Noritake itron

Vacuum Fluorescent Display Module

GU-D series

“General Function”

Software Specification

Model: GU-D series

Applicable firmware version: F110 [or later]

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1 General Description

1.1 Scope

This specification covers the software aspects of the GU-D series vacuum fluorescent graphic display modules.

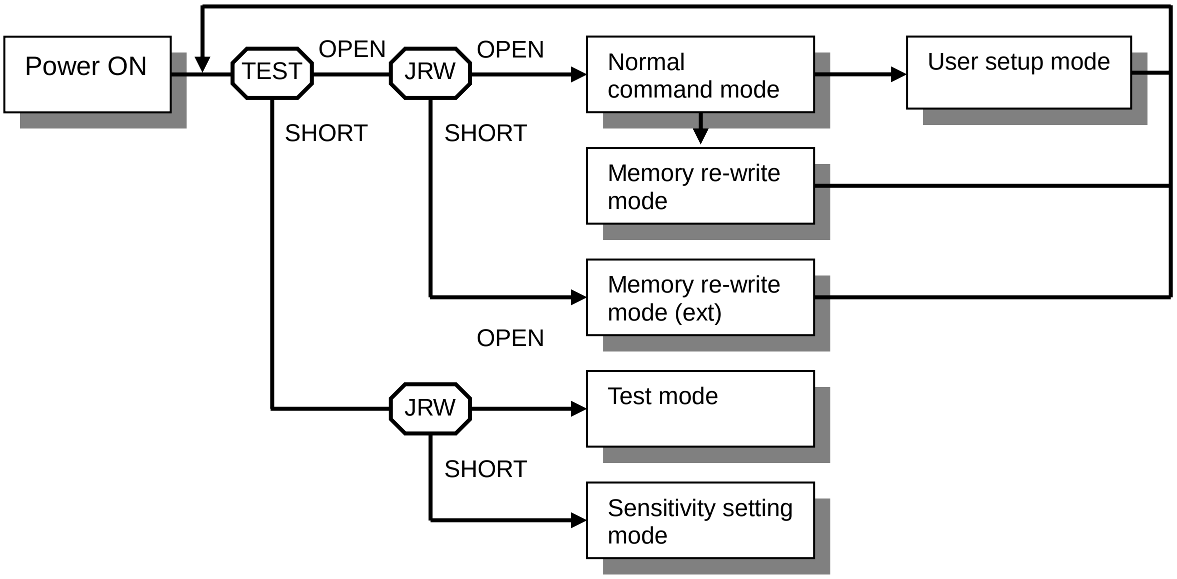
Related specifications:

・Hardware Specification for the particular VFD module.
・GU-D Series "Program Macro" Software Specification: DS-1900-0004-XX
(Refer to "5.2.9.1 RAM Macro define / delete" and "5.2.10.4 FROM Macro define / delete")
・Character fonts specification: Refer to "4.1.2 Character display".

1.2 Functions

Character display, Graphic display, Control command,
Display action command, Bit Image display/download function, Window function,
Download (user-definable) font, Macro / Program Macro function, Memory Switch (MSW),
I/O port control, Touch information read, Touch sensitivity adjustment

2 Operating Mode



2.1 Normal command mode

Normal operation mode in which the module can receive commands and data via the various interfaces.

2.2 User setup mode

This mode is used for saving Memory SW and various data to FROM.

2.3 Memory re-write mode / Memory re-write mode (ext)

Mode for factory re-writing of memory. Not for routine use.

2.4 Test mode

Test for display and internal operation. Used for factory test.

2.5 Sensitivity setting mode

For adjustment of internal parameters for the Touch-Switch. Used for factory test.

2.6 Power-on setting

At power-on, the various display settings are set to default value, or value stored in Memory SW.
(Refer to "6.2 Memory SW (MSW)".)
・If “Macro execution at power-on” in enabled, Macro or Program Macro is automatically executed.

3 VFD Module model-specific information

3.1 Timing Unit

Timing unit length varies between different modules.
The timing unit length for each module display dot size is shown below.

Module Type Item	GU128X32D -D903S	GU140X32F -D903S	GU256X64C -D903M	GU256X128C -D903M	-
Timing unit (Typ.) ± 5% ***IntTime***	14ms	14ms	14ms	14ms	-

Timing unit affects the timing of the following commands and operations:

・5.2.1.3 Cursor display ON/OFF
・5.2.2.4 Horizontal scroll speed
・5.2.4.2 Scroll display action
・5.2.4.3 Blink display action
・5.2.9.2 Macro execution
・5.2.10.4 FROM Macro define / delete

3.2 Display Memory configuration

Display Memory size and configuration varies between different modules. For each module, the following module-specific values are referred to throughout this specification:

Item	Description
DispXdots	The number of dots in the X-direction (horizontal) on the VFD screen.
DispYdots	The number of dots in the Y-direction (vertical) on the VFD screen.
Xdots	The number of dots in the X-direction (horizontal) for the entire Display Memory.
Ydots	The number of dots in the Y-direction (vertical) for the entire Display Memory.
Ybytes	Used when specifying Y-parameter in bytes (8-dot units). [***Ydots*** ÷ 8]
Max_Xdot	Valid X-coordinate values range from 0 to Max_Xdot. [***Xdots*** - 1]
Max_Ydot	Valid Y-coordinate values range from 0 to Max_Ydot. [***Ydots*** - 1]
Max_Ybyte	Valid Y-coordinate 8-dot unit values range from 0 to Max_Ybyte. [***Ybytes*** - 1]
Max_Xdot_CurtWin	Maximum valid X-coordinate value for current window.
Max_Ydot_CurtWin	Maximum valid Y-coordinate value for current window.
DispMemSize	Size of Display Memory in bytes. (number of bytes)
Max_DispMemAddr	Valid Display Memory addresses range from 0 to Max_DispMemAddr. [***DispMemSize*** - 1]

・The configuration for each module display dot size is shown below.

Module Type Item		GU128X32D -D903S	GU140X32F -D903S	GU256X64C -D903M	GU256X128C -D903M	-
Display area [***DispXdots*** × ***DispYdots***]		128×32	140×32	256X64	256X128	-
Hidden area [(***Xdots*** –***DispXdots***) × ***DispYdots***]		384×32	372×32	768X64	256X128	-
Total area [***Xdots*** × ***Ydots***]		512×32	512×32	1024X64	512X128	-
Display Memory	***Xdots***	512 (0200h)	512 (0200h)	1024 (0400h)	512 (0200h)	-
	Ydots	32 (0020h)	32 (0020h)	64 (0040h)	128 (0080h)	-
	Ybytes	4 (04h)	4 (04h)	8 (08h)	16 (10h)	-
	Max_Xdot	511 (01FFh)	511 (01FFh)	1023 (03FFh)	511 (01FFh)	-
	Max_Ydot	31 (001Fh)	31 (001Fh)	63 (003Fh)	127 (007Fh)	-
	Max_Ybyte	3 (03h)	3 (03h)	7 (0007h)	15 (000Fh)	-
	Max_Xdot_CurtWin	0 to 511 * (0000h to 01FFh)	0 to 511 * (0000h to 01FFh)	0 to 1023 * (0000h to 03FFh)	0 to 511 * (0000h to 01FFh)	-
	Max_Ydot_CurtWin	7 to 31 * (0007h to 001Fh)	7 to 31 * (0007h to 001Fh)	7 to 63 * (0007h to 003Fh)	7 to 127 * (0007h to 007Fh)	-
	DispMemSize [byte]	2048 (0800h)	2048 (0800h)	8192 (2000h)	8192 (2000h)	-
	Max_DispMemAddr	2047 (07FFh)	2047 (07FFh)	8191 (1FFFh)	8191 (1FFFh)	-

* Depends on size of current window.

3.3 Related Touch-Switch Information

Touch-Switch size and configuration varies between different modules.

Item \ Module Type	GU128X32D -D903S	GU140X32F -D903S	GU256X64C -D903M	GU256X128C -D903M	-
Number of Switch [X × Y] ***SwMax***	16 [8×2] SW1 – SW16	16 [8×2] SW1 – SW16	16 [8×2] SW1 – SW16	32 [8×4] SW1 – SW32	-
Information Data Length [byte] ***InfoDatLen***	2 (02h)	2 (02h)	2 (02h)	4 (04h)	-
Max. Number of Switch ***SwNumMax*** [***SwMax*** - 1]	15 (0Fh)	15 (0Fh)	15 (0Fh)	31 (1Fh)	-
Sampling timing ***SampTime***	14ms	14ms	20ms	20ms	
Auto calibration timing ***AutoCaliTime***	100ms	100ms	100ms	100ms	
Count level ***CntLevel***	00h – 0Fh	00h – 0Fh	00h – 1Fh	00h – 1Fh	

* Touch-Switch placement details: Refer to the Hardware Specification for the VFD module

4 Normal command mode and User setup mode

4.1 Displayable image types

4.1.1 Graphic display

Number of dots: Depends on VFD module. (Refer to "3.2 Display Memory configuration".)

4.1.2 Character display

Character mode: 5×7 dot, 8×16 dot, 16×16 dot mode

Built-in Character font type: **1-byte character**
5×7 dot, 8×16 dot
- ANK, International font (Refer to DS-1162-0002-XX)

2-byte character
16×16 dot
- Japanese Kanji (Refer to DS-1162-0003-XX)
- Simplified Chinese (Refer to DS-1162-0005-XX)
- Traditional Chinese (Refer to DS-1162-0006-XX)
- Korean (Refer to DS-1162-0004-XX)

[Standard fonts]

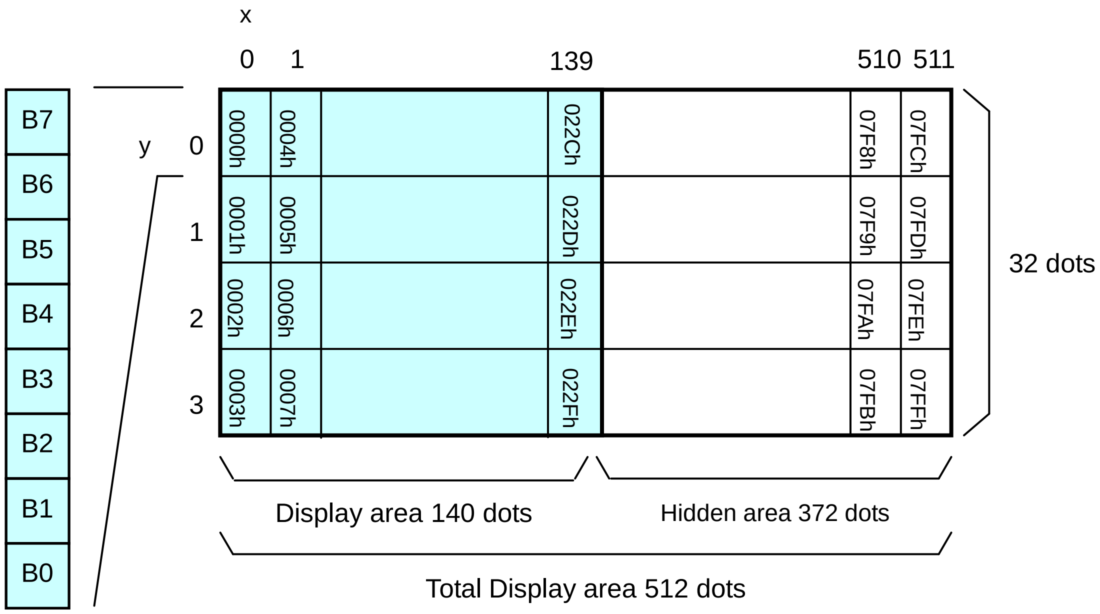
Font size	1-byte character	2-byte character			
	International	Japanese	Korean	Simlified Chinese	Traditional Chinese
5×7 dot	○	×	×	×	×
8×16 dot	○	○(16×16)	○(16×16)	○(16×16)	○(16×16)

4.2 Memory

4.2.1 Display Memory

- Display Memory is comprised of Display area and Hidden area. (Refer to "3.2 Display Memory configuration".)
- By using "User Window" function, the memory area can be separated, and each separate window can be controlled independently. (Refer to "5.2.7.3 User Window define / cancel".)
- Hidden area can be displayed by using scroll or other action commands.

[Example] Display Memory configuration for GU140X32F Type module.



4.2.2 Definition memory

Bit image definition

Arbitrary bit image data can be defined and saved using bit image definition commands.

FROM: 524,288 bytes

(Refer to "5.2.10.3 FROM bit image definition".)

Macro / Program Macro definition

Arbitrary Macro / Program Macro data can be defined and saved using Macro / Program Macro definition commands.

RAM: 256 bytes
FROM: 32,768 bytes (8,192 × 4 areas)

(Refer to "5.2.9.1 RAM Macro define / delete" and "5.2.10.4 FROM Macro define / delete".)

User-defined fonts

User-defined 5×7 dot characters can be defined to memory space in RAM.

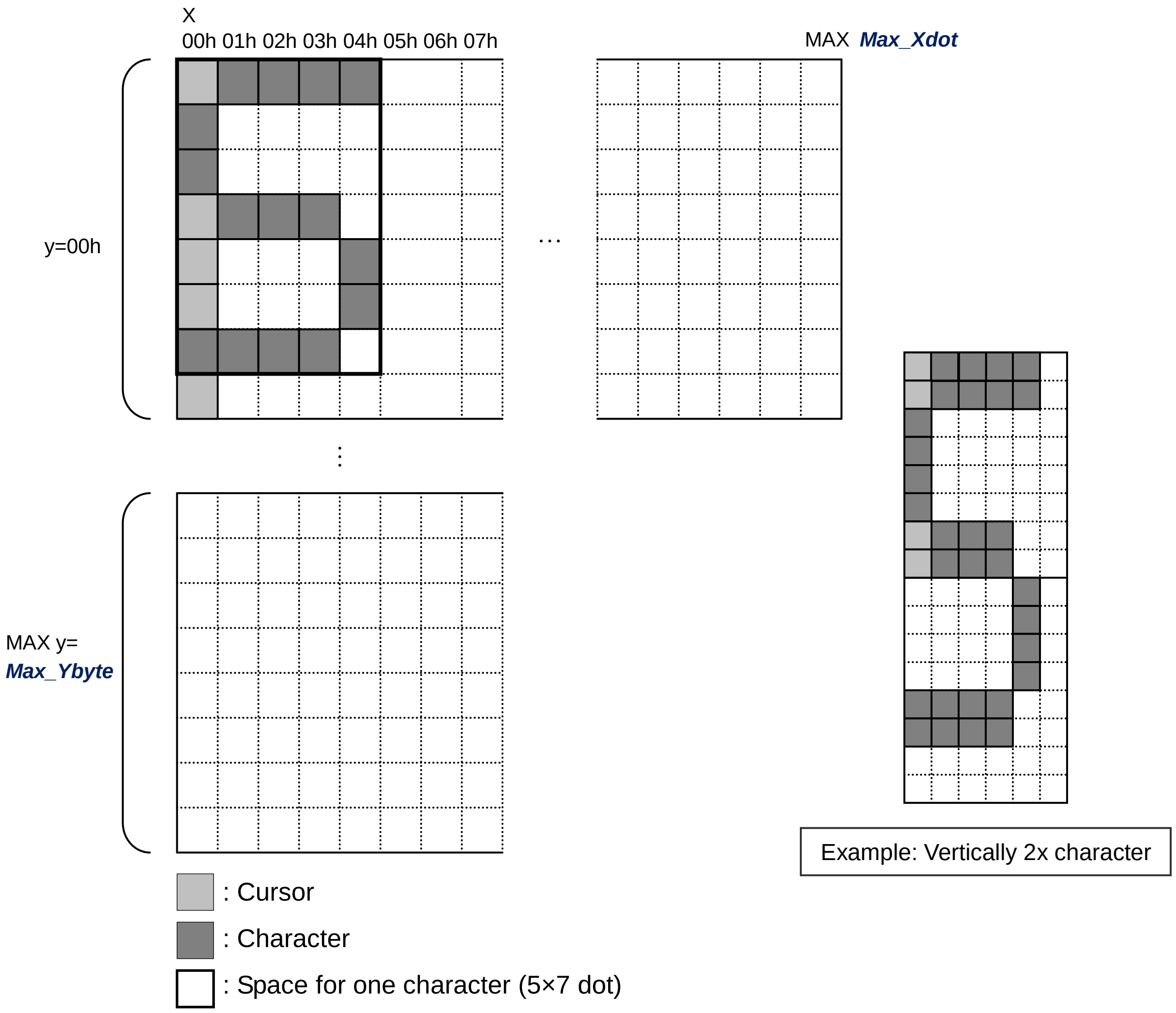
RAM: 5×7 dot 1-byte character, maximum 16 caracters

(Refer to "5.2.3.9 Download character definition".)

4.3 Cursor

4.3.1 Basic function

- Cursor indicates the write start position for displaying a character or bit image.
- Cursor consists of 1 dot horizontally and 8 dots vertically.
- Character and Bit image is written to the right in the X direction and downwards in the Y direction from and including the Cursor position.
- Cursor position can be moved by "5.2.1.2 Cursor set" command.
- The cursor is normally not displayed, but can be displayed by "5.2.1.3 Cursor display ON/OFF" command.
- Cursor position relates to Display Memory as shown below;


X
00h 01h 02h 03h 04h 05h 06h 07h
MAX *Max_Xdot*
y=00h
MAX y=
Max_Ybyte
Example: Vertically 2x character
: Cursor
: Character
: Space for one character (5×7 dot)

4.3.2 Cursor mode

・The cursor moves to the next display position automatically after each character is displayed. Operation of the automatic cursor movement depends on the cursor mode, as explained below.

