

M37280MF-XXXSP, M37280MK-XXXSP M37280EKSP

SINGLE-CHIP 8-BIT CMOS MICROCOMPUTER with CLOSED CAPTION DECODER
and ON-SCREEN DISPLAY CONTROLLER

1. DESCRIPTION

The M37280MF-XXXSP and M37280MK-XXXSP are single-chip microcomputers designed with CMOS silicon gate technology. They have a OSD function and a data slicer function, so it is useful for a channel selection system for TV with a closed caption decoder. The features of the M37280EKSP is similar to those of the M37280MK-XXXSP except that the chip has a built-in PROM which can be written electrically. The difference between M37280MK-XXXSP and M37280MF-XXXSP are the ROM size and RAM size. Accordingly, the following descriptions will be for the M37280MK-XXXSP.

2. FEATURES

- Number of basic instructions 71
- Memory size
 - ROM 60K bytes (M37280MF-XXXSP)
80K bytes (M37280MK-XXXSP, M37280EKSP)
 - RAM 1024 bytes (M37280MF-XXXSP)
1472 bytes (M37280MK-XXXSP, M37280EKSP)
 - ROM correction memory 64 bytes
- Minimum instruction execution time
..... 0.5 μ s (at 8 MHz oscillation frequency)
- Power source voltage 5 V \pm 10 %
- Subroutine nesting 128 levels (Max.)
- Interrupts 19 types, 16 vectors
- 8-bit timers 6
- Programmable I/O ports (Ports P0, P1, P2, P30, P31) 26
- Input ports (Ports P40-P46, P63, P64, P70-P72) 12
- Output ports (Ports P32, P47, P5, P60-P62, P65-P67) 16
- 12 V withstand ports 8
- LED drive ports 2
- Serial I/O 8-bit \times 1 channel
- Multi-master I²C-BUS interface 1 (2 systems)
- A-D converter (8-bit resolution) 8 channels
- PWM output circuit 8-bit \times 8
- Power dissipation
 - In high-speed mode 165 mW
(at V_{CC} = 5.5V, 8 MHz oscillation frequency, CRT on, and Data slicer on)
 - In low-speed mode 0.33 mW
(at V_{CC} = 5.5V, 32 kHz oscillation frequency)
- ROM correction function

● Closed caption data slicer

● OSD function

Display characters 32 characters \times 16 lines + RAM font (1 character)
 (CC/OSD mode)(CDOSD mode)(RAM font)
 Kinds of characters 510 kinds + 62 kinds + 1 kind
 (Coloring unit) (a character) (a dot) (a dot)
 Triple layer function
 2 layers selected from CC/CDOSD/OSD mode + RAM font layer
 Character display area CC/CDOSD mode: 16 \times 26 dots
 OSD mode/RAM font: 16 \times 20 dots
 Kinds of character sizes CC mode/RAM font: 4 kinds
 OSD/CDOSD mode: 14 kinds
 Kinds of character colors
 64 colors (4 adjustment levels for each R, G, B)
 Coloring unit dot, character, character background, raster
 Blanking output OUT1, OUT2
 Display position
 Horizontal: 256 levels Vertical :1024 levels
 (RAM font can be set independently)
 Attribute
 CC mode: smooth italic, underline, flash, automatic solid space
 OSD mode: border, shadow
 Window/Blank function

3. APPLICATION

TV with a closed caption decoder

4. PIN CONFIGURATION

Refer to page 3.

5. BLOCK DIAGRAM

Refer to page 4.

6. PERFORMANCE OVERVIEW

Refer to pages 5 and 6.

7. PIN DESCRIPTION

Refer to pages 7 to 11.

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8. PIN CONFIGURATION

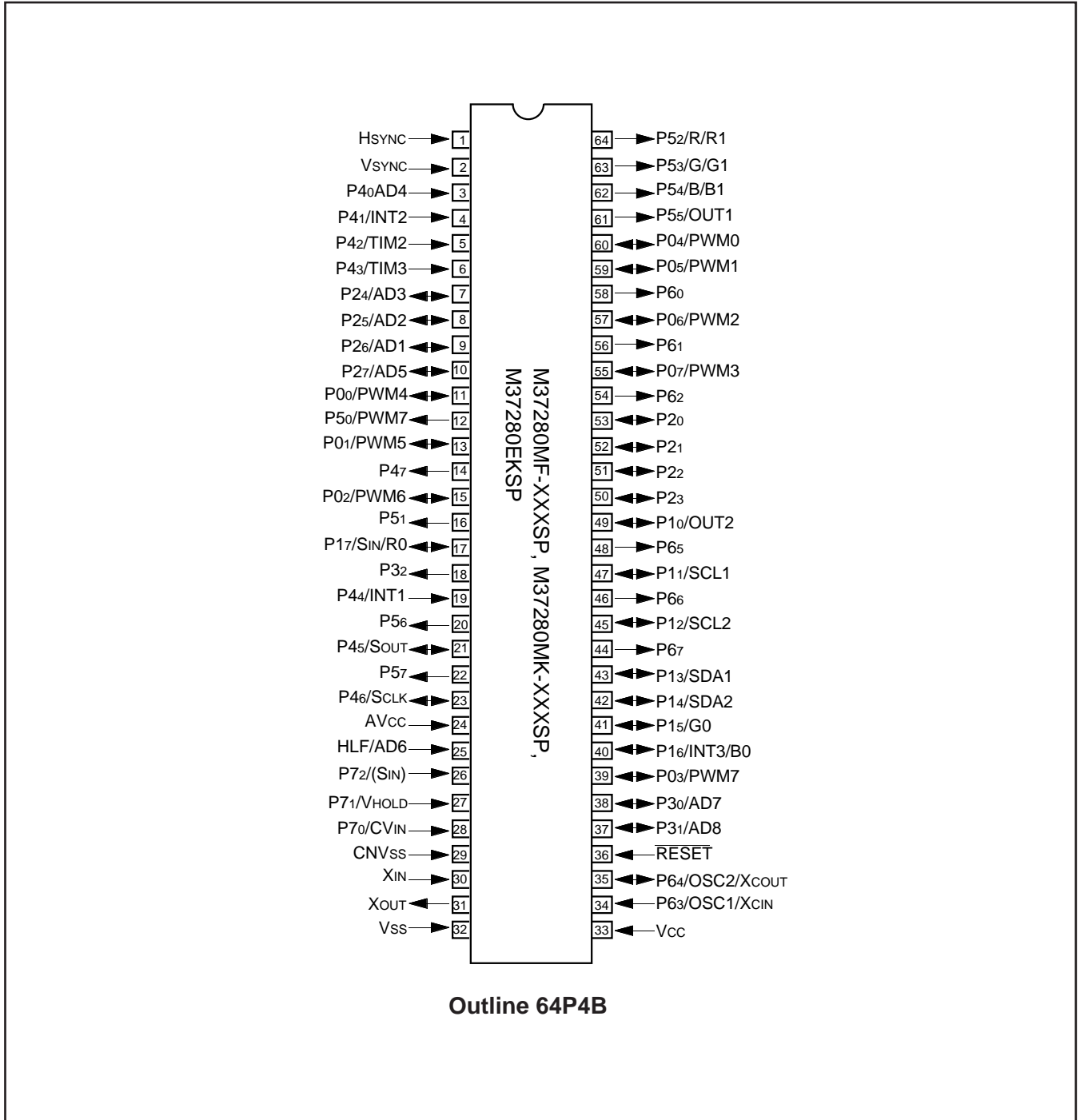


Fig. 8.1 Pin Configuration (Top View)

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9. FUNCTIONAL BLOCK DIAGRAM

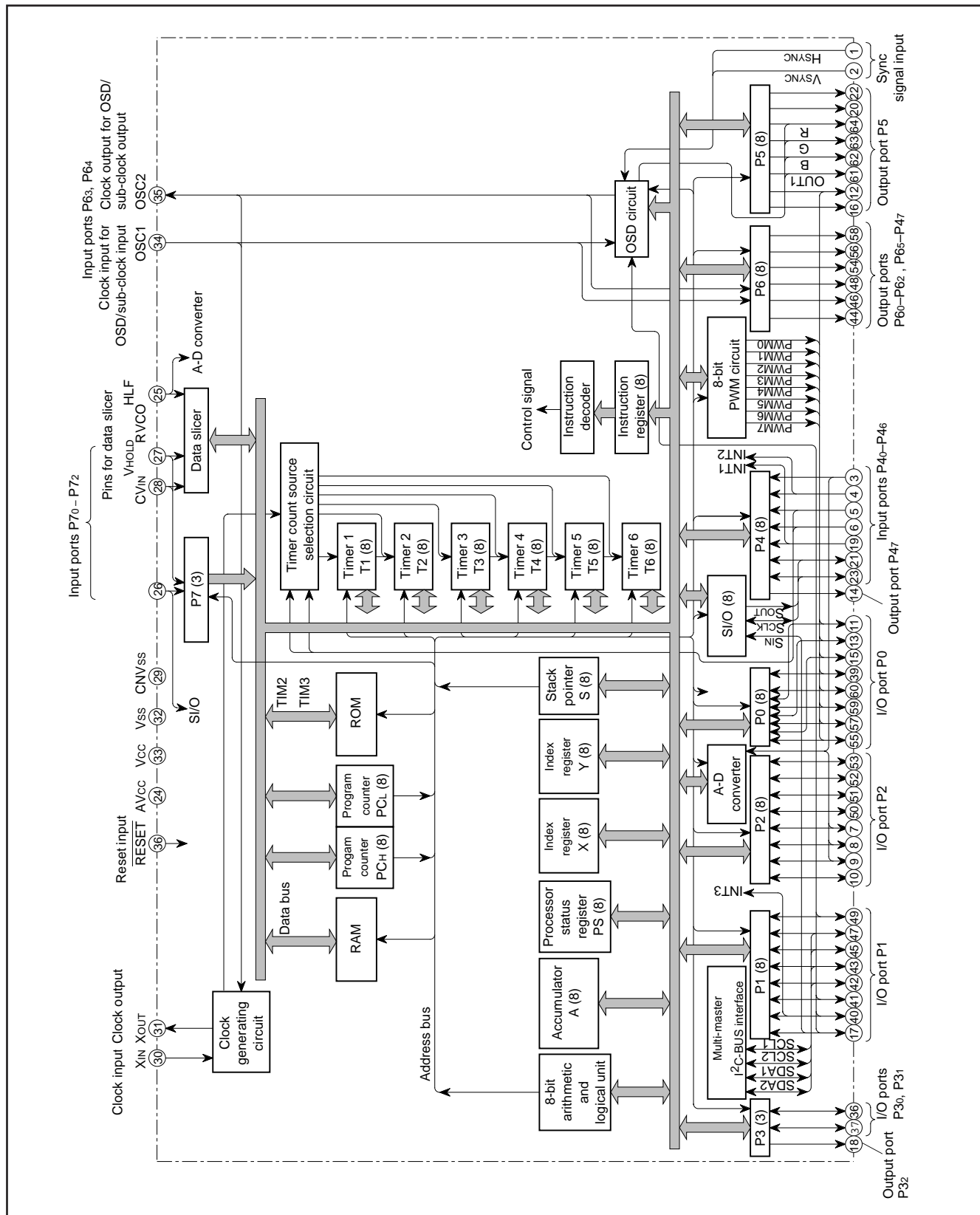


Fig. 9.1 Functional Block Diagram of M37280

M37280MF-XXXSP, M37280MK-XXXSP M37280EKSP

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10. PERFORMANCE OVERVIEW

Table 10.1 Performance Overview

| Parameter | | | Functions |
|---|--------------------------|----------------------------|--|
| Number of basic instructions | | | 71 |
| Instruction execution time | | | 0.5 μ s (the minimum instruction execution time, at 8 MHz oscillation frequency) |
| Clock frequency | | | 8 MHz (maximum) |
| Memory size | ROM | M37280MF-XXXSP | 60K bytes |
| | | M37280MK-XXXSP, M37280EKSP | 80K bytes |
| | RAM | M37280MF-XXXSP | 1024 bytes |
| | | M37280MK-XXXSP, M37280EKSP | 1472 bytes |
| | ROM correction memory | | 64 bytes |
| | OSD ROM (character font) | | 20400 bytes |
| | OSD ROM (color dot font) | | 9672 bytes |
| | OSD RAM (SPRITE) | | 120 bytes |
| | OSD RAM (character) | | 1536 bytes |
| | | | |
| Input/Output ports | P00–P02, P04–P07 | I/O | 7-bit X 1 (N-channel open-drain output structure, can be used as 8-bit PWM output pins) |
| | P03 | I/O | 1-bit X 1 (CMOS input/output structure, can be used as 14-bit PWM output pin) |
| | P10, P15–P17 | I/O | 4-bit X 1 (CMOS input/output structure, can be used as OSD output pin, INT input pin, serial input pin) |
| | P11–P14 | I/O | 4-bit X 1 (N-channel open-drain output structure, can be used as multi-master I ² C-BUS interface) |
| | P2 | I/O | 8-bit X 1 (CMOS input/output structure, can be used as A-D input pins) |
| | P30, P31 | I/O | 2-bit X 1 (CMOS input/output structure, can be used as A-D input pins) |
| | P32 | Output | 1-bit X 1 (N-channel open-drain output structure) |
| | P40–P44 | Input | 5-bit X 1 (can be used as A-D input pins, INT input pins, external clock input pins) |
| | P45, P46 | Input | 2-bit X 1 (N-channel open-drain output structure when serial I/O is used, can be used as serial I/O pins) |
| | P47 | Output | 1-bit X 1 (N-channel open-drain output structure) |
| | P50, P51, P56, P57 | Output | 4-bit X 1 (N-channel open-drain output structure, can be used as PWM output pin) |
| | P52–P55 | Output | 4-bit X 1 (CMOS output structure, can be used as OSD output pins) |
| | P60–P62, P65–P67 | Output | 6-bit X 1 (N-channel open-drain output structure) |
| | P63 | Input | 1-bit X 1 (can be used as sub-clock input pin, OSD clock input pin) |
| | P64 | Input | 1-bit X 1 (CMOS output structure when LC is oscillating, can be used as sub-clock output pin, OSD clock output pin) |
| | P70–P72 | Input | 3-bit X 1 (can be used as data slicer input/output, serial input pin) |
| Serial I/O | | | 8-bit X 1 |
| Multi-master I ² C-BUS interface | | | 1 (2 systems) |
| A-D converter | | | 8 channels (8-bit resolution) |
| PWM output circuit | | | 8-bit X 8 |
| Timers | | | 8-bit timer X 6 |
| Subroutine nesting | | | 128 levels (maximum) |
| Interrupt | | | <19 types> External interrupt X 3, Internal timer interrupt X 6, Serial I/O interrupt X 1, OSD interrupt X 1, Multi-master I ² C-BUS interface interrupt X 1, Data slicer interrupt X 1, f(XIN)/4096 interrupt X 1, SPRITE OSD interrupt X 1, VSYNC interrupt X 1, A-D conversion interrupt X 1, BRK instruction interrupt X 1 |
| Clock generating circuit | | | 2 built-in circuits (externally connected to a ceramic resonator or a quartz-crystal oscillator) |
| Data slicer | | | Built in |

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Table 10.2 Performance Overview

| Parameter | | | | Functions | |
|-----------------------------|--------------------|---|-------------------------|---|--|
| OSD function | | Number of display characters | | 32 characters X 16 lines | |
| | | Character display area | | CC mode: 16 X 26 dots (dot structure: 16 X 20 dots) OSD mode: 16 X 20 dots EXOSD mode: 16 X 26 dots SPRITE display: 16 X 20 dots | |
| | | Kinds of characters | | CC/OSD mode: 510 kinds CDOSD mode: 62 kinds SPRITE display: 1 kind | |
| | | Kinds of character sizes | | CC mode: 2 kinds OSD/CDOSD mode: 14 kinds SPRITE display: 8 kinds | |
| | | Kinds of character colors | | CC/CDOSD mode: 8 kinds (R, G, B, OUT1, OUT2)) OSD mode: 15 kinds (R, G, B, OUT1, OUT2) SPRITE display: 8 kinds (R, G, B, OUT1) | |
| | | Display position (horizontal, vertical) | | 256 levels (horizontal) X 1024 levels (vertical) SPRITE display: 2048 X 1024 | |
| Power source voltage | | | | 5V ± 10% | |
| Power dissipation | In high-speed mode | OSD ON (Analog output) | Data slicer ON | 275 mW typ. (at oscillation frequency f(XIN) = 8 MHz, fosc = 27 MHz) | |
| | | | OSD ON (Digital output) | Data slicer OFF | 165 mW typ. (at oscillation frequency f(XIN) = 8 MHz, fosc = 27 MHz) |
| | | | OSD OFF | Data slicer OFF | 82.5 mW typ. (at oscillation frequency f(XIN) = 8 MHz) |
| | In low-speed mode | OSD OFF | Data slicer OFF | 0.33 mW typ. (at oscillation frequency f(XCIN) = 32 kHz, f(XIN) = stop) | |
| | In stop mode | | | 0.055 mW (maximum) | |
| Operating temperature range | | | | −10 °C to 70 °C | |
| Device structure | | | | CMOS silicon gate process | |
| Package | | | | 64-pin shrink plastic molded DIP | |

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11. PIN DESCRIPTION

Table 11.1 Pin Description

| Pin | Name | Input/ Output | Functions |
|--|---|------------------|--|
| VCC, AVCC, VSS | Power source | | Apply voltage of 5 V \pm 10 % (typical) to VCC and AVCC, and 0 V to VSS. |
| CNVSS | CNVSS | Input | Connected to VSS. |
| RESET | Reset input | Input | To enter the reset state, the reset input pin must be kept at a LOW for 2 μ s or more (under normal VCC conditions). If more time is needed for the quartz-crystal oscillator to stabilize, this LOW condition should be maintained for the required time. |
| XIN | Clock input | Input | This chip has an internal clock generating circuit. To control generating frequency, an external ceramic resonator or a quartz-crystal oscillator is connected between pins XIN and XOUT. If an external clock is used, the clock source should be connected to the XIN pin and the XOUT pin should be left open. |
| XOUT | Clock output | Output | |
| P00/ PWM4– P02/PWM6, P03/PWM7, P04/ PWM0– P07/PWM3 | I/O port P0 | I/O | Port P0 is an 8-bit I/O port with direction register allowing each I/O bit to be individually programmed as input or output. At reset, this port is set to input mode. The output structure of P03 is CMOS output, that of P00–P02 and P04–P07 are N-channel open-drain output. See notes at end of Table for full details of port P0 functions. |
| | 8-bit PWM output | Output | Pins P00–P03 and P04–P07 are also used as 8-bit PWM output pins PWM4–PWM7 and PWM0–PWM3 respectively. The output structure of PWM0–PWM6 is N-channel open-drain output. And the output structure of PWM7 is CMOS output. |
| P10/OUT2, P11/SCL1, P12/SCL2, P13/SDA1, P14/SDA2, P15/G0, P16/INT3/ B0, P17/SIN/R0 | I/O port P1 | I/O | Port P1 is an 8-bit I/O port and has basically the same functions as port P0. The output structure of P10 and P15–P17 is CMOS output, that of P11–P14 is N-channel open-drain output. |
| | OSD output | Output | Pin P10, P15–P17 are also used as OSD output pins OUT2, G0, B0, R0, respectively. The output structure is CMOS output. |
| | Multi-master I ² C-BUS interface | Output | Pin P11–P14 are used as SCL1, SCL2, SDA1 and SDA2 respectively, when multi-master I ² C-BUS interface is used. The output structure is N-channel open-drain output. |
| | External interrupt input | Input | Pin P16 is also used as external interrupt input pin INT3. |
| | Serial I/O data input | Input | Pin P17 is also used as serial I/O data input pin SIN. |
| P20–P23 P24/AD3– P26/AD1, P27/AD5 | I/O port P2 | I/O | Port P2 is an 8-bit I/O port and has basically the same functions as port P0. The output structure is CMOS output. |
| | Analog input | Input | Pins P24–P26, P27 are also used as analog input pins AD3–AD1, AD5 respectively. |
| P30/AD7, P31/AD8 | I/O port P3 | I/O | Ports P30 and P31 are 2-bit I/O ports and have basically the same functions as port P0. The output structure is CMOS output. |
| | Analog input | Input | Pins P30, P31 are also used as analog input pins AD7, AD8 respectively. |
| P32 | Output port P3 | Output | Port P32 is a 1-bit output port. The output structure is N-channel open-drain output. |
| P40/AD4, P41/INT2, P42/TIM2, P43/TIM3, P44/INT1, P45/SOUT, P46/SCLK | Input port P4 | Input | Ports P40–P46 are a 7-bit input port. |
| | Analog input | Input | Pin P40 is also used as analog input pin AD4. |
| | External interrupt input | Input | Pins P41, P44 are also used as external interrupt input pins INT2, INT1. |
| | External clock input | Input | Pins P42 and P43 are also used as external clock input pins TIM2, TIM3 respectively. |
| | Serial I/O data output | Output | Pin P45 is used as serial I/O data output pin SOUT. The output structure is N-channel open-drain output. |
| | Serial I/O synchronous clock input/output | I/O | Pin P46 is used as serial I/O synchronous clock input/output pin SCLK. The output structure is N-channel open-drain output. |
| P47 | Output port P4 | Output | Port P47 is a 1-bit output port. The output structure is N-channel open-drain output. |

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Table 11.2 Pin Description (continued)

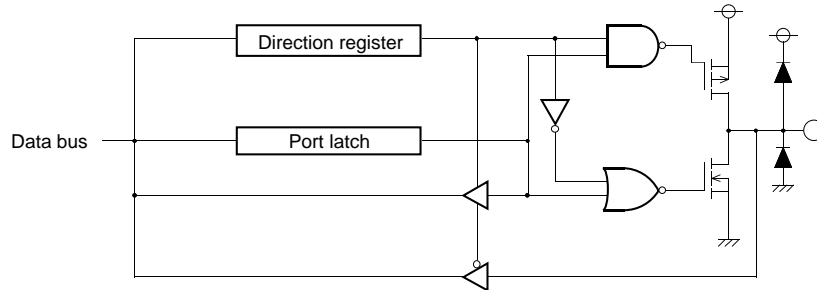
| Pin | Name | Input/ Output | Functions |
|---|-----------------------|------------------|--|
| P50/PWM7, P51, P52/R/R1, P53/G/G1, P54/B/B1, P55/OUT1, P56, P57 | Output port P5 | Output | Port P5 is a 4-bit output port. The output structure of P50, P51, P56 and P57 is N-channel open-drain output, that of P52–P55 is CMOS output. |
| | PWM output | Output | Pin P50 is also used as 8-bit PWM output pin PWM7. The output structure is N-channel open-drain output. |
| | OSD output | Output | Pins P52–P55 are also used as OSD output pins R/R1, G/G1, B/B1, OUT1 respectively. At R, G, B output, the output structure is analog output. At R1, G1, B1 and OUT1 output, the output structure is CMOS output. |
| P60–P62, P65–P67 | Output port P6 | Output | Ports P60–P62 and P65–P67 are 6-bit output ports. The output structure is N-channel open-drain output. |
| P63/OSC1/ XCIN, P64/OSC2/ XCOUT | Input port P6 | Input | Ports P63 and P64 are 2-bit input port. |
| | Clock input for OSD | Input | Pin P63 is also used as OSD clock input pin OSC1. |
| | Clock output for OSD | Output | Pin P64 is also used as OSD clock output pin OSC2. The output structure is CMOS output. |
| | Sub-clock output | Output | Pin P64 is also used as sub-clock output pin XCOUT. The output structure is CMOS output. |
| P70/CVIN, P71/VHOLD, P72/(SIN) | Sub-clock input | Input | Pin P63 is also used as sub-clock input pin XCIN. |
| | Input port P7 | Input | Ports P70–P72 are 3-bit input port. |
| | Input for data slicer | Input | Pins P70, P71 are also used as data slicer input pins CVIN, VHOLD respectively. When using data slicer, input composite video signal through a capacitor. Connect a capacitor between VHOLD and VSS. |
| HLF/AD6 | Serial I/O data input | Input | Pins P72 is also used as serial I/O data input pin SIN. |
| | | | When using data slicer, connect a filter using of a capacitor and a resistor between HLF and VSS. |
| | Analog input | Input | This is an analog input pin AD6 . |
| HSYNC | HSYNC input | Input | This is a horizontal synchronous signal input for OSD. |
| VSNC | VSNC input | Input | This is a vertical synchronous signal input for OSD. |

Note : As shown in the memory map (Figure 12.2.1), port P0 is accessed as a memory at address 00C016 of zero page. Port P0 has the port P0 direction register (address 00C116 of zero page) which can be used to program each bit as an input ("0") or an output ("1"). The pins programmed as "1" in the direction register are output pins. When pins are programmed as "0," they are input pins. When pins are programmed as output pins, the output data are written into the port latch and then output. When data is read from the output pins, the output pin level is not read but the data of the port latch is read. This allows a previously-output value to be read correctly even if the output "L" voltage has risen, for example, because a light emitting diode was directly driven. The input pins float, so the values of the pins can be read. When data is written into the input pin, it is written only into the port latch, while the pin remains in the floating state.

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Ports P03, P10, P15-P17, P2, P30, P31



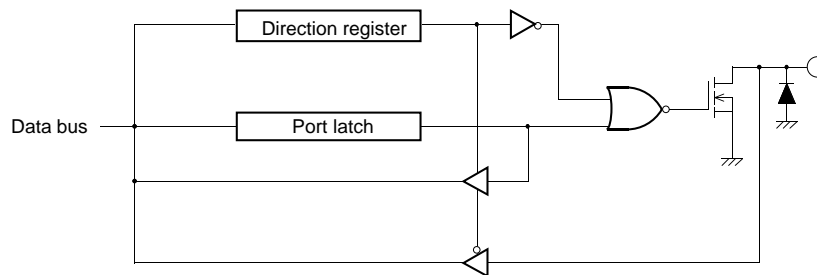
CMOS output

Ports P03, P10, P15-P17,
P2, P30, P31

Note : Each port is also used as follows :

P00 : PWM7
P10 : OUT2
P15 : G0
P16 : INT3/B0
P17 : Sin/R0
P24-P26 : AD3-AD1
P27 : AD5
P30 : AD7
P31 : AD8

Ports P00-P02, P04-P07



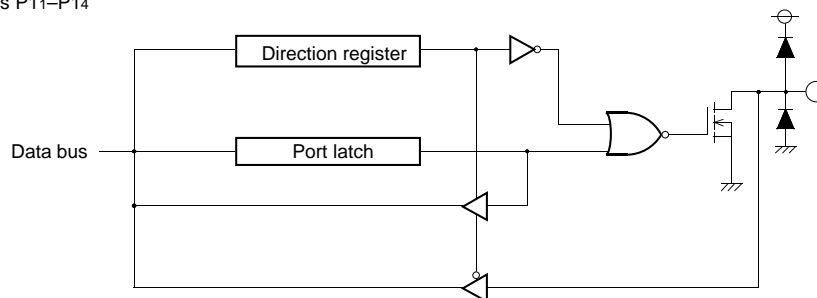
N-channel open-drain output

Ports P00-P02, P04-P07

Note : Each port is also used as follows :

P00-P02 : PWM4-PWM6
P04-P07 : PWM0-PWM3

Ports P11-P14



N-channel open-drain output

Port P11-P14

Note : Each port is also used as follows :

P11 : SCL1
P12 : SCL2
P13 : SDA1
P14 : SDA2

Fig. 11.1 I/O Pin Block Diagram (1)

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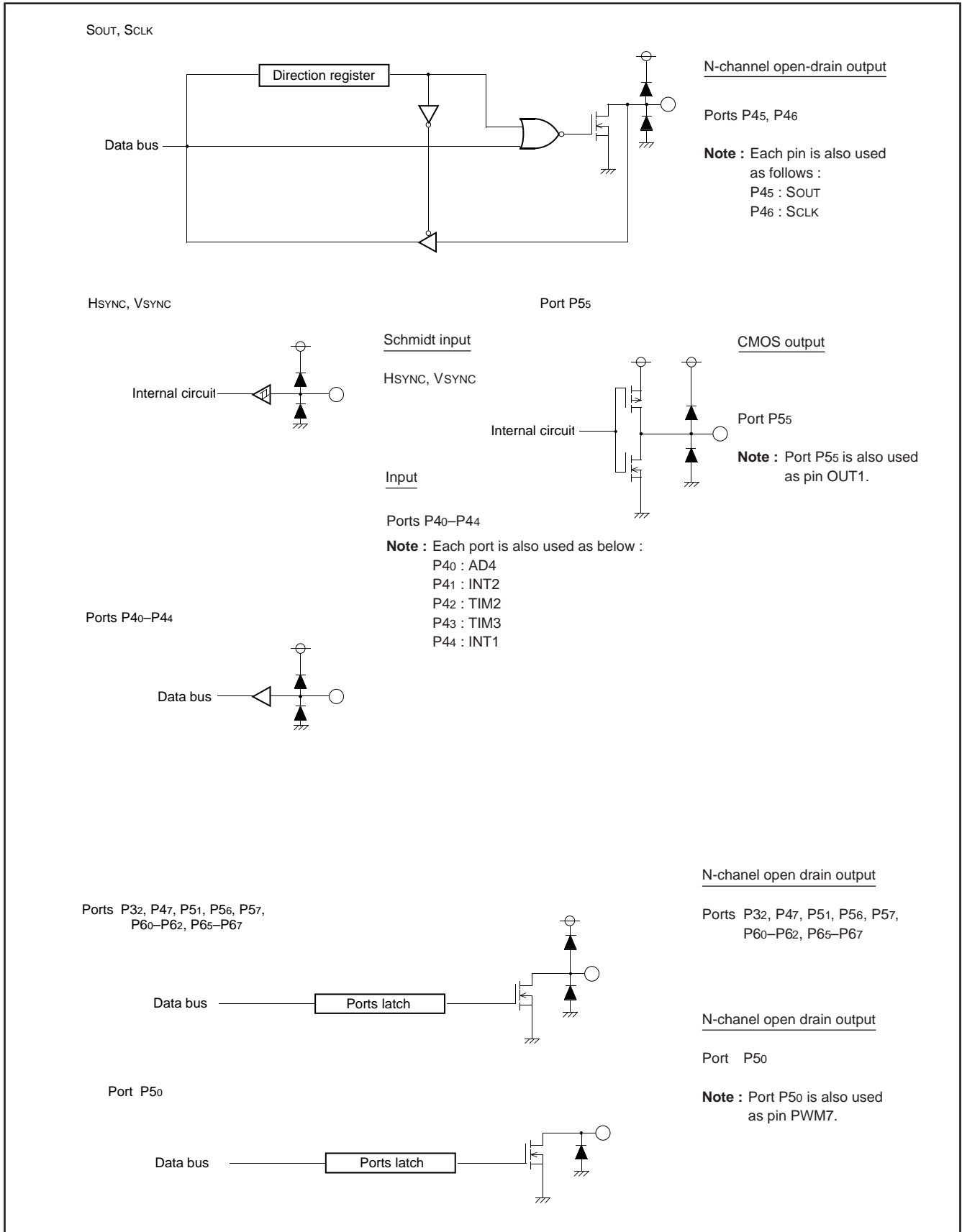


Fig. 11.2 I/O Pin Block Diagram (2)

PRELIMINARY

Notice: This is not a final specification.
Some parametric limits are subject to change.

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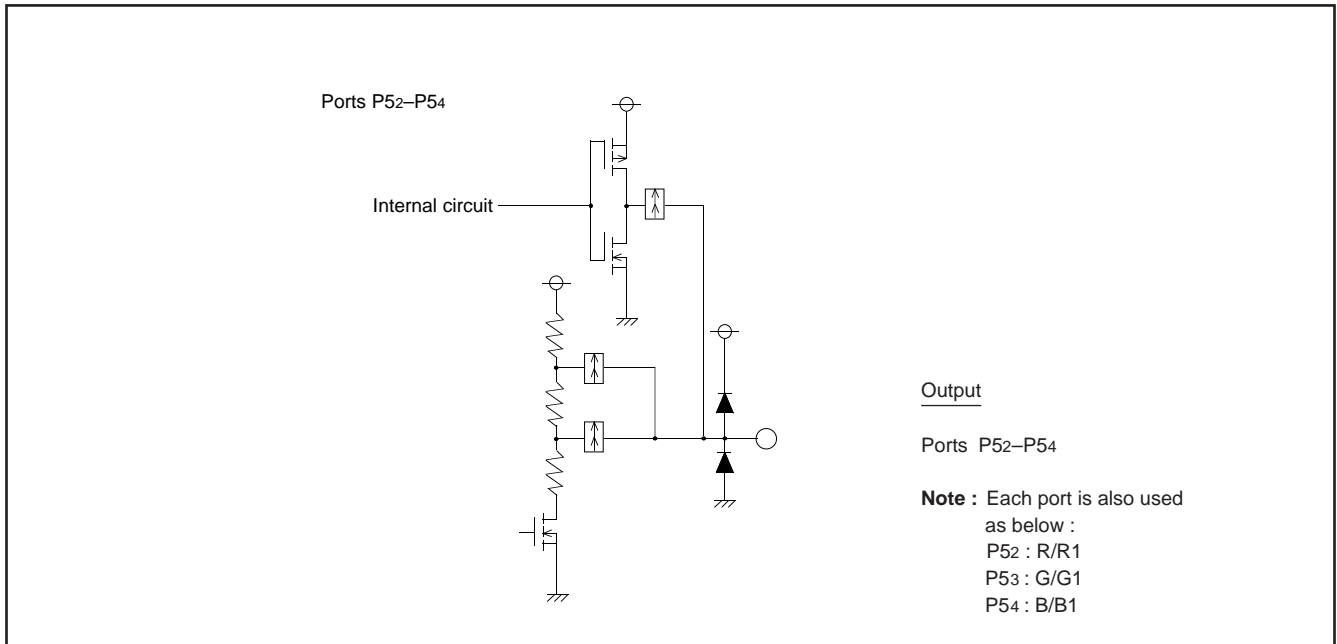


Fig. 11.3 I/O Pin Block Diagram (3)

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12. FUNCTIONAL DESCRIPTION

12.1. CENTRAL PROCESSING UNIT (CPU)

This microcomputer uses the standard 740 Family instruction set. Refer to the table of 740 Family addressing modes and machine instructions or the SERIES 740 <Software> User's Manual for details on the instruction set.

Machine-resident 740 Family instructions are as follows:

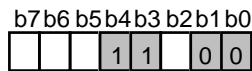
The FST, SLW instruction cannot be used.

The MUL, DIV, WIT and STP instructions can be used.

12.1.1 CPU Mode Register

The CPU mode register contains the stack page selection bit and internal system clock selection bit. The CPU mode register is allocated at address 00FB16.

CPU Mode Register



CPU mode register (CM) [Address 00FB16]

| B | Name | Functions | After reset | R | W |
|------|---|---|-------------|---|---|
| 0, 1 | Processor mode bits (CM0, CM1) | b1 b0 0 0: Single-chip mode 0 1: } Not available 1 0: } 1 1: } | 0 | R | W |
| 2 | Stack page selection bit (CM2) (See note) | 0: 0 page 1: 1 page | 1 | R | W |
| 3, 4 | Fix these bits to "1." | | 1 | R | W |
| 5 | XcOUT drivability selection bit (CM5) | 0: LOW drive 1: HIGH drive | 1 | R | W |
| 6 | Main Clock (XIN-XOUT) stop bit (CM6) | 0: Oscillating 1: Stopped | 0 | R | W |
| 7 | Internal system clock selection bit (CM7) | 0: XIN-XOUT selected (high-speed mode) 1: XCIN-XCOUT selected (low-speed mode) | 0 | R | W |

Note: This bit is set to "1" after the reset release.

Fig. 12.1.1 CPU Mode Register

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12.2 MEMORY

12.2.1 Special Function Register (SFR) Area

The special function register (SFR) area in the zero page contains control registers such as I/O ports and timers.

12.2.2 RAM

RAM is used for data storage and for stack area of subroutine calls and interrupts.

12.2.3 ROM

The M37280MF-XXXSP has 60K-byte program area. The M37280MK-XXXSP has 56K-byte program area and 24K-byte data-dedicated area. For the M37280EKSP, the two area (60K, 24K + 56K) can be swithed each other by setting the bank control register.

12.2.4 OSD RAM

RAM for display is used for specifying the character codes and colors to display.

12.2.5 OSD ROM

ROM for display is used for storing character data.

12.2.6 Interrupt Vector Area

The interrupt vector area contains reset and interrupt vectors.

12.2.7 Zero Page

The 256 bytes from addresses 0000₁₆ to 00FF₁₆ are called the zero page area. The internal RAM and the special function registers (SFR) are allocated to this area.

The zero page addressing mode can be used to specify memory and register addresses in the zero page area. Access to this area with only 2 bytes is possible in the zero page addressing mode.

12.2.8 Special Page

The 256 bytes from addresses FF00₁₆ to FFFF₁₆ are called the special page area. The special page addressing mode can be used to specify memory addresses in the special page area. Access to this area with only 2 bytes is possible in the special page addressing mode.

12.2.9 ROM Correction Memory (RAM)

This is used as the program area for ROM correction.

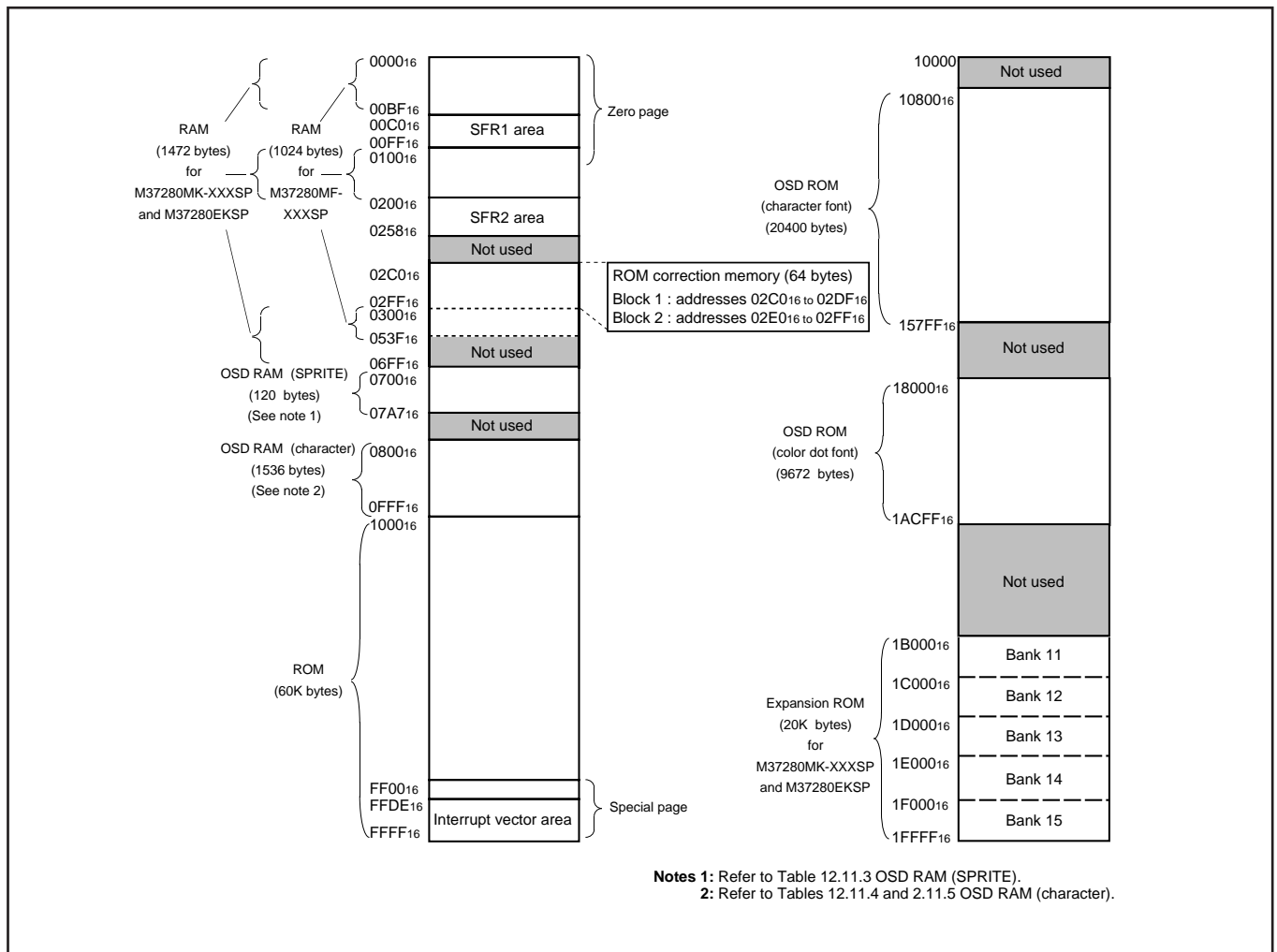


Fig. 12.2.1 Memory Map

M37280MF-XXXSP, M37280MK-XXXSP M37280EKSP

SINGLE-CHIP 8-BIT CMOS MICROCOMPUTER with CLOSED CAPTION DECODER
and ON-SCREEN DISPLAY CONTROLLER

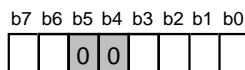
12.2.10 Expansion ROM (only M37280MK-XXXSP/M37280EKSP)

The M37280MK-XXXSP/M37280EKSP can use 5-bank (total 20K bytes) expansion ROM (4K bytes each bank) by setting the bank register.

The expansion ROM is assigned to address 1B000₁₆ to 1FFFF₁₆. The contents of each bank in the expansion ROM are read by setting the bank register and accessing addresses 1000₁₆ to 1FFF₁₆. As the expansion ROM is not programmable, use it as data-dedicated area. When using the expansion ROM area, the internal ROM at addresses 1000₁₆ to 1FFF₁₆ (extra area) is not also programmable.

- Notes**
- 1: When using the expansion ROM (BK7 = "1"), the ROM correction function do not operate for addresses 1000₁₆ to 1FFF₁₆.
 - 2: When using the emulator MCU (M37280ERSS), as addresses 1000₁₆ to FFFF₁₆ can be emulated by setting bit 7 of the bank control register to "0," the expansion ROM cannot be used. Addresses 2000₁₆ to FFFF₁₆ can be emulated by setting it to "1." The data in specified area by the bank selection bits can be read by accessing addresses 1000₁₆ to 1FFF₁₆.
 - 3: When using the emulator MCU, the expansion ROM and the extra area cannot be emulated by setting bit 7 of the bank control register to "1." Therefore, write the data to this area before using.
 - 4: For the M37280MK-XXXSP, fix bit 7 of the bank control register to "1." For M37280MF-XXXSP, fix the address 00ED₁₆ to "00₁₆."

Bank Control Register



Bank control register (BK) [Address 00ED₁₆]

| B | Name | Functions | | | | After reset | R | W |
|--------|----------------------------------|---|----|----------|--|-------------|---|---|
| 0 to 3 | Bank selection bits (BK0 to BK3) | Bank number is selected (bank 11 to 15) | | | | 0 | R | W |
| 4, 5 | Fix these bits to "0". | | | | | 0 | R | W |
| 6, 7 | Bank control bits (BK6, BK7) | b7 | b6 | Bank ROM | Address 1000 ₁₆ level access | 0 | R | W |
| | | 0 | X | Not used | Read out from extra area (programmable) | | | |
| | | 1 | 0 | Used | Read out the data from area specified by the bank selection bits | | | |
| | | 1 | 1 | Used | Read out from extra area (data-dedicated) | | | |

Fig. 12.2.2 Bank Control Register

M37280MF-XXXSP, M37280MK-XXXSP M37280EKSP

SINGLE-CHIP 8-BIT CMOS MICROCOMPUTER with CLOSED CAPTION DECODER
and ON-SCREEN DISPLAY CONTROLLER

■ SFR1 area (addresses C0₁₆ to DF₁₆)

Bit allocation

☐ : } Function bit
Name : }

☐ : No function bit

☒ 0 : Fix to this bit to "0"
(do not write to "1")

☒ 1 : Fix to this bit to "1"
(do not write to "0")

State immediately after reset

☐ 0 : "0" immediately after reset

☐ 1 : "1" immediately after reset

☐ ? : Indeterminate immediately
after reset

| Address | Register | Bit allocation | | | | | | | | State immediately after reset | | | | | | | |
|------------------|---|----------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------------------|------------------|---|---|---|---|---|----|
| | | b7 | | | | | | | b0 | b7 | | | | | | | b0 |
| C0 ₁₆ | Port P0 (P0) | | | | | | | | | | ? | | | | | | |
| C1 ₁₆ | Port P0 direction register (D0) | | | | | | | | | | 00 ₁₆ | | | | | | |
| C2 ₁₆ | Port P1 (P1) | | | | | | | | | | ? | | | | | | |
| C3 ₁₆ | Port P1 direction register (D1) | | | | | | | | | | 00 ₁₆ | | | | | | |
| C4 ₁₆ | Port P2 (P2) | | | | | | | | | | ? | | | | | | |
| C5 ₁₆ | Port P2 direction register (D2) | | | | | | | | | | 00 ₁₆ | | | | | | |
| C6 ₁₆ | Port P3 (P3) | | | | | | | | | | ? | | | | | | |
| C7 ₁₆ | Port P3 direction register (D3) | P6IM | T3CS | | | | | | | | 00 ₁₆ | | | | | | |
| C8 ₁₆ | Port P4 (P4) | | | | | | | | | | ? | | | | | | |
| C9 ₁₆ | Port P4 direction register (D4) | | | | | | | | 0 | | 00 ₁₆ | | | | | | |
| CA ₁₆ | Port P5 (P5) | | | | | | | | | | ? | | | | | | |
| CB ₁₆ | OSD port control register (PF) | 0 | OUT2 | OUT1 | B | G | R | RGB 2BIT | 0 | | 00 ₁₆ | | | | | | |
| CC ₁₆ | Port P6 (P6) | | | | | | | | | | ? | | | | | | |
| CD ₁₆ | Port P7 (P7) | | | | | | | | | 0 | 0 | 0 | 0 | 0 | ? | ? | ? |
| CE ₁₆ | OSD control register 1 (OC 1) | OC17 | OC16 | OC15 | OC14 | OC13 | OC12 | OC11 | OC10 | | 00 ₁₆ | | | | | | |
| CF ₁₆ | Horizontal position register (HP) | HP17 | HP16 | HP15 | HP14 | HP13 | HP12 | HP11 | HP10 | | 00 ₁₆ | | | | | | |
| D0 ₁₆ | Block control register 1 (BC ₁) | | BC ₁₆ | BC ₁₅ | BC ₁₄ | BC ₁₃ | BC ₁₂ | BC ₁₁ | BC ₁₀ | | ? | | | | | | |
| D1 ₁₆ | Block control register 2 (BC ₂) | | BC ₂₆ | BC ₂₅ | BC ₂₄ | BC ₂₃ | BC ₂₂ | BC ₂₁ | BC ₂₀ | | ? | | | | | | |
| D2 ₁₆ | Block control register 3 (BC ₃) | | BC ₃₆ | BC ₃₅ | BC ₃₄ | BC ₃₃ | BC ₃₂ | BC ₃₁ | BC ₃₀ | | ? | | | | | | |
| D3 ₁₆ | Block control register 4 (BC ₄) | | BC ₄₆ | BC ₄₅ | BC ₄₄ | BC ₄₃ | BC ₄₂ | BC ₄₁ | BC ₄₀ | | ? | | | | | | |
| D4 ₁₆ | Block control register 5 (BC ₅) | | BC ₅₆ | BC ₅₅ | BC ₅₄ | BC ₅₃ | BC ₅₂ | BC ₅₁ | BC ₅₀ | | ? | | | | | | |
| D5 ₁₆ | Block control register 6 (BC ₆) | | BC ₆₆ | BC ₆₅ | BC ₆₄ | BC ₆₃ | BC ₆₂ | BC ₆₁ | BC ₆₀ | | ? | | | | | | |
| D6 ₁₆ | Block control register 7 (BC ₇) | | BC ₇₆ | BC ₇₅ | BC ₇₄ | BC ₇₃ | BC ₇₂ | BC ₇₁ | BC ₇₀ | | ? | | | | | | |
| D7 ₁₆ | Block control register 8 (BC ₈) | | BC ₈₆ | BC ₈₅ | BC ₈₄ | BC ₈₃ | BC ₈₂ | BC ₈₁ | BC ₈₀ | | ? | | | | | | |
| D8 ₁₆ | Block control register 9 (BC ₉) | | BC ₉₆ | BC ₉₅ | BC ₉₄ | BC ₉₃ | BC ₉₂ | BC ₉₁ | BC ₉₀ | | ? | | | | | | |
| D9 ₁₆ | Block control register 10 (BC ₁₀) | | BC ₁₀₆ | BC ₁₀₅ | BC ₁₀₄ | BC ₁₀₃ | BC ₁₀₂ | BC ₁₀₁ | BC ₁₀₀ | | ? | | | | | | |
| DA ₁₆ | Block control register 11 (BC ₁₁) | | BC ₁₁₆ | BC ₁₁₅ | BC ₁₁₄ | BC ₁₁₃ | BC ₁₁₂ | BC ₁₁₁ | BC ₁₁₀ | | ? | | | | | | |
| DB ₁₆ | Block control register 12 (BC ₁₂) | | BC ₁₂₆ | BC ₁₂₅ | BC ₁₂₄ | BC ₁₂₃ | BC ₁₂₂ | BC ₁₂₁ | BC ₁₂₀ | | ? | | | | | | |
| DC ₁₆ | Block control register 13 (BC ₁₃) | | BC ₁₃₆ | BC ₁₃₅ | BC ₁₃₄ | BC ₁₃₃ | BC ₁₃₂ | BC ₁₃₁ | BC ₁₃₀ | | ? | | | | | | |
| DD ₁₆ | Block control register 14 (BC ₁₄) | | BC ₁₄₆ | BC ₁₄₅ | BC ₁₄₄ | BC ₁₄₃ | BC ₁₄₂ | BC ₁₄₁ | BC ₁₄₀ | | ? | | | | | | |
| DE ₁₆ | Block control register 15 (BC ₁₅) | | BC ₁₅₆ | BC ₁₅₅ | BC ₁₅₄ | BC ₁₅₃ | BC ₁₅₂ | BC ₁₅₁ | BC ₁₅₀ | | ? | | | | | | |
| DF ₁₆ | Block control register 16 (BC ₁₆) | | BC ₁₆₆ | BC ₁₆₅ | BC ₁₆₄ | BC ₁₆₃ | BC ₁₆₂ | BC ₁₆₁ | BC ₁₆₀ | | ? | | | | | | |

Fig. 12.2.3 Memory Map of Special Function Register 1 (SFR1) (1)

M37280MF-XXXSP, M37280MK-XXXSP M37280EKSP

SINGLE-CHIP 8-BIT CMOS MICROCOMPUTER with CLOSED CAPTION DECODER
and ON-SCREEN DISPLAY CONTROLLER

■ SFR1 area (addresses E0₁₆ to FF₁₆)

Bit allocation

☐ : } Function bit
 Name : }

☐ : No function bit

☒ 0 : Fix to this bit to "0"
(do not write to "1")

☒ 1 : Fix to this bit to "1"
(do not write to "0")

State immediately after reset

☐ 0 : "0" immediately after reset

☐ 1 : "1" immediately after reset

☐ ? : Indeterminate immediately
after reset

| Address | Register | Bit allocation | | | | | | | | State immediately after reset | | | | | | | |
|------------------|--|------------------|-------|-------|--------|-------|-------|-------|-------|-------------------------------|---|---|---|---|---|---|----|
| | | b7 | | | | | | | b0 | b7 | | | | | | | b0 |
| E0 ₁₆ | Data slicer control register 1 (DSC1) | 0 | 0 | 0 | 0 | 0 | DSC25 | DSC24 | DSC23 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| E1 ₁₆ | Data slicer control register 2 (DSC2) | | 0 | DSC25 | DSC24 | DSC23 | | | 0 | | ? | 0 | ? | 0 | ? | ? | 0 |
| E2 ₁₆ | Caption data register 1 (CD1) | CDL17 | CDL16 | CDL15 | CDL14 | CDL13 | CDL12 | CDL11 | CDL10 | | | | | | | | |
| E3 ₁₆ | Caption data register 2 (CD2) | CDH17 | CDH16 | CDH15 | CDH14 | CDH13 | CDH12 | CDH11 | CDH10 | | | | | | | | |
| E4 ₁₆ | Caption data register 3 (CD3) | CDL27 | CDL26 | CDL25 | CDL24 | CDL23 | CDL22 | CDL21 | CDL20 | | | | | | | | |
| E5 ₁₆ | Caption data register 4 (CD4) | CDH27 | CDH26 | CDH25 | CDH24 | CDH23 | CDH22 | CDH21 | CDH20 | | | | | | | | |
| E6 ₁₆ | Caption Position register (CPS) | CPS7 | CPS6 | CPS5 | CPS4 | CPS3 | CPS2 | CPS1 | CPS0 | | 0 | 0 | ? | 0 | 0 | 0 | 0 |
| E7 ₁₆ | Data slicer test register 2 | 00 ₁₆ | | | | | | | | | | | | | | | |
| E8 ₁₆ | Data slicer test register 1 | 00 ₁₆ | | | | | | | | | | | | | | | |
| E9 ₁₆ | Sync signal counter register (HC) | | | HC5 | HC4 | HC3 | HC2 | HC1 | HC0 | | 0 | 0 | ? | ? | ? | ? | ? |
| EA ₁₆ | Clock run-in detect register (CRD) | CRD7 | CRD6 | CRD5 | CRD4 | CRD3 | | | | | | | | | | | |
| EB ₁₆ | Data clock position register (DPS) | DPS7 | DPS6 | DPS5 | DPS4 | DPS3 | 0 | 0 | 1 | | | | | | | | |
| EC ₁₆ | | | | | | | | | | | | | | | | | |
| ED ₁₆ | Bank control register (BK) | BK7 | BK6 | 0 | 0 | BK3 | BK2 | BK1 | BK0 | | | | | | | | |
| EE ₁₆ | A-D conversion register (AD) | | | | | | | | | | | | | | | | |
| EF ₁₆ | A-D control register (ADCON) | 0 | | 0 | ADVREF | ADSTR | ADIN2 | ADIN1 | ADIN0 | | 0 | ? | 0 | 0 | 1 | 0 | 0 |
| F0 ₁₆ | Timer 1 (T1) | | | | | | | | | | | | | | | | |
| F1 ₁₆ | Timer 2 (T2) | | | | | | | | | | | | | | | | |
| F2 ₁₆ | Timer 3 (T3) | | | | | | | | | | | | | | | | |
| F3 ₁₆ | Timer 4 (T4) | | | | | | | | | | | | | | | | |
| F4 ₁₆ | Timer mode register 1 (TM1) | TM17 | TM16 | TM15 | TM14 | TM13 | TM12 | TM11 | TM10 | | | | | | | | |
| F5 ₁₆ | Timer mode register 2 (TM2) | TM27 | TM26 | TM25 | TM24 | TM23 | TM22 | TM21 | TM20 | | | | | | | | |
| F6 ₁₆ | I ² C data shift register (S0) | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | | | | | | | | |
| F7 ₁₆ | I ² C address register (S0D) | SAD6 | SAD5 | SAD4 | SAD3 | SAD2 | SAD1 | SAD0 | RBW | | | | | | | | |
| F8 ₁₆ | I ² C status register (S1) | MST | TRX | BB | PIN | AL | AAS | AD0 | LRB | | 0 | 0 | 0 | 1 | 0 | 0 | ? |
| F9 ₁₆ | I ² C control register (S1D) | BSEL1 | BSEL0 | 10BIT | SAD | ALS | ESO | BC2 | BC1 | BC0 | | | | | | | |
| FA ₁₆ | I ² C clock control register (S2) | ACK | FAST | MODE | CCR4 | CCR3 | CCR2 | CCR1 | CCR0 | | | | | | | | |
| FB ₁₆ | CPU mode register (CM) | CM7 | CM6 | CM5 | 1 | 1 | CM2 | 0 | 0 | | | | | | | | |
| FC ₁₆ | Interrupt request register 1 (IREQ1) | | ADR | VSCR | OSDR | TM4R | TM3R | TM2R | TM1R | | | | | | | | |
| FD ₁₆ | Interrupt request register 2 (IREQ2) | 0 | TM56R | IICR | IN2R | CKR | SIOR | DSR | IN1R | | | | | | | | |
| FE ₁₆ | Interrupt control register 1 (ICON1) | | ADE | VSCE | OSDE | TM4E | TM3E | TM2E | TM1E | | | | | | | | |
| FF ₁₆ | Interrupt control register 2 (ICON2) | TM56S | TM56E | IICE | IN2E | CKE | SIOE | DSE | IN1E | | | | | | | | |

Fig. 12.2.4 Memory Map of Special Function Register 1 (SFR2) (2)

M37280MF-XXXSP, M37280MK-XXXSP M37280EKSP

SINGLE-CHIP 8-BIT CMOS MICROCOMPUTER with CLOSED CAPTION DECODER
and ON-SCREEN DISPLAY CONTROLLER

■ SFR2 area (addresses 200₁₆ to 21F₁₆)

Bit allocation

| | | |
|-------------------------------------|---|---|
| <input type="checkbox"/> | : | Function bit |
| <input type="checkbox"/> | : | No function bit |
| <input checked="" type="checkbox"/> | : | Fix to this bit to "0" (do not write to "1") |
| <input checked="" type="checkbox"/> | : | Fix to this bit to "1" (do not write to "0") |

State immediately after reset

| | | |
|-------------------------------------|---|---------------------------------------|
| <input type="checkbox"/> | : | "0" immediately after reset |
| <input checked="" type="checkbox"/> | : | "1" immediately after reset |
| <input type="checkbox"/> | : | Indeterminate immediately after reset |

| Address | Register | Bit allocation | State immediately after reset |
|-------------------|--|---|-------------------------------|
| | | b7 b0 | b7 b0 |
| 200 ₁₆ | PWM0 register (PWM0) | | ? |
| 201 ₁₆ | PWM1 register (PWM1) | | ? |
| 202 ₁₆ | PWM2 register (PWM2) | | ? |
| 203 ₁₆ | PWM3 register (PWM3) | | ? |
| 204 ₁₆ | PWM4 register (PWM4) | | ? |
| 205 ₁₆ | PWM5 register (PWM5) | | ? |
| 206 ₁₆ | PWM6 register (PWM6) | | ? |
| 207 ₁₆ | PWM7 register (PWM7) | | ? |
| 208 ₁₆ | | | ? |
| 209 ₁₆ | | | ? |
| 20A ₁₆ | PWM mode register 1 (PN) | PN4 PN3 PN0 | 00 ₁₆ |
| 20B ₁₆ | PWM mode register 2 (PW) | PW7 PW6 PW5 PW4 PW3 PW2 PW1 PW0 | 00 ₁₆ |
| 20C ₁₆ | ROM correction address 1 (high-order) | | 00 ₁₆ |
| 20D ₁₆ | ROM correction address 1 (low-order) | | 00 ₁₆ |
| 20E ₁₆ | ROM correction address 2 (high-order) | | 00 ₁₆ |
| 20F ₁₆ | ROM correction address 2 (low-order) | | 00 ₁₆ |
| 210 ₁₆ | ROM correction enable register (RCR) | 0 0 RCR1 RCR0 | 00 ₁₆ |
| 211 ₁₆ | Test register | 00 ₁₆ | 00 ₁₆ |
| 212 ₁₆ | Interrupt input polarity register (IP) | AD/INT3 SEL POL3 POL2 POL1 | 00 ₁₆ |
| 213 ₁₆ | Serial I/O mode register (SM) | SM6 SM5 SM4 SM3 SM2 SM1 SM0 | 00 ₁₆ |
| 214 ₁₆ | Serial I/O register (SIO) | | ? |
| 215 ₁₆ | OSD control register 2(OC2) | OC27 OC26 OC25 OC24 OC23 OC12 OC21 OC20 | 00 ₁₆ |
| 216 ₁₆ | Clock control register (CS) | 0 0 0 0 CS2 CS1 CS0 | 00 ₁₆ |
| 217 ₁₆ | I/O polarity control register (PC) | PC7 PC6 PC5 PC4 PC2 PC1 PC0 | 80 ₁₆ |
| 218 ₁₆ | Raster color register (RC) | RC4 RC3 RC2 RC1 RC0 | 00 ₁₆ |
| 219 ₁₆ | OSD control register 3(OC3) | OC37 OC36 OC35 OC34 OC33 OC32 OC31 OC30 | 00 ₁₆ |
| 21A ₁₆ | Timer 5 (TM5) | | 07 ₁₆ |
| 21B ₁₆ | Timer 6 (TM6) | | FF ₁₆ |
| 21C ₁₆ | Top border control register 1 (TB1) | TB17 TB16 TB15 TB14 TB13 TB12 TB11 TB10 | ? |
| 21D ₁₆ | Bottom border control register 1 (BB1) | BB17 BB16 BB15 BB14 BB13 BB12 BB11 BB10 | ? |
| 21E ₁₆ | Top border control register 1 (TB2) | TB21 TB20 | ? |
| 21F ₁₆ | Bottom border control register 1 (BB2) | BB21 BB20 | ? |

Fig. 12.2.5 Memory Map of Special Function Register 2 (SFR2) (1)

M37280MF-XXXSP, M37280MK-XXXSP M37280EKSP

SINGLE-CHIP 8-BIT CMOS MICROCOMPUTER with CLOSED CAPTION DECODER
and ON-SCREEN DISPLAY CONTROLLER

■ SFR2 area (addresses 220₁₆ to 23F₁₆)

Bit allocation

☐ : } Function bit
 Name :

☐ : No function bit

☐ : Fix to this bit to "0"
 (do not write to "1")

☐ : Fix to this bit to "1"
 (do not write to "0")

