undisplay	○
		0	1	Solid-fill	○
		1	0	Shaded background (concave)	×
		1	1	Shaded background (convex)	×
1	1	0	0	Undisplay	○
		0	1	Solid-fill	○
		1	0	Shaded background (concave)	○
		1	1	Shaded background (convex)	○

X: Undisplay

○:Display

## ■ Trimming type control

Trimming type can select 8-direction trimming or non-display. The setting can be set each line.

### ● trimming type control

Table 2.5-4 shows the trimming type control.

**Table 2.5-4 Trimming type control (Line control data setting 1 (command 3): LFB,LFA bit)**

Trimming type control		Trimming output
LFB	LFA	
0	0	Undisplay
0	1	Reserved (Setting prohibited)
1	0	Reserved (Setting prohibited)
1	1	8-direction trimming

## ■ Trimming colors

The trimming color can be set from 16-color. The setting can be set each line.

### ● Trimming color (16 colors, each line setting)

Line control data setting 1 (command 3): LF3 to LF0 bit

## ■ Trimming display rules

- Trimming dots for a character can be displayed in the right-side or left-side adjacent character area only when the character background types of the two characters are the same.
- Trimming dots for the character at the left or right end of a line can be displayed beyond the character area only when the character background type is "no character background". If 3-system output control is used, the trimming dot should not be displayed beyond the character area over the left end of line. The dot on the position can not be controlled by character unit. The display of trimming dot beyond the character area over right end of line depends on the character output control setting of the right end.
- The trimming can not be displayed to the character upper/lower area (the upper character, the lower character, line margin between upper and lower).
- Trimming dots on a line are not enlarged when the line is displayed enlarged. The trimming dot of typical dot size should be displayed around the surrounding all enlarged character dots.

---

### Note

To use three-channel output control to control the output of each character, design the display screen and fonts in consideration of the display of trimming dots protruding to the right or left adjacent character area.

Three-channel output control of each character is display output control of the character area. Turning on or off the display of trimming dots protruding to an adjacent character area depends on the character output control setting for that adjacent character.

---

## 2.5.2 Line Enlarged Display

Line enlarged display control is used to control the display size of each line including the characters, character backgrounds, and line background on that line (as well as the line spacing portions).

It also controls enlargement of the shadow frames of shaded backgrounds.

The trimming dot width are not be controlled enlargement.

Note that the lines following the line for which line enlarged display has been specified are shifted down accordingly. The setting can be controlled each line.

### ■ Line Enlarged Display

Table 2.5-5 shows the setting of line enlarged display.

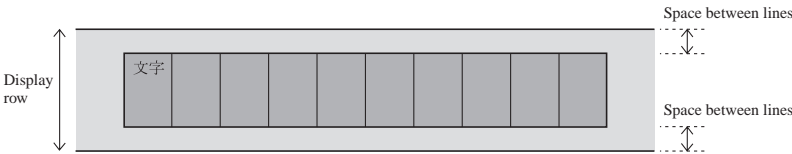
**Table 2.5-5 Line enlarged display (line control setting 2 (command 4): LG1,LG0 bit)**

LG1	LG0	Display size
0	0	Typical size
0	1	Double width size
1	0	Double height size
1	1	Double in height and width

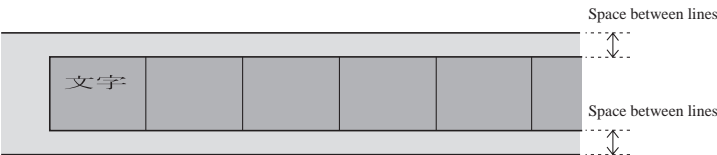
■ Line Enlarged Display Examples

Figure 2.5-4 shows the line enlarged display example of (typical, double width, double height, double width x double height).

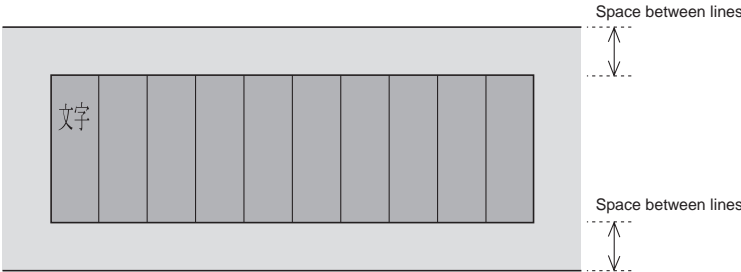
● Typical size



● Double width size



● Double height size



● Double width x double height

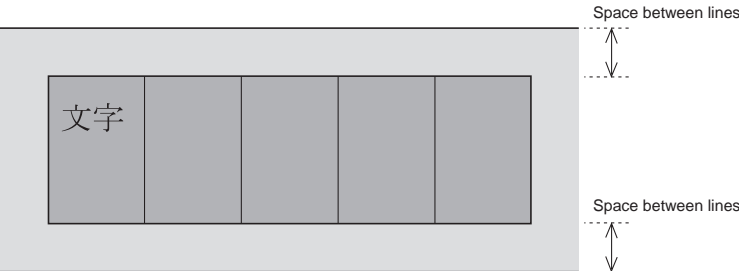


Figure 2.5-4 Line Enlarged Display Examples

■ Enlarged display dot interpolation function

Dot interpolation display is available only when the line enlarged display control setting is "double width x double height". Settable for each line.

Dots are interpolated character by character. The dots of a character are not interpolated with those of adjacent characters.

Trimming display is generated for character dots and interpolated dots. The trimming dot width is not enlarged.

- Line enlargement interpolation control (specified for each line)

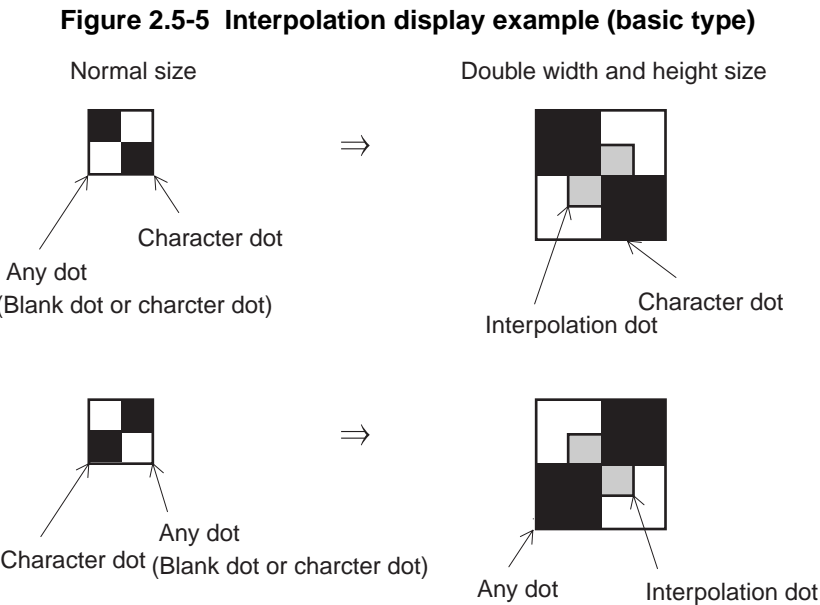
Table 2.5-6 shows setting operation contents of line enlargement interpolation control.

**Table 2.5-6 Line control setting 2 (command 4): LGS bit)**

LGS	control
0	Interpolation OFF
1	Interpolation ON

- Interpolation display example (basic type)

Figure 2.5-5 shows interpolation display example in size of double width and height.



## 2.6 Character background display

The character background can be selected from among four types and the character background color can be selected from among 16 different colors, each for each character.

### ■ Character background display

#### ● Character background control

Table 2.6-1 shows setting operation contents of character background control.

**Table 2.6-1 Character data setting 1 (command 1): MM1,MM0 bit**

MM1	MM0	Characters background
0	0	No background (Undisplay)
0	1	Solid-fill
1	0	Shaded background (concave)
1	1	Shaded background (convex)

The character background color is displayed around characters when the character background type is "solid-fill", "concaved shaded background or "convexed shaded background".

The shaded background highlight color and shaded background shadow color are displayed around character areas when the character background type is "concaved shaded background" or "convexed shaded background".

Each color control bit is described below.

#### ● Characters background colors (16 colors, set for each character)

Character data setting 1 (command 1): MB3 to MB0 bit

#### Note

The character background color is transparent when all of MB3 to MB0 have been set to 0.  
For the character background, the lower layer is displayed.

#### ● Shaded background highlight colors (16 colors, set for each screen)

Shadow background frame color control (command 6-1):BH3 to BH0 bits

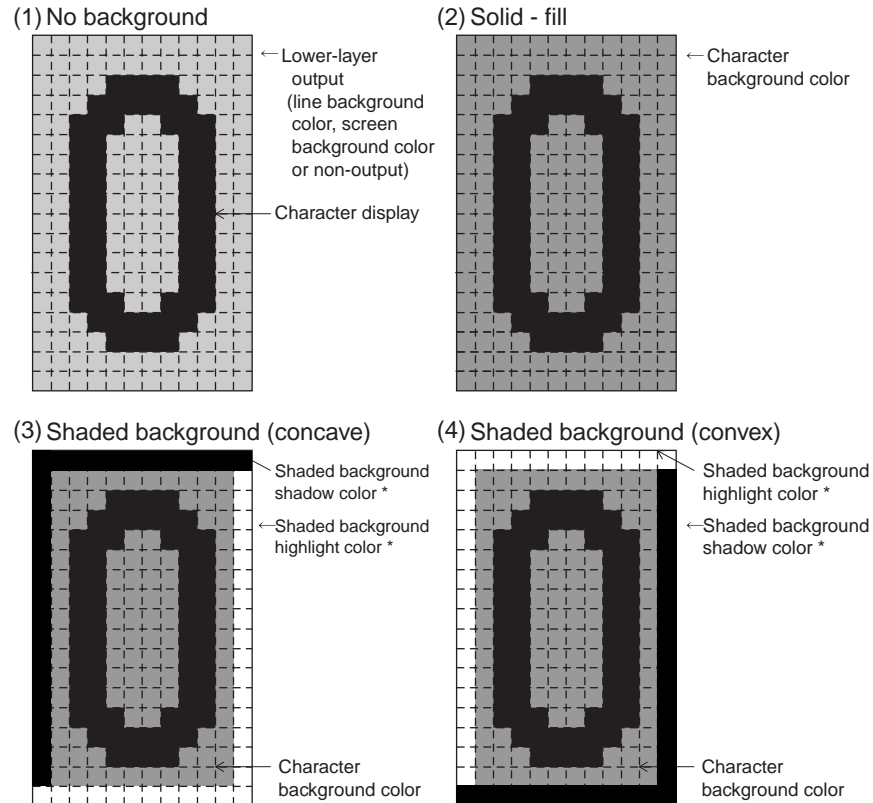
#### ● Shaded background shadow colors (16 colors, set for each screen)

Shadow background frame color control (command 6-1):BS3 to BS0 bits

## ■ Example of a character background display

Figure 2.6-1 shows example of a character background display of no background, solid fill, solid background (concave) and shaded background (convex).

**Figure 2.6-1 Example of a character background display**



\*: Shaded background frame (shaded background highlight color and shaded background shadow color) are displayed around own character areas (1 dot width ).

## 2.6.1 Shaded background succeeding character merge display

---

When setting character data, specifying "shaded background character display" and "shaded background succeeding character merge display" for a character undisplay the right line of the shadow frame of the character and the left line of the shadow frame of the next (right adjacent) character. This enables two or more characters to be displayed with shaded backgrounds.

---

### ■ Shaded background succeeding character merge display

- Shaded background succeeding character merge control (Setting for each character)

Table 2.6-2 shows setting operation contents of shaded background succeeding character merge control.

**Table 2.6-2 Character data setting 2 (command 2): MR bit**

MR	Shaded background succeeding character merge control
0	OFF (independent display)
1	ON (merge display)

- Example of shaded background character merge display

Figure 2.6-2 shows example of shaded background independent display and Figure 2.6-3 shows example of shaded background character merge display.



Figure 2.6-2 Example of Shaded Background Independent Display

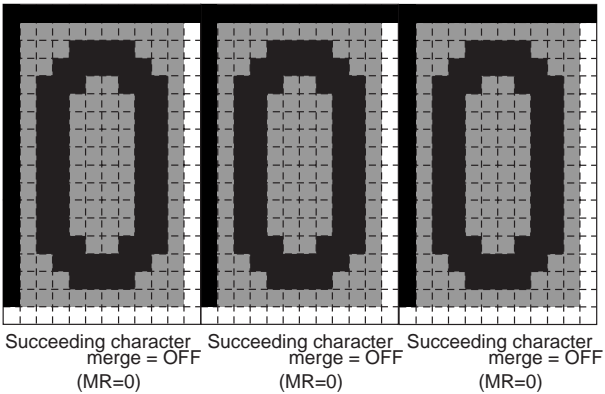
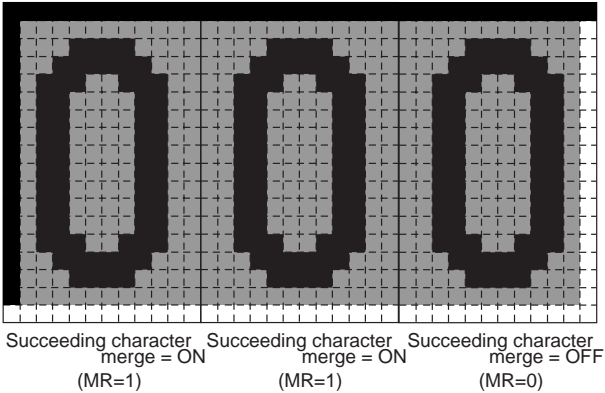


Figure 2.6-3 Example of shaded background character merge display



## 2.6.2 Shaded background succeeding line merge display

Specifying "shaded background character display" for characters on a line and both of "character background extended display" and "shaded background succeeding line merge display" for the line undisplay the lower lines of the shadow frames of the characters on that line and the upper lines of the shadow frames of the characters on the next line. (Specify both of "shaded background succeeding line merge display" and "character background extended display" for the current line and "character background extended display" for the next line.) This enables two or more lines to be displayed with shaded backgrounds.