Over-write mode (MD1)

When the cursor is at the right end, the next data write makes the cursor move one line lower, to the left end. When the cursor is at the bottom right end, it moves to the top left end.

[Display example]

```
01234          56789
ABCDE          FGHIJ

!″#$%          &’()*
```

Input "?" after "*".
→

```
?1234          56789
ABCDE          FGHIJ

!″#$%          &’()*
```

Vertical scroll mode (MD2)

When the cursor is at the bottom right end, the next data write causes the display to scroll up one line, and the bottom line to be cleared. The cursor moves to the bottom left end.

[Display example]

```
01234          56789
ABCDE          FGHIJ

!″#$%          &’()*
```

Input "?" after "*"
→

```
ABCDE          FGHIJ

!″#$%          &’()*
?
```

Horizontal scroll mode (MD3)

When the cursor is at the right end, the next character write causes the current line to scroll left by one character, and the new character is then written at the right end. The rest of the display is unaffected. The cursor does not move.

[Display example]

```
01234          56789
ABCDE          FGHIJ

!″#$%          &’()*
```

Input "?" after "*"
→

```
01234          56789
ABCDE          FGHIJ

″#$%          &’()*?
```

・Mode selection: Refer to "5.2.2.1 Over-write mode [US MD1]", "5.2.2.2 Vertical scroll mode [US MD2]" and "5.2.2.3 Horizontal scroll mode [US MD3]".
・Detailed description of each mode: Refer to "5.1.1.1 Character Code", "5.1.1.2 Back Space [BS]", "5.1.1.3 Horizontal Tab [HT]" and "5.1.1.4 Line Feed [LF]".

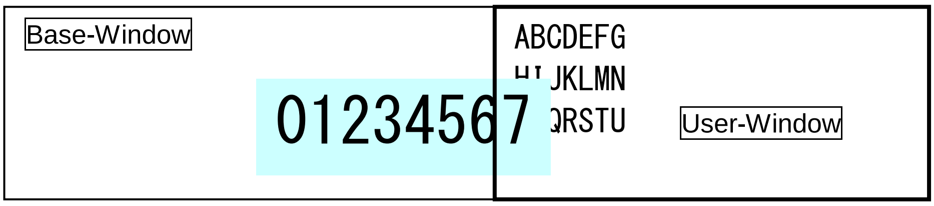
Note: Hereinafter, Over-write mode, Vertical scroll mode, and Horizontal scroll mode are referred to as MD1, MD2, and MD3 respectively.

4.4 Window

- Window function enables the display screen to be divided into "windows" each of which can be controlled and displayed independently.
- Display Memory is shared by all windows; individual windows do not have their own display memory.
- There are 2 types of "window" Base-Window and User-Window.
- Refer to "5.2.7.3 User Window define / cancel".

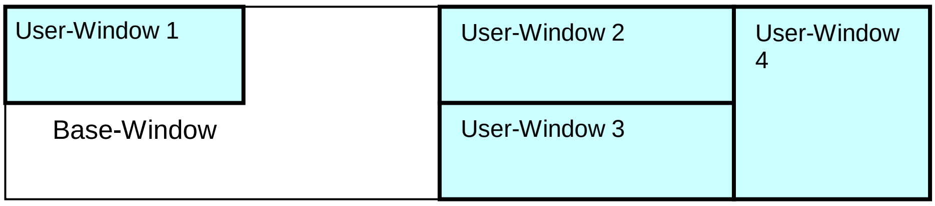
4.4.1 Base-Window

- Base-Window covers the entire display screen.
- If no User-Windows are defined, all display operation is processed on this window.
- If one or more User-Windows are defined, display operation on any area not covered by a User-Window is done by selecting Base-Window.
- When Base-Window is selected, even if User-Window(s) are defined, all display operation is processed under Base-Window. Therefore the current display contents of User-Window(s) is overwritten.
- Operation on Base-Window depends on the setting of "5.2.7.1 Write screen mode".



4.4.2 User-Window

- User-Window is defined by User-Window definition command.
- Display operation is processed on the window selected by Current Window select command.
- A maximum of 4 User-Windows can be defined.

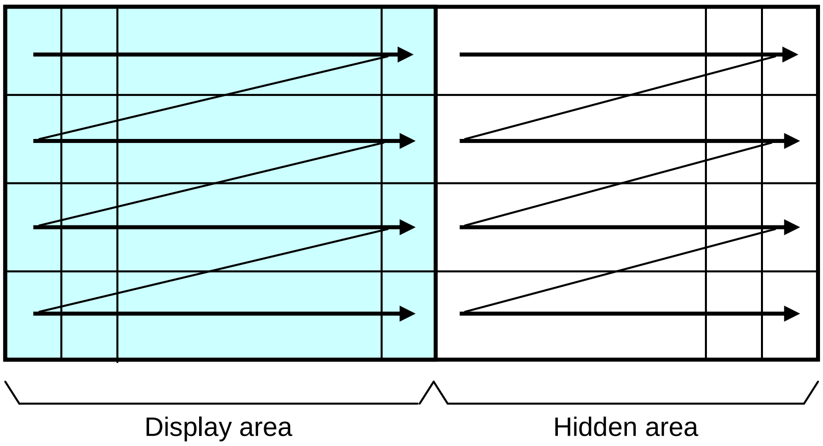


4.5 Write screen mode

- **This setting is only applicable for Base-Window.**
- There are two Write screen modes, Display screen mode and All screen mode. The mode is set by command. (Refer to "5.2.7.1 Write screen mode select".)

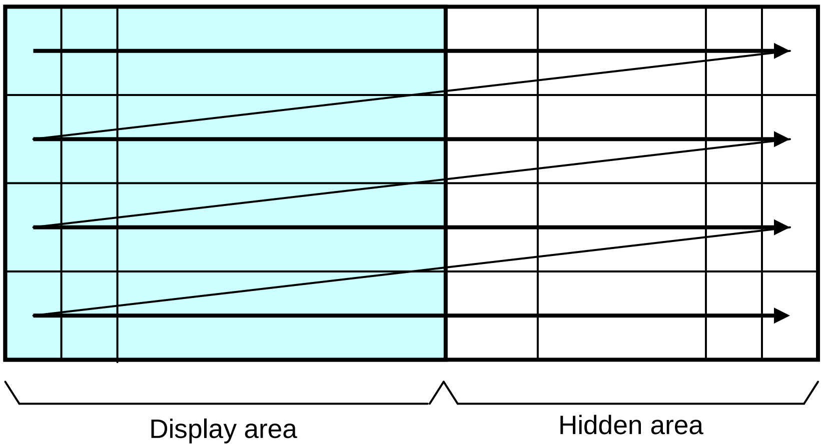
4.5.1 Display screen mode

- When the cursor is located in the Display area, all operation will be done within Display area, and when cursor is located in the Hidden area, it will be done within Hidden area.
- Character write depends on the specified character display mode.
- Bit image is written within the current area, and any data outside the area is ignored.



4.5.2 All screen mode

- Regardless of the cursor position, operation will be done over the entire area.
- Character write depends on the specified character display mode.
- Bit image is written within the entire memory area, and any data outside the area is ignored.



4.6 Character display format

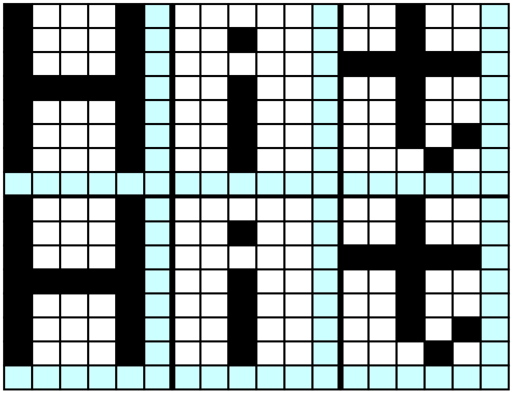
- 5×7 and 7×8 Character display format depends on "Font Width setting" command as follows:

Type of character	Display position	Format	Fixed character width 1	Fixed character width 2	Proportional character width 1	Proportional character width 2
Standard character / Download character 5×7 dot	-	Character format	5 × 7	5 × 7	n × 7	n × 7
		Upper space	0	0	0	0
		Lower space	1	1	1	1
		Left space	0	1	0	1
		Right space	1	1	1	1
Download character 7×8 dot	-	Character format	6 × 8 *	7 × 8	6 × 8 *	7 × 8
		Upper space	0	0	0	0
		Lower space	0	0	0	0
		Left space	0	0	0	0
		Right space	0	0	0	0

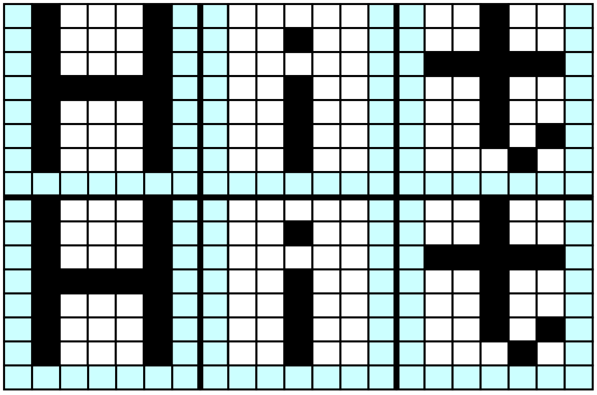
* The left-most 6×8 dot part of the 7×8 dot character is displayed.

- When proportional character width is specified, the blank character (20h) is treated as a 2-dot width character.

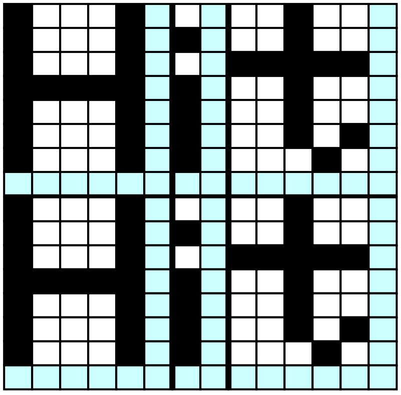
[Fixed character width 1]



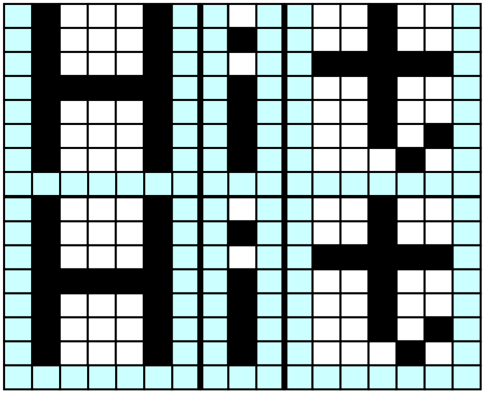
[Fixed character width 2]



[Proportional character width 1]



[Proportional character width 2]



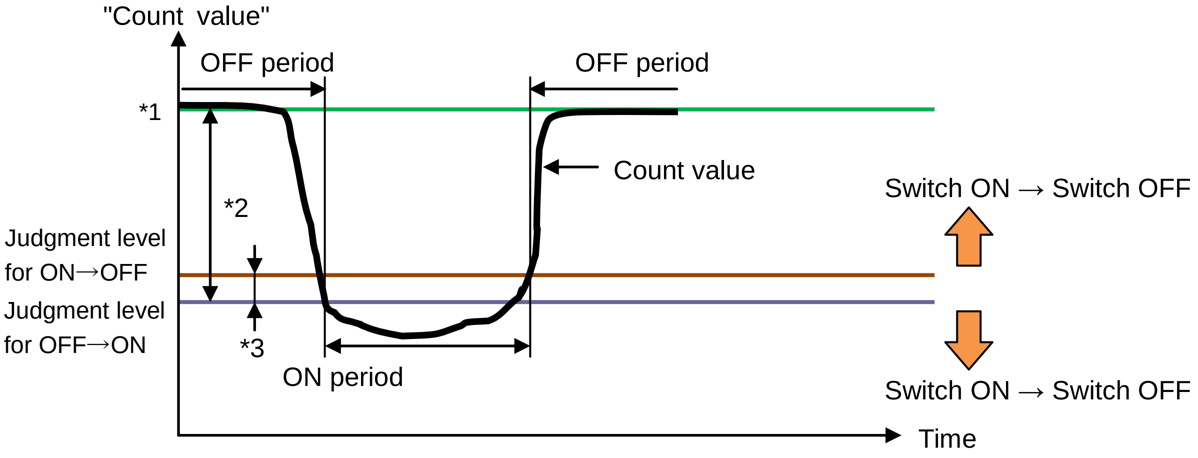
4.7 Touch-Switch control

4.7.1 Basic function

・The Touch-Switch uses the static-capacitive method, wherein ON and OFF are determined by monitoring changes in the measured capacitance. "**Count value**" represents the measured capacitance, which is used for touch detection as explained below.

・**ON / OFF determination**

1. When finger (or equivalent conductor) is not in near the Touch-Switch, OFF state is maintained.
2. When finger approaches the Touch-Switch, "Count value" decreases.
3. If "Count value" falls below the "**Judgment level for OFF→ON**", Touch-Switch turns ON.
4. When finger moves away from the Touch-Switch, "Count value" increases.
5. If "Count value" exceeds the "**Judgment level for ON→OFF**", Touch-Switch turns OFF.



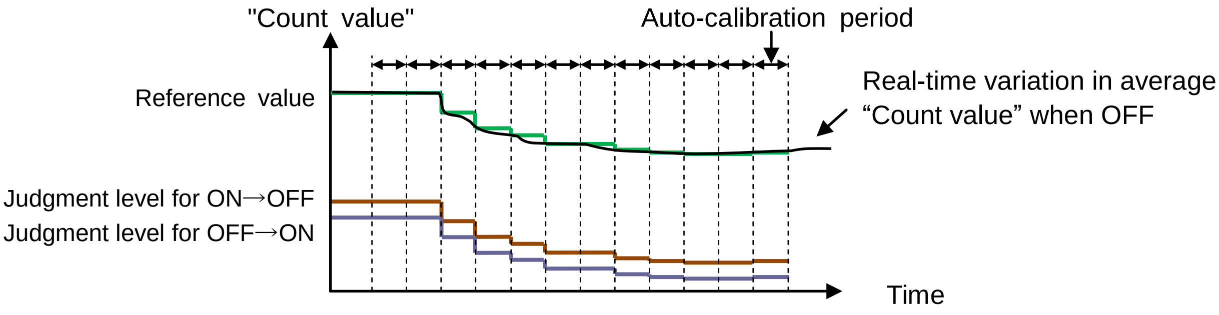
*1 **Reference value:** Average "Count value" at OFF determination time
*2 **Threshold value:** The threshold value for OFF → ON (relative to "Reference value")
*3 **Hysteresis value:** The margin value for ON → OFF (relative to "Threshold value")

・Judgement levels are calculated as follows:

Judgment level for OFF→ON = "Reference value" - "Threshold value"
Judgment level for ON→OFF = "Reference value" - ("Threshold value" - "Hysteresis value")
(= "Judgment level for OFF→ON" + "Hysteresis value")

4.7.2 Auto-calibration

・When **Auto-calibration function** is ON, if the average "Count value" changes, due to changes in the surrounding environment, etc, the "Reference value" will continue to change to follow it. The ON and OFF judgement levels will likewise change in synchronization with the "Reference value". This enables consistent ON/OFF touch detection, unaffected by environmental changes.



*: The "Reference value" will re-adjust each Auto-calibration period. The "Threshold value" and the "Hysteresis value" are relative values, so each "Judgment level" will continue to remain at the same relative level, in synchronization with the "Reference value".

4.7.3 Touch-Switch commands

- Touch-Switch operation is controlled by commands. (Refer to **"5.2.11 Touch-Switch command group"**)
- **Detection of Touch-Switch ON / OFF information and the Count-level/ Touch-level.**

(1) **Detection of Touch-Switch ON / OFF information**

Two commands can be used to read the ON / OFF state of the Touch-Switches – **"All Touch-Switch status read"** and **"Individual Touch-Switch status read"**.
The module sends the corresponding data (ON: "1", OFF: "0") to the host (refer to the command details for the data format).
In addition, the **"Touch-Switch status read mode setting"** command is used to set whether touch data is sent only in response to the above commands, or is automatically sent whenever touch status changes are detected by the module.

○**Detailed explanation pages**

Section	Heading
5.2.11.1	All Touch-Switch status read
5.2.11.2	Individual Touch-Switch status read
5.2.11.5	Touch-Switch status read mode setting

(2) **Detection of Count-level/ Touch-level**

The current (real-time) count-level and touch-level for the Touch-Switches can be read out using the **"All Touch-Switch count-level read" and "All Touch-Switch touch-level read"** commands.
"Count-level" is the "Count value" expressed as a ***CntLevel***. **"Touch-level"** is the “Count value” expressed as a normalized value in the range 00h to F8h (upper 5 bits only (32 steps)), with 00h corresponding to Reference value and 80h corresponding to Threshold value. Both values are independent of the Touch-Switch ON / OFF state. Count value changes for each switch can be monitored, allowing the host to determine ON/OFF status. The information can also be used for creating slider controls, etc.