State immediately after reset

☐ : "0" immediately after reset

☐ : "1" immediately after reset

☐ : Indeterminate immediately
after reset

| Address | Register | Bit allocation | | | | | | | | State immediately after reset | | | | | | | |
|-------------------|---|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|-------------------------------|---|--|--|--|--|--|----|
| | | b7 | | | | | | | b0 | b7 | | | | | | | b0 |
| 220 ₁₆ | Vertical position register 1 ₁ (VP1 ₁) | VP1 ₁ 7 | VP1 ₁ 6 | VP1 ₁ 5 | VP1 ₁ 4 | VP1 ₁ 3 | VP1 ₁ 2 | VP1 ₁ 1 | VP1 ₁ 0 | | ? | | | | | | |
| 221 ₁₆ | Vertical position register 1 ₂ (VP1 ₂) | VP1 ₂ 7 | VP1 ₂ 6 | VP1 ₂ 5 | VP1 ₂ 4 | VP1 ₂ 3 | VP1 ₂ 2 | VP1 ₂ 1 | VP1 ₂ 0 | | ? | | | | | | |
| 222 ₁₆ | Vertical position register 1 ₃ (VP1 ₃) | VP1 ₃ 7 | VP1 ₃ 6 | VP1 ₃ 5 | VP1 ₃ 4 | VP1 ₃ 3 | VP1 ₃ 2 | VP1 ₃ 1 | VP1 ₃ 0 | | ? | | | | | | |
| 223 ₁₆ | Vertical position register 1 ₄ (VP1 ₄) | VP1 ₄ 7 | VP1 ₄ 6 | VP1 ₄ 5 | VP1 ₄ 4 | VP1 ₄ 3 | VP1 ₄ 2 | VP1 ₄ 1 | VP1 ₄ 0 | | ? | | | | | | |
| 224 ₁₆ | Vertical position register 1 ₅ (VP1 ₅) | VP1 ₅ 7 | VP1 ₅ 6 | VP1 ₅ 5 | VP1 ₅ 4 | VP1 ₅ 3 | VP1 ₅ 2 | VP1 ₅ 1 | VP1 ₅ 0 | | ? | | | | | | |
| 225 ₁₆ | Vertical position register 1 ₆ (VP1 ₆) | VP1 ₆ 7 | VP1 ₆ 6 | VP1 ₆ 5 | VP1 ₆ 4 | VP1 ₆ 3 | VP1 ₆ 2 | VP1 ₆ 1 | VP1 ₆ 0 | | ? | | | | | | |
| 226 ₁₆ | Vertical position register 1 ₇ (VP1 ₇) | VP1 ₇ 7 | VP1 ₇ 6 | VP1 ₇ 5 | VP1 ₇ 4 | VP1 ₇ 3 | VP1 ₇ 2 | VP1 ₇ 1 | VP1 ₇ 0 | | ? | | | | | | |
| 227 ₁₆ | Vertical position register 1 ₈ (VP1 ₈) | VP1 ₈ 7 | VP1 ₈ 6 | VP1 ₈ 5 | VP1 ₈ 4 | VP1 ₈ 3 | VP1 ₈ 2 | VP1 ₈ 1 | VP1 ₈ 0 | | ? | | | | | | |
| 228 ₁₆ | Vertical position register 1 ₉ (VP1 ₉) | VP1 ₉ 7 | VP1 ₉ 6 | VP1 ₉ 5 | VP1 ₉ 4 | VP1 ₉ 3 | VP1 ₉ 2 | VP1 ₉ 1 | VP1 ₉ 0 | | ? | | | | | | |
| 229 ₁₆ | Vertical position register 1 ₁₀ (VP1 ₁₀) | VP1 ₁₀ 7 | VP1 ₁₀ 6 | VP1 ₁₀ 5 | VP1 ₁₀ 4 | VP1 ₁₀ 3 | VP1 ₁₀ 2 | VP1 ₁₀ 1 | VP1 ₁₀ 0 | | ? | | | | | | |
| 22A ₁₆ | Vertical position register 1 ₁₁ (VP1 ₁₁) | VP1 ₁₁ 7 | VP1 ₁₁ 6 | VP1 ₁₁ 5 | VP1 ₁₁ 4 | VP1 ₁₁ 3 | VP1 ₁₁ 2 | VP1 ₁₁ 1 | VP1 ₁₁ 0 | | ? | | | | | | |
| 22B ₁₆ | Vertical position register 1 ₁₂ (VP1 ₁₂) | VP1 ₁₂ 7 | VP1 ₁₂ 6 | VP1 ₁₂ 5 | VP1 ₁₂ 4 | VP1 ₁₂ 3 | VP1 ₁₂ 2 | VP1 ₁₂ 1 | VP1 ₁₂ 0 | | ? | | | | | | |
| 22C ₁₆ | Vertical position register 1 ₁₃ (VP1 ₁₃) | VP1 ₁₃ 7 | VP1 ₁₃ 6 | VP1 ₁₃ 5 | VP1 ₁₃ 4 | VP1 ₁₃ 3 | VP1 ₁₃ 2 | VP1 ₁₃ 1 | VP1 ₁₃ 0 | | ? | | | | | | |
| 22D ₁₆ | Vertical position register 1 ₁₄ (VP1 ₁₄) | VP1 ₁₄ 7 | VP1 ₁₄ 6 | VP1 ₁₄ 5 | VP1 ₁₄ 4 | VP1 ₁₄ 3 | VP1 ₁₄ 2 | VP1 ₁₄ 1 | VP1 ₁₄ 0 | | ? | | | | | | |
| 22E ₁₆ | Vertical position register 1 ₁₅ (VP1 ₁₅) | VP1 ₁₅ 7 | VP1 ₁₅ 6 | VP1 ₁₅ 5 | VP1 ₁₅ 4 | VP1 ₁₅ 3 | VP1 ₁₅ 2 | VP1 ₁₅ 1 | VP1 ₁₅ 0 | | ? | | | | | | |
| 22F ₁₆ | Vertical position register 1 ₁₆ (VP1 ₁₆) | VP1 ₁₆ 7 | VP1 ₁₆ 6 | VP1 ₁₆ 5 | VP1 ₁₆ 4 | VP1 ₁₆ 3 | VP1 ₁₆ 2 | VP1 ₁₆ 1 | VP1 ₁₆ 0 | | ? | | | | | | |
| 230 ₁₆ | Vertical position register 2 ₁ (VP2 ₁) | | | | | | | VP2 ₁ 7 | VP2 ₁ 0 | | ? | | | | | | |
| 231 ₁₆ | Vertical position register 2 ₂ (VP2 ₂) | | | | | | | VP2 ₂ 7 | VP2 ₂ 0 | | ? | | | | | | |
| 232 ₁₆ | Vertical position register 2 ₃ (VP2 ₃) | | | | | | | VP2 ₃ 7 | VP2 ₃ 0 | | ? | | | | | | |
| 233 ₁₆ | Vertical position register 2 ₄ (VP2 ₄) | | | | | | | VP2 ₄ 7 | VP2 ₄ 0 | | ? | | | | | | |
| 234 ₁₆ | Vertical position register 2 ₅ (VP2 ₅) | | | | | | | VP2 ₅ 7 | VP2 ₅ 0 | | ? | | | | | | |
| 235 ₁₆ | Vertical position register 2 ₆ (VP2 ₆) | | | | | | | VP2 ₆ 7 | VP2 ₆ 0 | | ? | | | | | | |
| 236 ₁₆ | Vertical position register 2 ₇ (VP2 ₇) | | | | | | | VP2 ₇ 7 | VP2 ₇ 0 | | ? | | | | | | |
| 237 ₁₆ | Vertical position register 2 ₈ (VP2 ₈) | | | | | | | VP2 ₈ 7 | VP2 ₈ 0 | | ? | | | | | | |
| 238 ₁₆ | Vertical position register 2 ₉ (VP2 ₉) | | | | | | | VP2 ₉ 7 | VP2 ₉ 0 | | ? | | | | | | |
| 239 ₁₆ | Vertical position register 2 ₁₀ (VP2 ₁₀) | | | | | | | VP2 ₁₀ 7 | VP2 ₁₀ 0 | | ? | | | | | | |
| 23A ₁₆ | Vertical position register 2 ₁₁ (VP2 ₁₁) | | | | | | | VP2 ₁₁ 7 | VP2 ₁₁ 0 | | ? | | | | | | |
| 23B ₁₆ | Vertical position register 2 ₁₂ (VP2 ₁₂) | | | | | | | VP2 ₁₂ 7 | VP2 ₁₂ 0 | | ? | | | | | | |
| 23C ₁₆ | Vertical position register 2 ₁₃ (VP2 ₁₃) | | | | | | | VP2 ₁₃ 7 | VP2 ₁₃ 0 | | ? | | | | | | |
| 23D ₁₆ | Vertical position register 2 ₁₄ (VP2 ₁₄) | | | | | | | VP2 ₁₄ 7 | VP2 ₁₄ 0 | | ? | | | | | | |
| 23E ₁₆ | Vertical position register 2 ₁₅ (VP2 ₁₅) | | | | | | | VP2 ₁₅ 7 | VP2 ₁₅ 0 | | ? | | | | | | |
| 23F ₁₆ | Vertical position register 2 ₁₆ (VP2 ₁₆) | | | | | | | VP2 ₁₆ 7 | VP2 ₁₆ 0 | | ? | | | | | | |

Fig. 12.2.6 Memory Map of Special Function Register 2 (SFR2) (2)

M37280MF-XXXSP, M37280MK-XXXSP M37280EKSP

SINGLE-CHIP 8-BIT CMOS MICROCOMPUTER with CLOSED CAPTION DECODER
and ON-SCREEN DISPLAY CONTROLLER

■ SFR2 area (addresses 240₁₆ to 258₁₆)

Bit allocation

☐ : Function bit
 Name :

☐ : No function bit

☐ 0 : Fix to this bit to "0"
 (do not write to "1")

☐ 1 : Fix to this bit to "1"
 (do not write to "0")

State immediately after reset

☐ 0 : "0" immediately after reset

☐ 1 : "1" immediately after reset

☐ ? : Indeterminate immediately
 after reset

| Address | Register | Bit allocation | | | | | | | | State immediately after reset | | | | | | | |
|-------------------|---|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|------|-------------------------------|--|--|--|--|--|--|-----------------|
| | | b7 | | | | | | | | b0 | | | | | | | |
| 240 ₁₆ | | | | | | | | | | ? | | | | | | | |
| 241 ₁₆ | Color pallet register 1 (CR1) | CR ₁ 6 | CR ₁ 5 | CR ₁ 4 | CR ₁ 3 | CR ₁ 2 | CR ₁ 1 | CR ₁ 0 | | | | | | | | | ? |
| 242 ₁₆ | Color pallet register 2 (CR2) | CR ₂ 6 | CR ₂ 5 | CR ₂ 4 | CR ₂ 3 | CR ₂ 2 | CR ₂ 1 | CR ₂ 0 | | | | | | | | | ? |
| 243 ₁₆ | Color pallet register 3 (CR3) | CR ₃ 6 | CR ₃ 5 | CR ₃ 4 | CR ₃ 3 | CR ₃ 2 | CR ₃ 1 | CR ₃ 0 | | | | | | | | | ? |
| 244 ₁₆ | Color pallet register 4 (CR4) | CR ₄ 6 | CR ₄ 5 | CR ₄ 4 | CR ₄ 3 | CR ₄ 2 | CR ₄ 1 | CR ₄ 0 | | | | | | | | | ? |
| 245 ₁₆ | Color pallet register 5 (CR5) | CR ₅ 6 | CR ₅ 5 | CR ₅ 4 | CR ₅ 3 | CR ₅ 2 | CR ₅ 1 | CR ₅ 0 | | | | | | | | | ? |
| 246 ₁₆ | Color pallet register 6 (CR6) | CR ₆ 6 | CR ₆ 5 | CR ₆ 4 | CR ₆ 3 | CR ₆ 2 | CR ₆ 1 | CR ₆ 0 | | | | | | | | | ? |
| 247 ₁₆ | Color pallet register 7 (CR7) | CR ₇ 6 | CR ₇ 5 | CR ₇ 4 | CR ₇ 3 | CR ₇ 2 | CR ₇ 1 | CR ₇ 0 | | | | | | | | | ? |
| 248 ₁₆ | | | | | | | | | | | | | | | | | |
| 249 ₁₆ | Color pallet register 9 (CR9) | CR ₉ 6 | CR ₉ 5 | CR ₉ 4 | CR ₉ 3 | CR ₉ 2 | CR ₉ 1 | CR ₉ 0 | | | | | | | | | ? |
| 24A ₁₆ | Color pallet register10 (CR10) | CR ₁₀ 6 | CR ₁₀ 5 | CR ₁₀ 4 | CR ₁₀ 3 | CR ₁₀ 2 | CR ₁₀ 1 | CR ₁₀ 0 | | | | | | | | | ? |
| 24B ₁₆ | Color pallet register 11 (CR11) | CR ₁₁ 6 | CR ₁₁ 5 | CR ₁₁ 4 | CR ₁₁ 3 | CR ₁₁ 2 | CR ₁₁ 1 | CR ₁₁ 0 | | | | | | | | | ? |
| 24C ₁₆ | Color pallet register 12 (CR12) | CR ₁₂ 6 | CR ₁₂ 5 | CR ₁₂ 4 | CR ₁₂ 3 | CR ₁₂ 2 | CR ₁₂ 1 | CR ₁₂ 0 | | | | | | | | | ? |
| 24D ₁₆ | Color pallet register 13 (CR13) | CR ₁₃ 6 | CR ₁₃ 5 | CR ₁₃ 4 | CR ₁₃ 3 | CR ₁₃ 2 | CR ₁₃ 1 | CR ₁₃ 0 | | | | | | | | | ? |
| 24E ₁₆ | Color pallet register 14 (CR14) | CR ₁₄ 6 | CR ₁₄ 5 | CR ₁₄ 4 | CR ₁₄ 3 | CR ₁₄ 2 | CR ₁₄ 1 | CR ₁₄ 0 | | | | | | | | | ? |
| 24F ₁₆ | Color pallet register 15 (CR15) | CR ₁₅ 6 | CR ₁₅ 5 | CR ₁₅ 4 | CR ₁₅ 3 | CR ₁₅ 2 | CR ₁₅ 1 | CR ₁₅ 0 | | | | | | | | | ? |
| 250 ₁₆ | Left border control register 1 (LB1) | LB17 | LB16 | LB15 | LB14 | LB13 | LB12 | LB11 | LB10 | | | | | | | | 0116 |
| 251 ₁₆ | Left border control register 2 (LB2) | | | | | | LB22 | LB21 | LB20 | | | | | | | | 0016 |
| 252 ₁₆ | Right border control register 1 (RB1) | RB17 | RB16 | RB15 | RB14 | RB13 | RB12 | RB11 | RB10 | | | | | | | | FF16 |
| 253 ₁₆ | Right border control register 2 (RB2) | | | | | | RB22 | RB21 | RB20 | | | | | | | | 0716 |
| 254 ₁₆ | SPRITE vertical position register 1 (VS1) | VS17 | VS16 | VS15 | VS14 | VS13 | VS12 | VS11 | VS10 | | | | | | | | ? |
| 255 ₁₆ | SPRITE vertical position register 2 (VS2) | | | | | | | VS21 | VS20 | | | | | | | | 0016 |
| 256 ₁₆ | SPRITE horizontal position register 1 (HS1) | HS17 | HS16 | HS15 | HS14 | HS13 | HS12 | HS11 | HS10 | | | | | | | | ? |
| 257 ₁₆ | SPRITE horizontal position register 2 (HS2) | | | | | | HS22 | HS21 | HS20 | | | | | | | | 0 0 0 0 0 ? ? ? |
| 258 ₁₆ | SPRITE OSD control register (SC) | | | SC5 | SC4 | SC3 | SC2 | SC1 | SC0 | | | | | | | | 0016 |

Fig. 12.2.7 Memory Map of Special Function Register 2 (SFR2) (3)

MITSUBISHI MICROCOMPUTERS

M37280MF-XXXSP, M37280MK-XXXSP

M37280EKSP

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 and ON-SCREEN DISPLAY CONTROLLER

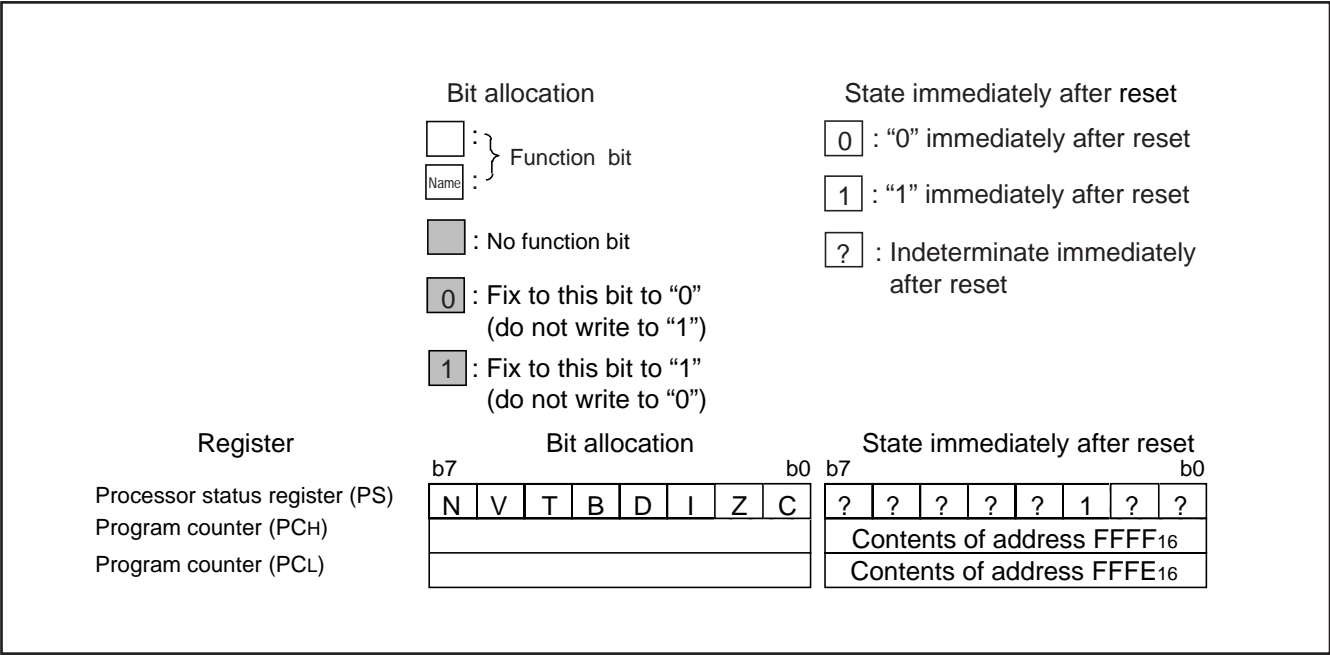


Fig. 12.2.8 Internal State of Processor Status Register and Program Counter at Reset

M37280MF-XXXSP, M37280MK-XXXSP M37280EKSP

SINGLE-CHIP 8-BIT CMOS MICROCOMPUTER with CLOSED CAPTION DECODER
and ON-SCREEN DISPLAY CONTROLLER

12.3 INTERRUPTS

Interrupts can be caused by 19 different sources consisting of 3 external, 14 internal, 1 software, and reset. Interrupts are vectored interrupts with priorities as shown in Table 12.3.1. Reset is also included in the table because its operation is similar to an interrupt. When an interrupt is accepted,

- ① The contents of the program counter and processor status register are automatically stored into the stack.
- ② The interrupt disable flag I is set to "1" and the corresponding interrupt request bit is set to "0."
- ③ The jump destination address stored in the vector address enters the program counter.

Other interrupts are disabled when the interrupt disable flag is set to "1."

All interrupts except the BRK instruction interrupt have an interrupt request bit and an interrupt enable bit. The interrupt request bits are in interrupt request registers 1 and 2 and the interrupt enable bits are in interrupt control registers 1 and 2. Figures 12.3.2 to 12.3.6 show the interrupt-related registers.

Interrupts other than the BRK instruction interrupt and reset are accepted when the interrupt enable bit is "1," interrupt request bit is "1," and the interrupt disable flag is "0." The interrupt request bit can be set to "0" by a program, but not set to "1." The interrupt enable bit can be set to "0" and "1" by a program.

Reset is treated as a non-maskable interrupt with the highest priority. Figure 12.3.1 shows interrupt control.

12.3.1 Interrupt Causes

(1) Vsync and OSD Interrupts

The Vsync interrupt is an interrupt request synchronized with the vertical sync signal.

The OSD interrupt occurs after character block display to the CRT is completed.

(2) INT1, INT2 Interrupts

The INT1 and INT2 interrupts are external interrupt inputs, the system detects that the level of a pin changes from LOW to HIGH or from HIGH to LOW, and generates an interrupt request. The input active edge can be selected by bits 3 and 4 of the interrupt input polarity register (address 021216) : when this bit is "0," a change from LOW to HIGH is detected; when it is "1," a change from HIGH to LOW is detected. Note that both bits are cleared to "0" at reset.

(3) Timer 1 to 4 Interrupts

An interrupt is generated by an overflow of timer 1, 2, 3 or 4.

Table 12.3.1 Interrupt Vector Addresses and Priority

| Priority | Interrupt Source | Vector Addresses | Remarks |
|----------|---|---|---|
| 1 | Reset | FFFF ₁₆ , FFFE ₁₆ | Non-maskable |
| 2 | OSD interrupt | FFFD ₁₆ , FFFC ₁₆ | |
| 3 | INT1 interrupt | FFFB ₁₆ , FFFA ₁₆ | Active edge selectable |
| 4 | Data slicer interrupt | FFF9 ₁₆ , FFF8 ₁₆ | |
| 5 | Serial I/O interrupt | FFF7 ₁₆ , FFF6 ₁₆ | |
| 6 | Timer 4 • SPRITE OSD interrupt | FFF5 ₁₆ , FFF4 ₁₆ | |
| 7 | f(XIN)/4096 interrupt | FFF3 ₁₆ , FFF2 ₁₆ | Software switch by software (See note) |
| 8 | Vsync interrupt | FFF1 ₁₆ , FFF0 ₁₆ | Active edge selectable |
| 9 | Timer 3 interrupt | FFEF ₁₆ , FFEE ₁₆ | |
| 10 | Timer 2 interrupt | FFED ₁₆ , FFEC ₁₆ | |
| 11 | Timer 1 interrupt | FFEB ₁₆ , FFEA ₁₆ | |
| 12 | A-D conversion • INT3 interrupt | FFE9 ₁₆ , FFE8 ₁₆ | Software switch by software (See note)/ When selecting INT3 interrupt, active edge selectable. |
| 13 | INT2 interrupt | FFE7 ₁₆ , FFE6 ₁₆ | Active edge selectable |
| 14 | Multi-master I ² C-BUS interface interrupt | FFE5 ₁₆ , FFE4 ₁₆ | |
| 15 | Timer 5 • 6 interrupt | FFE3 ₁₆ , FFE2 ₁₆ | Software switch by software (See note) |
| 16 | BRK instruction interrupt | FFDF ₁₆ , FFDE ₁₆ | Non-maskable (software interrupt) |

Note : Switching a source during a program causes an unnecessary interrupt occurs. Accordingly, set a source at initializing of program.

M37280MF-XXXSP, M37280MK-XXXSP M37280EKSP

SINGLE-CHIP 8-BIT CMOS MICROCOMPUTER with CLOSED CAPTION DECODER
and ON-SCREEN DISPLAY CONTROLLER

(4) Serial I/O Interrupt

This is an interrupt request from the clock synchronous serial I/O function.

(5) $f(X_{IN})/4096$ • SPRITE OSD Interrupt

The $f(X_{IN})/4096$ interrupt occurs regularly with a $f(X_{IN})/4096$ period. Set bit 0 of the PWM mode register 1 to "0."

The SPRITE OSD interrupt occurs at the completion of SPRITE display.

Since $f(X_{IN})/4096$ interrupt and SPRITE OSD interrupt share the same vector, an interrupt source is selected by bit 5 of the SPRITE OSD control register (address 0258₁₆).

(6) Data Slicer Interrupt

An interrupt occurs when slicing data is completed.

(7) Multi-master I²C-BUS Interface Interrupt

This is an interrupt request related to the multi-master I²C-BUS interface.

(8) A-D Conversion • INT3 Interrupt

The A-D conversion interrupt occurs at the completion of A-D conversion.

The INT3 is an external input, the system detects that the level of a pin changes from LOW to HIGH or from HIGH to LOW, and generates an interrupt request. The input active edge can be selected by bit 6 of the interrupt input polarity register (address 0212₁₆): when this bit is "0," a change from LOW to HIGH is detected; when it is "1," a change from HIGH to LOW is detected. Note that this bit is cleared to "0" at reset.

Since A-D conversion interrupt and the INT3 interrupt share the same vector, an interrupt source is selected by bit 7 of the interrupt interval determination control register (address 0212₁₆).

(9) Timer 5 • 6 Interrupt

An interrupt is generated by an overflow of timer 5 or 6. Their priorities are same, and can be switched by software.

(10) BRK Instruction Interrupt

This software interrupt has the least significant priority. It does not have a corresponding interrupt enable bit, and it is not affected by the interrupt disable flag I (non-maskable).

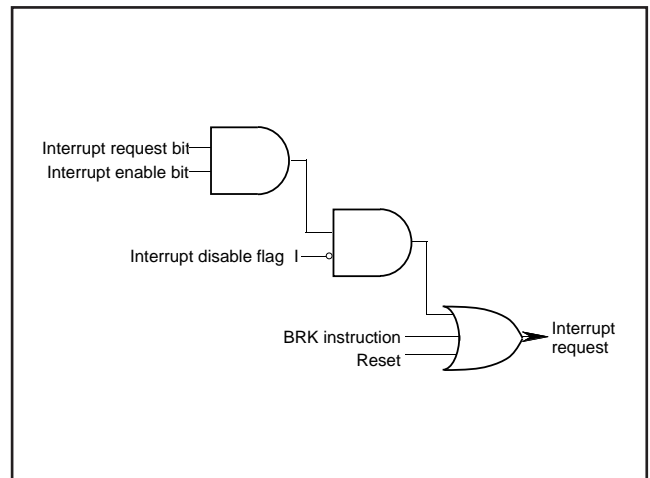


Fig. 12.3.1 Interrupt Control

M37280MF-XXXSP, M37280MK-XXXSP M37280EKSP

SINGLE-CHIP 8-BIT CMOS MICROCOMPUTER with CLOSED CAPTION DECODER
and ON-SCREEN DISPLAY CONTROLLER

Interrupt Request Register 1

b7 b6 b5 b4 b3 b2 b1 b0

Interrupt request register 1 (IREQ1) [Address 00FC₁₆]

| B | Name | Functions | After reset | R | W |
|---|--|---|-------------|---|---|
| 0 | Timer 1 interrupt request bit (TM1R) | 0 : No interrupt request issued 1 : Interrupt request issued | 0 | R | * |
| 1 | Timer 2 interrupt request bit (TM2R) | 0 : No interrupt request issued 1 : Interrupt request issued | 0 | R | * |
| 2 | Timer 3 interrupt request bit (TM3R) | 0 : No interrupt request issued 1 : Interrupt request issued | 0 | R | * |
| 3 | Timer 4 interrupt request bit (TM4R) | 0 : No interrupt request issued 1 : Interrupt request issued | 0 | R | * |
| 4 | OSD interrupt request bit (OSDR) | 0 : No interrupt request issued 1 : Interrupt request issued | 0 | R | * |
| 5 | VSNC interrupt request bit (VSCR) | 0 : No interrupt request issued 1 : Interrupt request issued | 0 | R | * |
| 6 | A-D conversion • INT3 interrupt request bit (ADR) | 0 : No interrupt request issued 1 : Interrupt request issued | 0 | R | * |
| 7 | Nothing is assigned. This bit is a write disable bit. When this bit is read out, the value is "0." | | 0 | R | — |

*: "0" can be set by software, but "1" cannot be set.

Fig. 12.3.2 Interrupt Request Register 1

Interrupt Request Register 2

b7 b6 b5 b4 b3 b2 b1 b0

0

Interrupt request register 2 (IREQ2) [Address 00FD₁₆]

| B | Name | Functions | After reset | R | W |
|---|---|---|-------------|---|---|
| 0 | INT1 interrupt request bit (IN1R) | 0 : No interrupt request issued 1 : Interrupt request issued | 0 | R | * |
| 1 | Data slicer interrupt request bit (DSR) | 0 : No interrupt request issued 1 : Interrupt request issued | 0 | R | * |
| 2 | Serial I/O interrupt request bit (SIOR) | 0 : No interrupt request issued 1 : Interrupt request issued | 0 | R | * |
| 3 | f(X _{IN})/4096 • SPRITE OSD interrupt request bit (CKR) | 0 : No interrupt request issued 1 : Interrupt request issued | 0 | R | * |
| 4 | INT2 interrupt request bit (IN2R) | 0 : No interrupt request issued 1 : Interrupt request issued | 0 | R | * |
| 5 | Multi-master I ² C-BUS interrupt request bit (IICR) | 0 : No interrupt request issued 1 : Interrupt request issued | 0 | R | * |
| 6 | Timer 5 • 6 interrupt request bit (TM56R) | 0 : No interrupt request issued 1 : Interrupt request issued | 0 | R | * |
| 7 | Fix this bit to "0." | | 0 | R | W |

*: "0" can be set by software, but "1" cannot be set.

Fig. 12.3.3 Interrupt Request Register 2

M37280MF-XXXSP, M37280MK-XXXSP M37280EKSP

SINGLE-CHIP 8-BIT CMOS MICROCOMPUTER with CLOSED CAPTION DECODER
and ON-SCREEN DISPLAY CONTROLLER

Interrupt Control Register 1

b7 b6 b5 b4 b3 b2 b1 b0



Interrupt control register 1 (ICON1) [Address 00FE₁₆]

| B | Name | Functions | After reset | R | W |
|---|--|---|-------------|---|---|
| 0 | Timer 1 interrupt enable bit (TM1E) | 0 : Interrupt disabled 1 : Interrupt enabled | 0 | R | W |
| 1 | Timer 2 interrupt enable bit (TM2E) | 0 : Interrupt disabled 1 : Interrupt enabled | 0 | R | W |
| 2 | Timer 3 interrupt enable bit (TM3E) | 0 : Interrupt disabled 1 : Interrupt enabled | 0 | R | W |
| 3 | Timer 4 interrupt enable bit (TM4E) | 0 : Interrupt disabled 1 : Interrupt enabled | 0 | R | W |
| 4 | OSD interrupt enable bit (OSDE) | 0 : Interrupt disabled 1 : Interrupt enabled | 0 | R | W |
| 5 | VS _{SYNC} interrupt enable bit (VSCE) | 0 : Interrupt disabled 1 : Interrupt enabled | 0 | R | W |
| 6 | A-D conversion • INT3 interrupt enable bit (ADE) | 0 : Interrupt disabled 1 : Interrupt enabled | 0 | R | W |
| 7 | Nothing is assigned. This bit is a write disable bit. When this bit is read out, the value is "0." | | 0 | R | — |

Fig. 12.3.4 Interrupt Control Register 1

Interrupt Control Register 2

b7 b6 b5 b4 b3 b2 b1 b0



Interrupt control register 2 (ICON2) [Address 00FF₁₆]

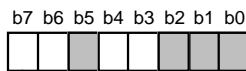
| B | Name | Functions | After reset | R | W |
|---|---|---|-------------|---|---|
| 0 | INT1 interrupt enable bit (IN1E) | 0 : Interrupt disabled 1 : Interrupt enabled | 0 | R | W |
| 1 | Data slicer interrupt enable bit (DSE) | 0 : Interrupt disabled 1 : Interrupt enabled | 0 | R | W |
| 2 | Serial I/O interrupt enable bit (SIOE) | 0 : Interrupt disabled 1 : Interrupt enabled | 0 | R | W |
| 3 | f(X _{IN})/4096 • SPRITE OSD interrupt enable bit (CKE) | 0 : Interrupt disabled 1 : Interrupt enabled | 0 | R | W |
| 4 | INT2 interrupt enable bit (IN2E) | 0 : Interrupt disabled 1 : Interrupt enabled | 0 | R | W |
| 5 | Multi-master I ² C-BUS interface interrupt enable bit (IICE) | 0 : Interrupt disabled 1 : Interrupt enabled | 0 | R | W |
| 6 | Timer 5 • 6 interrupt enable bit (TM56E) | 0 : Interrupt disabled 1 : Interrupt enabled | 0 | R | W |
| 7 | Timer 5 • 6 interrupt switch bit (TM56S) | 0 : Timer 5 1 : Timer 6 | 0 | R | W |

Fig. 12.3.5 Interrupt Control Register 2

M37280MF-XXXSP, M37280MK-XXXSP M37280EKSP

SINGLE-CHIP 8-BIT CMOS MICROCOMPUTER with CLOSED CAPTION DECODER
and ON-SCREEN DISPLAY CONTROLLER

Interrupt Input Polarity Register



Interrupt input polarity register (IP) [Address 0212₁₆]

| B | Name | Functions | After reset | R ⁺ W |
|--------|---|--|-------------|------------------|
| 0 to 2 | Nothing is assigned. These bits are write disable bits. When these bits are read out, the values are "0." | | 0 | R ⁺ — |
| 3 | INT1 polarity switch bit (POL1) | 0 : Positive polarity 1 : Negative polarity | 0 | R ⁺ W |
| 4 | INT2 polarity switch bit (POL2) | 0 : Positive polarity 1 : Negative polarity | 0 | R ⁺ W |
| 5 | Nothing is assigned. This bit is write disable bit. When this bit is read out, the value is "0." | | 0 | R ⁺ — |
| 6 | INT3 polarity switch bit (POL3) | 0 : Positive polarity 1 : Negative polarity | 0 | R ⁺ W |
| 7 | A-D conversion • INT3 interrupt source selection bit (AD/INT3SEL) | 0 : INT3 interrupt 1 : A-D conversion interrupt | 0 | R ⁺ W |

Fig. 12.3.6 Interrupt Input Polarity Register

M37280MF-XXXSP, M37280MK-XXXSP M37280EKSP

SINGLE-CHIP 8-BIT CMOS MICROCOMPUTER with CLOSED CAPTION DECODER
and ON-SCREEN DISPLAY CONTROLLER

12.4 TIMERS

This microcomputer has 6 timers: timer 1, timer 2, timer 3, timer 4, timer 5, and timer 6. All timers are 8-bit timers with the 8-bit timer latch. The timer block diagram is shown in Figure 12.4.3.

All of the timers count down and their divide ratio is $1/(n+1)$, where n is the value of timer latch. By writing a count value to the corresponding timer latch (addresses 00F0₁₆ to 00F3₁₆: timers 1 to 4, addresses 021A₁₆ and 021B₁₆: timers 5 and 6), the value is also set to a timer, simultaneously.

The count value is decremented by 1. The timer interrupt request bit is set to "1" by a timer overflow at the next count pulse, after the count value reaches "00₁₆".

12.4.1 Timer 1

Timer 1 can select one of the following count sources:

- $f(XIN)/16$ or $f(XCIN)/16$
- $f(XIN)/4096$ or $f(XCIN)/4096$
- External clock from the P42/TIM2 pin

The count source of timer 1 is selected by setting bits 5 and 0 of timer mode register 1 (address 00F4₁₆). Either $f(XIN)$ or $f(XCIN)$ is selected by bit 7 of the CPU mode register.

Timer 1 interrupt request occurs at timer 1 overflow.

12.4.2 Timer 2

Timer 2 can select one of the following count sources:

- $f(XIN)/16$ or $f(XCIN)/16$
- Timer 1 overflow signal
- External clock from the TIM2 pin

The count source of timer 2 is selected by setting bits 4 and 1 of timer mode register 1 (address 00F4₁₆). Either $f(XIN)$ or $f(XCIN)$ is selected by bit 7 of the CPU mode register. When timer 1 overflow signal is a count source for the timer 2, the timer 1 functions as an 8-bit prescaler.

Timer 2 interrupt request occurs at timer 2 overflow.

12.4.3 Timer 3

Timer 3 can select one of the following count sources:

- $f(XIN)/16$ or $f(XCIN)/16$
- $f(XCIN)$
- External clock from the TIM3 pin

The count source of timer 3 is selected by setting bit 0 of timer mode register 2 (address 00F5₁₆) and bit 6 at address 00C7₁₆. Either $f(XIN)$ or $f(XCIN)$ is selected by bit 7 of the CPU mode register.

Timer 3 interrupt request occurs at timer 3 overflow.

12.4.4 Timer 4

Timer 4 can select one of the following count sources:

- $f(XIN)/16$ or $f(XCIN)/16$
- $f(XIN)/2$ or $f(XCIN)/2$
- $f(XCIN)$

The count source of timer 3 is selected by setting bits 1 and 4 of timer mode register 2 (address 00F5₁₆). Either $f(XIN)$ or $f(XCIN)$ is selected by bit 7 of the CPU mode register. When timer 3 overflow signal is a count source for the timer 4, the timer 3 functions as an 8-bit prescaler.

Timer 4 interrupt request occurs at timer 4 overflow.

12.4.5 Timer 5

Timer 5 can select one of the following count sources:

- $f(XIN)/16$ or $f(XCIN)/16$
- Timer 2 overflow signal
- Timer 4 overflow signal

The count source of timer 3 is selected by setting bit 6 of timer mode register 1 (address 00F4₁₆) and bit 7 of timer mode register 2 (address 00F5₁₆). When overflow of timer 2 or 4 is a count source for timer 5, either timer 2 or 4 functions as an 8-bit prescaler. Either $f(XIN)$ or $f(XCIN)$ is selected by bit 7 of the CPU mode register.

Timer 5 interrupt request occurs at timer 5 overflow.

12.4.6 Timer 6

Timer 6 can select one of the following count sources:

- $f(XIN)/16$ or $f(XCIN)/16$
- Timer 5 overflow signal

The count source of timer 6 is selected by setting bit 7 of timer mode register 1 (address 00F4₁₆). Either $f(XIN)$ or $f(XCIN)$ is selected by bit 7 of the CPU mode register. When timer 5 overflow signal is a count source for timer 6, timer 5 functions as an 8-bit prescaler.

Timer 6 interrupt request occurs at timer 6 overflow.

At reset, timers 3 and 4 are connected by hardware and "FF₁₆" is automatically set in timer 3; "07₁₆" in timer 4. The $f(XIN)^*/16$ is selected as the timer 3 count source. The internal reset is released by timer 4 overflow in this state and the internal clock is connected.

At execution of the STP instruction, timers 3 and 4 are connected by hardware and "FF₁₆" is automatically set in timer 3; "07₁₆" in timer 4. However, the $f(XIN)^*/16$ is not selected as the timer 3 count source. So set both bit 0 of timer mode register 2 (address 00F5₁₆) and bit 6 at address 00C7₁₆ to "0" before execution of the STP instruction ($f(XIN)^*/16$ is selected as the timer 3 count source). The internal STP state is released by timer 4 overflow in this state and the internal clock is connected.

As a result of the above procedure, the program can start under a stable clock.

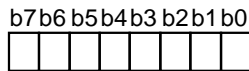
*: When bit 7 of the CPU mode register (CM7) is "1," $f(XIN)$ becomes $f(XCIN)$.

The structure of timer-related registers is shown in Figures 12.4.1 and 12.4.2.

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Timer Mode Register 1



Timer mode register 1 (TM1) [Address 00F416]

| B | Name | Functions | After rese | R | W |
|---|--|---|------------|---|---|
| 0 | Timer 1 count source selection bit 1 (TM10) | 0: $f(X_{IN})/16$ or $f(X_{CIN})/16$ (Note) 1: Count source selected by bit 5 of TM1 | 0 | R | W |
| 1 | Timer 2 count source selection bit 1 (TM11) | 0: Count source selected by bit 4 of TM1 1: External clock from TIM2 pin | 0 | R | W |
| 2 | Timer 1 count stop bit (TM12) | 0: Count start 1: Count stop | 0 | R | W |
| 3 | Timer 2 count stop bit (TM13) | 0: Count start 1: Count stop | 0 | R | W |
| 4 | Timer 2 count source selection bit 2 (TM14) | 0: $f(X_{IN})/16$ or $f(X_{CIN})/16$ (See note) 1: Timer 1 overflow | 0 | R | W |
| 5 | Timer 1 count source selection bit 2 (TM15) | 0: $f(X_{IN})/4096$ or $f(X_{CIN})/4096$ (See note) 1: External clock from TIM2 pin | 0 | R | W |
| 6 | Timer 5 count source selection bit 2 (TM16) | 0: Timer 2 overflow 1: Timer 4 overflow | 0 | R | W |
| 7 | Timer 6 internal count source selection bit (TM17) | 0: $f(X_{IN})/16$ or $f(X_{CIN})/16$ (See note) 1: Timer 5 overflow | 0 | R | W |

Note: Either $f(X_{IN})$ or $f(X_{CIN})$ is selected by bit 7 of the CPU mode register.

Fig. 12.4.1 Timer Mode Register 1

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Timer Mode Register 2

b7 b6 b5 b4 b3 b2 b1 b0

Timer mode register 2 (TM2) [Address 00F516]

| B | Name | Functions | After reset | R | W |
|------|--|---|-------------|---|---|
| 0 | Timer 3 count source selection bit (TM20) | (b6 at address 00C716) ↓ b0 0 0 : f(XIN)/16 or f(XCIN)/16 (See note) 1 0 : f(XCIN) 0 1 : } External clock from TIM3 pin 1 1 : | 0 | R | W |
| 1, 4 | Timer 4 count source selection bits (TM21, TM24) | b4 b1 0 0 : Timer 3 overflow signal 0 1 : f(XIN)/16 or f(XCIN)/16 (See note) 1 0 : f(XIN)/2 or f(XCIN)/2 (See note) 1 1 : f(XCIN) | 0 | R | W |
| 2 | Timer 3 count stop bit (TM22) | 0: Count start 1: Count stop | 0 | R | W |
| 3 | Timer 4 count stop bit (TM23) | 0: Count start 1: Count stop | 0 | R | W |
| 5 | Timer 5 count stop bit (TM25) | 0: Count start 1: Count stop | 0 | R | W |
| 6 | Timer 6 count stop bit (TM26) | 0: Count start 1: Count stop | 0 | R | W |
| 7 | Timer 5 count source selection bit 1 (TM27) | 0: f(XIN)/16 or f(XCIN)/16 (See note) 1: Count source selected by bit 6 of TM1 | 0 | R | W |

Note: Either f(XIN) or f(XCIN) is selected by bit 7 of the CPU mode register.

Fig. 12.4.2 Timer Mode Register 2

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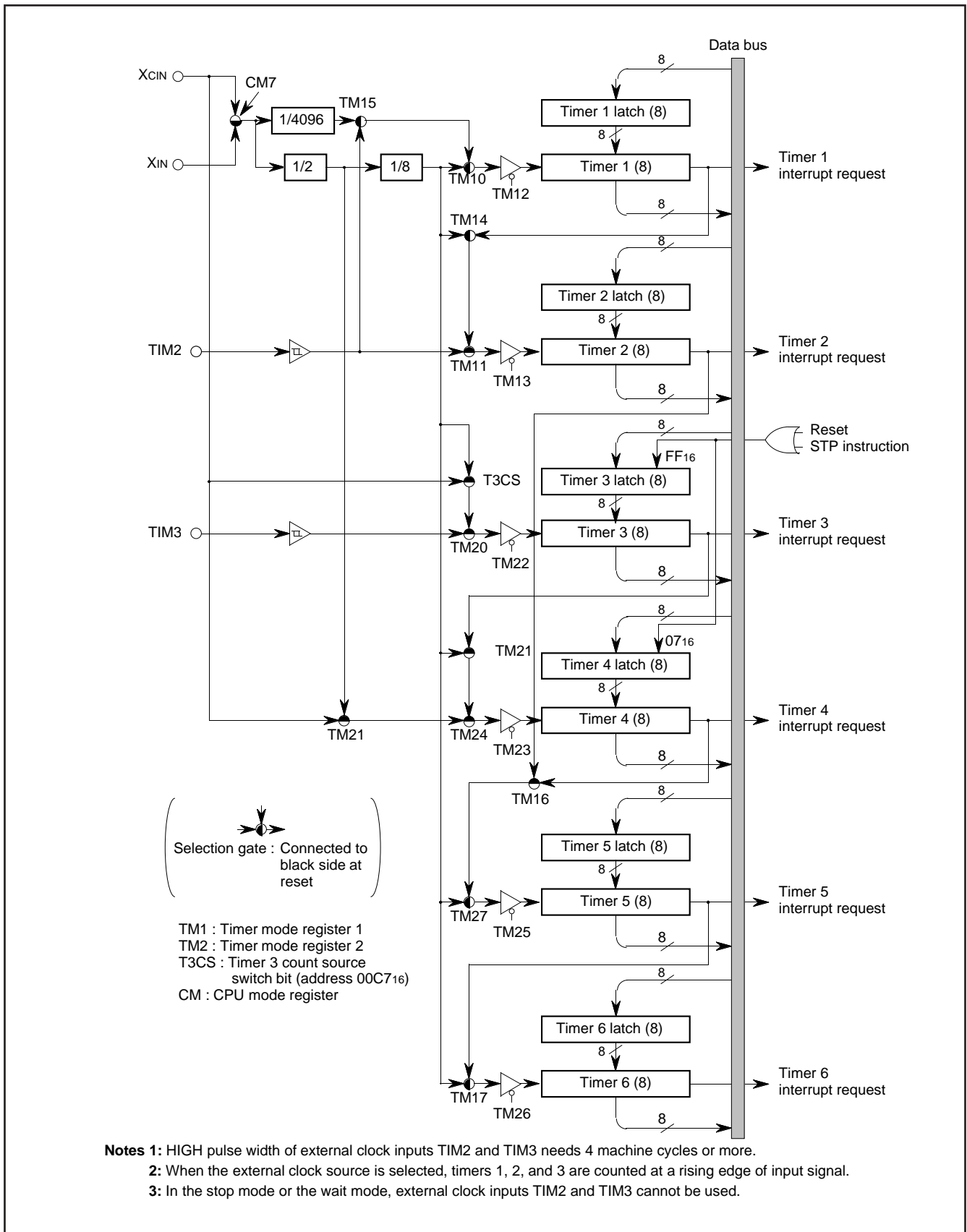


Fig. 12.4.3 Timer Block Diagram

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SINGLE-CHIP 8-BIT CMOS MICROCOMPUTER with CLOSED CAPTION DECODER
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12.5 SERIAL I/O

This microcomputer has a built-in serial I/O which can either transmit or receive 8-bit data serially in the clock synchronous mode.

The serial I/O block diagram is shown in Figure 12.5.1. The synchronous clock I/O pin (SCLK), and data output pin (SOUT) also function as port P4, data input pin (SIN) also functions as ports P1 and P7.

Bit 2 of the serial I/O mode register (address 0213₁₆) selects whether the synchronous clock is supplied internally or externally (from the SCLK pin). When an internal clock is selected, bits 1 and 0 select whether f(XIN) or f(XCIN) is divided by 8, 16, 32, or 64. To use SOUT and SCLK pins for serial I/O, set the corresponding bits of the port P4 direction register (address 00C9₁₆) to "0." To use SIN pin for serial I/O, set the corresponding bit of the port P1 direction register (address 00C3₁₆) to "0."

The operation of the serial I/O is described below. The operation of the serial I/O differs depending on the clock source; external clock or internal clock.

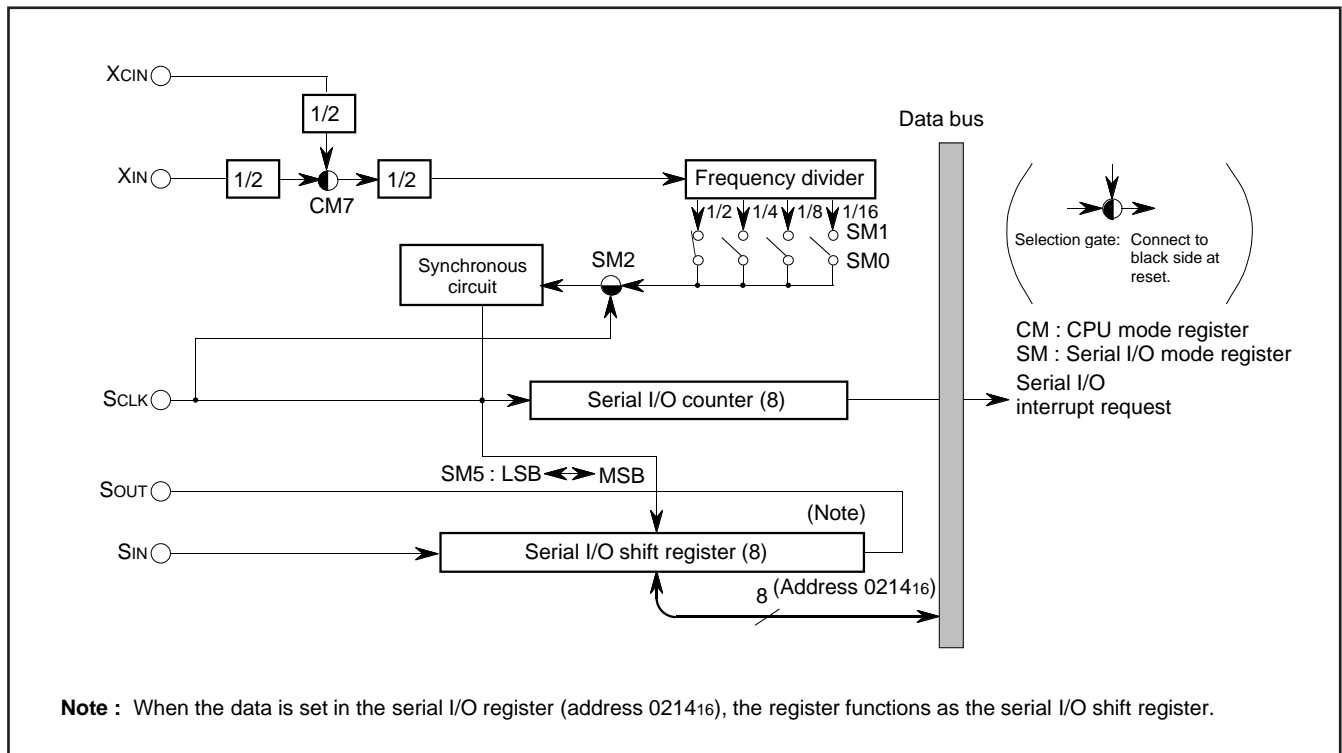


Fig. 12.5.1 Serial I/O Block Diagram

M37280MF-XXXSP, M37280MK-XXXSP M37280EKSP

SINGLE-CHIP 8-BIT CMOS MICROCOMPUTER with CLOSED CAPTION DECODER
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Internal clock : The serial I/O counter is set to "7" during the write cycle into the serial I/O register (address 021416), and the transfer clock goes "H" forcibly. At each falling edge of the transfer clock after the write cycle, serial data is output from the SOUT pin. Transfer direction can be selected by bit 5 of the serial I/O mode register. At each rising edge of the transfer clock, data is input from the SIN pin and data in the serial I/O register is shifted 1 bit.

After the transfer clock has counted 8 times, the serial I/O counter becomes "0" and the transfer clock stops at HIGH. At this time the interrupt request bit is set to "1."

External clock : The an external clock is selected as the clock source, the interrupt request is set to "1" after the transfer clock has been counted 8 counts. However, transfer operation does not stop, so the clock should be controlled externally. Use the external clock of 500kHz or less with a duty cycle of 50%.

The serial I/O timing is shown in Figure 12.5.2. When using an external clock for transfer, the external clock must be held at HIGH for initializing the serial I/O counter. When switching between an internal clock and an external clock, do not switch during transfer. Also, be sure to initialize the serial I/O counter after switching.

Notes 1: On programming, note that the serial I/O counter is set by writing to the serial I/O register with the bit managing instructions, such as SEB and CLB.

2: When an external clock is used as the synchronous clock, write transmit data to the serial I/O register when the transfer clock input level is HIGH.

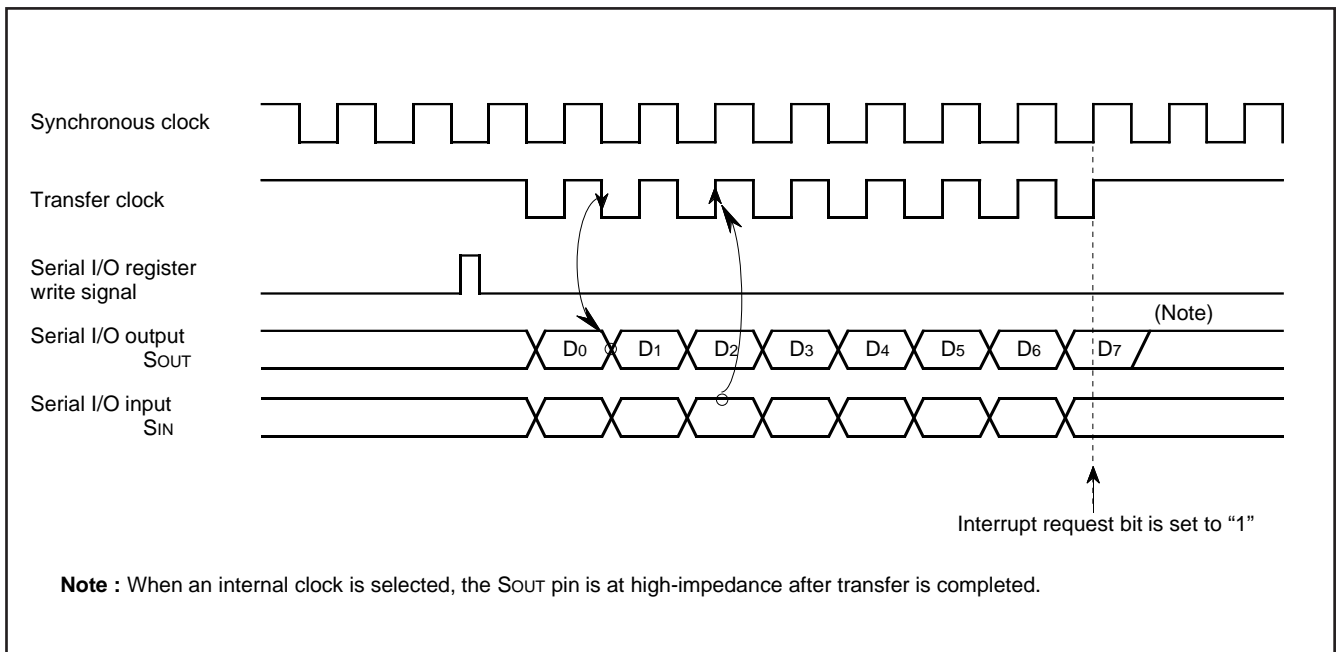


Fig. 12.5.2 Serial I/O Timing (for LSB first)

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Serial I/O Mode Register

b7 b6 b5 b4 b3 b2 b1 b0

Serial I/O mode register (SM) [Address 021316]

| B | Name | Functions | After reset | R | W |
|------|--|---|-------------|---|---|
| 0, 1 | Internal synchronous clock selection bits (SM0, SM1) | b1 b0 0 0: $f(X_{IN})/8$ or $f(X_{CIN})/8$ 0 1: $f(X_{IN})/16$ or $f(X_{CIN})/16$ 1 0: $f(X_{IN})/32$ or $f(X_{CIN})/32$ 1 1: $f(X_{IN})/64$ or $f(X_{CIN})/64$ | 0 | R | W |
| 2 | Synchronous clock selection bit (SM2) | 0: External clock 1: Internal clock | 0 | R | W |
| 3 | Port function selection bit (SM3) | 0: P11, P13 1: SCL1, SDA1 | 0 | R | W |
| 4 | Port function selection bit (SM4) | 0: P12, P14 1: SCL2, SDA2 | 0 | R | W |
| 5 | Transfer direction selection bit (SM5) | 0: LSB first 1: MSB first | 0 | R | W |
| 6 | SIN pin switch bit (SM6) | 0: P17 is SIN pin. 1: P72 is SIN pin. | 0 | R | W |
| 7 | Nothing is assigned. This bit is a write disable bit. When this bit is read out, the value is "0." | | 0 | R | — |

Fig. 12.5.3 Serial I/O Mode Register

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12.6 MULTI-MASTER I²C-BUS INTERFACE

The multi-master I²C-BUS interface is a serial communications circuit, conforming to the Philips I²C-BUS data transfer format. This interface, offering both arbitration lost detection and a synchronous functions, is useful for the multi-master serial communications. Figure 12.6.1 shows a block diagram of the multi-master I²C-BUS interface and Table 12.6.1 shows multi-master I²C-BUS interface functions.

This multi-master I²C-BUS interface consists of the I²C address register, the I²C data shift register, the I²C clock control register, the I²C control register, the I²C status register and other control circuits.

Table 12.6.1 Multi-master I²C-BUS Interface Functions

| Item | Function |
|---------------------|--|
| Format | In conformity with Philips I ² C-BUS standard: 10-bit addressing format 7-bit addressing format High-speed clock mode Standard clock mode |
| Communication mode | In conformity with Philips I ² C-BUS standard: Master transmission Master reception Slave transmission Slave reception |
| SCL clock frequency | 16.1 kHz to 400 kHz (at $\phi = 4$ MHz) |

ϕ : System clock = $f(XIN)/2$

Note : We are not responsible for any third party's infringement of patent rights or other rights attributable to the use of the control function (bits 6 and 7 of the I²C control register at address 00F916) for connections between the I²C-BUS interface and ports (SCL1, SCL2, SDA1, SDA2).

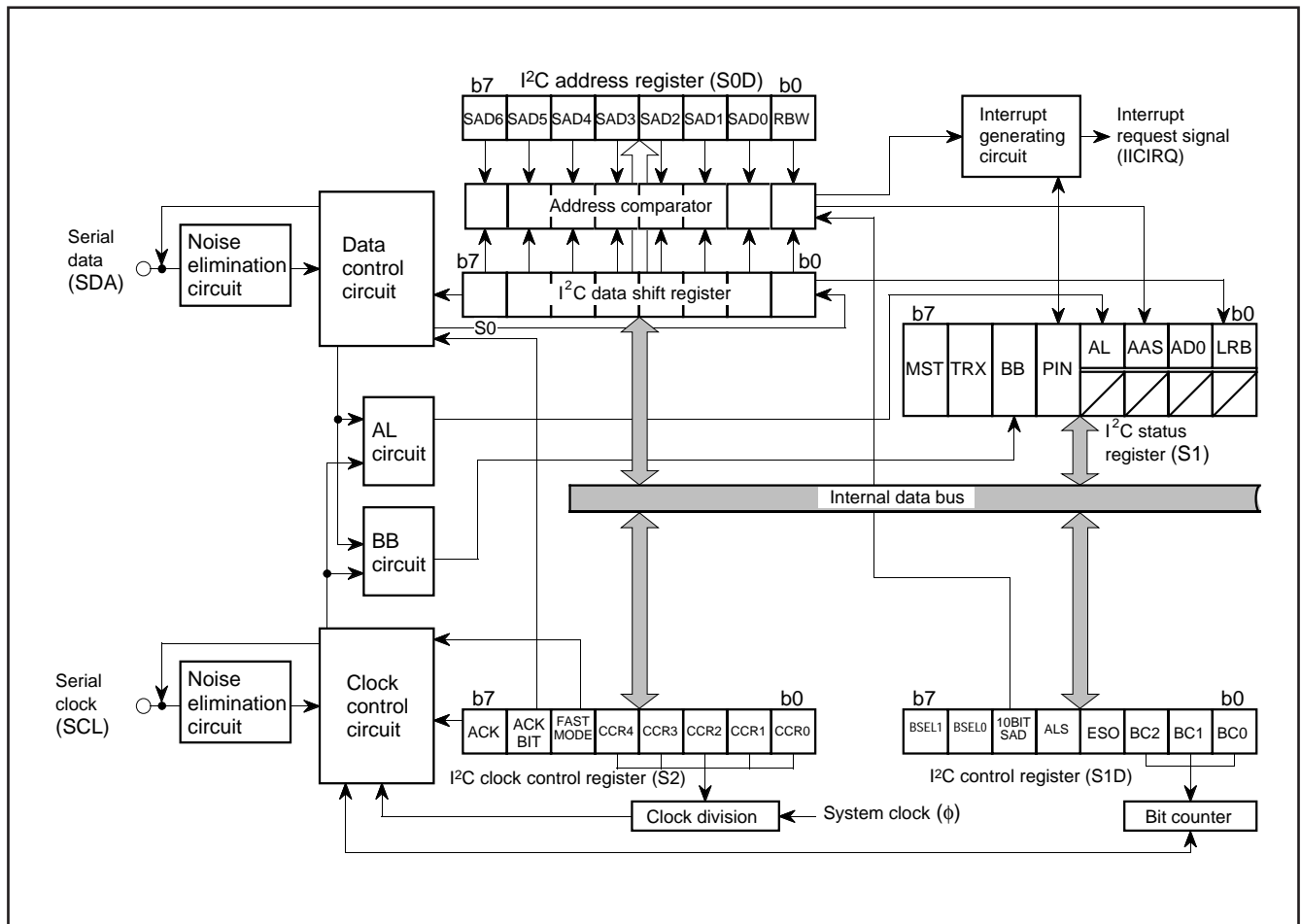


Fig. 12.6.1 Block Diagram of Multi-master I²C-BUS Interface

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SINGLE-CHIP 8-BIT CMOS MICROCOMPUTER with CLOSED CAPTION DECODER
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12.6.1 I²C Data Shift Register

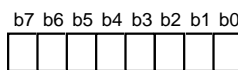
The I²C data shift register (S0 : address 00F6₁₆) is an 8-bit shift register to store receive data and write transmit data.

When transmit data is written into this register, it is transferred to the outside from bit 7 in synchronization with the SCL clock, and each time one-bit data is output, the data of this register are shifted one bit to the left. When data is received, it is input to this register from bit 0 in synchronization with the SCL clock, and each time one-bit data is input, the data of this register are shifted one bit to the left.

The I²C data shift register is in a write enable status only when the ESO bit of the I²C control register (address 00F9₁₆) is "1." The bit counter is reset by a write instruction to the I²C data shift register. When both the ESO bit and the MST bit of the I²C status register (address 00F8₁₆) are "1," the SCL is output by a write instruction to the I²C data shift register. Reading data from the I²C data shift register is always enabled regardless of the ESO bit value.

Note: To write data into the I²C data shift register after setting the MST bit to "0" (slave mode), keep an interval of 8 machine cycles or more.

I²C Data Shift Register



I²C data shift register 1 (S0) [Address 00F6₁₆]

| B | Name | Functions | After reset | R | W |
|--------|----------|--|---------------|---|---|
| 0 to 7 | D0 to D7 | This is an 8-bit shift register to store receive data and write transmit data. | Indeterminate | R | W |

Note: To write data into the I²C data shift register after setting the MST bit to "0" (slave mode), keep an interval of 8 machine cycles or more.

Fig. 12.6.2 Data Shift Register

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SINGLE-CHIP 8-BIT CMOS MICROCOMPUTER with CLOSED CAPTION DECODER
and ON-SCREEN DISPLAY CONTROLLER

12.6.2 I²C Address Register

The I²C address register (address 00F7₁₆) consists of a 7-bit slave address and a read/write bit. In the addressing mode, the slave address written in this register is compared with the address data to be received immediately after the START condition are detected.

(1) Bit 0: Read/Write Bit (RBW)

Not used when comparing addresses, in the 7-bit addressing mode.
In the 10-bit addressing mode, the first address data to be received is compared with the contents (SAD₆ to SAD₀ + RBW) of the I²C address register.

The RBW bit is cleared to "0" automatically when the stop condition is detected.

(2) Bits 1 to 7: Slave Address (SAD₀–SAD₆)

These bits store slave addresses. Regardless of the 7-bit addressing mode and the 10-bit addressing mode, the address data transmitted from the master is compared with the contents of these bits.

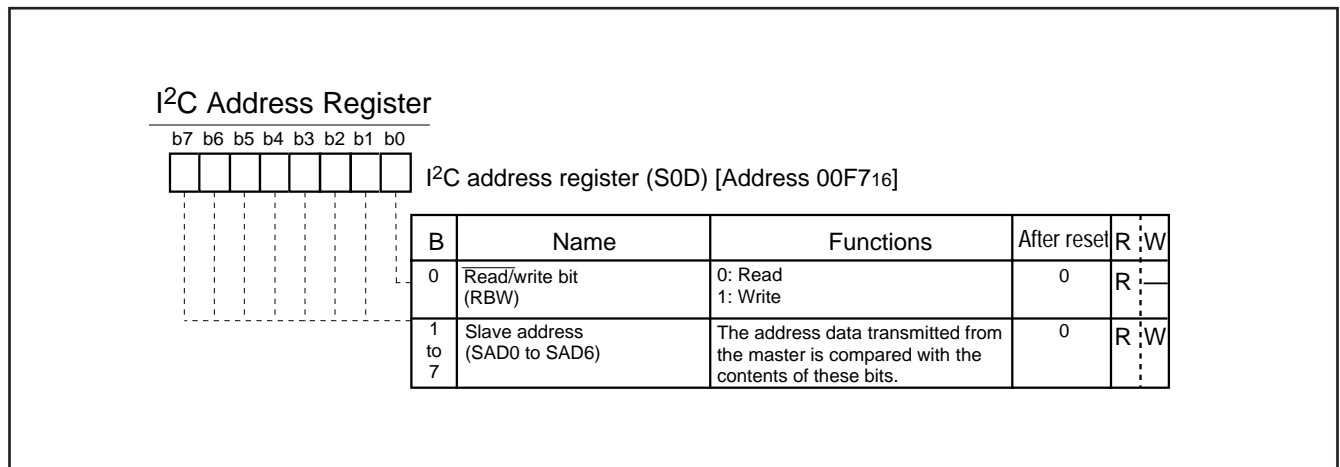


Fig. 12.6.3 I²C Address Register

M37280MF-XXXSP, M37280MK-XXXSP M37280EKSP

SINGLE-CHIP 8-BIT CMOS MICROCOMPUTER with CLOSED CAPTION DECODER
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12.6.3 I²C Clock Control Register

The I²C clock control register (address 00FA16) is used to set ACK control, SCL mode and SCL frequency.

(1) Bits 0 to 4: SCL Frequency Control Bits (CCR0-CCR4)

These bits control the SCL frequency.

(2) Bit 5: SCL Mode Specification Bit (FAST MODE)

This bit specifies the SCL mode. When this bit is set to "0," the standard clock mode is set. When the bit is set to "1," the high-speed clock mode is set.

(3) Bit 6: ACK Bit (ACK BIT)

This bit sets the SDA status when an ACK clock* is generated. When this bit is set to "0," the ACK return mode is set and SDA goes to LOW at the occurrence of an ACK clock. When the bit is set to "1," the ACK non-return mode is set. The SDA is held in the HIGH status at the occurrence of an ACK clock.

However, when the slave address matches the address data in the reception of address data at ACK BIT = "0," the SDA is automatically made LOW (ACK is returned). If there is a mismatch between the slave address and the address data, the SDA is automatically made HIGH (ACK is not returned).

(4) Bit 7: ACK Clock Bit (ACK)

This bit specifies a mode of acknowledgment which is an acknowledgment response of data transmission. When this bit is set to "0," the no ACK clock mode is set. In this case, no ACK clock occurs after data transmission. When the bit is set to "1," the ACK clock mode is set and the master generates an ACK clock upon completion of each 1-byte data transmission. The device for transmitting address data and control data releases the SDA at the occurrence of an ACK clock (make SDA HIGH) and receives the ACK bit generated by the data receiving device.

Note: Do not write data into the I²C clock control register during transmission. If data is written during transmission, the I²C clock generator is reset, so that data cannot be transmitted normally.

*ACK clock: Clock for acknowledgement

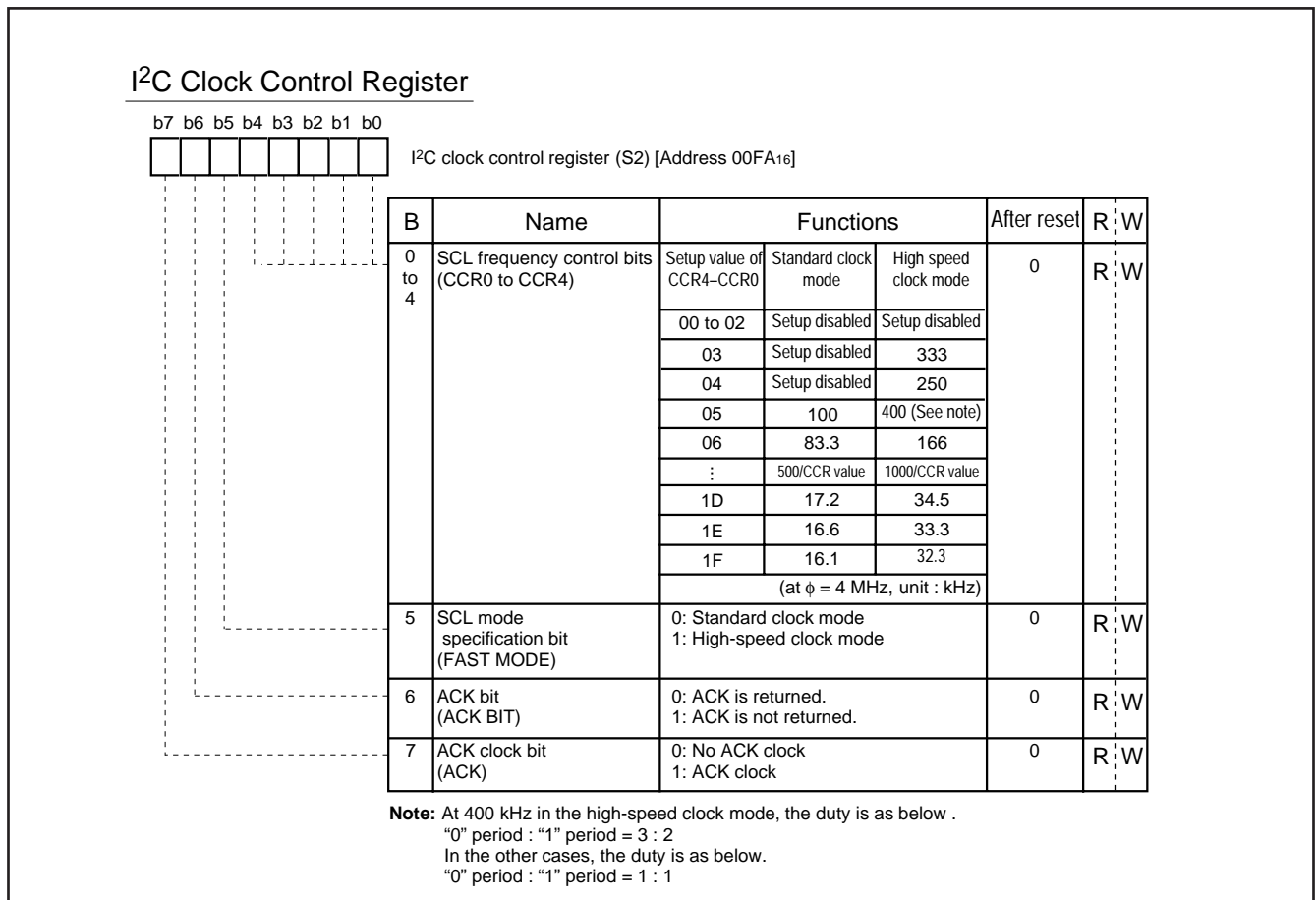


Fig. 12.6.4 I²C Address Register

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12.6.4 I²C Control Register

The I²C control register (address 00F9₁₆) controls the data communication format.