### ■ Shaded background succeeding line merge display

- Shaded background succeeding line merge control (Setting for each line)

Table 2.6-3 shows setting operation contents of shaded background succeeding line merge control.

**Table 2.6-3 Line control setting 2 (command 4): LD bit)**

LD	Shaded background succeeding line merge control
0	OFF (independent display)
1	ON (merge display)

- Character background extension control (set for each line)

Table 2.6-4 shows setting operation contents of character background extended control.

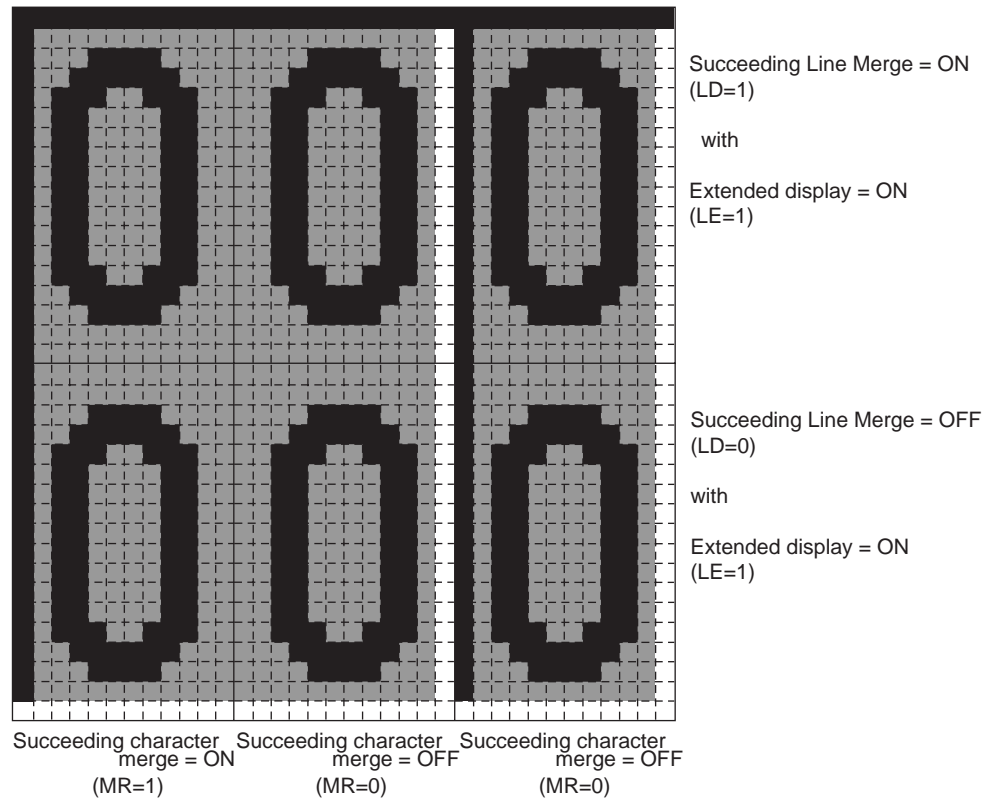
**Table 2.6-4 Line control setting 2 (command 4): LE bit)**

LE	Character background extension control
0	OFF (normal display)
1	ON (extended display)

● Example of Shaded Background Line Merge Display

Figure 2.6-4 shows the example of displaying the background line uniting with the shadow.

**Figure 2.6-4 Example of Shaded Background Line Merge Display**



Note

If character background extended display is not specified, shaded background succeeding line merge display is disabled for character backgrounds. (The setting of shaded background succeeding line merge display applies only to the line background shadow frame.)

## 2.6.3 Characters background extended display

Character background extended display extends character backgrounds to line spacing portions.

Note that this setting is required to apply shaded background succeeding line merge display to character backgrounds.

### ■ Characters background extended display

- Character background extension control (set for each line)

Table 2.6-5 shows setting operation contents of character background extension control.

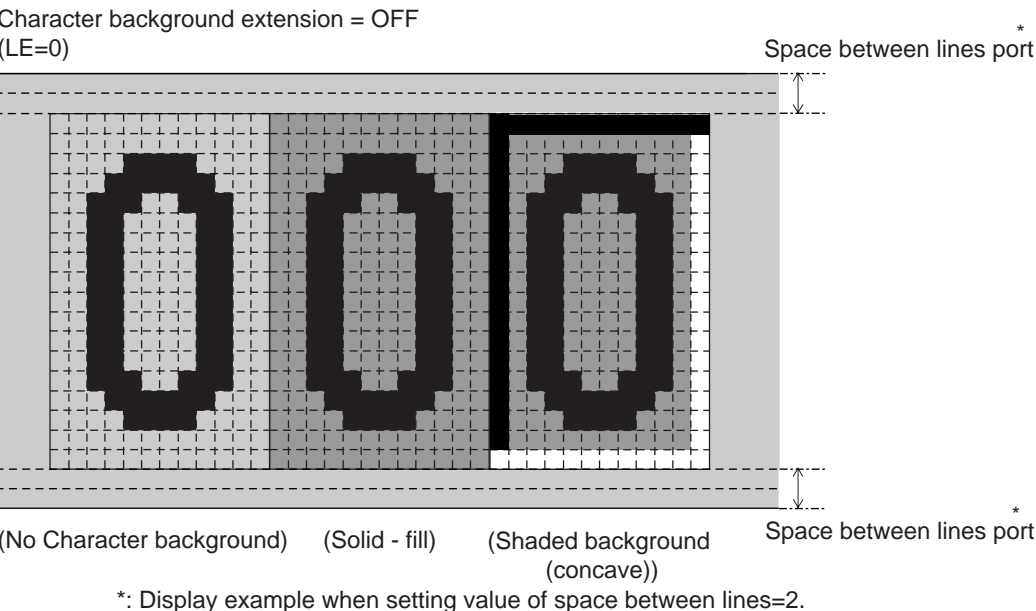
**Table 2.6-5 Line control setting 2 (command 4): LE bit)**

LE	Character background extension control
0	OFF (normal display)
1	ON (extended display)

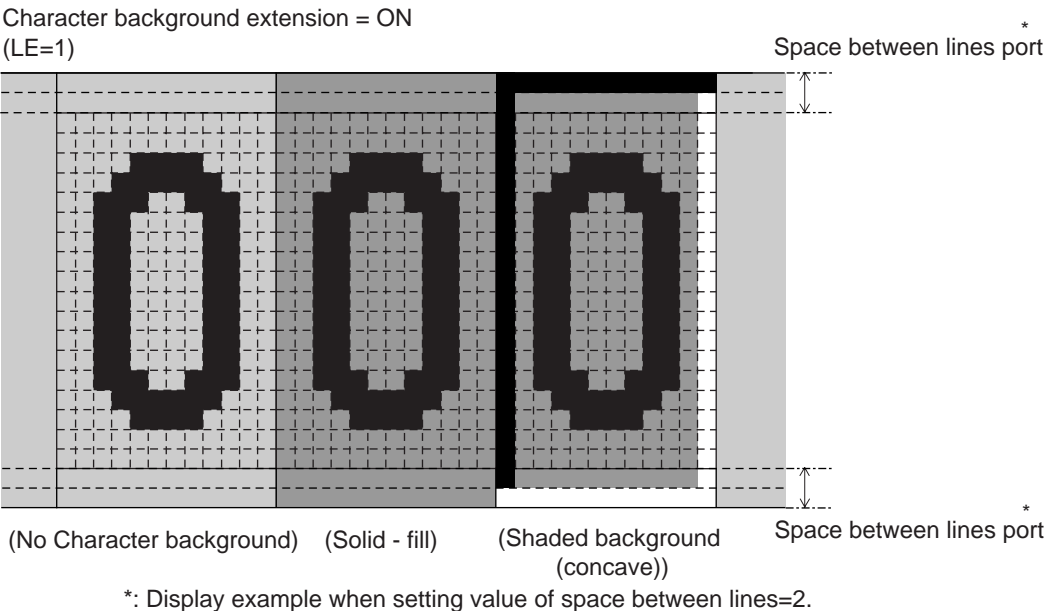
- Example of Display with Character Background Extension

Figure 2.6-5 shows an example of display with character background extension set to OFF (LE = 0).

**Figure 2.6-5 Example of display with character background extension set to OFF**



**Figure 2.6-6 Example of display with character background extension set to ON**



## 2.7 Line background display

Line background display for a line displays the line background in the line area of the characters on the line, the areas to the right and left of that area, and the line spacing areas above and below it. There are four types of line backgrounds available (None, Solid fill, Concaved shaded background, and Convexed shaded background), one of which can be set for each line. Shaded line background display is used to display the shaded background frame highlight color and shaded background frame shadow color above and below the line background area, respectively, along with the line background color display.

### ■ Line background display

Control bits related to line background control and line background display are explained.

- Line background control (set for each line)

Table 2.7-1 shows setting operation contents of line background control.

**Table 2.7-1 Line control data setting 2 (command 4): LM1,LM0 bit**

LM1	LM0	Line background
0	0	No background (Undisplay)
0	1	Solid-fill
1	0	Shaded background (concave)
1	1	Shaded background (convex)

- Line background color (Setting for each line, selected from among 16 colors)

Line control data setting 2 (command 4): L3 to L0 bit

- Shaded background highlight color (16 colors, set for each screen)

Shadow background frame color control (command 6-1):BH3 to BH0 bits

- Shaded background shadow color (Setting for each screen, selected from among 16 colors)

Shadow background frame color control (command 6-1):BS3 to BS0 bits

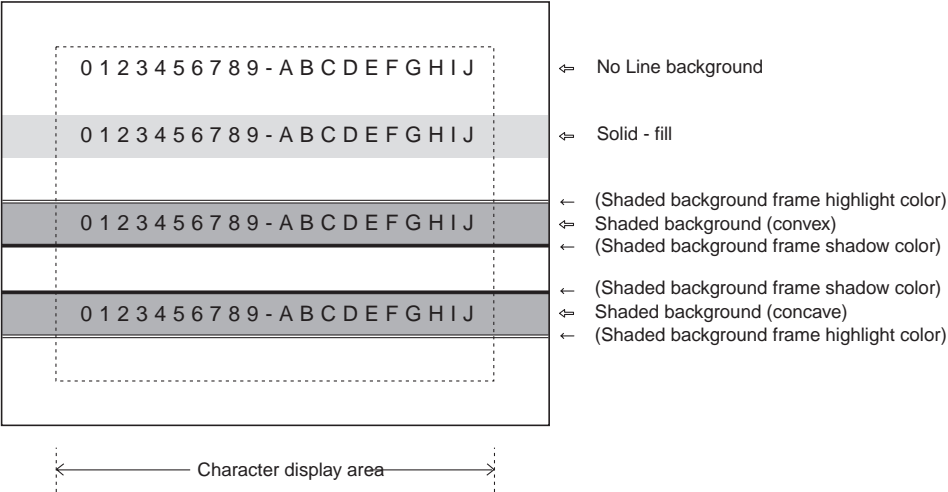
- Space between lines (set for each lines)

Space between lines control (command 3):LW2 to LW0 bits

● Example of display

Figure 2.7-1 shows the example of displaying the line background.

Figure 2.7-1 Example of display



## 2.7.1 Shaded background succeeding line merge display

Specifying "shaded background succeeding line merge display" for a line enables the line to be displayed with the line background merged with that of the next line. This undisplay the lower line of the line background shadow frame of the current line and the upper line of the line background shadow frame of the next line, allowing two or more lines to be displayed with shaded line backgrounds.

### ■ Shaded background succeeding line merge display

- Shaded background succeeding line merge control (Setting for each line)

Table 2.7-2 shows setting operation contents of shaded background succeeding line merge control.

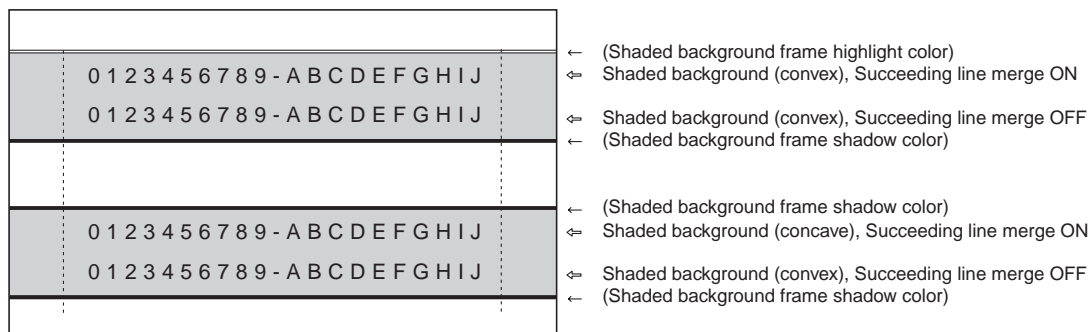
**Table 2.7-2 Line control data setting 2 (command 4): LD bit**

LD	Shaded background succeeding line merge control
0	OFF (independent display)
1	ON (merge display)

- Example of Shaded Background Succeeding Line Merge Display

Figure 2.7-2 shows example of shaded background succeeding line merge display.