○**Detailed explanation pages**

Section	Heading
5.2.11.3	All Touch-Switch count-level read
5.2.11.4	All Touch-Switch touch-level read

- **Adjustment of internal parameters by Memory Switch**

(1) **Adjustment factor for Threshold value**

MSW59 can be used to set an adjustment factor for the **Threshold value**. Decreasing this value causes the judgement level for OFF→ON to move closer to the Reference value, resulting in increased sensitivity for detecting touch.

(2) **Adjustment of sampling times**

MSW60 and MSW61 can be used to adjust the sampling times (for ON and OFF respectively). This sets the number of consecutive times the ON level (or OFF level) must be measured before the touch (or release) is recognized. Decreasing this value reduces the amount of time before a touch (or release) is recognized, effectively increasing the touch sensitivity.

(3) **Adjustment of calibration period**

MSW62 sets the calibration period in ***AutoCaliTime*** units. **If set to "0", Auto-calibration function will be OFF.** (If Auto-calibration function is OFF, "Reference value" will remain at the factory default setting)
The effect of changing the above parameters can be checked using the **"Touch-Switch internal parameters change"** command. However, this command does not change the Memory Switch value; this must be done separately using the **"Memory SW setting"** command.

○**Detailed explanation page**

Section	Heading
5.2.10.5	Memory SW setting
5.2.11.6	Touch-Switch internal parameters change
6.2	Memory SW (MSW)

- **Reading parameters within a Program Macro**

Count value, **Reference value**, **Threshold value**, and **Hysteresis value** can be read directly within a Program Macro. **Internal parameters** (threshold value adjustment factor, sampling times, and calibration period) can also be adjusted directly. **Refer to "Program Macro" Software specification for details.**

5 Commands

This section describes the operation of each command.

- The character size (X × Y dot) referred to in this section, depends on the "5.2.3.1 Font size select", "5.2.3.4 Font Width setting", and "5.2.3.5 Font Magnification setting" settings.
- For commands that produce response data from the display, this data is placed in the transmit buffer, then transmitted. **Data transmission is stopped by HBUSY = BUSY, etc (refer to Hardware Specification for details). Command processing is paused while transmit buffer is full.**

5.1 Code set

5.1.1 Detail of code set

5.1.1.1 Character Code

[Code] **20h–FFh or 2-byte character code**

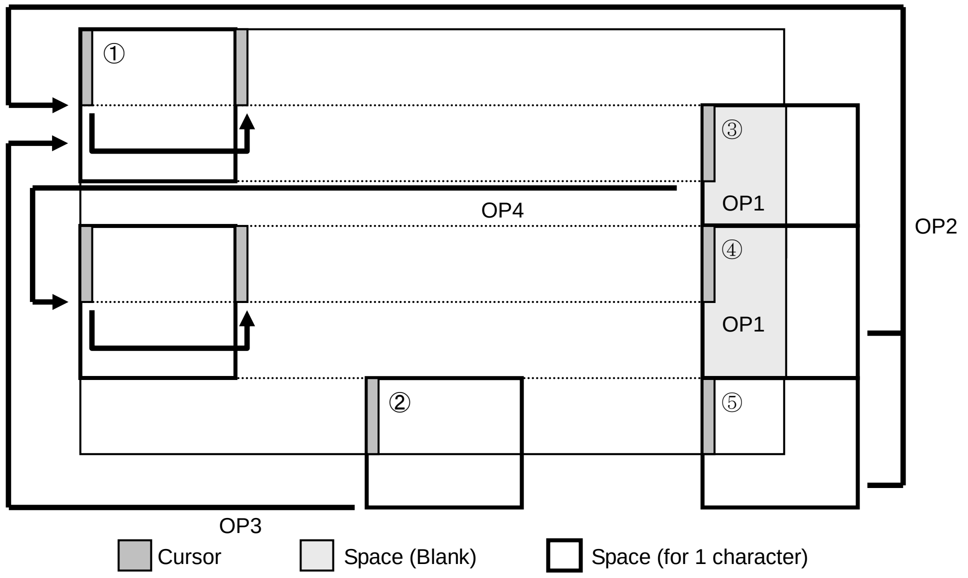
[Function] **Display character at cursor position.**

- This command operates on the current window. (Refer to "5.1.1.8 Window select shortcut" and "5.2.7.2 Current window select".)
- Details of operation are as follows;

MD1

Cursor position		Figure Number	Operation
X direction	Y direction		
Space for character on right side.	Space for character at current cursor position.	①	Display character at cursor. → Horizontal Tab (HT).
	No space for character at current cursor position.	②	Cursor moves to the left end of top line (OP3). → Display character at cursor. → Horizontal Tab (HT).
No space for character on right side.	Space for character in next lower line.	③	Display space at cursor (OP1). → Cursor moves to left end of next lower line (OP4). → Display character at cursor. → Horizontal Tab (HT).
	No space for character in next lower line.	④	Display space at cursor (OP1). → Cursor moves to left end of top line (OP2). → Display character at cursor. → Horizontal Tab (HT).
	No space for character at current cursor position.	⑤	Cursor moves to the left end of top line (OP2). → Display character at cursor. → Horizontal Tab (HT).

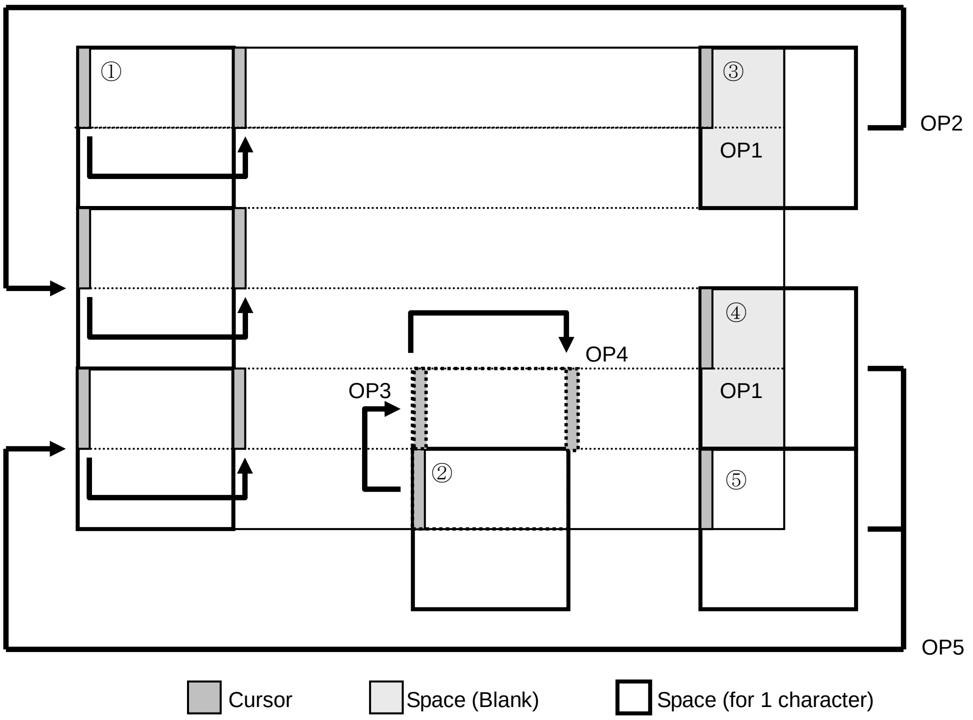
Note: HT operation depends on cursor position. (Refer to "5.1.1.3 Horizontal Tab [HT]".)



MD2

Cursor position		Figure Number	Display Operation
X direction	Y direction		
Space for character on right side.	Space for character at current cursor position.	①	Display character at cursor. → Horizontal Tab (HT) (OP4).
	No space for character at current cursor position.	②	Display contents are scrolled up the required number of dots, and the bottom line is cleared. → Cursor moves to the displayable upper position (OP3). → Display character at cursor → Horizontal Tab (HT)
No space for character on right side.	Space for character in next lower line.	③	Display space at cursor (OP1). → Cursor moves to the left end of next lower line (OP2). → Display character at cursor. → Horizontal Tab (HT).
	No space for character in next lower line.	④	Display space at cursor (OP1). → Display contents are scrolled up the required number of dots, and the bottom line is cleared. → Cursor moves to left end of bottom line (OP5). → Display character at cursor. → Horizontal Tab (HT).
	No space for character at current cursor position.	⑤	Display contents are scrolled up the required number of dots, and the bottom line is cleared. → Cursor moves to left end of bottom line (OP5) → Display character at cursor. → Horizontal Tab (HT).

Note: HT operation depends on cursor position. (Refer to "5.1.1.3 Horizontal Tab [HT]".)



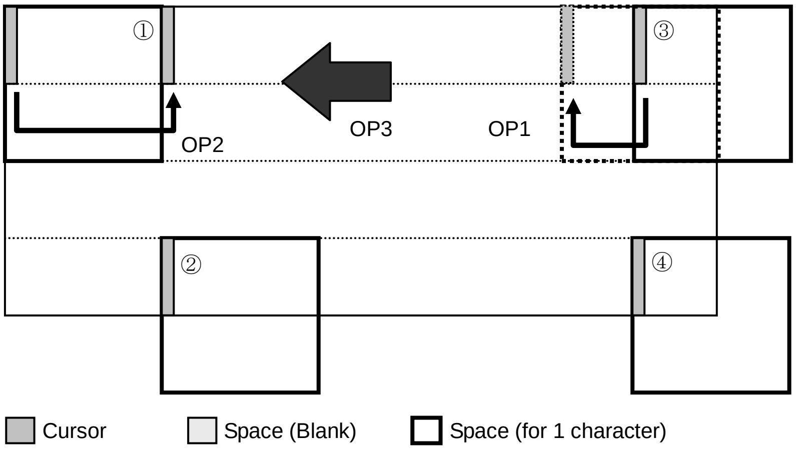
MD3

Cursor position			Figure Number	Display Operation
X direction		Y direction		
Space for character on right side.	Not right end.	-	①	Display character at cursor. → Horizontal Tab (HT) (OP2).
	Right end (refer to Figure 2).		-	Display character at cursor. → Shift to Scroll ON*.
	-	No space for character at current cursor position.	②	No action. → Cursor does not move.
No space for character on right side.	-	-	③	Contents of current line scroll left until sufficient space for character is available at the right end (OP3). → Cursor moves to the left edge of newly-created space (OP1). → Display character at cursor. → Shift to "Scroll ON". *
	-	No space for character at current cursor position.	④	No action. → Cursor does not move.

*Note: Operation during "Scroll ON";

Contents of current line scroll left until sufficient space for character is available at the right end, then character is displayed at cursor.

"Scroll ON" condition is cancelled by any command that moves the cursor except Character Display or Horizontal Tab.



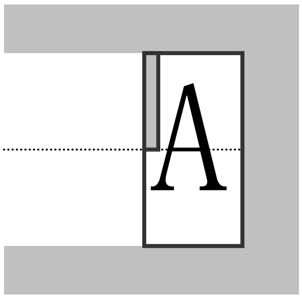


Figure 2

5.1.1.2 Back Space [BS]

[Code] **08h**

[Function] **Cursor moves to the left by one character.**

・This command has effect for the current window.

・Details of operation are as follows;

MD1 and MD2

Cursor position		Operation
X direction	Y direction	
Space for character on left side.	-	Cursor moves left by one character.
No space for character on left side.	Space for one line above.	Cursor moves to right end of next upper line.
	No space for one line above.	Cursor does not move.

MD3

Cursor position		Operation
X direction	Y direction	
Space for character on left side.	-	Cursor moves left by one character.
No space for character on left side.	-	Cursor does not move.

5.1.1.3 Horizontal Tab [HT]

[Code] **09h**

[Function] **Cursor moves to the right by one character.**

・This command has effect for the current window.

・Details of operation are as follows;

MD1

Cursor position		Operation
X direction	Y direction	
Space for character on right side.	-	Cursor moves right by one character.
No space for character on right side.	Space for character in next lower line.	Cursor moves to left end of next lower line.
	No space for character in next lower line.	Cursor moves to left end of top line.

MD2

Cursor position		Operation
X direction	Y direction	
Space for character on right side.	-	Cursor moves right by one character.
No space for character on right side.	Space for character in next lower line.	Cursor moves to left end of next lower line.
	No space for character in next lower line.	Display contents are scrolled up the required number of dots, and the bottom line is cleared. → Cursor moves to left end of bottom line.

MD3

Cursor position			Operation
X direction		Y direction	
Space for character on right side.	Not right end.	-	Cursor moves right by one character.
	Right end (refer to Figure 2, page 14).		Shift to "Scroll ON". *
No space for character on right side.	-	-	Contents of current line scroll left until sufficient space for character is available at the right end. → Cursor moves to the left edge of newly-created space. → Shift to "Scroll ON". *

*Note: Operation during "Scroll ON";

Contents of current line scroll left until sufficient space for character is available at the right end (cursor does not move).

"Scroll ON" condition is cancelled by any command that moves the cursor except Character Display or Horizontal Tab.

5.1.1.4 Line Feed [LF]

[Code] **0Ah**

[Function] **Cursor moves to next lower line.**

・This command has effect for the current window.

・Details of operation are as follows;

MD1

Cursor position		Operation
X direction	Y direction	
-	Space for character in next lower line.	Cursor moves to the same position on next lower line.
	No space for character in next lower line.	Cursor moves to the same position on top line.

MD2

Cursor position		Operation
X direction	Y direction	
-	Space for character in next lower line.	Cursor moves to the same position on next lower line.
	No space for character in next lower line.	Display contents are scrolled up the required number of dots, and the bottom line is cleared. → Cursor does not move.

MD3

Cursor position		Operation
X direction	Y direction	
-	-	Cursor does not move.

5.1.1.5 Home Position [HOM]

[Code] **0Bh**

[Function] **Cursor moves to home position (top left).**

・This command has effect for the current window.

5.1.1.6 Carriage Return [CR]

[Code] **0Dh**

[Function] **Cursor moves to left end of current line.**

・This command has effect for the current window.

5.1.1.7 Display Clear [CLR]

[Code] **0Ch**

[Function] **Display screen is cleared.**

・Cursor moves to home position.

・This command has effect for the current window.

5.1.1.8 Window select shortcut [WINx]

[Code] **10h - 14h**

[Function] **Select current window (1-byte command).**

・Refer to "5.2.7.2 Current window select" for more details.

Code	Function
WIN0 (10h)	Select Base-Window
WIN1 (11h)	Select User-Window 1
WIN2 (12h)	Select User-Window 2
WIN3 (13h)	Select User-Window 3
WIN4 (14h)	Select User-Window 4

5.2 Command Set Details

5.2.1 General setting command group

[Function] **Execute processing of General setting and control command.**

Command	Function
ESC @	Initialize Display
US $ ...	Cursor set
US C n	Cursor display ON/OFF
US X n	Brightness level setting
US r n	Reverse display setting
US w n	Write screen mode select

5.2.1.1 Initialize Display [ESC @]

[Code] **1Bh 40h**

[Function] **Settings return to default values**

- **Jumper and Memory-SW settings are not re-loaded (except for MSW19 and MSW63), so if MSW19 is set to run at power-on, Macro / Program Macro is run when this command is executed.**
- **Settings of general-purpose I/O ports are not reset.**
- **Contents of transmit and receive buffer remain in memory.**

5.2.1.2 Cursor set [US $ xL xH yL yH]

[Code] **1Fh 24h xL xH yL yH**

xL:	Cursor position x, lower byte (1 dot / unit)
xH:	Cursor position x, upper byte (1 dot / unit)
yL:	Cursor position y, lower byte (8 dots / unit)
yH:	Cursor position y, upper byte (8 dots / unit)

[Definable area]

0000h ≤ (xL + xH × 100h) ≤ ***Max_Xdot***
0000h ≤ (yL + yH × 100h) ≤ ***Max_Ybyte***

[Function] **Cursor moves to the specified (X, Y) position on Display Memory.**

- If the specified X, Y position (X and/or Y) is outside the definable area, the command is ignored and the cursor remains in the same position.
- This command has effect for the current window.

5.2.1.3 Cursor display ON/OFF [US C n]

[Code] **1Fh 43h n**

[Definable area]

n = 00h, 01h
n = 00h: Cursor display OFF
n = 01h: Cursor display ON

[Default] n = 00h

[Function] **Cursor display setting.**

- When cursor display is ON, cursor position appears as reverse blinking, 1×8 dots.
- When cursor is in hidden area, it does not appear, even when cursor display is set ON.
- This command has effect for the current window.
- Blink rate of the cursor is affected by the parameters of the "5.2.4.3 Blink display action" command. This parameter is set to [30 × ***IntTime***] ms, at power-on.

5.2.1.4 Brightness level setting [US X n]

[Code] **1Fh 58h n**

[Definable area]

01h ≤ n ≤ 08h

[Default] n = 08h

[Function] **Set display brightness level.**

n	Brightness level
01h	12.5 %
02h	25.0 %
03h	37.5 %
04h	50.0 %
05h	62.5 %
06h	75.0 %
07h	87.5 %
08h	100 %

5.2.1.5 Reverse display setting [US r n]

[Code] **1Fh 72h n**

[Definable area]

n = 00h, 01h

n = 00h: Reverse OFF
n = 01h: Reverse ON

[Default] n = 00h

[Function] **Reverse display ON/OFF for character and image display.**

・Changing this setting only affects subsequent data.

・Content already displayed is not affected.