(1) Bits 0 to 2: Bit Counter (BC0-BC2)

These bits decide the number of bits for the next 1-byte data to be transmitted. An interrupt request signal occurs immediately after the number of bits specified with these bits are transmitted.

When a START condition is received, these bits become "000₂" and the address data is always transmitted and received in 8 bits.

(2) Bit 3: I²C Interface Use Enable Bit (ESO)

This bit enables usage of the multimaster I²C BUS interface. When this bit is set to "0," the use disable status is provided, so the SDA and the SCL become high-impedance. When the bit is set to "1," use of the interface is enabled.

When ESO = "0," the following is performed.

- PIN = "1," BB = "0" and AL = "0" are set (they are bits of the I²C status register at address 00F8₁₆).
- Writing data to the I²C data shift register (address 00F6₁₆) is disabled.

(3) Bit 4: Data Format Selection Bit (ALS)

This bit decides whether or not to recognize slave addresses. When this bit is set to "0," the addressing format is selected, so that address data is recognized. When a match is found between a slave address and address data as a result of comparison or when a general call (refer to "12.6.5 I²C Status Register," bit 1) is received, transmission processing can be performed. When this bit is set to "1," the free data format is selected, so that slave addresses are not recognized.

(4) Bit 5: Addressing Format Selection Bit (10BIT SAD)

This bit selects a slave address specification format. When this bit is set to "0," the 7-bit addressing format is selected. In this case, only the high-order 7 bits (slave address) of the I²C address register (address 00F7₁₆) are compared with address data. When this bit is set to "1," the 10-bit addressing format is selected, all the bits of the I²C address register are compared with address data.

(5) Bits 6 and 7: Connection Control Bits between I²C-BUS Interface and Ports (BSEL0, BSEL1)

These bits controls the connection between SCL and ports or SDA and ports (refer to Figure 12.6.5).

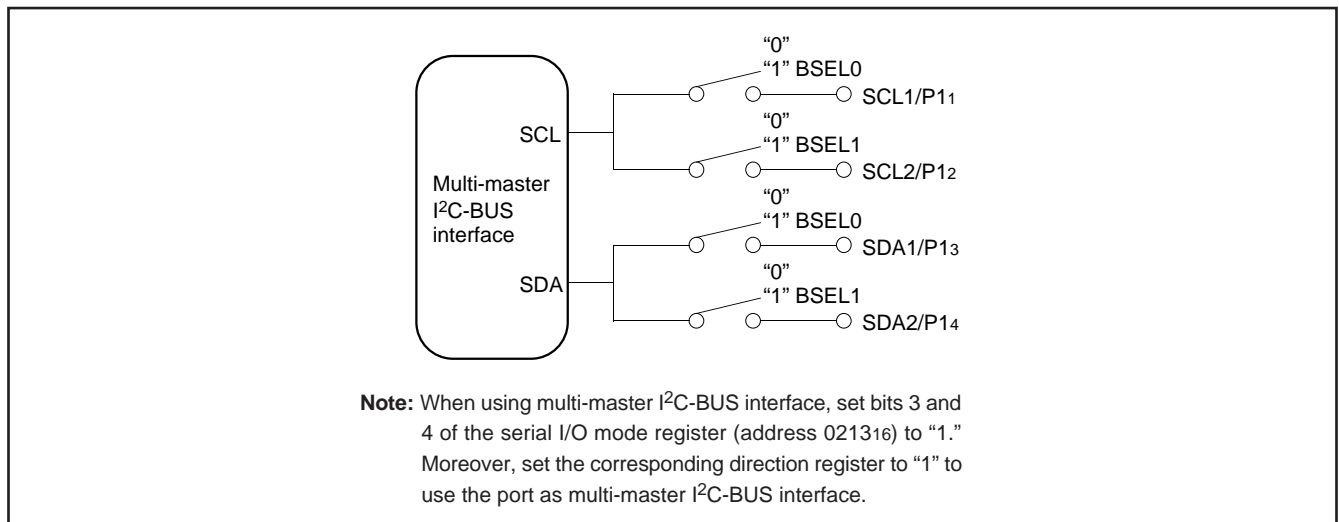
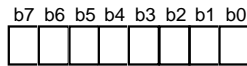


Fig. 12.6.5 Connection Port Control by BSEL0 and BSEL1

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I²C Control Register



I²C control register (S1D) [Address 00F9₁₆]

| B | Name | Functions | After reset | R | W |
|--------|---|--|-------------|---|---|
| 0 to 2 | Bit counter (Number of transmit/recieve bits) (BC0 to BC2) | b2 b1 b0 0 0 0: 8 0 0 1: 7 0 1 0: 6 0 1 1: 5 1 0 0: 4 1 0 1: 3 1 1 0: 2 1 1 1: 1 | 0 | R | W |
| 3 | I ² C-BUS interface use enable bit (ESO) | 0: Disabled 1: Enabled | 0 | R | W |
| 4 | Data format selection bit(ALS) | 0: Addressing format 1: Free data format | 0 | R | W |
| 5 | Addressing format selection bit (10BIT SAD) | 0: 7-bit addressing format 1: 10-bit addressing format | 0 | R | W |
| 6, 7 | Connection control bits between I ² C-BUS interface and ports (BSEL0, BSEL1) | b7 b6 Connection port (See note) 0 0: None 0 1: SCL1, SDA1 1 0: SCL2, SDA2 1 1: SCL1, SDA1, SCL2, SDA2 | 0 | R | W |

Fig. 12.6.6 I²C Control Register

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12.6.5 I²C Status Register

The I²C status register (address 00F8₁₆) controls the I²C-BUS interface status. The low-order 4 bits are read-only bits and the high-order 4 bits can be read out and written to.

(1) Bit 0: Last Receive Bit (LRB)

This bit stores the last bit value of received data and can also be used for ACK receive confirmation. If ACK is returned when an ACK clock occurs, the LRB bit is set to "0." If ACK is not returned, this bit is set to "1." Except in the ACK mode, the last bit value of received data is input. The state of this bit is changed from "1" to "0" by executing a write instruction to the I²C data shift register (address 00F6₁₆).

(2) Bit 1: General Call Detecting Flag (AD0)

This bit is set to "1" when a general call* whose address data is all "0" is received in the slave mode. By a general call of the master device, every slave device receives control data after the general call. The AD0 bit is set to "0" by detecting the STOP condition or START condition.

*General call: The master transmits the general call address "00₁₆" to all slaves.

(3) Bit 2: Slave Address Comparison Flag (AAS)

This flag indicates a comparison result of address data.

■ In the slave receive mode, when the 7-bit addressing format is selected, this bit is set to "1" in one of the following conditions.

- The address data immediately after occurrence of a START condition matches the slave address stored in the high-order 7 bits of the I²C address register (address 00F7₁₆).
- A general call is received.

■ In the slave reception mode, when the 10-bit addressing format is selected, this bit is set to "1" with the following condition.

- When the address data is compared with the I²C address register (8 bits consists of slave address and RBW), the first bytes match.

■ The state of this bit is changed from "1" to "0" by executing a write instruction to the I²C data shift register (address 00F6₁₆).

(4) Bit 3: Arbitration Lost* detecting flag (AL)

In the master transmission mode, when a device other than the microcomputer sets the SDA to "L", arbitration is judged to have been lost, so that this bit is set to "1." At the same time, the TRX bit is set to "0," so that immediately after transmission of the byte whose arbitration was lost is completed, the MST bit is set to "0." When arbitration is lost during slave address transmission, the TRX bit is set to "0" and the reception mode is set. Consequently, it becomes possible to receive and recognize its own slave address transmitted by another master device.

*Arbitration lost: The status in which communication as a master is disabled.

(5) Bit 4: I²C-BUS Interface Interrupt Request Bit (PIN)

This bit generates an interrupt request signal. Each time 1-byte data is transmitted, the state of the PIN bit changes from "1" to "0." At the same time, an interrupt request signal is sent to the CPU. The PIN bit is set to "0" in synchronization with a falling edge of the last clock (including the ACK clock) of an internal clock and an interrupt request signal occurs in synchronization with a falling edge of the PIN bit. When the PIN bit is "0," the SCL is kept in the "0" state and clock generation is disabled. Figure 12.6.8 shows an interrupt request signal generating timing chart.

The PIN bit is set to "1" in any one of the following conditions.

- Executing a write instruction to the I²C data shift register (address 00F6₁₆).
- When the ESO bit is "0"
- At reset

The conditions in which the PIN bit is set to "0" are shown below:

- Immediately after completion of 1-byte data transmission (including when arbitration lost is detected)
- Immediately after completion of 1-byte data reception
- In the slave reception mode, with ALS = "0" and immediately after completion of slave address or general call address reception
- In the slave reception mode, with ALS = "1" and immediately after completion of address data reception

(6) Bit 5: Bus Busy Flag (BB)

This bit indicates the status of use of the bus system. When this bit is set to "0," this bus system is not busy and a START condition can be generated. When this bit is set to "1," this bus system is busy and the occurrence of a START condition is disabled by the START condition duplication prevention function (Note).

This flag can be written by software only in the master transmission mode. In the other modes, this bit is set to "1" by detecting a START condition and set to "0" by detecting a STOP condition. When the ESO bit of the I²C control register (address 00F9₁₆) is "0" and at reset, the BB flag is kept in the "0" state.

(7) Bit 6: Communication Mode Specification Bit (transfer direction specification bit: TRX)

This bit decides the direction of transfer for data communication. When this bit is "0," the reception mode is selected and the data of a transmitting device is received. When the bit is "1," the transmission mode is selected and address data and control data are output into the SDA in synchronization with the clock generated on the SCL.

When the ALS bit of the I²C control register (address 00F9₁₆) is "0" in the slave reception mode is selected, the TRX bit is set to "1" (transmit) if the least significant bit (R/W bit) of the address data transmitted by the master is "1." When the ALS bit is "0" and the R/W bit is "0," the TRX bit is cleared to "0" (receive).

The TRX bit is cleared to "0" in one of the following conditions.

- When arbitration lost is detected.
- When a STOP condition is detected.
- When occurrence of a START condition is disabled by the START condition duplication prevention function (Note).
- With MST = "0" and when a START condition is detected.
- With MST = "0" and when ACK non-return is detected.
- At reset

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(8) Bit 7: Communication Mode Specification Bit (master/slave specification bit: MST)

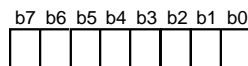
This bit is used for master/slave specification for data communication. When this bit is "0," the slave is specified, so that a START condition and a STOP condition generated by the master are received, and data communication is performed in synchronization with the clock generated by the master. When this bit is "1," the master is specified and a START condition and a STOP condition are generated, and also the clocks required for data communication are generated on the SCL.

The MST bit is cleared to "0" in one of the following conditions.

- Immediately after completion of 1-byte data transmission when arbitration lost is detected
- When a STOP condition is detected.
- When occurrence of a START condition is disabled by the START condition duplication preventing function (Note).
- At reset

Note: The START condition duplication prevention function disables the START condition generation, reset of bit counter reset, and SCL output, when the following condition is satisfied:
a START condition is set by another master device.

I²C Status Register



I²C status register (S1) [Address 00F816]

| B | Name | Functions | After reset | R | W |
|------|---|---|---------------|---|---|
| 0 | Last receive bit (LRB) (See note) | 0 : Last bit = "0 " 1 : Last bit = "1 " (See note) | Indeterminate | R | — |
| 1 | General call detecting flag (AD0) (See note) | 0 : No general call detected 1 : General call detected (See note) | 0 | R | — |
| 2 | Slave address comparison flag (AAS) (See note) | 0 : Address match 1 : Address mismatch (See note) | 0 | R | — |
| 3 | Arbitration lost detecting flag (AL) (See note) | 0 : Not detected 1 : Detected (See note) | 0 | R | — |
| 4 | I ² C-BUS interface interrupt request bit (PIN) | 0 : Interrupt request issued 1 : No interrupt request issued | 0 | R | W |
| 5 | Bus busy flag (BB) | 0 : Bus free 1 : Bus busy | 0 | R | W |
| 6, 7 | Communication mode specification bits (TRX, MST) | b7 b6 0 0 : Slave receive mode 0 1 : Slave transmit mode 1 0 : Master receive mode 1 1 : Master transmit mode | 0 | R | W |

Note : These bits and flags can be read out, but cannot be written.

Fig. 12.6.7 I²C Status Register

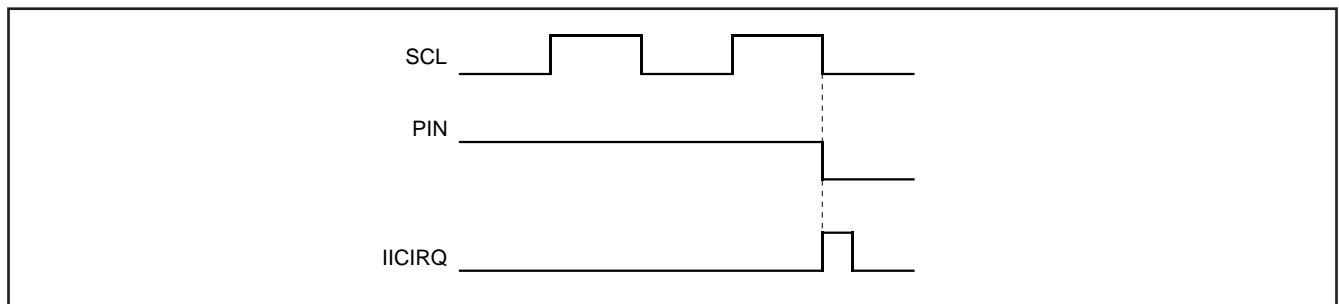


Fig. 12.6.8 Interrupt Request Signal Generation Timing

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12.6.6 START Condition Generation Method

When the ESO bit of the I²C control register (address 00F9₁₆) is "1," execute a write instruction to the I²C status register (address 00F8₁₆) to set the MST, TRX and BB bits to "1." A START condition will then be generated. After that, the bit counter becomes "000₂" and an SCL for 1 byte is output. The START condition generation timing and BB bit set timing are different in the standard clock mode and the high-speed clock mode. Refer to Figure 12.6.9 for the START condition generation timing diagram, and Table 12.6.2 for the START condition/STOP condition generation timing table.

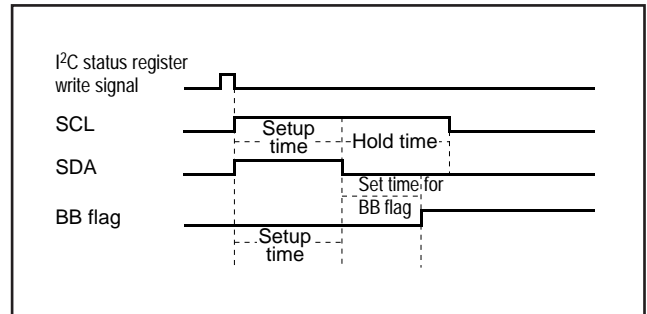


Fig. 12.6.9 START Condition Generation Timing Diagram

12.6.7 STOP Condition Generation Method

When the ESO bit of the I²C control register (address 00F9₁₆) is "1," execute a write instruction to the I²C status register (address 00F8₁₆) for setting the MST bit and the TRX bit to "1" and the BB bit to "0". A STOP condition will then be generated. The STOP condition generation timing and the BB flag reset timing are different in the standard clock mode and the high-speed clock mode. Refer to Figure 12.6.10 for the STOP condition generation timing diagram, and Table 12.6.2 for the START condition/STOP condition generation timing table.

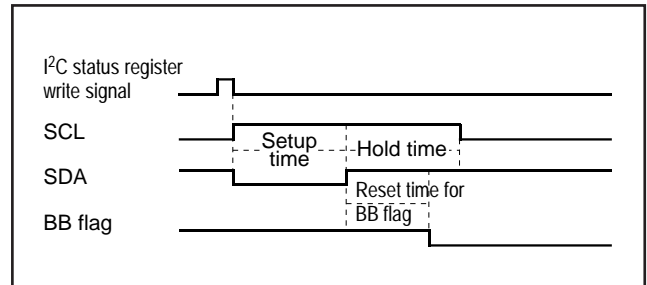


Fig. 12.6.10 STOP Condition Generation Timing Diagram

Table 12.6.2 START Condition/STOP Condition Generation Timing Table

| Item | Standard Clock Mode | High-speed Clock Mode |
|----------------------------|--------------------------|-------------------------|
| Setup time | 4.25 μ s (17 cycles) | 1.75 μ s (7 cycles) |
| Hold time | 5.0 μ s (20 cycles) | 2.5 μ s (10 cycles) |
| Set/reset time for BB flag | 3.0 μ s (12 cycles) | 1.5 μ s (6 cycles) |

Note: Absolute time at $\phi = 4$ MHz. The value in parentheses denotes the number of ϕ cycles.

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12.6.8 START/STOP Condition Detect Conditions

The START/STOP condition detect conditions are shown in Figure 12.6.11 and Table 12.6.3. Only when the 3 conditions of Table 12.6.3 are satisfied, a START/STOP condition can be detected.

Note: When a STOP condition is detected in the slave mode (MST = 0), an interrupt request signal "IICIRQ" is generated to the CPU.

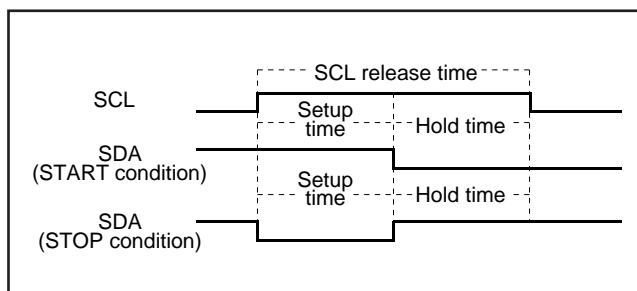


Fig. 12.6.11 START Condition/STOP Condition Detect Timing Diagram

Table 12.6.3 START Condition/STOP Condition Detect Conditions

| Standard Clock Mode | High-speed Clock Mode |
|--|---|
| 6.5 μ s (26 cycles) < SCL release time | 1.0 μ s (4 cycles) < SCL release time |
| 3.25 μ s (13 cycles) < Setup time | 0.5 μ s (2 cycles) < Setup time |
| 3.25 μ s (13 cycles) < Hold time | 0.5 μ s (2 cycles) < Hold time |

Note: Absolute time at $\phi = 4$ MHz. The value in parentheses denotes the number of ϕ cycles.

12.6.9 Address Data Communication

There are two address data communication formats, namely, 7-bit addressing format and 10-bit addressing format. The respective address communication formats is described below.

(1) 7-bit Addressing Format

To meet the 7-bit addressing format, set the 10BIT SAD bit of the I²C control register (address 00F9₁₆) to "0." The first 7-bit address data transmitted from the master is compared with the high-order 7-bit slave address stored in the I²C address register (address 00F7₁₆). At the time of this comparison, address comparison of the RBW bit of the I²C address register (address 00F7₁₆) is not made. For the data transmission format when the 7-bit addressing format is selected, refer to Figure 12.6.12, (1) and (2).

(2) 10-bit Addressing Format

To meet the 10-bit addressing format, set the 10BIT SAD bit of the I²C control register (address 00F9₁₆) to "1." An address comparison is made between the first-byte address data transmitted from the master and the 7-bit slave address stored in the I²C address register (address 00F7₁₆). At the time of this comparison, an address comparison between the RBW bit of the I²C address register (address 00F7₁₆) and the R/W bit which is the last bit of the address data transmitted from the master is made. In the 10-bit addressing mode, the R/W bit which is the last bit of the address data not only specifies the direction of communication for control data but also is processed as an address data bit.

When the first-byte address data matches the slave address, the AAS bit of the I²C status register (address 00F8₁₆) is set to "1." After the second-byte address data is stored into the I²C data shift register (address 00F6₁₆), make an address comparison between the second-byte data and the slave address by software. When the address data of the 2nd bytes matches the slave address, set the RBW bit of the I²C address register (address 00F7₁₆) to "1" by software. This processing can match the 7-bit slave address and R/W data, which are received after a RESTART condition is detected, with the value of the I²C address register (address 00F7₁₆). For the data transmission format when the 10-bit addressing format is selected, refer to Figure 12.6.12, (3) and (4).

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12.6.10 Example of Master Transmission

An example of master transmission in the standard clock mode, at the SCL frequency of 100 kHz and in the ACK return mode is shown below.

- ① Set a slave address in the high-order 7 bits of the I²C address register (address 00F7₁₆) and "0" in the RBW bit.
- ② Set the ACK return mode and SCL = 100 kHz by setting "85₁₆" in the I²C clock control register (address 00FA₁₆).
- ③ Set "10₁₆" in the I²C status register (address 00F8₁₆) and hold the SCL at the HIGH.
- ④ Set a communication enable status by setting "48₁₆" in the I²C control register (address 00F9₁₆).
- ⑤ Set the address data of the destination of transmission in the high-order 7 bits of the I²C data shift register (address 00F6₁₆) and set "0" in the least significant bit.
- ⑥ Set "F0₁₆" in the I²C status register (address 00F8₁₆) to generate a START condition. At this time, an SCL for 1 byte and an ACK clock automatically occurs.
- ⑦ Set transmit data in the I²C data shift register (address 00F6₁₆). At this time, an SCL and an ACK clock automatically occurs.
- ⑧ When transmitting control data of more than 1 byte, repeat step ⑦.
- ⑨ Set "D0₁₆" in the I²C status register (address 00F8₁₆). After this, if ACK is not returned or transmission ends, a STOP condition will be generated.

12.6.11 Example of Slave Reception

An example of slave reception in the high-speed clock mode, at the SCL frequency of 400 kHz, in the ACK non-return mode, using the addressing format, is shown below.

- ① Set a slave address in the high-order 7 bits of the I²C address register (address 00F7₁₆) and "0" in the RBW bit.
- ② Set the no ACK clock mode and SCL = 400 kHz by setting "25₁₆" in the I²C clock control register (address 00FA₁₆).
- ③ Set "10₁₆" in the I²C status register (address 00F8₁₆) and hold the SCL at the HIGH.
- ④ Set a communication enable status by setting "48₁₆" in the I²C control register (address 00F9₁₆).
- ⑤ When a START condition is received, an address comparison is made.
- ⑥ •When all transmitted address are "0" (general call):
AD0 of the I²C status register (address 00F8₁₆) is set to "1" and an interrupt request signal occurs.
•When the transmitted addresses match the address set in ①:
ASS of the I²C status register (address 00F8₁₆) is set to "1" and an interrupt request signal occurs.
•In the cases other than the above:
AD0 and AAS of the I²C status register (address 00F8₁₆) are set to "0" and no interrupt request signal occurs.
- ⑦ Set dummy data in the I²C data shift register (address 00F6₁₆).
- ⑧ When receiving control data of more than 1 byte, repeat step ⑦.
- ⑨ When a STOP condition is detected, the communication ends.

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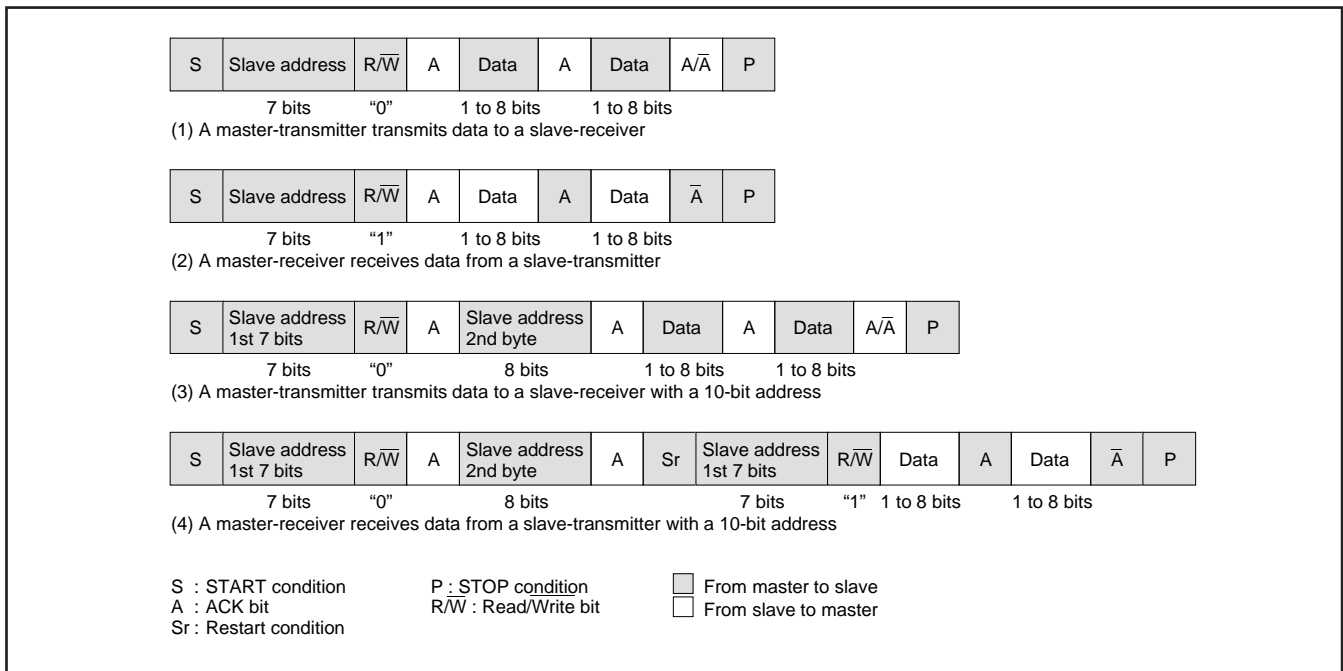


Fig. 12.6.12 Address Data Communication Format

12.6.12 Precautions when using multi-master I²C-BUS interface

(1) Read-modify-write instruction

The precautions when the read-modify-write instruction such as SEB, CLB etc. is executed for each register of the multi-master I²C-BUS interface are described below.

•I²C data shift register (S0)

When executing the read-modify-write instruction for this register during transfer, data may become a value not intended.

•I²C address register (S0D)

When the read-modify-write instruction is executed for this register at detecting the STOP condition, data may become a value not intended. It is because hardware changes the read/write bit (R/W) at the above timing.

•I²C status register (S1)

Do not execute the read-modify-write instruction for this register because all bits of this register are changed by hardware.

•I²C control register (S1D)

When the read-modify-write instruction is executed for this register at detecting the START condition or at completing the byte transfer, data may become a value not intended. Because hardware changes the bit counter (BC0-BC2) at the above timing.

•I²C clock control register (S2)

The read-modify-write instruction can be executed for this register.

(2) START condition generating procedure using multi-master

① Procedure example (The necessary conditions of the generating procedure are described as the following ② to ⑤).

```

•
•
LDA      —          (Taking out of slave address value)
SEI                      (Interrupt disabled)
BBS  5,S1,BUSBUSY  (BB flag confirming and branch process)
BUSFREE:
STA  S0          (Writing of slave address value)
LDM  #$F0, S1    (Trigger of START condition generating)
CLI                      (Interrupt enabled)

```

```

•
•
BUSBUSY:
CLI                      (Interrupt enabled)

```

② Use "STA," "STX" or "STY" of the zero page addressing instruction for writing the slave address value to the I²C data shift register.

③ Use "LDM" instruction for setting trigger of START condition generating.

④ Write the slave address value of above ② and set trigger of START condition generating of above ③ continuously shown the above procedure example.

⑤ Disable interrupts during the following three process steps:

- BB flag confirming
- Writing of slave address value
- Trigger of START condition generating

When the condition of the BB flag is bus busy, enable interrupts immediately.

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(3) RESTART condition generating procedure

① Procedure example (The necessary conditions of the generating procedure are described as the following ② to ⑥.)

Execute the following procedure when the PIN bit is "0."

```

      •
      •
LDM  #$00, S1    (Select slave receive mode)
LDA   —          (Taking out of slave address value)
SEI                   (Interrupt disabled)
STA   S0          (Writing of slave address value)
LDM  #$F0, S1    (Trigger of RESTART condition generating)
CLI                   (Interrupt enabled)
      •
      •
  
```

② Select the slave receive mode when the PIN bit is "0." Do not write "1" to the PIN bit. Neither "0" nor "1" is specified for the writing to the BB bit.

The TRX bit becomes "0" and the SDA pin is released.

③ The SCL pin is released by writing the slave address value to the I²C data shift register. Use "STA," "STX" or "STY" of the zero page addressing instruction for writing.

④ Use "LDM" instruction for setting trigger of RESTART condition generating.

⑤ Write the slave address value of above ③ and set trigger of RESTART condition generating of above ④ continuously shown the above procedure example.

⑥ Disable interrupts during the following two process steps:

- Writing of slave address value
- Trigger of RESTART condition generating

(4) STOP condition generating procedure

① Procedure example (The necessary conditions of the generating procedure are described as the following ② to ④.)

```

      •
      •
SEI                   (Interrupt disabled)
LDM  #$C0, S1        (Select master transmit mode)
NOP                   (Set NOP)
LDM  #$D0, S1        (Trigger of STOP condition generating)
CLI                   (Interrupt enabled)
      •
      •
  
```

② Write "0" to the PIN bit when master transmit mode is select.

③ Execute "NOP" instruction after setting of master transmit mode. Also, set trigger of STOP condition generating within 10 cycles after selecting of master transmit mode.

④ Disable interrupts during the following two process steps:

- Select of master transmit mode
- Trigger of STOP condition generating

(5) Writing to I²C status register

Do not execute an instruction to set the PIN bit to "1" from "0" and an instruction to set the MST and TRX bits to "0" from "1" simultaneously. It is because it may enter the state that the SCL pin is released and the SDA pin is released after about one machine cycle. Do not execute an instruction to set the MST and TRX bits to "0" from "1" simultaneously when the PIN bit is "1." It is because it may become the same as above.

(6) Process of after STOP condition generating

Do not write data in the I²C data shift register S0 and the I²C status register S1 until the bus busy flag BB becomes "0" after generating the STOP condition in the master mode. It is because the STOP condition waveform might not be normally generated. Reading to the above registers do not have the problem.

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12.7 PWM OUTPUT CIRCUIT

This microcomputer is equipped with eight 8-bit PWMs (PWM0–PWM7). PWM0–PWM7 have the same circuit structure and an 8-bit resolution with minimum resolution bit width of 4 μ s and repeat period of 1024 μ s (for $f(X_{IN}) = 8$ MHz) .

Figure 12.7.1 shows the PWM block diagram. The PWM timing generating circuit applies individual control signals to PWM0–PWM7 using $f(X_{IN})$ divided by 2 as a reference signal.

12.7.1 Data Setting

When outputting PWM0–PWM7, set 8-bit output data to the PWMi register (i means 0 to 7; addresses 0200₁₆ to 0207₁₆).

12.7.2 Transmitting Data from Register to PWM circuit

Data transfer from the PWM register to the PWM circuit is executed at writing data to the register.

The signal output from the PWM output pin corresponds to the contents of this register.

12.7.3 PWM Operation

The following explains PWM operation.

First, set the bit 0 of PWM mode register 1 (address 020A₁₆) to "0" (at reset, bit 0 is already set to "0" automatically), so that the PWM count source is supplied.

PWM0–PWM3 are also used as pins P04–P07, PWM4–PWM6 are also used as pins P00–P02, and PWM7 is also used as pin P50 and P03 respectively. Set the corresponding bits of the port P0 direction register to "1" (output mode). And select each output polarity by bit 3 of PWM mode register 1 (address 020A₁₆). Then, set bits 7 to 0 of PWM mode register 2 to "1" (PWM output).

The PWM waveform is output from the PWM output pins by setting these registers.

Figure 12.7.2 shows the PWM timing. One cycle (T) is composed of 256 (2^8) segments. The 8 kinds of pulses, relative to the weight of each bit (bits 0 to 7), are output inside the circuit during 1 cycle. Refer to Figure 12.7.2 (a). The PWM outputs waveform which is the logical sum (OR) of pulses corresponding to the contents of bits 0 to 7 of the PWM register. Several examples are shown in Figure 12.7.2 (b). 256 kinds of output (HIGH area: 0/256 to 255/256) are selected by changing the contents of the PWM register. A length of entirely HIGH cannot be output, i.e. 256/256.

12.7.4 Output after Reset

At reset, the output of port P0 is in the high-impedance state, port P50 outputs Low, and the contents of the PWM register and the PWM circuit are undefined. Note that after reset, the PWM output is undefined until setting the PWM register.

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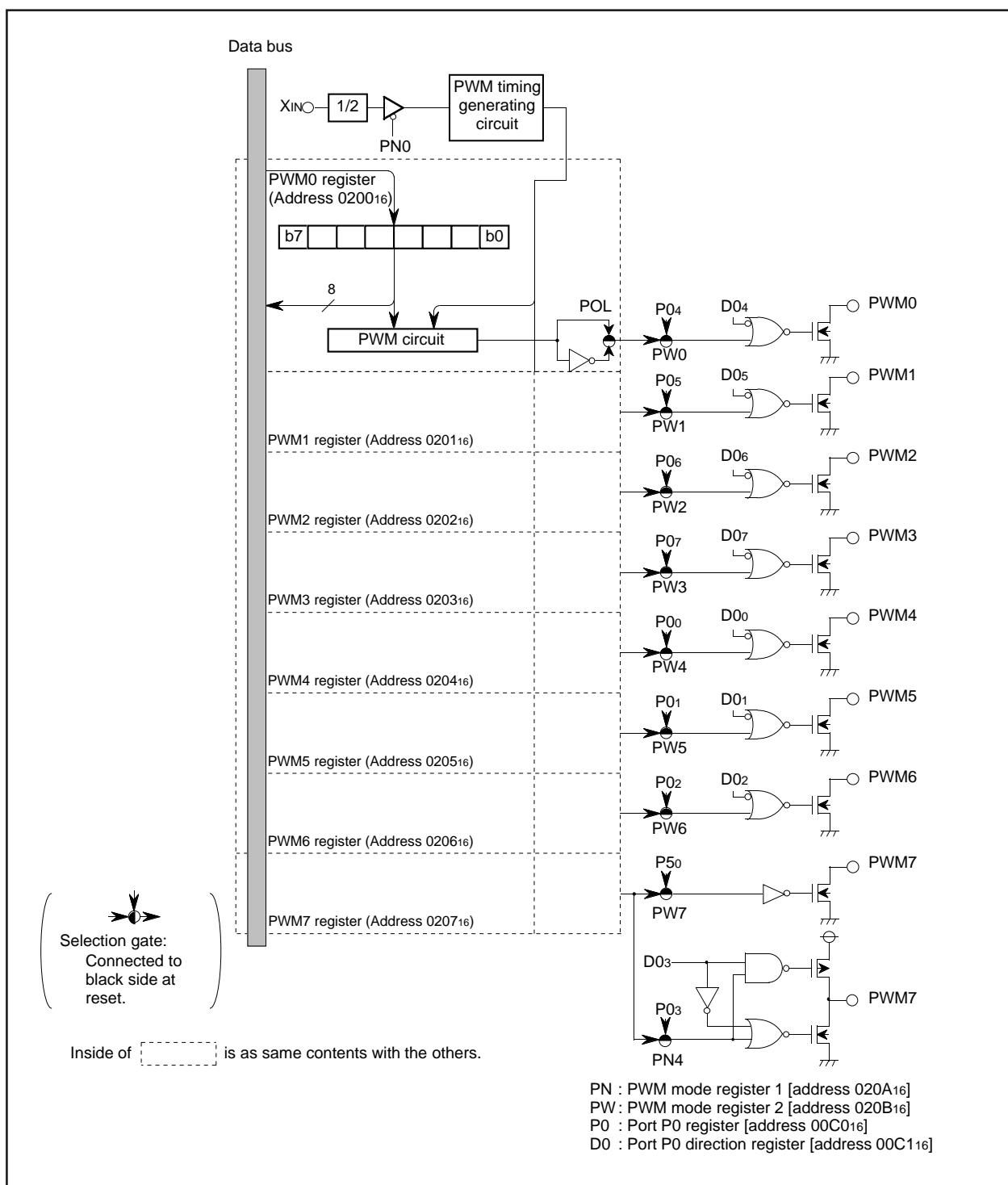


Fig. 12.7.1 PWM Block Diagram

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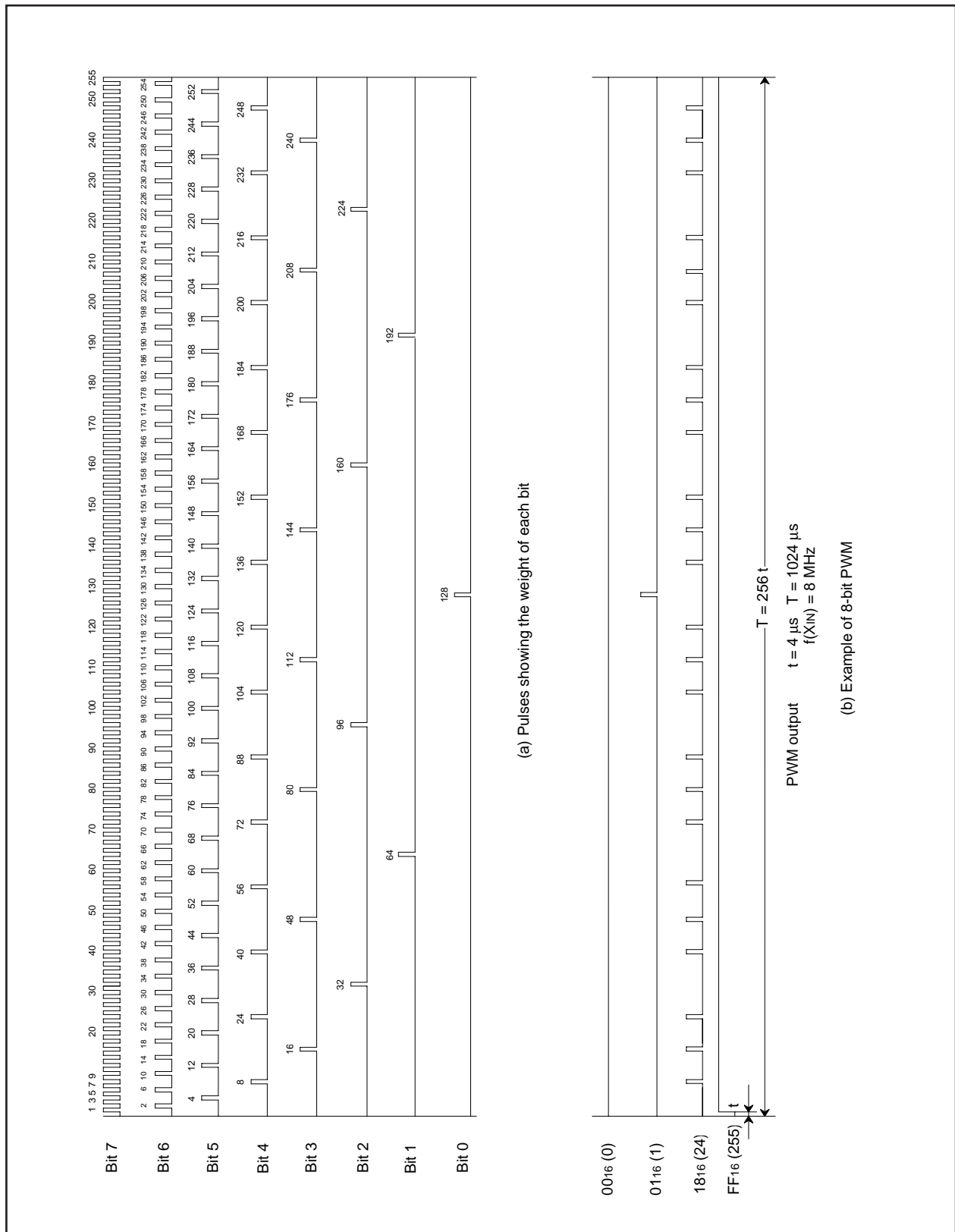


Fig. 12.7.2 PWM Timing

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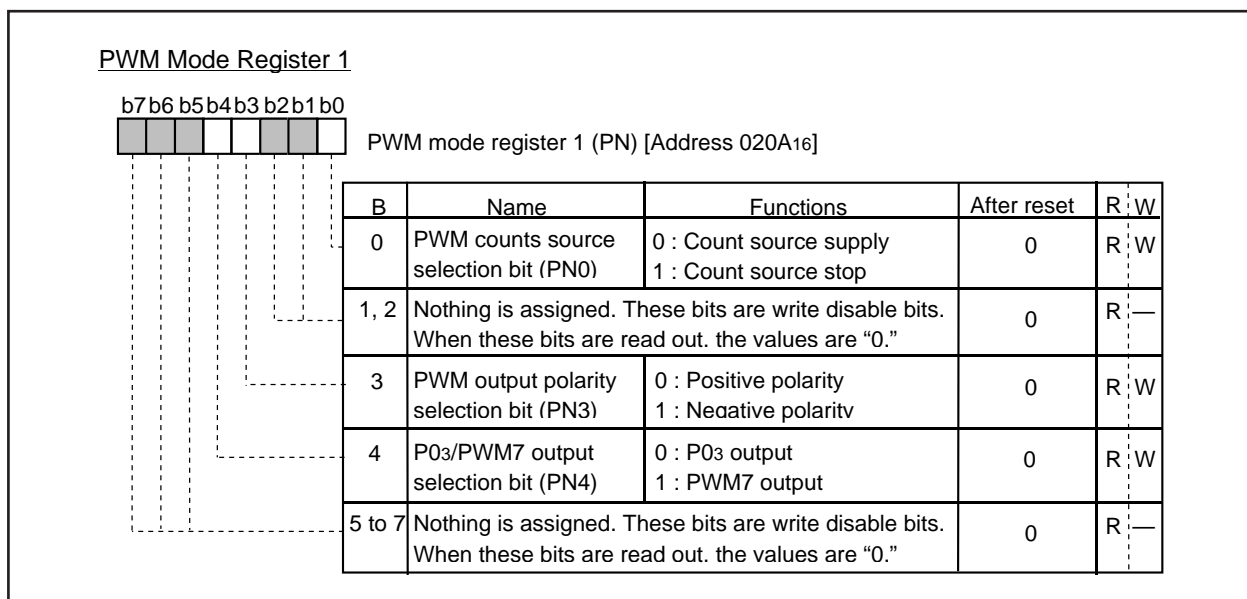


Fig. 12.7.3 PWM Mode Register 1

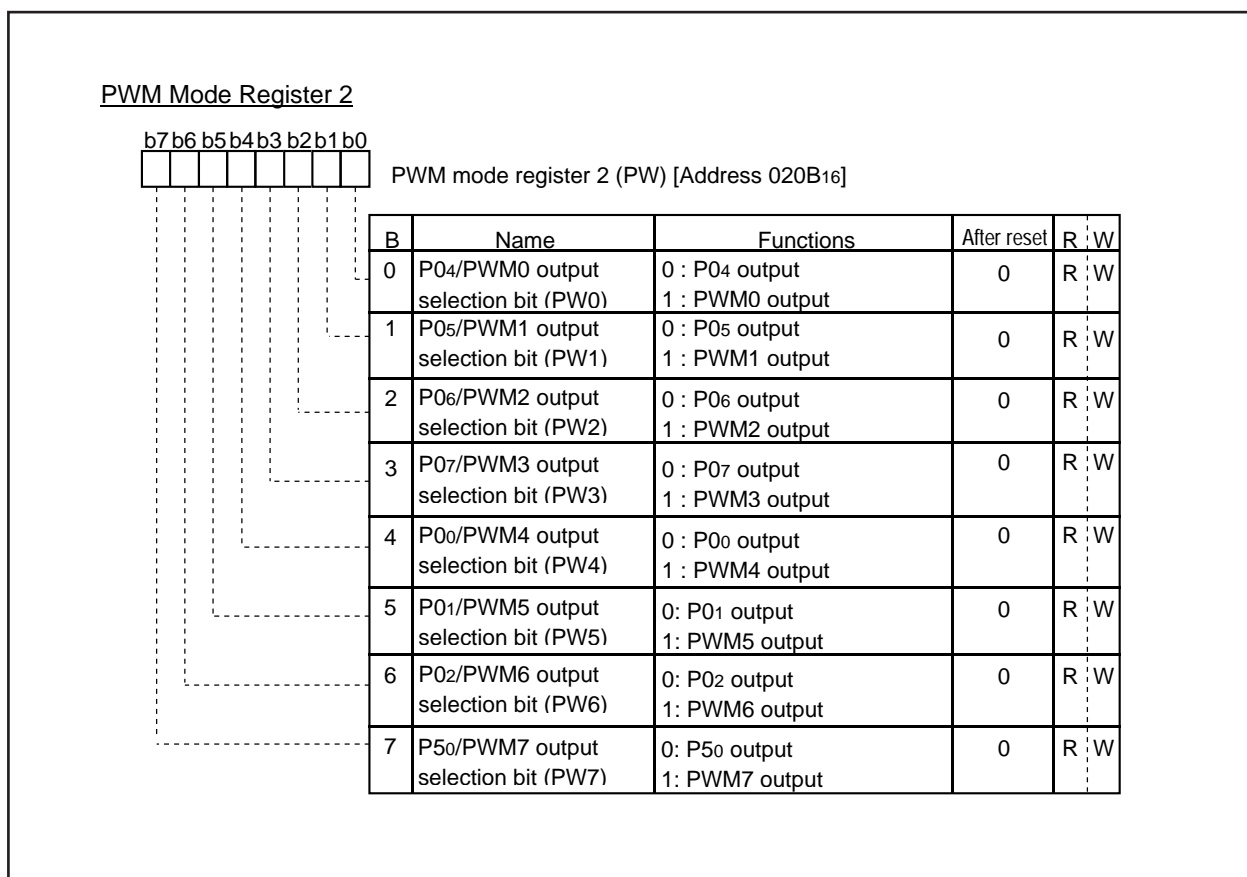


Fig. 12.7.4 PWM Mode Register 2

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12.8 A-D CONVERTER

12.8.1 A-D Conversion Register (AD)

A-D conversion register is a read-only register that stores the result of an A-D conversion. This register should not be read during A-D conversion.

12.8.2 A-D Control Register (ADCON)

The A-D control register controls A-D conversion. Bits 2 to 0 of this register select analog input pins. When these pins are not used as analog input pins, they are used as ordinary I/O pins. Bit 3 is the A-D conversion completion bit, A-D conversion is started by writing "0" to this bit. The value of this bit remains at "0" during an A-D conversion, then changes to "1" when the A-D conversion is completed. Bit 4 controls connection between the resistor ladder and Vcc. When not using the A-D converter, the resistor ladder can be cut off from the internal Vcc by setting this bit to "0," accordingly providing low-power dissipation.

12.8.3 Comparison Voltage Generator (Resistor Ladder)

The voltage generator divides the voltage between Vss and Vcc by 256, and outputs the divided voltages to the comparator as the reference voltage Vref.

12.8.4 Channel Selector

The channel selector connects an analog input pin, selected by bits 2 to 0 of the A-D control register, to the comparator.

12.8.5 Comparator and Control Circuit

The conversion result of the analog input voltage and the reference voltage "Vref" is stored in the A-D conversion register. The A-D conversion completion bit and A-D conversion interrupt request bit are set to "1" at the completion of A-D conversion.

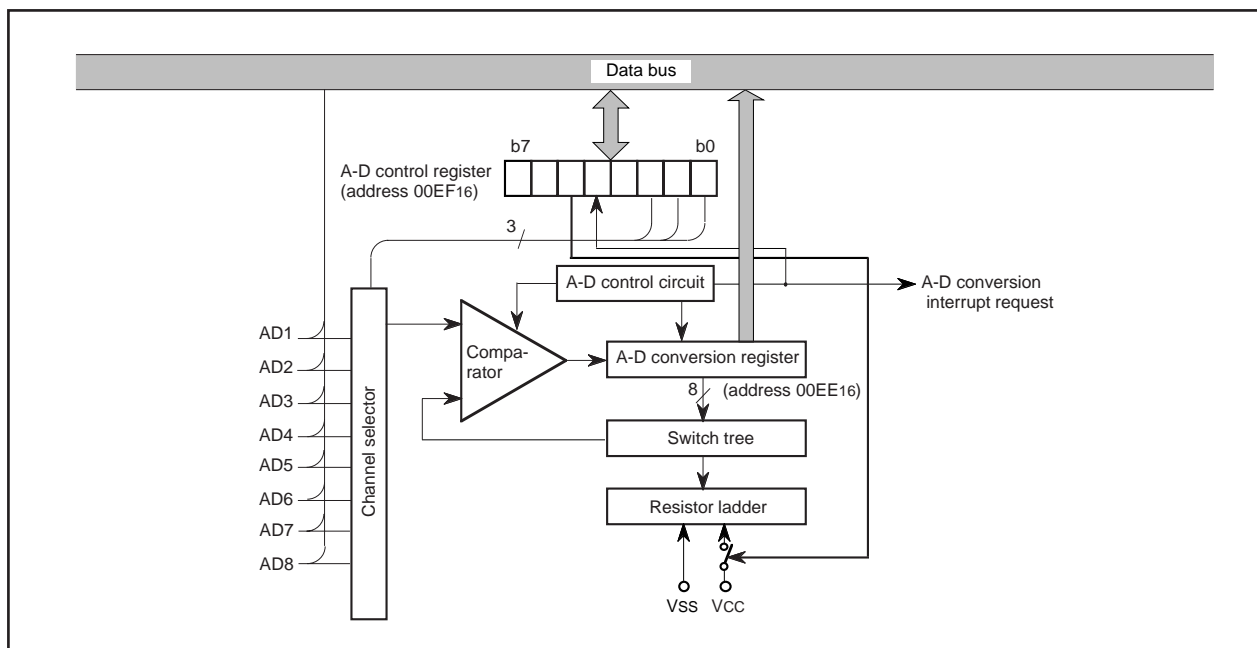
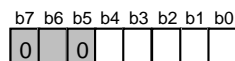


Fig. 12.8.1 A-D Comparator Block Diagram

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A-D Control Register



A-D control register (ADCON) [Address 00EF₁₆]

| B | Name | Functions | After reset | R | W |
|--------|--|--|---------------|---|---|
| 0 to 2 | Analog input pin selection to bits (ADIN0 to ADIN2) | b2 b1 b0 0 0 0 : AD1 0 0 1 : AD2 0 1 0 : AD3 0 1 1 : AD4 1 0 0 : AD5 1 0 1 : AD6 1 1 0 : AD7 1 1 1 : AD8 | 0 | R | W |
| 3 | A-D conversion completion bit (ADSTR) | 0: Conversion in progress 1: Conversion completed | 1 | R | W |
| 4 | Vcc connection selection bit (ADVREF) | 0: OFF 1: ON | 0 | R | W |
| 5 | Fix this bit to "0." | | 0 | R | W |
| 6 | Nothing is assigned. This bit is a write disable bit. When this bit is read out, the value is indeterminate. | | Indeterminate | R | — |
| 7 | Fix this bit to "0." | | 0 | R | W |

Fig. 12.8.2 A-D Control Register

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12.8.6 Conversion Method

- ① Set bit 7 of the interrupt input polarity register (address 021216) to "1" to generate an interrupt request at completion of A-D conversion.
- ② Set the A-D conversion · INT3 interrupt request bit to "0" (even when A-D conversion is started, the A-D conversion · INT3 interrupt request bit is not set to "0" automatically).
- ③ When using A-D conversion interrupt, enable interrupts by setting A-D conversion · INT3 interrupt request bit to "1" and setting the interrupt disable flag to "0."
- ④ Set the Vcc connection selection bit to "1" to connect Vcc to the resistor ladder.
- ⑤ Select analog input pins by the analog input selection bit of the A-D control register.
- ⑥ Set the A-D conversion completion bit to "0." This write operation starts the A-D conversion. Do not read the A-D conversion register during the A-D conversion.
- ⑦ Verify the completion of the conversion by the state ("1") of the A-D conversion completion bit, the state ("1") of A-D conversion · INT3 interrupt request bit, or the occurrence of an A-D conversion interrupt.
- ⑧ Read the A-D conversion register to obtain the conversion results.

Note : When the ladder resistor is disconnect from Vcc, set the Vcc connection selection bit to "0" between steps ⑦ and ⑧.

12.8.7 Internal Operation

When the A-D conversion starts, the following operations are automatically performed.

- ① The A-D conversion register is set to "0016."
- ② The most significant bit of the A-D conversion register becomes "1," and the comparison voltage "Vref" is input to the comparator. At this point, Vref is compared with the analog input voltage "VIN."
- ③ Bit 7 is determined by the comparison results as follows.
 When $V_{ref} < V_{IN}$: bit 7 holds "1"
 When $V_{ref} > V_{IN}$: bit 7 becomes "0"

With the above operations, the analog value is converted into a digital value. The A-D conversion terminates in a maximum of 50 machine cycles ($12.5 \mu s$ at $f(XIN) = 8 \text{ MHz}$) after it starts, and the conversion result is stored in the A-D conversion register.

An A-D conversion interrupt request occurs at the same time as A-D conversion completion, the A-D conversion · INT3 interrupt request bit becomes "1." The A-D conversion completion bit also becomes "1."

Table 12.8.1 Expression for Vref and VREF

| A-D conversion register contents "n" (decimal notation) | Vref (V) |
|--|---|
| 0 | 0 |
| 1 to 255 | $\frac{V_{REF}}{256} \sim (n \mid 0.5)$ |

Note: VREF indicates the reference voltage (= Vcc).

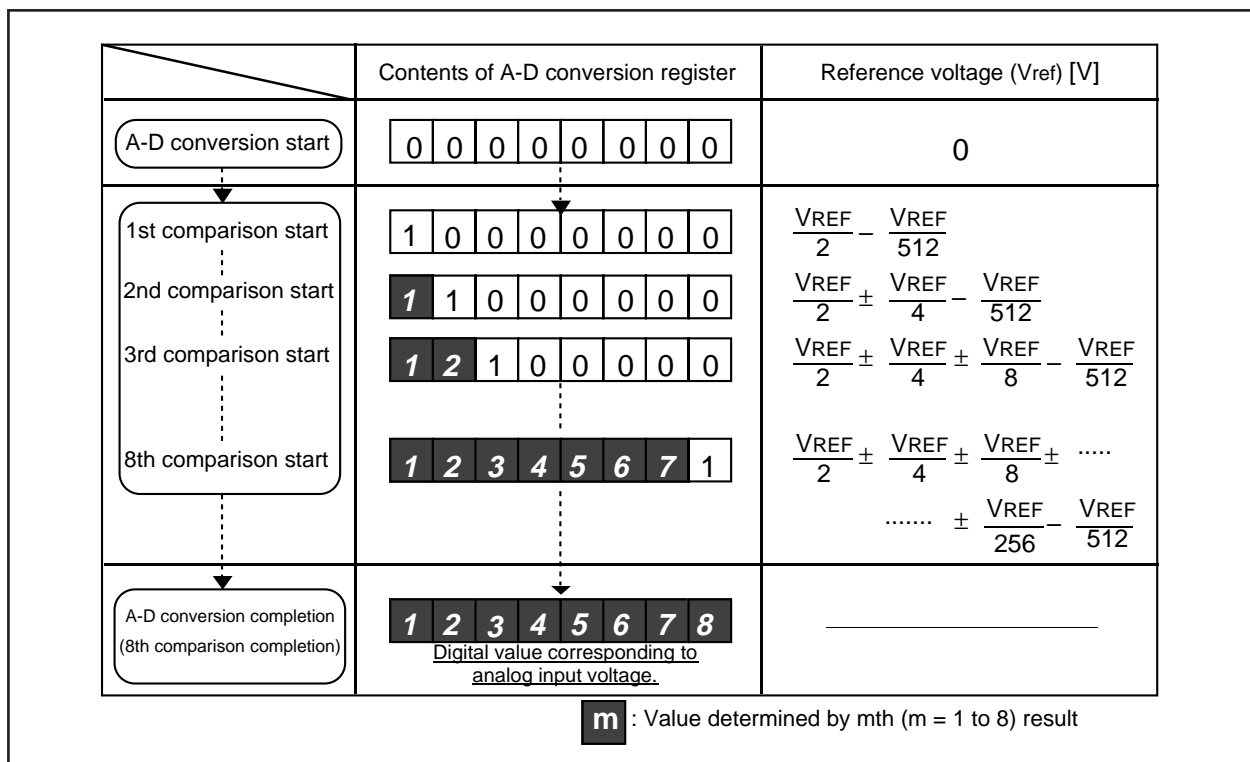


Fig. 12.8.3 Changes in A-D Conversion Register and Comparison Voltage during A-D Conversion

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12.8.8 Definition of A-D Conversion Accuracy

The definition of A-D conversion accuracy is described below (refer to Figure 12.8.4).

(1) Relative Accuracy

• Zero transition error (V_{0T})

The deviation of the input voltage at which A-D conversion output data changes from "0" to "1," from the corresponding ideal A-D conversion characteristics between 0 and V_{REF}.

$$V_{0T} = \frac{(V_0 - 1/2 \times V_{REF}/256)}{1\text{LSB}} \quad [\text{LSB}]$$

• Full-scale transition error (V_{FST})

The deviation of the input voltage at which A-D conversion output data changes from "255" to "254," from the corresponding ideal A-D conversion characteristics between 0 and V_{REF}.

$$V_{FST} = \frac{(V_{REF} - 3/2 \times V_{REF}/256) - V_{254}}{1\text{LSB}} \quad [\text{LSB}]$$

• Non-linearity error

The deviation of the actual A-D conversion characteristics, from the ideal A-D conversion characteristics between V₀ and V₂₅₄.

$$\text{Non-linearity error} = \frac{V_n - (1\text{LSB} \times n + V_0)}{1\text{LSB}} \quad [\text{LSB}]$$

• Differential non-linearity error

The deviation of the input voltage required to change output data by "1," from the corresponding ideal A-D conversion characteristics between 0 and V_{REF}.

$$\text{Differential non-linearity error} = \frac{(V_{n+1} - V_n) - 1\text{LSB}}{1\text{LSB}} [\text{LSB}]$$

(2) Absolute Accuracy

• Absolute accuracy error

The deviation of the actual A-D conversion characteristics, from the ideal A-D conversion characteristics between 0 and V_{REF}.

$$\text{Absolute accuracy error} = \frac{V_n - 1\text{LSBA} \times (n + 1/2)}{1\text{LSBA}} \quad [\text{LSB}]$$

Note: The analog input voltage "V_n" at which A-D conversion output data changes from "n" to "n + 1" (n : 0 to 254) is as follows (refer to Figure 12.8.4) :

$$1\text{LSB with respect to relative accuracy} = \frac{V_{254} - V_0}{254} \quad [\text{V}]$$

$$1\text{LSBA with respect to absolute accuracy} = \frac{V_{REF}}{256} \quad [\text{V}]$$

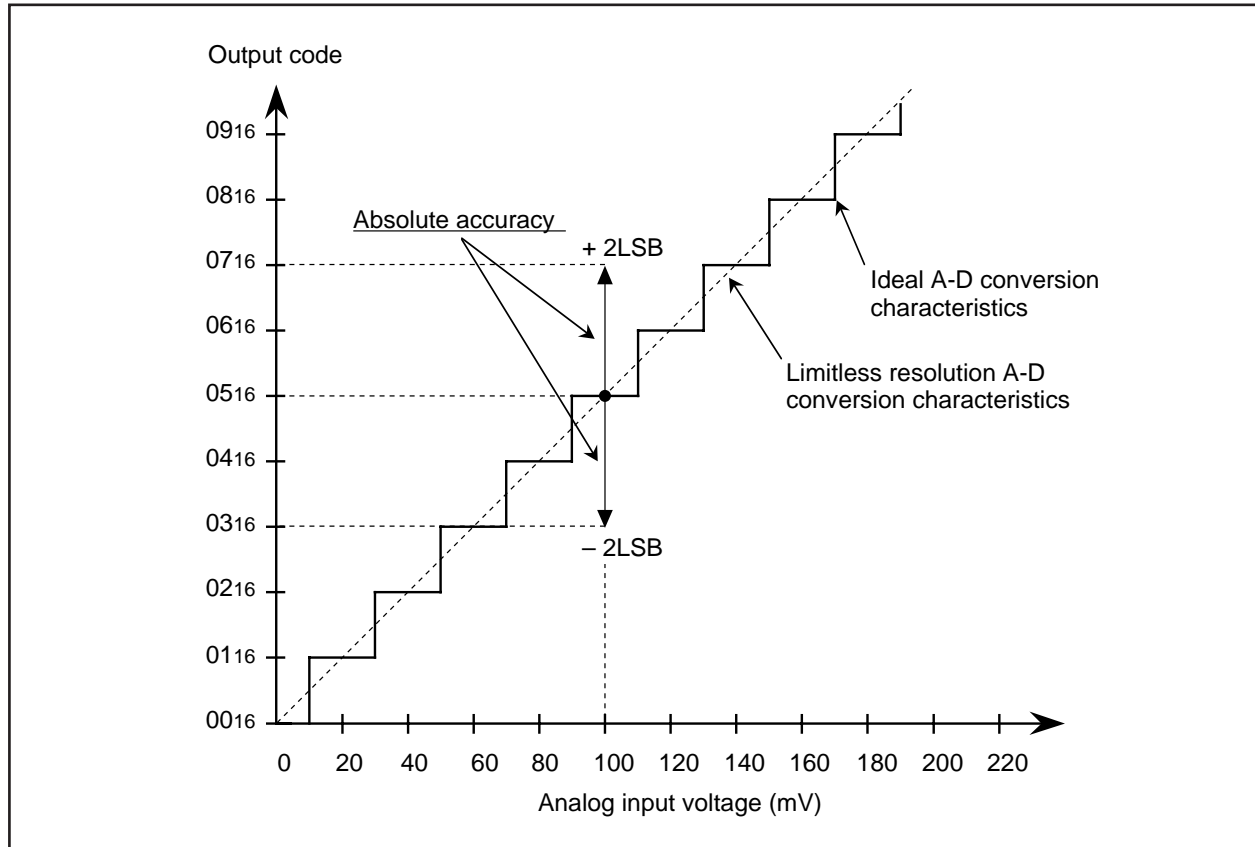


Fig. 12.8.4 Definition of A-D Conversion Accuracy

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12.9 ROM CORRECTION FUNCTION

This can correct program data in ROM. Up to 2 addresses (2 blocks) can be corrected, a program for correction is stored in the ROM correction memory in RAM. The ROM memory for correction is 32 bytes \times 2 blocks.

Block 1 : addresses 02C0₁₆ to 02DF₁₆

Block 2 : addresses 02E0₁₆ to 02FF₁₆

Set the address of the ROM data to be corrected into the ROM correction address register. When the value of the counter matches the ROM data address in the ROM correction address, the main program branches to the correction program stored in the ROM memory for correction. To return from the correction program to the main program, the op code and operand of the JMP instruction (total of 3 bytes) are necessary at the end of the correction program. When the blocks 1 and 2 are used in series, the above instruction is not needed at the end of the block 1.

The ROM correction function is controlled by the ROM correction enable register.

- Notes 1:** Specify the first address (op code address) of each instruction as the ROM correction address.
2: Use the JMP instruction (total of 3 bytes) to return from the correction program to the main program.
3: Do not set the same ROM correction address to blocks 1 and 2.
4: For the M37280MK-XXXSP and M37280EKSP, when using the expansion ROM (BK7 = "1"), the ROM correction function do not operate used for addresses 1000₁₆ to 1FFF₁₆. Note that on programming.

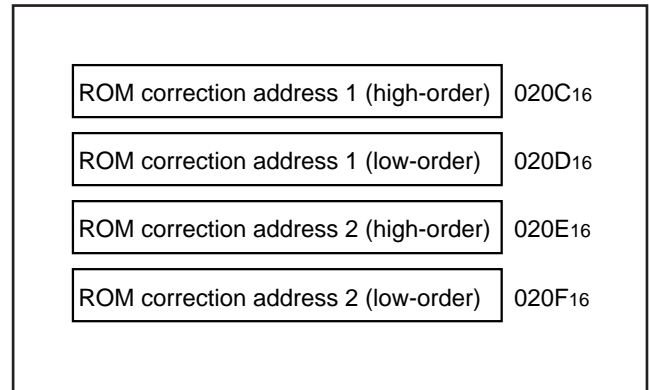
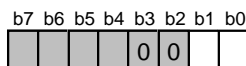


Fig. 12.9.1 ROM Correction Address Registers

ROM Correction Enable Register



ROM correction enable register (RCR) [Address 0210₁₆]

| B | Name | Functions | After reset | R | W |
|--------|---|---------------------------|-------------|---|---|
| 0 | Block 1 enable bit (RCR0) | 0: Disabled 1: Enabled | 0 | R | W |
| 1 | Block 2 enable bit (RCR1) | 0: Disabled 1: Enabled | 0 | R | W |
| 2, 3 | Fix these bits to "0." | | 0 | R | W |
| 4 to 7 | Nothing is assigned. These bits are write disable bits. When these bits are read out, the values are "0." | | 0 | R | — |

Fig. 12.9.2 ROM Correction Enable Register

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12.10 DATA SLICER

This microcomputer includes the data slicer function for the closed caption decoder (referred to as the CCD). This function takes out the caption data superimposed in the vertical blanking interval of a composite video signal. A composite video signal which makes the sync chip's polarity negative is input to the CV_{IN} pin.