**Figure 2.7-2 Example of Shaded Background Succeeding Line Merge Display**



#### Note

Specifying shaded background succeeding line merge display applies merge control to the character and line backgrounds at the same time. If character background extended display is off for a line, however, merge control ignores the shaded background characters on that line.



## 2.8 Display background color control

---

The screen background color can be output to the bottom layer of display output.

---

### ■ Screen background color display control

#### ● Screen background output control

Table 2.8-1 shows setting operation contents of screen background output control.

**Table 2.8-1 Screen background output control (Screen output control 1A (command 5 - 00):UDS bit)**

UDS	Screen background color output
0	OFF (Undisplay)
1	ON (display)

#### ● Screen background color control

Screen background control (command 7-3):U3 to U0 bit

Selected from among 16 colors.

### ■ Three-channel output control

When screen background color output is ON (UDS = 1), the screen background outputs to output B and output C can be controlled independently. (Output A is controlled only with the UDS bit.)

#### ● Output B screen background color output control

Table 2.8-2 shows setting operation contents of output B screen background color output control.

**Table 2.8-2 Output B screen background color output control (Screen output control 1B (command 5-01):BGB bit)**

BGB	Output B screen background color output
0	OFF (Undisplay)
1	ON (display) *

\*: Valid only when screen background color output is ON (UDS=1).

● Output C screen background color output control

Table 2.8-3 shows setting operation contents of output C screen background color output control.

**Table 2.8-3 Output C screen background color output control (screen output control 1C (command 5-02):BGC bit)**

BGC	Output C screen background color output
0	OFF (Undisplay)
1	ON (display) *

\*: Valid only when screen background color output is ON (UDS=1).

## 2.9 Sprite character display

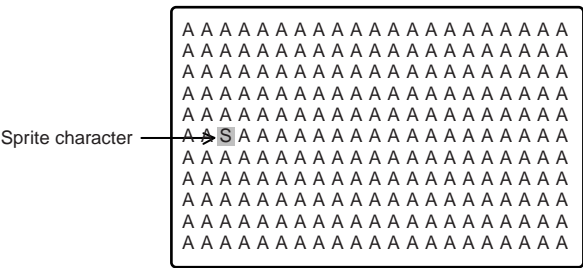
Sprite characters can be displayed on the top layer of the display screen.

### ■ Sprite character display

- Example of sprite characters

Figure 2.9-1 shows example of sprite characters display.

Figure 2.9-1 Example of sprite characters



## 2.9.1 Sprite character display control

Sprite character display control consists of the following 8 functions.

- Sprite character output control
- Sprite character code
- Sprite character color
- Sprite character trimming color
- Sprite character trimming control
- Sprite character vertical display position control
- Sprite character horizontal display position control
- Sprite character configuration control

### ■ Sprite character display control

#### ● Sprite character output control

Table 2.9-1 shows setting operating contents of sprite character output control.

**Table 2.9-1 Sprite character output control (screen output 1A(command 5-00): SDS bit)**

SDS	Sprite character output
0	OFF (Undisplay)
1	ON (display)

#### ● Sprite character code

Sprite character control 2 (command 8-1):SM7 to SM0 bits

Selection from 256 types of characters between the character code 000<sub>H</sub> and 0FF<sub>H</sub>.

When the sprite character consists of two characters, only an even-numbered character code can be set.

#### ● Sprite character color

Sprite character control 1(command 8-0):SC3 to SC0 bit

Selected from among 16 colors.

#### ● Sprite character trimming color

Sprite character control 1 (command 8-0):SF3 to SF0 bit

Selected from among 16 colors.

● Sprite character trimming control

Table 2.9-2 shows setting operation contents of sprite character trimming control.

**Table 2.9-2 Sprite character trimming control (sprite character control 1(command 8-0):SFB,SFA bit)**

SFB	SFA	Sprite character trimming
0	0	Undisplay
0	1	Reserved (Setting prohibited)
1	0	Reserved (Setting prohibited)
1	1	8-direction trimming

● Sprite character vertical display position control

Sprite character control 4(command 9-0):SY9 to SY0 bit

Setting between 0 and 1023 dots in 2-dot units.

● Sprite character horizontal display position control

Sprite character control 5(command 9-1):SX9 to SX0 bit

Setting between 0 and 1023 dots in 1-dot units.

● Sprite character configuration control

Table 2.9-3 shows setting operation contents of sprite character configuration control.

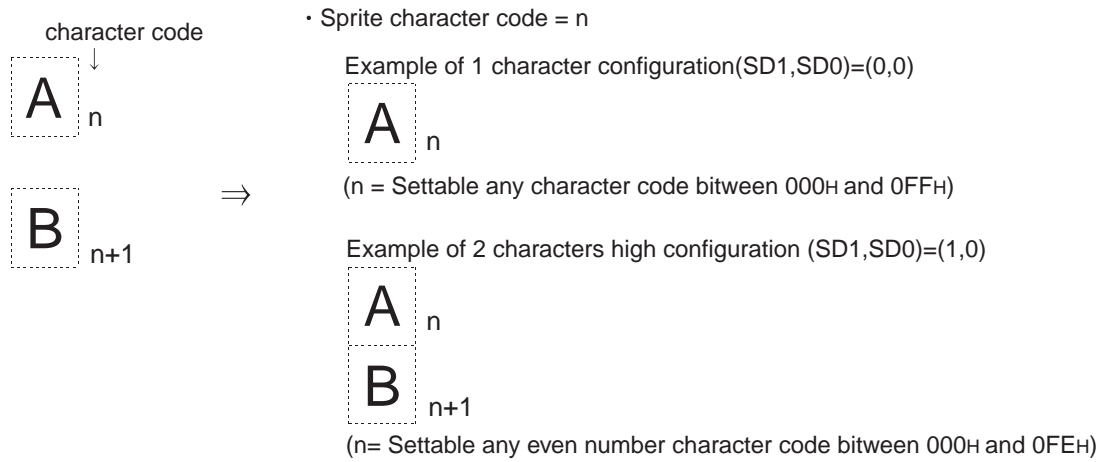
**Table 2.9-3 Sprite character configuration control (sprite character control 2(command 8-1):SD1,SD0 bit)**

SD1	SD0	Sprite character configuration
0	0	1 Font configuration
0	1	Reserved (Setting prohibited)
1	0	Font configuration of 2 characters high
1	1	Reserved (Setting prohibited)

## ■ Example of sprite character configuration

Figure 2.9-2 shows example of sprite character configuration.

**Figure 2.9-2 Example of sprite character configuration**



## 2.9.2 Three-channel output control

When sprite character output is ON (SDS = 1), the sprite character outputs to output B and output C can be controlled independently. (Output A is controlled only with the SDS bit.)

### ■ Three-channel output control

#### ● Output B sprite character output control

Table 2.9-4 shows setting operation contents of output B sprite character output control.

**Table 2.9-4 Output B sprite character output control (screen output control 1B(command 5 to command 01):SOB bit)**

SOB	Output B sprite character output
0	OFF (Undisplay) *1
1	ON (display) *2

\*1: When the lower layer has display output, that portion appear transparent. (The lower layer cannot be displayed.)

\*2: Enabled only when sprite character output is ON (SDS = 1).

#### ● Output C sprite character output control

Table 2.9-5 shows setting operation contents of output C sprite character output control.

**Table 2.9-5 Output C sprite character output control (screen output control 1C(command 5 to command 02):SOC bit)**

SOC	Output C sprite character output
0	OFF (Undisplay) *1
1	ON (display) *2

\*1: When the lower layer has display output, that portion appear transparent. (The lower layer cannot be displayed.)

\*2: Enabled only when sprite character output is ON (SDS = 1).

# **CHAPTER 3**

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## ***Control Functions***

**This chapter describes the control functions of the MB90099.**

- 3.1 Serial command control
- 3.2 Dot clock control
- 3.3 Vertical sync control
- 3.4 Horizontal sync control
- 3.5 Blanking Control
- 3.6 Three-Channel Display Signal Output Control
- 3.7 Three-Channel Character Display Output Control
- 3.8 Display Signal Output Timings



### 3.1 Serial command control

The device executes serial command/data transfer using the chip select ( $\overline{\text{CS}}$ ), serial clock (SCLK), and serial data input (SIN) pins. The data transfer direction (MSB-first or LSB-first transfer) is selected under control of the serial data input direction select (SDR) pin.

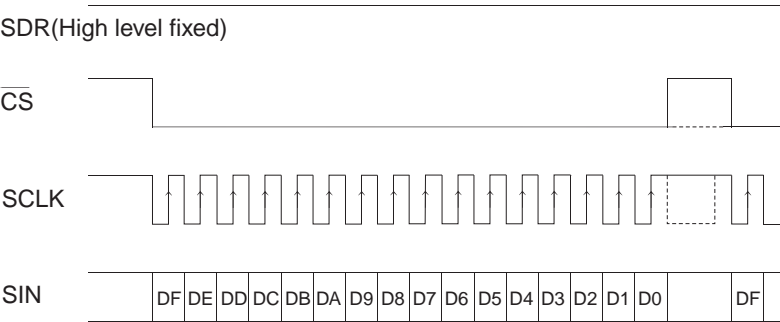
#### Serial command control

The data length is 16-bit. If the  $\overline{\text{CS}}$  pin goes High during transfer with data less than 16 bits being transferred, command transfer is not guaranteed. Keeping the  $\overline{\text{CS}}$  pin Low allows multiple items of command data to be transferred continuously. (It is however recommended to set the  $\overline{\text{CS}}$  pin to the High level at intervals of tens of words for word synchronization.)

The SCLK clock frequency is 4 MHz at maximum. Set it such that: VRAM write cycle (a minimum of 16 serial clock pulses) > input horizontal sync pulse width. If this condition is not satisfied, VRAM write may fail.

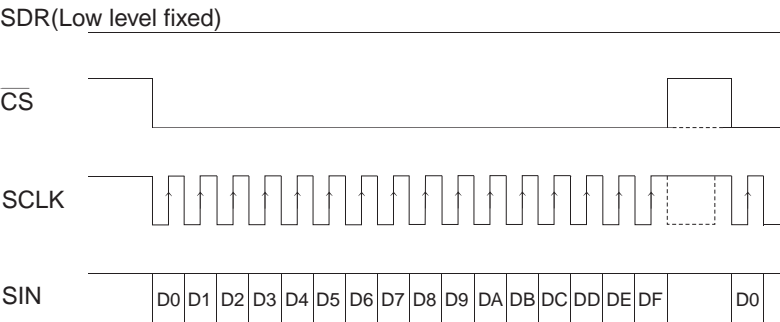
● MSB-first signal input timing

Figure 3.1-1 MSB-first signal input timing



● LSB-first signal input timing

Figure 3.1-2 LSB-first signal input timing



## 3.2 Dot clock control

For the dot clock, you can select dot clock frequency direct input or frequency-doubled input. Set bits DC2 to DC0 of command 11-2 (dot clock control) to select dot clock control.

### ■ Dot clock selection control

Table 3.2-1 lists the settings for dot clock selection control and the resulting operations.

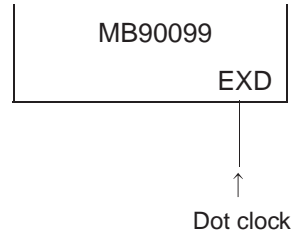
**Table 3.2-1 Dot clock selection control (Dot clock control 1(command 11-2):DC2 to DC0 bit)**

DC2	DC1	DC0	Dot clock control
0	1	0	Dot clock External input
0	1	1	2x Dot clock External input
Other than settings			Setting prohibited

### ■ Dot clock External input

The MB90099 inputs a dot clock signal to the EXD pin as shown in Figure 3.2-1 .

**Figure 3.2-1 Dot clock External input**



#### Note

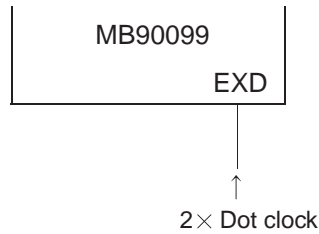
The input horizontal cycle must be synchronized in integer multiples of the input clock cycle. The input clock signal must be a continuous signal without being intermitted.

At least five clock pulses must be input even at reset input (when the Low level signal is input to the RESET pin).

### ■ External 2x (frequency-doubled) dot clock input

The MB90099 inputs a dot clock signal to the EXD pin as shown in Figure 3.2-2 .

**Figure 3.2-2 External 2x (frequency-doubled) dot clock input**



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#### Note

The input horizontal cycle must be synchronized in integer multiples of the input clock cycle. The horizontal synchronization operating edge must be the trailing edge. (Set the horizontal synchronization operating edge (bit HE) of I/O pin control (command 13-0) to 0.) The input clock signal must be a continuous signal without being intermitted.)