5.2.1.6 Write mixture display mode [US w n]

[Code] **1Fh 77h n**

[Definable area]

00h ≤ n ≤ 03h

n = 00h: Normal display write (not mixture display)
n = 01h: OR display write
n = 02h: AND display write
n = 03h: EX-OR display write

[Default] n = 00h

[Function] **Specifies write mixture mode.**

・Newly-written characters and images are combined with current display contents in Display Memory.

5.2.2 Cursor Mode command group

[Function] Select Cursor Mode.

Comand	Function
US MD1	Over-write mode
US MD2	Vertical scroll mode
US MD3	Horizontal scroll mode
US s n	Horizontal scroll speed setting

5.2.2.1 Over-write mode [US MD1]

[Code] 1Fh 01h

[Function] Cursor mode set to Over-write mode.

・This command has effect for the current window.

5.2.2.2 Vertical scroll mode [US MD2]

[Code] 1Fh 02h

[Function] Cursor mode set to Vertical scroll mode.

・This command has effect for the current window.

5.2.2.3 Horizontal scroll mode [US MD3]

[Code] 1Fh 03h

[Function] Cursor mode set to Horizontal scroll mode.

・This command has effect for the current window.

5.2.2.4 Horizontal scroll speed setting [US s n]

[Code] 1Fh 73h n

[Definable area]

00h ≤ n ≤ 1Fh

[Default] n = 00h

[Function] Set speed for Horizontal scroll mode.

・Scroll speed is set by n.

n	Speed
00h	Instantaneous
01h	***IntTime*** / 2 dots
02h - 1Fh	(n-1) × ***IntTime*** / dot

(***IntTime***: Refer to "3.1 Timing Unit".)

・Subsequent commands are not processed until scroll is completed.

5.2.3 Font command group

[Function] Execute processing of Character Font setting and control command.

[US (g n [parameter]]

n	Function
01h	Font size select
02h	2-byte character ON/OFF
03h	Font Width setting
0Fh	2-byte character type select
40h	Font Magnification setting

n: Function No.

○1-byte font setting commands

Command	Function
ESC R n	International font select
ESC t n	Character table type select

○Download character control commands

Command	Function
ESC % n	Download character ON/OFF
ESC & ...	Download character definition
ESC ? ...	Download character delete

5.2.3.1 <Function 01h> Font size select [US (g 01h m]

[Code] **1Fh 28h 67h 01h m**

[Definable area]
m = 01h, 02h

[Default] m = 01h

[Function] **Sets the font size for 1-byte characters.**

m	Function
01h	5×7 dot character
02h	8×16 dot character

5.2.3.2 <Function 02h> 2-byte character ON/OFF [US (g 02h m]

[Code] **1Fh 28h 67h 02h m**

[Definable area]
m = 00h, 01h

[Default] m = 00h

[Function] **Sets 2-byte character ON/OFF.**

m	Function
00h	2-byte character mode OFF
01h	2-byte character mode ON

・Example for displaying a 16×16, 2-byte character:

1).Set the font size:	1Fh 28h 67h 01h 02h (8×16 dot mode)
2).Specify 2-byte character mode:	1Fh 28h 67h 02h 01h (2-byte character mode ON)
3).Specify 2-byte character type:	1Fh 28h 67h 0Fh 00h (Japanese)
	1Fh 28h 67h 0Fh 01h (Korean)
	1Fh 28h 67h 0Fh 02h (Simplified Chinese)
	1Fh 28h 67h 0Fh 03h (Traditional Chinese)

5.2.3.3 <Function 0Fh> 2-byte character type select [US (g 0Fh m]

[Code] **1Fh 28h 67h 0Fh m**

[Definable area]
00h ≤ m ≤ 03h

[Default] m = 00h

[Function] **Sets 2-byte character type.**

m	Character type	Code type	1st byte	2nd byte
00h	Japanese	JIS X0208(SHIFT-JIS)	81h ≤ c1 ≤ 9Fh E0h ≤ c1 ≤ EFh	40h ≤ c2 ≤ 7Eh 80h ≤ c2 ≤ FCh
01h	Korean	KSC5601-87	A1h ≤ c1 ≤ FEh	A1h ≤ c2 ≤ FEh
02h	Simplified Chinese	GB2312-80	A1h ≤ c1 ≤ FEh	A1h ≤ c2 ≤ FEh
03h	Traditional Chinese	Big-5	A1h ≤ c1 ≤ FEh	40h ≤ c2 ≤ 7Eh A1h ≤ c2 ≤ FEh

[Exanple] Displaying a 2-byte character "阿", in Simplified Chinese.

1). Sets the font size (8×16):	1Fh 28h 67h 01h 02h
2). 2-byte character mode ON:	1Fh 28h 67h 02h 01h
3). Sets 2-byte character type (Simplified Chinese):	1Fh 28h 67h 0Fh 02h
4). 2-byte character code input:	B0h A2h (character code: "阿")

5.2.3.4 <Function 03h> Font Width setting [US (g 03h w]

[Code] **1Fh 28h 67h 03h w**

[Definable area]

00h ≤ w ≤ 03h

w = 00h: Fixed character width 1 (1 dot space on right side)
w = 01h: Fixed character width 2 (1 dot space on right side and left side)
w = 02h: Proportional character width 1 (1 dot space on right side)
w = 03h: Proportional character width 2 (1 dot space on right side and left side)

[Default] w = 01h

[Function] **Sets the character width.**

・Fixed character width 1 & 2: Character is written with fixed character width (6 or 7 dot).
・Proportional character width: Character is written with proportioned character width.
・**Refer to "4.6 Character display format" for more details.**
・**Setting is not applicable when 8×16 or 16×16 font is selected.**

5.2.3.5 <Function 40h> Font Magnification setting [US (g 40h x y]

[Code] **1Fh 28h 67h 40h x y**

x: X magnification factor
y: Y magnification factor

[Definable area]

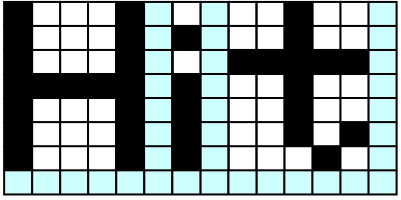
01h ≤ x ≤ 04h
01h ≤ y ≤ 02h

[Default] x = 01h
y = 01h

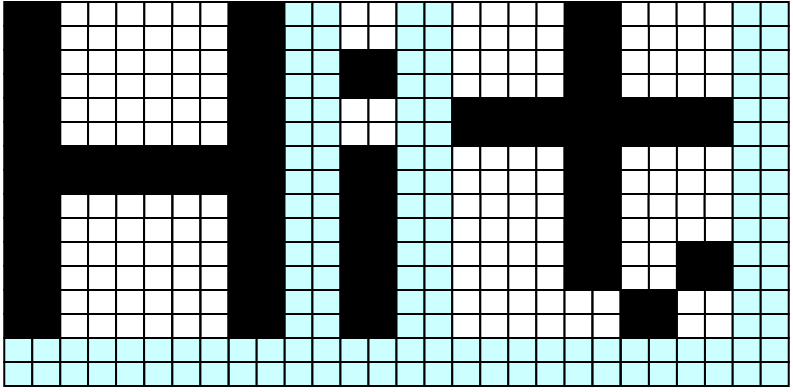
[Function] **Set character magnification ‘x’ times to the right and ‘y’ times downward.**

・**Character magnification includes the space specified by Font Width command.**

[Example 1] Proportional character width 1 setting, x = 1, y = 1



[Example 2] Proportional character width 1 setting, x = 2, y = 2



5.2.3.6 International font select [ESC R n]

[Code] **1Bh 52h n**

[Definable area]

00h ≤ n ≤ 0Dh

[Default] n = 00h

[Function] **Select international font set.**

・Characters already displayed are not affected.

n	Font set
00h	America
01h	France
02h	Germany
03h	England
04h	Denmark 1
05h	Sweden
06h	Italy
07h	Spain 1
08h	Japan
09h	Norway
0Ah	Denmark 2
0Bh	Spain 2
0Ch	Latin America
0Dh	Korea

5.2.3.7 Character table type select [ESC t n]

[Code] **1Bh 74h n**

[Definable area]

00h ≤ n ≤ 05h, 10h ≤ n ≤ 13h

[Default] n = 00h

[Function] **Select Character table type.**

・Characters already displayed are not affected.

n	Font code type
00h	PC437(USA – Euro std)
01h	Katakana – Japanese
02h	PC850 (Multilingual)
03h	PC860 (Portuguese)
04h	PC863 (Canadian-French)
05h	PC865 (Nordic)
10h	WPC1252
11h	PC866 (Cyrillic #2)
12h	PC852 (Latin 2)
13h	PC858

5.2.3.8 Download character ON/OFF [ESC % n]

[Code] **1Bh 25h n**

[Definable area]

n = 00h, 01h

[Default] n = 00h

[Function] **Enable or disable display of download characters.**

・n = 01h: Enable (If download character is not defined, built-in character is displayed.)

・n = 00h: Disable

・Characters already displayed are not affected.

5.2.3.9 Download character definition [ESC & a c1 c2 [x1 d1...d(a×x1)]...[xk d1...d(a×xk)]]

[Code] **1Bh 26h a c1 c2 [x1 d1…d(a×x1)]…[xk d1…d(a×xk)]**

a: Select character type
c1: Start character code
c2: End character code
x: Number of dots for X-direction
d: Definition data

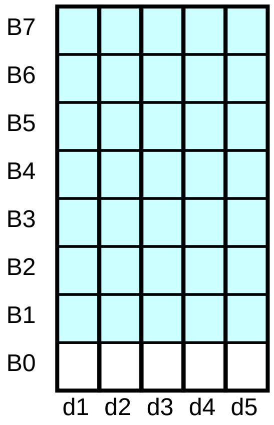
[Definable area]

a = 01h
x = 05h, 07h
x = 05h: 5×7 dot font
x = 07h: 7×8 dot font
20h ≤ c1 ≤ c2 ≤ FFh
00h ≤ d ≤ FFh
x = 05h: Upper 7 bits are valid.
x = 07h: All 8 bits are valid.
k = (c2 - c1) + 1

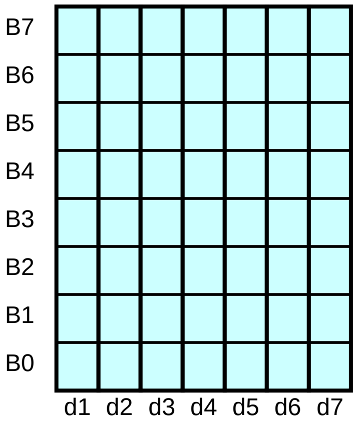
[Function] **Define download characters (1-byte characters) into RAM.**

・A maximum of 16 download characters can be defined.
・x = 05h: Defined as 5×7 dot. Surrounding space is same as standard character display.
・x = 07h: Defined as 7×8 dot. Displayed as 6×8 or 7×8 dot character. (Refer to "4.6 Character display format".)
・After the maximum number of download characters are defined, in order to define other character codes, space must first be obtained using the Download character delete command.
・Downloaded characters are valid until redefined, an "Initialize Display" is executed, or the power is turned off.
・To display download characters the commands Download character definition and Download character ON/OFF (set to ON) are required.
・If a currently-displayed download character is re-defined, there is no affect on the currently-displayed character. It is effective only for newly input characters.

[5×7dot]



[7×8 dot]



5.2.3.10 Download character delete [ESC ? a c]

[Code] **1Bh 3Fh a c**

a: Select character type
c : Delete Character code

[Definable area]

a = 01h
20h ≤ c ≤ FFh

[Function] **Delete defined download character.**

・Built-in character is displayed after download character is deleted.
・Characters already displayed are not affected.
・Command is ignored if download character is not defined for the given character code.

5.2.4 Display action command group [US (a n [parameter]]

[Function] Execute processing of display action command.

n	Function
01h	Wait
10h	Scroll display action
11h	Blink display action
40h	Screen saver action

n: Function No.

・**Subsequent commands are not processed until display action processing is completed.**

・**It is possible to interrupt these commands if the command is defined and run in a Macro.**

5.2.4.1 <Function 01h> Wait [US (a 01h t]

[Code] **1Fh 28h 61h 01h t**

[Definable area]

00h ≤ t ≤ FFh

[Function] **Waits for the specified time (command and data processing is stopped).**

・Wait time is specified by 't'.
Wait time = t × approximately 0.5s

5.2.4.2 <Function 10h> Scroll display action [US (a 10h wL wH cL cH s]

[Code] **1Fh 28h 61h 10h wL wH cL cH s**

wL:	Display screen shift byte count, lower byte
wH:	Display screen shift byte count, upper byte
cL:	Number of cycles, lower byte
cH:	Number of cycles, upper byte
s:	Scroll speed

[Definable area]

0000h ≤ (wL + wH × 100h) ≤ ***Max_DispMemAddr***
0001h ≤ (cL + cH × 100h) ≤ FFFFh
00h ≤ s ≤ FFh

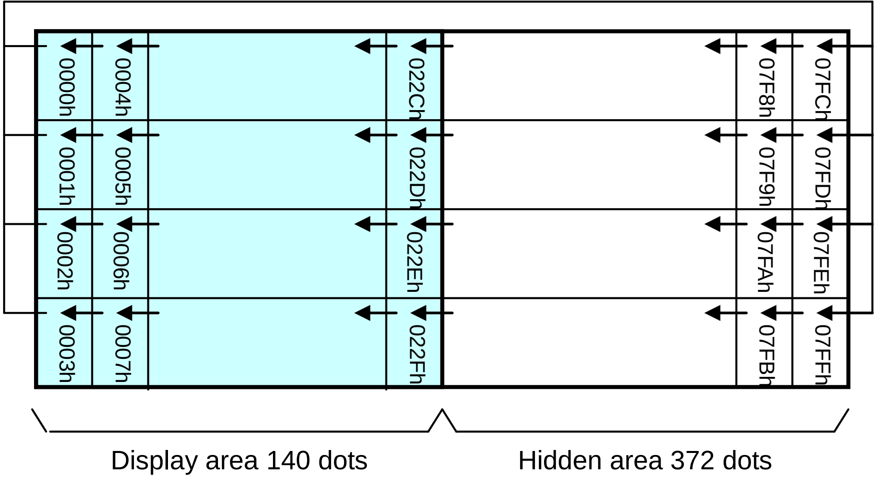
[Function] **Shift the display screen.**

・Horizontal scrolling is possible by specifying as the shift byte count a multiple of ***Ybytes***.

・Display switching is possible by specifying shift byte count as ***Xdots***×***Ybytes***.

・Scroll speed is specified by 's'.
Scroll speed: s ×***IntTime*** (approximately) / shift
(***IntTime***: Refer to "3.1 Timing Unit".)

[Example] 1 dot scroll to the left: wL = 04h, wH = 00h (GU140X32F type module)



5.2.4.3 <Function 11h> Blink display action [US (a 11h p t1 t2 c]

[Code] **1Fh 28h 61h 11h p t1 t2 c**

p:	Blink pattern
t1:	Normal display time
t2:	Blank or reverse display time
c:	Number of cycles

[Definable area]

00h ≤ p ≤ 02h

p = 00h: Normal display
p = 01h: Blink display (alternately Normal and Blank display)
p = 02h: Blink display (alternately Normal and Reverse display)

01h ≤ t1 ≤ FFh
01h ≤ t2 ≤ FFh
00h ≤ c ≤ FFh

[Function] **Blink display action**

・Blink pattern specified by 'p'.

・Time is specified by 't1' and 't2'
A: t1 × ***IntTime*** Normal display
B: t2 × ***IntTime*** Blank or Reverse display
(***IntTime***: Refer to "3.1 Timing Unit".)
Repeated 'c' times.

・This command does not affect Display Memory.

・c = 00h;
Blink continues during subsequent command and data processing, until c = 01h–FFh is set, or Initialize command.

・c=01h – FFh;
Blink display is repeated 1–255 times while command and data processing is stopped. After display blinking is completed, Normal display returns and command and data processing resumes. Command / data processing does not resume until operation is completed.

5.2.4.4 <Function 40h> Screen saver action [US (a 40h p]

[Code] **1Fh 28h 61h 40h p**

[Definable area]

00h ≤ p ≤ 04h

p = 00h: Display power OFF (Power save mode)
p = 01h: Display power ON
p = 02h: All dot OFF
p = 03h: All dot ON
p = 04h: Repeat blink display with normal and reverse display
(Normal: 2s, Reverse: 2s)

[Function] **Control Power ON or OFF, and Start Screen saver mode.**

・p = 00h – 01h;
Control Power ON or OFF. This setting is applied until this command is re-specified.

・p = 02h – 04h;
Start Screen saver mode. This setting is cancelled when next data is input.

5.2.5 Bit image display command group [US (f n [parameter]]

[Function] **Display bit image.**

n	Function
10h	Downloaded bit image display
11h	Real-time bit image display

n: Function No.