When the data slicer function is not used, the data slicer circuit and the timing signal generating circuit can be cut off by setting bit 0 of the data slicer control register 1 (address 00E0₁₆) to "0." These settings can realize the low-power dissipation.

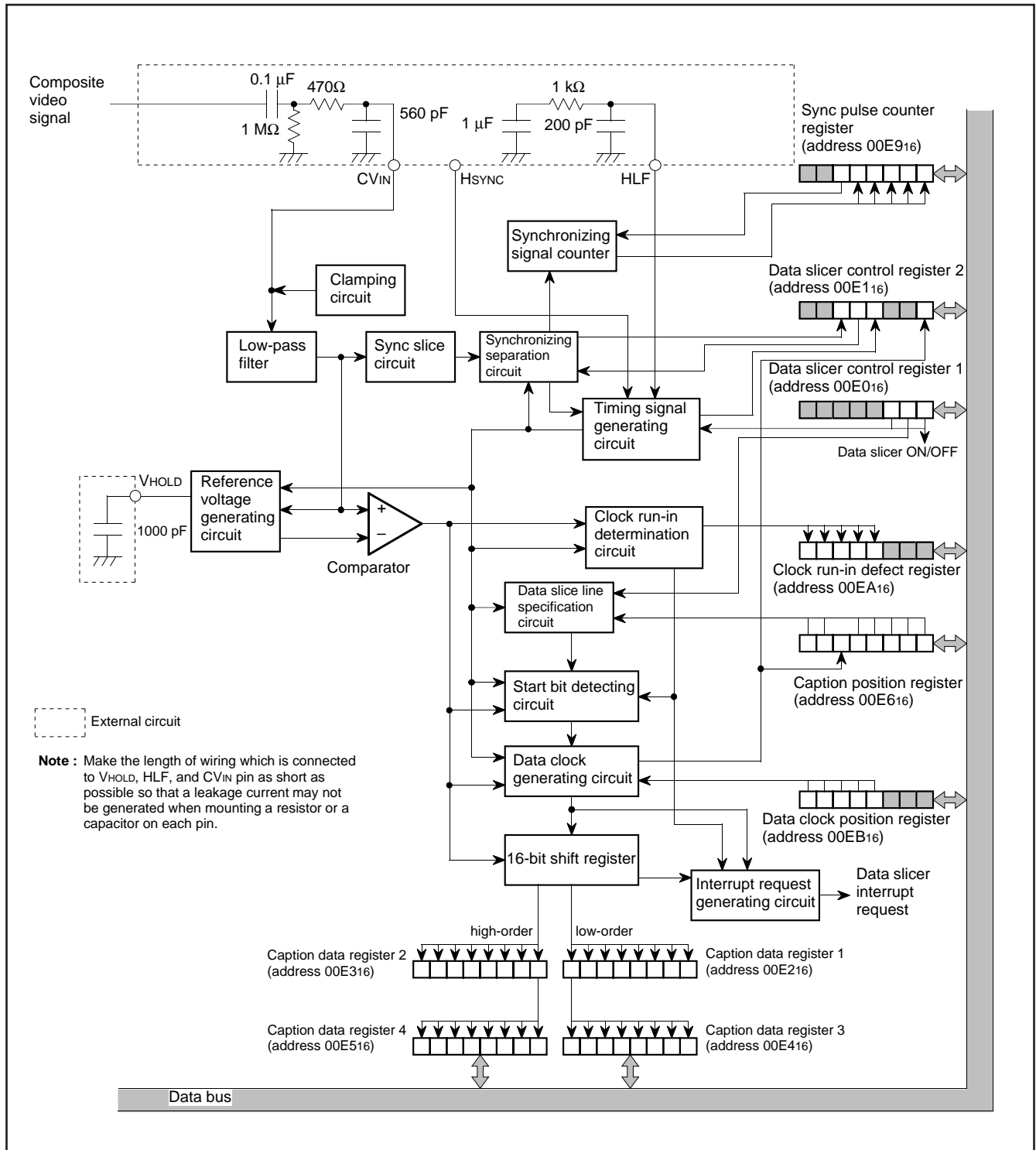


Fig. 12.10.1 Data Slicer Block Diagram

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12.10.1 Notes When not Using Data Slicer

When bit 0 of data slicer control register 1 (address 00E016) is "0,"
terminate the pins as shown in Figure 12.10.2.

<When data slicer circuit and timing signal generating circuit is in OFF state>

Apply the same voltage as VCC to
AVCC pin.

Apply HLF pin VCC or VSS level.

Apply VHOLD pin VCC or VSS level.

Pull-up CVIN pin to VCC through
a resistor of 5 kΩ or more.

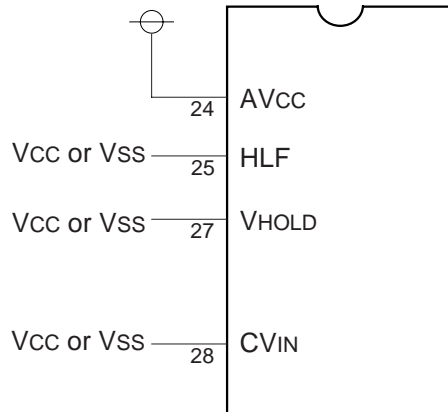


Fig. 12.10.2 Termination of Data Slicer Input/Output Pins when Data Slicer Circuit and Timing Generating Circuit Is in OFF State

When both bits 0 and 2 of data slicer control register 1 (address
00E016) are "1," terminate the pins as shown in Figure 12.10.3.

<When using a reference clock generated in timing signal generating circuit as OSD clock>

Apply the same voltage as VCC to AVCC pin.

Connect the same external circuit as when
using data slicer to HLF pin.

Leave VHOLD pin open.

Pull-up CVIN to VCC through a resistor
of 5 kΩ or more.

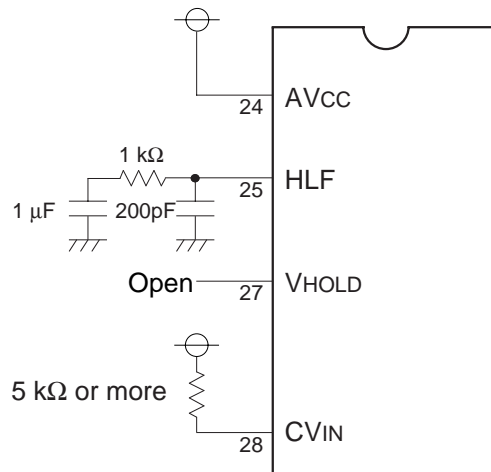


Fig. 12.10.3 Termination of Data Slicer Input/Output Pins when Timing Signal Generating Circuit Is in ON State

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Figures 12.10.4 and 12.10.5 the data slicer control registers.

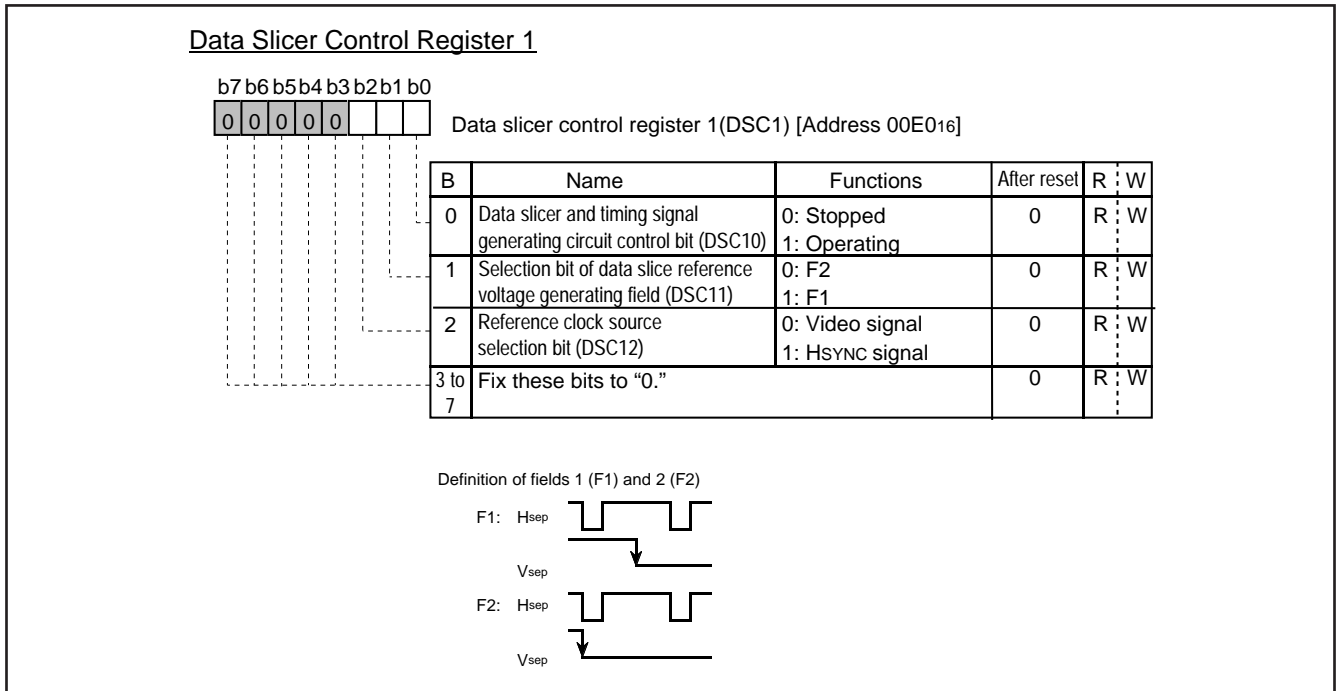


Fig. 12.10.4 Data Slicer Control Register 1

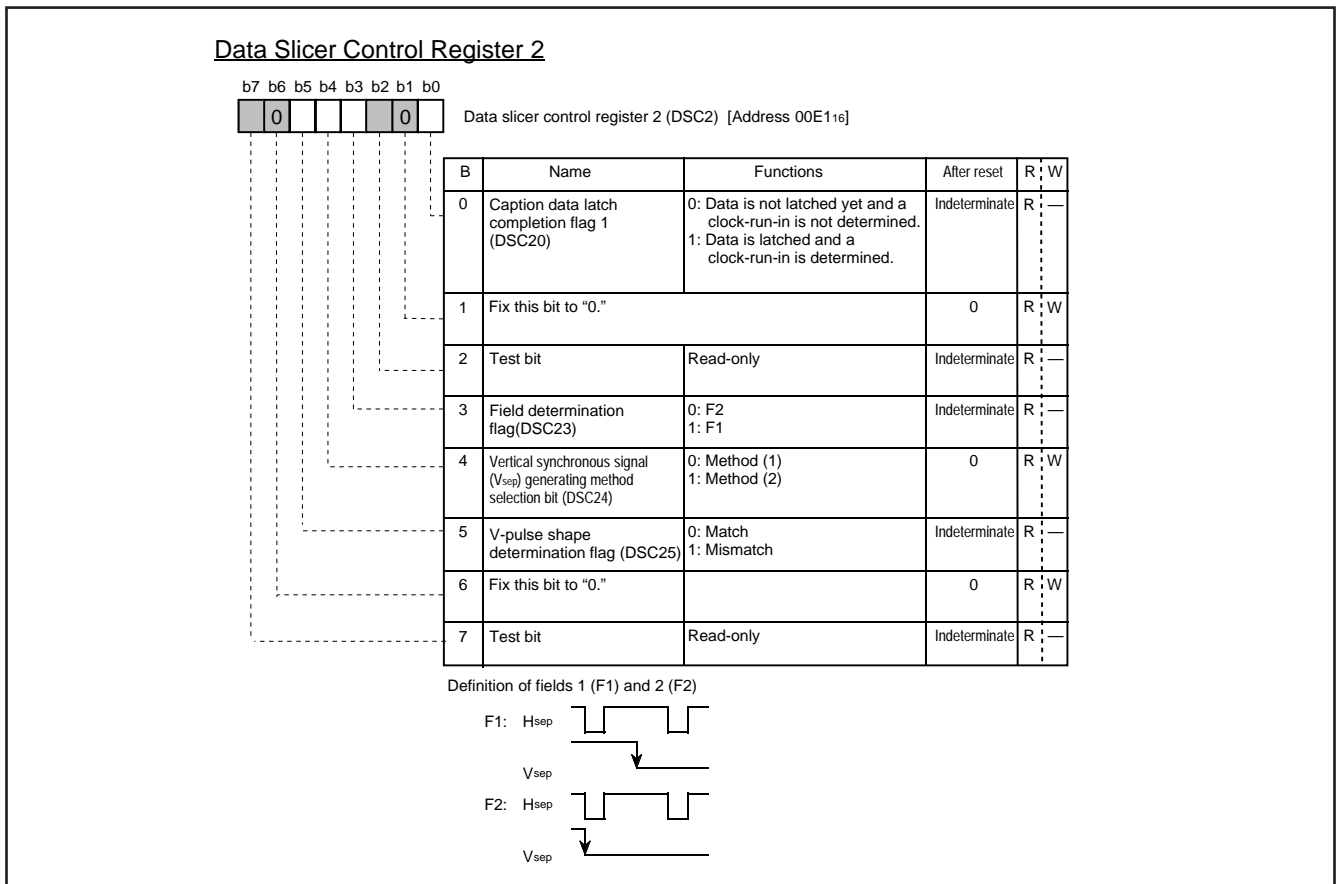


Fig. 12.10.5 Data Slicer Control Register 2

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12.10.2 Clamping Circuit and Low-pass Filter

The clamp circuit clamps the sync chip part of the composite video signal input from the CVIN pin. The low-pass filter attenuates the noise of clamped composite video signal. The CVIN pin to which composite video signal is input requires a capacitor (0.1 μ F) coupling outside. Pull down the CVIN pin with a resistor of hundreds of kilohms to 1 M Ω . In addition, we recommend to install externally a simple low-pass filter using a resistor and a capacitor at the CVIN pin (refer to Figure 12.10.1).

12.10.3 Sync Slice Circuit

This circuit takes out a composite sync signal from the output signal of the low-pass filter.

12.10.4 Synchronous Signal Separation Circuit

This circuit separates a horizontal synchronous signal and a vertical synchronous signal from the composite sync signal taken out in the sync slice circuit.

(1) Horizontal Synchronous Signal (Hsep)

A one-shot horizontal synchronizing signal Hsep is generated at the falling edge of the composite sync signal.

(2) Vertical Synchronous Signal (Vsep)

As a Vsep signal generating method, it is possible to select one of the following 2 methods by using bit 4 of the data slicer control register 2 (address 00E116).

- Method 1 The "L" level width of the composite sync signal is measured. If this width exceeds a certain time, a Vsep signal is generated in synchronization with the rising of the timing signal immediately after this "L" level.
- Method 2 The "L" level width of the composite sync signal is measured. If this width exceeds a certain time, it is detected whether a falling of the composite sync signal exits or not in the "L" level period of the timing signal immediately after this "L" level. If a falling exists, a Vsep signal is generated in synchronization with the rising of the timing signal (refer to Figure 12.10.6).

Figure 12.10.6 shows a Vsep generating timing. The timing signal shown in the figure is generated from the reference clock which the timing generating circuit outputs.

Reading bit 5 of data slicer control register 2 permits determining the shape of the V-pulse portion of the composite sync signal. As shown in Figure 12.10.7, when the A level matches the B level, this bit is "0." In the case of a mismatch, the bit is "1."

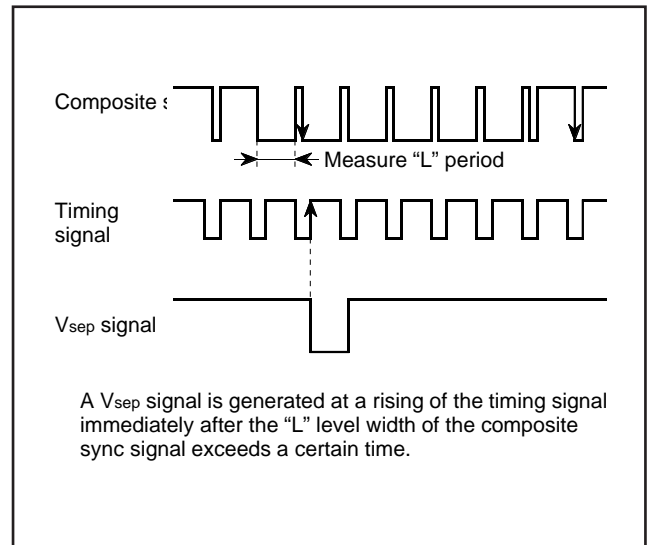


Fig. 12.10.6 Vsep Generating Timing (method 2)

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12.10.5 Timing Signal Generating Circuit

This circuit generates a reference clock which is 832 times as large as the horizontal synchronous signal frequency. It also generates various timing signals on the basis of the reference clock, horizontal synchronous signal and vertical synchronizing signal. The circuit operates by setting bit 0 of data slicer control register 1 (address 00E016) to "1."

The reference clock can be used as a display clock for OSD function in addition to the data slicer. The HSYNC signal can be used as a count source instead of the composite sync signal. However, when the HSYNC signal is selected, the data slicer cannot be used. A count source of the reference clock can be selected by bit 2 of data slicer control register 1 (address 00E016).

For the pins HLF, connect a resistor and a capacitor as shown in Figure 12.10.1. Make the length of wiring which is connected to these pins as short as possible so that a leakage current may not be generated.

Note: It takes a few tens of milliseconds until the reference clock becomes stable after the data slicer and the timing signal generating circuit are started. In this period, various timing signals, Hsep signals and Vsep signals become unstable. For this reason, take stabilization time into consideration when programming.

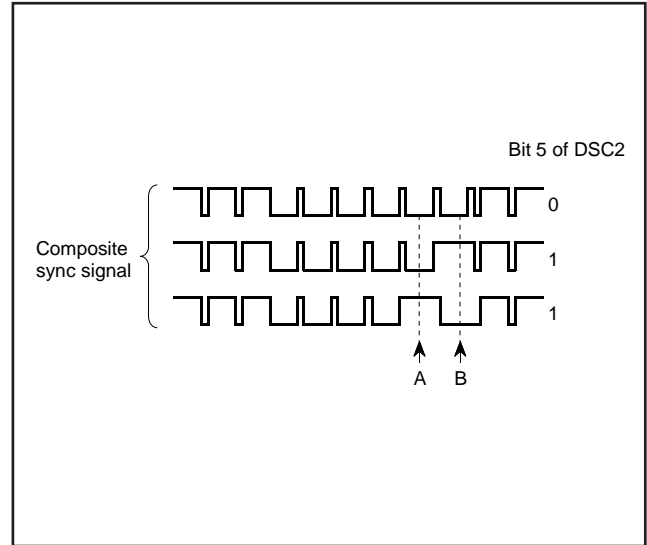


Fig. 12.10.7 Determination of V-pulse Waveform

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12.10.6 Data Slice Line Specification Circuit

(1) Specification of Data Slice Line

This circuit decides a line on which caption data is superimposed. The line 21 (fixed), 1 appropriate line for a period of 1 field (total 2 line for a period of 1 field), and both fields (F1 and F2) are sliced their data. The caption position register (address 00E616) is used for each setting (refer to Table 12.10.1).

The counter is reset at the falling edge of V_{sep} and is incremented by 1 every H_{sep} pulse. When the counter value matched the value specified by bits 4 to 0 of the caption position register, this H_{sep} is sliced.

The values of "0016" to "1F16" can be set in the caption position register (at setting only 1 appropriate line). Figure 12.10.8 shows the signals in the vertical blanking interval. Figure 12.10.9 shows the structure of the caption position register.

(2) Specification of Line to Set Slice Voltage

The reference voltage for slicing (slice voltage) is generated for the clock run-in pulse in the particular line (refer to Table 7). The field to generate slice voltage is specified by bit 1 of data slicer control register 1. The line to generate slice voltage 1 field is specified by bits 6, 7 of the caption position register (refer to Table 12.10.1).

(3) Field Determination

The field determination flag can be read out by bit 3 of data slicer control register 2. This flag charge at the falling edge of V_{sep} .

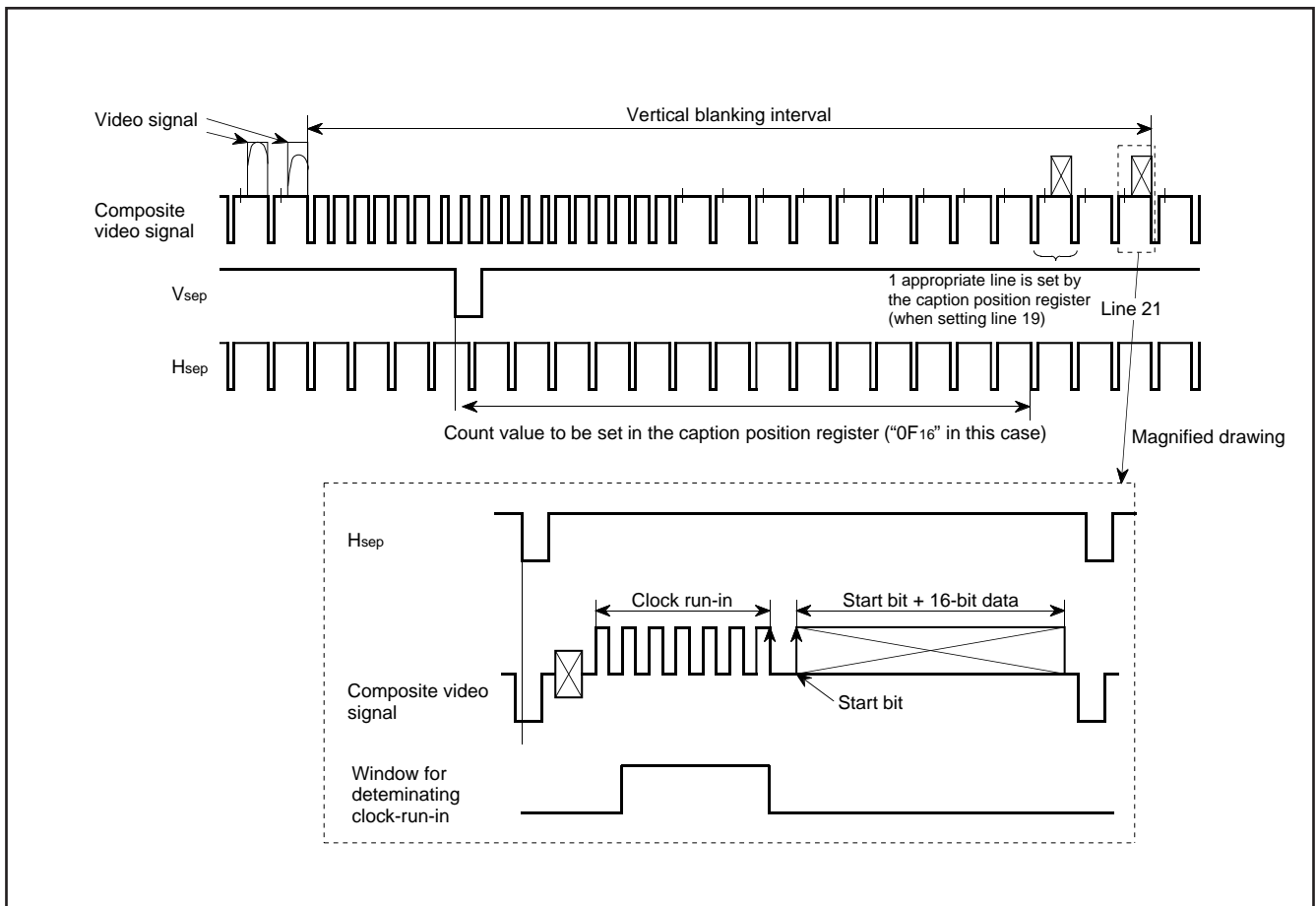
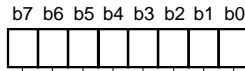


Fig. 12.10.8 Signals in Vertical Blanking Interval

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Caption Position Register



Caption Position Register (CPS) [Address 00E6₁₆]

| B | Name | Functions | After reset | R | W |
|--------|--|--|---------------|---|---|
| 0 to 4 | Caption position bits(CPS0 to CPS4) | | 0 | R | W |
| 5 | Caption data latch completion flag 2 (CPS5) | 0: Data is not latched yet and a clock-run-in is not determined. 1: Data is latched and a clock-run-in is determined. | Indeterminate | R | — |
| 6, 7 | Slice line mode specification bits (in 1 field) (CPS6, CPS7) | Refer to the corresponding Table (Table 12.10.1). | 0 | R | W |

Fig. 12.10.9 Caption Position Register

Table 12.10.1 Specification of Data Slice Line

| CPS | | Field and Line to Be Sliced Data | Field and Line to Generate Slice Voltage |
|-----|----|---|---|
| b7 | b6 | | |
| 0 | 0 | <ul style="list-style-type: none"> Both fields of F1 and F2 Line 21 and a line specified by bits 4 to 0 of CPS (total 2 lines) (See note 2) | <ul style="list-style-type: none"> Field specified by bit 1 of DSC1 Line 21 (total 1 line) |
| 0 | 1 | <ul style="list-style-type: none"> Both fields of F1 and F2 A line specified by bits 4 to 0 of CPS (total 1 line) (See note 3) | <ul style="list-style-type: none"> Field specified by bit 1 of DSC1 A line specified by bits 4 to 0 of CPS (total 1 line) (See note 3) |
| 1 | 0 | <ul style="list-style-type: none"> Both fields of F1 and F2 Line 21 (total 1 line) | <ul style="list-style-type: none"> Field specified by bit 1 of DSC1 Line 21 (total 1 line) |
| 1 | 1 | <ul style="list-style-type: none"> Both fields of F1 and F2 Line 21 and a line specified by bits 4 to 0 of CPS (total 2 lines) (See note 2) | <ul style="list-style-type: none"> Field specified by bit 1 of DSC1 Line 21 and a line specified by bits 4 to 0 of CPS (total 2 lines) (See note 2) |

Notes 1: DSC1 is data slicer control register 1.
 CPS is caption position register.
 2: Set "00₁₆" to "10₁₆" to bits 4 to 0 of CPS.
 3: Set "00₁₆" to "1F₁₆" to bits 4 to 0 of CPS.

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12.10.7 Reference Voltage Generating Circuit and Comparator

The composite video signal clamped by the clamping circuit is input to the reference voltage generating circuit and the comparator.

(1) Reference Voltage Generating Circuit

This circuit generates a reference voltage (slice voltage) by using the amplitude of the clock run-in pulse in line specified by the data slice line specification circuit. Connect a capacitor between the VHOLD pin and the VSS pin, and make the length of wiring as short as possible so that a leakage current may not be generated.

(2) Comparator

The comparator compares the voltage of the composite video signal with the voltage (reference voltage) generated in the reference voltage generating circuit, and converts the composite video signal into a digital value.

12.10.8 Start Bit Detecting Circuit

This circuit detects a start bit at line decided in the data slice line specification circuit.

The detection of a start bit is described below.

- ① A sampling clock is generated by dividing the reference clock output by the timing signal.
- ② A clock run-in pulse is detected by the sampling clock.
- ③ After detection of the pulse, a start bit pattern is detected from the comparator output.

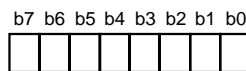
12.10.9 Clock Run-in Determination Circuit

This circuit determinates clock run-in by counting the number of pulses in a window of the composite video signal.

The reference clock count value in one pulse cycle is stored in bits 3 to 7 of the clock run-in detect register (address 00EA16). Read out these bits after the occurrence of a data slicer interrupt (refer to "12.10.12 Interrupt Request Generating Circuit").

Figure 12.10.10 shows the structure of clock run-in detect register.

Clock Run-in Detect Register



Clock run-in detect register (CRD) [Address 00EA16]

| B | Name | Functions | After reset | R | W |
|--------|--|--|-------------|---|---|
| 0 to 2 | Test bits | Read-only | 0 | R | — |
| 3 to 7 | Clock run-in detection bit(CRD3 to CRD7) | Number of reference clocks to be counted in one clock run-in pulse period. | 0 | R | — |

Fig. 12.10.10 Clock Run-in Detect Register

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12.10.10 Data Clock Generating Circuit

This circuit generates a data clock synchronized with the start bit detected in the start bit detecting circuit. The data clock stores caption data to the 16-bit shift register. When the 16-bit data has been stored and the clock run-in determination circuit determines clock run-in, the caption data latch completion flag is set. This flag is reset at a falling of the vertical synchronous signal (V_{sep}).

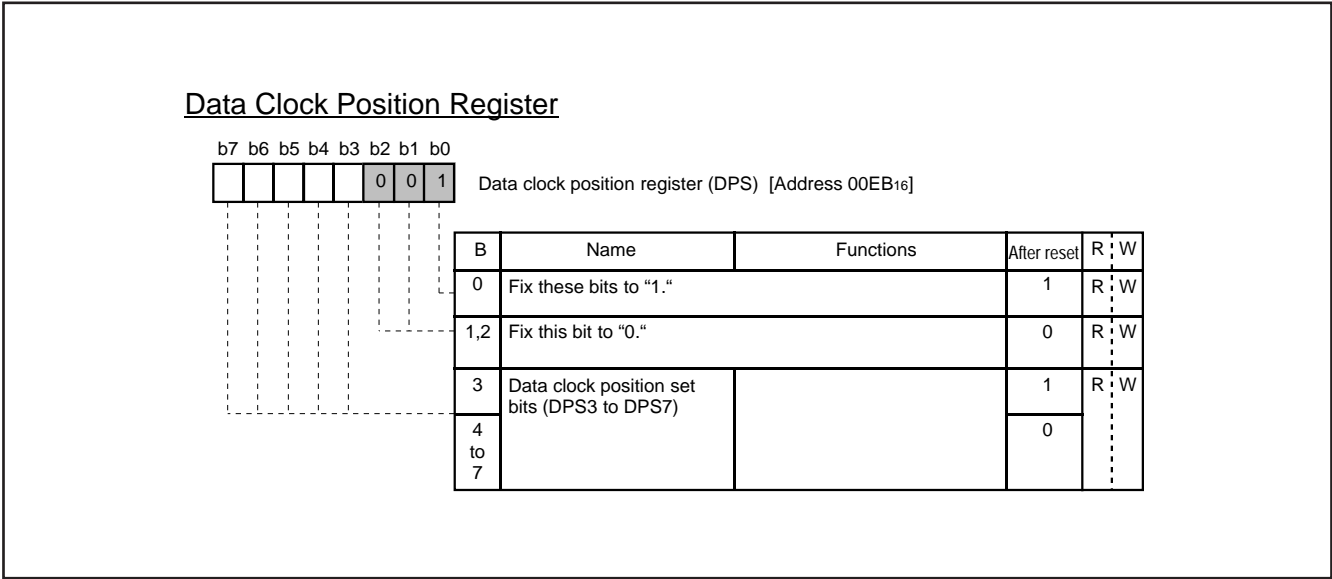


Fig. 12.10.11 Data Clock Position Register

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12.10.11 16-bit Shift Register

The caption data converted into a digital value by the comparator is stored into the 16-bit shift register in synchronization with the data clock. The contents of the high-order 8 bits of the stored caption data can be obtained by reading out data register 2 (address 00E316) and data register 4 (address 00E516). The contents of the low-order 8 bits can be obtained by reading out data register 1 (address 00E216) and data register 3 (address 00E416), respectively. These registers are reset to "0" at a falling of V_{sep} . Read out data registers 1 and 2 after the occurrence of a data slicer interrupt (refer to "12.10.12 Interrupt Request Generating Circuit").

12.10.12 Interrupt Request Generating Circuit

The interrupt requests as shown in Table 12.10.3 are generated by combination of the following bits; bits 6 and 7 of the caption position register (address 00E616). Read out the contents of data registers 1 to 4 and the contents of bits 3 to 7 of the clock run-in detect register after the occurrence of a data slicer interrupt request.

Table 12.10.2 Contents of Caption Data Latch Completion Flag and 16-bit Shift Register

| Slice Line Specification Mode | | Contents of Caption Data Latch Completion Flag | | Contents of 16-bit Shift Register | |
|-------------------------------|-------|--|---|--|--|
| CPS | | Completion Flag 1 (bit 0 of DSC2) | Completion Flag 2 (bit 5 of CPS) | Caption Data Registers 1, 2 | Caption Data Registers 3, 4 |
| bit 7 | bit 6 | | | | |
| 0 | 0 | Line 21 | A line specified by bits 4 to 0 of CPS | 16-bit data of line 21 | 16-bit data of a line specified by bits 4 to 0 of CPS |
| 0 | 1 | A line specified by bits 4 to 0 of CPS | Invalid | 16-bit data of a line specified by bits 4 to 0 of CPS | Invalid |
| 1 | 0 | Line 21 | Invalid | 16-bit data of line 21 | Invalid |
| 1 | 1 | Line 21 | A line specified by bits 4 to 0 of CPS | 16-bit data of line 21 | 16-bit data of a line specified by bits 4 to 0 of CPS |

CPS: Caption position register

DSC2: Data slicer control register 2

Table 12.10.3 Occurrence Sources of Interrupt Request

| Caption position register | | Occurrence Sources of Interrupt Request at End of Data Slice Line |
|---------------------------|----|---|
| b7 | b6 | |
| 0 | 0 | After slicing line 21 |
| | 1 | After a line specified by bits 4 to 0 of CPS |
| 1 | 0 | After slicing line 21 |
| | 1 | After slicing line 21 |

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12.10.13 Synchronous Signal Counter

The synchronous signal counter counts the composite sync signal taken out from a video signal in the data slicer circuit or the vertical synchronous signal V_{sep} as a count source.

The count value in a certain time (T time) generated by $f(X_{IN})/2^{13}$ or $f(X_{IN})/2^{13}$ is stored into the 5-bit latch. Accordingly, the latch value changes in the cycle of T time. When the count value exceeds "1F₁₆," "1F₁₆" is stored into the latch.

The latch value can be obtained by reading out the sync pulse counter register (address 00E9₁₆). A count source is selected by bit 5 of the sync pulse counter register.

The synchronous signal counter is used when bit 0 of PWM mode register 1 (address 0208₁₆).

Figure 12.10.12 shows the structure of the sync pulse counter and Figure 12.10.13 shows the synchronous signal counter block diagram.

Sync Pulse Counter Register

b7 b6 b5 b4 b3 b2 b1 b0



Sync pulse counter register (HC) [Address 00E9₁₆]

| B | Name | Functions | After reset | R | W |
|--------|---|---|---------------|---|---|
| 0 to 4 | Count value (HC0 to HC4) | | Indeterminate | R | — |
| 5 | Count source (HC5) | 0: Hsync signal 1: Composite sync signal | 0 | R | W |
| 6, 7 | Nothing is assigned. These bits are write disable bits. When these bits are read out, the values are "0." | | 0 | R | — |

Fig. 12.10.12 Sync Pulse Counter Register

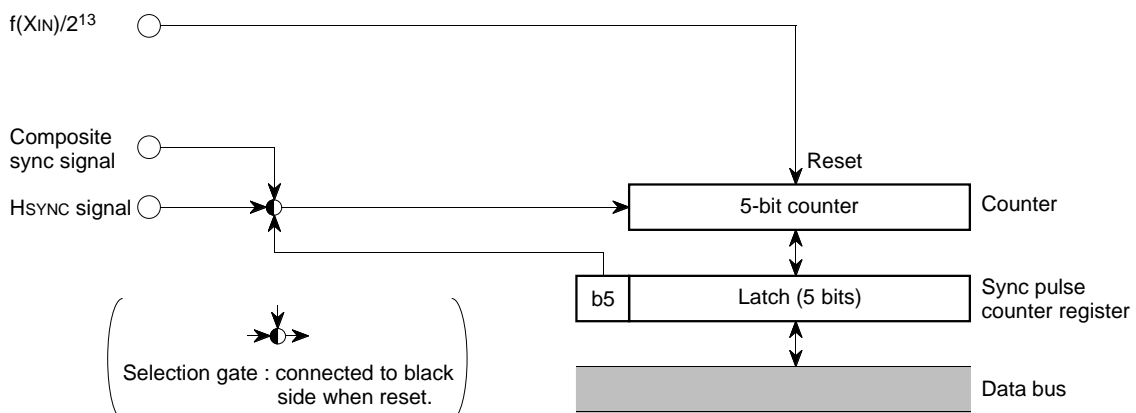


Fig. 12.10.13 Synchronous Signal Counter Block Diagram

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12.11 OSD FUNCTIONS

Table 12.11.1 outlines the OSD functions.

This OSD function can display the following: the block display (32 characters X 16 lines), the SPRITE display. And besides, the function can display the both display at the same time. There are 3 display modes and they are selected by a block unit. The display modes are selected by block control register i (i = 1 to 16).

The features of each mode are described below.

Table.12.11.1 Features of Each Display Style

| Display style Parameter | | Block display | | | SPRITE display |
|--|-------------------------|---|---|--|---|
| | | CC mode (Closed caption mode) | OSD mode (On-screen display mode) | CDOSD mode (Color dot on-screen display mode) | |
| Number of display characters | | 32 characters × 16 lines | | | 1 character |
| Dot structure | | 16 × 20 dots | 16 × 20 dots | 16 × 26 dots | 16 × 20 dots |
| | | (Character sidplay area: 16 × 26 dots) | | | |
| Kinds of characters | | 510 kinds | | 62 kinds | 1 kind |
| Font memory | | ROM | | | RAM |
| Kinds of character sizes | | 4 kinds | 14 kinds | | 8 kinds |
| | Pre-divide ratio (Note) | × 1, × 2 | × 1, × 2, × 3 | | × 1, × 2 |
| | Dot size | 1Tc × 1/2H, 1Tc × 1H | 1Tc × 1/2H, 1Tc × 1H, 1.5Tc × 1/2H, 1.5Tc × 1H, 2Tc × 2H, 3Tc × 3H | | 1Tc × 1/2H, 1Tc × 1H, 2Tc × 2H, 3Tc × 3H |
| Attribute | | Smooth italic, under line, flash | Border | | |
| Character font coloring | | 1 screen: 8 kinds (per character unit) Max. 64 kinds | 1 screen: 15 kinds (per character unit) Max. 64 kinds | 1 screen: 8 kinds (per dot unit) 1 screen: 15 kinds (only specified dots are colored per character unit) Max. 64 kinds | 1 screen: 8 kinds (per dot unit) Max. 64 kinds |
| Character background coloring | | Possible (a character unit, 1 screen: 4 kinds, Max. 64 kinds) | Possible (a character unit, 1 screen: 15 kinds, Max. 64 kinds) | | |
| Display layer | | Layer 1 | Layer 1 and layer 2 | | Layer 3 (with highest priority) |
| OSD output | | Analog R, G, B output (each 4 adjustment levels : 64 colors), Digital OUT1, OUT2 output | | | |
| Raster coloring | | Possible (a screen unit, max 64 kinds) | | | |
| Function | | Auto solid space function | Triple layer OSD function, window function, blank funtion | | |
| Display expansion (multiline display) | | Possible | | | |

Notes1: The divide ratio of the frequency divider (the pre-divide circuit) is referred as "pre-divide ratio" hereafter.

2: The character size is specified with dot size and pre-divide ratio (refer to "2.11.3 Dot Size").

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The OSD circuit has an extended display mode. This mode allows multiple lines (16 lines or more) to be displayed on the screen by interrupting the display each time one line is displayed and rewriting data in the block for which display is terminated by software.

Figure 12.11.1 shows the configuration of OSD character display area. Figure 12.11.2 shows the block diagram of the OSD circuit. Figure 12.11.3 shows the OSD control register 1. Figure 12.11.4 shows the block control register i.

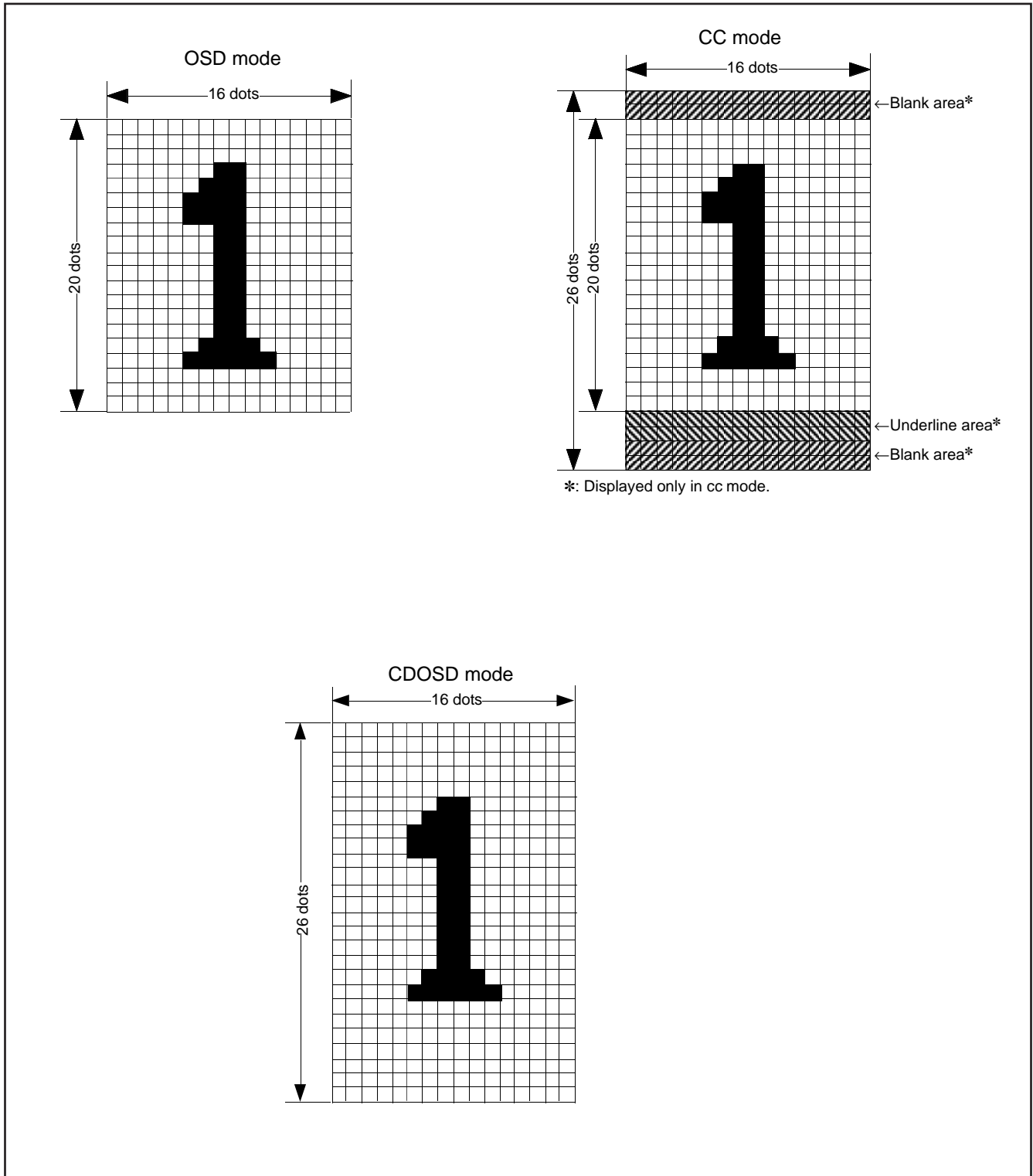


Fig. 12.11.1 Configuration of OSD Character Display Area

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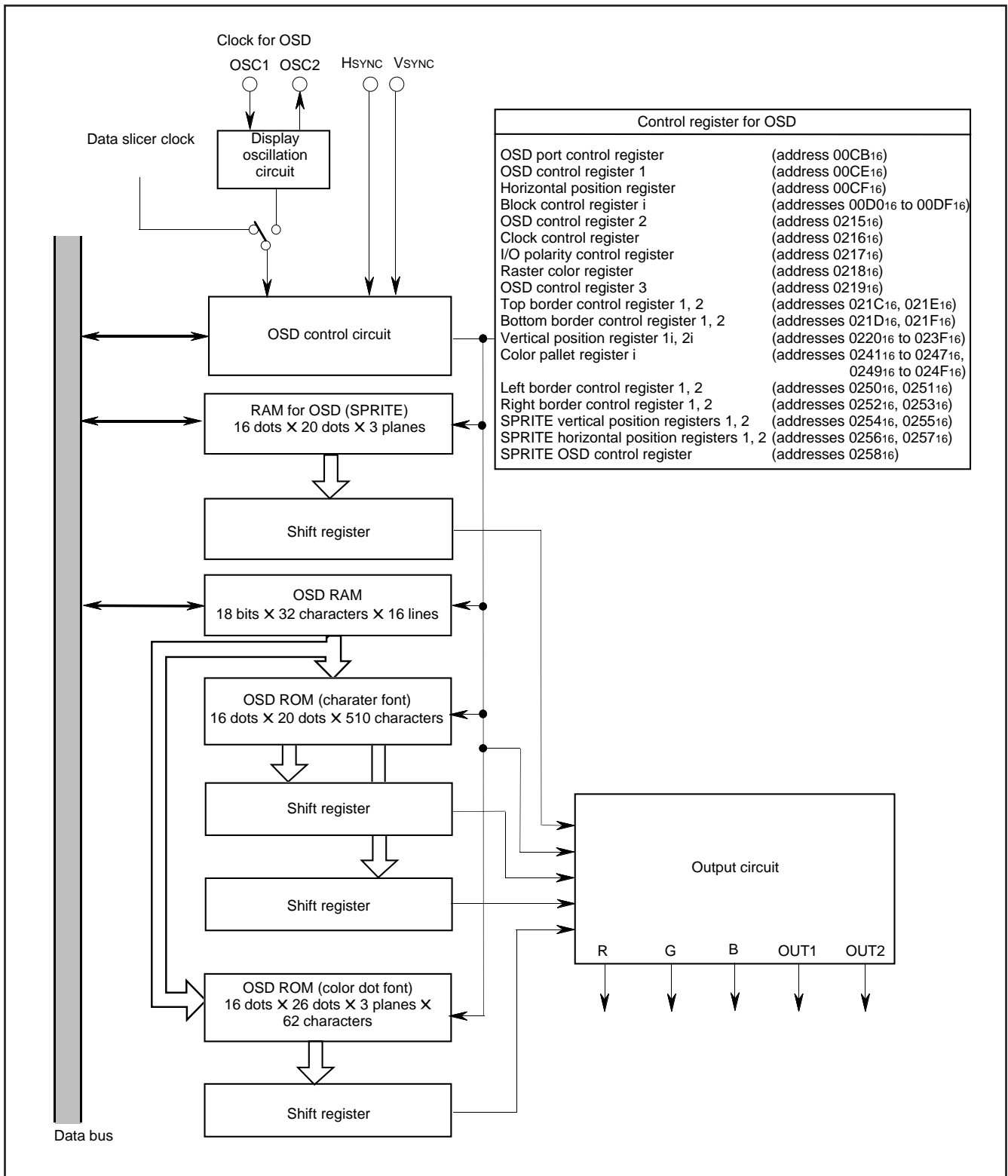


Fig. 12.11.2 Block Diagram of OSD Circuit

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OSD Control Register 1

b7 b6 b5 b4 b3 b2 b1 b0



OSD control register 1 (OC1) [Address 00CE16]

| B | Name | Functions | After reset | R:W |
|------|---|---|-------------|-----|
| 0 | OSD control bit (OC10) (See note 1) | 0 : All-blocks display off 1 : All-blocks display on | 0 | R:W |
| 1 | Scan mode selection bit (OC11) | 0 : Normal scan mode 1 : Bi-scan mode | 0 | R:W |
| 2 | Border type selection bit (OC12) | 0 : All bordered 1 : Shadow bordered (See note 2) | 0 | R:W |
| 3 | Flash mode selection bit (OC13) | 0 : Color signal of character background part does not flash 1 : Color signal of character background part flashes | 0 | R:W |
| 4 | Automatic solid space control bit (OC14) | 0 : OFF 1 : ON | 0 | R:W |
| 5 | Vertical window/blank control bit (OC15) | 0 : OFF 1 : ON | 0 | R:W |
| 6, 7 | Layer mixing control bits (OC16, OC17) (See note 3) | b7 b6 0 0: Logic sum (OR) of layer 1's color and layer 2's color 0 1: Layer 1's color has priority 1 0: Layer 2's color has priority 1 1: Do not set. | 0 | R:W |

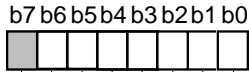
- Notes 1 :** Even this bit is switched during display, the display screen remains unchanged until a rising (falling) of the next VSYNC.
2 : Shadow border is output at right and bottom side of the font.
3 : OUT2 is always ORed, regardless of values of these bits.

Fig. 12.11.3 OSD Control Register 1

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Block Control Register i



Block control register i (BCi) (i=1 to 16) [Addresses 00D0₁₆ to 00DF₁₆]

| B | Name | Functions | | | | | After reset | R;W | |
|------|---|---------------------------------|----|-------------|----------|------------------|---------------|---------------|-----|
| 0, 1 | Display mode selection bits (BCi0, BCi1) | b1 | b0 | Functions | | | Indeterminate | R;W | |
| | | 0 | 0 | Display OFF | | | | | |
| | | 0 | 1 | OSD mode | | | | | |
| | | 1 | 0 | CC mode | | | | | |
| | | 1 | 1 | CDOSD mode | | | | | |
| 2 | Border control bit (BCi2) | 0 : Border OFF 1 : Border ON | | | | | Indeterminate | R;W | |
| 3, 4 | Dot size selection bits (BCi3, BCi4) | b6 | b5 | b4 | b3 | Pre-divide ratio | Dot size | Indeterminate | R;W |
| | | 0 | 0 | 0 | 0 | × 1 | 1Tc × 1/2H | | |
| | | | | 0 | 1 | | 1Tc × 1H | | |
| | | | | 1 | 0 | | 2Tc × 2H | | |
| | | 0 | 1 | 1 | 1 | × 2 | 3Tc × 3H | | |
| 0 | 0 | | | 1Tc × 1/2H | | | | | |
| 5, 6 | Pre-divide ratio selection bit (BCi5, BCi6) | 1 | 1 | 0 | 0 | × 3 | 1Tc × 1H | | |
| | | | | 0 | 1 | | 2Tc × 2H | | |
| | | | | 1 | 0 | | 3Tc × 3H | | |
| | | 1 | 1 | 1 | 1 | × 3 | 1Tc × 1/2H | | |
| | | | | 0 | 1 | | 1Tc × 1H | | |
| 1 | 1 | 1 | 0 | × 3 | 2Tc × 2H | | | | |
| | | 1 | 1 | | 3Tc × 3H | | | | |
| 7 | Nothing is assigned. This bit is a write disable bit. When this bit is read out, the value is indeterminate. | | | | | | Indeterminate | R;— | |

Notes 1: Tc : OSD clock cycle divided in pre-divide circuit

2: H : HSYNC

3: This character size is available only in Layer 2. At this time, set layer 1's pre-divide ratio = X 2, layer 1's horizontal dot size = 1Tc.

Fig. 12.11.4 Block Control Register i (i = 1 to 16)

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12.11.1 Triple Layer OSD

Three built-in layers of display screens accommodate triple display of channels, volume, etc., closed caption, and sprite displays within layers 1 to 3.

The layer to be displayed in each block is selected by bit 0 or 1 of the OSD control register 2 for each display mode (refer to Figure 12.11.7). Layer 3 always displays the sprite display.

When the layer 1 block and the layer 2 block overlay, the screen is composed (refer to Figure 12.11.5) with layer mixing by bit 6 or 7 of the OSD control register 1, as shown in Figure 12.11.3. Layer 3 always takes display priority of layers 1 and 2.

Notes 1: When mixing layer 1 and layer 2, note Table 12.11.2.

2: OUT2 is always ORed, regardless of values of bits 6, 7 of the OSD control register 1. And besides, even when OUT2 (layer 1 or layer 2) overlaps with SPRITE display (layer 3), OUT2 is output.

Table 12.11.2 Mixing Layer 1 and Layer 2

| Block Parameter | Block in Layer 1 | Block in Layer 2 | |
|-----------------------------------|--|--|--|
| Display mode | CC, OSD, CDOSD mode | OSD, CDOSD mode | |
| Pre-divide ratio | X 1, X 2 (CC mode) | Same as layer 1 | |
| Dot size | X 1 to X 3 (OSD, CDOSD mode) | | |
| | 1Tc X 1/2H, 1Tc X 1H (CC mode) | Pre-divide ratio = X 1 | Pre-divide ratio = X 2 |
| | | 1Tc X 1/2H 1Tc X 1H | 1Tc X 1/2H, 1.5Tc X 1/2H 1Tc X 1H, 1.5Tc X 1H |
| | 1Tc X 1H, 1Tc X 1/2H, 2Tc X 2H, 3Tc X 3H (OSD, CDOSD mode) | <ul style="list-style-type: none">• Same saize as layer 1• 1.5Tc can be selected only when: layer 1's pre-divide ratio = X 2 AND layer 1's horizontal dot size = 1Tc. As this time, vertical dot size is the same as layer 1. | |
| Horizontal display start position | Arbitrary | Same position as layer 1 | |
| Vertical display start position | Arbitrary However, when dot size is 2Tc X 2H or 2Tc X 3H, set difference between vertical display position of layer 1 and that of layer 2 as follows. •2Tc X 2H: 2H Units •3Tc X 3H: 3H Units | | |

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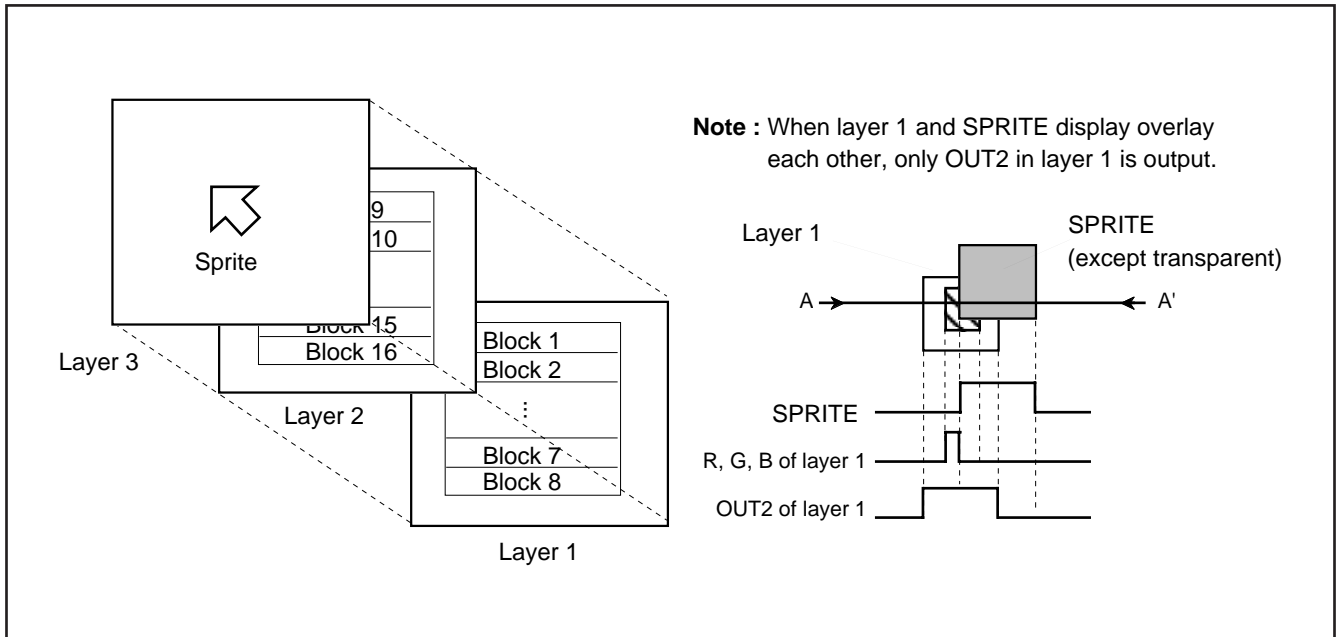


Fig. 12.11.5 Triple Layer OSD

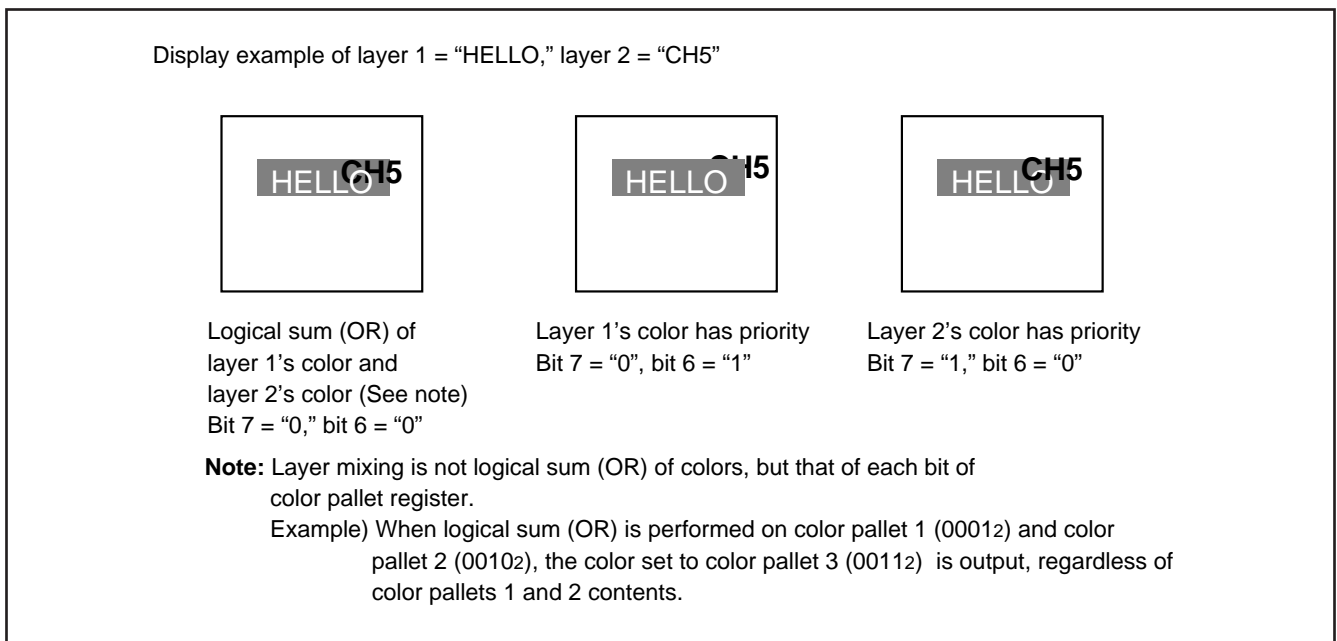
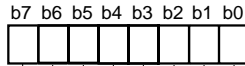


Fig. 12.11.6 Display Example of Triple Layer OSD

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OSD Control Register 2



OSD control register 2 (OC2) [Address 0215₁₆]

| B | Name | Functions | | | | At reset | R | W |
|------|--|--|----|----------------|-----------|----------|---|---|
| 0, 1 | Display layer selection bits (OC20, OC21) | b1 | b0 | Layer 1 | Layer 2 | 0 | R | W |
| | | 0 | 0 | CC, OSD, CDOSD | — | | | |
| | | 0 | 1 | CC, OSD | CDOSD | | | |
| | | 1 | 0 | CC, CDOSD | OSD | | | |
| | | 1 | 1 | CC | CDOSD OSD | | | |
| 2 | R, G, B signal output selection bit(OC22) | 0: Digital output (See note) 1: Analog output (4 gradations) | | | | 0 | R | W |
| 3 | Solid space output bit (OC23) | 0: OUT1 output 1: OUT2 output | | | | 0 | R | W |
| 4 | Horizotal window/blank control bit (OC24) | 0: OFF 1: ON | | | | 0 | R | W |
| 5 | Window/blank selection bit 1 (horizontal) (OC25) | 0: Horizontal blank function 1: Horizontal window function | | | | 0 | R | W |
| 6 | Window/blank selection bit 2 (vertical) (OC26) | 0: Vertical blank function 1: Vertical window function | | | | 0 | R | W |
| 7 | OSD interrupt request selection bit (OC27) | 0: At completion of layer 1 block display 1: At completion of layer 2 block display | | | | 0 | R | W |

Note: When setting bit 1 of the OSD port control register to "1," the value which is converted from the 4-adjustment-level analog to the 2-bit digital is output regardless of this bit value as follows : the high-order bit (R1, G1 and B1) is output from pins P5₂, P5₃ and P5₄, and the low-order bit is (R0, G0 and B0) output from pins P1₇, P1₅ and P1₆. And besides, when not using OSD function, the low-power dissipation can realize by setting this bit to "0."

Fig. 12.11.7 OSD Control Register 2

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12.11.2 Display Position

The display positions of characters are specified by a block. There are 16 blocks, blocks 1 to 16. Up to 32 characters can be displayed in each block (refer to "12.11.6 Memory for OSD").

The display position of each block can be set in both horizontal and vertical directions by software.

The display position in the horizontal direction can be selected for all blocks in common from 256-step display positions in units of 4 TOSC (TOSC = OSD oscillation cycle).

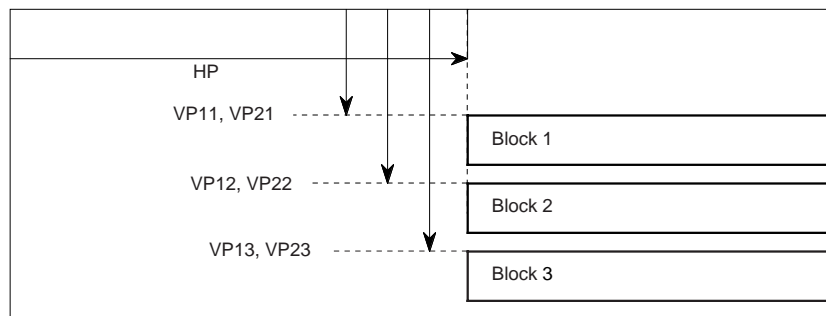
The display position in the vertical direction for each block can be selected from 1024-step display positions in units of 1 TH (TH = HSYNC cycle).

Blocks are displayed in conformance with the following rules:

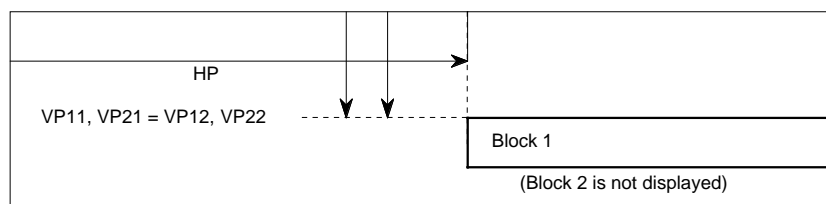
- When the display position is overlapped with another block (Figure 12.11.8 (b)), a lower block number (1 to 16) is displayed on the front.
- When another block display position appears while one block is displayed (Figure 12.11.8 (c)), the block with a larger set value as the vertical display start position is displayed. However, do not display block with the dot size of $2T_c \times 2H$ or $3T_c \times 3H$ during display period (*) of another block.

* In the case of OSD mode block: 20 dots in vertical from the vertical display start position.

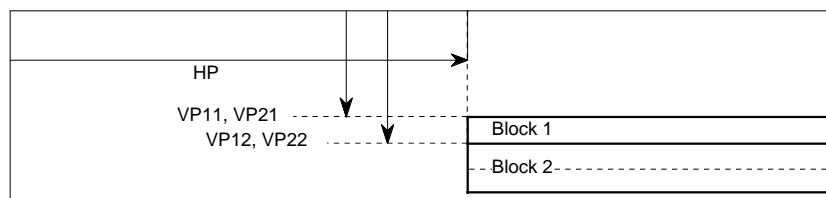
* In the case of CC or CDOSD mode block: 26 dots in vertical from the vertical display start position.



(a) Example when each block is separated



(b) Example when block 2 overlaps with block 1



(c) Example when block 2 overlaps in process of block 1

Note: VP1i or VP2i (i : 1 to 16) indicates the vertical display start position of display block i.

Fig. 12.11.8 Display Position

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The display position in the vertical direction is determined by counting the horizontal sync signal (HSYNC). At this time, when VSYNC and HSYNC are positive polarity (negative polarity), it starts to count the rising edge (falling edge) of HSYNC signal from after fixed cycle of rising edge (falling edge) of VSYNC signal. So interval from rising edge (falling edge) of VSYNC signal to rising edge (falling edge) of HSYNC signal needs enough time (2 machine cycles or more) for avoiding jitter. The polarity of HSYNC and VSYNC signals can select with the I/O polarity control register (address 0217₁₆).