At least five clock pulses must be input even at reset input (when the Low level signal is input to the RESET pin).

---

### 3.3 Vertical sync control

Vertical synchronization control is the function to control vertical display by vertical synchronization detection. The level of the vertical sync signal is monitored at the leading or trailing edge of the horizontal sync pulse to detect the transition in signal level. The vertical display position on the screen depends on the transition detection position.

#### ■ Vertical synchronization detection

Use I/O pin control (command 13-0) to select control operation.

Table 3.3-1 -1 to Table 3.3-3 list the settings of individual control bits.

**Table 3.3-1 Selecting a Vertical Synchronization Detection Edge (I/O Pin Control (Command 13-0): Bit VVE)**

VVE	Vertical synchronization detection edge* <sup>1</sup>
0	Detect the leading edge of 0VSYNC.
1	Detect the trailing edge of 1VSYNC.

**Table 3.3-2 Selecting a Vertical Synchronization Detection HSYNC Edge (I/O Pin Control (Command 13-0): Bit VHE)**

VHE	Vertical synchronization detection HSYNC edge* <sup>1</sup>
0	Detect vertical synchronization at the leading edge of HSYNC.
1	Detect vertical synchronization at the trailing edge of HSYNC.

**Table 3.3-3 Sync Signal Input Logic Control (I/O Pin Control (Command 13-0): Bit SIX)**

SIX	Sync signal input logic
0	$\overline{\text{HSYNC}}$ and $\overline{\text{VSYNC}}$ pins are inverse logic input.
1	$\overline{\text{HSYNC}}$ and $\overline{\text{VSYNC}}$ pins are normal logic input.

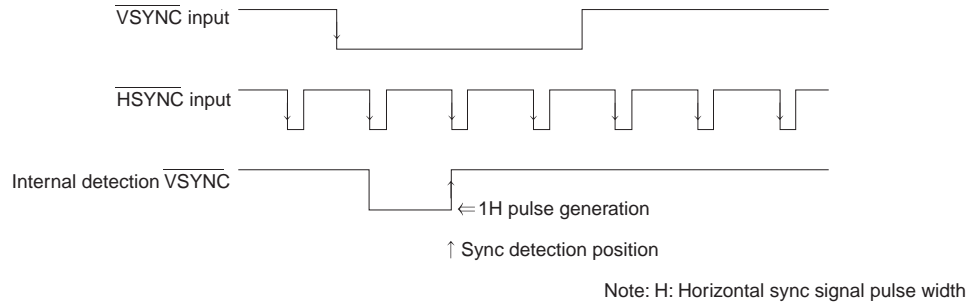
\*1: When VVE, VHE, and HE\*<sup>2</sup> are all set to 1, however, the trailing edge of the vertical sync signal (VSYNC) is detected at the leading edge of the horizontal sync signal (HSYNC).

\*2: "HE" is the horizontal synchronization operating edge select bit. See "3.4 Horizontal sync control".

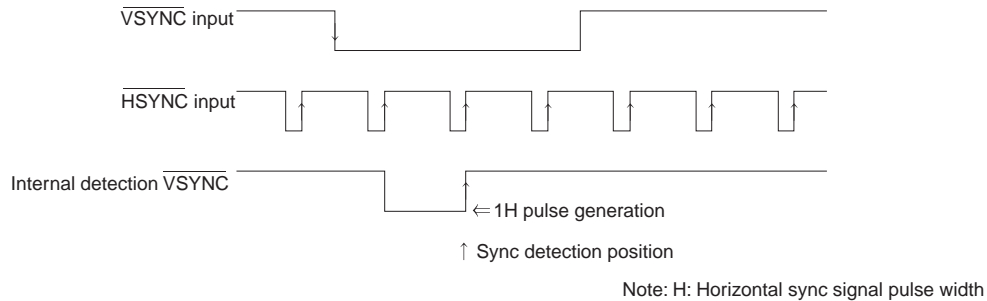
## ■ Principle of operation of detecting vertical synchronization

Figure 3.3-1 illustrate the principle of operation of detecting vertical synchronization (an example with sync signal input logic SIX = 0).

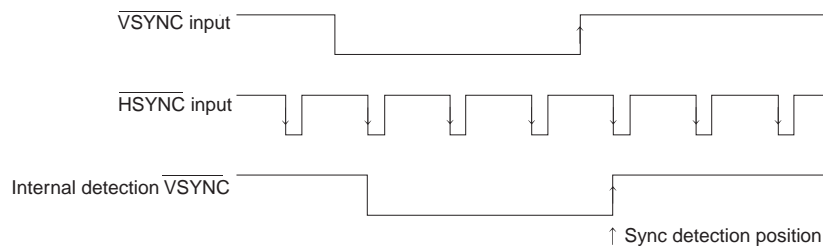
- Detect the leading edge of vertical sync signal at the leading edge of horizontal sync signal (during operation with VVE = 0 and VHE = 0).



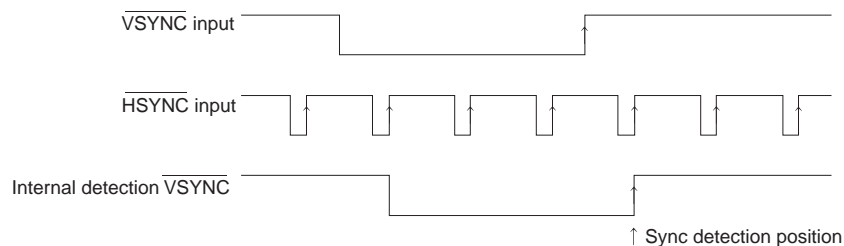
- Detect the leading edge of vertical sync signal at the trailing edge of horizontal sync signal (during operation with VVE = 0 and VHE = 1).



- Detect the trailing edge of vertical sync signal at the leading edge of horizontal sync signal (during operation with "VVE = 1, VHE = 0" or "VVE = 1, VHE = 1, HE = 1")



- Detect the trailing edge of vertical sync signal at the trailing edge of horizontal sync signal (during operation with VVE = 1, VHE = 1, and HE = 0).



**Figure 3.3-1 Principle of operation of detecting vertical synchronization (an example with sync signal input logic SIX = 0)**

## 3.4 Horizontal sync control

---

For horizontal synchronization control, you can select operation at the leading or trailing edge of the input horizontal sync pulse. The horizontal display position on the screen depends on this selection.

---

### ■ Dot clock external input operation

You can select operation at the leading or trailing edge of the input horizontal sync signal.

#### ● Selecting a horizontal synchronization detection edge

Table 3.4-1 lists the settings for selecting the horizontal synchronization detection edge.

**Table 3.4-1 Selecting a Horizontal Synchronization Detection Edge (I/O Pin Control (Command 13-0): Bit HE)**

HE	Horizontal synchronization operating edge
0	Trailing-edge operation
1	Leading-edge operation

---

#### Note

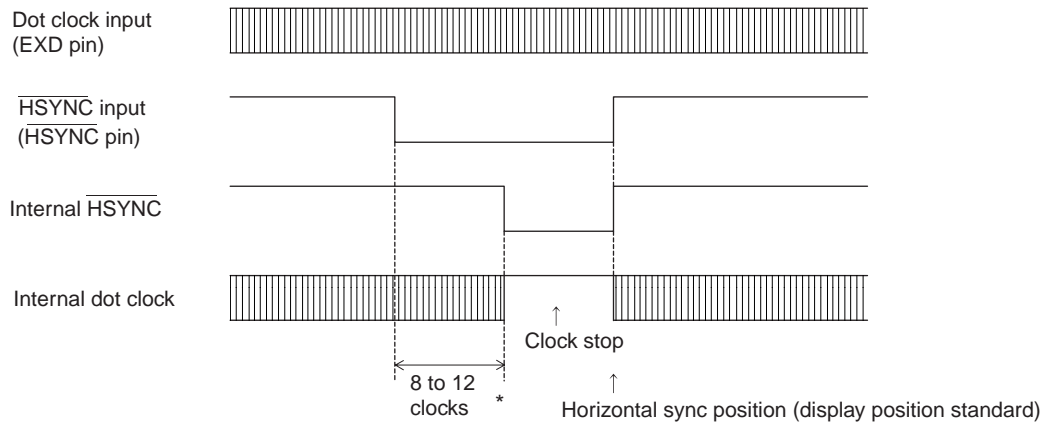
For 2x dot clock input, select the trailing edge operation

---

#### ● Example of horizontal operation

Figure 3.4-1 shows example of horizontal sync signal trailing edge operation (HE=0) and Figure 3.4-2 shows example of horizontal sync signal leading edge operation (HE=1).

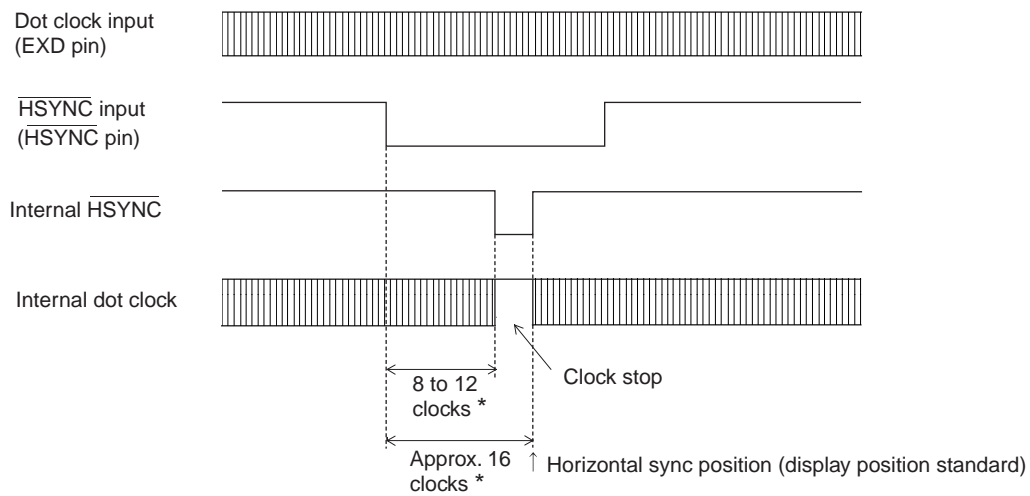
**Figure 3.4-1 Horizontal Sync Signal Trailing Edge Operation**



\*: Value in normal clock input.

2 cycles of input dot clock correspond to 1 clock in 2 x dot clock input.

**Figure 3.4-2 Horizontal Sync Signal Leading Edge Operation**



\*: Value in normal clock input.

Don't set the horizontal sync leading edge operation in 2 x dot clock input.

## 3.5 Blanking Control

Blanking control is available in the following two types.

- Vertical blanking control
- Horizontal blanking control

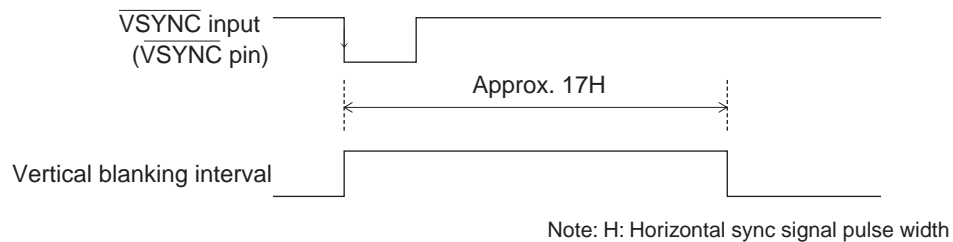
### ■ Vertical blanking control

Vertical blanking control is used to internally generate the vertical blanking interval to control display signal output. Display signal output is stopped during the vertical blanking interval. Vertical blanking control results in either of the following two operations depending on the setting of bit VVE (vertical sync signal detection edge select bit) of I/O pin control (command 13-0).

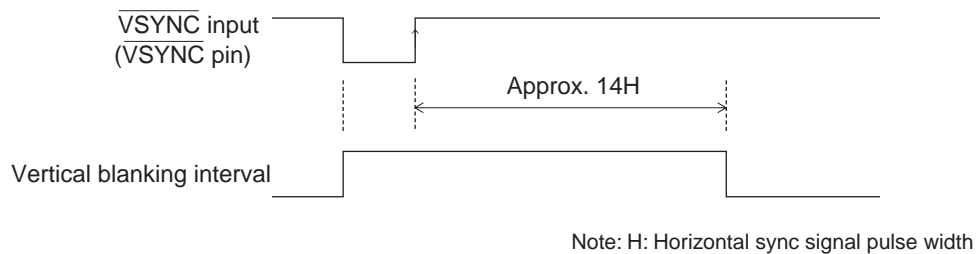
- Operation of vertical sync signal leading edge detection (bit VVE = 0)
- Operation of vertical sync signal trailing edge detection (bit VVE = 1)

Figure 3.5-1 show the operation under vertical blanking control.