○**Related Command**

"5.2.10.3 FROM bit image definition"

5.2.5.1 <Function 10h> Downloaded bit image display [US (f 10h m aL aH aE ySL ySH xL xH yL yH g]

[Code] **1Fh 28h 66h 10h m aL aH aE ySL ySH xL xH yL yH g**

m:	Select bit image data memory = 1 (fixed)
aL:	Bit image data definition address, lower byte
aH:	Bit image data definition address, upper byte
aE:	Bit image data definition address, extension byte
ySL:	Bit image defined Y size, lower byte (by 8 dots)
ySH:	Bit image defined Y size, upper byte (by 8 dots)
xL:	Bit image display X size, lower byte (by 1 dot)
xH:	Bit image display X size, upper byte (by 1 dot)
yL:	Bit image display Y size, lower byte (by 8 dots)
yH:	Bit image display Y size, upper byte (by 8 dots)
g:	Image information = 1 (fixed)

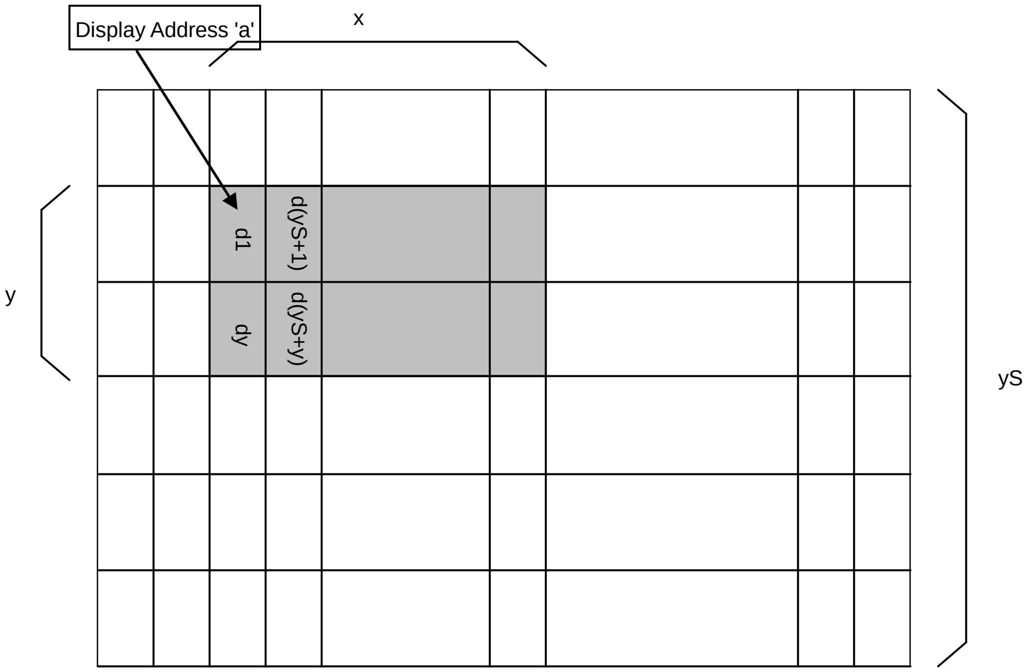
[Definable area]

m = 01h
000000h ≤ (aL + aH × 100h + aE × 10000h) ≤ 07FFFFh
0000h ≤ (ySL + ySH × 100h) ≤ FFFFh
0001h ≤ (xL + xH × 100h) ≤ ***Xdots***
0001h ≤ (yL + yH × 100h) ≤ ***Ybytes***
g = 01h

[Function] **Display, at the cursor position, the bit image defined in FROM.**

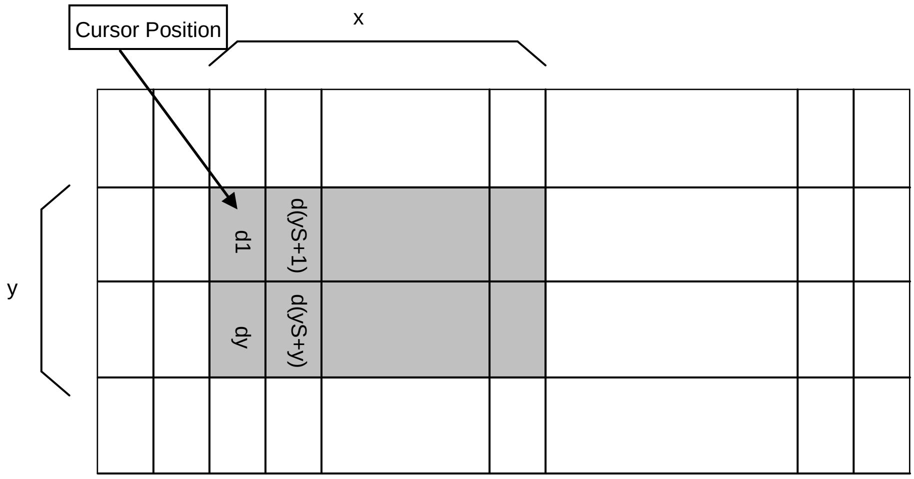
- Cursor position does not change.
- Set Bit image defined Y size to the same Y size of the bit image defined in memory.
- A portion of the Defined bit image can be displayed by setting Bit image display Y size less than Defined bit image Y size, or by changing Bit image display X size and/or Bit image data definition address.
- If the bit image extends beyond the current window, only the portion within the current window is displayed.
- When the bit image is being written to the Display Memory, if the bit image memory area is exceeded, undefined data is displayed.

Bit image memory



Bit image data write

Display memory



5.2.5.2 <Function 11h> Real-time bit image display [US (f 11h xL xH yL yH g d(1)...d(k)]

[Code] **1Fh 28h 66h 11h xL xH yL yH g d(1)...d(k)**

xL:	Bit image X size, lower byte (by 1 dot)
xH:	Bit image X size, upper byte (by 1 dot)
yL:	Bit image Y size, lower byte (by 8 dots)
yH:	Bit image Y size, upper byte (by 8 dots)
g:	Image information = 1 (fixed)
d(1)–d(k):	Bit image data (see below)

[Definable area]

0001h ≤ (xL + xH × 100h) ≤ ***Xdots***

0001h ≤ (yL + yH × 100h) ≤ ***Ybytes***

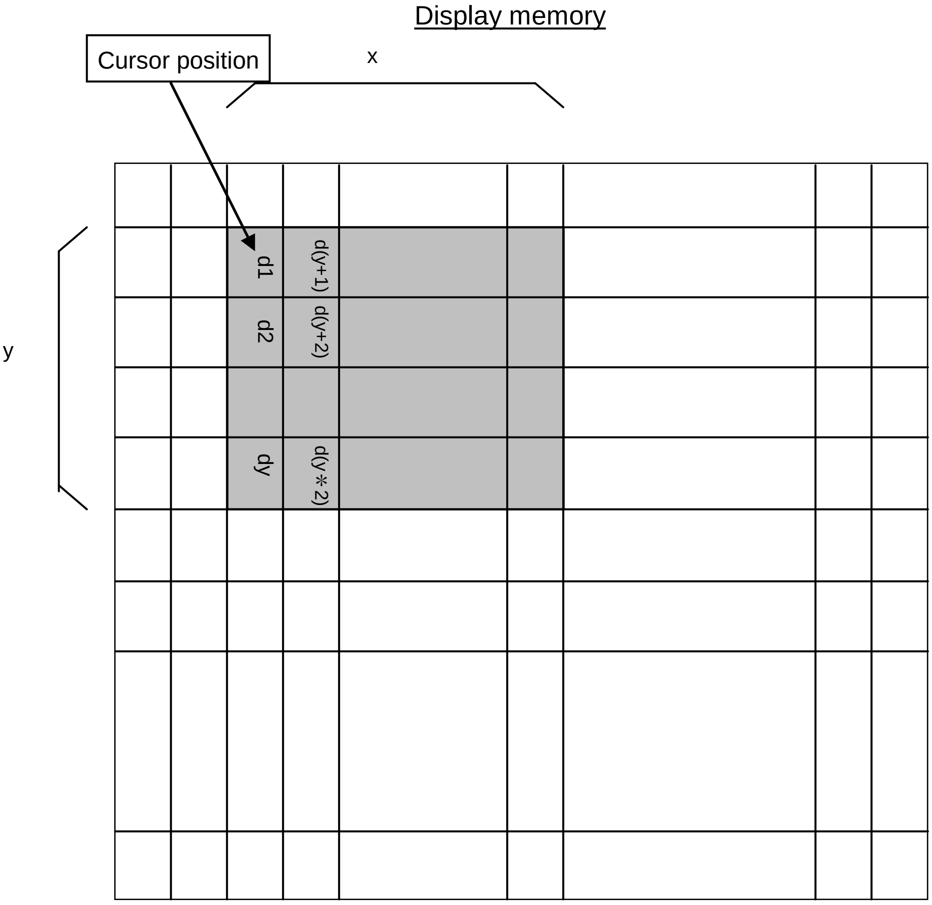
g = 01h

00h ≤ d ≤ FFh

k = x × y × g

[Function] **Display the bit image data at the cursor position in real-time.**

- Cursor position does not change.
- If bit image exceeds the bounds of the current window, only the portion within the current window is displayed.
- If Display position or display size etc, are outside the definable area, the command is cancelled at the point where the error is detected, and the remaining data is treated as standard data.



5.2.6 Dot unit control command group [US (d n [parameter]]

[Function] Dot unit display of Bit image or characters.

n	Function
20h	Dot unit downloaded bit image display
21h	Dot unit real-time bit image display
30h	Dot unit character display

n: Function No.

○**Related Command**

"5.2.10.3 FROM bit image definition"

5.2.6.1 <Function 20h> Dot unit downloaded bit image display [US (d 20h xPL xPH yPL yPH m aL aH aE ySL ySH xOL xOH yOL yOH xL xH yL yH g]

[Code] **1Fh 28h 64h 20h xPL xPH yPL yPH m aL aH aE ySL ySH xOL xOH yOL yOH xL xH yL yH 01h**

xPL:	Display position x, lower byte (by 1 dot)
xPH:	Display position x, upper byte (by 1 dot)
yPL:	Display position y, lower byte (by 1 dot)
yPH:	Display position y, upper byte (by 1 dot)
m:	Image data display memory select
aL:	Bit image data definition address, lower byte
aH:	Bit image data definition address, upper byte
aE:	Bit image data definition address, extension byte
ySL:	Bit image defined, Y size, lower byte (by 8 dots)
ySH:	Bit image defined, Y size, upper byte (by 8 dots)
xOL:	Image data offset x, lower byte (by 1 dot)
xOH:	Image data offset x, upper byte (by 1 dot)
yOL:	Image data offset y, lower byte (by 1 dot)
yOH:	Image data offset y, upper byte (by 1 dot)
xL:	Bit image display X size, lower byte (by 1 dot)
xH:	Bit image display X size, upper byte (by 1 dot)
yL:	Bit image display Y size, lower byte (by 1 dot)
yH:	Bit image display Y size, upper byte (by 1 dot)
g:	Image information = 1 (fixed)

[Definable area]

0000h ≤ (xPL + xPH × 100h) ≤ ***Max_Xdot_CurtWin***
0000h ≤ (yPL + yPH × 100h) ≤ ***Max_Ydot_CurtWin***
01h ≤ m ≤ 02h
m = 01h: FROM bit image
m = 02h: Display Memory bit image

FROM bit image:
000000h ≤ (aL + aH × 100h + aE × 10000h) ≤ 07FFFFh
0000h ≤ (ySL + ySH × 100h) ≤ FFFFh
0000h ≤ (xOL + xOH × 100h) ≤ FFFFh
0000h ≤ (yOL + yOH × 100h) ≤ FFFFh

Display Memory bit image:
(aL + aH×100h + aE × 10000 h) = XXXXXXh (fixed internally at 000000h)
(ySL + ySH × 100h) = 0000h
0000h ≤ (xOL + xOH × 100h) ≤ ***Max_Xdot***
0000h ≤ (yOL + yOH × 100h) ≤ ***Max_Ydot***

0001h ≤ (xL + xH × 100h) ≤ ***Xdots***
0001h ≤ (yL + yH × 100h) ≤ ***Ydots***
g = 01h

[Function] Display the bit image defined in FROM at the specified (x,y) position.

・Display position, display size, and image data offset are specified in units of 1 dot.

・If Display position or image size, etc are outside the definable area, the command is cancelled at the point where the error is detected, and the remaining data is treated as standard data.

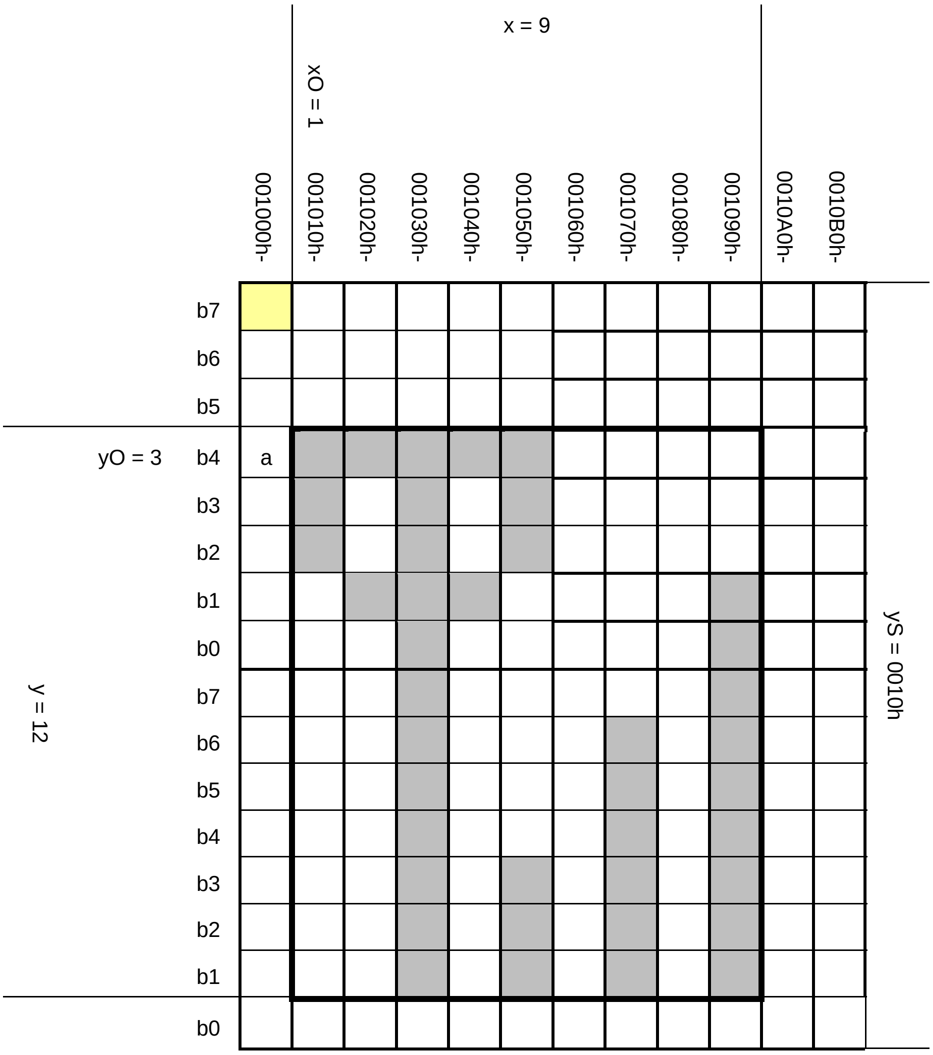
・**If Display Memory is selected, xO and/or yO can be set beyond the above range, up to FFFFh, but operation is not guaranteed.　Data definition address is fixed at 0 internally.**

・If bit image exceeds the bounds of the current window, only the portion within the current window is displayed.