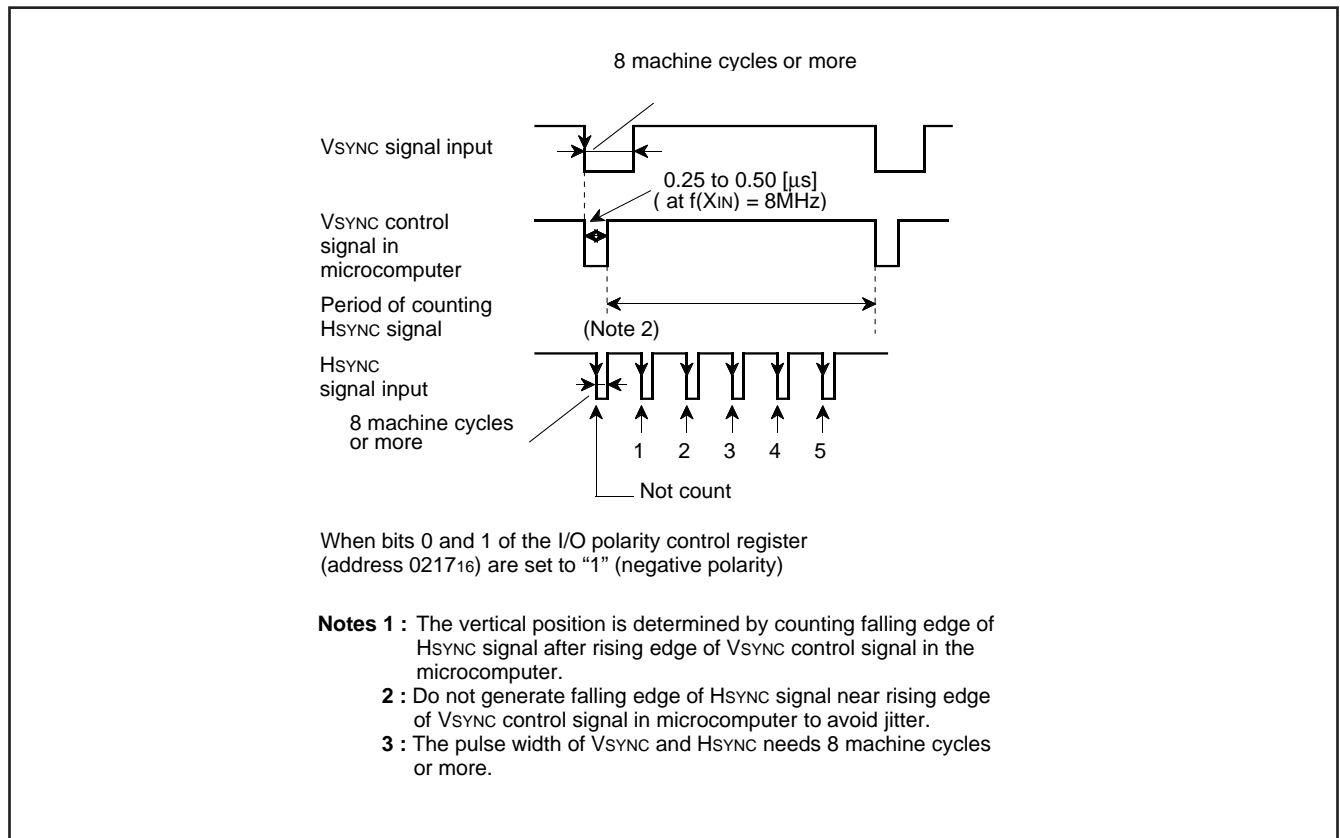


Fig. 12.11.9 Supplement Explanation for Display Position

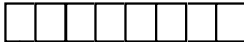
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The vertical position for each block can be set in 1024 steps (where each step is 1TH (TH: HSYNC cycle)) as values "00₁₆" to "FF₁₆" in vertical position register 1i (i = 1 to 16) (addresses 0220₁₆ to 022F₁₆) and values "00₁₆" to "03₁₆" in vertical position register 2i (i = 1 to 16) (addresses 0230₁₆ to 023F₁₆). The vertical position registers are shown in Figures 12.11.10 and 12.11.11.

Vertical Position Register 1i

b7 b6 b5 b4 b3 b2 b1 b0



Vertical position register 1i (VP1i) (i = 1 to 16) [Addresses 0220₁₆ to 022F₁₆]

| B | Name | Functions | After reset | R | W |
|--------|--|---|---------------|---|---|
| 0 to 7 | Control bits of vertical display start positions (VP1i0 to VP1i7) (See note 1) | Vertical display start positions (low-order 8 bits) TH X (setting value of low-order 2 bits of VP2i X 16 ² + setting value of low-order 4 bits of VP1i X 16 ¹ + setting value of low-order 4 bits of VP1i X 16 ⁰) | Indeterminate | R | W |

Notes 1: Do not "00₁₆" and "01₁₆" to VP1i at VP2i = "00₁₆."

2: TH is cycle of HSYNC.

3: VP2i is vertical position register 2i.

Fig. 12.11.10 Vertical Position Register 1i (i = 1 to 16)

Vertical Position Register 2i

b7 b6 b5 b4 b3 b2 b1 b0



Vertical position register 2i (VP2i) (i = 1 to 16) [Addresses 0230₁₆ to 023F₁₆]

| B | Name | Functions | After reset | R | W |
|--------|---|--|---------------|---|---|
| 0, 1 | Control bits of vertical display start positions (VP2i0, VP2i1) (See note 1) | Vertical display start positions (high-order 2 bits) TH X (setting value of low-order 2 bits of VP2i X 16 ² + setting value of low-order 4 bits of VP1i X 16 ¹ + setting value of low-order 4 bits of VP1i X 16 ⁰) | Indeterminate | R | W |
| 2 to 7 | Nothing is assigned. These bits are write disable bits. When these bits are read out, the values are indeterminate. | | Indeterminate | R | — |

Notes 1: Do not set "00₁₆" and "01₁₆" to VP1i at VP2i = "00₁₆."

2: TH is cycle of HSYNC.

3: VP1i is vertical position register 1i.

Fig. 12.11.11 Vertical Position Register 2i (i = 1 to 16)

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The horizontal position is common to all blocks, and can be set in 256 steps (where 1 step is 4Tosc, TOSC being the oscillating cycle for display) as values "00₁₆" to "FF₁₆" in bits 0 to 7 of the horizontal position register (address 00CF₁₆). The horizontal position register is shown in Figure 12.11.12.

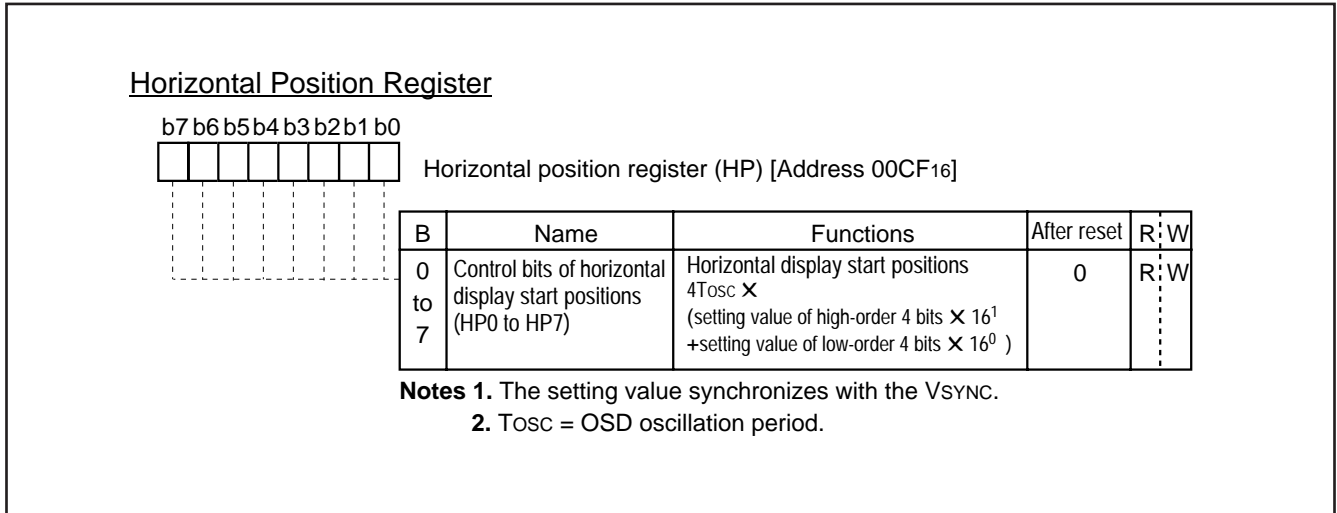


Fig. 12.11.12 Horizontal Position Register

Note : 1Tc (Tc : OSD clock cycle divided in pre-divide circuit) gap occurs between the horizontal display start position set by the horizontal position register and the most left dot of the 1st block. Accordingly, when 2 blocks have different pre-divide ratios, their horizontal display start position will not match.
 Ordinarily, this gap is 1Tc regardless of character sizes, however, the gap is 1.5Tc only when the character size is 1.5Tc.

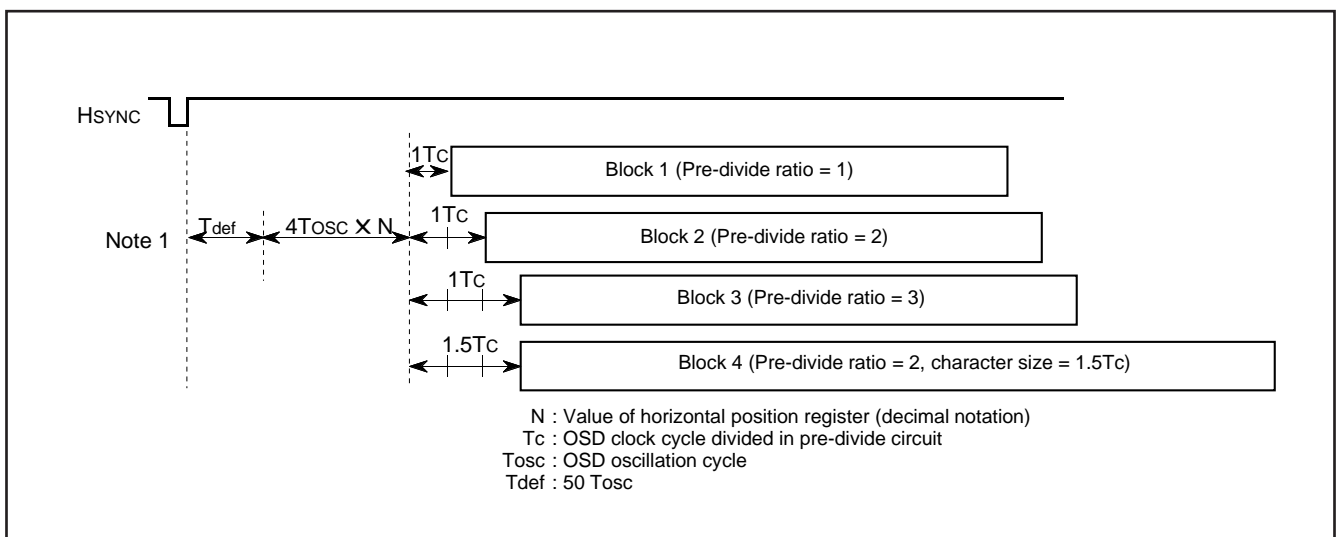


Fig. 12.11.13 Notes on Horizontal Display Start Position

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12.11.3 Dot Size

The dot size can be selected by a block unit. The dot size in vertical direction is determined by dividing HSYNC in the vertical dot size control circuit. The dot size in horizontal is determined by dividing the following clock in the horizontal dot size control circuit : the clock gained by dividing the OSD clock source (data slicer clock, OSC1, main clock) in the pre-divide circuit. The clock cycle divided in the pre-divide circuit is defined as $1T_c$.

The dot size is specified by bits 6 to 3 of the block control register.

Refer to Figure 12.11.4 (the block control register i), refer to Figure 12.11.6 (the clock control register).

The block diagram of dot size control circuit is shown in Figure 12.11.4.

Notes 1: The pre-divide ratio = 3 cannot be used in the CC mode.

2: The pre-divide ratio of the layer 2 must be same as that of the layer 1 by the block control register i.

3: In the bi-scan mode, the dot size in the vertical direction is 2 times as compared with the normal mode. Refer to "12.11.13 Scan Mode" about the scan mode.

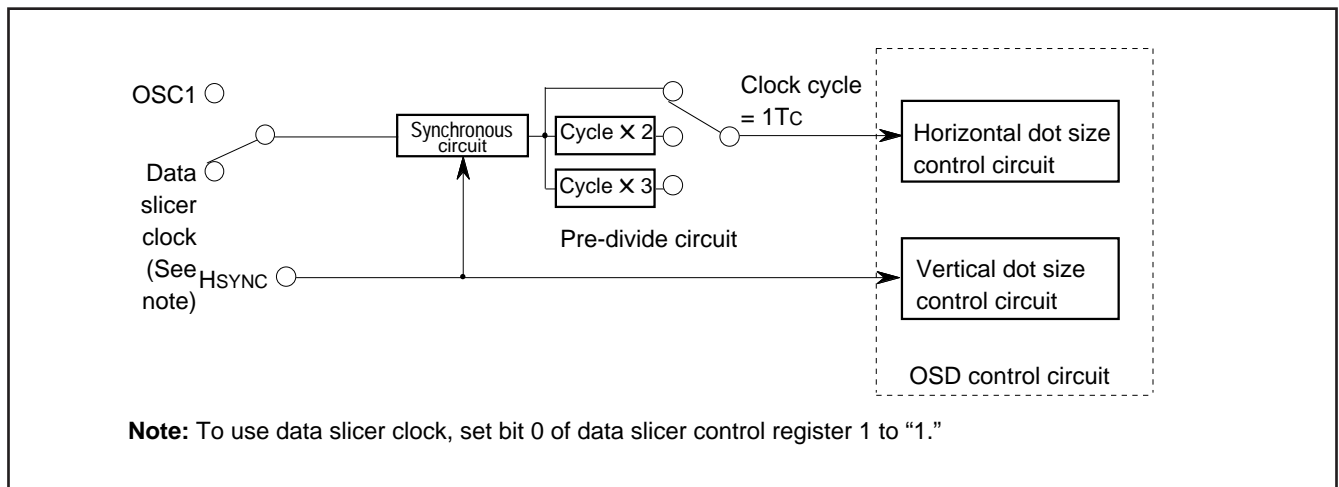


Fig. 12.11.14 Block Diagram of Dot Size Control Circuit

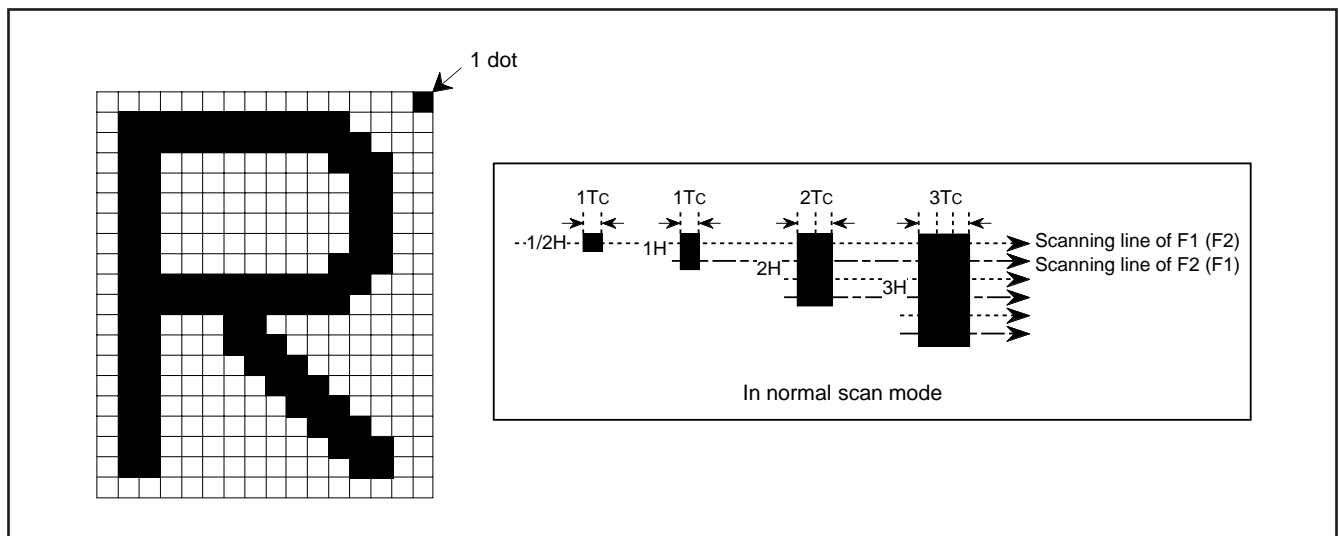


Fig. 12.11.15 Definition of Dot Sizes

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12.11.4 Clock for OSD

As a clock for display to be used for OSD, it is possible to select one of the following 3 types.

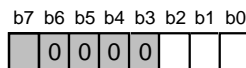
- Data slicer clock output from the data slicer (approximately 26 MHz)
- Clock from the LC oscillator supplied from the pins OSC1 and OSC2
- Clock from the ceramic resonator or the quartz-crystal oscillator from the pins OSC1 and OSC2

The clock for display to be used for OSD can be selected by bit 7 of port P3 direction register, bit 2 and bit 1 of clock source control register (address 0216₁₆). If the pins OSC1 and OSC2 are not used as OSD clock input/output, these pins can be used as the sub-clock input/output, or port P6.

Table 12.11.2 Setting of P63/OSC1/XCIN, P64/OSC2/XCOUT

| Function Registers | Clock input/ output pins for OSD | | Sub-clock input/ output pins | Input port |
|--|--|---|------------------------------------|------------|
| Bit 7 of Port P3 Direction Register | 0 | | 0 | 1 |
| Clock Control Register | Bit 2 | 1 | 1 | 0 |
| | Bit 1 | 0 | 1 | 0 |

Clock Control Register



Clock control register (CS) [Address 0216₁₆]

| B | Name | Functions | After reset | R | W |
|--------|---|---|-------------|---|---|
| 0 | Clock selection bit (CS0) | 0: Data slicer clock 1: OSC1 clock | 0 | R | W |
| 1, 2 | OSC1 oscillating mode selection bits (CS1, CS2) | b2 b1 0 0: 32kHz oscillating mode. 0 1: Used as input port of P6 ₃ and P6 ₄ (See note 1). 1 0: LC oscillating mode 1 1: Ceramic • quartz-crystal oscillating mode | 0 | R | W |
| 3 to 6 | Fix these bits to "0." | | 0 | R | W |
| 7 | Test bit (See note 2) | | 0 | R | W |

Note 1: Set bit 7 of address 00C7₁₆ to "1", when OSC1 and OSC2 are used as P6₃ and P6₄.

2: Be sure to set bit 7 to "0" for program of the mask and the EPROM versions. For the emulator MCU version (M37280ERSS), be sure to set bit 7 to "1" when using the data slicer clock for software debugging.

Fig. 12.11.16 Clock Control Register

PRELIMINARY

Notice: This is not a final specification.
Some parametric limits are subject to change.

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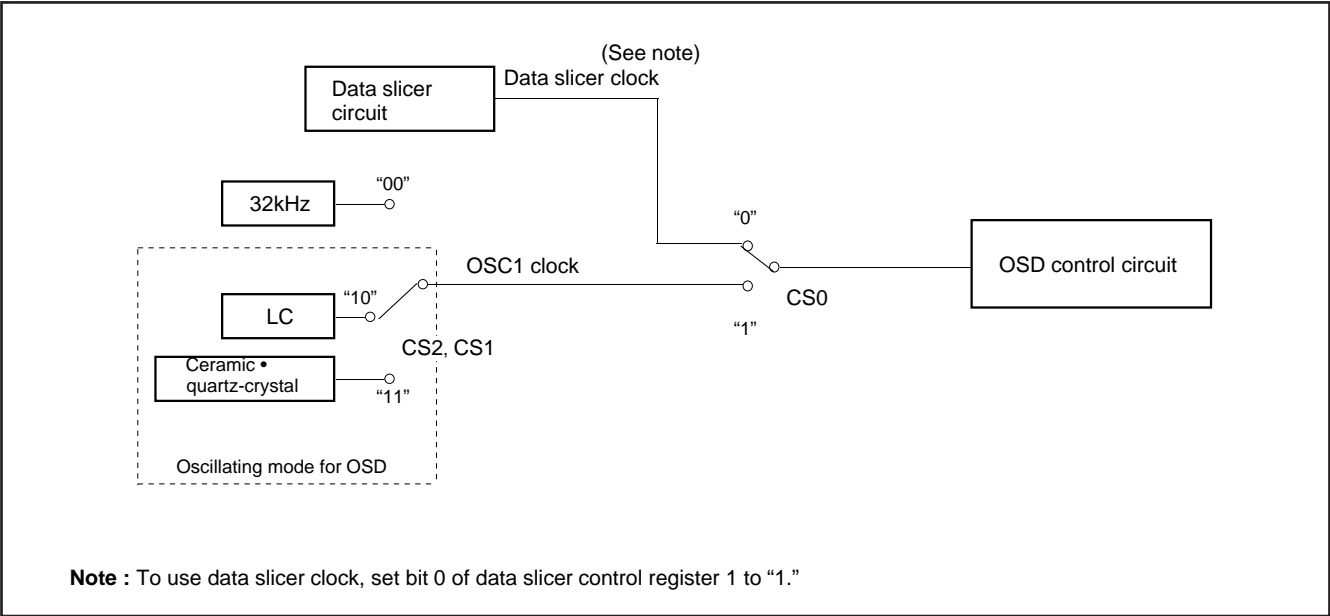


Fig. 12.11.17 Block Diagram of OSD Selection Circuit

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12.11.5 Field Determination Display

To display the block with vertical dot size of 1/2H, whether an even field or an odd field is determined through differences in a synchronizing signal waveform of interlacing system. The dot line 0 or 1 (refer to Figure 12.11.19) corresponding to the field is displayed alternately.

In the following, the field determination standard for the case where both the horizontal sync signal and the vertical sync signal are negative-polarity inputs will be explained. A field determination is determined by detecting the time from a falling edge of the horizontal sync signal until a falling edge of the VSYNC control signal (refer to Figure

12.11.19) in the microcomputer and then comparing this time with the time of the previous field. When the time is longer than the comparing time, it is regarded as even field. When the time is shorter, it is regarded as odd field.

The field determination flag changes at a rising edge of VSYNC control signal in the microcomputer.

The contents of this field can be read out by the field determination flag (bit 7 of the I/O polarity control register at address 021716). A dot line is specified by bit 6 of the I/O polarity control register (refer to Figure 12.11.19).

However, the field determination flag read out from the CPU is fixed to "0" at even field or "1" at odd field, regardless of bit 6.

I/O Polarity Control Register

b7 b6 b5 b4 b3 b2 b1 b0



I/O polarity control register (PC) [Address 021716]

| B | Name | Functions | After reset | R | W |
|---|--|--|-------------|---|---|
| 0 | Hsync input polarity switch bit (PC0) | 0 : Positive polarity input 1 : Negative polarity input | 0 | R | W |
| 1 | Vsync input polarity switch bit (PC1) | 0 : Positive polarity input 1 : Negative polarity input | 0 | R | W |
| 2 | R, G, B output polarity switch bit (PC2) | 0 : Positive polarity output 1 : Negative polarity output | 0 | R | W |
| 3 | Nothing is assigned. This bit is a write disable bit. When this bit is read out, the value is "0". | | 0 | R | — |
| 4 | OUT1 output polarity switch bit (PC4) | 0 : Positive polarity output 1 : Negative polarity output | 0 | R | W |
| 5 | OUT2 output polarity switch bit (PC5) | 0 : Positive polarity output 1 : Negative polarity output | 0 | R | W |
| 6 | Display dot line selection bit (PC6) (See note) | 0 : "□" at even field "▨" at odd field 1 : "▨" at even field "□" at odd field | 0 | R | W |
| 7 | Field determination flag(PC7) | 0 : Even field 1 : Odd field | 1 | R | — |

Note: Refer to Fig. 12.11.19.

Fig. 12.11.18 I/O Polarity Control Register

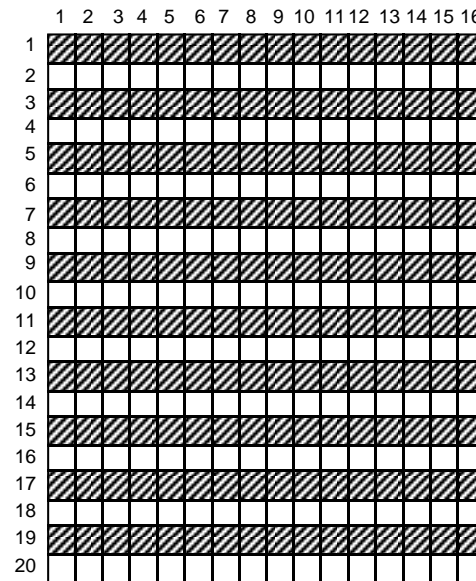
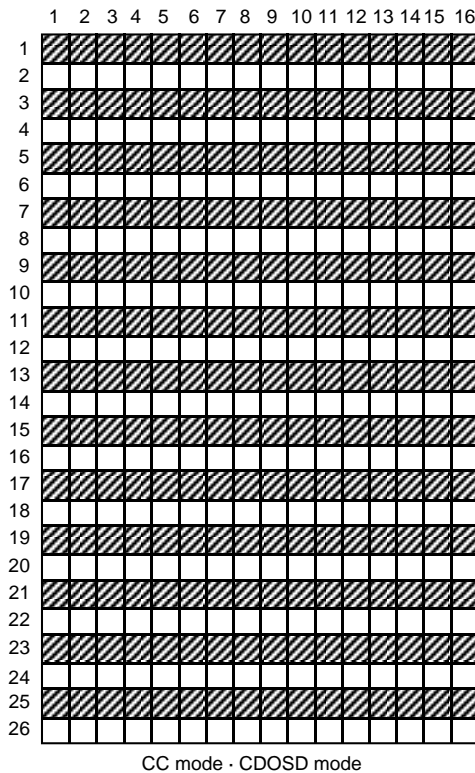
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Both HSYNC signal and VSYNC signal are negative-polarity input

| HSYNC | | Field | Field determination flag(Note) | Display dot line selection bit | Display dot line |
|---|--|-------|--------------------------------|--------------------------------|--|
| VSYNC and VSYNC control signal in microcomputer | | Odd | | | |
| Upper : VSYNC signal | | Even | 0 (T2 > T1) | 0 | Dot line 1 <input type="checkbox"/> |
| Lower : VSYNC control signal in microcomputer | | Odd | 1 (T3 < T2) | 0 | Dot line 0 <input checked="" type="checkbox"/> |
| | | | | 1 | Dot line 1 <input type="checkbox"/> |

When using the field determination flag, be sure to set bit 0 of the PWM mode register 1 (address 020A16) to "0."



When the display dot line selection bit is "0," the "□" font is displayed at even field, the "▨" font is displayed at odd field. Bit 7 of the I/O polarity control register can be read as the field determination flag : "1" is read at odd field, "0" is read at even field.

OSD ROM font configuration diagram

Note : The field determination flag changes at a rising edge of the VSYNC control signal (negative-polarity input) in the microcomputer.

Fig. 12.11.19 Relation Between Field Determination Flag and Display Font

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12.11.6 Memory for OSD

There are 2 types of memory for OSD : OSD ROM (addresses 10800₁₆ to 157FF₁₆ and 18000₁₆ to 1ACFF₁₆) used to specify character dot data and OSD RAM (addresses 0700₁₆ to 07A7₁₆ and 0800₁₆ to 0FDF₁₆) used to specify the kinds of display characters, display colors, and SPRITE display. The following describes each type of memory.

(1) OSD ROM (addresses 10800₁₆ to 157FF₁₆, 18000₁₆ to 1ACFF₁₆)

The dot pattern data for OSD characters is stored in the character font area in the OSD ROM and the CD font data for OSD characters is stored in the color dot font area in the OSD ROM. To specify the kinds of the character font and the CD font, it is necessary to write the character code into the OSD RAM.

The modes are selected by bit 3 of the OSD control register 3 for each screen.

The character font data storing address is shown in Figure 12.11.20. The CD font data storing address is shown in Figure 2.11.21. The 510 kinds of character font and 62 kinds of CD font can be stored.

OSD ROM address of character font data

| OSD ROM address bit | AD16 | AD15 | AD14 | AD13 | AD12 | AD11 | AD10 | AD9 | AD8 | AD7 | AD6 | AD5 | AD4 | AD3 | AD2 | AD1 | AD0 |
|---|------|------|-------------|------|------|------|------|-----|----------------|-----|-----|-----|-----|-----|-----|-----|----------|
| Line number / Character code / Area bit | 1 | 0 | Line number | | | | | | Character code | | | | | | | | Area bit |

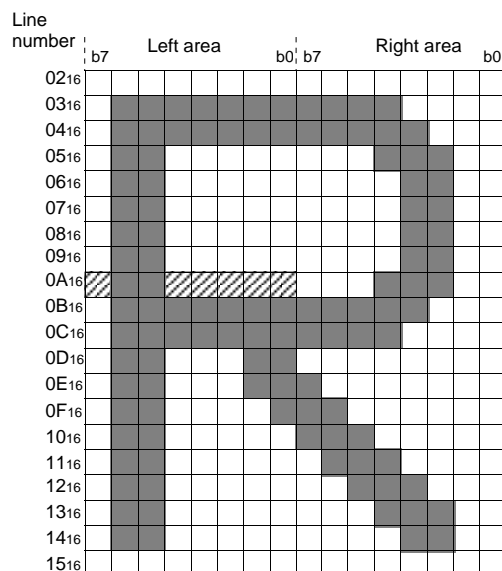
Line number = "02₁₆" to "15₁₆"

Character code = "00₁₆" to "1F₁₆" ("0F₁₆" and "10₁₆" can not be used. Write "FF₁₆" to corresponding addresses.)

Area bit = 0: Left area

1: Right area

For example : The font data of the hatching area of the character code AA₁₆ is 1 0010 1001 0101 0100₂ = 12954₁₆



Character code AA₁₆

Fig. 12.11.20 Character Font Data Storing Address

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OSD ROM address of CD font data

| OSD ROM address bit | AD16 | AD15 | AD14 | AD13 | AD12 | AD11 | AD10 | AD9 | AD8 | AD7 | AD6 | AD5 | AD4 | AD3 | AD2 | AD1 | AD0 |
|------------------------------|------|------|------|---------------------|-------------|------|------|-----|-----|-----|---------|-----|-----|-----|-----|-----|----------|
| Line number/CD code/Area bit | 1 | 1 | 0 | Plain selection bit | Line number | | | | | | CD code | | | | | | Area bit |

Line number = "0016" to "1916"

CD code = "0016" to "3F16" ("1F16" and "2016" cannot be used. Write "FF16" to the corresponding address.)

Area bit = 0 : Left area 1 : Right area

Example) "0316" is stored to address 1A77516 (Plain 2), "C016" is stored to address 1977516 (Plain 1), and "F816" is stored to address 1877516 (Plain 0) as the font data of the hatching area of the CD code 3A16.

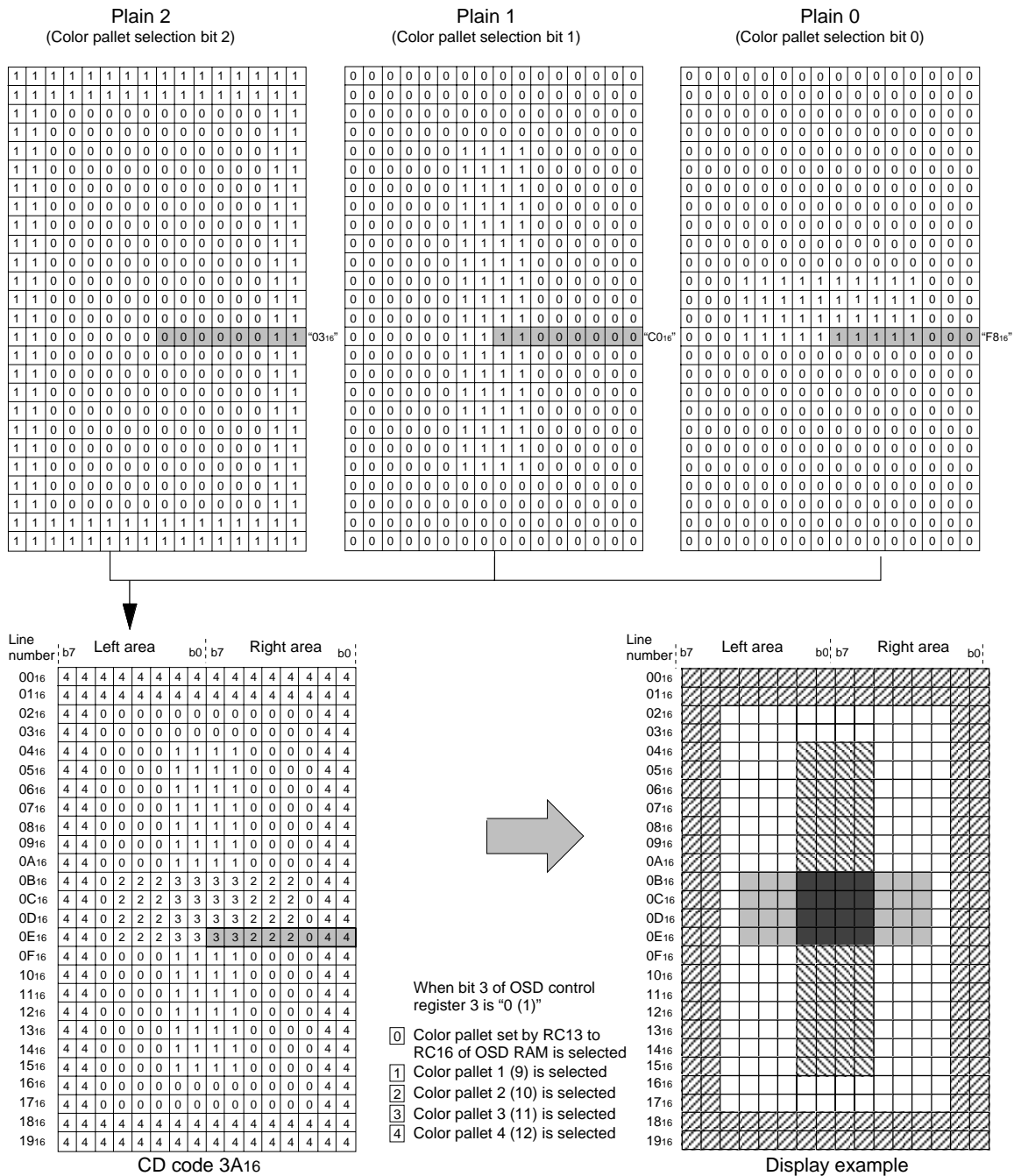


Fig. 12.11.21 Color Dot Font Data Storing Address

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(2) OSD RAM (addresses 0700₁₆ to 07A7₁₆, 0800₁₆ to 0FFF₁₆)

The OSD RAM for SPRITE consisting of 3 planes, is assigned to addresses 0700₁₆ to 07A7₁₆. Each plane corresponds to each color pallet selection bit and the color pallet of each dot is determined from among 8 kinds.

The OSD RAM for character is allocated at addresses 0800₁₆ to 0FFF₁₆, and is divided into a display character code specification part, color code 1 specification part, and color code 2 specification part for each block. Tables 2.11.4 and 2.11.5 show the contents of the OSD RAM.

For example, to display 1 character position (the left edge) in block 1, write the character code in address 0800₁₆, write color code 1 at 0820₁₆, and write color code 2 at 0840₁₆. The structure of the OSD RAM is shown in Figure 12.11.23.

Note : For the layer 2 's OSD mode block with dot size of 1.5Tc X 1/2H and 1.5Tc X 1H, the 3nth (n = 1 to 10) character is skipped as compared with ordinary block (blocks with dot size of 1Tc X 1/2H, or blocks on the layer 1). Accordingly, maximum 22 characters are only displayed in 1 block. Blocks with dot size of 1Tc X 1/2H and 1Tc X 1H, or blocks on the layer 1

However, note the following:

- In OSD mode
The character is not displayed, and only the left 1/3 part of the 22nd character back ground is displayed in the 22nd's character area.
When not displaying this background, set transparent for background.
- In CDOSD mode
The character is not displayed, and color pallet color specified by bit 3 to 6 of color code 1 can be output in the 22nd's character area (left 1/3 part).

The RAM data for the 3nth character does not effect the display.
Any character data can be stored here (refer to Figure 12.11.22).

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Table 12.11.3 Contents of OSD RAM (SPRITE)

| Line (from top) | Dot (from left) | Plain 0 (Color pallet selection bit 0) | Plain 1 (Color pallet selection bit 1) | Plain 2 (Color pallet selection bit 2) |
|-----------------|-----------------|---|---|---|
| Line 1 | Dots 1 to 8 | 0700 ₁₆ | 0740 ₁₆ | 0780 ₁₆ |
| | Dots 9 to 16 | 0701 ₁₆ | 0741 ₁₆ | 0781 ₁₆ |
| Line 2 | Dots 1 to 8 | 0702 ₁₆ | 0742 ₁₆ | 0782 ₁₆ |
| | Dots 9 to 16 | 0703 ₁₆ | 0743 ₁₆ | 0783 ₁₆ |
| : | : | : | : | : |
| Line 19 | Dots 1 to 8 | 0724 ₁₆ | 0764 ₁₆ | 07A4 ₁₆ |
| | Dots 9 to 16 | 0725 ₁₆ | 0765 ₁₆ | 07A5 ₁₆ |
| Line 20 | Dots 1 to 8 | 0726 ₁₆ | 0766 ₁₆ | 07A6 ₁₆ |
| | Dots 9 to 16 | 0727 ₁₆ | 0767 ₁₆ | 07A7 ₁₆ |

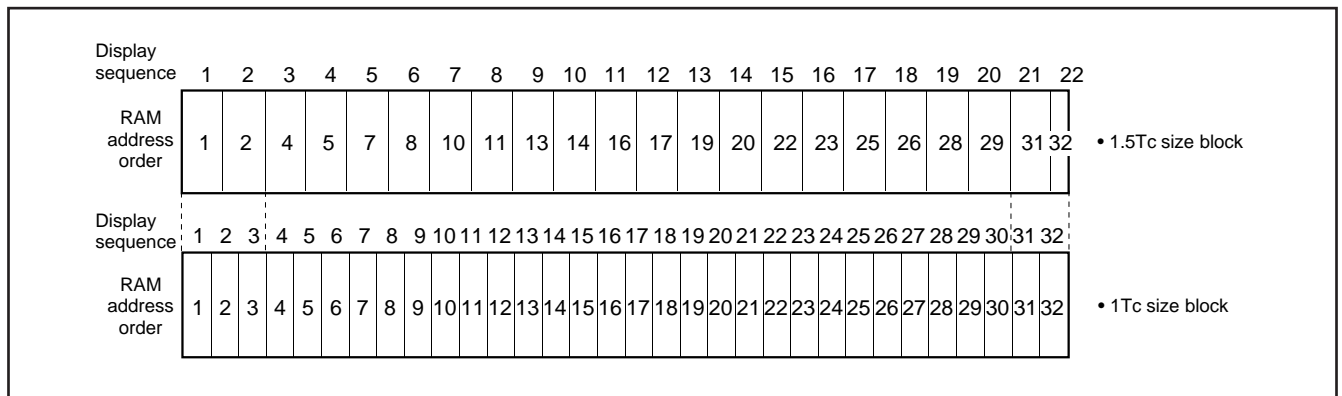
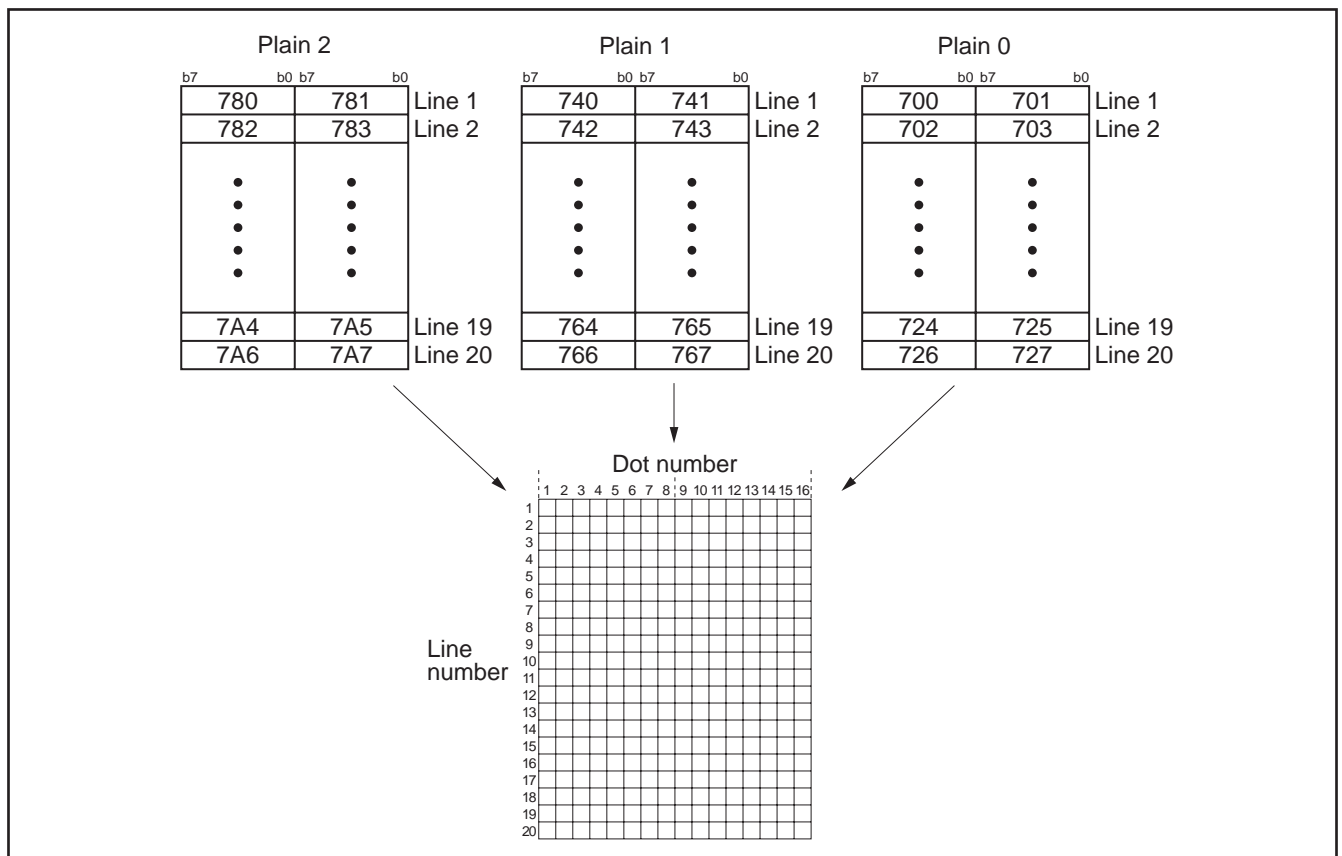


Fig. 12.11.22 RAM Data for 3nth Character

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Table 12.11.14 Contents of OSD RAM (Character)

| Block | Display Position (from left) | Character Code Specification | Color Code 1 Specification | Color Code 2 Specification |
|----------|------------------------------|------------------------------|----------------------------|----------------------------|
| Block 1 | 1st character | 0800 ₁₆ | 0820 ₁₆ | 0840 ₁₆ |
| | 2nd character | 0801 ₁₆ | 0821 ₁₆ | 0841 ₁₆ |
| | ⋮ | ⋮ | ⋮ | ⋮ |
| | 31st character | 081E ₁₆ | 083E ₁₆ | 085E ₁₆ |
| Block 2 | 32nd character | 081F ₁₆ | 083F ₁₆ | 085F ₁₆ |
| | 1st character | 0880 ₁₆ | 08A0 ₁₆ | 08C0 ₁₆ |
| | 2nd character | 0881 ₁₆ | 08A1 ₁₆ | 08C1 ₁₆ |
| | ⋮ | ⋮ | ⋮ | ⋮ |
| Block 3 | 31st character | 089E ₁₆ | 08BE ₁₆ | 08DE ₁₆ |
| | 32nd character | 089F ₁₆ | 08BF ₁₆ | 08DF ₁₆ |
| | 1st character | 0900 ₁₆ | 0920 ₁₆ | 0940 ₁₆ |
| | 2nd character | 0901 ₁₆ | 0921 ₁₆ | 0941 ₁₆ |
| Block 4 | ⋮ | ⋮ | ⋮ | ⋮ |
| | 31st character | 091E ₁₆ | 093E ₁₆ | 095E ₁₆ |
| | 32nd character | 091F ₁₆ | 093F ₁₆ | 095F ₁₆ |
| | 1st character | 0980 ₁₆ | 09A0 ₁₆ | 09C0 ₁₆ |
| Block 5 | 2nd character | 0981 ₁₆ | 09A1 ₁₆ | 09C1 ₁₆ |
| | ⋮ | ⋮ | ⋮ | ⋮ |
| | 31st character | 099E ₁₆ | 09BE ₁₆ | 09DE ₁₆ |
| | 32nd character | 099F ₁₆ | 09BF ₁₆ | 09DF ₁₆ |
| Block 6 | 1st character | 0A00 ₁₆ | 0A20 ₁₆ | 0A40 ₁₆ |
| | 2nd character | 0A01 ₁₆ | 0A21 ₁₆ | 0A41 ₁₆ |
| | ⋮ | ⋮ | ⋮ | ⋮ |
| | 31st character | 0A1E ₁₆ | 0A3E ₁₆ | 0A5E ₁₆ |
| Block 7 | 32nd character | 0A1F ₁₆ | 0A3F ₁₆ | 0A5F ₁₆ |
| | 1st character | 0A80 ₁₆ | 0AA0 ₁₆ | 0AC0 ₁₆ |
| | 2nd character | 0A81 ₁₆ | 0AA1 ₁₆ | 0AC1 ₁₆ |
| | ⋮ | ⋮ | ⋮ | ⋮ |
| Block 8 | 31st character | 0A9E ₁₆ | 0ABE ₁₆ | 0ADE ₁₆ |
| | 32nd character | 0A9F ₁₆ | 0ABF ₁₆ | 0ADF ₁₆ |
| | 1st character | 0B00 ₁₆ | 0B20 ₁₆ | 0B40 ₁₆ |
| | 2nd character | 0B01 ₁₆ | 0B21 ₁₆ | 0B41 ₁₆ |
| Block 9 | ⋮ | ⋮ | ⋮ | ⋮ |
| | 31st character | 0B1E ₁₆ | 0B3E ₁₆ | 0B5E ₁₆ |
| | 32nd character | 0B1F ₁₆ | 0B3F ₁₆ | 0B5F ₁₆ |
| | 1st character | 0B80 ₁₆ | 0BA0 ₁₆ | 0BC0 ₁₆ |
| Block 10 | 2nd character | 0B81 ₁₆ | 0BA1 ₁₆ | 0BC1 ₁₆ |
| | ⋮ | ⋮ | ⋮ | ⋮ |
| | 31st character | 0B9E ₁₆ | 0BBE ₁₆ | 0BDE ₁₆ |
| | 32nd character | 0B9F ₁₆ | 0BBF ₁₆ | 0BDF ₁₆ |
| Block 11 | 1st character | 0C00 ₁₆ | 0C20 ₁₆ | 0C40 ₁₆ |
| | 2nd character | 0C01 ₁₆ | 0C21 ₁₆ | 0C41 ₁₆ |
| | ⋮ | ⋮ | ⋮ | ⋮ |
| | 31st character | 0C1E ₁₆ | 0C3E ₁₆ | 0C5E ₁₆ |
| Block 12 | 32nd character | 0C1F ₁₆ | 0C3F ₁₆ | 0C5F ₁₆ |
| | 1st character | 0C80 ₁₆ | 0CA0 ₁₆ | 0CC0 ₁₆ |
| | 2nd character | 0C81 ₁₆ | 0CA1 ₁₆ | 0CC1 ₁₆ |
| | ⋮ | ⋮ | ⋮ | ⋮ |
| Block 13 | 31st character | 0C9E ₁₆ | 0CBE ₁₆ | 0CDE ₁₆ |
| | 32nd character | 0C9F ₁₆ | 0CBF ₁₆ | 0CDF ₁₆ |

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Table 12.11.15 Contents of OSD RAM (continued)

| Block | Display Position (from left) | Character Code Specification | Color Code 1 Specification | Color Code 2 Specification |
|----------|------------------------------|------------------------------|----------------------------|----------------------------|
| Block 11 | 1st character | 0D00 ₁₆ | 0D20 ₁₆ | 0D40 ₁₆ |
| | 2nd character | 0D01 ₁₆ | 0D21 ₁₆ | 0D41 ₁₆ |
| | ⋮ | ⋮ | ⋮ | ⋮ |
| | 31st character | 0D1E ₁₆ | 0D3E ₁₆ | 0D5E ₁₆ |
| Block 12 | 32nd character | 0D1F ₁₆ | 0D3F ₁₆ | 0D5F ₁₆ |
| | 1st character | 0D80 ₁₆ | 0DA0 ₁₆ | 0DC0 ₁₆ |
| | 2nd character | 0D81 ₁₆ | 0DA1 ₁₆ | 0DC1 ₁₆ |
| | ⋮ | ⋮ | ⋮ | ⋮ |
| Block 13 | 31st character | 0D9E ₁₆ | 0DBE ₁₆ | 0DDE ₁₆ |
| | 32nd character | 0D9F ₁₆ | 0DBF ₁₆ | 0DDF ₁₆ |
| | 1st character | 0E00 ₁₆ | 0E20 ₁₆ | 0E40 ₁₆ |
| | 2nd character | 0E01 ₁₆ | 0E21 ₁₆ | 0E41 ₁₆ |
| Block 14 | ⋮ | ⋮ | ⋮ | ⋮ |
| | 31st character | 0E1E ₁₆ | 0E3E ₁₆ | 0E5E ₁₆ |
| | 32nd character | 0E1F ₁₆ | 0E3F ₁₆ | 0E5F ₁₆ |
| | 1st character | 0E80 ₁₆ | 0EA0 ₁₆ | 0EC0 ₁₆ |
| Block 15 | 2nd character | 0E81 ₁₆ | 0EA1 ₁₆ | 0EC1 ₁₆ |
| | ⋮ | ⋮ | ⋮ | ⋮ |
| | 31st character | 0E9E ₁₆ | 0EBE ₁₆ | 0EDE ₁₆ |
| | 32nd character | 0E9F ₁₆ | 0EBF ₁₆ | 0EDF ₁₆ |
| Block 16 | 1st character | 0F00 ₁₆ | 0F20 ₁₆ | 0F40 ₁₆ |
| | 2nd character | 0F01 ₁₆ | 0F21 ₁₆ | 0F41 ₁₆ |
| | ⋮ | ⋮ | ⋮ | ⋮ |
| | 31st character | 0F1E ₁₆ | 0F3E ₁₆ | 0F5E ₁₆ |
| Block 17 | 32nd character | 0F1F ₁₆ | 0F3F ₁₆ | 0F5F ₁₆ |
| | 1st character | 0F80 ₁₆ | 0FA0 ₁₆ | 0FC0 ₁₆ |
| | 2nd character | 0F81 ₁₆ | 0FA1 ₁₆ | 0FC1 ₁₆ |
| | ⋮ | ⋮ | ⋮ | ⋮ |
| Block 18 | 31st character | 0F9E ₁₆ | 0FBE ₁₆ | 0FDE ₁₆ |
| | 32nd character | 0F9F ₁₆ | 0FBF ₁₆ | 0FDF ₁₆ |

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Note: Do not read from/write to the addresses in Table 12.11.6.

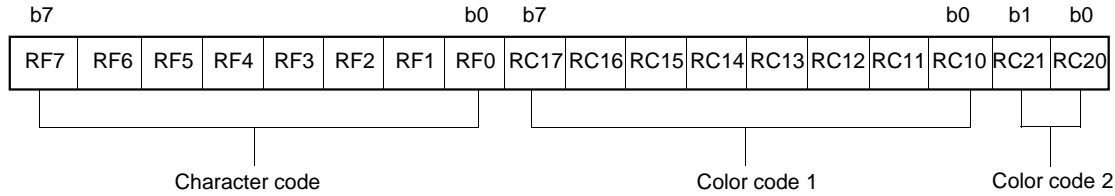
Table 12.11.6 List of Access Disable Addresses

| | |
|--|--|
| 0860 ₁₆ to 087F ₁₆ | 0C60 ₁₆ to 0C7F ₁₆ |
| 08E0 ₁₀ to 08FF ₁₆ | 0CE0 ₁₆ to 0CFF ₁₆ |
| 0960 ₁₆ to 097F ₁₆ | 0D60 ₁₆ to 0D7F ₁₆ |
| 09E0 ₁₆ to 09FF ₁₆ | 0DE0 ₁₆ to 0DFF ₁₆ |
| 0A60 ₁₆ to 0A7F ₁₆ | 0E60 ₁₆ to 0E7F ₁₆ |
| 0AE0 ₁₆ to 0AFF ₁₆ | 0EE0 ₁₆ to 0EFF ₁₆ |
| 0B60 ₁₆ to 0B7F ₁₆ | 0F60 ₁₆ to 0F7F ₁₆ |
| 0BE0 ₁₆ to 0BFF ₁₆ | 0FE0 ₁₆ to 0FFF ₁₆ |

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Blocks 1 to 16



| Bit | CC mode | | OSD mode | | CDOSD mode | | | | | | | | | |
|------|------------------------------------|------------------------------|--|--|------------------------------------|------------------------------|--|--|--|------------------------------|--|--|---|------------------------------|
| | Bit name | | Function | | Bit name | | Function | | | | | | | |
| RF0 | Character code (Low-order 8 bits) | | Specify character code in OSD ROM (See note 3) | | Character code (Low-order 8 bits) | | Specify character code in OSD ROM (See note 3) | | CD code (6 bits) | | Specify character code in OSD ROM (color dot) (See note 4) | | | |
| RF1 | | | | | | | | | | | | | | |
| RF2 | | | | | | | | | | | | | | |
| RF3 | | | | | | | | | | | | | | |
| RF4 | | | | | | | | | | | | | | |
| RF5 | | | | | | | | | | | | | | |
| RF6 | | | | | | | | | | | | | | |
| RF7 | | | | | | | | | | | | | | |
| RC10 | Character code (High-order 1 bits) | | | | Character code (High-order 1 bits) | | | | Not used | | _____ | | | |
| RC11 | Character | Color pallet selection bit 0 | | Specify color pallet for character (See note 5) | | Character | Color pallet selection bit | | | | | | | |
| RC12 | | Color pallet selection bit 1 | | | | | Color pallet selection bit | | | | | | | |
| RC13 | | Color pallet selection bit 2 | | | | | Color pallet selection bit | | | | | | | |
| RC14 | | Italic control | | | | | 0: Italic OFF 1: Italic ON | | | | | | Character background | Color pallet selection bit 3 |
| RC15 | Flash control | | 0: Flash OFF 1: Flash ON | | Color pallet selection bit 0 | | Specify color pallet for background (See note 5) | | | | | | | |
| RC16 | Underline control | | 0: Underline OFF 1: Underline ON | | Color pallet selection bit 1 | | | | | | | | | |
| RC17 | OUT2 output control | | 0: OUT2 output OFF 1: OUT2 output ON | | OUT2 output control | | 0: OUT2 output OFF 1: OUT2 output ON | | Dot color | | Color pallet selection bit 0 | | Specify a dot which selects color pallet 0 or 8 by OSD ROM (See note 6) | |
| | | | | | | Color pallet selection bit 1 | | | | | | | | |
| | | | | | | Color pallet selection bit 2 | | | | | | | | |
| | | | | | | | | | | Color pallet selection bit 3 | | | | |
| RC20 | Character background | Color pallet selection bit 0 | | Specify color pallet for background (See note 5) | | Character background | Color pallet selection bit 2 | | Specify color pallet for background (See note 5) | | Not used | | _____ | |
| RC21 | | Color pallet selection bit 1 | | | | | Color pallet selection bit 3 | | | | | | | |

Notes 1: Read value of bits 2 to 7 of the color code 2 is undefined.

2: For "not used" bits, the write value is read.

3: Do not use character code "0FF₁₆," "100₁₆."

4: Do not use character code "1F₁₆," "20₁₆."

5: Refer to Figure 12.11.24.

6: Only CDOSD mode, a dot which selects color pallet 0 or 8 is colored to the color pallet set by RC13 to RC16 of OSD RAM in character units.

Fig. 12.11.23 Structure of OSD RAM

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12.11.7 Character Color

As shown in Figure 2.11.24, there are 16 built-in color pallets. Color pallet 0 is fixed at transparent, and color pallet 8 is fixed at black.

The remaining 14 colors can be set to any of the 64 colors available.

The setting procedure for character colors is as follows:

- CC mode 8 kinds
Color pallet selection range (color pallets 0 to 7 or 8 to 15) can be selected by bit 0 of the OSD control register 3 (address 0219₁₆). Color pallets are set by bits RC11 to RC13 of the OSD RAM from among the selection range.
- OSD mode 15 kinds
Color pallets are set by bits RC14 to RC16 of the OSD RAM.
- CDOSD mode 8 kinds
Color pallet selection range (color pallets 0 to 7 or 8 to 15) can be selected by bit 3 of the OSD control register 3 (address 0219₁₆). Color pallets are set in dot units according to the CD font data (the OSD RAM<color dot font> contents) from among the selection range.
Only in CDOSD mode, a dot which selects color pallet 0 or 8 is colored to the color pallet set by RC13 to RC16 of OSD RAM in character units.
- SPRITE display 8 kinds
Color pallet selection range (color pallets 0 to 7 or 8 to 15) can be selected by bit 4 of the OSD control register 3 (address 0219₁₆). Color pallets are set in dot units according to the CD font data (the OSD RAM<color dot font> contents) from among the selection range.

Notes 1: Color pallet 8 is always selected for bordering and solid space output (OUT 1 output) regardless of the set value in the register.

2: Color pallet 0 (transparent) and the transparent setting of other color pallets will differ. When there are multiple layers overlapping (on top of each other, piled up), and the priority layer is color pallet 0 (transparent), the bottom layer is displayed, but if the priority layer is the transparent setting of any other color pallet, the background is displayed without displaying the bottom layer (refer to Figure 12.11.26).

12.11.8 Character Background Color

The display area around the characters can be colored in with a character background color. Character background colors are set in character units.

- CC mode 4 kinds
Color pallet selection range (color pallets 0 to 3, 4 to 7, 8 to 11, or 12 to 15) can be selected by bits 1 and 2 of the OSD control register 3 (address 0219₁₆). Color pallets are set by bits RC20 and RC21 of the OSD RAM from among the selection range.
- OSD mode 15 kinds
Color pallets are set by bits RC15, RC16, RC20, and RC21 of the OSD RAM.

Note : The character background is displayed in the following part:
(character display area) – (character font) – (border).
Accordingly, the character background color and the color signal for these two sections cannot be mixed.

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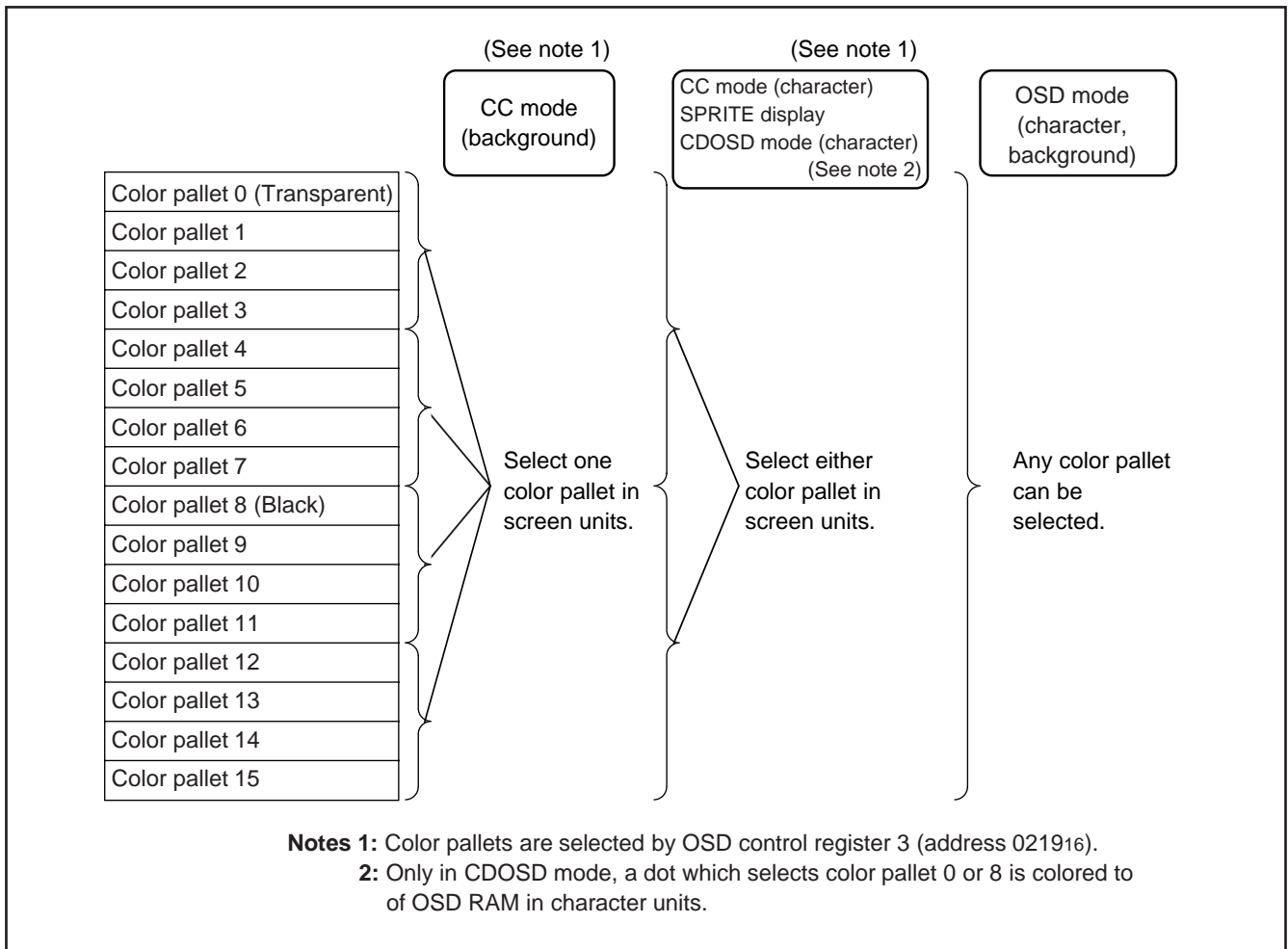


Fig. 12.11.24 Color Code Selection

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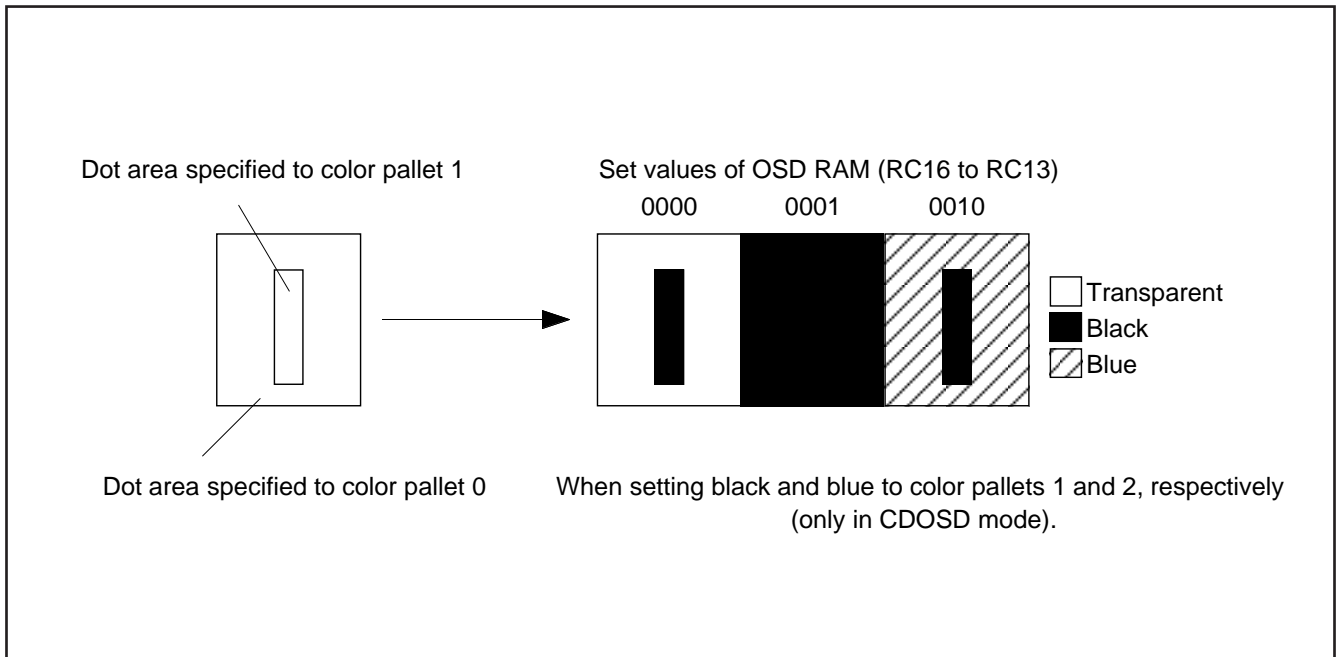


Fig. 12.11.25 Set of Color Pallet 0 or 8 in CDROM Mode

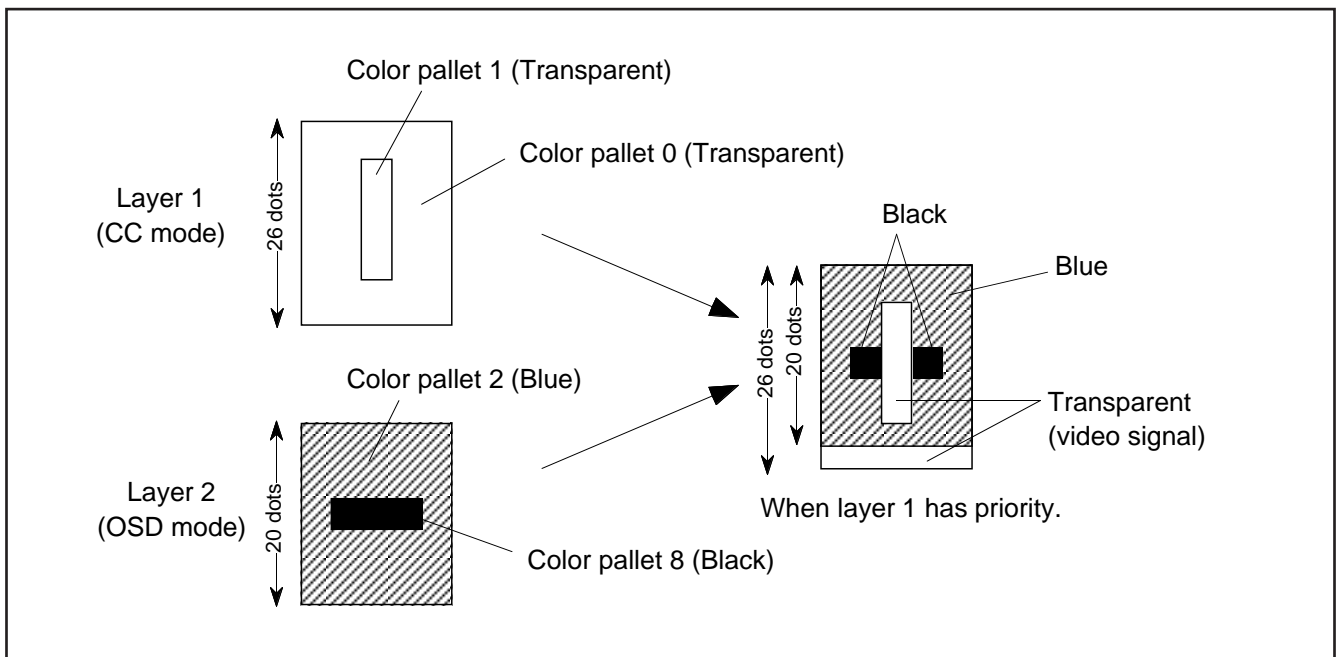
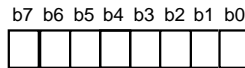


Fig. 12.11.26 Difference Between Color Code 0 (Transparent) and Transparent Setting of Other Color Codes

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OSD Control Register 3



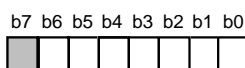
OSD control register 3 (OC3) [Address 0219₁₆]

| B | Name | Functions | After reset | R | W |
|------|---|--|-------------|---|---|
| 0 | CC mode character color selection bit (OC30) | 0: Color code 0 to 7 1: Color code 8 to 15 | 0 | R | W |
| 1, 2 | CC mode character background color selection bits (OC31, OC32) (See note) | b1 b1 0 0: Color code 0 to 3 0 1: Color code 4 to 7 1 0: Color code 8 to 11 1 1: Color code 12 to 15 | 0 | R | W |
| 3 | CDOSD mode character color selection bit (OC33) | 0: Color code 0 to 7 1: Color code 8 to 15 | 0 | R | W |
| 4 | SPRITE color selection bit (OC34) | 0: Color code 0 to 7 1: Color code 8 to 15 | 0 | R | W |
| 5 | OSD mode window control bit (OC35) | 0: Window OFF 1: Window ON | 0 | R | W |
| 6 | CC mode window control bit (OC36) | 0: Window OFF 1: Window ON | 0 | R | W |
| 7 | CDOSD mode window control bit (OC37) | 0: Window OFF 1: Window ON | 0 | R | W |

Note: Color pallet 8 is always selected for solid space (when OUT1 output is selected), regardless of value of this register.