- Operation of vertical sync signal leading edge detection (bit VVE = 0)



- Operation of vertical sync signal trailing edge detection (bit VVE = 1)



**Figure 3.5-1 Vertical blanking control**



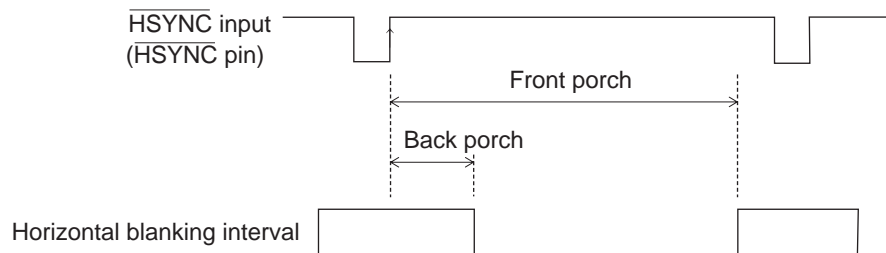
## ■ Horizontal blanking control

Horizontal blanking control is used to generate the horizontal blanking interval to control display signal output. Display signal output is stopped during the horizontal blanking interval. Horizontal blanking control can be set for the back porch and front porch by command control. Horizontal blanking control results in either of the following two operations depending on the setting of bit HE (horizontal synchronization operating edge select bit) of I/O pin control (command 13-0).

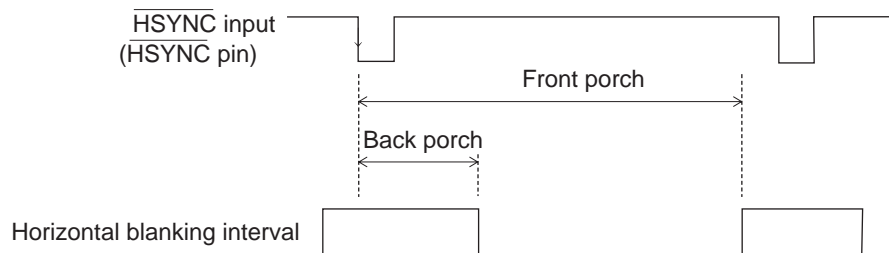
- Operation with horizontal synchronization operating edge as trailing edge (bit HE = 0)
- Operation with horizontal synchronization operating edge as leading edge (bit HE = 1)

Figure 3.5-2 show the operation under horizontal blanking control.

- Operation with horizontal synchronization operating edge as trailing edge (bit HE = 0)



- Operation with horizontal synchronization operating edge as leading edge (bit HE = 1)



**Figure 3.5-2 Horizontal blanking control**

The horizontal blanking back porch and front porch can be set as follows.

- Horizontal blanking back porch control  
Horizontal blanking control 1(command 13-1):BB5 to BB0 bits 0 to 126 dots, setting by 2-dot unit
- Horizontal blanking front porch control  
Horizontal blanking control 2(command 13-2):BF8 to BF0 bits 0 to 1022 dots, setting by 2-dot unit

---

### Note

- The back porch must be shorter than the front porch. Do not make any other setting.
  - The actual Horizontal blanking interval is offset from The set value by several tens of dots in The positive direction.
-

## 3.6 Three-Channel Display Signal Output Control

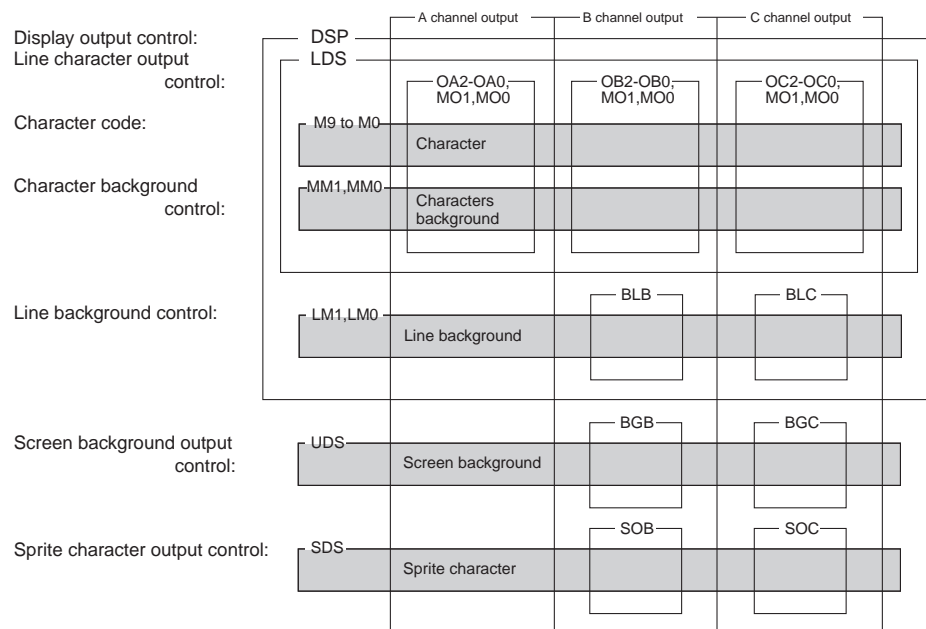
Display signal output can be controlled in three channels by using the output signals from the BLKA, BLKB, and BLKC pins.

### ■ Three-channel output control

#### ● Display Control Bits and Control Ranges

Figure 3.6-1 shows the display control bits and the ranges of three-channel output control.

**Figure 3.6-1 Display Control Bits and Control Ranges**



Note: Each system outputs are controlled by the following pin

A channel output :BLKA pin

B channel output :BLKB pin

C channel output :BLKC pin

- If character display is turned off by OA2 to OA0, OB2 to OB0, OC2 to OC0 bits, or MO1 and MO0 bits, the attribute of character including its trimming and character background, and the corresponding portions of the lower layer including line and screen backgrounds are displayed transparent.
- If line background display is turned off by bit BLB or BLC, line background and the portions of the screen background display layers are displayed transparent.
- If screen background display is turned off by bit BGB or BGC, the screen background display layer is displayed transparent.
- If sprite character display is turned off by bit SOB or SOC, the sprite character (including its trimming) and the corresponding portions of all the lower layers are displayed transparent.

### 3.7 Three-Channel Character Display Output Control

---

**The character attributes (character, trimming, and character background) of each character can be displayed under three-channel (A/B/C) output control.**

---

■ **Three-Channel Character Display Output Control**

Commands 5-00 to 5-02 are used for output control for each screen; command 1 is used for output control for each character.

- Output-A character control  
Screen output control 1A(command 5-00):OA2 to OA0 bits, settable 8 types
- Output-B character control  
Screen output control 1B(command 5-01):OB2 to OB0 bits, settable 8 types
- Output-C character control  
Screen output control 1C(command 5-02):OC2 to OC0 bits, settable 8 types
- Character output control  
Character data sets 1(command 1):MO1,MO0 bit, settable 4 types, setting by character

---

Note

When trimming dots for a character are displayed protruding to the area for an adjacent character, the output of the trimming dots is controlled by the character output control of that adjacent character. Three-channel output control for each character serves as output control within the character area (12 x 18 dots for normal characters).

If there are trimming dots to the left of the leftmost character on a line, they cannot be controlled by three-channel output control. In this case, place a blank character at the left end of the line and set characters to be displayed to the right.

When trimming dots are displayed to the right of the rightmost character on a line, the three-channel output control of the trimming dots depends on the character output control of the rightmost character.

---

Table 3.7-1 shows the contents of three-channel character output control.

**Table 3.7-1 Three-Channel Character Output Control**

Output-A/B/C character control			Character output control		Output (pin output)	
OA2/ OB2/ OC2	OA1/ OB1/ OC1	OA0/ OB0/ OC0	MO1	MO0	Output A(BLKA pin output)/ Output B(BLKB pin output)/ Output C(BLKC pin output)	
0	0	0	0	0	×	All display OFF
			0	1	×	
			1	0	×	
			1	1	×	
0	0	1	0	0	○	All display ON
			0	1	○	
			1	0	○	
			1	1	○	
0	1	0	0	0	×	Display ON for only characters with MO0 = 1
			0	1	○	
			1	0	×	
			1	1	○	
0	1	1	0	0	×	Display ON for only characters with MO1 = 1
			0	1	×	
			1	0	○	
			1	1	○	
1	0	0	0	0	×	Display ON for only characters with MO0 = 1 or MO1 = 1
			0	1	○	
			1	0	○	
			1	1	○	
1	0	1	0	0	○	Display ON for only characters with MO0 = 0
			0	1	×	
			1	0	○	
			1	1	×	
1	1	0	0	0	○	Display ON for only characters with MO1 = 0
			0	1	○	
			1	0	×	
			1	1	×	
1	1	1	0	0	○	Display ON for only characters with MO0 = 0 and MO1 = 0
			0	1	×	
			1	0	×	
			1	1	×	

○: display ON

×: display OFF

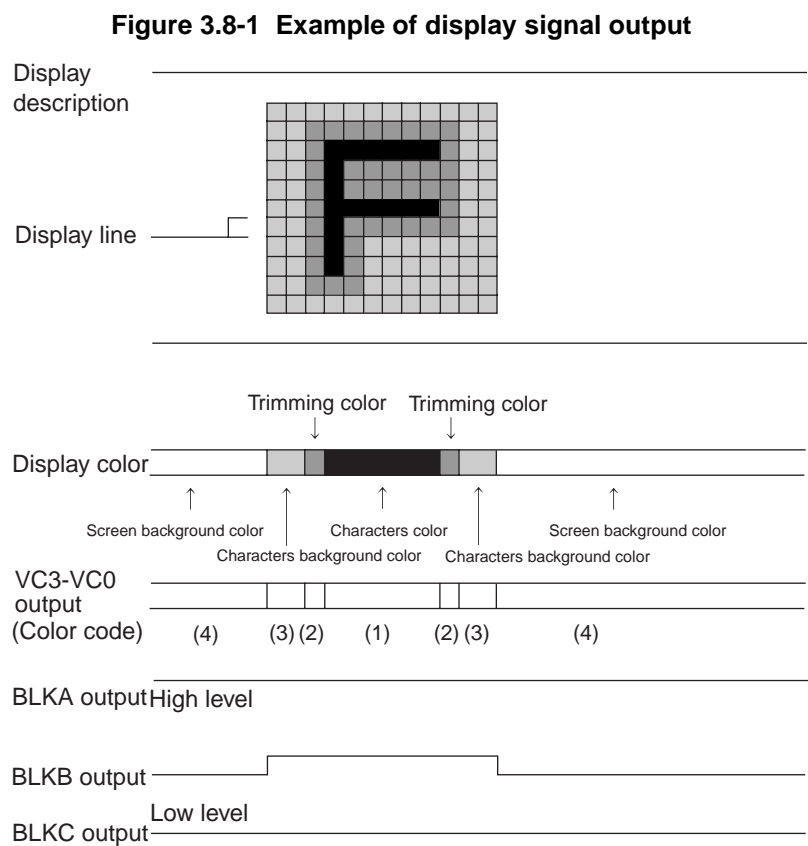
### 3.8 Display Signal Output Timings

Display signals are output to the following output pins.

- Output channel-A display period signal: BLKA pin
- Output channel-B display period signal: BLKB pin
- Output channel-C display period signal: BLKC pin
- Color code signals: VC3 to VC0 pins

■ Example of display signal output

Figure 3.8-1 shows an example of display signal output.



- (Note) Settings are as follows.
- Output - A: all schreen (schreen background output ON)
  - Output - B: only character type output
  - Output - C: output OFF
  - Color setting
- |                                  |    |
|----------------------------------|----|
| Character color code             | :1 |
| Trimming color code              | :2 |
| Characters background color code | :3 |
| Screen background color code     | :4 |

# **CHAPTER 4**

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## ***Display Control Command***

**This chapter explains display control commands.**

4.1 Commands

4.2 Notes on Issuing Commands

## 4.1 Commands

Table 4.1-1 lists the commands.

### ■ Commands

Table 4.1-1 Commands

No.	Command code/data													Function
	15 to 12	11	10	9	8	7	6	5	4	3	2	1	0	
	DF to DC	DB	DA	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0	
0	0000	AY3	AY2	AY1	AY0	FL	0	0	AX4	AX3	AX2	AX1	AX0	VRAM programming address setting
1	0001	MO1	MO0	MM1	MM0	MB3	MB2	MB1	MB0	MC3	MC2	MC1	MC0	Character data setting 1
2	0010	MR	MS	M9	M8	M7	M6	M5	M4	M3	M2	M1	M0	Character data setting 2
3	0011	LHS	LW2	LW1	LW0	LFD	LFC	LFB	LFA	LF3	LF2	LF1	LF0	Line control data setting 1
4	0100	LDS	LGS	LG1	LG0	LD	LE	LM1	LM0	L3	L2	L1	L0	Line control data setting 2
5-00	0101	0	0	0	0	SDS	UDS	0	DSP	0	OA2	OA1	OA0	Screen output control 1A
5-01	0101	0	0	0	1	SOB	BGB	BLB	0	0	OB2	OB1	OB0	Screen output control 1B
5-02	0101	0	0	1	0	SOC	BGC	BLC	0	0	OC2	OC1	OC0	Screen output control 1C
5-2	0101	1	0	0	Y8	Y7	Y6	Y5	Y4	Y3	Y2	Y1	Y0	Vertical display position control
5-3	0101	1	1	0	X8	X7	X6	X5	X4	X3	X2	X1	X0	Horizontal display position control
6-1	0110	0	1	0	0	BH3	BH2	BH1	BH0	BS3	BS2	BS1	BS0	Shaded background frame color control
7-3	0111	1	1	0	0	0	0	0	0	U3	U2	U1	U0	Screen background control
8-0	1000	0	0	SFB	SFA	SF3	SF2	SF1	SF0	SC3	SC2	SC1	SC0	Sprite character control 1
8-1	1000	0	1	SD1	SD0	SM7	SM6	SM5	SM4	SM3	SM2	SM1	SM0	Sprite character control 2
9-0	1001	0	0	SY9	SY8	SY7	SY6	SY5	SY4	SY3	SY2	SY1	SY0	Sprite character control 4
9-1	1001	1	0	SX9	SX8	SX7	SX6	SX5	SX4	SX3	SX2	SX1	SX0	Sprite character control 5
11-0	1011	0	0	0	0	0	EG0	0	0	0	0	0	0	Screen extension control
11-2	1011	1	0	0	0	0	0	0	0	0	DC2	DC1	DC0	Dot clock control 1
13-0	1101	0	0	VVE	VHE	HE	0	SIX	0	0	0	DBX	DCX	I/O pin control
13-1	1101	0	1	0	0	0	0	BB5	BB4	BB3	BB2	BB1	BB0	Horizontal blanking control 1
13-2	1101	1	0	0	BF8	BF7	BF6	BF5	BF4	BF3	BF2	BF1	BF0	Horizontal blanking control 2

Note: Reset input (Low level signal input to the  $\overline{\text{RESET}}$  pin) initializes bits DSP, UDS, and SDS of screen output control 1A (command 5-00) and bits DCX and DBX of I/O pin control (command 13-0) to zero. The contents of other register bits and VRAM remain indeterminate. After a reset, be sure to set all the register bits and VRAM.