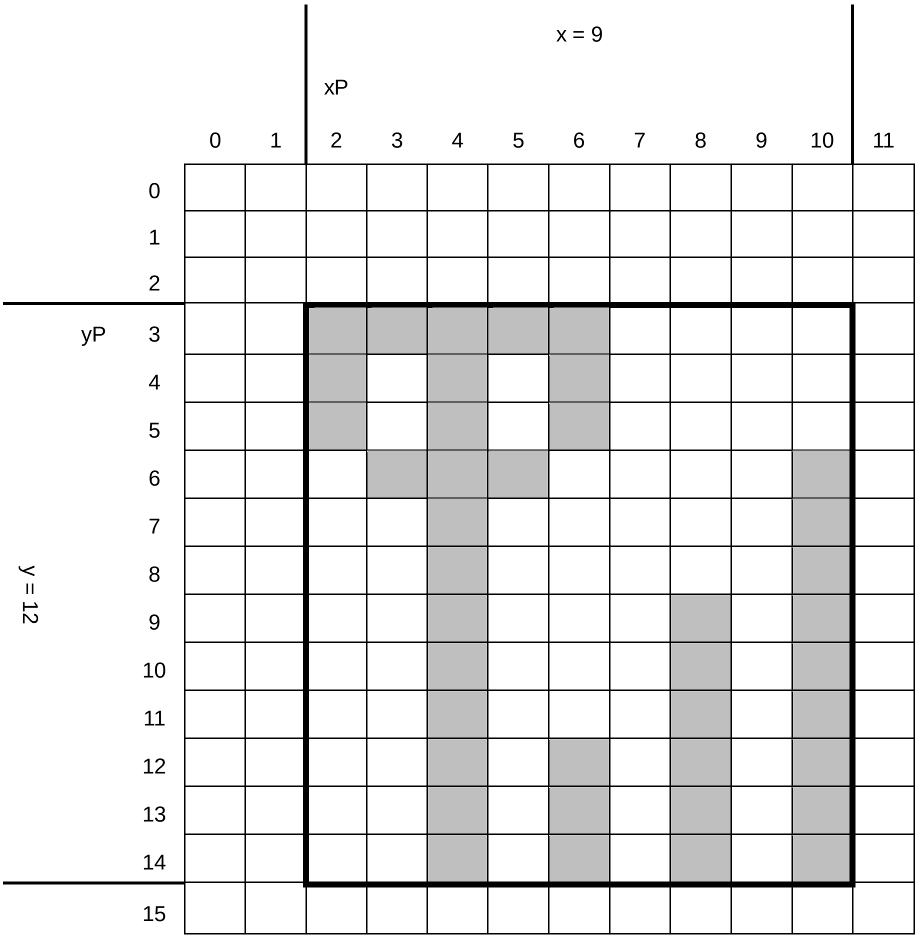
[Example]

Display position	xP = 2、yP = 3
Defined image data	m = 01h、a = 001000h
Defined image data Y size	yS = 0010h
Offset	xO = 1、yO = 3
Display size	x = 9、y = 12

FROM Bit image memory



Display memory



5.2.6.2 <Function 21h> Dot unit real-time bit image display [US (d 21h xPL xPH yPL yPH xL xH yL yH g d(1)...d(k)]

[Code] **1Fh 28h 64h 21h xPL xPH yPL yPH xL xH yL yH g d(1)...d(k)**

xPL:	Display position x, lower byte (by 1 dot)
xPH:	Display position x, upper byte (by 1 dot)
yPL:	Display position y, lower byte (by 1 dot)
yPH:	Display position y, upper byte (by 1 dot)
xL:	Bit image display X size, lower byte (by 1 dot)
xH:	Bit image display X size, upper byte (by 1 dot)
yL:	Bit image display Y size, lower byte (by 1 dot)
yH:	Bit image display Y size, upper byte (by 1 dot)
g:	Display information = 1 (fixed)

d(1)–d(k): Bit image data (see below)

[Definable area]

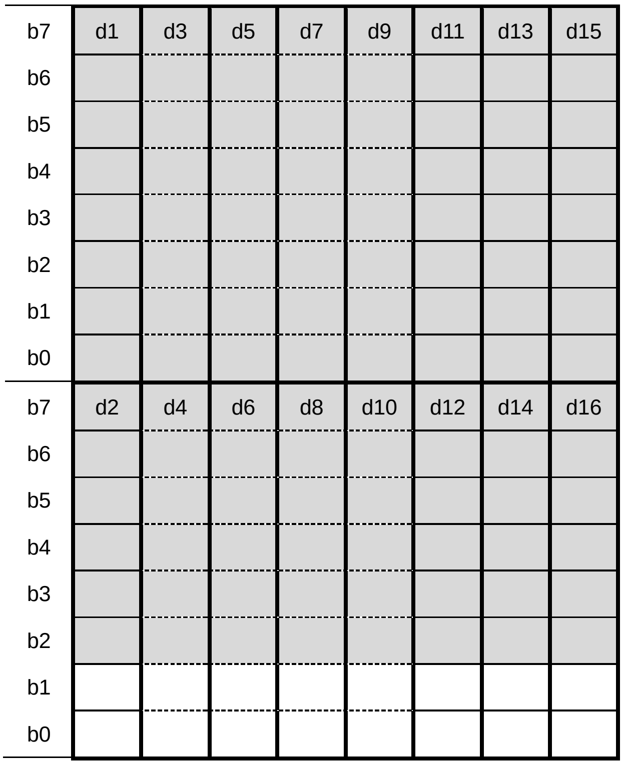
0000h ≤ (xPL + xPH × 100h) ≤ ***Max_Xdot_CurtWin***
0000h ≤ (yPL + yPH × 100h) ≤ ***Max_Ydot_CurtWin***
0001h ≤ (xL + xH × 100h) ≤ ***Xdots***
0001h ≤ (yL + yH × 100h) ≤ ***Ydots***
g = 01h
00h ≤ d ≤ FFh

[Function] **Display the bit image data at the specified (x,y) position in real-time.**

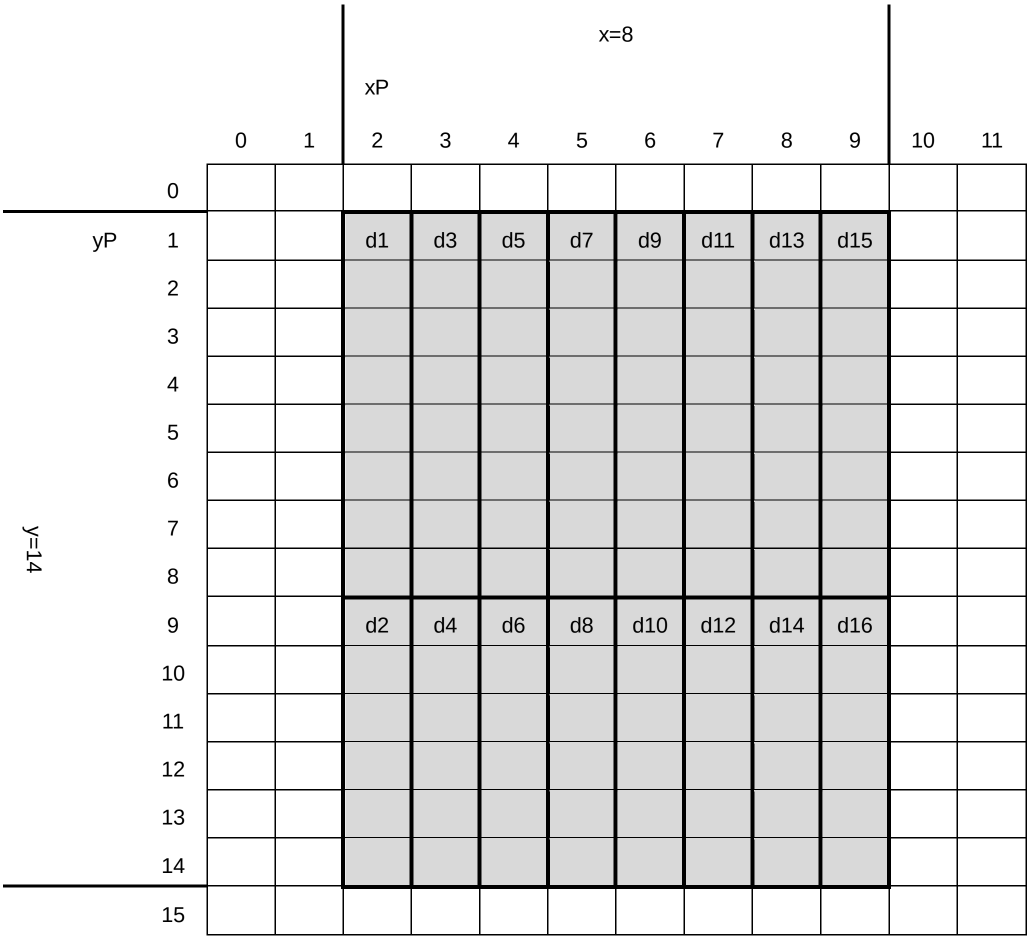
- Display position and display size are specified in units of 1 dot.
- If bit image exceeds the bounds of the current window, only the portion within the current window is displayed.
- If Display position (xP, yP) or display size (x, y) are outside the definable area, the command is cancelled at the point where the error is detected, and the remaining data is treated as standard data.

[Example] xP = 2, yP = 1, Display size x = 8, y = 14

Image data



Display memory



	0	1	2	3	4	5	6	7	8	9	10	11
0												
1			d1	d3	d5	d7	d9	d11	d13	d15		
2												
3												
4												
5												
6												
7												
8												
9			d2	d4	d6	d8	d10	d12	d14	d16		
10												
11												
12												
13												
14												
15												

5.2.6.3 <Function 30h> Dot unit character display [US (d 30h xPL xPH yPL yPH m bLen d(1)...d(bLen)]

[Code] **1Fh 28h 64h 30h xPL xPH yPL yPH m bLen d(1)...d(bLen)**

xPL:	Display position x, lower byte (by 1 dot)
xPH:	Display position x, upper byte (by 1 dot)
yPL:	Display position y, lower byte (by 1 dot)
yPH:	Display position y, upper byte (by 1 dot)
m:	Response select
bLen:	Character data length

d(1)–d(bLen): Character data / reverse select

[Definable area]

0000h ≤ (xPL + xPH × 100h) ≤ ***Max_Xdot_CurtWin***, FFFFh
0000h ≤ (yPL + yPH × 100h) ≤ ***Max_Ydot_CurtWin***
m = 00h (fixed)
00h ≤ bLen ≤ FFh
10h ≤ d ≤ 11h、20h ≤ d ≤ FFh
d = 10h: Reverse OFF
d = 11h: Reverse ON

[Function] **Display the specified text characters at the specified (x,y) position.**

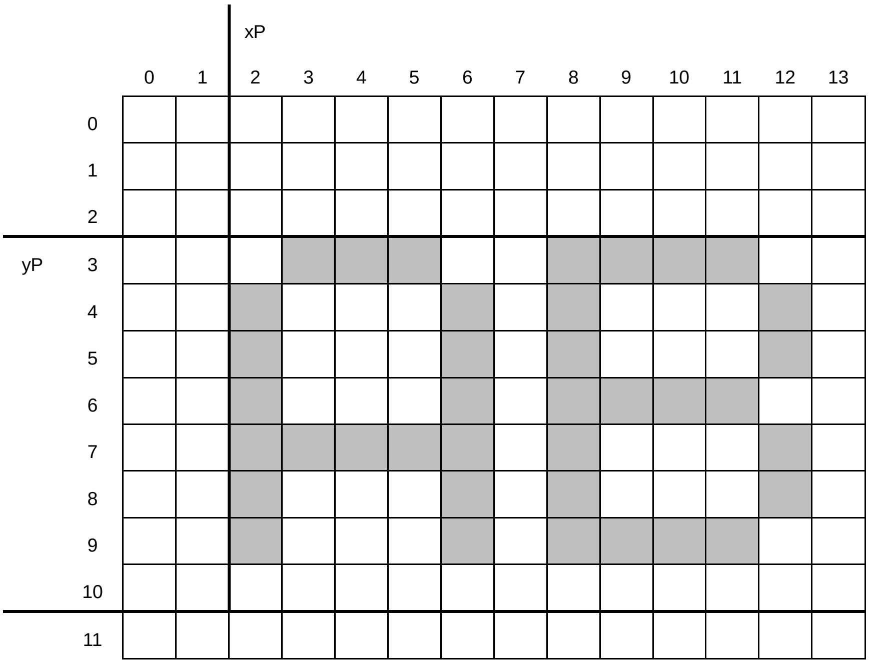
- Display position is specified in units of 1 dot.
- For display position xP = FFFFh, write position continues from previous writes done using this command. **(Note: This applies for x-direction only; yP must be set appropriately)**
- The current settings for character size and table type, etc are used **(except character magnification setting).**
- If character display exceeds the bounds of the current window, only the portion within the current window is displayed.
- If Display position (xP, yP) or Response select (m) is outside the definable area, the command is cancelled at the point where the error is detected, and the remaining data is treated as standard data.

d = 10h or 11h;

- Character Reverse OFF / ON (10h / 11h) can be included in the character data to control reverse display setting for certain characters.　This setting is effective after Reverse OFF/ON is specified until the next Reverse OFF / ON is inputted.　For example, if the character data "**11h 41h 42h 43h 10h 44h**" (bLen = 06h) is input, **41h – 43h are displayed as reverse display, and 44h as normal display**.

[Example] Display position xP = 2, yP = 3, 6×8 dot character "AB"

Display memory



5.2.7 Window / Screen command group [US (w n [parameter]]

[Function] Window / Screen command processing.

n	Function
01h	Current window select
02h	User-Window definition / cancel
10h	Write screen mode select

n: Function No.

○**Related Command**

"5.1.1.8 Window select shortcut"

5.2.7.1 <Function 10h> Write screen mode select [US (w 10h a]

[Code] **1Fh 28h 77h 10h a**

[Definable area]

a = 00h, 01h

a = 00h: Display screen mode

a = 01h: All screen mode

[Default] a = 00h

[Function] **Select the write screen mode.**

・**This setting is only applicable for Base-Window.**

・Display screen mode: Display action is valid within area of either Display area or Hidden area, depending on cursor position.

・All screen mode: Display action is valid over the entire display memory. (Refer to "4.5 Write screen mode" for details.)

5.2.7.2 <Function 01h> Current window select [US (w 01h a]

[Code] **1Fh 28h 77h 01h a**

[Definable area]

00h ≤ a ≤ 04h

a = 00h: Base-Window

a = 01h: User-Window 1

a = 02h: User-Window 2

a = 03h: User-Window 3

a = 04h: User-Window 4

[Function] **Select current window.**

・Command is ignored if Window number is for a User-Window that is not defined.

5.2.7.3 <Function 02h> User Window define / cancel [US (w 02h a b [xPL xPH yPL yPH xSL xSH ySL ySH]]

[Code] **1Fh 28h 77h 02h a b [xPL xPH yPL yPH xSL xSH ySL ySH]**

a:	Definable window No.
b:	Define or Cancel
xPL:	Left position of window x, lower byte (by 1 dot)
xPH:	Left position of window x, upper byte (by 1 dot)
yPL:	Top position of window y, lower byte (by 8 dot)
yPH:	Top position of window y, upper byte (by 8 dot)
xSL:	X size of window, lower byte (by 1 dot)
xSH:	X size of window, upper byte (by 1 dot)
ySL:	Y size of window, lower byte (by 8 dot)
ySH:	Y size of window, upper byte (by 8 dot)

[Definable area]

01h ≤ a ≤ 04h

a = 01h: User-Window 1
a = 02h: User-Window 2
a = 03h: User-Window 3
a = 04h: User-Window 4

b = 00h, 01h

b = 0: Cancel、b = 1: Define

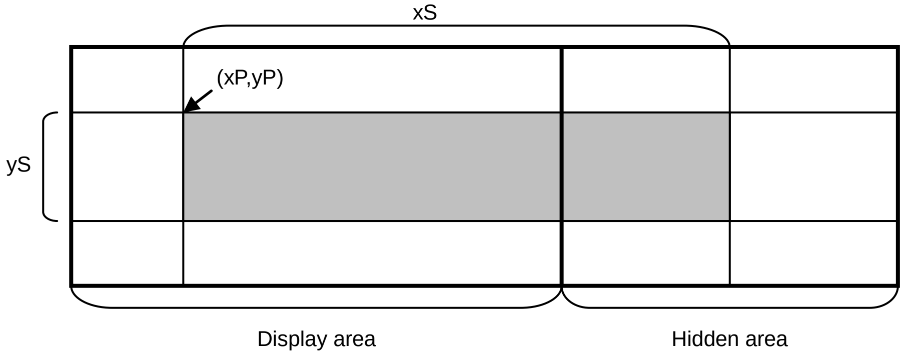
0000h ≤ (xPL + xPH × 100h) ≤ ***Max_Xdot***
0000h ≤ (yPL + yPH × 100h) ≤ ***Max_Ybyte***
0001h ≤ (xSL + xSH × 100h) ≤ (***Xdots*** - (xPL + xPH × 100h))
0001h ≤ (ySL + ySH × 100h) ≤ (***Ybytes*** - (yPL + yPH × 100h))

[Function] **Define or cancel User-Window**

・Display contents are not changed by this command.

User-Window define (b = 01h);

・Specify User-Window number, window position, and window size.
・Window position and Window size are specified in units of one block (1×8 dot).



・Up to 4 User-Windows can be defined.
・The cursor position for the window is initialized to top left (X=0, Y=0).

User-Window cancel (b = 00h);

・For User-Window cancel, window range parameters [xPL – ySH] are not used.
・If the current window is cancelled, the Base-Window becomes the current window.

5.2.8 General-purpose I/O port command group [US (p n [parameter]]

[Function] **General-purpose I/O port operations.**

n	Function
01h	I/O Port Input / Output setting
10h	I/O Port Output
20h	I/O Port Input

n: Function No.

5.2.8.1 <Function 01h> I/O Port Input / Output setting [US (p 01h n a]

[Code] **1Fh 28h 70h 01h n a**

n: I/O port number

a: Set Input / Output (bit-wise)

[Definable area]

n = 00h: Port 0

00h ≤ a ≤ 0Fh (see below)

[Default] a = 00h (All Input)

[Function] **Set input or output for general-purpose I/O ports.**

・Port input / output is set by value of 'a'. Bit assignment is as follows;

Port bit No.	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0
'a' Data bit	*	*	*	*	P03	P02	P01	P00

Bit value = 0: Input, 1: Output

*: Don't care.

Caution: I/O port is intended for simple peripheral switches and for controlling lights, etc, and should not be used for applications where high reliability is required.

5.2.8.2 <Function 10h> I/O Port Output [US (p 10h n a]

[Code] **1Fh 28h 70h 10h n a**

n: I/O port number

a: Output data value

[Definable area]

n = 00h: Port 0

00h ≤ a ≤ 0Fh (see below)

[Default] a = 00h (All 0)

[Function] **Output data to general-purpose I/O port.**

・Output data is set by value of 'a'. Bit assignment is as follows;

Port bit No.	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0
'a' Data bit	*	*	*	*	P03	P02	P01	P00

Bit value = 0: Low output, 1: High output

*: Don't care.

Caution: When switching from Input to Output, set the output value first.