Fig. 12.11.27 OSD Control Register 3

Color Pallet Register i



Color pallet register i (CRi) (i = 1 to 7, 9 to 15) [Addresses 0241₁₆ to 0247₁₆, 0249₁₆ to 024F₁₆]

| B | Name | Functions | After reset | R | W |
|------|--|--|---------------|---|---|
| 0, 1 | R signal output control bits (CRi0, CRi1) | b0 b1 0 0: No output (See note) 0 1: 1/3 Vcc 1 0: 2/3 Vcc 1 1: Vcc | Indeterminate | R | W |
| 2, 3 | G signal output control bits (CRi2, CRi3) | b3 b2 0 0: No output (See note) 0 1: 1/3 Vcc 1 0: 2/3 Vcc 1 1: Vcc | Indeterminate | R | W |
| 4, 5 | B signal output control bits (CRi4, CRi5) | b5 b4 0 0: No output (See note) 0 1: 1/3 Vcc 1 0: 2/3 Vcc 1 1: Vcc | Indeterminate | R | W |
| 6 | OUT1 signal output control bit (CRi6) | 0: No output 1: Output | Indeterminate | R | W |
| 7 | Nothing is assigned. This bit is a write disable bit. When this bit is read out, the value is indeterminate. | | Indeterminate | R | — |

Note: When selecting digital output, the output is Vcc at all values other than "00."

Fig. 12.11.28 Color Pallet Register i (i = 1 to 7, 9 to 15)

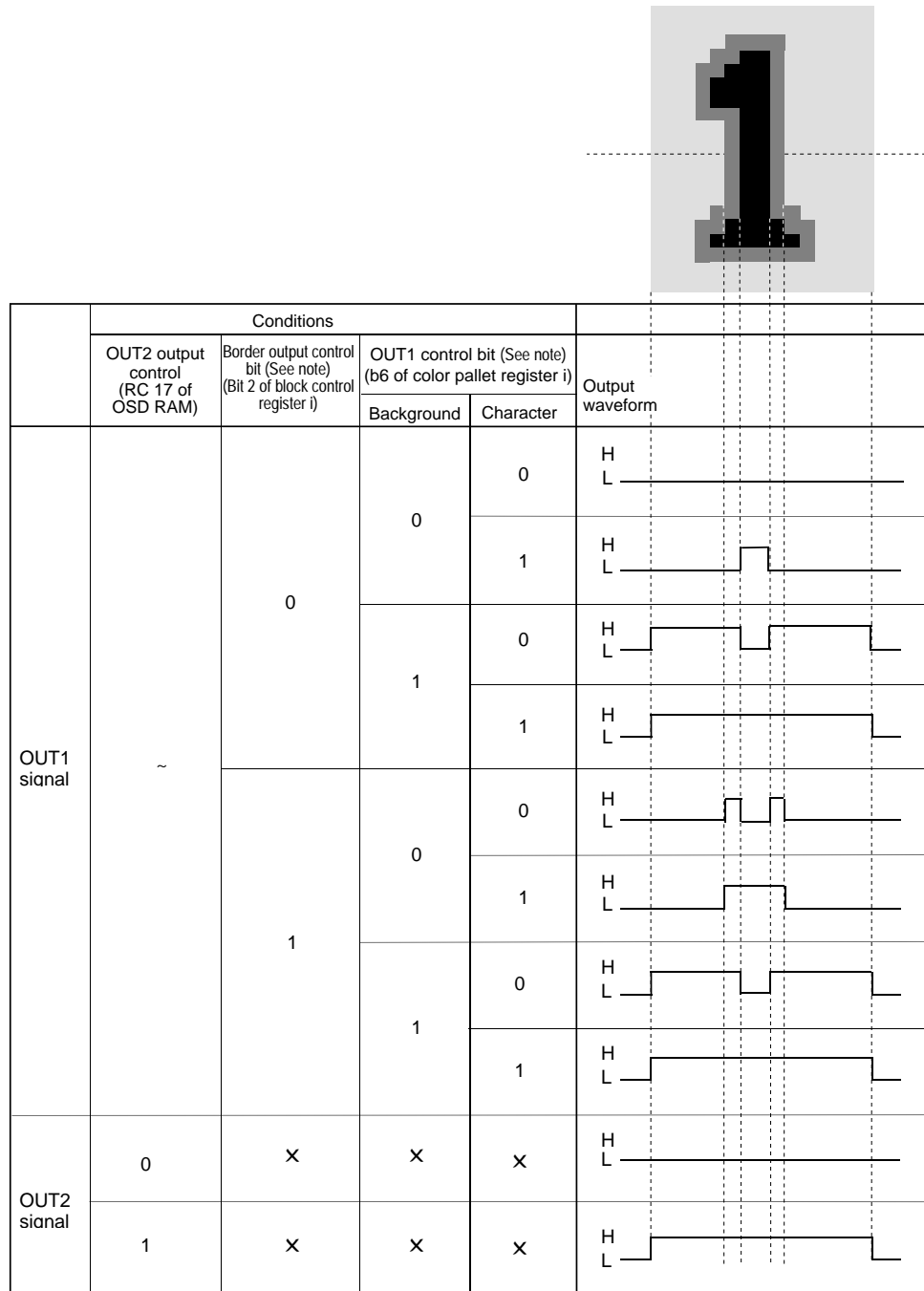
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12.11.9 OUT1, OUT2 Signals

The OUT1, OUT2 signals are used to control the luminance of the video signal. The output waveform of the OUT1, OUT2 signals is controlled by bit 6 of the color code register i (refer to Figure 86), bits

2 and 7 of the block control register i (refer to Figure 63) and RC17 of OSD RAM. The setting values for controlling OUT1, OUT2 and the corresponding output waveform is shown in Figure 12.11.29



- Notes** 1: This control is only valid in the OSD mode. It is invalid in CC/CDOSD mode .
 2: In the CDOSD mode, coloring is performed for each dot. Accordingly, OUT1 outputs to dots which bit 6 of the color pallet register i is set to "0."
 3: OUT2 cannot be output in sprite OSD.
 4: X is an arbitrary value.

Fig. 12.11.29 Setting Value for Controlling OUT1, OUT2 and Corresponding Output Waveform

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12.11.10 Attribute

The attributes (flash, underline, italic) are controlled to the character font. The attributes to be controlled are different depending on each mode.

CC mode Flash, underline, italic for each character
OSD mode Border (all bordered, shadow bordered can be selected) for each block

(1) Under line

The underline is output at the 23rd and 24th lines in vertical direction only in the CC mode. The underline is controlled by RC16 of OSD RAM. The color of underline is the same color as that of the character font.

(2) Flash

The parts of the character font, the underline, and the character background are flashed only in the CC mode. The flash for each character is controlled by RC15 of OSD RAM. The ON/OFF for flash is controlled by bit 3 of the OSD control register 1 (refer to Figure 12.11.3). When this bit is "0", only character font and underline flash. When "1", for a character without solid space output, R, G, B and OUT1 (all display area) flash, for a character with solid space output, only R, G and B (all display area) flash. The flash cycle bases on the VSYNC count.

<NTSC method>

- VSYNC cycle X 48 ≈ 800 ms (at flash ON)
- VSYNC cycle X 16 ≈ 267 ms (at flash OFF)

(3) Italic

The italic is made by slanting the font stored in OSD ROM to the right only in the CC mode. The italic is controlled by RC14 of OSD RAM.

The display example of attribute is shown in Figure 12.11.31. In this case, "R" is displayed.

- Notes**
- 1: When setting both the italic and the flash, the italic character flashes.
 - 2: When a flash character (with flash character background) join on the right side of a non-flash italic character, parts out of the non-flash italic character is also flashed.
 - 3: OUT2 is not flashed.
 - 4: When the pre-divide ratio = 1, the italic character with slant of 1 dot X 5 steps is displayed (refer to Figure 12.11.30 (c)). When the pre-divide ratio = 2, the italic character with slant of 1/2 dot X 10 steps is displayed (refer to Figure 12.11.30 (d)).
 - 5: The boundary of character color is displayed in italic. However, the boundary of character background color is not affected by the italic (refer to Figure 12.11.31).
 - 6: The adjacent character (one side or both side) to an italic character is displayed in italic even when the character is not specified to display in italic (refer to Figure 12.11.31).
 - 7: When displaying the 32nd character in the italic and when solid space is off (OC14 = "0"), parts out of character area is not displayed.
 - 8: When displaying the italic character in the block with the pre-divide ratio = 1, set the OSD clock frequency to 11 MHz to 14 MHz.

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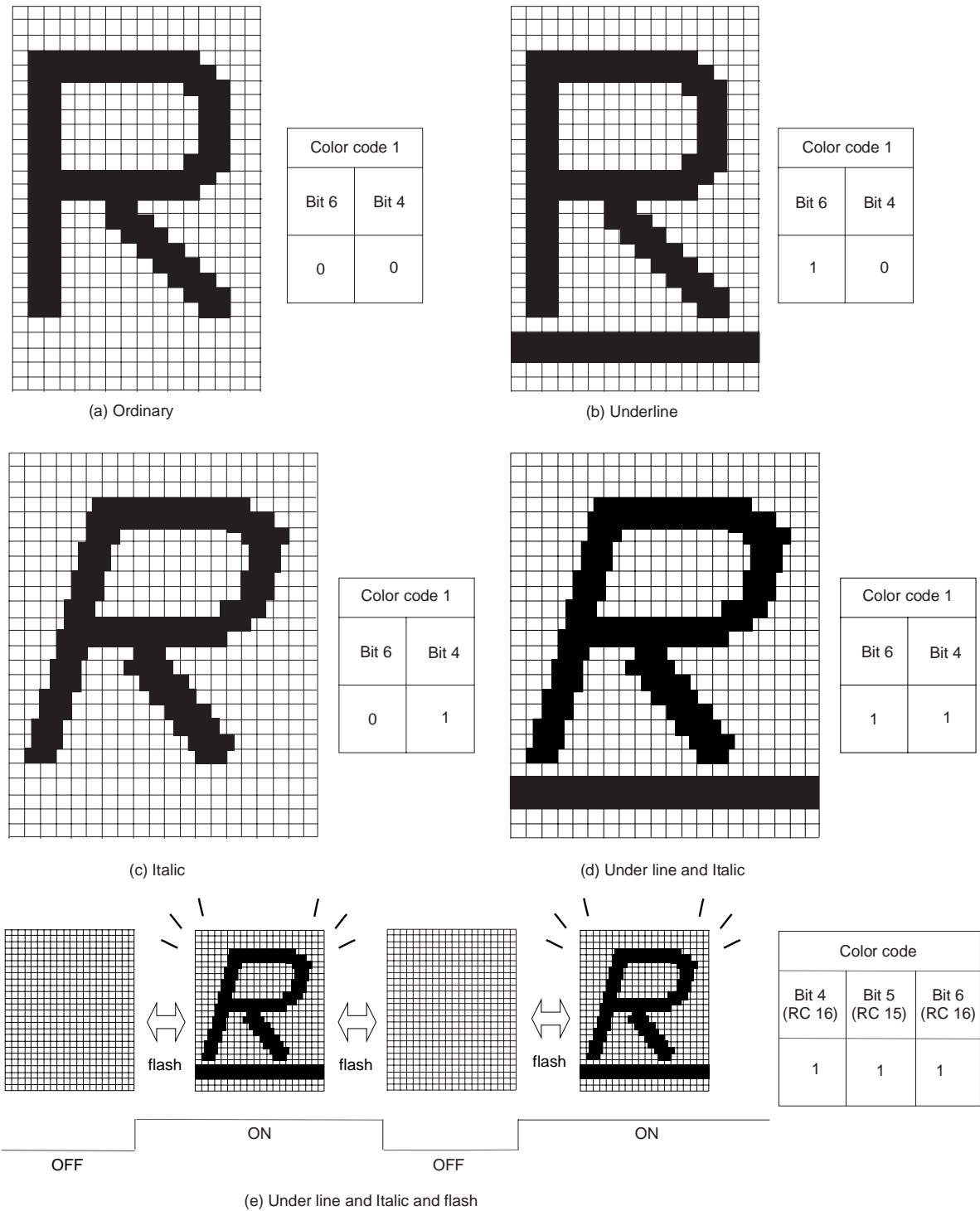


Fig. 12.11.30 Example of Attribute Display (in CC Mode)

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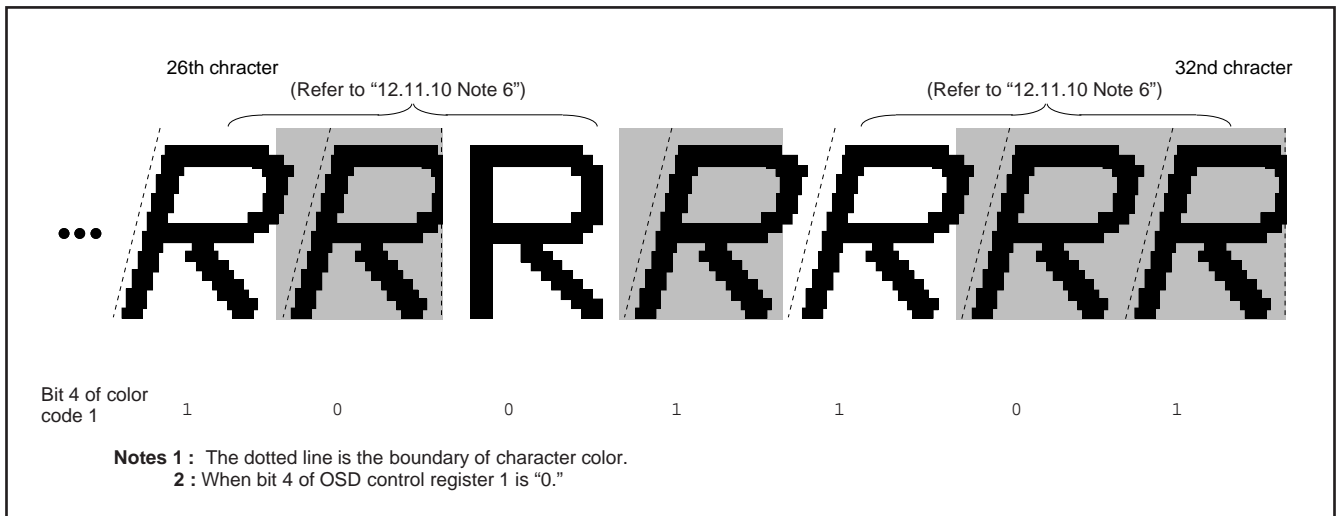


Fig. 12.11.31 Example of Italic Display

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(4) Border

The border is output only in the OSD mode. The all bordered (bordering around of character font) and the shadow bordered (bordering right and bottom sides of character font) are selected (refer to Figure 12.11.31) by bit 2 of the OSD control register 1 (refer to Figure 12.11.3). The ON/OFF switch for borders can be controlled in block units by bit 2 of the block control register i (refer to Figure 12.11.4).

The OUT1 signal is used for border output. The border color is fixed at color code 8 (black). The border color for each screen is specified by the border color register i.

The horizontal size (x) of border is 1Tc (OSD clock cycle divided in the pre-divide circuit) regardless of the character font dot size. However, only when the pre-divide ratio = 2 and character size = 1.5Tc, the horizontal size is 1.5Tc. The vertical size (y) different depending on the screen scan mode and the vertical dot size of character font.

Notes 1: The border dot area is the shaded area as shown in Figure 12.11.34.

2: When the border dot overlaps on the next character font, the character font has priority (refer to Figure 12.11.35 A). When the border dot overlaps on the next character back ground, the border has priority (refer to Figure 12.11.35 B).

3: The border in vertical out of character area is not displayed (refer to Figure 12.11.35).

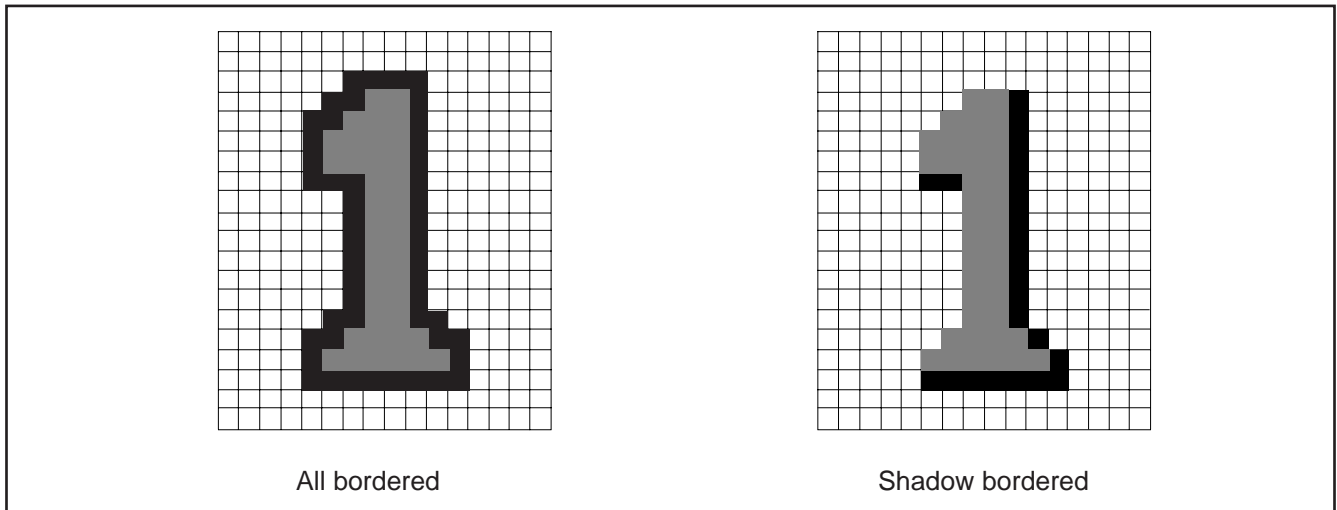


Fig. 12.11.32 Example of Border Display

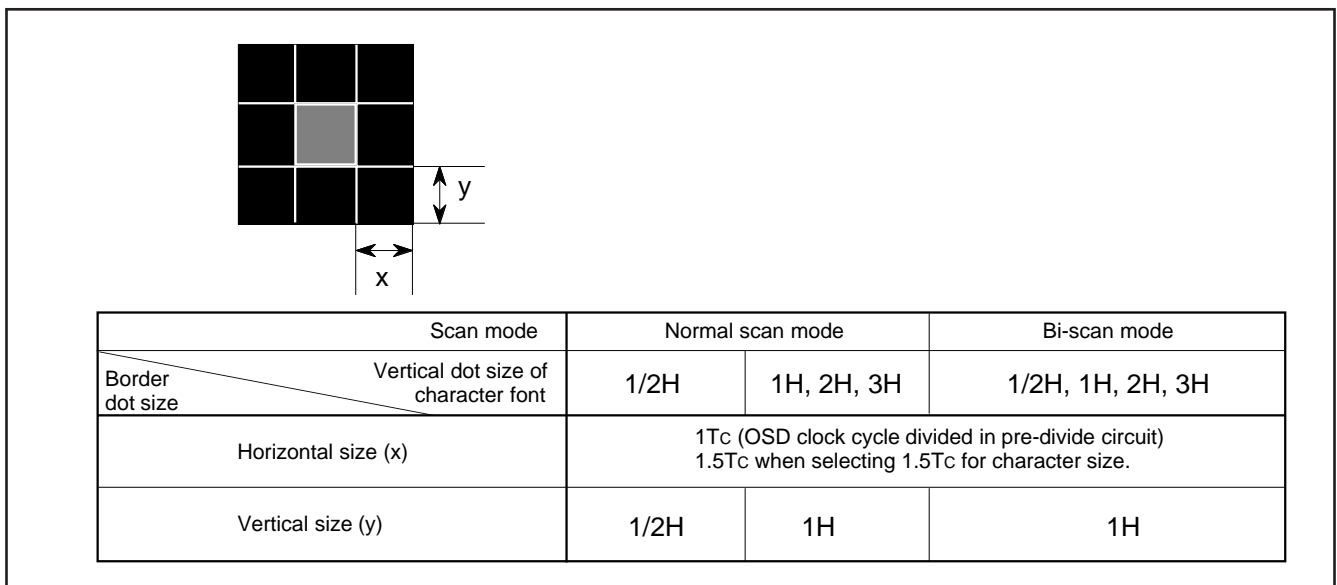


Fig. 12.11.33 Horizontal and Vertical Size of Border

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 M37280EKSP**

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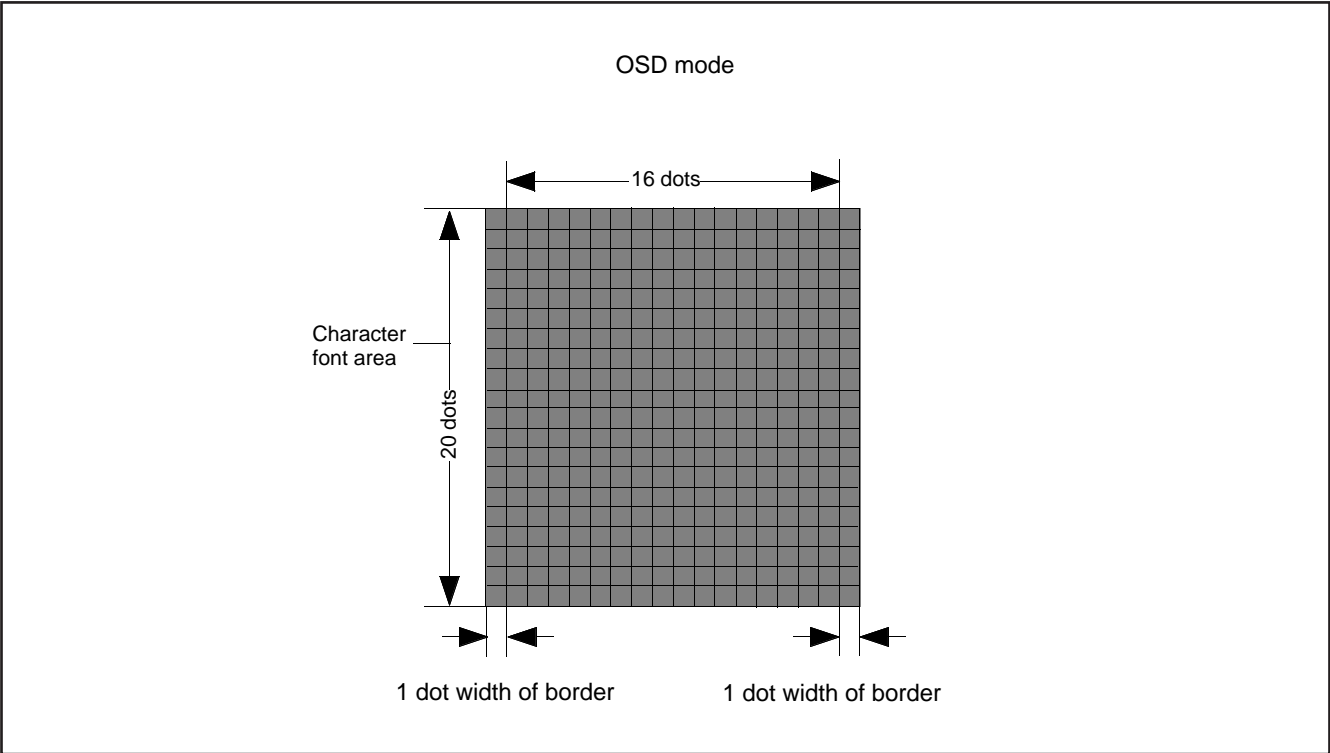


Fig. 12.11.34 Border Area

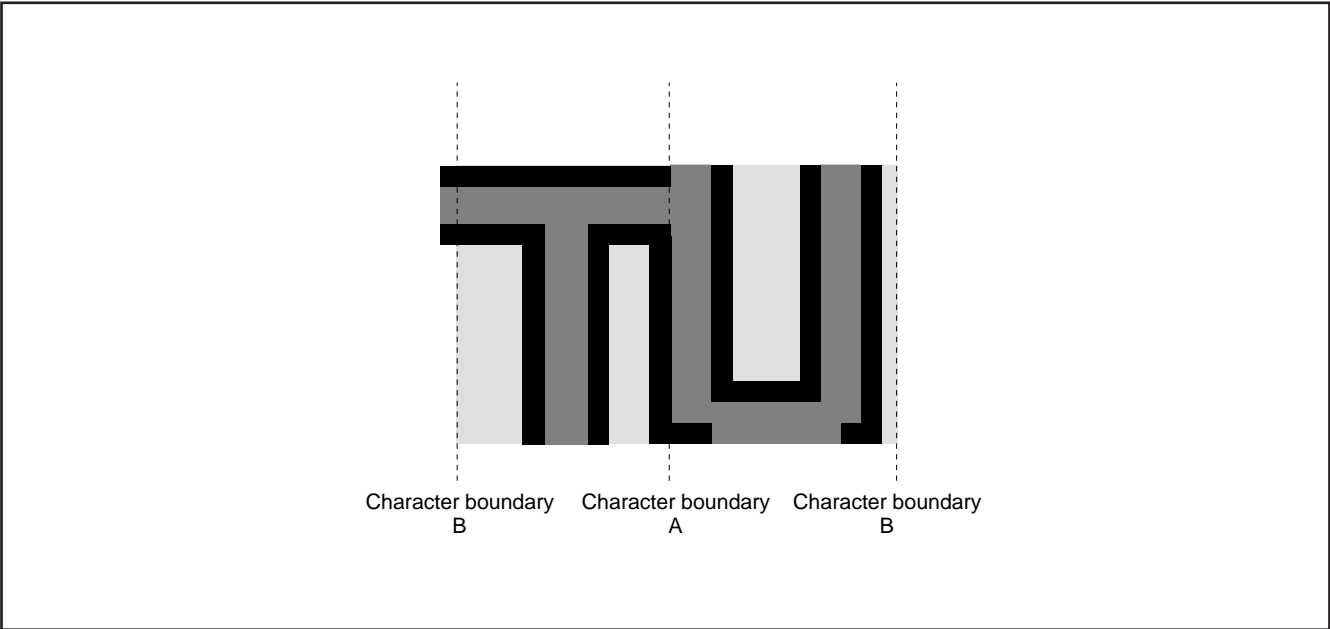


Fig. 12.11.35 Border Priority

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SINGLE-CHIP 8-BIT CMOS MICROCOMPUTER with CLOSED CAPTION DECODER
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12.11.11 Multiline Display

This microcomputer can ordinarily display 16 lines on the CRT screen by displaying 16 blocks at different vertical positions. In addition, it can display up to 16 lines by using OSD interrupts.

An OSD interrupt request occurs at the point at which display of each block has been completed. In other words, when a scanning line reaches the point of the display position (specified by the vertical position registers) of a certain block, the character display of that block starts, and an interrupt occurs at the point at which the scanning line exceeds the block. The mode in which an OSD interrupt occurs is different depending on the setting of the OSD control register 2 (refer to Figure 12.11.7).

- When bit 7 of the OSD control register 2 is "0"

An OSD interrupt request occurs at the completion of layer 1 block display.

- When bit 7 of the OSD control register 2 is "1"

An OSD interrupt request occurs at the completion of layer 2 block display.

Notes 1: An OSD interrupt does not occur at the end of display when the block is not displayed. In other words, if a block is set to off display by the display control bit of the block control register i (addresses 00D016 to 00DF16), an OSD interrupt request does not occur (refer to Figure 12.11.36 (A)).

2: When another block display appears while one block is displayed, an OSD interrupt request occurs only once at the end of the another block display (refer to Figure 12.11.36 (B)).

3: On the screen setting window, an OSD interrupt occurs even at the end of the CC mode block (off display) out of window (refer to Figure 12.11.36 (C)).

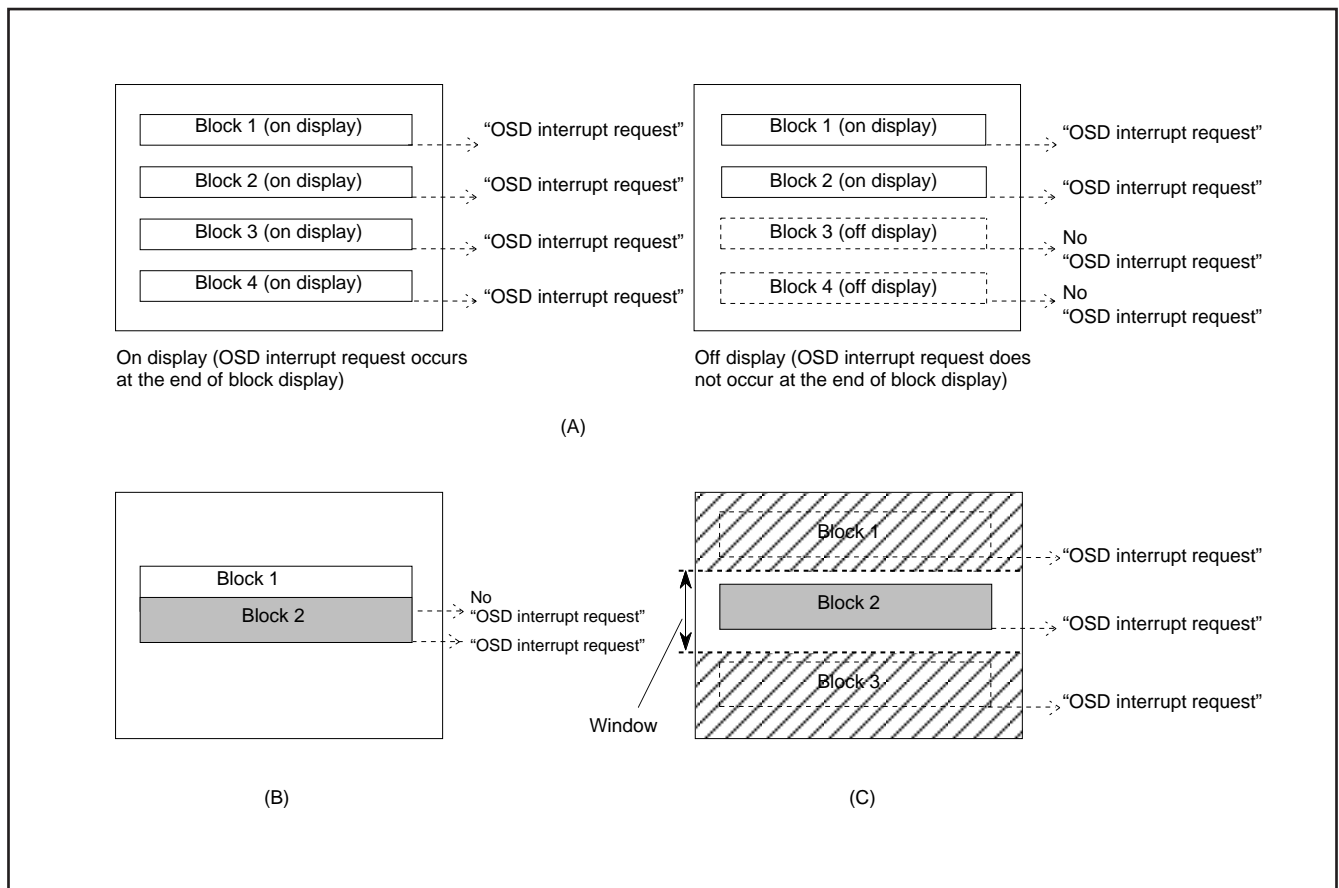


Fig. 12.11.36 Note on Occurrence of OSD Interrupt

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12.11.12 Automatic Solid Space Function

This function generates automatically the solid space (OUT1 or OUT2 blank output) of the character area in the CC mode.

The solid space is output in the following area :

- Any character area except character code "00916 "
 - Character area on the left and right sides of the above character
- This function is turned on and off by bit 4 of the OSD control register 1 (refer to Figure 12.11.3).
- And the OUT1 output or OUT2 output can be selected by bit 3 of OSD control register 2.

Note: When selecting OUT1 as solid space output, character background color with solid space output is fixed to color pallet 8 (black) regardless of setting.

Table 12.11.7 Setting for Automatic Solid Space

| Bit 4 of OSD Control Register 1 | 0 | | | | 1 | | | |
|---------------------------------|--|-------------------------|--|-------------------------|-------------------|-------------------------|--|---|
| Bit 3 of OSD Control Register 2 | 0 | | 1 | | 0 | | 1 | |
| RC17 of OSD RAM | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 |
| OUT1 Output Signal | •Character font area •Character background area | | •Character font area •Character background area | | •Solid space area | | •Character font area •Character background area | |
| OUT2 Output Signal | OFF | •Character display area | OFF | •Character display area | OFF | •Character display area | OFF | •Solid space •Character display area |

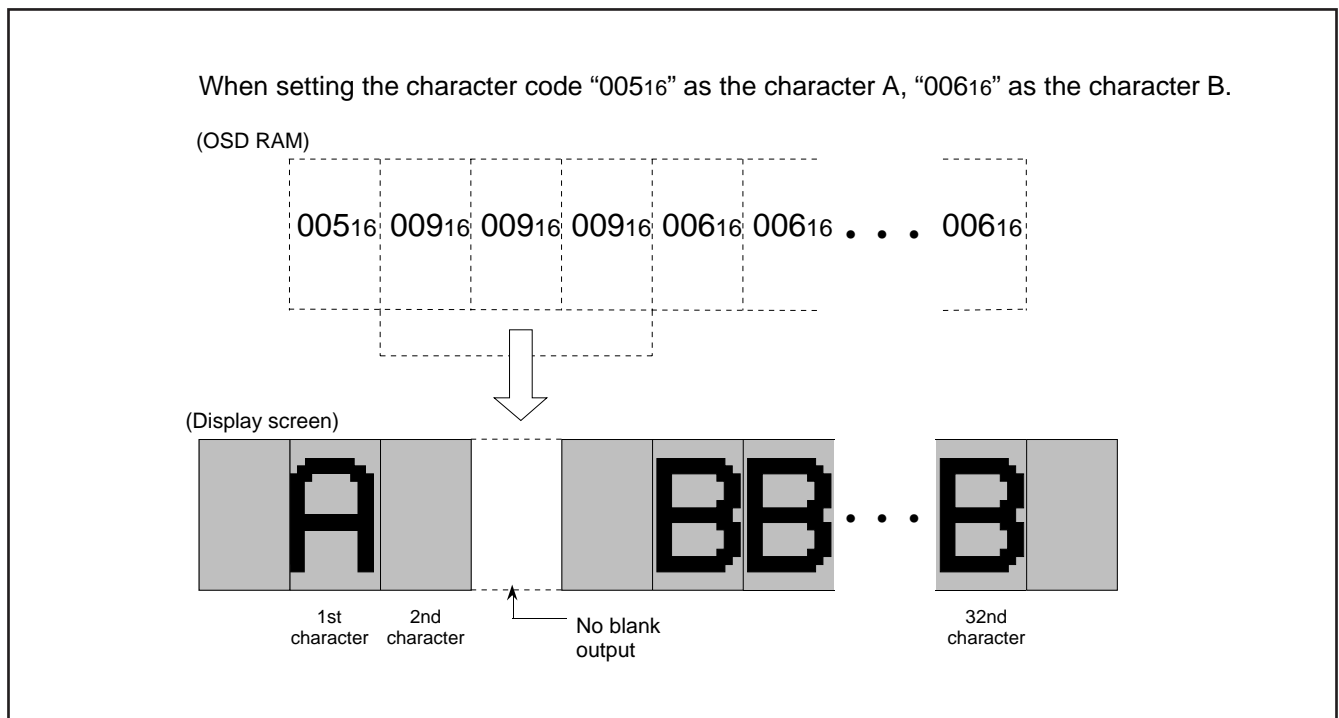


Fig. 12.11.37 Display Screen Example of Automatic Solid Space

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12.11.13 Scan Mode

This microcomputer has the bi-scan mode for corresponding to Hsync of double speed frequency. In the bi-scan mode, the vertical start display position and the vertical size is two times as compared with the normal scan mode. The scan mode is selected by bit 1 of the OSD control register 1 (refer to Figure 12.11.3).

Table 12.11.8 Setting for Scan Mode

| Scan Mode | Normal Scan | Bi-Scan |
|---------------------------------|--|--|
| Parameter | | |
| Bit 1 of OSD Control Register 1 | 0 | 1 |
| Vertical Display Start Position | Value of vertical position register X 1H | Value of vertical position register X 2H |
| Vertical Dot Size | 1TC X 1/2H 1TC X 1H 2TC X 2H 3TC X 3H | 1TC X 1H 1TC X 2H 2TC X 4H 3TC X 6H |

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12.11.14 Window Function

The window function can be set windows on-screen, and output OSD within only the area where the window is set.

The ON/OFF for vertical window function is performed by bit 5 of OSD control register 1 and is used to select vertical window function or vertical blank function by bit 6 of OSD control register 2. Accordingly, the vertical window function cannot be used simultaneously with the vertical blank function. The display mode to validate the window function is selected by bits 5 to 7 of OSD control register 3. The top boundary is set by top border control registers 1 and 2 (TB1, TB2) and the bottom boundary is set by bottom border control registers 1 and 2 (BB1, BB2).

The ON/OFF for horizontal window function is performed by bit 4 of OSD control register 2 and is used interchangeably for the horizontal blank function with bit 5 of OSD control register 2. Accordingly, the horizontal blank function cannot be used simultaneously with the horizontal window function. The display mode to validate the window function is selected by bits 5 to 7 of OSD control register 3. The left boundary is set by left border control registers 1 and 2 (LB1 and LB2), and the right boundary is set by right border control registers 1 and 2 (RB1 and RB2).

- Notes**
- 1: When using vertical window, do not set "0016" or "0116" to TB1 at TB2 = "0016."
 - 2: When using horizontal window, do not set LB1 = LB2 = "0016."
 - 3: Horizontal blank and horizontal window, as well as vertical blank and vertical window can not be used simultaneously.
 - 4: When using horizontal window, set as follows:
 $(LB1 + LB2 \times 16^2) < (RB1 + RB2 \times 16^2)$.
 - 5: When using vertical window, set as follows:
 $(TB1 + TB2 \times 16^2) < (BB1 + BB2 \times 16^2)$.
 - 6: When the window function is ON by OSD control registers 1 and 2, the window function of OUT2 is valid in all display mode regardless of setting value of OSD control register 3 (bits 5 to 7). For example, even when make the window function valid in only CC mode, the function of OUT2 is valid in OSD and CDOSD modes.

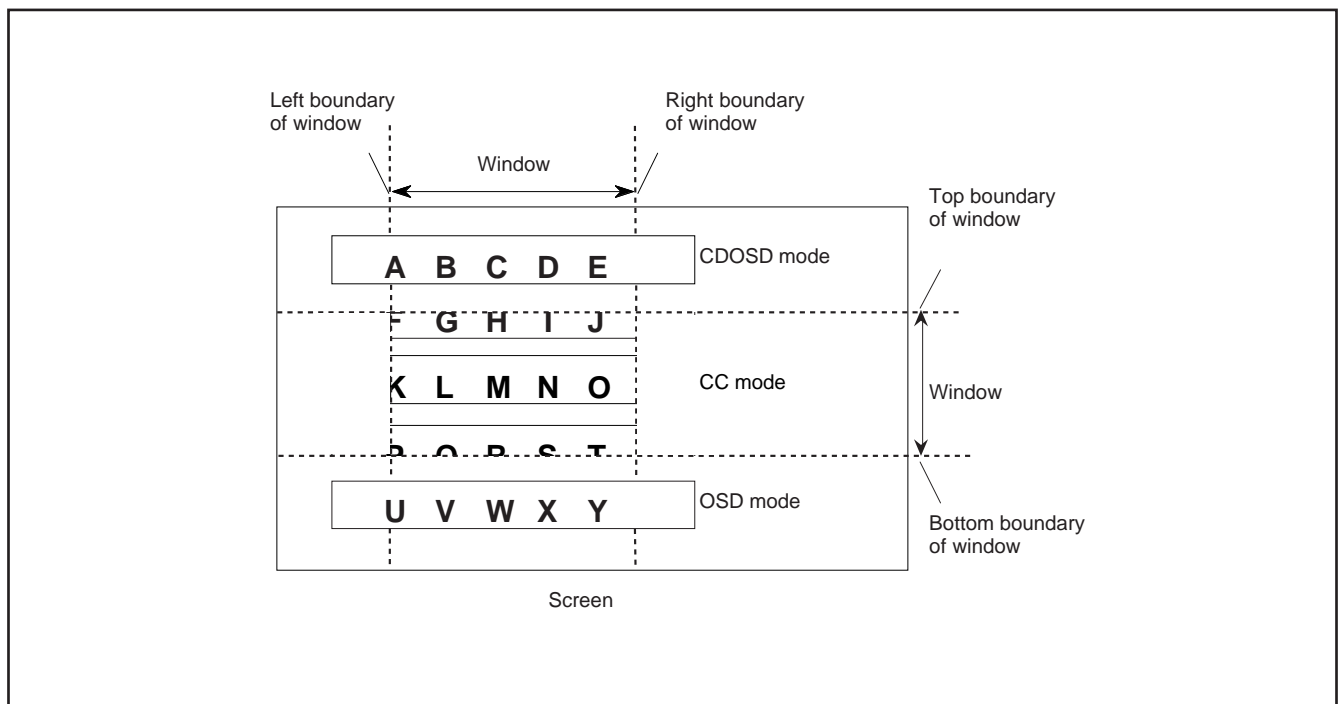


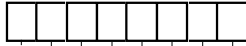
Fig. 12.11.38 Example of window function (When CC Mode Is Valid)

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Top Border Control Register 1

b7 b6 b5 b4 b3 b2 b1 b0



Top border control register 1 (TB1) [Address 021C16]

| B | Name | Functions | After reset | R | W |
|--------------|---|--|---------------|---|---|
| 0 to 7 | Control bits of top border (TB10 to TB17) | Top border position (low-order 8 bits) $T_H \times$ (setting value of low-order 2 bits of TB2 $\times 16^2$ + setting value of high-order 4 bits of TB1 $\times 16^1$ + setting value of low-order 4 bits of TB1 $\times 16^0$) | Indeterminate | R | W |

Notes 1: Do not set "0016" or "0116" to the TB1 at TB2 = "0016."

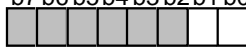
2: T_H is cycle of HSYNC.

3: TB2 is top border control register 2.

Fig. 12.11.39 Top Border Control Register 1

Top Border Control Register 2

b7 b6 b5 b4 b3 b2 b1 b0



Top border control register 2 (TB2) [Address 021E16]

| B | Name | Functions | After reset | R | W |
|--------------|--|---|---------------|---|---|
| 0, 1 | Control bits of top border (TB20 ,TB21) | Top border position (high-order 2 bits) $T_H \times$ (setting value of low-order 2 bits of TB2 $\times 16^2$ + setting value of high-order 4 bits of TB1 $\times 16^1$ + setting value of low-order 4 bits of TB1 $\times 16^0$) | Indeterminate | R | W |
| 2 to 7 | Nothing is assigned. These bits are write disable bits. When these bits are read out, the values are indeterminate. | | Indeterminate | R | — |

Notes 1: Do not set "0016" or "0116" to the TB1 at TB2 = "0016."

2: T_H is cycle of HSYNC.

3: TB1 is top border control register 1.

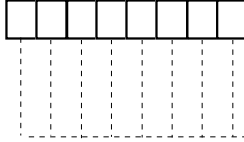
Fig. 12.11.40 Top Border Control Register 2

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Bottom Border Control Register 1

b7 b6 b5 b4 b3 b2 b1 b0



Bottom border control register 1 (BB1) [Address 021D16]

| B | Name | Functions | After reset | R: W |
|--------|--|---|---------------|------|
| 0 to 7 | Control bits of bottom border (BB10 to BB17) | Bottom border position (low-order 8 bits) TH X (setting value of low-order 2 bits of BB2 X 16 ² + setting value of high-order 4 bits of BB1 X 16 ¹ + setting value of low-order 4 bits of BB1 X 16 ⁰) | Indeterminate | R: W |

Notes 1: Set values fit for the following condition:

$$(TB1 + TB2 \times 16^2) < (BB1 + BB2 \times 16^2).$$

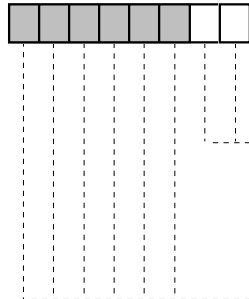
2: TH is cycle of HSYNC.

3: BB2 is bottom border control register 2.

Fig. 12.11.41 Bottom Border Control Register 1

Bottom Border Control Register 2

b7 b6 b5 b4 b3 b2 b1 b0



Bottom border control register 2 (BB2) [Address 021F16]

| B | Name | Functions | After reset | R: W |
|--------|---|--|---------------|------|
| 0, 1 | Control bits of bottom border (BB20, BB21) | Bottom border position (high-order 2 bits) TH X (setting value of low-order 2 bits of BB2 X 16 ² + setting value of high-order 4 bits of BB1 X 16 ¹ + setting value of low-order 4 bits of BB1 X 16 ⁰) | Indeterminate | R: W |
| 2 to 7 | Nothing is assigned. These bits are write disable bits. When these bits are read out, the values are indeterminate. | | Indeterminate | R: — |

Notes 1: Set values fit for the following condition:

$$(TB1 + TB2 \times 16^2) < (BB1 + BB2 \times 16^2).$$

2: TH is cycle of HSYNC.

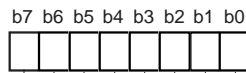
3: BB1 is bottom border control register 1.

Fig. 12.11.42 Bottom Border Control Register 2

M37280MF-XXXSP, M37280MK-XXXSP M37280EKSP

SINGLE-CHIP 8-BIT CMOS MICROCOMPUTER with CLOSED CAPTION DECODER
and ON-SCREEN DISPLAY CONTROLLER

Left Border Control Register 1



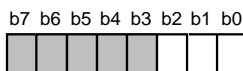
Left border control register 1 (LB1) [Address 0250₁₆]

| B | Name | Functions | After reset | R | W |
|--------|--|---|-------------|---|---|
| 0 | Control bits of left border (LB10 to LB17) | Left border position (low-order 8 bits) Tosc X (setting value of low-order 3 bits of LB2 X 16 ² + setting value of high-order 4 bits of LB1 X 16 ¹ + setting value of low-order 4 bits of LB1 X 16 ⁰) | 1 | R | W |
| 1 to 7 | | | 0 | | |

- Notes** 1: Do not set LB1 = LB2 = "00₁₆."
 2: Set values fit for the following condition:
 $(LB1 + LB2 \times 16^2) < (RB1 + RB2 \times 16^2)$.
 3: TOSC is OSD oscillation period.
 4: LB2 is left border control register 2.

Fig. 12.11.43 Left BorderControl Register 1

Left Border Control Register 2



Left border control register 2 (LB2) [Address 0251₁₆]

| B | Name | Functions | After reset | R | W |
|--------|---|--|-------------|---|---|
| 0 to 2 | Control bits of left border (LB20 to LB22) | Left border position (high-order 3 bits) Tosc X (setting value of low-order 3 bits of LB2 X 16 ² + setting value of high-order 4 bits of LB1 X 16 ¹ + setting value of low-order 4 bits of LB1 X 16 ⁰) | 0 | R | W |
| 3 to 7 | Nothing is assigned. These bits are write disable bits. When these bits are read out, the values are indeterminate. | | 0 | R | W |

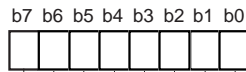
- Notes** 1: Do not set LB1 = LB2 = "00₁₆."
 2: Set values fit for the following condition:
 $(LB1 + LB2 \times 16^2) < (RB1 + RB2 \times 16^2)$.
 3: TOSC is OSD oscillation period.
 4: LB1 is left border control register 1.

Fig. 12.11.44 Left Border Control Register 2

M37280MF-XXXSP, M37280MK-XXXSP M37280EKSP

SINGLE-CHIP 8-BIT CMOS MICROCOMPUTER with CLOSED CAPTION DECODER
and ON-SCREEN DISPLAY CONTROLLER

Right Border Control Register 1



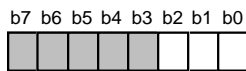
Right border control register 1 (RB1) [Address 0252₁₆]

| B | Name | Functions | After reset | R | W |
|--------|---|--|-------------|---|---|
| 0 to 7 | Control bits of right border (RB10 to RB17) | Right border position (low-order 8 bits) Tosc X (setting value of low-order 3 bits of RB2 × 16 ² + setting value of high-order 4 bits of RB1 × 16 ¹ + setting value of low-order 4 bits of RB1 × 16 ⁰) | 1 | R | W |

Notes 1: Set values fit for the following condition:
 $(LB1 + LB2 \times 16^2) < (RB1 + RB2 \times 16^2)$.
2: TOSC is OSD oscillation period.
3: RB2 is right border control register 2.

Fig. 12.11.45 Right Border Control Register 1

Right Border Control Register 2



Right border control register 2 (RB2) [Address 0253₁₆]

| B | Name | Functions | After reset | R | W |
|--------|---|---|-------------|---|---|
| 0 to 2 | Control bits of right border (RB20 to RB22) | Right border position (high-order 3 bits) Tosc X (setting value of low-order 3 bits of RB2 × 16 ² + setting value of high-order 4 bits of RB1 × 16 ¹ + setting value of low-order 4 bits of RB1 × 16 ⁰) | 1 | R | W |
| 3 to 7 | Nothing is assigned. These bits are write disable bits. When these bits are read out, the values are "0". | | 0 | R | W |

Notes 1: Set values fit for the following condition:
 $(LB1 + LB2 \times 16^2) < (RB1 + RB2 \times 16^2)$.
2: TOSC is OSD oscillation period.
3: RB1 is right border control register 1.

Fig. 12.11.46 Right Border Control Register 2

M37280MF-XXXSP, M37280MK-XXXSP M37280EKSP

SINGLE-CHIP 8-BIT CMOS MICROCOMPUTER with CLOSED CAPTION DECODER
and ON-SCREEN DISPLAY CONTROLLER

12.11.15 Blank Function

The blank function can output blank (OUT1) area on all sides (vertical and horizontal) of the screen.

The ON/OFF for vertical blank function is performed by bit 5 of the OSD control register 1 and is used to select vertical window function or vertical blank function by bit 6 of the OSD control register 2. Accordingly, the vertical blank function cannot be used simultaneously with the vertical window function. The top border is set by the top border control registers 1 and 2 (TB1, TB2), and the bottom border is set by the bottom border control registers 1 and 2 (BB1, BB2), in 1H units.

The ON/OFF for horizontal blank function is performed by bit 4 of the OSD control register 2 and is used interchangeably for the horizontal window function with bit 5 of the OSD control register 2. Accordingly, the horizontal blank function cannot be used simultaneously with the horizontal window function. The left border is set by the left border control registers 1 and 2 (LB1, LB2) and the right border is set by the right border control registers 1 and 2 (RB1, RB2), in 1Tosc units. The OSD output (except raster) in area with blank output is not deleted.

These blank signals are not output in the horizontal/vertical blanking interval.

- Notes**
- 1: When using vertical blank, do not set "0016" and "0116" to TB1 at TB2 = "0016."
 - 2: When using horizontal blank, do not set LB1 = LB2 = "0016."
 - 3: Horizontal blank and horizontal window, as well as vertical blank and vertical window can not be used simultaneously.
 - 4: When using horizontal blank, set as follows:
 $(LB1 + LB2 \times 16^2) < (RB1 + RB2 \times 16^2)$.
 - 5: When using vertical blank, set as follows:
 $(TB1 + TB2 \times 16^2) < (BB1 + BB2 \times 16^2)$.
 - 6: When all-blocks display is OFF (bit 0 of OSD control register 1 = "0"), do not use vertical blank.

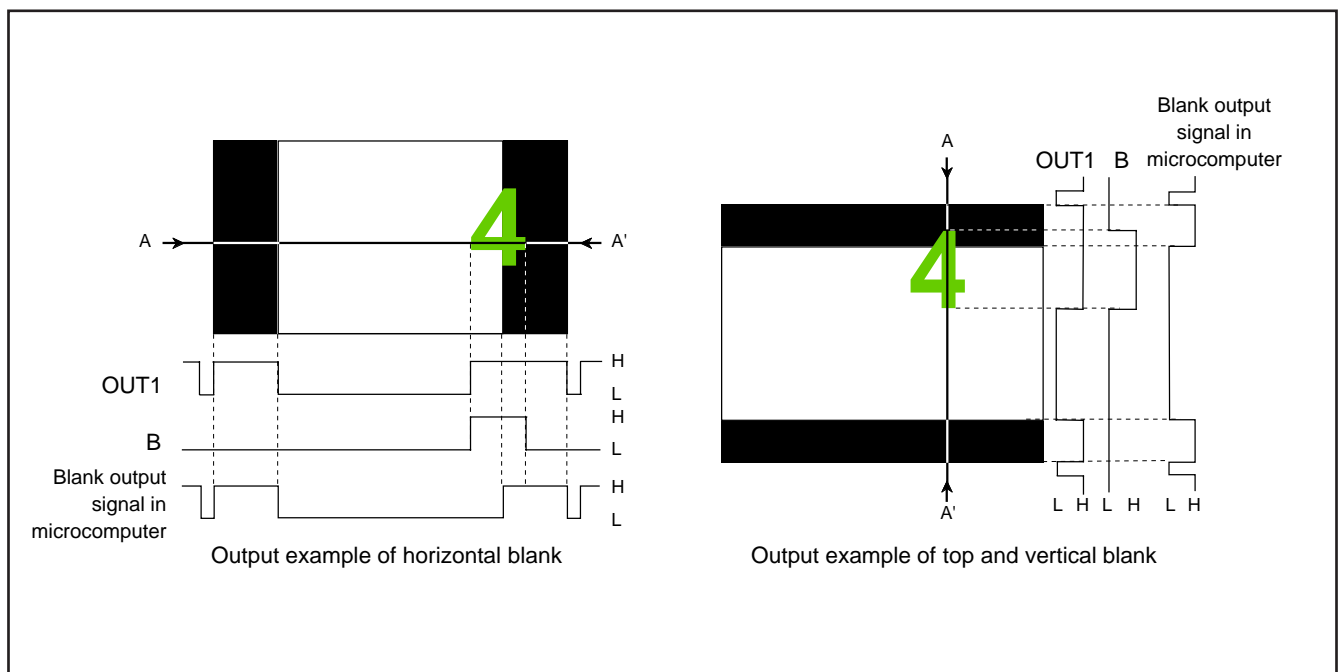


Fig. 12.11.47 Blank Output Example (When OSD Output is B + OUT1)

**M37280MF-XXXSP, M37280MK-XXXSP
 M37280EKSP**

SINGLE-CHIP 8-BIT CMOS MICROCOMPUTER with CLOSED CAPTION DECODER
 and ON-SCREEN DISPLAY CONTROLLER

12.11.16 SPRITE OSD Function

This is especially suitable for cursor and other displays as its function allows for display in any position, regardless of the validity of other OSDs or display positions. The sprite font is a RAM font consisting of 16 horizontal dots 5 20 vertical dots, three planes, and three bits of data per dot. Each plane has corresponding color pallet selection bits, and 8 kinds of color pallets can be selected by the plane bit combination (three bits) for each dot. In addition, the selection range (color pallets 0 to 7 and 8 to 15) can be set, per screen, by bit 4 of the OSD control register 3. The color pallet is set in dot units according to the selection range and the OSD RAM (SPRITE) contents from among the selection range. It is possible to arbitrarily add font data by software for the RAM font in the SPRITE font.

The SPRITE OSD control register can control SPRITE display, dot size, interrupt position, and interrupt generation factors for the SPRITE OSD. The display position can also be set independently of the block display by the SPRITE horizontal position registers and the sprite horizontal vertical position registers. At this time, the horizontal position is set in 2048 steps in 1Tosc units, and the vertical position is set in 1024 steps in 1Th units. When SPRITE display overlaps with other OSDs, SPRITE display is always given priority. However, the SPRITE display overlaps with the OSD which includes OUT2 output, OUT2 in the OSD is output without masking.

- Notes 1:** The SPRITE OSD function cannot output OUT2.
2: When using SPRITE OSD, do not set HS1 < "3016." at HS2 = "0016."
3: When using SPRITE OSD, do not set VS1 = VS2 = "0016."

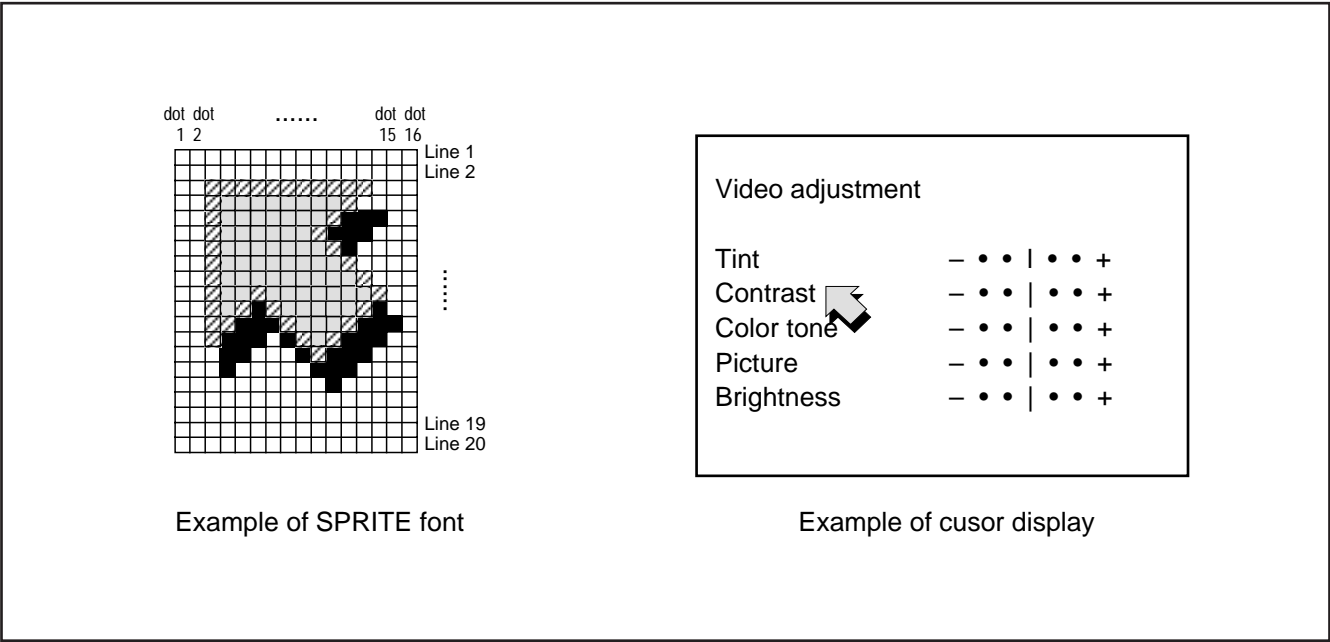
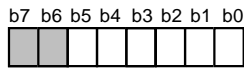


Fig. 12.11.48 SPRITE OSD Display Example

M37280MF-XXXSP, M37280MK-XXXSP M37280EKSP

SINGLE-CHIP 8-BIT CMOS MICROCOMPUTER with CLOSED CAPTION DECODER
and ON-SCREEN DISPLAY CONTROLLER

SPRITE OSD Control Register



SPRITE OSD control register (SC) [Address 0258₁₆]

| B | Name | Functions | After reset | R | W |
|------|--|---|-------------|---|---|
| 0 | SPRITE OSD control bit (SC0) | 0: Stopped 1: Operating | 0 | R | W |
| 1 | Pre-divide ratio selection bit (SC1) | 0: Pre-divide ratio 1 1: Pre-divide ratio 2 | 0 | R | W |
| 2, 3 | Dot size selection bits (SC2, SC3) | b3 b2 0 0: 1T _c × 1/2H 0 1: 1T _c × 1H 1 0: 2T _c × 1H 1 1: 2T _c × 2H | 0 | R | W |
| 4 | Interrupt occurrence position selection bit (SC4) | 0: After display of horizontal 20 dots 1: After display of horizontal 10 dots or 20 dots | 0 | R | W |
| 5 | X _{IN} /4096 • SPRITE interrupt source switch bit (SC5) | 0: X _{IN} /4096 interrupt 1: SPRITE OSD interrupt | 0 | R | W |
| 6, 7 | Nothing is assigned. This bit is a write disable bit. When this bit is read out, the value is "0". | | 0 | R | — |

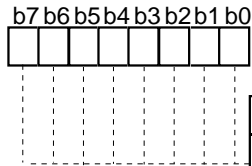
Notes 1: T_c : Pre-divided clock period for OSD
 2: H : Hsync

Fig. 12.11.49 SPRITE OSD Control Register

M37280MF-XXXSP, M37280MK-XXXSP M37280EKSP

SINGLE-CHIP 8-BIT CMOS MICROCOMPUTER with CLOSED CAPTION DECODER
and ON-SCREEN DISPLAY CONTROLLER

SPRITE Horizontal Position Register 1



SPRITE horizontal position register 1 (HS1) [Address 0256₁₆]

| B | Name | Functions | After reset | R ₁ W |
|--------|---|--|---------------|------------------|
| 0 to 7 | Horizontal display start position control bits of SPRITE OSD (HS10 to HS17) | Horizontal display start position (low-order 8 bits) Tosc X (setting value of low-order 2 bits of HS2 × 16 ² + setting value of high-order 4 bits of HS1 × 16 ¹ + setting value of low-order 4 bits of HS1 × 16 ⁰) | Indeterminate | R ₁ W |

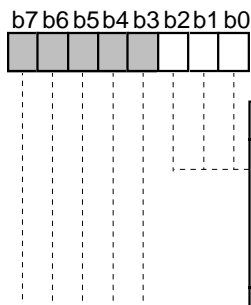
Notes 1: Do not set HS1 < "30₁₆" at HS2 = "00₁₆."

2: Tosc is OSD oscillation period.

3: HS2 is SPRITE horizontal position register 2.

Fig. 12.11.50 SPRITE Horizontal Position Register 1

SPRITE Horizontal Position Register 2



SPRITE horizontal position register 2 (HS2) [Address 0257₁₆]

| B | Name | Functions | After reset | R ₁ W |
|--------|---|---|---------------|------------------|
| 0 to 2 | Horizontal display start position control bits of SPRITE OSD (HS20 to HS22) | Horizontal display start position (high-order 3 bits) Tosc X (setting value of low-order 2 bits of HS2 × 16 ² + setting value of high-order 4 bits of HS1 × 16 ¹ + setting value of low-order 4 bits of HS1 × 16 ⁰) | Indeterminate | R ₁ W |
| 3 to 7 | Nothing is assigned. These bits are write disable bits. When these bits are read out, the values are "0." | | 0 | R ₁ — |

Notes 1: Do not set HS1 < "30₁₆" at HS2 = "00₁₆."

2: Tosc is oscillation period.

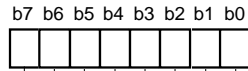
3: HS1 is SPRITE horizontal position register 1.

Fig. 12.11.51 SPRITE Horizontal Position Register 2

M37280MF-XXXSP, M37280MK-XXXSP M37280EKSP

SINGLE-CHIP 8-BIT CMOS MICROCOMPUTER with CLOSED CAPTION DECODER
and ON-SCREEN DISPLAY CONTROLLER

SPRITE Vertical Position Register 1



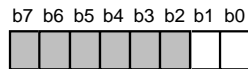
SPRITE vertical position register 1 (VS1) [Address 0254₁₆]

| B | Name | Functions | After reset | R | W |
|--------|---|--|-------------|---|---|
| 0 | Vertical display start position (low-order 8 bits) | Vertical display start position (low-order 8 bits) | 1 | R | W |
| 1 to 7 | Vertical display start position control bits of SPRITE OSD (VS10 to VS17) | $T_H \times$ (setting value of low-order 2 bits of $VS2 \times 16^2$ + setting value of high-order 4 bits of $VS1 \times 16^1$ + setting value of low-order 4 bits of $VS1 \times 16^0$) | 0 | R | W |

Notes 1: Do not set "00₁₆" to the VS1 at VS2 = "00₁₆."
 2: T_H is cycle of Hsync.
 3: VS2 is SPRITE vertical position register 2.