## 4.1.1 Command Description (Commands 0 to 4)

Five commands, from 0 to 4, are described below.

- Command 0 (VRAM programming address setting)
- Command 1 (Character data setting 1)
- Command 2 (Character data setting 2)
- Command 3 (Line control data setting 1)
- Command 4 (Line control data setting 2)

### ■ Command Description (Commands 0 to 4)

#### ● Command 0 (VRAM programming address setting)

Command 0 sets the write address in VRAM and controls execution of "VRAM fill".

The command sets the write address by specifying the row and column addresses.

Execution of character data setting 2 (command 2) activates VRAM fill.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	0	AY3	AY2	AY1	AY0	FL	0	0	AX4	AX3	AX2	AX1	AX0

AY3-AY0 : Row address  
(0H to BH)

FL : VRAM fill specification  
(0:OFF, 1:ON)

AX4-AX0 : Column address  
(00H to 1BH)

#### ● Command 1 (Character data setting 1)

Sets character data.

Executing command 2 (character data setting 2) sets VRAM to reflect it on the screen.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	1	MO1	MO0	MM1	MM0	MB3	MB2	MB1	MB0	MC3	MC2	MC1	MC0

MO1,MO0 : Character Output Control  
(Refer to Table3.7-1 Three-Channel  
Character Output Control)

MB3-MB0 : Character background color  
(0H to FH:16 colors)

MM1,MM0 : Character background control  
(0,O: OFF)

MC3-MC0 : Character color  
(0H to FH:16 colors)

(0,1: Solid display)

(1,0: Shaded (concave) display)

(1,1: Shaded (convex) display)



● Command 2 (Character data setting 2)

Command 2 writes this setting data to the location in VRAM specified by command 0 (VRAM write address setting), along with the character data set by command 1 (character data setting 1).

The VRAM write address is incremented automatically after execution of command 2.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	1	0	MR	MS	M9	M8	M7	M6	M5	M4	M3	M2	M1	M0

MR : Shaded background succeeding character merge control  
(0:Independent)  
(1:Succeeding character merge)

MS : Characters horizontal size control  
(0:S size 6 dots)  
(1:L size 12 dots)

M9-M0: Character code  
(000H to 3FFH:1024 Character types)

● Command 3 (Line control data setting 1)

Sets line control data.

Executing command 4 (line control data setting 2) sets VRAM to reflect it on the screen.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	1	1	LHS	LW2	LW1	LW0	LFD	LFC	LFB	LFA	LF3	LF2	LF1	LF0

LHS : Line character vertical size type control  
(0:character vertical size A)  
(1:character vertical size B)

LW2-LW0 : Control of space between lines  
(0H to 7H : 0 to 7 dots)

LFD,LFC : Trimming output control  
(0,0: all schreen OFF)  
(0,1:Without character background trimming of character only ON)  
(1,0:Without character background, trimming of solid character only ON)  
(1,1: all schreen ON)

LFB,LFA: Trimming control  
(0,0:Trimming OFF)  
(0,1:Reserved (Setting prohibited))  
(1,0:Reserved (Setting prohibited))  
(1,1:8 direction trimming)

LF3-LF0 : Trimming color  
(0H to FH:16 colors)

● Command 4 (Line control data setting 2)

Command 4 writes this setting data to the row address in line VRAM specified by command 0 (VRAM write address setting), along with the line control data set by command 3 (line control data setting 1).

Executing this command does not change the VRAM write address.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	1	0	0	LDS	LGS	LG1	LG0	LD	LE	LM1	LM0	L3	L2	L1	L0

LDS : line character output control  
(character+trimming+Character  
background control)  
(0:OFF,1:ON)

LGS: Line enlargement interpolation control  
(0:OFF,1:ON)

LG1,LG0 : Line expansion control  
(0,0:Typical size)  
(0,1:Double width size)  
(1,0:Double height size)  
(1,1:Double width and height)

LD : Shaded background succeeding  
line merge control  
(0:Independent ,1:succeeding line merge)

LE : Character background extension control  
(0:Normal,1:Extended)

LM1,LM0 : Line background control  
(0,0: OFF)

(0,1:Solid display)

(1,0:Shaded (concave) display)

(1,1:Shaded (convex) display)

L3-L0 : Line background color  
(0H to FH:16 colors)

## 4.1.2 Command Description (Commands 5-00 to 5-3)

Five commands, from 5-00 to 5-3, are described below.

- Command 5-00 (Screen output control 1A)
- Command 5-01 (Screen output control 1B)
- Command 5-02 (Screen output control 1C)
- Command 5-2 (Vertical display position control)
- Command 5-3 (Horizontal display position control)

### ■ Command Description (Commands 5-00 to 5-3)

#### ● Command 5-00 (Screen output control 1A)

Screen display output

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	1	0	1	0	0	0	0	SDS	UDS	0	DSP	0	OA2	OA1	OA0

SDS : Sprite character output control  
(0:OFF,1:ON) \*

UDS : Screen background output control  
(0:OFF,1:ON) \*

DSP : display output control  
(Character+Trimming+Characters  
background+Line background control)  
(0:OFF,1:ON) \*

OA2-OA0 : Output - A character control  
(0H to 7H:8 types)

\*: Level input to the  $\overline{\text{RESET}}$  pin initializes SDS, UDS and DSP to 0.

#### ● Command 5-01 (Screen output control 1B)

This function controls output-B screen display output.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	1	0	1	0	0	0	1	SOB	BGB	BLB	0	0	OB2	OB1	OB0

SOB : Output - B Sprite character output control  
(0:OFF,1:ON)

BGB : Output - B Screen background output control  
(0:OFF,1:ON)

BLB : Output - B Line background output control  
(0:OFF,1:ON)

OB2-OB0 : Output - B character control  
(0H to 7H:8 types)

● Command 5-02 (Screen output control 1C)

This function controls output-C screen display output.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	1	0	1	0	0	1	0	SOC	BGC	BLC	0	0	OC2	OC1	OC0

SOC : Output - C Sprite character output control  
(0:OFF,1:ON)

BGC : Output - C Screen background output control  
(0:OFF,1:ON)

BLC : Output - C Line background output control  
(0:OFF,1:ON)

OC2-OC0 : Output - C Character control  
(0H to 7H:8 types)

● Command 5-2 (Vertical display position control)

The command controls the vertical display position on the screen.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	1	0	1	1	0	0	Y8	Y7	Y6	Y5	Y4	Y3	Y2	Y1	Y0

Y8-Y0 : Vertical display position control  
(000H to 1FFH: 0-1022, 2 - dot units)

● Command 5-3 (Horizontal display position control)

The command controls the horizontal display position on the screen.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	1	0	1	1	1	0	X8	X7	X6	X5	X4	X3	X2	X1	X0

X8-X0 : Horizontal display position control  
(000H to 1FFH: 0-1022, 2 - dot units)

### 4.1.3 Command Description (Commands 6-1 to 11-2)

Eight commands, from 6-1 to 11-2, are described below.

- Command 6-1 (Shaded background frame color control)
- Command 7-3 (Screen background control)
- Command 8-0 (Sprite character control 1)
- Command 8-1 (Sprite character control 2)
- Command 9-0 (Sprite character control 4)
- Command 9-1 (Sprite character control 5)
- Command 11-0 (Screen extension control)
- Command 11-2 (Dot clock control 1)

#### ■ Command Description (Commands 6-1 to 11-2)

- Command 6-1(Shaded background frame color control)

Shaded background frame color control (command 6-1) controls the frame color of a shaded background.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	1	1	0	0	1	0	0	BH3	BH2	BH1	BH0	BS3	BS2	BS1	BS0

BH3-BH0 : Shaded background frame highlight color  
(0H to FH: 16 colors)

BS3-BS0 : Shaded background frames shadow color  
(0H to FH: 16 colors)

- Command 7-3 (Screen background control)

This function controls screen background colors.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	1	1	1	1	1	0	0	0	0	0	0	U3	U2	U1	U0

U3-U0 : Display background color  
(0H to FH: 16 colors)

● Command 8-0 (Sprite character control 1)

This command controls sprite characters

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
1	0	0	0	0	0	SFB	SFA	SF3	SF2	SF1	SF0	SC3	SC2	SC1	SC0

SFB,SFA : Sprite character trimming control  
 (0,0:Trimming OFF)  
 (0,1:Reserved (Setting prohibited))  
 (1,0:Reserved (Setting prohibited))  
 (1,1:8 direction trimming)

SF3-SF0 : Sprite character trimming color  
 (0H to FH:16 colors)

SC3-SC0 : Sprite character color  
 (0H to FH:16 colors)

● Command 8-1 (Sprite character control 2)

This command controls sprite characters

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
1	0	0	0	0	1	SD1	SD0	SM7	SM6	SM5	SM4	SM3	SM2	SM1	SM0

SD1,SD0 : Sprite character configuration control  
 (0,0:1 character)  
 (0,1:Reserved (Setting prohibited))  
 (1,0:2 characters high)  
 (1,1:Reserved (Setting prohibited))

SM7-SM0 : Sprite character code  
 (00H to FFH:256 types)

● Command 9-0 (Sprite character control 4)

Controls a vertical display position of sprite characters.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
1	0	0	1	0	0	SY9	SY8	SY7	SY6	SY5	SY4	SY3	SY2	SY1	SY0

SY9-SY0 : Sprite character vertical display position control  
 (000H to 3FFH:0-1023,1 - dot units )

● Command 9-1 (Sprite character control 5)

Controls a horizontal display position of sprite characters.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
1	0	0	1	1	0	SX9	SX8	SX7	SX6	SX5	SX4	SX3	SX2	SX1	SX0

SX9-SX0 : Sprite character horizontal display position control  
 (000H to 3FFH:0-1023,1 - dot units )

● Command 11-0 (Screen extension control)

This command is reserved for screen extension control.

Be sure to set this.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
1	0	1	1	0	0	0	0	0	EG0	0	0	0	0	0	0

EG0 : (Reserved)  
 (0:Normal)  
 (1:Reserved (Setting prohibited))

● Command 11-2 (Dot clock control 1)

This command controls the dot clock.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
1	0	1	1	1	0	0	0	0	0	0	0	0	DC2	DC1	DC0

DC2-DC0 : Dot clock selection control  
 (0,1,0:Dot clock external input)  
 (0,1,1:2× Dot clock external input)

## 4.1.4 Command Description (Commands 13-0 to 13-2)

Three commands, from 13-0 to 13-2, are described below.

- Command 13-0 (I/O pin control)
- Command 13-1 (Horizontal blanking control 1)
- Command 13-2 (Horizontal blanking control 2)

### ■ Command Description (Commands 13-0 to 13-2)

#### ● Command 13-0 (I/O pin control)

This command controls I/O pins.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
1	1	0	1	0	0	VVE	VHE	HE	0	SIX	0	0	0	DBX	DCX

VVE : Vertical synchronization detection  
edge select \*1  
(0:Leading edge, 1:Trailing edge)

VHE : Vertical Synchronization Detection  
HSYNC Edge select  
(0:Leading edge, 1:Trailing edge)

HE : Horizontal synchronization operating  
edge select \*1  
(0:Leading edge, 1:Trailing edge)

SIX : Synchronization signal input logic control  
(0:negative logic, 1:positive logic)

DBX : Display output period signal output logic control  
(0:positive logic, 1:negative logic) \*2

DCX : Display color signal output logic control  
(0:positive logic, 1:negative logic) \*2

\*1:When VVE, VHE, and HE are all set to 1, HSYNC edge for vertical synchronization detection is the standard of "Leading edge".

VVE	VHE	HE	Content of vertical synchronization detection	Vertical synchronization detection position *3
0	0	0	Detect the leading edge of VSYNC.	Leading edge of HSYNC
0	0	1	Detect the leading edge of VSYNC.	Leading edge of HSYNC
0	1	0	Detect the leading edge of VSYNC.	Trailing edge of HSYNC
0	1	1	Detect the leading edge of VSYNC.	Trailing edge of HSYNC
1	0	0	Detect the trailing edge of VSYNC.	Leading edge of HSYNC
1	0	1	Detect the trailing edge of VSYNC.	Leading edge of HSYNC
1	1	0	Detect the trailing edge of VSYNC.	Trailing edge of HSYNC
1	1	1	Detect the trailing edge of VSYNC.	Leading edge of HSYNC + 10 clock cycles

\*2:Low level input to the  $\overline{\text{RESET}}$  pin initializes DCX and DBX to 0.