5.2.8.3 <Function 20h> I/O Port Input [US (p 20h n]

[Code] 1Fh 28h 70h 20h n

n: I/O port number

[Definable area]

n = 00h: Port 0

[Function] **The state of a general-purpose I/O port at the time this command is processed is transmitted.**

・The following data is transmitted;

Transmitted data	Value (Hex)	Data length
(1) Header	28h	1 byte
(2) Identifier 1	70h	1 byte
(3) Identifier 2	20h	1 byte
(4) Data *	00h–0Fh	1 byte

*: **This data is same format as 'a' parameter of "I/O Port Output" command.**

5.2.9 Macro / Program Macro command group

[Function] **Macro / Program Macro command processing.**

Command	Function
US : pL pH ...	RAM Macro define / delete
US ^ a t1 t2	Macro execution

○**Related Command**

"5.2.10.4 FROM Macro define / delete"

5.2.9.1 RAM Macro define / delete [US : pL pH [d1...dk]]

[Code] **1Fh 3Ah pL pH [d1…dk]**

pL:	RAM Macro data length, lower byte
pH:	RAM Macro data length, upper byte
d:	RAM Macro data

[Definable area]

0000h ≤ (pL + pH × 100h) ≤ 0100h

00h ≤ d ≤ FFh

[Function] **Define or delete RAM Macro or RAM Program Macro.**

・(pL + pH × 100h) > 0000h: Supplied data 'd' is stored as Macro.

・(pL + pH × 100h) = 0000h: Macro is deleted.

・If Macro data length (p) is outside the definable area, the command is cancelled, and the following data is treated as standard data.

・Do not define any of the following commands in a Macro;
Initialize, Macro execution, RAM Macro define / delete, User setup mode start, [US (e] group commands (FROM bit image definition, Memory SW setting, etc), Memory re-write mode.

・**Program Macro details: Refer to "Program Macro" Software specification.**

5.2.9.2 Macro execution [US ^ a t1 t2]

[Code] **1Fh 5Eh a t1 t2**

a:	Macro processing definition number
t1:	Display time interval (t1 × ***IntTime***)
t2:	Idle time for Macro repetition (t2 × ***IntTime***)

(***IntTime***: Refer to "3.1 Timing Unit".)

[Definable area]

00h ≤ a ≤ 04h, 80h ≤ a ≤ 84h

a = 00h:	RAM Macro
01h ≤ a ≤ 04h:	FROM Macro 1–4
a = 80h:	RAM Program Macro
81h ≤ a ≤ 84h:	FROM Program Macro 1–4

00h ≤ t1, t2 ≤ FFh

[Function] **Execute contents of defined Macro 'a'.**

・Macro 'a' is executed either as Normal Macro or Program Macro.

・If Macro 'a' is not defined, or is outside the definable area, the entire command (up to t2) is ignored.

Normal Macro;

・Normal Macro execution is recursive execution of commands and display data, etc, listed as-is in the macro data.

・Display time interval refers to the interval time between displaying characters, and does not affect the processing speed of command code.

・Idle time refers to the time period from processing the last Macro data until the Macro is re-executed.

・Macro execution is stopped when a command is input.　The current window (Write screen mode area if Base-Window) is cleared and cursor moves to home position.　Display settings remain in the current state when the Macro ended.

Program Macro;

・Program Macro execution operation follows the Program Macro script specification.

・Program Macro execution is stopped by the following method;
END command specified within Program Macro definition.

・Display time interval (t1), and Idle time (t2) are not used.

5.2.10 User setup mode command group [US (e n [parameter]]

[Function] **User setup mode command processing.**

n	Function
01h	User setup mode start
02h	User setup mode end
03h	Memory SW setting
04h	Memory SW data send
10h	FROM bit image definition
12h	FROM Macro define / delete
40h	Display status send

n: Function No.

・**"BUSY signal" is referred to in this section. This is when the MBUSY signal is in the "BUSY" state. Refer to Hardware Specification for details.**

5.2.10.1 <Function 01h> User setup mode start [US (e 01h d1 d2]

[Code] **1Fh 28h 65h 01h d1 d2**

[Definable area]

d1 = 49h (Character 'I')
d2 = 4Eh (Character 'N')

[Function] **Start User setup mode.**

・**This command is only valid in Normal mode.**

・Display screen is blanked.

・The following data is transmitted;

Transmitted data	Value (Hex)	Data length
(1) Header	28h	1 byte
(2) Identifier 1	65h	1 byte
(3) Identifier 2	01h	1 byte
(4) NULL	00h	1 byte

5.2.10.2 <Function 02h> User setup mode end [US (e 02h d1 d2 d3]

[Code] **1Fh 28h 65h 02h d1 d2 d3**

[Definable area]

d1 = 4Fh (Character 'O')
d2 = 55h (Character 'U')
d3 = 54h (Character 'T')

[Function] **End User setup mode.**

・**This command is only valid in User setup mode.**

・End User setup mode, and software reset of display as follows:

(1) Wait for any in-progress operations (memory control, information transmission, etc) to complete.

(2) Output display BUSY signal.

(3) Software reset.

1. **Jumper and Memory-SW settings are re-loaded.**
2. **Settings of general-purpose I/O ports are reset.**
3. **Contents of transmit and receive buffer are reset.**

5.2.10.3 <Function 10h> FROM bit image definition [US (e 10h aL aH aE sL sH sE d(1)...d(s)]

[Code] **1Fh 28h 65h 10h aL aH aE sL sH sE d(1)...d(s)**

aL:	Bit image data definition address, lower byte
aH:	Bit image data definition address, upper byte
aE:	Bit image data definition address, extension byte
sL:	Bit image data length, lower byte
sH:	Bit image data length, upper byte
sE:	Bit image data length, extension byte

d(1)–d(s): Bit Image data (see below)

[Definable area]

000000h ≤ (aL + aH × 100h + aE × 10000h) ≤ 07FFFFh
000001h ≤ (sL + sH × 100h + sE × 10000h) ≤ 080000h
00h ≤ d ≤ FFh

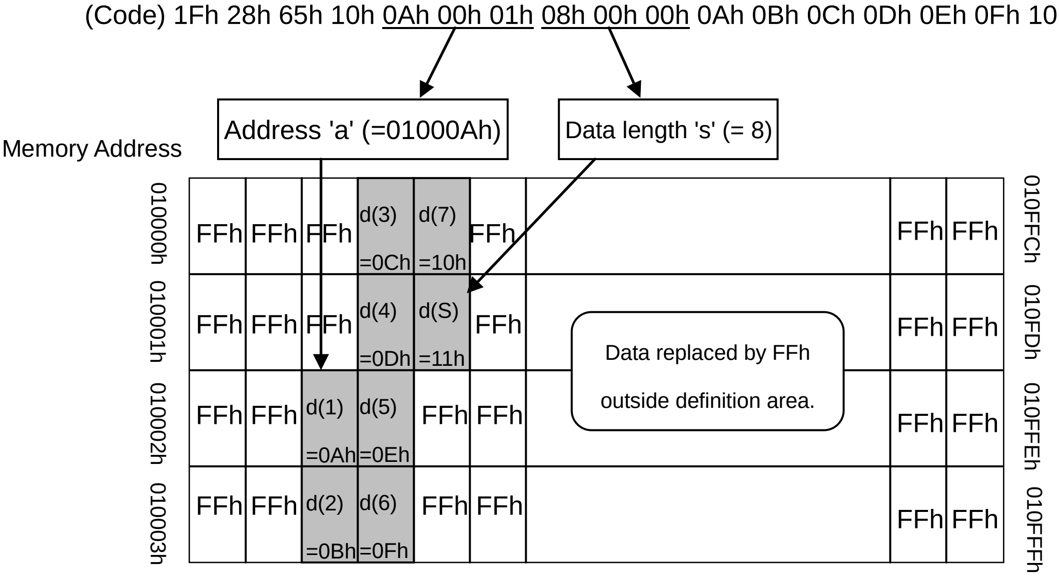
[Function] **Define user bit image to the FROM.**

- FROM bit image capacity is 524,288 byte (512KB).
- Bit images defined in FROM can be displayed using "5.2.5.1 Downloaded bit image display" or "5.2.6.1 Dot unit downloaded bit image display" command.
- If Bit image data definition address or Bit image data length is outside the definable area, the command is cancelled at that point, and the remaining data is treated as standard data.
- **This command is only valid in User setup mode.**
- BUSY signal is output by the display module during processing of this command. The host should not transmit any data during this time.
- Total definable area is 000000h to 07FFFFh (524,288 bytes). Bit image definition is performed in units of 4,096 bytes (4KB). For example, if 1KB of bit image data is defined, the remaining 3KB data is set to FFh.
- **Defined contents are not guaranteed if an error occurs.**

[Example] FROM bit image definition memory

Defin 8 bytes data "0Ah 0Bh 0Ch 0Dh 0Eh 0Fh 10h 11h" from definition address 01000Ah.

(Code) 1Fh 28h 65h 10h 0Ah 00h 01h 08h 00h 00h 0Ah 0Bh 0Ch 0Dh 0Eh 0Fh 10h 11h



5.2.10.4 <Function 12h> FROM Macro define / delete [US (e 12h a pL pH t1 t2 [d1…dp]]

[Code] **1Fh 28h 65h 12h a pL pH t1 t2 [d1…dp]**

a:	FROM Macro registration number
pL:	FROM Macro data length, lower byte
pH:	FROM Macro data length, upper byte
t1:	Display time interval (t1 × ***IntTime***) *for execution at power-on
t2:	Idle time for Macro repetition (t2 × ***IntTime***) *for execution at power-on (***IntTime***: Refer to "3.1 Timing Unit".)
d:	FROM Macro data

[Definable area]

01h ≤ a ≤ 04h
0000h ≤ (pL + pH × 100h) ≤ 2000h (if using 4 Macros), **8000h (if using 1 Macro)**
00h ≤ t1 ≤ FFh
00h ≤ t2 ≤ FFh
00h ≤ d ≤ FFh

[Function] **Define or delete FROM Macro or FROM Program Macro.**

- FROM Macro storage capacity is a total of 32KB, 8KB / Macro when using 4 Macros.
- For Macros exceeding 8KB, multiple Macro definition areas are used, which may result in some Macro number areas being undefined (see example below).
- (pL + pH × 100h) > 0000h: Supplied data 'd' is stored as Macro.
- (pL + pH × 100h) = 0000h: Macro is deleted.
- If Macro data length is outside the definable area, the command is cancelled, and the following data is treated as standard data.
- Display time interval (t1) and Idle time (t2) settings are used when FROM Macro execution at power-on is used.
- Display time interval refers to the interval time between displaying characters, and does not affect the processing speed of command code.
- Idle time refers to the time period from processing the last Macro data until the Macro is re-executed.
- **This command is only valid in User setup mode.**
- BUSY signal is output by the display module during processing of this command. The host should not transmit any data during this time.
- Do not define any of the following commands in a Macro;
  Initialize, Macro execution, RAM Macro define / delete, User setup mode start, [US (e] group commands (FROM bit image definition, Memory SW setting, etc), Memory re-write mode.
- **Program Macro details: Refer to "Program Macro" Software specification.**

- **Each Macro area is 2000h (8,192 bytes), but consecutive areas can used for defining larger Macros. (Note: Continuing from Macro 4 Area to Macro 1 Area is not possible)**
- **For Macros spanning multiple Macro Areas, areas numbers other than the head area are in undefined state. Similarly, when a new Macro is defined, any overlapping previous numbers are set to undefined state (see example below).**
- **Undefined Macros cannot be executed. Any attempt to do so (including by using MSW19 setting) will be ignored.**

[Example]

Unexecutable →	Macro 1 Area	Undefined
Unexecutable →	Macro 2 Area	Undefined
Unexecutable →	Macro 3 Area	Undefined
Unexecutable →	Macro 4 Area	Undefined

↓ Define 1 area-size (8KB) Macro in each area for Macro 1 – 4

Executable →	Macro 1 Area	Operate as Macro 1.
Executable →	Macro 2 Area	Operate as Macro 2.
Executable →	Macro 3 Area	Operate as Macro 4.
Executable →	Macro 4 Area	Operate as Macro 4.

↓ Define 2 area-size (16KB) Macro in Macro 2.

Executable →	Macro 1 Area	Operate as Macro 1.
Executable →	Macro 2 Area	Operate as Macro 2. (Definable up to 4000h.)
Unexecutable →	Macro 3 Area	
Executable →	Macro 4 Area	Operate as Macro 4.

↓ Define 2 area-size (16KB) Macro in Macro 3.

Executable →	Macro 1 Area	Operate as Macro 1.
Unexecutable →	Macro 2 Area	Undefined
Executable →	Macro 3 Area	Operate as Macro 3. (Definable up to 4000h.)
Unexecutable →	Macro 4 Area	

↓ Define 3 area-size (24KB) Macro in Macro 1.

Executable →	Macro 1 Area	Operate as Macro 1. (Definable up to 6000h.)
Unexecutable →	Macro 2 Area	
Unexecutable →	Macro 3 Area	
Unexecutable →	Macro 4 Area	Undefined

5.2.10.5 <Function 03h> Memory SW setting [US (e 03h a b]

[Code] **1Fh 28h 65h 03h a b**

a: Memory SW Number
b: Setting data

[Definable area]

00h ≤ a ≤ 3Fh
00h ≤ b ≤ FFh

[Function] **Set Memory SW 'a' with the value specified by 'b'.**

・**This command is only valid in User setup mode.**

・BUSY signal is output by the display module during processing of this command. The host should not transmit any data during this time.

* Memory SW details: Refer to "6.2 Memory SW (MSW)".

5.2.10.6 <Function 04h> Memory SW data send [US (e 04h a]

[Code] **1Fh 28h 65h 04h a**

a: Memory SW Number

[Definable area]

00h ≤ a ≤ 3Fh

[Function] **Send the contents of Memory SW data.**

・The following data is transmitted;

Transmitted data	Value (Hex)	Data length
(1) Header	28h	1 byte
(2) Identifier 1	65h	1 byte
(3) Identifier 2	04h	1 byte
(4) Data	00h–FFh	1 byte

・**This command is valid in both User setup mode and Normal mode.**

* Memory SW details: Refer to "6.2 Memory SW (MSW)".

5.2.10.7 <Function 40h> Display status send [US (e 40h a [b c]]

[Code] **1Fh 28h 65h 40h a [b c]**

[Definable area]

a = 02h: Firmware version information (b, c not used)
a = 10h: 2-byte character code information (b, c not used)
a = 11h: Language type information (b, c not used)
a = 20h: Memory checksum information
00h ≤ b ≤ FFh: Start address (Effective address = b × 10000h)
00h ≤ c ≤ FFh: Data length (Effective data length = c × 10000h)
a = 30h: Product type information (b, c not used)
a = 40h: Display x dot information (b, c not used)
a = 41h: Display y dot information (b, c not used)
a = 50h: X direction switch number information (b, c not used)
a = 51h: Y direction switch number information (b, c not used)

[Function] Send display status information.

・The following data is transmitted;

Transmitted data	Value (Hex)	Data length
(1) Header	28h	1 byte
(2) Identifier 1	65h	1 byte
(3) Identifier 2	40h	1 byte

(4) Data	00h–FFh	a=02h: 4 bytes, a=10h: 15 bytes,
		a=11h: 15 bytes, a=20h: 4 bytes,
		a=30h: 15 bytes, a=40h: 3 bytes,
		a=41h: 3 bytes, a=50h: 2 bytes,
		a=51h: 2 bytes

・**This command is valid in both User setup mode and Normal mode.**

5.2.11 Touch-Switch command group [US K n [parameter]]

[Function] Touch-Switch command processing.

n	Function
10h	All Touch-Switch status read
11h	Individual Touch-Switch status read
14h	All Touch-Switch count-level read
15h	All Touch-Switch touch-level read
18h	Touch-Switch status read mode setting
70h	Touch-Switch internal parameters change

n: Function No.

・**Touch-Switch position: Refer to Hardware Specification for details.**

5.2.11.1 <Function 10h> All Touch-Switch status read [US K 10h]

[Code] 1Fh 4Bh 10h

[Function] Send ON/OFF status information for all Touch-Switches.

・The following data is transmitted:

Transmitted data	Value (Hex)	Data length
(1) Identifier	10h	1 byte
(2) Information data length	***InfoDatLen***	1 byte
(3) Information ON/OFF	00h–FFh [dn]	***InfoDatLen*** bytes

・ON/OFF information is formatted as follows;

1) Least-significant bit (bit 0) corresponds to lower switch number.
2) Any unused bits are set to 0.
3) Data is sent starting from higher switch number

[Example] For 16 Switches: [GU128X32D Type / GU140X32F Type / GU256X64C Type module]

	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0
d1	SW16	SW15	SW14	SW13	SW12	SW11	SW10	SW9
d2	SW8	SW7	SW6	SW5	SW4	SW3	SW2	SW1

SWn = 0: Switch OFF
SWn = 1: Switch ON

[Example] For 32 Switches: [GU256X128C Type module]

	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0
d1	SW32	SW31	SW30	SW29	SW28	SW27	SW26	SW25
d2	SW24	SW23	SW22	SW21	SW20	SW19	SW18	SW17
d3	SW16	SW15	SW14	SW13	SW12	SW11	SW10	SW9
d4	SW8	SW7	SW6	SW5	SW4	SW3	SW2	SW1

SWn = 0: Switch OFF
SWn = 1: Switch ON

5.2.11.2 <Function 11h> Individual Touch-Switch status read [US K 11h sn]

[Code] 1Fh 4Bh 11h sn

sn: SW Number

[Definable area]

00h ≤ sn ≤ ***SwNumMax***

sn = 00h: SW1
sn = 01h: SW2
:
sn = n-1: SWn

[Function] Send ON/OFF status information for individual Touch-Switch.