Fig. 12.11.52 PRITE Vertical Position Register 1

SPRITE Vertical Position Register 2



SPRITE vertical position register 2 (VS2) [Address 0255₁₆]

| B | Name | Functions | After reset | R | W |
|--------|---|---|-------------|---|---|
| 0, 1 | Vertical start position control bits of SPRITE OSD (VS20, VS21) | Vertical display start position (high-order 2 bits) $T_H \times$ (setting value of low-order 2 bits of $VS2 \times 16^2$ + setting value of high-order 4 bits of $VS1 \times 16^1$ + setting value of low-order 4 bits of $VS1 \times 16^0$) | 0 | R | W |
| 2 to 7 | Nothing is assigned. These bits are write disable bits. When these bits are read out, the values are "0". | | 0 | R | — |

Notes 1: Do not set "00₁₆" to the VS1 at VS2 = "00₁₆."
 2: T_H is cycle of Hsync.
 3: VS1 is SPRITE vertical position register 1.

Fig. 12.11.53 SPRITE Vertical Position Register 2

M37280MF-XXXSP, M37280MK-XXXSP M37280EKSP

SINGLE-CHIP 8-BIT CMOS MICROCOMPUTER with CLOSED CAPTION DECODER
and ON-SCREEN DISPLAY CONTROLLER

12.11.7 OSD Output Pin Control

The OSD output pins R(R1), G(G1), B(B1) and OUT1 can also function as ports P52 to P55. Set the corresponding bit of the OSD port control register (address 00CB16) to "0" to specify these pins as OSD output pins, or set it to "1" to specify it as a general-purpose port P5 pin.

Pins R0, G0 and B0 can also function as ports P17, P15 and P16, respectively. Set bit 1 of the OSD port control register to "0" to specify these pins as a general-purpose output port P1 pin, or set it to "1" to specify it as OSD output pins. When "0," 4-adjustment-level analog output is output from pins R, G and B. When "1," the value which is converted from the analog to the 2-bit digital is output as follows: the high-order bit is output pins R1, G1 and B1 and the low-order bit is output from pins R0, G0 and B0.

The OUT2 can also function as Port P10. Set bit 0 of the port P1 direction register (address 00C316) to "1" (output mode). After that, set bit 6 of the OSD port control register to "1" to specify the pin as OSD output pin, or set it to "0" to specify as port P10 pin.

The input polarity of the HSYNC, VSYNC and output polarity of signals R, G, B, OUT1 and OUT2 can be specified with the I/O polarity control register (address 021716). Set a bit to "0" to specify positive polarity; set it to "1" to specify negative polarity (refer to Figure 12.11.18). The OSD port control register is shown in Figure 12.11.54.

Note: When using ports P52 to P54 as general-purpose pins, set bit 2 of OSD control register 2 (address 021516) to "0."

OSD Port Control Register

b7 b6 b5 b4 b3 b2 b1 b0

0 0 0 0 0 0 0 0

OSD port control register (PF) [Address 00CB16]

| b | Name | Functions | After reset | R : W |
|---|---|---|-------------|-------|
| 0 | Fix this bit to "0" | | 0 | R : W |
| 1 | R, G, B output method selection bit (RGB2BIT) | 0 : 4-adjustment-level analog is output from pins R, G, B. 1 : Value which is converted from 4-adjustment-level analog to 2-bit digital is output as below: High-order: from R1, G1, B1 Low-order: from R0, G0, B0 | 0 | R : W |
| 2 | Port P52 output signal selection bit (R) | 0 : R signal output 1 : Port P52 output | 0 | R : W |
| 3 | Port P53 output signal selection bit (G) | 0 : G signal output 1 : Port P53 output | 0 | R : W |
| 4 | Port P54 output signal selection bit (B) | 0 : B signal output 1 : Port P54 output | 0 | R : W |
| 5 | Port P55 output signal selection bit (OUT1) | 0 : OUT1 signal output 1 : Port P55 output | 0 | R : W |
| 6 | Port P10 output signal selection bit (OUT2) | 0 : Port P10 signal output 1 : OUT2 output | 0 | R : W |
| 7 | Fix this bit to "0" | | 0 | R : W |

Fig. 12.11.54 OSD Port Control Register

M37280MF-XXXSP, M37280MK-XXXSP M37280EKSP

SINGLE-CHIP 8-BIT CMOS MICROCOMPUTER with CLOSED CAPTION DECODER
and ON-SCREEN DISPLAY CONTROLLER

12.11.18 Raster Coloring Function

An entire screen (raster) can be colored by setting the bits 6 to 0 of the raster color register. Since each of the R, G, B, OUT1, and OUT2 pins can be switched to raster coloring output, 64 raster colors can be obtained.

When the character color/the character background color overlaps with the raster color, the color (R, G, B, OUT1, OUT2), specified for the character color/the character background color, takes priority of the raster color. This ensures that the character color/the character background color is not mixed with the raster color.

The structure of the raster color register is shown in Figure 12.11.55, the example of raster coloring is shown in Figure 12.11.56.

Note : Raster is not output to the area which includes blank output.

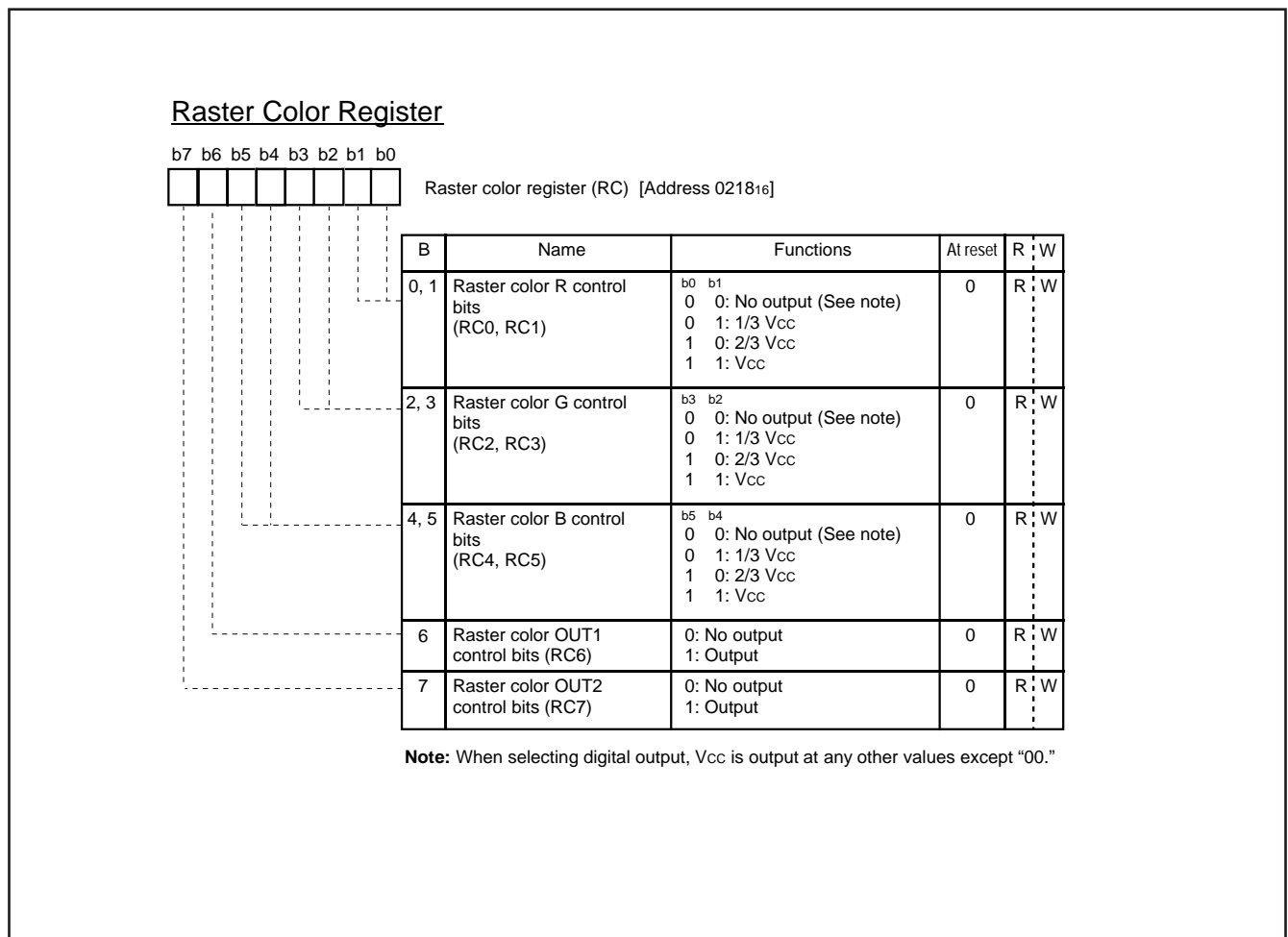


Fig. 12.11.54 Raster Color Register

M37280MF-XXXSP, M37280MK-XXXSP M37280EKSP

SINGLE-CHIP 8-BIT CMOS MICROCOMPUTER with CLOSED CAPTION DECODER
 and ON-SCREEN DISPLAY CONTROLLER

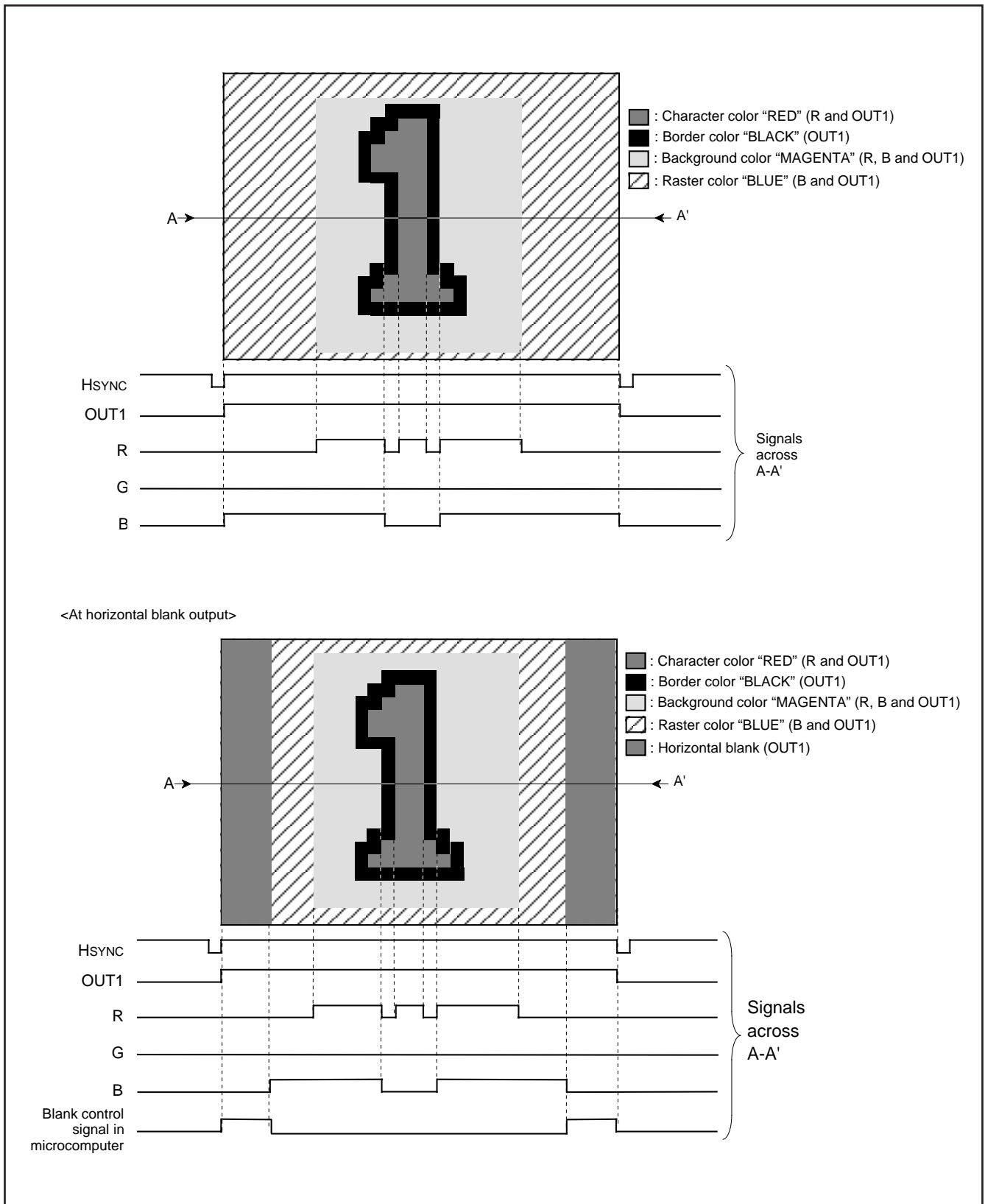


Fig. 12.11.56 Example of Raster Coloring

M37280MF-XXXSP, M37280MK-XXXSP M37280EKSP

SINGLE-CHIP 8-BIT CMOS MICROCOMPUTER with CLOSED CAPTION DECODER
and ON-SCREEN DISPLAY CONTROLLER

13. SOFTWARE RUNAWAY DETECT FUNCTION

This microcomputer has a function to decode undefined instructions to detect a software runaway.

When an undefined op-code is input to the CPU as an instruction code during operation, the following processing is done.

- ① The CPU generates an undefined instruction decoding signal.
- ② The device is internally reset because of occurrence of the undefined instruction decoding signal.
- ③ As a result of internal reset, the same reset processing as in the case of ordinary reset operation is done, and the program restarts from the reset vector.

Note, however, that the software runaway detecting function cannot be invalid.

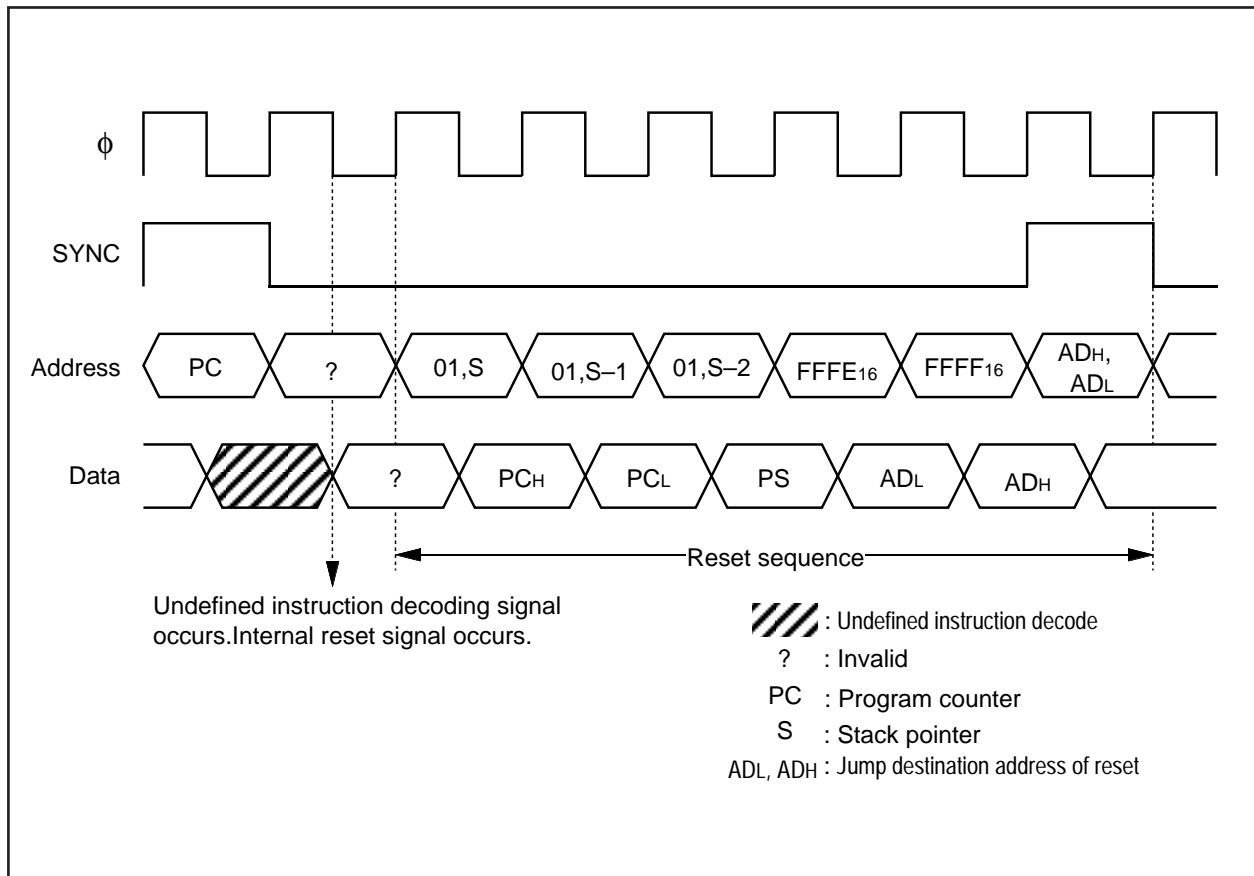


Fig.13.1 Sequence at Detecting Software Runaway Detection

M37280MF-XXXSP, M37280MK-XXXSP M37280EKSP

SINGLE-CHIP 8-BIT CMOS MICROCOMPUTER with CLOSED CAPTION DECODER
and ON-SCREEN DISPLAY CONTROLLER

14. RESET CIRCUIT

When the oscillation of a quartz-crystal oscillator or a ceramic resonator is stable and the power source voltage is $5\text{ V} \pm 10\%$, hold the RESET pin at LOW for $2\text{ }\mu\text{s}$ or more, then return it to HIGH. Then, as shown in Figure 14.2, reset is released and the program starts from the address formed by using the content of address FFFF_{16} as the high-order address and the content of the address FFFE_{16} as the low-order address. The internal state of microcomputer at reset are shown in Figures 12.2.2 to 12.2.7.

An example of the reset circuit is shown in Figure 14.1.

The reset input voltage must be kept 0.9 V or less until the power source voltage surpasses 4.5 V .

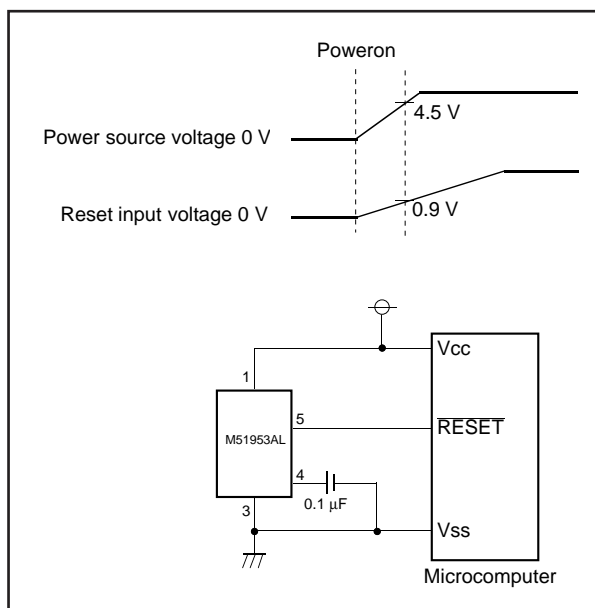


Fig.14.1 Example of Reset Circuit

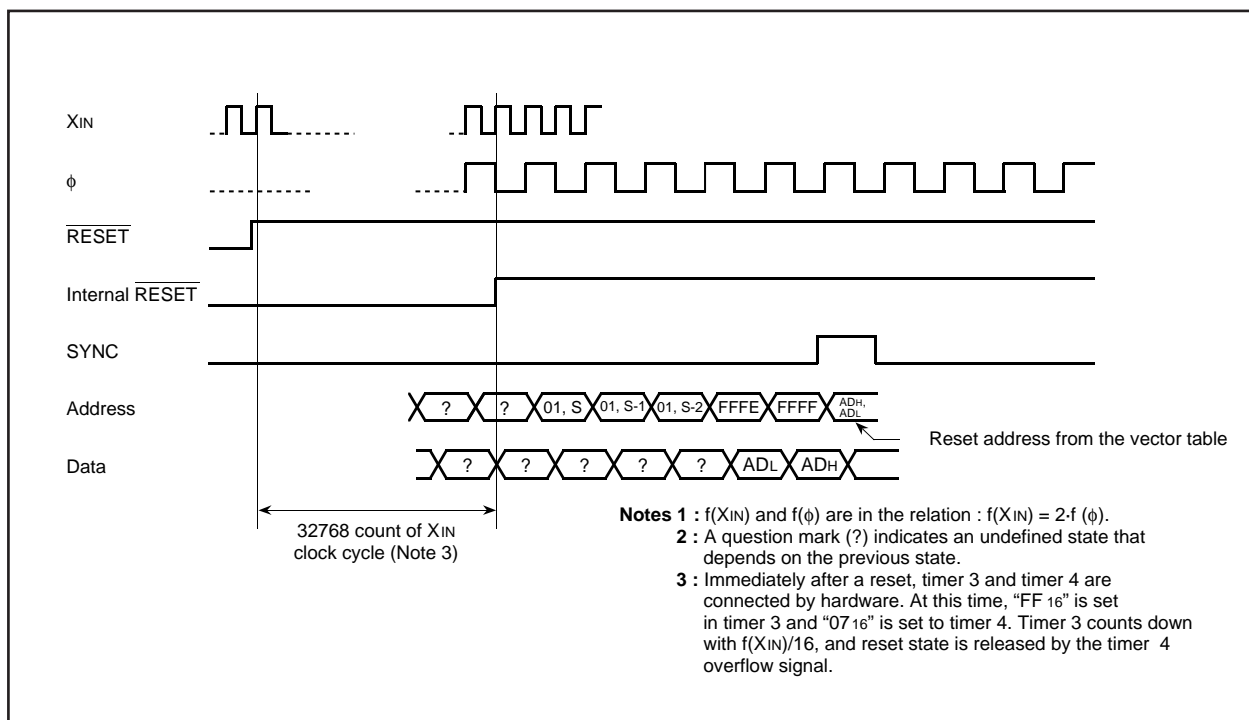


Fig.14.2 Reset Sequence

M37280MF-XXXSP, M37280MK-XXXSP M37280EKSP

SINGLE-CHIP 8-BIT CMOS MICROCOMPUTER with CLOSED CAPTION DECODER
and ON-SCREEN DISPLAY CONTROLLER

15. CLOCK GENERATING CIRCUIT

This microcomputer has 2 built-in oscillation circuits. An oscillation circuit can be formed by connecting a resonator between XIN and XOUT (XCIN and XCOUT). Use the circuit constants in accordance with the resonator manufacturer's recommended values. No external resistor is needed between XIN and XOUT since a feed-back resistor exists on-chip. However, an external feed-back resistor is needed between XCIN and XCOUT. When using XCIN-XCOUT as sub-clock, clear bits 5 and 4 of the clock source control register to "0." To supply a clock signal externally, input it to the XIN (XCIN) pin and make the XOUT (XCOUT) pin open. When not using XCIN clock, connect the XCIN to VSS and make the XCOUT pin open.

After reset has completed, the internal clock ϕ is half the frequency of XIN. Immediately after poweron, both the XIN and XCIN clock start oscillating. To set the internal clock ϕ to low-speed operation mode, set bit 7 of the CPU mode register (address 00FB16) to "1."

15.1 OSCILLATION CONTROL

15.1.1 Stop Mode

The built-in clock generating circuit is shown in Figure 120. When the STP instruction is executed, the internal clock ϕ stops at HIGH. At the same time, timers 3 and 4 are connected by hardware and "FF16" is set in timer 3 and "0716" is set in timer 4. Select $f(XIN)/16$ or $f(XCIN)/16$ as the timer 3 count source (set both bit 0 of the timer mode register 2 and bit 6 at address 00C716 to "0" before the execution of the STP instruction). Moreover, set the timer 3 and timer 4 interrupt enable bits to disabled ("0") before execution of the STP instruction. The oscillator restarts when external interrupt is accepted. However, the internal clock ϕ keeps its HIGH level until timer 4 overflows, allowing time for oscillation stabilization when a ceramic resonator or a quartz-crystal oscillator is used.

15.1.2 Wait Mode

When the WIT instruction is executed, the internal clock ϕ stops in the HIGH level but the oscillator continues running. This wait state is released at reset or when an interrupt is accepted (Note). Since the oscillator does not stop, the next instruction can be executed at once.

Note: In the wait mode, the following interrupts are invalid.

- VSYNC interrupt
- OSD interrupt
- All timers interrupts using TIM2 pin input as count source
- All timers interrupt using TIM3 pin input as count source
- Data slicer interrupt
- Multi-master I²C-BUS interface interrupt
- $f(XIN)/4096$ interrupt
- All timer interrupts using $f(XIN)/2$ or $f(XCIN)/2$ as count source
- All timer interrupts using $f(XIN)/4096$ or $f(XCIN)/4096$ as count source
- A-D conversion interrupt
- SPRITE OSD interrupt

15.1.3 Low-speed Mode

If the internal clock is generated from the sub-clock (XCIN), a low power consumption operation can be realized by stopping only the main clock XIN. To stop the main clock, set bit 6 (CM6) of the CPU mode register (00FB16) to "1." When the main clock XIN is restarted, the program must allow enough time to for oscillation to stabilize. Note that in low-power-consumption mode the XCIN-XCOUT drivability can be reduced, allowing even lower power consumption. To reduce the XCIN-XCOUT drivability, clear bit 5 (CM5) of the CPU mode register (00FB16) to "0." At reset, this bit is set to "1" and strong drivability is selected to help the oscillation to start. When an STP instruction is executed, set this bit to "1" by software before executing.

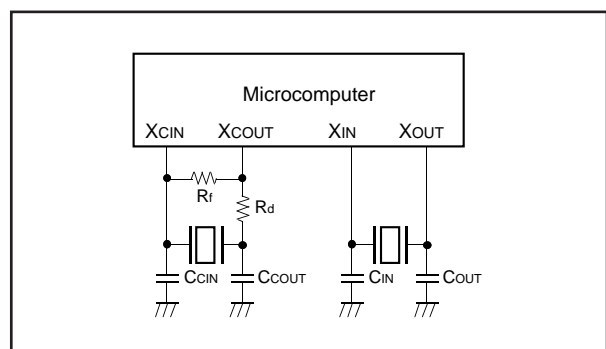


Fig.15.1 Ceramic Resonator Circuit Example

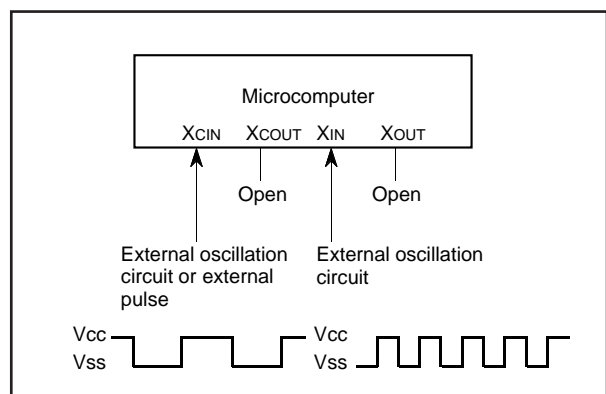


Fig.15.2 External Clock Input Circuit Example

M37280MF-XXXSP, M37280MK-XXXSP M37280EKSP

SINGLE-CHIP 8-BIT CMOS MICROCOMPUTER with CLOSED CAPTION DECODER
and ON-SCREEN DISPLAY CONTROLLER

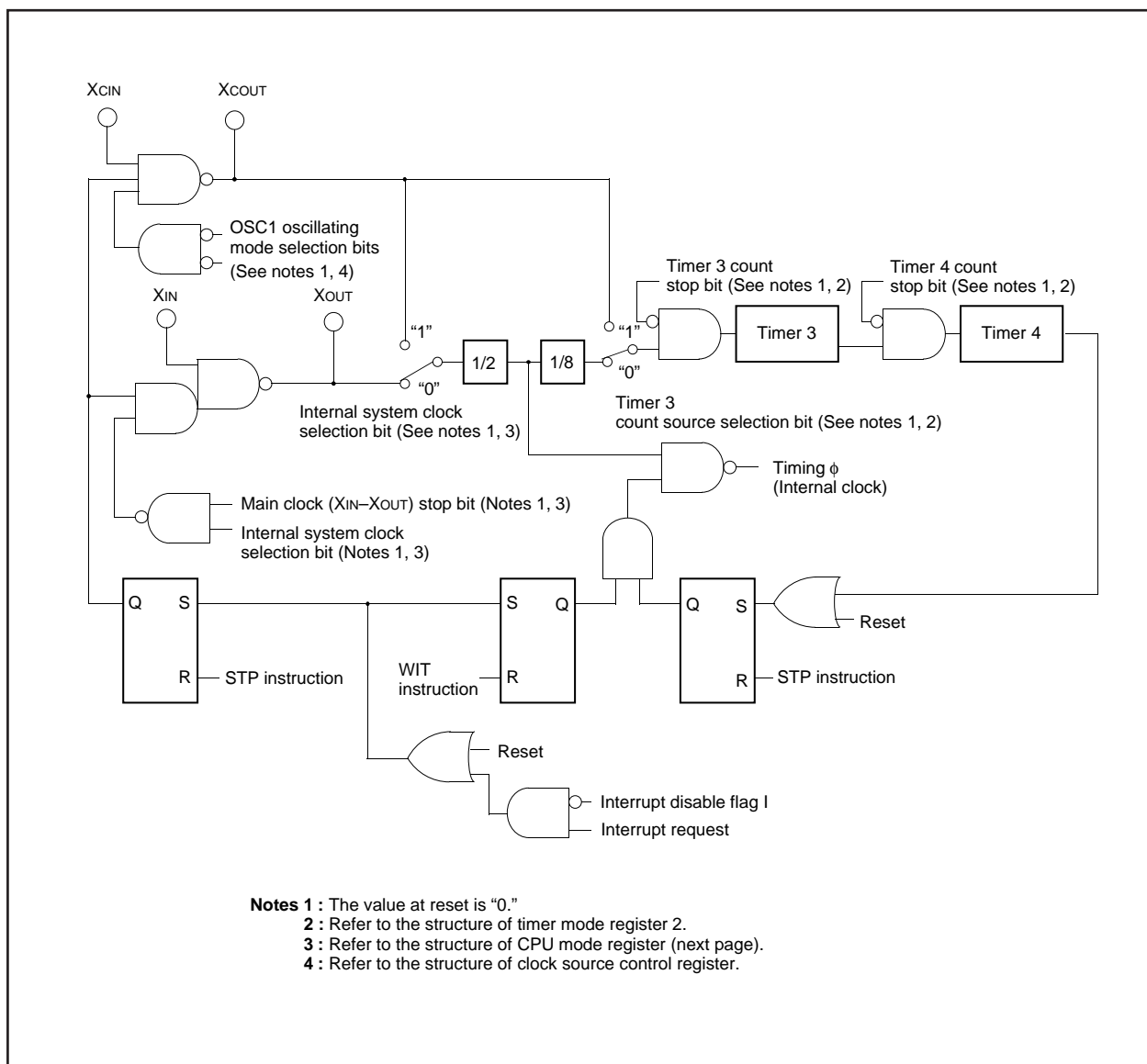


Fig.15.3 Clock Generating Circuit Block Diagram

M37280MF-XXXSP, M37280MK-XXXSP M37280EKSP

SINGLE-CHIP 8-BIT CMOS MICROCOMPUTER with CLOSED CAPTION DECODER
and ON-SCREEN DISPLAY CONTROLLER

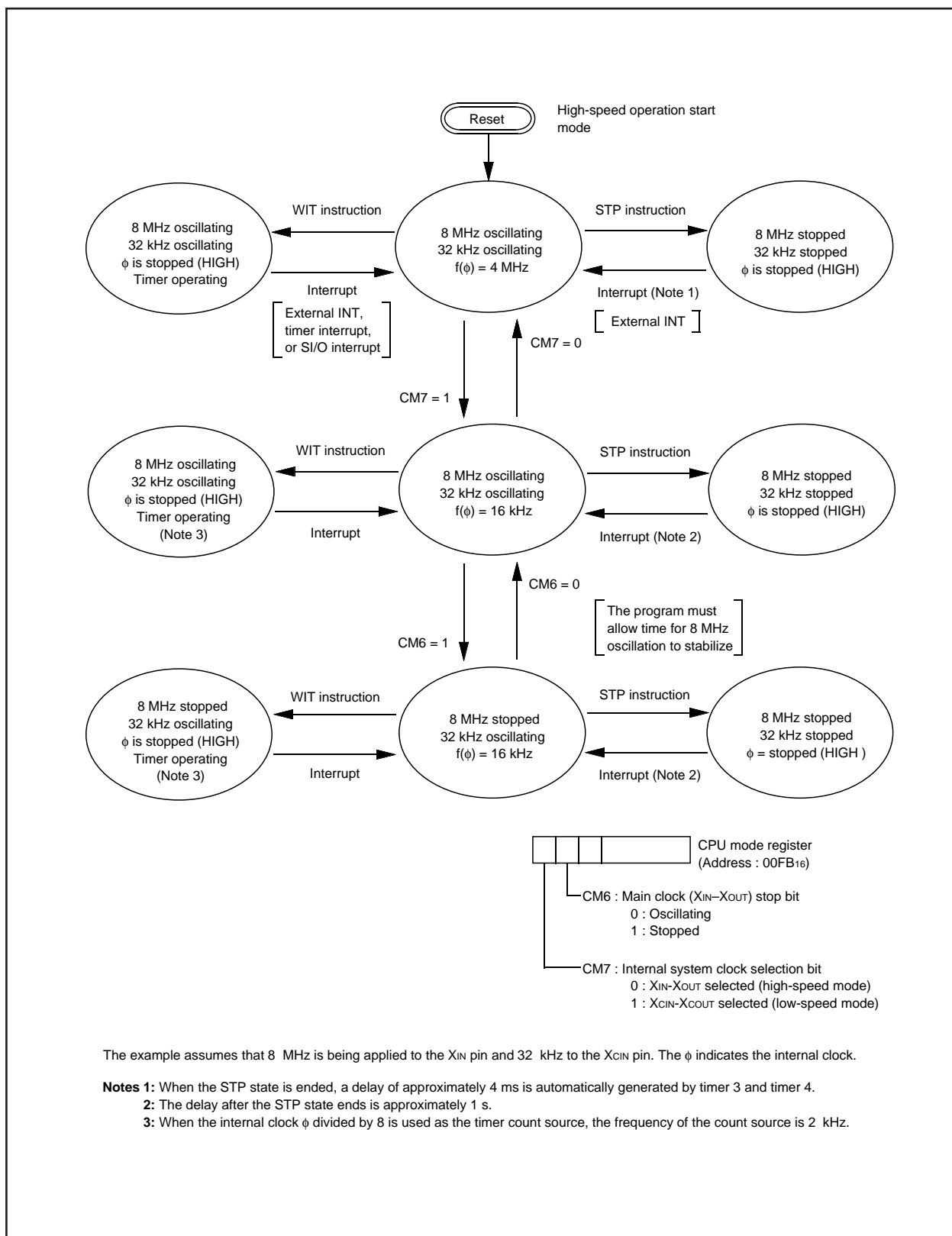


Fig.15.4 State Transitions of System Clock

M37280MF-XXXSP, M37280MK-XXXSP M37280EKSP

SINGLE-CHIP 8-BIT CMOS MICROCOMPUTER with CLOSED CAPTION DECODER
and ON-SCREEN DISPLAY CONTROLLER

16. DISPLAY OSCILLATION CIRCUIT

The OSD oscillation circuit has a built-in clock oscillation circuits, so that a clock for OSD can be obtained simply by connecting an LC, a ceramic resonator, or a quartz-crystal oscillator across the pins OSC1 and OSC2. Which of the sub-clock or the OSD oscillation circuit is selected by setting bits 5 and 4 of the clock control register (address 021616).

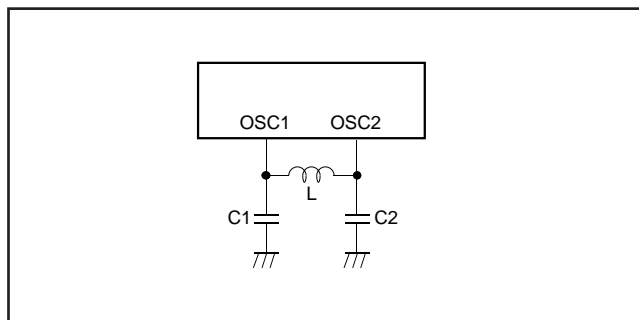


Fig.16.1 Display Oscillation Circuit

17. AUTO-CLEAR CIRCUIT

When a power source is supplied, the auto-clear function will operate by connecting the following circuit to the $\overline{\text{RESET}}$ pin.

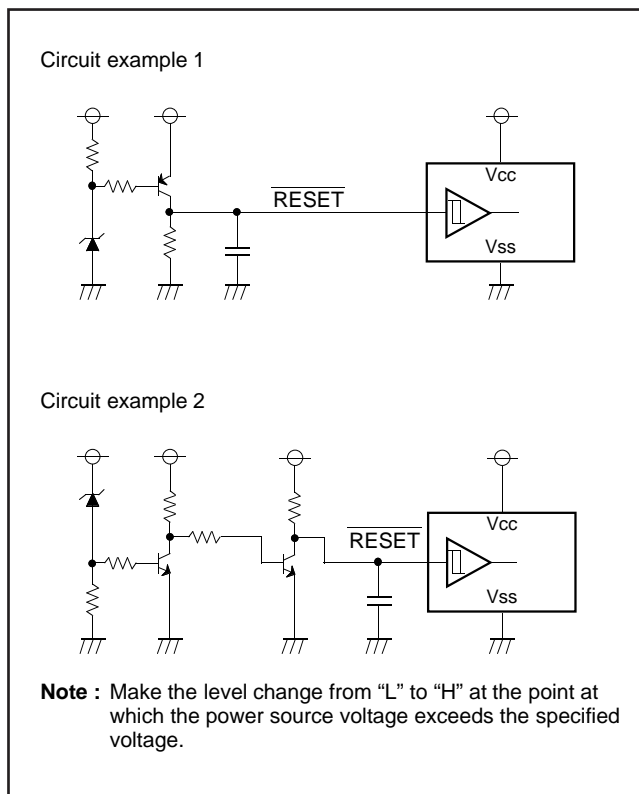


Fig.17.1 Auto-clear Circuit Example

18. ADDRESSING MODE

The memory access is reinforced with 17 kinds of addressing modes. Refer to SERIES 740 <Software> User's Manual for details.

19. MACHINE INSTRUCTIONS

There are 71 machine instructions. Refer to SERIES 740 <Soft-ware> User's Manual for details.

20. PROGRAMMING NOTES

- The divide ratio of the timer is $1/(n+1)$.
- Even though the BBC and BBS instructions are executed immediately after the interrupt request bits are modified (by the program), those instructions are only valid for the contents before the modification. At least one instruction cycle is needed (such as an NOP) between the modification of the interrupt request bits and the execution of the BBC and BBS instructions.
- After the ADC and SBC instructions are executed (in the decimal mode), one instruction cycle (such as an NOP) is needed before the SEC, CLC, or CLD instruction is executed.
- An NOP instruction is needed immediately after the execution of a PLP instruction.
- In order to avoid noise and latch-up, connect a bypass capacitor ($\approx 0.1\mu\text{F}$) directly between the VCC pin-Vss pin, AVCC pin-Vss pin, and the VCC pin-CNVss pin, using a thick wire.

PRELIMINARY
Notice: This is not a final specification.
Some parametric limits are subject to change.

M37280MF-XXXSP, M37280MK-XXXSP M37280EKSP

SINGLE-CHIP 8-BIT CMOS MICROCOMPUTER with CLOSED CAPTION DECODER
and ON-SCREEN DISPLAY CONTROLLER

21. ABSOLUTE MAXIMUM RATINGS

| Symbol | Parameter | Conditions | Ratings | Unit |
|------------------------------------|---|--|-------------------------------|------|
| V _{CC} , AV _{CC} | Power source voltage V _{CC} , AV _{CC} | All voltages are based on V _{SS} . Output transistors are cut off. | -0.3 to 6 | V |
| V _I | Input voltage CNV _{SS} | | -0.3 to 6 | V |
| V _I | Input voltage P00-P07, P10-P17, P20-P27, P30, P31, P40-P46, P64, P63, P70-P72, XIN, HSYNC, VSYNC, RESET | | -0.3 to V _{CC} + 0.3 | V |
| V _O | Output voltage P03, P10-P17, P20-P27, P30-P32, P47, P51-P57, P60-P62, P65-P67, SOUT, SCLK, XOUT, OSC2 | | -0.3 to V _{CC} + 0.3 | V |
| V _O | Output voltage P00-P02, P04-P07, P50 | | -0.3 to 13 | V |
| I _{OH} | Circuit current P52-P55, P10, P03, P15-P17, P20-P27, P30, P31 | | 0 to 1 (See note 1) | mA |
| I _{OL1} | Circuit current P52-P57, P10, P03, P15-P17, P20-P27, P65-P67, SOUT, SCLK | | 0 to 2 (See note 2) | mA |
| I _{OL2} | Circuit current P11-P14 | | 0 to 6 (See note 2) | mA |
| I _{OL3} | Circuit current P00-P02, P04-P07, P32, P47, P50, P51, P60-P62 | | 0 to 1 (See note 2) | mA |
| I _{OL4} | Circuit current P30, P31 | | 0 to 10 (See note 3) | mA |
| P _d | Power dissipation | T _a = 25 °C | 550 | mW |
| T _{opr} | Operating temperature | | -10 to 70 | °C |
| T _{stg} | Storage temperature | | -40 to 125 | °C |

22. RECOMMENDED OPERATING CONDITIONS (T_a = -10 °C to 70 °C, V_{CC} = 5 V ± 10 %, unless otherwise noted)

| Symbol | Parameter | Limits | | | Unit |
|------------------------------------|--|--------------------|--------|---------------------|------|
| | | Min. | Typ. | Max. | |
| V _{CC} , AV _{CC} | Power source voltage (See note 4), During CPU, OSD, data slicer operation | 4.5 | 5.0 | 5.5 | V |
| V _{CC} , AV _{CC} | RAM hold voltage (when clock is stopped) | 2.0 | | 5.5 | V |
| V _{SS} | Power source voltage | 0 | 0 | 0 | V |
| V _{IH1} | HIGH input voltage P00-P07, P10-P17, P20-P27, P30, P31, P40-P46, P63, P64, P70-P72, HSYNC, VSYNC, RESET, XIN | 0.8V _{CC} | | V _{CC} | V |
| V _{IH2} | HIGH input voltage SCL1, SCL2, SDA1, SDA2 | 0.7V _{CC} | | V _{CC} | V |
| V _{IL1} | LOW input voltage P00-P07, P10-P17, P20-P27, P30, P31, P40-P46, P63, P64, P70-P72 | 0 | | 0.4 V _{CC} | V |
| V _{IL2} | LOW input voltage SCL1, SCL2, SDA1, SDA2 | 0 | | 0.3 V _{CC} | V |
| V _{IL3} | LOW input voltage (See note 6) RESET, XIN, OSC1, HSYNC, VSYNC, INT1, INT2, INT3, TIM2, TIM3, SCLK, SIN | 0 | | 0.2 V _{CC} | V |
| I _{OH} | HIGH average output current (See note 1) P52-P55, P10, P03, P15-P17, P20-P27, P30, P31 | | | 1 | mA |
| I _{OL1} | LOW average output current (See note 2) P51-P57, P10, P03, P15-P17, P20-P27, SOUT, SCLK, P47, P65-P67 | | | 2 | mA |
| I _{OL2} | LOW average output current (See note 2) P11-P14 | | | 6 | mA |
| I _{OL3} | LOW average output current (See note 2) P00-P02, P04-P07, P32, P47, P50, P51, P60-P62 | | | 1 | mA |
| I _{OL4} | LOW average output current (See note 3) P30, P31 | | | 10 | mA |
| f(XIN) | Oscillation frequency (for CPU operation) (See note 5) XIN | 7.9 | 8.0 | 8.1 | MHz |
| f(XCIN) | Oscillation frequency (for sub-clock operation) XCIN | 29 | 32 | 35 | kHz |
| fosc | Oscillation frequency (for OSD) OSC1 | | | | MHz |
| | LC oscillating mode | 11.0 | | 27.0 | |
| | Ceramic oscillating mode | 25.5 | 26.5 | 27.5 | |
| RL | Load resistance During R,G,B analog output | 20.0 | | | |
| f _{hs1} | Input frequency TIM2, TIM3, INT1, INT2, INT3 | | | 100 | kHz |
| f _{hs2} | Input frequency SCLK | | | 1 | MHz |
| f _{hs3} | Input frequency SCL1, SCL2 | | | 400 | kHz |
| f _{hs4} | Input frequency Horizontal sync. signal of video signal | 15.262 | 15.734 | 16.206 | kHz |
| V _I | Input amplitude video signal CVIN | 1.5 | 2.0 | 2.5 | V |

M37280MF-XXXSP, M37280MK-XXXSP M37280EKSP

SINGLE-CHIP 8-BIT CMOS MICROCOMPUTER with CLOSED CAPTION DECODER
and ON-SCREEN DISPLAY CONTROLLER

23. ELECTRIC CHARACTERISTICS (VCC = 5 V ± 10 %, VSS = 0 V, f(XIN) = 8 MHz, Ta = -10 °C to 70 °C, unless otherwise noted)

| Symbol | Parameter | | Test conditions | | Limits | | | Unit | Test circuit |
|-----------|---|--|--|---|--------|------|------|------|--------------|
| | | | | | Min. | Typ. | Max. | | |
| Icc | Power source current | System operation | VCC = 5.5 V, f(XIN) = 8 MHz | CRT OFF Data slicer OFF | | 15 | 30 | mA | 1 |
| | | | | CRT ON (digital output) Data slicer ON | | 30 | 50 | | |
| | | | | CRT ON (analog output) Data slicer ON | | 50 | 70 | | |
| | | | VCC = 5.5 V, f(XIN) = 0, f(XCIN) = 32 kHz, OSD OFF, Data slicer OFF, Low-power dissipation mode set (CM5 = "0", CM6 = "1") | | | 60 | 200 | μA | |
| | Wait mode | | VCC = 5.5 V, f(XIN) = 8 MHz | | | 2 | 4 | mA | |
| | | | VCC = 5.5 V, f(XIN) = 0, f(XCIN) = 32kHz, Low-power dissipation mode set (CM5 = "0", CM6 = "1") | | | 25 | 100 | μA | |
| | Stop mode | | VCC = 5.5 V, f(XIN) = 0 f(XCIN) = 0 | | | 1 | 10 | V | |
| VOH | HIGH output voltage | P52-P55, P10, P03, P15-P17, P20-P27, P30, P31 | VCC = 4.5 V IOH = -0.5 mA | | 2.4 | | | V | 2 |
| VOL | LOW output voltage | SOUT, SCLK, P00-P07, P10, P15-P17, P20-P27, P32, P47, P50-P57, P60-P62, P65-P67 | VCC = 4.5 V IOL = 0.5 mA | | | | 0.4 | V | 3 |
| | LOW output voltage | P30, P31 | VCC = 4.5 V IOL = 10.0 mA | | | | 3.0 | | |
| | LOW output voltage | P11-P14 | VCC = 4.5 V | IOL = 3 mA | | | 0.4 | | |
| | | | | IOL = 6 mA | | | 0.6 | | |
| VT+ - VT- | Hysteresis (See note 6) | RESET, HSYNC, VSYNC, INT1, INT2, INT3, TIM2, TIM3, SIN, SCLK, SCL1, SCL2, SDA1, SDA2 | VCC = 5.0 V | | | 0.5 | 1.3 | V | 4 |
| IIZH | HIGH input leak current | RESET, P03, P10-P17, P20-P27, P30, P31, P40-P46, P63, P64, P70-P72, HSYNC, VSYNC | VCC = 5.5 V VI = 5.5 V | | | | 5 | μA | 5 |
| IIZL | LOW input leak current | RESET, P00-P07, P10-P17, P20-P27, P30, P31, P40-P46, P63, P64, P70-P72, HSYNC, VSYNC | VCC = 5.5 V VI = 0 V | | | | 5 | mA | |
| OZH | HIGH input leak current | P00-P02, P04-P07, P50 | VCC = 5.5 V VI = 12 V | | | | 10 | μA | 6 |
| RBS | I ² C-BUS-BUS switch connection resistor (between SCL1 and SCL2, SDA1 and SDA2) | | VCC = 4.5 V | | | | 130 | Ω | |

Notes 1: The total current that flows out of the IC must be 20 or less.

2: The total input current to IC (IOL1 + IOL2 + IOL3) must be 20 mA or less.

3: The total average input current for ports P30, P31 to IC must be 10 mA or less.

4: Connect 0.1 μF or more capacitor externally between the power source pins VCC-VSS and AVCC-VSS so as to reduce power source noise.

Also connect 0.1 μF or more capacitor externally between the pins VCC-CNVSS.

5: Use a quartz-crystal oscillator or a ceramic resonator for the CPU oscillation circuit. When using the data slicer, use 8 MHz.

6: P16, P41-P44 have the hysteresis when these pins are used as interrupt input pins or timer input pins. P11-P14 have the hysteresis when these pins are used as multi-master I²C-BUS interface ports. P17, P46 and P72 have the hysteresis when these pins are used as serial I/O pins.

7: When using the sub-clock, set fCLK < fCPU/3.

8: Pin names in each parameter is described as below.

(1) Dedicated pins: dedicated pin names.

(2) Duple-/triple-function ports

• When the same limits: I/O port name.

• When the limits of functions except ports are different from I/O port limits: function pin name.

M37280MF-XXXSP, M37280MK-XXXSP M37280EKSP

SINGLE-CHIP 8-BIT CMOS MICROCOMPUTER with CLOSED CAPTION DECODER
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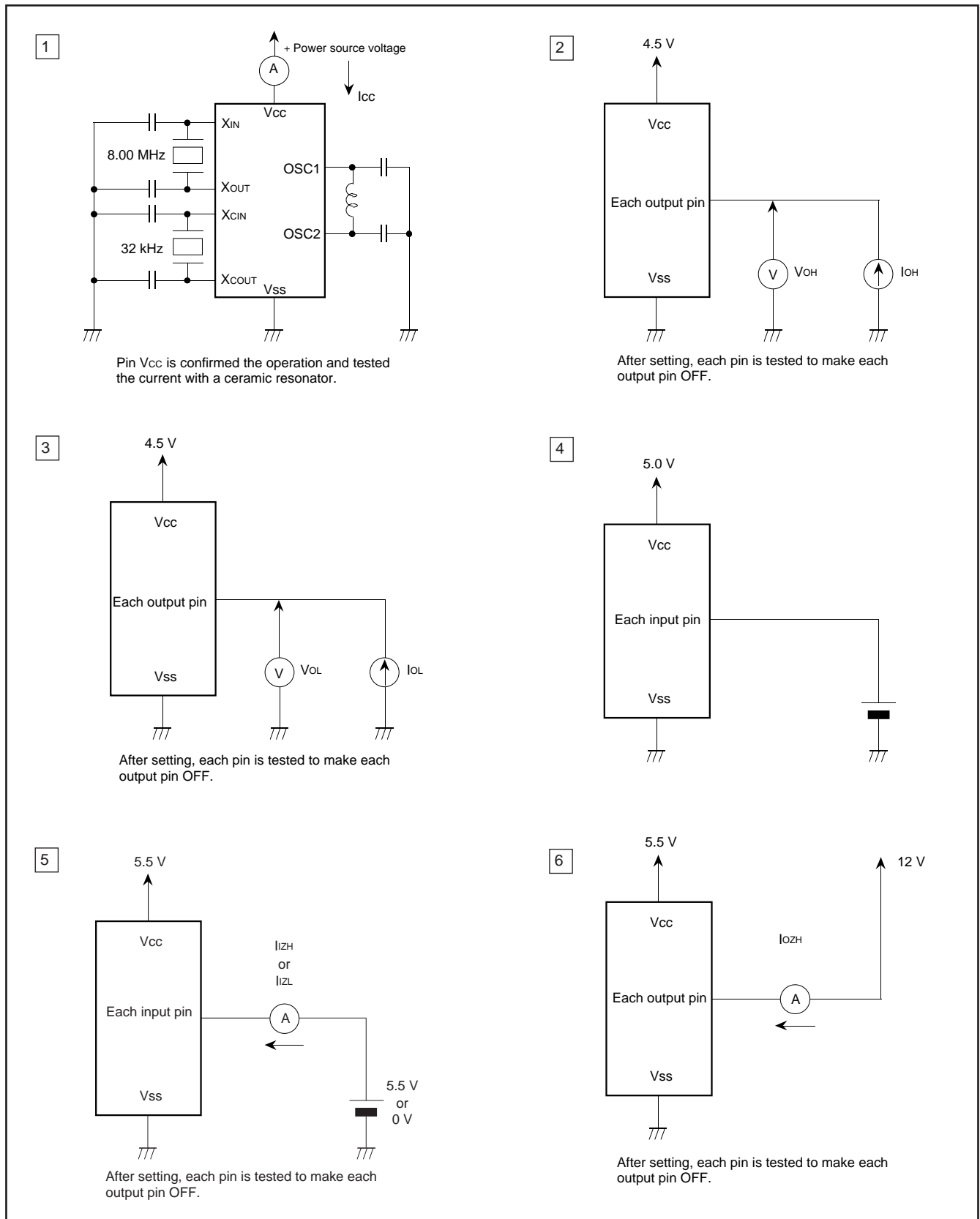


Fig.23.1 Test circuit

PRELIMINARY
 Notice: This is not a final specification.
 Some parametric limits are subject to change.

M37280MF-XXXSP, M37280MK-XXXSP M37280EKSP

SINGLE-CHIP 8-BIT CMOS MICROCOMPUTER with CLOSED CAPTION DECODER
and ON-SCREEN DISPLAY CONTROLLER

24. ANALOG R, G, B OUTPUT CHARACTERISTICS

($V_{CC} = 5\text{ V} \pm 10\%$, $V_{SS} = 0\text{ V}$, $f(XIN) = 8\text{ MHz}$, $T_a = -10\text{ }^{\circ}\text{C}$ to $70\text{ }^{\circ}\text{C}$, unless otherwise noted)

| Symbol | Parameter | Test conditions | Limits | | | Unit |
|--------|-------------------|---|--------|------|-----------|-----------|
| | | | Min. | Typ. | Max. | |
| RO | Output resistance | $V_{CC} = 4.5\text{ V}$ | | | 2 | $k\Omega$ |
| VOE | Output deviation | $V_{CC} = 5.5\text{ V}$ | | | ± 0.5 | V |
| TST | Settling time | $V_{CC} = 4.5\text{ V}$, load capacity of 10 pF , load resistor of $20\text{ k}\Omega$, 70 % DC level | | | 50 | ns |

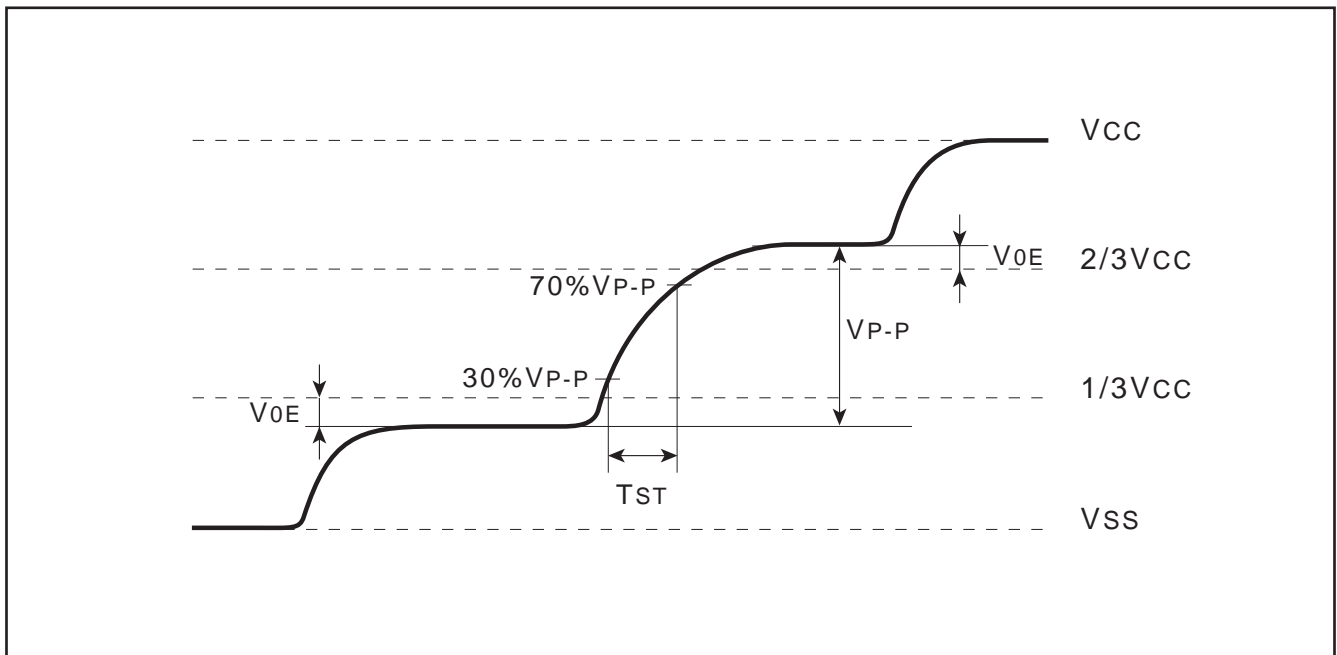


Fig.24.1 Analog R, G, B, Output Characteristics

25. A-D CONVERTER CHARACTERISTICS

($V_{CC} = 5\text{ V} \pm 10\%$, $V_{SS} = 0\text{ V}$, $f(XIN) = 8\text{ MHz}$, $T_a = -10\text{ }^{\circ}\text{C}$ to $70\text{ }^{\circ}\text{C}$, unless otherwise noted)

| Symbol | Parameter | Test conditions | Limits | | | Unit |
|---------|---|-----------------------|--------|------|-----------|---------------|
| | | | Min. | Typ. | Max. | |
| — | Resolution | | | | 8 | bits |
| — | Absolute accuracy (excludig quantization error) | $V_{CC} = 5\text{ V}$ | | | ± 2.5 | LSB |
| TCONV | Conversion time | | 12.25 | | 12.5 | μs |
| RLADDER | Ladder resistor | | | 25 | | $k\Omega$ |
| VIA | Analog input voltage | | 0 | | VREF | V |

M37280MF-XXXSP, M37280MK-XXXSP M37280EKSP

SINGLE-CHIP 8-BIT CMOS MICROCOMPUTER with CLOSED CAPTION DECODER
and ON-SCREEN DISPLAY CONTROLLER

26. MULTI-MASTER I²C-BUS BUS LINE CHARACTERISTICS

| Symbol | Parameter | Standard clock mode | | High-speed clock mode | | Unit |
|----------------------|--|---------------------|------|-----------------------|------|------|
| | | Min. | Max. | Min. | Max. | |
| t _{BUF} | Bus free time | 4.7 | | 1.3 | | μs |
| t _{HD; STA} | Hold time for START condition | 4.0 | | 0.6 | | μs |
| t _{LOW} | LOW period of SCL clock | 4.7 | | 1.3 | | μs |
| t _R | Rising time of both SCL and SDA signals | | 1000 | 20+0.1C _b | 300 | ns |
| t _{HD; DAT} | Data hold time | 0 | | 0 | 0.9 | μs |
| t _{HIGH} | HIGH period of SCL clock | 4.0 | | 0.6 | | μs |
| t _F | Falling time of both SCL and SDA signals | | 300 | 20+0.1C _b | 300 | ns |
| t _{SU; DAT} | Data set-up time | 250 | | 100 | | ns |
| t _{SU; STA} | Set-up time for repeated START condition | 4.7 | | 0.6 | | μs |
| t _{SU; STO} | Set-up time for STOP condition | 4.0 | | 0.6 | | μs |

Note: C_b = total capacitance of 1 bus line

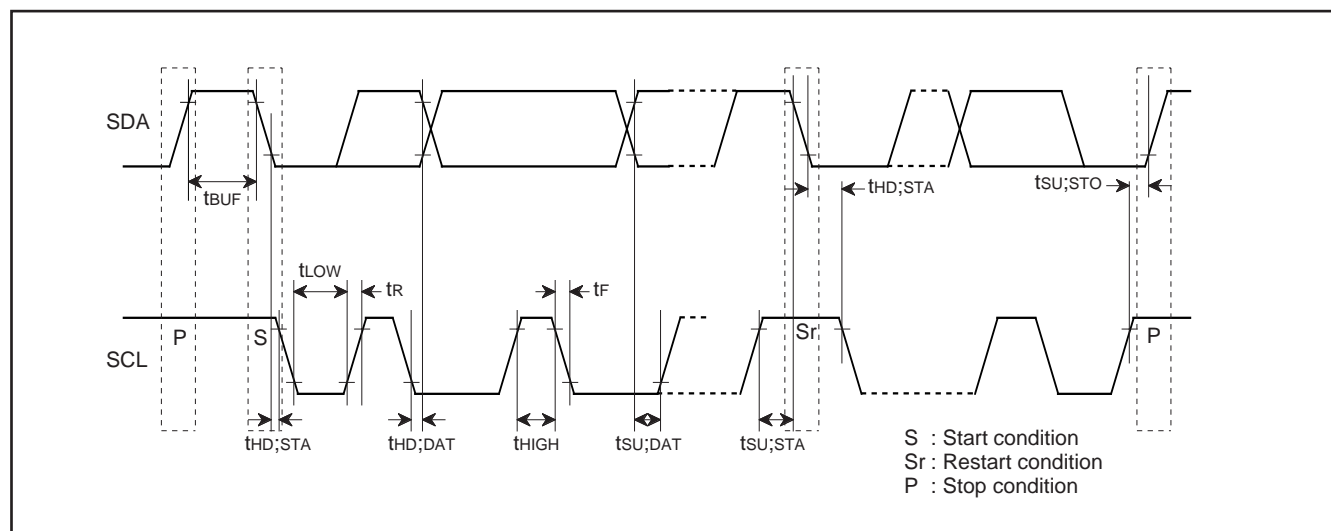


Fig.26.1 Definition Diagram of Timing on Multi-master I²C-BUS

M37280MF-XXXSP, M37280MK-XXXSP M37280EKSP

SINGLE-CHIP 8-BIT CMOS MICROCOMPUTER with CLOSED CAPTION DECODER
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27. DATA REQUIRED FOR MASK ORDERS

The following are necessary when ordering a mask ROM production:

- Mask ROM Order Confirmation Form
- Mask Specification Form
- Data to be written to ROM, in EPROM form (32-pin DIP Type 27C101, three identical copies) or FDK

28. PROM PROGRAMMING METHOD

The built-in PROM of the One Time PROM version (blank) and the built-in EPROM version can be read or programmed with a general-purpose PROM programmer using a special programming adapter.

| Product | Name of Programming Adapter |
|------------|-----------------------------|
| M37280EKSP | PCA7401 |

The PROM of the One Time PROM version (blank) is not tested or screened in the assembly process nor any following processes. To ensure proper operation after programming, the procedure shown in Figure 29.1 is recommended to verify programming.

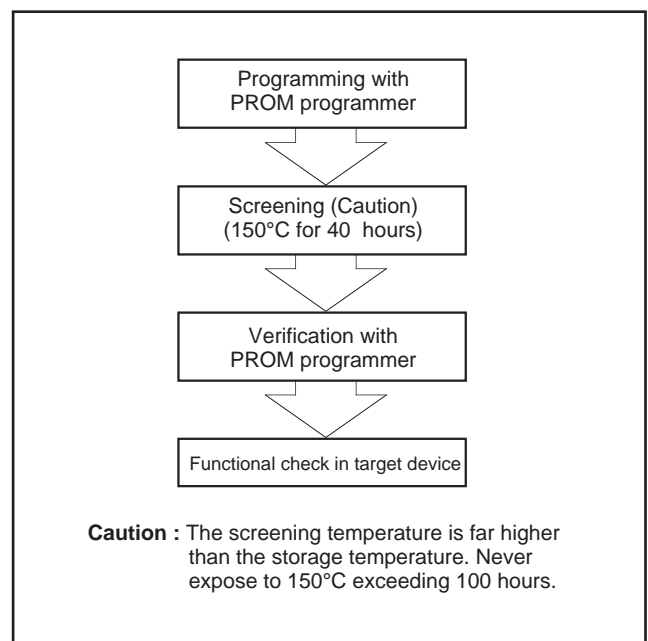


Fig. 29.1 Programming and Testing of One Time PROM Version

M37280MF-XXXSP, M37280MK-XXXSP M37280EKSP

SINGLE-CHIP 8-BIT CMOS MICROCOMPUTER with CLOSED CAPTION DECODER
and ON-SCREEN DISPLAY CONTROLLER

29. MASK CONFIRMATION FORM

GZZ-SH52-83B < 84A0 >

740 FAMILY MASK ROM CONFIRMATION FORM SINGLE-CHIP MICROCOMPUTER M37280MK-XXXSP MITSUBISHI ELECTRIC

| | |
|-----------------|--|
| Mask ROM number | |
|-----------------|--|

| | | |
|---------|------------------------|----------------------|
| Receipt | Date : | |
| | Section head signature | Supervisor signature |
| | | |

Note : Please fill in all items marked *.

| | | | | | | |
|---|----------|--------------|---------|--------------------|--------------|------------|
| * | Customer | Company name | TEL () | Issuance signature | Submitted by | Supervisor |
| | | Date issued | Date : | | | |

*1. Confirmation

Specify the name of the product being ordered and the type of EPROMs submitted.

Three EPROMs are required for each pattern.

If at least two of the three sets of EPROMs submitted contain identical data, we will produce masks based on this data. We shall assume the responsibility for errors only if the mask ROM data on the products we produce differs from this data. Thus, extreme care must be taken to verify the data in the submitted EPROMs.