\*3:If the VSYNC pin signal is changed in level in the detection direction near a vertical synchronization detection position, display may be disturbed (by vertical blurring). Avoid that vertical synchronization detection position to input the significant edge of the VSYNC signal.



● Command 13-1 (Horizontal blanking control 1)

This command controls the back porch of the horizontal blanking interval.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
1	1	0	1	0	1	0	0	0	0	BB5	BB4	BB3	BB2	BB1	BB0

BB5-BB0 : Back porch control  
(00H to 3FH:0 to 126, 2 - dot uni

● Command 13-2 (Horizontal blanking control 2)

This command controls the front porch of the horizontal blanking interval.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
1	1	0	1	1	0	0	BF8	BF7	BF6	BF5	BF4	BF3	BF2	BF1	BF0

BF8-BF0 : Front porch control  
(000H to 1FFH:0 to 1022,2 - dot units)

## 4.2 Notes on Issuing Commands

**This section summarizes notes on issuing commands.**

## ■ Initialization

The MB90099 enters the display off \* state at reset input (Low level signal input to the  $\overline{\text{RESET}}$  pin). The contents of VRAM (character RAM and line RAM) are indeterminate. Immediately after reset input/release, issue the following commands to initialize control operation.

- Dot clock control (Command 11-2)
- I/O pin control (command 13-0)

After that, set all of other command data and the contents of VRAM. (VRAM setting requires normal dot clock and sync signal inputs.)

\*: Reset

The reset input initializes control bits as shown below.

- Screen output control 1A (command 5-00) SDS = 0: Sprite display OFF  
UDS = 0: Screen background display=OFF  
DSP = 0: Character, character background,  
line background display OFF
- I/O pin control (command 13-0) DCX = 0: Sets the VC0 to VC3 pins to positive logic output.  
DBX = 0: Sets the BLKA, BLKB, and BLKC pins to positive  
logic output.

## ■ Command Refresh

Command data to the MB90099 and the contents of internal VRAM remain held as long as the MB90099 is powered. If the serial control, sync, and dot clock signals are affected by external noise, however, they may become abnormal signals, preventing the internal registers and VRAM from being set normally. You should therefore refresh all of command data and VRAM data periodically (at intervals of tens of milliseconds to several seconds) to restore them from the abnormal state.

## ■ Command issuance/execution timings

When a VRAM write command, such as character data setting 2 (command 2) or line control data setting 2 (command 4), or any other control command (command 5-00 to 13-2) is issued, the command is executed immediately, reflecting the result on the screen. When such a command is issued during a display period, the display in the relevant field may involve transient distortion. To prevent this symptom, you should issue the command during the vertical blanking interval.

To set one or more of bits DSP, SDS, and UDS, all set to OFF, to ON when setting screen output control 1A (command 5-00), wait until the next vertical sync signal after issuing the command to start displaying from the beginning of the scan field.



# ***APPENDIX***

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# ***APPENDIX***

**The appendix contains a package dimensional drawing of the MB90099, the font data for the MB90099-001, and the procedures for creating fonts and releasing font data.**

APPENDIX A Package Dimension

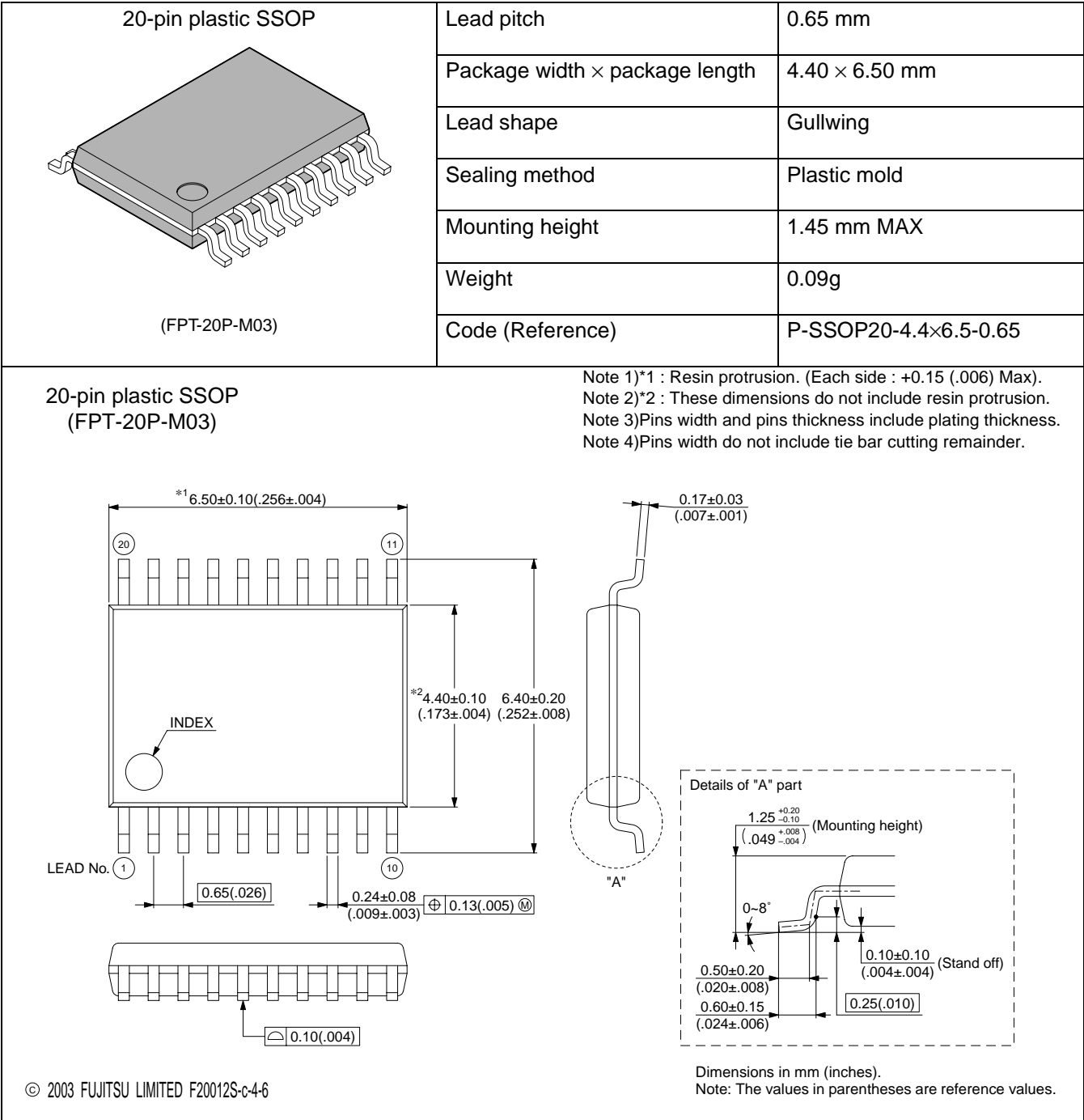
APPENDIX B MB90099-001 Font ROM data

APPENDIX C Creating a Font and Releasing Font Data

# APPENDIX A    Package Dimension

Invalid target parameter shows package dimension (FTP-20P-M03) of MB90099.

## ■ Package Dimension (FTP-20P-M03)



## APPENDIX B MB90099-001 Font ROM data

Figure B-1 shows the font data of MB90099-001.

■ MB90099-001 Font Data The MB90099-001 is a standard ROM model.

Figure B-1 MB90099-001 font data (continued)

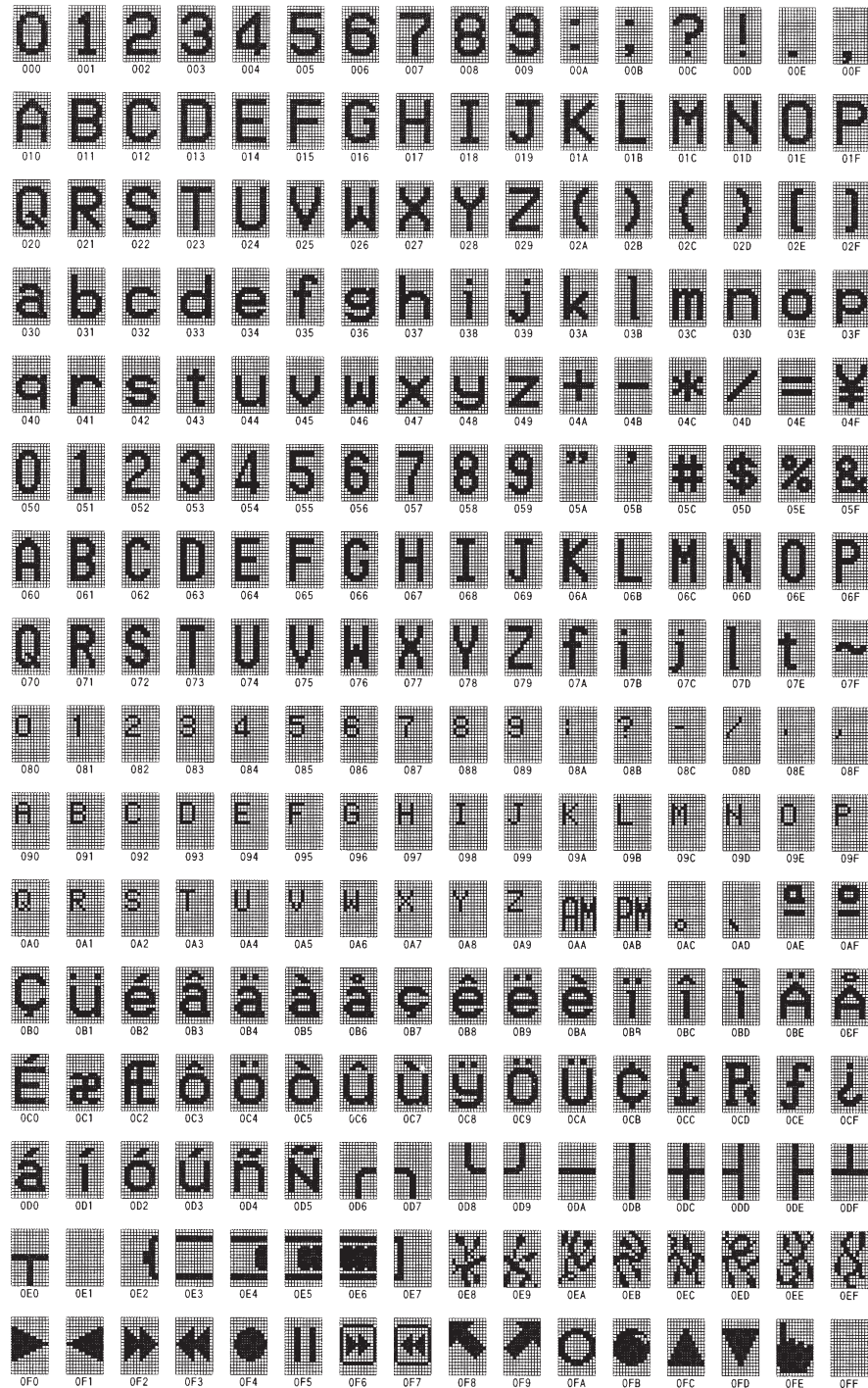


Figure B-2 MB90099-001 font data (continued)