・If 'sn' is outside the definable area, the command is cancelled.

・The following data is transmitted:

Transmitted data	Value (Hex)	Data length
(1) Identifier	11h	1 byte
(2) Switch number	00h – ***SwNumMax***	1 byte
(3) Information ON/OFF	00h–FFh	1 byte

・ON/OFF information is formatted as follows;

d = 00h: Switch OFF
d = 01h: Switch ON

5.2.11.3 <Function 14h> All Touch-Switch count-level read [US K 14h]

[Code] **1Fh 4Bh 14h**

[Function] **Sends the count-level for all Touch-Switches.**

・The current (real-time) count-levels for all switches (converted to *CntLevel*) are transmitted, regardless of ON/OFF state of the switch.

・The following data is transmitted:

Transmitted data	Value (Hex)	Data length
(1) Identifier	14h	1 byte
(2) Information data length	***SwMax***	1 byte
(3) Count level	***CntLevel*** [dn]	***SwMax*** bytes

・Response information data format:

(1) One byte assigned for each switch number.

(2) The data is sent in order starting from the largest switch number.

(3) ***CntLevel*** returns to 00h when released.

[Example] For 16 Switches:

d1	d2	d3	d4	d5	d6	d7	d8
SW16	SW15	SW14	SW13	SW12	SW11	SW10	SW9
d9	d10	d11	d12	d13	d14	d15	d16
SW8	SW7	SW6	SW5	SW4	SW3	SW2	SW1

[Example] For 32 Switches:

d1	d2	d3	d4	d5	d6	d7	d8
SW32	SW31	SW30	SW29	SW28	SW27	SW26	SW25
d9	d10	d11	d12	d13	d14	d15	d16
SW24	SW23	SW22	SW21	SW20	SW19	SW18	SW17
d17	d18	d19	d20	d21	d22	d23	d24
SW16	SW15	SW14	SW13	SW12	SW11	SW10	SW9
d25	d26	d27	d28	d29	d30	d31	d32
SW8	SW7	SW6	SW5	SW4	SW3	SW2	SW1

5.2.11.4 <Function 15h> All Touch-Switch touch-level read [US K 15h]

[Code] **1Fh 4Bh 15h**

[Function] **Sends the touch-level for all Touch-Switches.**

- **The current (real-time) touch-level for all switches (normalized, as explained below) are transmitted, regardless of ON/OFF state of the switch.**
- The following data is transmitted:

Transmitted data	Value (Hex)	Data length
(1) Identifier	15h	1 byte
(2) Information data length	***SwMax***	1 byte
(3) Touch level	00h – F8h [dn] Upper 5bit (valid) Lower 3bit (= 0)	***SwMax*** bytes

- Response information data format:

1) One byte assigned for each switch number.
2) The data is sent in order starting from the largest switch number.
3) Touch-level returns to 00h when released.
4) Touch-level 80h corresponds approximately to the threshold value.

[Example] For 16 Switches:

d1	d2	d3	d4	d5	d6	d7	d8
SW16	SW15	SW14	SW13	SW12	SW11	SW10	SW9
d9	d10	d11	d12	d13	d14	d15	d16
SW8	SW7	SW6	SW5	SW4	SW3	SW2	SW1

[Example] For 32 Switches:

d1	d2	d3	d4	d5	d6	d7	d8
SW32	SW31	SW30	SW29	SW28	SW27	SW26	SW25
d9	d10	d11	d12	d13	d14	d15	d16
SW24	SW23	SW22	SW21	SW20	SW19	SW18	SW17
d17	d18	d19	d20	d21	d22	d23	d24
SW16	SW15	SW14	SW13	SW12	SW11	SW10	SW9
d25	d26	d27	d28	d29	d30	d31	d32
SW8	SW7	SW6	SW5	SW4	SW3	SW2	SW1

5.2.11.5 <Function 18h> Touch-Switch status read mode setting [US K 18h m]

[Code] **1Fh 4Bh 18h m**

m: TSW read mode

[Definable area]

00h ≤ m ≤ 02h

m = 00h: Manual transmit mode (Send only in response to read command)
m = 01h: Automatic transmit mode 1 (All Touch Switch status)
m = 02h: Automatic transmit mode 2 (Individual Touch Switch status)

[Default] m = 00h or Memory SW setting.

[Function] **Set read action of touch switch status**

- m = 00h:
  Touch Switch status is transmitted when "All Touch-Switch status read", "Individual Touch-Switch status read" or "All Touch-Switch count level read" and "All Touch-Switch touch level read" command is used.
- m = 01h, 02h:
  Touch Switch status data is automatically transmitted (placed in the transmit buffer) when any touch switch status is changed. Transmitted data format is same as "All Touch-Switch status read" command (for m = 01h) or "Individual Touch-Switch status read" command (for m = 02h).
  Note: If transmit buffer has insufficient available space for the status data, at the time when the status data is to be placed into the transmit buffer, the status data is discarded.
- If 'm' is outside the definable area, the command is cancelled.

5.2.11.6 <Function 70h> Touch-Switch internal parameters change [US K 70h a b]

[Code] **1Fh 4Bh 70h a b**

[Definable area]

00h ≤ a ≤ 03h

a = 00h: Touch sensitivity level setting
00h ≤ b ≤ 07h

a = 01h: Sampling time setting (ON decision)
01h ≤ b ≤ FEh

a = 02h: Sampling time setting (OFF decision)
01h ≤ b ≤ FEh

a = 03h: Calibration period setting
00h ≤ b ≤ 64h

[Default] Memory SW setting

[Function] **Change the Touch-Switch internal parameters.**

- **Memory SW is not set by this command.** Set MSW59 – MSW62 to 'b' to set the default power-on value for Touch-Switch internal parameters. (Refer to "5.2.10.5 Memory SW setting" and "6.2 Memory SW".)

a = 00h (MSW59):

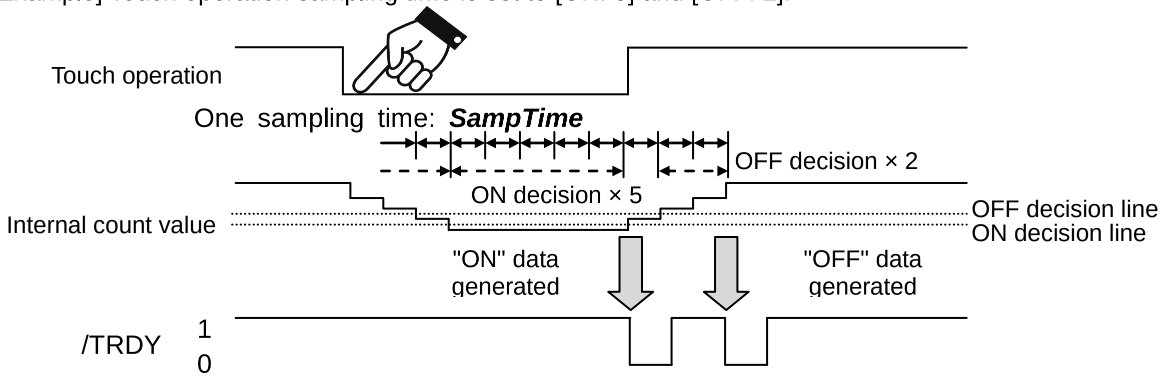
- Sets the Threshold value adjustment factor (default value: 100%) as follows:

b	Threshold value	Sensitivity
00h	12.5 %	↑
01h	25.0 %	More sensitive
02h	37.5 %	.
03h	50.0 %	.
04h	62.5 %	.
05h	75.0 %	.
06h	87.5 %	Less sensitive
07h	100 %	↓

a = 01h (MSW60), 02h (MSW61):

- Sets the number of consecutive samples that must be at the ON-level or OFF-level for the Touch-Switch operation to be recognized.
- Sampling period: ***SampTime***

[Example] Touch operation sampling time is set to [ON: 5] and [OFF: 2]:



a = 03h (MSW62):

- Sets the automatic calibration period. Automatic calibration is executed every [b ×***AutoCaliTime***]. If b = 00h, automatic calibration function is OFF.

5.2.12 Memory Re-write mode command group

[Function] Memory re-write mode processing.

Command	Function
FS | M ...	Memory re-write mode start
E k	Memory re-write mode end

5.2.12.1 Memory re-write mode start [FS | M m d1...d6]

[Code] **1Ch 7Ch 4Dh m d1...d6**

[Definable area]

m = D0h

d1...d6 = 4Dh 4Fh 44h 45h 49h 4Eh (Character strings "MODEIN")

[Function] Shift to "Memory re-write mode" from "Normal mode".

- **FROM re-write cycles are limited, so do not use this command in normal operation.**
- **Do not power on/off during Memory re-write mode, as this may corrupt FROM data.**

5.2.12.2 Memory re-write mode end [E k]

[Code] **45h k**

k = command keyword

[Definable area]

k = BAh

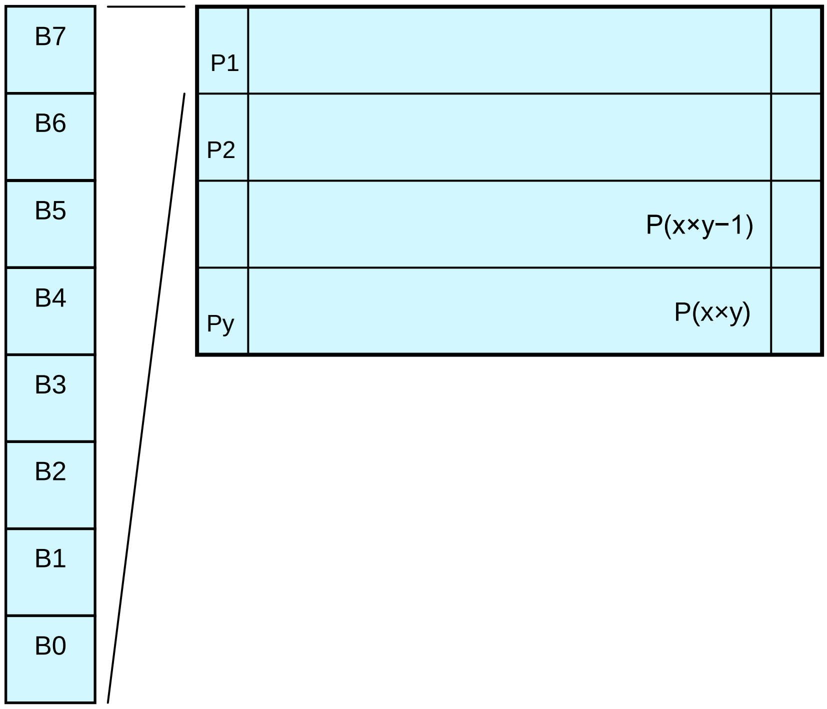
[Function] End "Memory re-write mode"

- **This command is only valid in Memory re-write mode.**
- End Memory re-write mode, and software reset of display.

5.3 Bit image data format

The Bit image consists of the data for image size (x × y) as follows;

Data	Pattern position
d (1)	P1
d (2)	P2
d (x × y)	P(x × y)



6 Setup

6.1 Jumper

No.	Function	Default
J0	Asynchronous serial baud rate select / I²C slave address select	OPEN
J1		OPEN
J2	Serial interface select	OPEN
J3		OPEN
TEST	Operating Mode select (Refer to "2 Operating Mode".)	OPEN
JRW		OPEN
BT	Factory use only (do not change)	OPEN

***Jumper position: Refer to Hardware Specification.**

6.1.1 Serial interface select

J2	J3	Interface type at power-on
-	OPEN	Asynchronous serial Interface
OPEN	SHORT	I²C Interface
SHORT	SHORT	SPI

6.2 Memory SW (MSW)

SW No.	Function	Valid range	Default
0 – 18	Reserved	-	-
19	Power-on FROM macro automatic execute	00h, 01h–04h, 0Fh, 81h–84h, 8Fh	00h
20 – 46	Reserved	-	-
47	I²C slave address setting	00h, 08h–77h, 88–F7h	00h
48	Asynchronous serial baud rate setting	00h–06h	00h
49	Asynchronous serial parity setting	00h–02h	00h
50 – 58	Reserved	-	-
59	Touch sensitivity level setting	00h–07h	07h
60	Sampling time setting (ON decision)	01h–FEh	03h
61	Sampling time setting (OFF decision)	01h–FEh	06h
62	Calibration time setting	00h–64h	0Ah
63	Touch switch read setting	00h–02h	00h

・Module operates with default value if Memory SW value is outside the valid range.

6.2.1 Power-on FROM macro automatic execution

FROM Macro / Program Macro is executed automatically at power-on, depending on MSW19 value.

MSW19	Setting
00h	No macro execution.
01h–04h	FROM Normal macro 1 – 4 is executed.
0Fh	FROM Normal macro 1 – 4 is executed. (selected by I/O port) *1
81h–84h	FROM Program macro 1 – 4 is executed.
8Fh	FROM Program macro 1 – 4 is executed. (selected by I/O port) *1
other values	Same as MSW19 = 00h.

*1: Executed Macro No. is selected by general-purpose I/O port. **If I/O port state combination is invalid, this setting is ignored** (same as MSW19 = 00h)**.**

P00 = Low, All others = High:	Normal Macro 1 / Program Macro 1 is executed.
P01 = Low, All others = High:	Normal Macro 2 / Program Macro 2 is executed.
P02 = Low, All others = High:	Normal Macro 3 / Program Macro 3 is executed.
P03 = Low, All others = High:	Normal Macro 4 / Program Macro 4 is executed.
Combinations other than the above:	No macro execution.

6.2.2 Touch switch read operation setting

Touch switch read operation at power-on is set by MSW63.

MSW63	Setting
00h	**Manual transmit mode**
01h	Automatic transmit mode (All Touch-Switch status read)
02h	Automatic transmit mode (Individual Touch-Switch status read)
other values	Same as MSW63 = 00h.

(Refer to "5.2.11.5 Touch-Switch status read mode setting" for details.)

6.2.3 I^{2}C slave address select

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

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

*1: The VFD module also responds on the General call address (00h).

*2: Response to General call address can be disabled (see below).

MSW47	Slave address
00h	**Slave address is set to 71h. The VFD module also responds to the General call address.**
08h – 77h	Slave address is set to MSW47 value (lower 7 bits). VFD module also responds to the General call address.
88h – F7h	Slave address is set to MSW47 value (lower 7 bits). **VFD module does not respond to the General call address.**
other value	Same as MSW47 = 00h.

6.2.4 Asynchronous serial baud rate select

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

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

MSW48	Baud rate
00h	**Baud rate is set to 115200bps.**
01h – 06h	Baud rate is set as follows: 01h: 4800bps 02h: 9600bps 03h: 19200bps 04h: 38400bps 05h: 57600bps 06h: 115200bps
other value	Same as MSW48 = 00h.

6.2.5 Asynchronous serial parity select

Asynchronous serial parity setting is set by Memory SW.

MSW49	Parity
00h	**Parity is set to Non-parity.**
01h, 02h	Parity is set as following; 01h: Even-parity 02h: Odd-parity
other value	Same as MSW49 = 00h.

6.2.6 Touch sensitivity level setting

MSW59 details: Refer to "5.2.11.6 Touch-Switch internal parameters change".

6.2.7 Sampling time setting (ON decision)

MSW60 details: Refer to "5.2.11.6 Touch-Switch internal parameters change".

6.2.8 Sampling time setting (OFF decision)

MSW61 details: Refer to "5.2.11.6 Touch-Switch internal parameters change".

6.2.9 Calibration time setting

MSW62 details: Refer to "5.2.11.6 Touch-Switch internal parameters change".

Revision Note

Specification No.	Date	Revision
DS-1900-0002-00	Apr. 08, 2015	Initial release.
DS-1900-0002-01	Jun. 29, 2015	3.3 Related Touch-Switch Information Added ***SampTime***, ***AutoCaliTime*** and ***ResLevel.*** 5.2.11.1 All Touch-Switch status read 5.2.11.3 All Touch-Switch response-level read Added an explanation for 4x8 switch.
DS-1900-0002-02	Jul. 1, 2015	Specification name has been changed: “GU-D900x series” to “GU-D series”.
DS-1900-0002-03	Aug. 26, 2015	3.2 Display Memory configuration Added ***Max_Xdot_CurtWin*** and ***Max_Ydot_CurtWin*** 5.2.6.1 Dot unit downloaded bit image display 5.2.6.2 Dot unit real-time bit image display 5.2.6.3 Dot unit character display Display position x,y upper limit changed ***Max_Xdot*** → ***Max_Xdot_CurtWin*** ***Max_Ydot*** → ***Max_Ydot_CurtWin*** 3.3 Related Touch-Switch Information GU256X128C-D903M sampling timing changed 40ms → 20ms Variable name changed: Response level ***ResLevel*** → Count level ***CntLevel*** 4.7.3 Touch-Switch commands All Touch-Switch touch-level read expression added. 5.2.11.3 All Touch-Switch count-level read Command name changed. All Touch-Switch response-level read → All Touch-Switch count-level read 5.2.11.4 All Touch-Switch touch-level read Command added. Other minor corrections