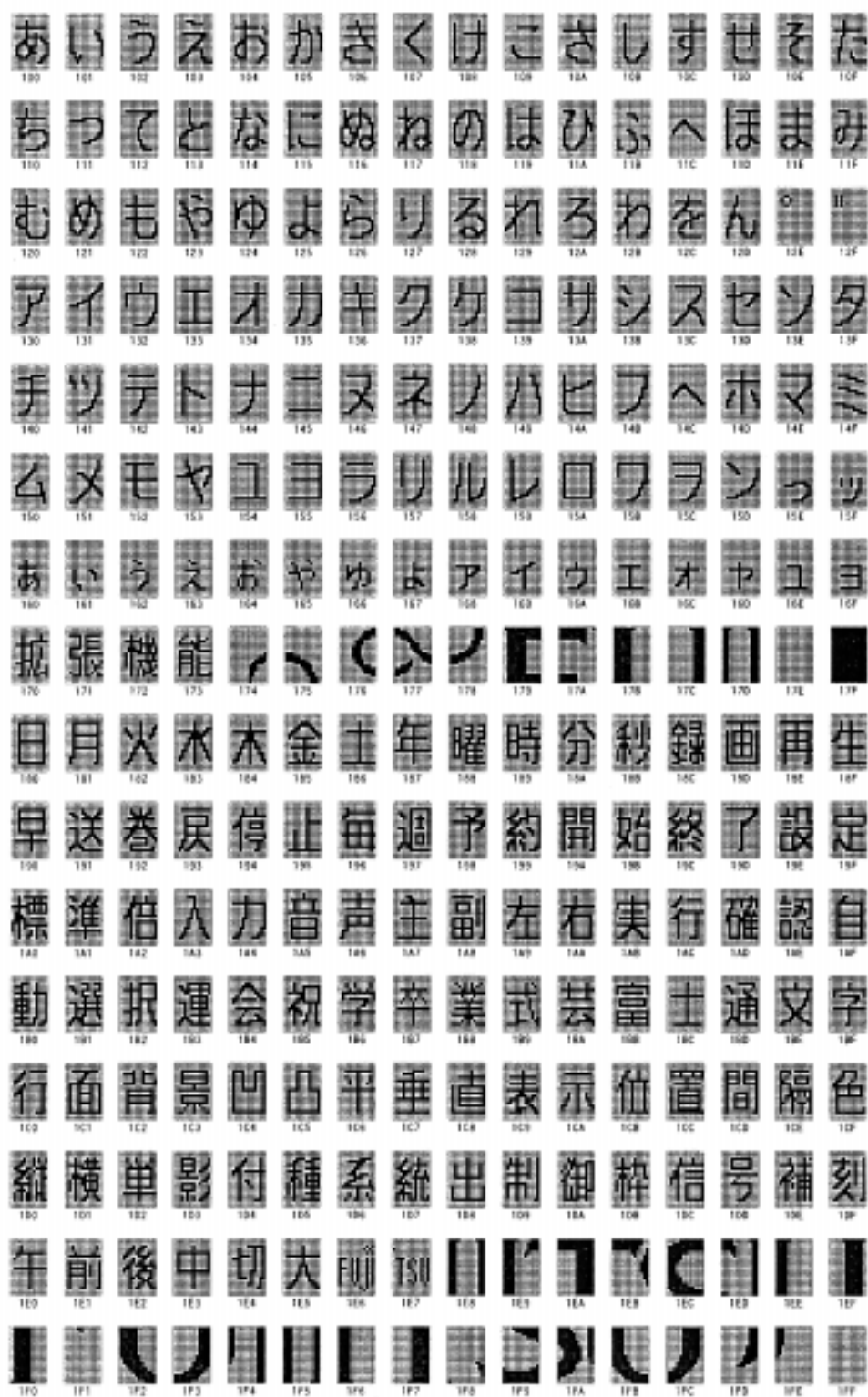




Figure B-3 MB90099-001 font data (continued)

0200	0201	0202	0203	0204	0205	0206	0207	0208	0209	020A	020B	020C	020D	020E	020F
210	211	212	213	214	215	216	217	218	219	21A	21B	21C	21D	21E	21F
0220	0221	0222	0223	0224	0225	0226	0227	0228	0229	022A	022B	022C	022D	022E	022F
0230	0231	0232	0233	0234	0235	0236	0237	0238	0239	023A	023B	023C	023D	023E	023F
0240	0241	0242	0243	0244	0245	0246	0247	0248	0249	024A	024B	024C	024D	024E	024F
0250	0251	0252	0253	0254	0255	0256	0257	0258	0259	025A	025B	025C	025D	025E	025F
0260	0261	0262	0263	0264	0265	0266	0267	0268	0269	026A	026B	026C	026D	026E	026F
0270	0271	0272	0273	0274	0275	0276	0277	0278	0279	027A	027B	027C	027D	027E	027F
0280	0281	0282	0283	0284	0285	0286	0287	0288	0289	028A	028B	028C	028D	028E	028F
0290	0291	0292	0293	0294	0295	0296	0297	0298	0299	029A	029B	029C	029D	029E	029F
02A0	02A1	02A2	02A3	02A4	02A5	02A6	02A7	02A8	02A9	02AA	02AB	02AC	02AD	02AE	02AF
02B0	02B1	02B2	02B3	02B4	02B5	02B6	02B7	02B8	02B9	02BA	02BB	02BC	02BD	02BE	02BF
02C0	02C1	02C2	02C3	02C4	02C5	02C6	02C7	02C8	02C9	02CA	02CB	02CC	02CD	02CE	02CF
02D0	02D1	02D2	02D3	02D4	02D5	02D6	02D7	02D8	02D9	02DA	02DB	02DC	02DD	02DE	02DF
02E0	02E1	02E2	02E3	02E4	02E5	02E6	02E7	02E8	02E9	02EA	02EB	02EC	02ED	02EE	02EF
02F0	02F1	02F2	02F3	02F4	02F5	02F6	02F7	02F8	02F9	02FA	02FB	02FC	02FD	02FE	02FF



Figure B-4 MB90099-001 font data

03 00	03 01	03 02	03 03	03 04	03 05	03 06	03 07	03 08	03 09	03 0A	03 0B	03 0C	03 0D	03 0E	03 0F
300	301	302	303	304	305	306	307	308	309	30A	30B	30C	30D	30E	30F
03 10	03 11	03 12	03 13	03 14	03 15	03 16	03 17	03 18	03 19	03 1A	03 1B	03 1C	03 1D	03 1E	03 1F
310	311	312	313	314	315	316	317	318	319	31A	31B	31C	31D	31E	31F
03 20	03 21	03 22	03 23	03 24	03 25	03 26	03 27	03 28	03 29	03 2A	03 2B	03 2C	03 2D	03 2E	03 2F
320	321	322	323	324	325	326	327	328	329	32A	32B	32C	32D	32E	32F
03 30	03 31	03 32	03 33	03 34	03 35	03 36	03 37	03 38	03 39	03 3A	03 3B	03 3C	03 3D	03 3E	03 3F
330	331	332	333	334	335	336	337	338	339	33A	33B	33C	33D	33E	33F
03 40	03 41	03 42	03 43	03 44	03 45	03 46	03 47	03 48	03 49	03 4A	03 4B	03 4C	03 4D	03 4E	03 4F
340	341	342	343	344	345	346	347	348	349	34A	34B	34C	34D	34E	34F
03 50	03 51	03 52	03 53	03 54	03 55	03 56	03 57	03 58	03 59	03 5A	03 5B	03 5C	03 5D	03 5E	03 5F
350	351	352	353	354	355	356	357	358	359	35A	35B	35C	35D	35E	35F
03 60	03 61	03 62	03 63	03 64	03 65	03 66	03 67	03 68	03 69	03 6A	03 6B	03 6C	03 6D	03 6E	03 6F
360	361	362	363	364	365	366	367	368	369	36A	36B	36C	36D	36E	36F
03 70	03 71	03 72	03 73	03 74	03 75	03 76	03 77	03 78	03 79	03 7A	03 7B	03 7C	03 7D	03 7E	03 7F
370	371	372	373	374	375	376	377	378	379	37A	37B	37C	37D	37E	37F
03 80	03 81	03 82	03 83	03 84	03 85	03 86	03 87	03 88	03 89	03 8A	03 8B	03 8C	03 8D	03 8E	03 8F
380	381	382	383	384	385	386	387	388	389	38A	38B	38C	38D	38E	38F
03 90	03 91	03 92	03 93	03 94	03 95	03 96	03 97	03 98	03 99	03 9A	03 9B	03 9C	03 9D	03 9E	03 9F
390	391	392	393	394	395	396	397	398	399	39A	39B	39C	39D	39E	39F
03 A0	03 A1	03 A2	03 A3	03 A4	03 A5	03 A6	03 A7	03 A8	03 A9	03 AA	03 AB	03 AC	03 AD	03 AE	03 AF
3A0	3A1	3A2	3A3	3A4	3A5	3A6	3A7	3A8	3A9	3AA	3AB	3AC	3AD	3AE	3AF
03 B0	03 B1	03 B2	03 B3	03 B4	03 B5	03 B6	03 B7	03 B8	03 B9	03 BA	03 BB	03 BC	03 BD	03 BE	03 BF
3B0	3B1	3B2	3B3	3B4	3B5	3B6	3B7	3B8	3B9	3BA	3BB	3BC	3BD	3BE	3BF
03 C0	03 C1	03 C2	03 C3	03 C4	03 C5	03 C6	03 C7	03 C8	03 C9	03 CA	03 CB	03 CC	03 CD	03 CE	03 CF
3C0	3C1	3C2	3C3	3C4	3C5	3C6	3C7	3C8	3C9	3CA	3CB	3CC	3CD	3CE	3CF
03 D0	03 D1	03 D2	03 D3	03 D4	03 D5	03 D6	03 D7	03 D8	03 D9	03 DA	03 DB	03 DC	03 DD	03 DE	03 DF
3D0	3D1	3D2	3D3	3D4	3D5	3D6	3D7	3D8	3D9	3DA	3DB	3DC	3DD	3DE	3DF
03 E0	03 E1	03 E2	03 E3	03 E4	03 E5	03 E6	03 E7	03 E8	03 E9	03 EA	03 EB	03 EC	03 ED	03 EE	03 EF
3E0	3E1	3E2	3E3	3E4	3E5	3E6	3E7	3E8	3E9	3EA	3EB	3EC	3ED	3EE	3EF
03 F0	03 F1	03 F2	03 F3	03 F4	03 F5	03 F6	03 F7	03 F8	03 F9	03 FA	03 FB	03 FC	03 FD	03 FE	03 FF
3F0	3F1	3F2	3F3	3F4	3F5	3F6	3F7	3F8	3F9	3FA	3FB	3FC	3FD	3FE	3FF

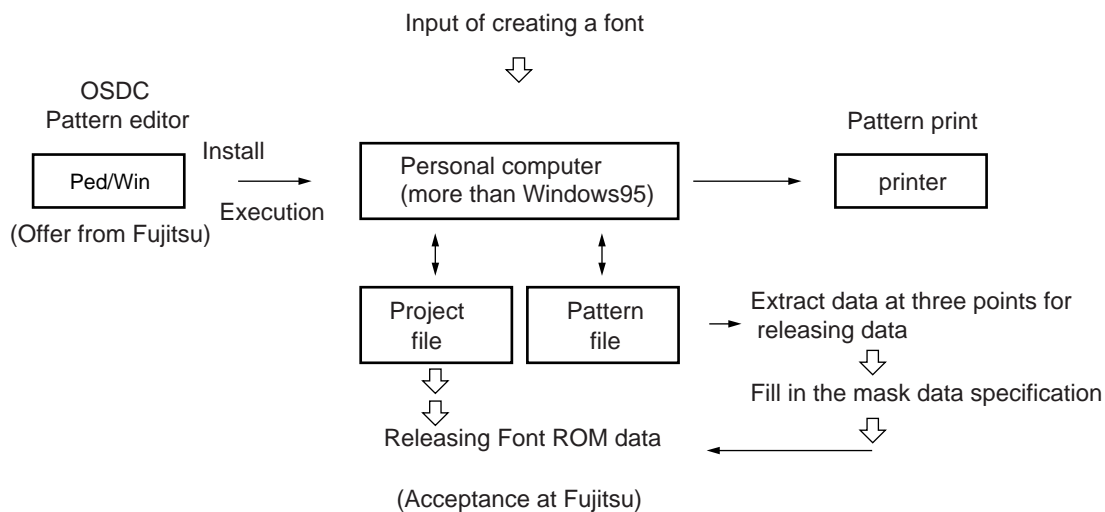
## APPENDIX C Creating a Font and Releasing Font Data

The MB90099 font ROM allows the user to set a total of 1024 different characters. You can create your font data using a pattern editor for OSDCs, Ped/Win. Ped/Win is the pattern editor dedicated to the OSDC series, which runs on the personal computer under (the Japanese version of) Windows.

### ■ Creating a Font and Releasing Font Data

Create a font and release font data as illustrated below.

**Figure C-1 Creating a Font and Releasing Font Data**



### ● Releasing Font ROM data

Font data is released only in the project file. Do not release pattern files. Fujitsu examines part of data in the pattern file to check for consistency before accepting the release data. For this check, please enter some data contents of the pattern file in the mask data specifications.

#### Note

Output the pattern file after finishing creating the font and the project. Once you have created the pattern file, do not update the project file. If you modify the project after creating the pattern file, recreate the pattern file.

### ● Project file

Created font data and other auxiliary data are stored in a project file. Usually, one project file is created for each model.

- Project file name: Project file names must be in the "MB90099-XXX.prj" format. XXX represents a ROM number designated by Fujitsu. For the ROM number, ask your local sales representative of Fujitsu. While the ROM number is undecided, use any character string beginning with a letter. You can use any file name for a project file when creating it on a trial basis with no font to be released.
- You can set any character string as a comment for the project you are creating. The comment is printed when the font is printed. You can change it freely when using Ped/Win.

### ● Pattern file

Created font ROM data can be saved to a pattern file. Since pattern data is usually saved to the project file, a pattern file must be created only to extract confirmation data before font data is released (or to fill in the mask data specifications). Do not release pattern files.

- Pattern files for some of conventional OSDs other than the MB90099 can also be loaded.
- Do not create more than one pattern file for one project. Doing so may result in errors. When creating another pattern file, you should create another project with a different project name.
- Extract data at three points of the start address, last address, and another address of pattern file data and enter it in the mask data specifications. For the arbitrary address, select one whose content is not "00" nor "FF".

---

### Note

Although the display functions of Ped/Win are based on OSD specifications, Ped/Win may not comply with all of the actual OSD display functions. Be sure to check this manual.

---

### ■ Data verification request

When Fujitsu has completed ROM masking after a data release, Fujitsu extract and return the ROM data used for it. Please verify the extracted data with your pattern file data to check that they match. When you have checked the extracted data for verification, return the "data verification sheet" after entering your decision to pass or fail. If the data does not match, contact the sales representative promptly. Created ES may contain errors.

# INDEX

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The index follows on the next page.  
This is listed in alphabetic order.

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