Checksum code for entire EPROM

| | | | |
|--|--|--|--|
| | | | |
|--|--|--|--|

(hexadecimal notation)

EPROM type (indicate the type used)

| | |
|--------------------------|---|
| <input type="checkbox"/> | 27C101 |
| EPROM address | |
| 0000 ₁₆ | Product name ASCII code : 'M37280MK -' |
| 000F ₁₆ | |
| 0100 ₁₆ | Program ROM 60 K bytes |
| 0FFF ₁₆ | |
| 1080 ₁₆ | OSD ROM |
| 157F ₁₆ | |
| 1800 ₁₆ | OSD ROM |
| 1ACF ₁₆ | |
| 1B00 ₁₆ | Expansion ROM (20K bytes) |
| 1FFF ₁₆ | |

(1) Set "FF₁₆" in the shaded area.

M37280MF-XXXSP, M37280MK-XXXSP M37280EKSP

SINGLE-CHIP 8-BIT CMOS MICROCOMPUTER with CLOSED CAPTION DECODER
and ON-SCREEN DISPLAY CONTROLLER

GZZ-SH52-83B < 84A0 >

740 FAMILY MASK ROM CONFIRMATION FORM SINGLE-CHIP MICROCOMPUTER M37280MK-XXXSP MITSUBISHI ELECTRIC

- (2) Write the ASCII codes that indicate the product name of "M37280MK-" to addresses 00000₁₆ to 0000F₁₆.

Addresses 00000₁₆ to 0000F₁₆ store the product name.
ASCII codes 'M37280MK-' are listed on the right.
The addresses and data are in hexadecimal notation.
address and data are described in hexadecimal notation.

Note: If the name of the product contained in the EPROMs does not match the name on the mask ROM confirmation form, the ROM processing is disabled. Please make sure the data is written correctly.

| Address | | Address | |
|---------------------|-------------------------|---------------------|-------------------------|
| 00000 ₁₆ | 'M' = 4 D ₁₆ | 00008 ₁₆ | '-' = 2 D ₁₆ |
| 00001 ₁₆ | '3' = 3 3 ₁₆ | 00009 ₁₆ | F F ₁₆ |
| 00002 ₁₆ | '7' = 3 7 ₁₆ | 0000A ₁₆ | F F ₁₆ |
| 00003 ₁₆ | '2' = 3 2 ₁₆ | 0000B ₁₆ | F F ₁₆ |
| 00004 ₁₆ | '8' = 3 8 ₁₆ | 0000C ₁₆ | F F ₁₆ |
| 00005 ₁₆ | '0' = 3 0 ₁₆ | 0000D ₁₆ | F F ₁₆ |
| 00006 ₁₆ | 'M' = 4 D ₁₆ | 0000E ₁₆ | F F ₁₆ |
| 00007 ₁₆ | 'K' = 4 B ₁₆ | 0000F ₁₆ | F F ₁₆ |

*2. Mark specification

Mark specification must be submitted using the correct form for the type of package being ordered. Fill the appropriate mark specification form (64P4B for M37280MK-XXXSP) and attach to the mask ROM confirmation form.

M37280MF-XXXSP, M37280MK-XXXSP M37280EKSP

SINGLE-CHIP 8-BIT CMOS MICROCOMPUTER with CLOSED CAPTION DECODER
and ON-SCREEN DISPLAY CONTROLLER

GZZ-SH52-83B < 84A0 >

740 FAMILY MASK ROM CONFIRMATION FORM SINGLE-CHIP MICROCOMPUTER M37280MK-XXXSP MITSUBISHI ELECTRIC

Note: Input "FF₁₆" to the following addresses in OSD ROM

| | | | |
|--|--|--|--|
| 109FE ₁₆ to 10A01 ₁₆ | 1803E ₁₆ to 18041 ₁₆ | 1903E ₁₆ to 19041 ₁₆ | 1A03E ₁₆ to 1A041 ₁₆ |
| 10DFE ₁₆ to 10E01 ₁₆ | 180BE ₁₆ to 180C1 ₁₆ | 190BE ₁₆ to 190C1 ₁₆ | 1A0BE ₁₆ to 1A0C1 ₁₆ |
| 111FE ₁₆ to 11201 ₁₆ | 1813E ₁₆ to 18141 ₁₆ | 1913E ₁₆ to 19141 ₁₆ | 1A13E ₁₆ to 1A141 ₁₆ |
| 115FE ₁₆ to 11601 ₁₆ | 181BE ₁₆ to 181C1 ₁₆ | 191BE ₁₆ to 191C1 ₁₆ | 1A1BE ₁₆ to 1A1C1 ₁₆ |
| 119FE ₁₆ to 11A01 ₁₆ | 1823E ₁₆ to 18241 ₁₆ | 1923E ₁₆ to 19241 ₁₆ | 1A23E ₁₆ to 1A241 ₁₆ |
| 11DFE ₁₆ to 11E01 ₁₆ | 182BE ₁₆ to 182C1 ₁₆ | 192BE ₁₆ to 192C1 ₁₆ | 1A2BE ₁₆ to 1A2C1 ₁₆ |
| 121FE ₁₆ to 12201 ₁₆ | 1833E ₁₆ to 18341 ₁₆ | 1933E ₁₆ to 19341 ₁₆ | 1A33E ₁₆ to 1A341 ₁₆ |
| 125FE ₁₆ to 12601 ₁₆ | 183BE ₁₆ to 183C1 ₁₆ | 193BE ₁₆ to 193C1 ₁₆ | 1A3BE ₁₆ to 1A3C1 ₁₆ |
| 129FE ₁₆ to 12A01 ₁₆ | 1843E ₁₆ to 18441 ₁₆ | 1943E ₁₆ to 19441 ₁₆ | 1A43E ₁₆ to 1A441 ₁₆ |
| 12DFE ₁₆ to 12E01 ₁₆ | 184BE ₁₆ to 184C1 ₁₆ | 194BE ₁₆ to 194C1 ₁₆ | 1A4BE ₁₆ to 1A4C1 ₁₆ |
| 131FE ₁₆ to 13201 ₁₆ | 1853E ₁₆ to 18541 ₁₆ | 1953E ₁₆ to 19541 ₁₆ | 1A53E ₁₆ to 1A541 ₁₆ |
| 135FE ₁₆ to 13601 ₁₆ | 185BE ₁₆ to 185C1 ₁₆ | 195BE ₁₆ to 195C1 ₁₆ | 1A5BE ₁₆ to 1A5C1 ₁₆ |
| 139FE ₁₆ to 13A01 ₁₆ | 1863E ₁₆ to 18641 ₁₆ | 1963E ₁₆ to 19641 ₁₆ | 1A63E ₁₆ to 1A641 ₁₆ |
| 13DFE ₁₆ to 13E01 ₁₆ | 186BE ₁₆ to 186C1 ₁₆ | 196BE ₁₆ to 196C1 ₁₆ | 1A6BE ₁₆ to 1A6C1 ₁₆ |
| 141FE ₁₆ to 14201 ₁₆ | 1873E ₁₆ to 18741 ₁₆ | 1973E ₁₆ to 19741 ₁₆ | 1A73E ₁₆ to 1A741 ₁₆ |
| 145FE ₁₆ to 14601 ₁₆ | 187BE ₁₆ to 187C1 ₁₆ | 197BE ₁₆ to 197C1 ₁₆ | 1A7BE ₁₆ to 1A7C1 ₁₆ |
| 149FE ₁₆ to 14A01 ₁₆ | 1883E ₁₆ to 18841 ₁₆ | 1983E ₁₆ to 19841 ₁₆ | 1A83E ₁₆ to 1A841 ₁₆ |
| 14DFE ₁₆ to 14E01 ₁₆ | 188BE ₁₆ to 188C1 ₁₆ | 198BE ₁₆ to 198C1 ₁₆ | 1A8BE ₁₆ to 1A8C1 ₁₆ |
| 151FE ₁₆ to 15201 ₁₆ | 1893E ₁₆ to 18941 ₁₆ | 1993E ₁₆ to 19941 ₁₆ | 1A93E ₁₆ to 1A941 ₁₆ |
| 155FE ₁₆ to 15601 ₁₆ | 189BE ₁₆ to 189C1 ₁₆ | 199BE ₁₆ to 199C1 ₁₆ | 1A9BE ₁₆ to 1A9C1 ₁₆ |
| 15800 ₁₆ to 17FFF ₁₆ | 18A3E ₁₆ to 18A41 ₁₆ | 19A3E ₁₆ to 19A41 ₁₆ | 1AA3E ₁₆ to 1AA41 ₁₆ |
| | 18ABE ₁₆ to 18AC1 ₁₆ | 19ABE ₁₆ to 19AC1 ₁₆ | 1AABE ₁₆ to 1AAC1 ₁₆ |
| | 18B3E ₁₆ to 18B41 ₁₆ | 19B3E ₁₆ to 19B41 ₁₆ | 1AB3E ₁₆ to 1AB41 ₁₆ |
| | 18BBE ₁₆ to 18BC1 ₁₆ | 19BBE ₁₆ to 19BC1 ₁₆ | 1ABBE ₁₆ to 1ABC1 ₁₆ |
| | 18C3E ₁₆ to 18C41 ₁₆ | 19C3E ₁₆ to 19C41 ₁₆ | 1AC3E ₁₆ to 1AC41 ₁₆ |
| | 18CBE ₁₆ to 18CC1 ₁₆ | 19CBE ₁₆ to 19CC1 ₁₆ | 1ACBE ₁₆ to 1ACC1 ₁₆ |
| | 18D00 ₁₆ to 18FFF ₁₆ | 19D00 ₁₆ to 19FFF ₁₆ | |

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M37280MF-XXXSP, M37280MK-XXXSP M37280EKSP

SINGLE-CHIP 8-BIT CMOS MICROCOMPUTER with CLOSED CAPTION DECODER
and ON-SCREEN DISPLAY CONTROLLER

GZZ-SH52-84B < 84A0 >

740 FAMILY MASK ROM CONFIRMATION FORM SINGLE-CHIP MICROCOMPUTER M37280MF-XXXSP MITSUBISHI ELECTRIC

| | |
|-----------------|--|
| Mask ROM number | |
|-----------------|--|

| | | |
|---------|------------------------|----------------------|
| Receipt | Date : | |
| | Section head signature | Supervisor signature |
| | | |

Note : Please fill in all items marked *.

| | | | | | | |
|---|----------|--------------|---------|--------------------|--------------|------------|
| * | Customer | Company name | TEL () | Issuance signature | Submitted by | Supervisor |
| | | Date issued | Date : | | | |

*1. Confirmation

Specify the name of the product being ordered and the type of EPROMs submitted.

Three EPROMs are required for each pattern.

If at least two of the three sets of EPROMs submitted contain identical data, we will produce masks based on this data. We shall assume the responsibility for errors only if the mask ROM data on the products we produce differs from this data. Thus, extreme care must be taken to verify the data in the submitted EPROMs.

Checksum code for entire EPROM

| | | | |
|--|--|--|--|
| | | | |
|--|--|--|--|

(hexadecimal notation)

EPROM type (indicate the type used)

| | |
|--------------------------|---|
| <input type="checkbox"/> | 27C101 |
| EPROM address | |
| 0000 ₁₆ | Product name ASCII code : 'M37280MF -' |
| 000F ₁₆ | |
| 0100 ₁₆ | Program ROM 60 K bytes |
| 0FFF ₁₆ | |
| 1080 ₁₆ | OSD ROM |
| 157F ₁₆ | |
| 1800 ₁₆ | OSD ROM |
| 1ACF ₁₆ | |
| 1FFF ₁₆ | |

(1) Set "FF₁₆" in the shaded area.

M37280MF-XXXSP, M37280MK-XXXSP M37280EKSP

SINGLE-CHIP 8-BIT CMOS MICROCOMPUTER with CLOSED CAPTION DECODER
and ON-SCREEN DISPLAY CONTROLLER

GZZ-SH52-84B < 84A0 >

740 FAMILY MASK ROM CONFIRMATION FORM SINGLE-CHIP MICROCOMPUTER M37280MF-XXXSP MITSUBISHI ELECTRIC

- (2) Write the ASCII codes that indicate the product name of "M37280MF-" to addresses 00000₁₆ to 0000F₁₆.

Addresses 00000₁₆ to 0000F₁₆ store the product name.
ASCII codes 'M37280MF-' are listed on the right.
The addresses and data are in hexadecimal notation.
address and data are described in hexadecimal notation.

Note: If the name of the product contained in the EPROMs does not match the name on the mask ROM confirmation form, the ROM processing is disabled. Please make sure the data is written correctly.

| Address | | Address | |
|---------------------|-------------------------|---------------------|-------------------------|
| 00000 ₁₆ | 'M' = 4 D ₁₆ | 00008 ₁₆ | '-' = 2 D ₁₆ |
| 00001 ₁₆ | '3' = 3 3 ₁₆ | 00009 ₁₆ | F F ₁₆ |
| 00002 ₁₆ | '7' = 3 7 ₁₆ | 0000A ₁₆ | F F ₁₆ |
| 00003 ₁₆ | '2' = 3 2 ₁₆ | 0000B ₁₆ | F F ₁₆ |
| 00004 ₁₆ | '8' = 3 8 ₁₆ | 0000C ₁₆ | F F ₁₆ |
| 00005 ₁₆ | '0' = 3 0 ₁₆ | 0000D ₁₆ | F F ₁₆ |
| 00006 ₁₆ | 'M' = 4 D ₁₆ | 0000E ₁₆ | F F ₁₆ |
| 00007 ₁₆ | 'F' = 4 6 ₁₆ | 0000F ₁₆ | F F ₁₆ |

*2. Mark specification

Mark specification must be submitted using the correct form for the type of package being ordered. Fill the appropriate mark specification form (64P4B for M37280MF-XXXSP) and attach to the mask ROM confirmation form.

M37280MF-XXXSP, M37280MK-XXXSP M37280EKSP

SINGLE-CHIP 8-BIT CMOS MICROCOMPUTER with CLOSED CAPTION DECODER
and ON-SCREEN DISPLAY CONTROLLER

GZZ-SH52-84B < 84A0 >

740 FAMILY MASK ROM CONFIRMATION FORM SINGLE-CHIP MICROCOMPUTER M37280MF-XXXSP MITSUBISHI ELECTRIC

Note: Input "FF₁₆" to the following addresses in OSD ROM

| | | | |
|--|--|--|--|
| 109FE ₁₆ to 10A01 ₁₆ | 1803E ₁₆ to 18041 ₁₆ | 1903E ₁₆ to 19041 ₁₆ | 1A03E ₁₆ to 1A041 ₁₆ |
| 10DFE ₁₆ to 10E01 ₁₆ | 180BE ₁₆ to 180C1 ₁₆ | 190BE ₁₆ to 190C1 ₁₆ | 1A0BE ₁₆ to 1A0C1 ₁₆ |
| 111FE ₁₆ to 11201 ₁₆ | 1813E ₁₆ to 18141 ₁₆ | 1913E ₁₆ to 19141 ₁₆ | 1A13E ₁₆ to 1A141 ₁₆ |
| 115FE ₁₆ to 11601 ₁₆ | 181BE ₁₆ to 181C1 ₁₆ | 191BE ₁₆ to 191C1 ₁₆ | 1A1BE ₁₆ to 1A1C1 ₁₆ |
| 119FE ₁₆ to 11A01 ₁₆ | 1823E ₁₆ to 18241 ₁₆ | 1923E ₁₆ to 19241 ₁₆ | 1A23E ₁₆ to 1A241 ₁₆ |
| 11DFE ₁₆ to 11E01 ₁₆ | 182BE ₁₆ to 182C1 ₁₆ | 192BE ₁₆ to 192C1 ₁₆ | 1A2BE ₁₆ to 1A2C1 ₁₆ |
| 121FE ₁₆ to 12201 ₁₆ | 1833E ₁₆ to 18341 ₁₆ | 1933E ₁₆ to 19341 ₁₆ | 1A33E ₁₆ to 1A341 ₁₆ |
| 125FE ₁₆ to 12601 ₁₆ | 183BE ₁₆ to 183C1 ₁₆ | 193BE ₁₆ to 193C1 ₁₆ | 1A3BE ₁₆ to 1A3C1 ₁₆ |
| 129FE ₁₆ to 12A01 ₁₆ | 1843E ₁₆ to 18441 ₁₆ | 1943E ₁₆ to 19441 ₁₆ | 1A43E ₁₆ to 1A441 ₁₆ |
| 12DFE ₁₆ to 12E01 ₁₆ | 184BE ₁₆ to 184C1 ₁₆ | 194BE ₁₆ to 194C1 ₁₆ | 1A4BE ₁₆ to 1A4C1 ₁₆ |
| 131FE ₁₆ to 13201 ₁₆ | 1853E ₁₆ to 18541 ₁₆ | 1953E ₁₆ to 19541 ₁₆ | 1A53E ₁₆ to 1A541 ₁₆ |
| 135FE ₁₆ to 13601 ₁₆ | 185BE ₁₆ to 185C1 ₁₆ | 195BE ₁₆ to 195C1 ₁₆ | 1A5BE ₁₆ to 1A5C1 ₁₆ |
| 139FE ₁₆ to 13A01 ₁₆ | 1863E ₁₆ to 18641 ₁₆ | 1963E ₁₆ to 19641 ₁₆ | 1A63E ₁₆ to 1A641 ₁₆ |
| 13DFE ₁₆ to 13E01 ₁₆ | 186BE ₁₆ to 186C1 ₁₆ | 196BE ₁₆ to 196C1 ₁₆ | 1A6BE ₁₆ to 1A6C1 ₁₆ |
| 141FE ₁₆ to 14201 ₁₆ | 1873E ₁₆ to 18741 ₁₆ | 1973E ₁₆ to 19741 ₁₆ | 1A73E ₁₆ to 1A741 ₁₆ |
| 145FE ₁₆ to 14601 ₁₆ | 187BE ₁₆ to 187C1 ₁₆ | 197BE ₁₆ to 197C1 ₁₆ | 1A7BE ₁₆ to 1A7C1 ₁₆ |
| 149FE ₁₆ to 14A01 ₁₆ | 1883E ₁₆ to 18841 ₁₆ | 1983E ₁₆ to 19841 ₁₆ | 1A83E ₁₆ to 1A841 ₁₆ |
| 14DFE ₁₆ to 14E01 ₁₆ | 188BE ₁₆ to 188C1 ₁₆ | 198BE ₁₆ to 198C1 ₁₆ | 1A8BE ₁₆ to 1A8C1 ₁₆ |
| 151FE ₁₆ to 15201 ₁₆ | 1893E ₁₆ to 18941 ₁₆ | 1993E ₁₆ to 19941 ₁₆ | 1A93E ₁₆ to 1A941 ₁₆ |
| 155FE ₁₆ to 15601 ₁₆ | 189BE ₁₆ to 189C1 ₁₆ | 199BE ₁₆ to 199C1 ₁₆ | 1A9BE ₁₆ to 1A9C1 ₁₆ |
| 15800 ₁₆ to 17FFF ₁₆ | 18A3E ₁₆ to 18A41 ₁₆ | 19A3E ₁₆ to 19A41 ₁₆ | 1AA3E ₁₆ to 1AA41 ₁₆ |
| | 18ABE ₁₆ to 18AC1 ₁₆ | 19ABE ₁₆ to 19AC1 ₁₆ | 1AABE ₁₆ to 1AAC1 ₁₆ |
| | 18B3E ₁₆ to 18B41 ₁₆ | 19B3E ₁₆ to 19B41 ₁₆ | 1AB3E ₁₆ to 1AB41 ₁₆ |
| | 18BBE ₁₆ to 18BC1 ₁₆ | 19BBE ₁₆ to 19BC1 ₁₆ | 1ABBE ₁₆ to 1ABC1 ₁₆ |
| | 18C3E ₁₆ to 18C41 ₁₆ | 19C3E ₁₆ to 19C41 ₁₆ | 1AC3E ₁₆ to 1AC41 ₁₆ |
| | 18CBE ₁₆ to 18CC1 ₁₆ | 19CBE ₁₆ to 19CC1 ₁₆ | 1ACBE ₁₆ to 1ACC1 ₁₆ |
| | 18D00 ₁₆ to 18FFF ₁₆ | 19D00 ₁₆ to 19FFF ₁₆ | |

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M37280MF-XXXSP, M37280MK-XXXSP M37280EKSP

SINGLE-CHIP 8-BIT CMOS MICROCOMPUTER with CLOSED CAPTION DECODER
and ON-SCREEN DISPLAY CONTROLLER

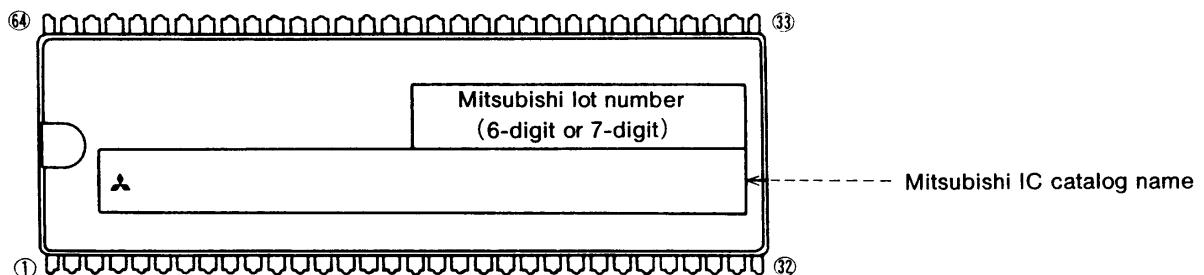
30. MARK SPECIFICATION FORM

64P4B (64-PIN SHRINK DIP) MARK SPECIFICATION FORM

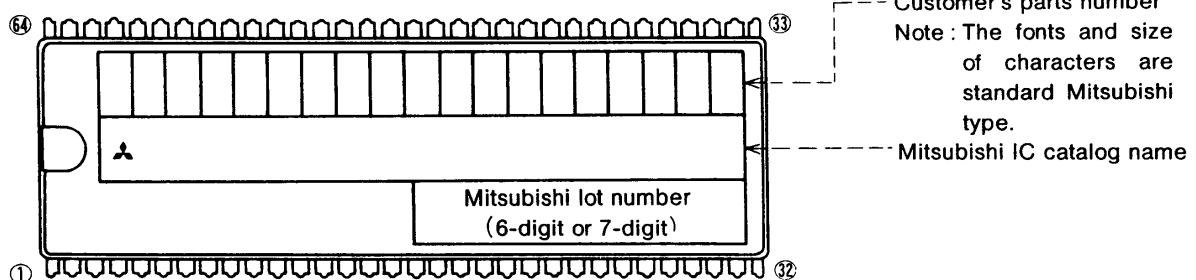
Mitsubishi IC catalog name

Please choose one of the marking types below (A, B, C), and enter the Mitsubishi IC catalog name and the special mark (if needed).

A. Standard Mitsubishi Mark



B. Customer's Parts Number + Mitsubishi Catalog Name



Note1: The mark field should be written right aligned.

2: The fonts and size of characters are standard Mitsubishi type.

3: Customer's parts number can be up to 19 characters:

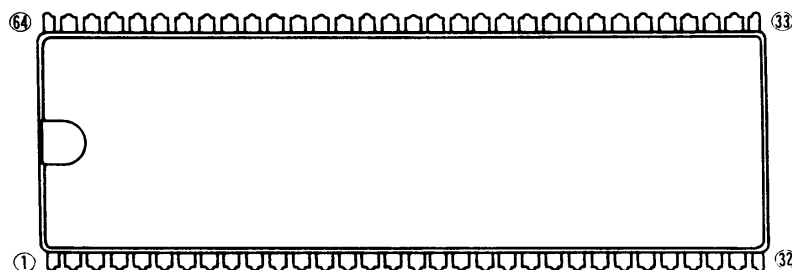
Only 0~9, A~Z, +, -, /, (,), &, ©, . (period), and , (comma) are usable.

4: If the Mitsubishi logo is not required, check the box on the right.

☐ Mitsubishi logo is not required

☐

C. Special Mark Required



Note1: If the special mark is to be printed, indicate the desired layout of the mark in the upper figure. The layout will be duplicated as close as possible. Mitsubishi lot number (6-digit or 7-digit) and mask ROM number (3-digit) are always marked.

2: If the customer's trade mark logo must be used in the special mark, check the box below. Please submit a clean original of the logo.

For the new special character fonts a clean font original (ideally logo drawing) must be submitted.

☐ Special logo required

The standard Mitsubishi font is used for all characters except for a logo.

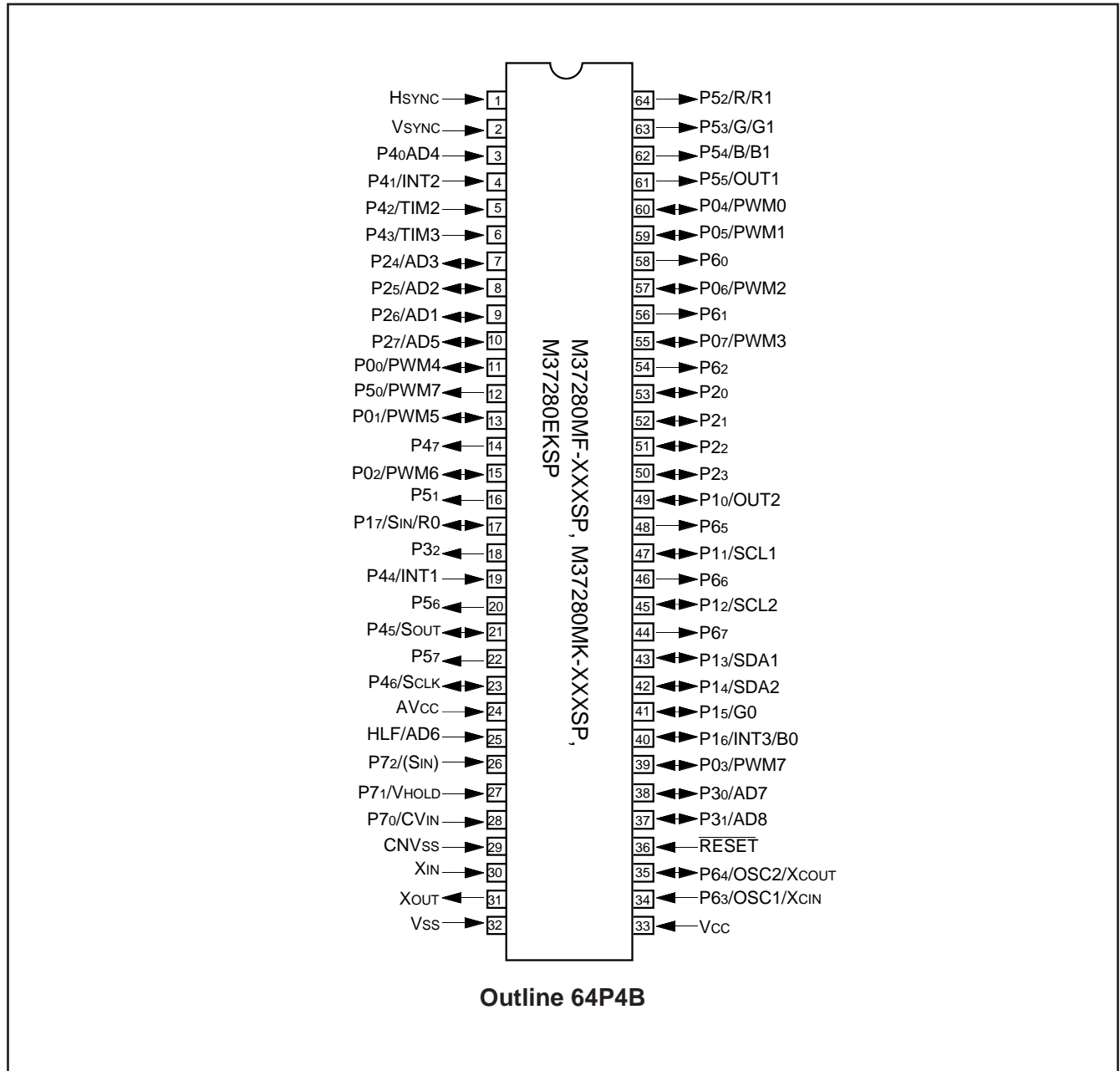
☐

M37280MF-XXXSP, M37280MK-XXXSP M37280EKSP

SINGLE-CHIP 8-BIT CMOS MICROCOMPUTER with CLOSED CAPTION DECODER
and ON-SCREEN DISPLAY CONTROLLER

31. APPENDIX

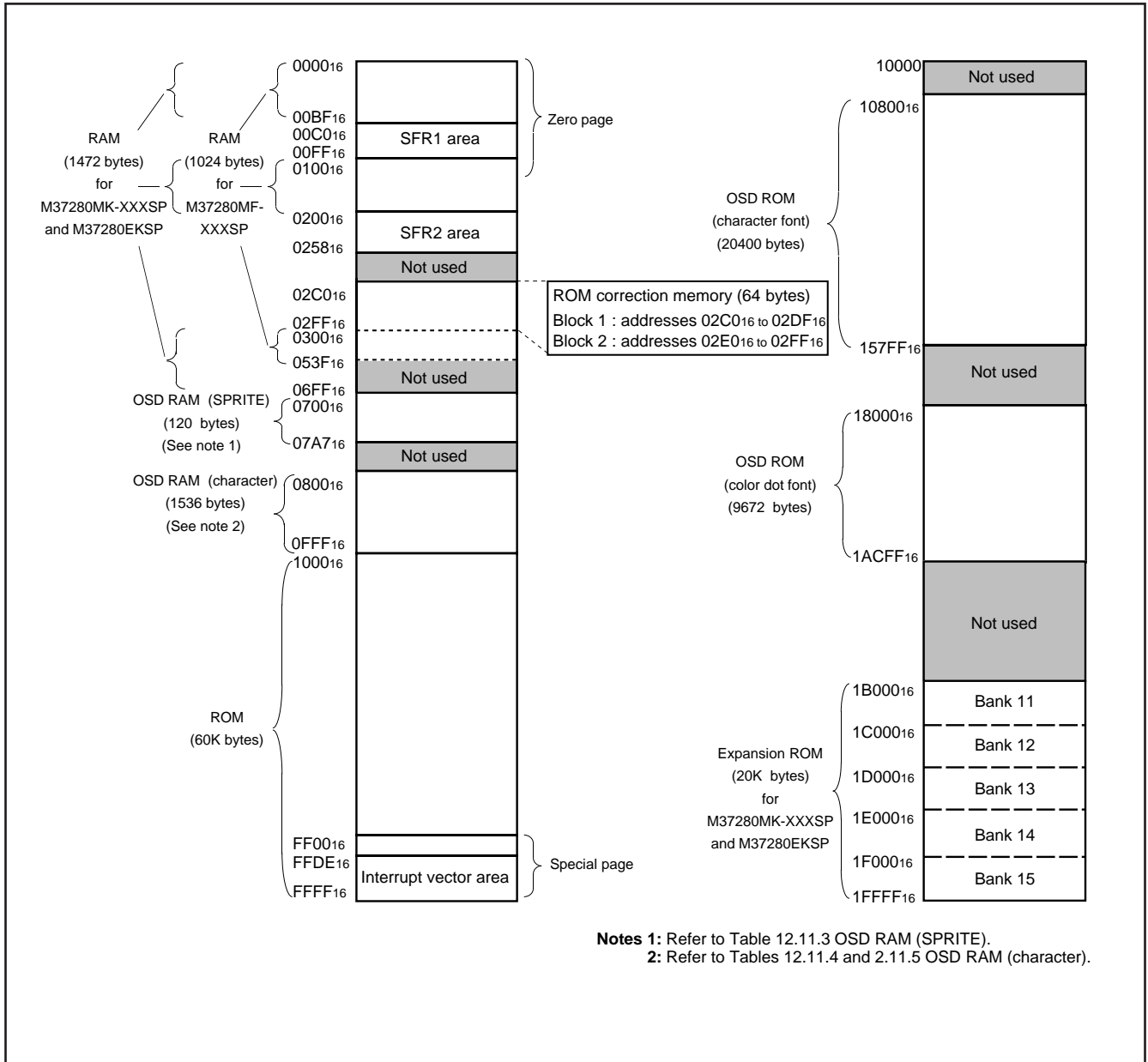
Pin Configuration (TOP VIEW)



M37280MF-XXXSP, M37280MK-XXXSP M37280EKSP

SINGLE-CHIP 8-BIT CMOS MICROCOMPUTER with CLOSED CAPTION DECODER
and ON-SCREEN DISPLAY CONTROLLER

Memory Map



Notes 1: Refer to Table 12.11.3 OSD RAM (SPRITE).
 2: Refer to Tables 12.11.4 and 2.11.5 OSD RAM (character).

M37280MF-XXXSP, M37280MK-XXXSP M37280EKSP

SINGLE-CHIP 8-BIT CMOS MICROCOMPUTER with CLOSED CAPTION DECODER
and ON-SCREEN DISPLAY CONTROLLER

Memory Map of Special Function Register (SFR)

■ SFR1 area (addresses C0₁₆ to DF₁₆)

| Bit allocation | State immediately after reset |
|--|--|
| <input type="checkbox"/> : } Function bit | <input type="checkbox"/> 0 : "0" immediately after reset |
| <input type="checkbox"/> Name : } | <input type="checkbox"/> 1 : "1" immediately after reset |
| <input type="checkbox"/> : No function bit | <input type="checkbox"/> ? : Indeterminate immediately after reset |
| <input type="checkbox"/> 0 : Fix to this bit to "0" (do not write to "1") | |
| <input type="checkbox"/> 1 : Fix to this bit to "1" (do not write to "0") | |

| Address | Register | Bit allocation | State immediately after reset |
|------------------|---|---|-------------------------------|
| | | b7 b0 | b7 b0 |
| C0 ₁₆ | Port P0 (P0) | | ? |
| C1 ₁₆ | Port P0 direction register (D0) | | 00 ₁₆ |
| C2 ₁₆ | Port P1 (P1) | | ? |
| C3 ₁₆ | Port P1 direction register (D1) | | 00 ₁₆ |
| C4 ₁₆ | Port P2 (P2) | | ? |
| C5 ₁₆ | Port P2 direction register (D2) | | 00 ₁₆ |
| C6 ₁₆ | Port P3 (P3) | | ? |
| C7 ₁₆ | Port P3 direction register (D3) | P6IM T3CS | 00 ₁₆ |
| C8 ₁₆ | Port P4 (P4) | | ? |
| C9 ₁₆ | Port P4 direction register (D4) | | 00 ₁₆ |
| CA ₁₆ | Port P5 (P5) | | ? |
| CB ₁₆ | OSD port control register (PF) | 0 OUT2 OUT1 B G R RGB 2BIT 0 | 00 ₁₆ |
| CC ₁₆ | Port P6 (P6) | | ? |
| CD ₁₆ | Port P7 (P7) | | 0 0 0 0 0 ? ? ? |
| CE ₁₆ | OSD control register 1 (OC 1) | OC17 OC16 OC15 OC14 OC13 OC12 OC11 OC10 | 00 ₁₆ |
| CF ₁₆ | Horizontal position register (HP) | HP17 HP16 HP15 HP14 HP13 HP12 HP11 HP10 | 00 ₁₆ |
| D0 ₁₆ | Block control register 1 (BC ₁) | BC ₁₆ BC ₁₅ BC ₁₄ BC ₁₃ BC ₁₂ BC ₁₁ BC ₁₀ | ? |
| D1 ₁₆ | Block control register 2 (BC ₂) | BC ₂₆ BC ₂₅ BC ₂₄ BC ₂₃ BC ₂₂ BC ₂₁ BC ₂₀ | ? |
| D2 ₁₆ | Block control register 3 (BC ₃) | BC ₃₆ BC ₃₅ BC ₃₄ BC ₃₃ BC ₃₂ BC ₃₁ BC ₃₀ | ? |
| D3 ₁₆ | Block control register 4 (BC ₄) | BC ₄₆ BC ₄₅ BC ₄₄ BC ₄₃ BC ₄₂ BC ₄₁ BC ₄₀ | ? |
| D4 ₁₆ | Block control register 5 (BC ₅) | BC ₅₆ BC ₅₅ BC ₅₄ BC ₅₃ BC ₅₂ BC ₅₁ BC ₅₀ | ? |
| D5 ₁₆ | Block control register 6 (BC ₆) | BC ₆₆ BC ₆₅ BC ₆₄ BC ₆₃ BC ₆₂ BC ₆₁ BC ₆₀ | ? |
| D6 ₁₆ | Block control register 7 (BC ₇) | BC ₇₆ BC ₇₅ BC ₇₄ BC ₇₃ BC ₇₂ BC ₇₁ BC ₇₀ | ? |
| D7 ₁₆ | Block control register 8 (BC ₈) | BC ₈₆ BC ₈₅ BC ₈₄ BC ₈₃ BC ₈₂ BC ₈₁ BC ₈₀ | ? |
| D8 ₁₆ | Block control register 9 (BC ₉) | BC ₉₆ BC ₉₅ BC ₉₄ BC ₉₃ BC ₉₂ BC ₉₁ BC ₉₀ | ? |
| D9 ₁₆ | Block control register 10 (BC ₁₀) | BC ₁₀₆ BC ₁₀₅ BC ₁₀₄ BC ₁₀₃ BC ₁₀₂ BC ₁₀₁ BC ₁₀₀ | ? |
| DA ₁₆ | Block control register 11 (BC ₁₁) | BC ₁₁₆ BC ₁₁₅ BC ₁₁₄ BC ₁₁₃ BC ₁₁₂ BC ₁₁₁ BC ₁₁₀ | ? |
| DB ₁₆ | Block control register 12 (BC ₁₂) | BC ₁₂₆ BC ₁₂₅ BC ₁₂₄ BC ₁₂₃ BC ₁₂₂ BC ₁₂₁ BC ₁₂₀ | ? |
| DC ₁₆ | Block control register 13 (BC ₁₃) | BC ₁₃₆ BC ₁₃₅ BC ₁₃₄ BC ₁₃₃ BC ₁₃₂ BC ₁₃₁ BC ₁₃₀ | ? |
| DD ₁₆ | Block control register 14 (BC ₁₄) | BC ₁₄₆ BC ₁₄₅ BC ₁₄₄ BC ₁₄₃ BC ₁₄₂ BC ₁₄₁ BC ₁₄₀ | ? |
| DE ₁₆ | Block control register 15 (BC ₁₅) | BC ₁₅₆ BC ₁₅₅ BC ₁₅₄ BC ₁₅₃ BC ₁₅₂ BC ₁₅₁ BC ₁₅₀ | ? |
| DF ₁₆ | Block control register 16 (BC ₁₆) | BC ₁₆₆ BC ₁₆₅ BC ₁₆₄ BC ₁₆₃ BC ₁₆₂ BC ₁₆₁ BC ₁₆₀ | ? |

M37280MF-XXXSP, M37280MK-XXXSP M37280EKSP

SINGLE-CHIP 8-BIT CMOS MICROCOMPUTER with CLOSED CAPTION DECODER
and ON-SCREEN DISPLAY CONTROLLER

■ SFR1 area (addresses E0₁₆ to FF₁₆)

Bit allocation

☐ : } Function bit
 Name :

☐ : No function bit

☒ 0 : Fix to this bit to "0"
(do not write to "1")

☒ 1 : Fix to this bit to "1"
(do not write to "0")

State immediately after reset

☐ 0 : "0" immediately after reset

☐ 1 : "1" immediately after reset

☐ ? : Indeterminate immediately
after reset

| Address | Register | Bit allocation | | | | | | | | State immediately after reset | | | | | | | |
|------------------|--|------------------|--------------|--------------|--------|-------|-------|-------|-------|-------------------------------|------------------|---|---|---|---|---|----|
| | | b7 | | | | | | | b0 | b7 | | | | | | | b0 |
| E0 ₁₆ | Data slicer control register 1 (DSC1) | 0 | 0 | 0 | 0 | 0 | | DSC12 | DSC11 | DSC10 | 00 ₁₆ | | | | | | |
| E1 ₁₆ | Data slicer control register 2 (DSC2) | | 0 | | DSC25 | DSC24 | DSC23 | | 0 | DSC20 | ? | 0 | ? | 0 | ? | ? | 0 |
| E2 ₁₆ | Caption data register 1 (CD1) | CDL17 | CDL16 | CDL15 | CDL14 | CDL13 | CDL12 | CDL11 | CDL10 | | 00 ₁₆ | | | | | | |
| E3 ₁₆ | Caption data register 2 (CD2) | CDH17 | CDH16 | CDH15 | CDH14 | CDH13 | CDH12 | CDH11 | CDH10 | | 00 ₁₆ | | | | | | |
| E4 ₁₆ | Caption data register 3 (CD3) | CDL27 | CDL26 | CDL25 | CDL24 | CDL23 | CDL22 | CDL21 | CDL20 | | 00 ₁₆ | | | | | | |
| E5 ₁₆ | Caption data register 4 (CD4) | CDH27 | CDH26 | CDH25 | CDH24 | CDH23 | CDH22 | CDH21 | CDH20 | | 00 ₁₆ | | | | | | |
| E6 ₁₆ | Caption Position register (CPS) | CPS7 | CPS6 | CPS5 | CPS4 | CPS3 | CPS2 | CPS1 | CPS0 | | 0 | 0 | ? | 0 | 0 | 0 | 0 |
| E7 ₁₆ | Data slicer test register 2 | 00 ₁₆ | | | | | | | | | 00 ₁₆ | | | | | | |
| E8 ₁₆ | Data slicer test register 1 | 00 ₁₆ | | | | | | | | | 00 ₁₆ | | | | | | |
| E9 ₁₆ | Sync signal counter register (HC) | | | HC5 | HC4 | HC3 | HC2 | HC1 | HC0 | | 0 | 0 | ? | ? | ? | ? | ? |
| EA ₁₆ | Clock run-in detect register (CRD) | CRD7 | CRD6 | CRD5 | CRD4 | CRD3 | | | | | 00 ₁₆ | | | | | | |
| EB ₁₆ | Data clock position register (DPS) | DPS7 | DPS6 | DPS5 | DPS4 | DPS3 | 0 | 0 | 1 | | 09 ₁₆ | | | | | | |
| EC ₁₆ | | | | | | | | | | | ? | | | | | | |
| ED ₁₆ | Bank control register (BK) | BK7 | BK6 | 0 | 0 | BK3 | BK2 | BK1 | BK0 | | 00 ₁₆ | | | | | | |
| EE ₁₆ | A-D conversion register (AD) | | | | | | | | | | ? | | | | | | |
| EF ₁₆ | A-D control register (ADCON) | 0 | | 0 | ADVREF | ADSTR | ADIN2 | ADIN1 | ADIN0 | | 0 | ? | 0 | 0 | 1 | 0 | 0 |
| F0 ₁₆ | Timer 1 (T1) | | | | | | | | | | FF ₁₆ | | | | | | |
| F1 ₁₆ | Timer 2 (T2) | | | | | | | | | | 07 ₁₆ | | | | | | |
| F2 ₁₆ | Timer 3 (T3) | | | | | | | | | | FF ₁₆ | | | | | | |
| F3 ₁₆ | Timer 4 (T4) | | | | | | | | | | 07 ₁₆ | | | | | | |
| F4 ₁₆ | Timer mode register 1 (TM1) | TM17 | TM16 | TM15 | TM14 | TM13 | TM12 | TM11 | TM10 | | 00 ₁₆ | | | | | | |
| F5 ₁₆ | Timer mode register 2 (TM2) | TM27 | TM26 | TM25 | TM24 | TM23 | TM22 | TM21 | TM20 | | 00 ₁₆ | | | | | | |
| F6 ₁₆ | I ² C data shift register (S0) | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | | ? | | | | | | |
| F7 ₁₆ | I ² C address register (S0D) | SAD6 | SAD5 | SAD4 | SAD3 | SAD2 | SAD1 | SAD0 | RBW | | 00 ₁₆ | | | | | | |
| F8 ₁₆ | I ² C status register (S1) | MST | TRX | BB | PIN | AL | AAS | AD0 | LRB | | 0 | 0 | 0 | 1 | 0 | 0 | ? |
| F9 ₁₆ | I ² C control register (S1D) | BSEL1 | BSEL0 | 10BIT SAD | ALS | ESO | BC2 | BC1 | BC0 | | 00 ₁₆ | | | | | | |
| FA ₁₆ | I ² C clock control register (S2) | ACK | FAST MODE | CCR4 | CCR3 | CCR2 | CCR1 | CCR0 | | | 00 ₁₆ | | | | | | |
| FB ₁₆ | CPU mode register (CM) | CM7 | CM6 | CM5 | 1 | 1 | CM2 | 0 | 0 | | 3C ₁₆ | | | | | | |
| FC ₁₆ | Interrupt request register 1 (IREQ1) | | ADR | VSCR | OSDR | TM4R | TM3R | TM2R | TM1R | | 00 ₁₆ | | | | | | |
| FD ₁₆ | Interrupt request register 2 (IREQ2) | 0 | TM56R | IICR | IN2R | CKR | SIOR | DSR | IN1R | | 00 ₁₆ | | | | | | |
| FE ₁₆ | Interrupt control register 1 (ICON1) | | ADE | VSCE | OSDE | TM4E | TM3E | TM2E | TM1E | | 00 ₁₆ | | | | | | |
| FF ₁₆ | Interrupt control register 2 (ICON2) | TM56S | TM56E | IICE | IN2E | CKE | SIOE | DSE | IN1E | | 00 ₁₆ | | | | | | |

M37280MF-XXXSP, M37280MK-XXXSP M37280EKSP

SINGLE-CHIP 8-BIT CMOS MICROCOMPUTER with CLOSED CAPTION DECODER
and ON-SCREEN DISPLAY CONTROLLER

■ SFR2 area (addresses 200₁₆ to 21F₁₆)

Bit allocation

☐ : } Function bit
 Name : }

☐ : No function bit

☒ 0 : Fix to this bit to "0"
(do not write to "1")

☒ 1 : Fix to this bit to "1"
(do not write to "0")

State immediately after reset

☐ 0 : "0" immediately after reset

☐ 1 : "1" immediately after reset

☐ ? : Indeterminate immediately
after reset

| Address | Register | Bit allocation | | | | | | | | State immediately after reset | | | | | | | |
|-------------------|--|----------------|------|------|------|------|------|------|------|-------------------------------|------|--|--|--|--|--|------------------|
| | | b7 | | | | | | | b0 | b7 | | | | | | | b0 |
| 200 ₁₆ | PWM0 register (PWM0) | | | | | | | | | | | | | | | | ? |
| 201 ₁₆ | PWM1 register (PWM1) | | | | | | | | | | | | | | | | ? |
| 202 ₁₆ | PWM2 register (PWM2) | | | | | | | | | | | | | | | | ? |
| 203 ₁₆ | PWM3 register (PWM3) | | | | | | | | | | | | | | | | ? |
| 204 ₁₆ | PWM4 register (PWM4) | | | | | | | | | | | | | | | | ? |
| 205 ₁₆ | PWM5 register (PWM5) | | | | | | | | | | | | | | | | ? |
| 206 ₁₆ | PWM6 register (PWM6) | | | | | | | | | | | | | | | | ? |
| 207 ₁₆ | PWM7 register (PWM7) | | | | | | | | | | | | | | | | ? |
| 208 ₁₆ | | | | | | | | | | | | | | | | | ? |
| 209 ₁₆ | | | | | | | | | | | | | | | | | ? |
| 20A ₁₆ | PWM mode register 1 (PN) | | | | | | | PN4 | PN3 | | | | | | | | 00 ₁₆ |
| 20B ₁₆ | PWM mode register 2 (PW) | PW7 | PW6 | PW5 | PW4 | PW3 | PW2 | PW1 | PW0 | | | | | | | | 00 ₁₆ |
| 20C ₁₆ | ROM correction address 1 (high-order) | | | | | | | | | | | | | | | | 00 ₁₆ |
| 20D ₁₆ | ROM correction address 1 (low-order) | | | | | | | | | | | | | | | | 00 ₁₆ |
| 20E ₁₆ | ROM correction address 2 (high-order) | | | | | | | | | | | | | | | | 00 ₁₆ |
| 20F ₁₆ | ROM correction address 2 (low-order) | | | | | | | | | | | | | | | | 00 ₁₆ |
| 210 ₁₆ | ROM correction enable register (RCR) | | | | | | | 0 | 0 | RCR1 | RCR0 | | | | | | 00 ₁₆ |
| 211 ₁₆ | Test register | | | | | | | | | | | | | | | | 00 ₁₆ |
| 212 ₁₆ | Interrupt input polarity register (IP) | AD/INT3 SEL | POL3 | | | POL2 | POL1 | | | | | | | | | | 00 ₁₆ |
| 213 ₁₆ | Serial I/O mode register (SM) | | SM6 | SM5 | SM4 | SM3 | SM2 | SM1 | SM0 | | | | | | | | 00 ₁₆ |
| 214 ₁₆ | Serial I/O register (SIO) | | | | | | | | | | | | | | | | ? |
| 215 ₁₆ | OSD control register 2(OC2) | OC27 | OC26 | OC25 | OC24 | OC23 | OC12 | OC21 | OC20 | | | | | | | | 00 ₁₆ |
| 216 ₁₆ | Clock control register (CS) | | 0 | 0 | 0 | 0 | CS2 | CS1 | CS0 | | | | | | | | 00 ₁₆ |
| 217 ₁₆ | I/O polarity control register (PC) | PC7 | PC6 | PC5 | PC4 | | PC2 | PC1 | PC0 | | | | | | | | 80 ₁₆ |
| 218 ₁₆ | Raster color register (RC) | | | | | RC4 | RC3 | RC2 | RC1 | RC0 | | | | | | | 00 ₁₆ |
| 219 ₁₆ | OSD control register 3(OC3) | OC37 | OC36 | OC35 | OC34 | OC33 | OC32 | OC31 | OC30 | | | | | | | | 00 ₁₆ |
| 21A ₁₆ | Timer 5 (TM5) | | | | | | | | | | | | | | | | 07 ₁₆ |
| 21B ₁₆ | Timer 6 (TM6) | | | | | | | | | | | | | | | | FF ₁₆ |
| 21C ₁₆ | Top border control register 1 (TB1) | TB17 | TB16 | TB15 | TB14 | TB13 | TB12 | TB11 | TB10 | | | | | | | | ? |
| 21D ₁₆ | Bottom border control register 1 (BB1) | BB17 | BB16 | BB15 | BB14 | BB13 | BB12 | BB11 | BB10 | | | | | | | | ? |
| 21E ₁₆ | Top border control register 1 (TB2) | | | | | | | | | TB21 | TB20 | | | | | | ? |
| 21F ₁₆ | Bottom border control register 1 (BB2) | | | | | | | | | BB21 | BB20 | | | | | | ? |

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SINGLE-CHIP 8-BIT CMOS MICROCOMPUTER with CLOSED CAPTION DECODER
and ON-SCREEN DISPLAY CONTROLLER

■ SFR2 area (addresses 220₁₆ to 23F₁₆)

Bit allocation

☐ : } Function bit
 Name : }

☐ : No function bit

☒ 0 : Fix to this bit to "0"
(do not write to "1")

☒ 1 : Fix to this bit to "1"
(do not write to "0")

State immediately after reset

☐ 0 : "0" immediately after reset

☐ 1 : "1" immediately after reset

☐ ? : Indeterminate immediately
after reset

| Address | Register | Bit allocation | | | | | | | | State immediately after reset | | | | | | | |
|-------------------|---|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|-------------------------------|---|--|--|--|--|--|----|
| | | b7 | | | | | | | b0 | b7 | | | | | | | b0 |
| 220 ₁₆ | Vertical position register 1 ₁ (VP1 ₁) | VP1 ₁ 7 | VP1 ₁ 6 | VP1 ₁ 5 | VP1 ₁ 4 | VP1 ₁ 3 | VP1 ₁ 2 | VP1 ₁ 1 | VP1 ₁ 0 | | ? | | | | | | |
| 221 ₁₆ | Vertical position register 1 ₂ (VP1 ₂) | VP1 ₂ 7 | VP1 ₂ 6 | VP1 ₂ 5 | VP1 ₂ 4 | VP1 ₂ 3 | VP1 ₂ 2 | VP1 ₂ 1 | VP1 ₂ 0 | | ? | | | | | | |
| 222 ₁₆ | Vertical position register 1 ₃ (VP1 ₃) | VP1 ₃ 7 | VP1 ₃ 6 | VP1 ₃ 5 | VP1 ₃ 4 | VP1 ₃ 3 | VP1 ₃ 2 | VP1 ₃ 1 | VP1 ₃ 0 | | ? | | | | | | |
| 223 ₁₆ | Vertical position register 1 ₄ (VP1 ₄) | VP1 ₄ 7 | VP1 ₄ 6 | VP1 ₄ 5 | VP1 ₄ 4 | VP1 ₄ 3 | VP1 ₄ 2 | VP1 ₄ 1 | VP1 ₄ 0 | | ? | | | | | | |
| 224 ₁₆ | Vertical position register 1 ₅ (VP1 ₅) | VP1 ₅ 7 | VP1 ₅ 6 | VP1 ₅ 5 | VP1 ₅ 4 | VP1 ₅ 3 | VP1 ₅ 2 | VP1 ₅ 1 | VP1 ₅ 0 | | ? | | | | | | |
| 225 ₁₆ | Vertical position register 1 ₆ (VP1 ₆) | VP1 ₆ 7 | VP1 ₆ 6 | VP1 ₆ 5 | VP1 ₆ 4 | VP1 ₆ 3 | VP1 ₆ 2 | VP1 ₆ 1 | VP1 ₆ 0 | | ? | | | | | | |
| 226 ₁₆ | Vertical position register 1 ₇ (VP1 ₇) | VP1 ₇ 7 | VP1 ₇ 6 | VP1 ₇ 5 | VP1 ₇ 4 | VP1 ₇ 3 | VP1 ₇ 2 | VP1 ₇ 1 | VP1 ₇ 0 | | ? | | | | | | |
| 227 ₁₆ | Vertical position register 1 ₈ (VP1 ₈) | VP1 ₈ 7 | VP1 ₈ 6 | VP1 ₈ 5 | VP1 ₈ 4 | VP1 ₈ 3 | VP1 ₈ 2 | VP1 ₈ 1 | VP1 ₈ 0 | | ? | | | | | | |
| 228 ₁₆ | Vertical position register 1 ₉ (VP1 ₉) | VP1 ₉ 7 | VP1 ₉ 6 | VP1 ₉ 5 | VP1 ₉ 4 | VP1 ₉ 3 | VP1 ₉ 2 | VP1 ₉ 1 | VP1 ₉ 0 | | ? | | | | | | |
| 229 ₁₆ | Vertical position register 1 ₁₀ (VP1 ₁₀) | VP1 ₁₀ 7 | VP1 ₁₀ 6 | VP1 ₁₀ 5 | VP1 ₁₀ 4 | VP1 ₁₀ 3 | VP1 ₁₀ 2 | VP1 ₁₀ 1 | VP1 ₁₀ 0 | | ? | | | | | | |
| 22A ₁₆ | Vertical position register 1 ₁₁ (VP1 ₁₁) | VP1 ₁₁ 7 | VP1 ₁₁ 6 | VP1 ₁₁ 5 | VP1 ₁₁ 4 | VP1 ₁₁ 3 | VP1 ₁₁ 2 | VP1 ₁₁ 1 | VP1 ₁₁ 0 | | ? | | | | | | |
| 22B ₁₆ | Vertical position register 1 ₁₂ (VP1 ₁₂) | VP1 ₁₂ 7 | VP1 ₁₂ 6 | VP1 ₁₂ 5 | VP1 ₁₂ 4 | VP1 ₁₂ 3 | VP1 ₁₂ 2 | VP1 ₁₂ 1 | VP1 ₁₂ 0 | | ? | | | | | | |
| 22C ₁₆ | Vertical position register 1 ₁₃ (VP1 ₁₃) | VP1 ₁₃ 7 | VP1 ₁₃ 6 | VP1 ₁₃ 5 | VP1 ₁₃ 4 | VP1 ₁₃ 3 | VP1 ₁₃ 2 | VP1 ₁₃ 1 | VP1 ₁₃ 0 | | ? | | | | | | |
| 22D ₁₆ | Vertical position register 1 ₁₄ (VP1 ₁₄) | VP1 ₁₄ 7 | VP1 ₁₄ 6 | VP1 ₁₄ 5 | VP1 ₁₄ 4 | VP1 ₁₄ 3 | VP1 ₁₄ 2 | VP1 ₁₄ 1 | VP1 ₁₄ 0 | | ? | | | | | | |
| 22E ₁₆ | Vertical position register 1 ₁₅ (VP1 ₁₅) | VP1 ₁₅ 7 | VP1 ₁₅ 6 | VP1 ₁₅ 5 | VP1 ₁₅ 4 | VP1 ₁₅ 3 | VP1 ₁₅ 2 | VP1 ₁₅ 1 | VP1 ₁₅ 0 | | ? | | | | | | |
| 22F ₁₆ | Vertical position register 1 ₁₆ (VP1 ₁₆) | VP1 ₁₆ 7 | VP1 ₁₆ 6 | VP1 ₁₆ 5 | VP1 ₁₆ 4 | VP1 ₁₆ 3 | VP1 ₁₆ 2 | VP1 ₁₆ 1 | VP1 ₁₆ 0 | | ? | | | | | | |
| 230 ₁₆ | Vertical position register 2 ₁ (VP2 ₁) | | | | | | | VP2 ₁ 1 | VP2 ₁ 0 | | ? | | | | | | |
| 231 ₁₆ | Vertical position register 2 ₂ (VP2 ₂) | | | | | | | VP2 ₂ 1 | VP2 ₂ 0 | | ? | | | | | | |
| 232 ₁₆ | Vertical position register 2 ₃ (VP2 ₃) | | | | | | | VP2 ₃ 1 | VP2 ₃ 0 | | ? | | | | | | |
| 233 ₁₆ | Vertical position register 2 ₄ (VP2 ₄) | | | | | | | VP2 ₄ 1 | VP2 ₄ 0 | | ? | | | | | | |
| 234 ₁₆ | Vertical position register 2 ₅ (VP2 ₅) | | | | | | | VP2 ₅ 1 | VP2 ₅ 0 | | ? | | | | | | |
| 235 ₁₆ | Vertical position register 2 ₆ (VP2 ₆) | | | | | | | VP2 ₆ 1 | VP2 ₆ 0 | | ? | | | | | | |
| 236 ₁₆ | Vertical position register 2 ₇ (VP2 ₇) | | | | | | | VP2 ₇ 1 | VP2 ₇ 0 | | ? | | | | | | |
| 237 ₁₆ | Vertical position register 2 ₈ (VP2 ₈) | | | | | | | VP2 ₈ 1 | VP2 ₈ 0 | | ? | | | | | | |
| 238 ₁₆ | Vertical position register 2 ₉ (VP2 ₉) | | | | | | | VP2 ₉ 1 | VP2 ₉ 0 | | ? | | | | | | |
| 239 ₁₆ | Vertical position register 2 ₁₀ (VP2 ₁₀) | | | | | | | VP2 ₁₀ 1 | VP2 ₁₀ 0 | | ? | | | | | | |
| 23A ₁₆ | Vertical position register 2 ₁₁ (VP2 ₁₁) | | | | | | | VP2 ₁₁ 1 | VP2 ₁₁ 0 | | ? | | | | | | |
| 23B ₁₆ | Vertical position register 2 ₁₂ (VP2 ₁₂) | | | | | | | VP2 ₁₂ 1 | VP2 ₁₂ 0 | | ? | | | | | | |
| 23C ₁₆ | Vertical position register 2 ₁₃ (VP2 ₁₃) | | | | | | | VP2 ₁₃ 1 | VP2 ₁₃ 0 | | ? | | | | | | |
| 23D ₁₆ | Vertical position register 2 ₁₄ (VP2 ₁₄) | | | | | | | VP2 ₁₄ 1 | VP2 ₁₄ 0 | | ? | | | | | | |
| 23E ₁₆ | Vertical position register 2 ₁₅ (VP2 ₁₅) | | | | | | | VP2 ₁₅ 1 | VP2 ₁₅ 0 | | ? | | | | | | |
| 23F ₁₆ | Vertical position register 2 ₁₆ (VP2 ₁₆) | | | | | | | VP2 ₁₆ 1 | VP2 ₁₆ 0 | | ? | | | | | | |

M37280MF-XXXSP, M37280MK-XXXSP M37280EKSP

SINGLE-CHIP 8-BIT CMOS MICROCOMPUTER with CLOSED CAPTION DECODER
and ON-SCREEN DISPLAY CONTROLLER

■ SFR2 area (addresses 240₁₆ to 258₁₆)

Bit allocation

☐ : } Function bit
☐ Name : }

☐ : No function bit

☒ 0 : Fix to this bit to "0"
(do not write to "1")

☒ 1 : Fix to this bit to "1"
(do not write to "0")

State immediately after reset

☐ 0 : "0" immediately after reset

☐ 1 : "1" immediately after reset

☐ ? : Indeterminate immediately
after reset

| Address | Register | Bit allocation | | | | | | | | State immediately after reset | | | | | | | |
|-------------------|---|----------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|-------------------------------|---|---|---|---|---|---|---|
| | | b7 | | | | | | | | b0 | | | | | | | |
| 240 ₁₆ | | | | | | | | | | ? | | | | | | | |
| 241 ₁₆ | Color pallet register 1 (CR1) | | CR ₁ 6 | CR ₁ 5 | CR ₁ 4 | CR ₁ 3 | CR ₁ 2 | CR ₁ 1 | CR ₁ 0 | ? | | | | | | | |
| 242 ₁₆ | Color pallet register 2 (CR2) | | CR ₂ 6 | CR ₂ 5 | CR ₂ 4 | CR ₂ 3 | CR ₂ 2 | CR ₂ 1 | CR ₂ 0 | ? | | | | | | | |
| 243 ₁₆ | Color pallet register 3 (CR3) | | CR ₃ 6 | CR ₃ 5 | CR ₃ 4 | CR ₃ 3 | CR ₃ 2 | CR ₃ 1 | CR ₃ 0 | ? | | | | | | | |
| 244 ₁₆ | Color pallet register 4 (CR4) | | CR ₄ 6 | CR ₄ 5 | CR ₄ 4 | CR ₄ 3 | CR ₄ 2 | CR ₄ 1 | CR ₄ 0 | ? | | | | | | | |
| 245 ₁₆ | Color pallet register 5 (CR5) | | CR ₅ 6 | CR ₅ 5 | CR ₅ 4 | CR ₅ 3 | CR ₅ 2 | CR ₅ 1 | CR ₅ 0 | ? | | | | | | | |
| 246 ₁₆ | Color pallet register 6 (CR6) | | CR ₆ 6 | CR ₆ 5 | CR ₆ 4 | CR ₆ 3 | CR ₆ 2 | CR ₆ 1 | CR ₆ 0 | ? | | | | | | | |
| 247 ₁₆ | Color pallet register 7 (CR7) | | CR ₇ 6 | CR ₇ 5 | CR ₇ 4 | CR ₇ 3 | CR ₇ 2 | CR ₇ 1 | CR ₇ 0 | ? | | | | | | | |
| 248 ₁₆ | | | | | | | | | | ? | | | | | | | |
| 249 ₁₆ | Color pallet register 9 (CR9) | | CR ₉ 6 | CR ₉ 5 | CR ₉ 4 | CR ₉ 3 | CR ₉ 2 | CR ₉ 1 | CR ₉ 0 | ? | | | | | | | |
| 24A ₁₆ | Color pallet register10 (CR10) | | CR ₁₀ 6 | CR ₁₀ 5 | CR ₁₀ 4 | CR ₁₀ 3 | CR ₁₀ 2 | CR ₁₀ 1 | CR ₁₀ 0 | ? | | | | | | | |
| 24B ₁₆ | Color pallet register 11 (CR11) | | CR ₁₁ 6 | CR ₁₁ 5 | CR ₁₁ 4 | CR ₁₁ 3 | CR ₁₁ 2 | CR ₁₁ 1 | CR ₁₁ 0 | ? | | | | | | | |
| 24C ₁₆ | Color pallet register 12 (CR12) | | CR ₁₂ 6 | CR ₁₂ 5 | CR ₁₂ 4 | CR ₁₂ 3 | CR ₁₂ 2 | CR ₁₂ 1 | CR ₁₂ 0 | ? | | | | | | | |
| 24D ₁₆ | Color pallet register 13 (CR13) | | CR ₁₃ 6 | CR ₁₃ 5 | CR ₁₃ 4 | CR ₁₃ 3 | CR ₁₃ 2 | CR ₁₃ 1 | CR ₁₃ 0 | ? | | | | | | | |
| 24E ₁₆ | Color pallet register 14 (CR14) | | CR ₁₄ 6 | CR ₁₄ 5 | CR ₁₄ 4 | CR ₁₄ 3 | CR ₁₄ 2 | CR ₁₄ 1 | CR ₁₄ 0 | ? | | | | | | | |
| 24F ₁₆ | Color pallet register 15 (CR15) | | CR ₁₅ 6 | CR ₁₅ 5 | CR ₁₅ 4 | CR ₁₅ 3 | CR ₁₅ 2 | CR ₁₅ 1 | CR ₁₅ 0 | ? | | | | | | | |
| 250 ₁₆ | Left border control register 1 (LB1) | LB17 | LB16 | LB15 | LB14 | LB13 | LB12 | LB11 | LB10 | 0116 | | | | | | | |
| 251 ₁₆ | Left border control register 2 (LB2) | | | | | | LB22 | LB21 | LB20 | 0016 | | | | | | | |
| 252 ₁₆ | Right border control register 1 (RB1) | RB17 | RB16 | RB15 | RB14 | RB13 | RB12 | RB11 | RB10 | FF16 | | | | | | | |
| 253 ₁₆ | Right border control register 2 (RB2) | | | | | | RB22 | RB21 | RB20 | 0716 | | | | | | | |
| 254 ₁₆ | SPRITE vertical position register 1 (VS1) | VS17 | VS16 | VS15 | VS14 | VS13 | VS12 | VS11 | VS10 | ? | | | | | | | |
| 255 ₁₆ | SPRITE vertical position register 2 (VS2) | | | | | | | VS21 | VS20 | 0016 | | | | | | | |
| 256 ₁₆ | SPRITE horizontal position register 1 (HS1) | HS17 | HS16 | HS15 | HS14 | HS13 | HS12 | HS11 | HS10 | ? | | | | | | | |
| 257 ₁₆ | SPRITE horizontal position register 2 (HS2) | | | | | | HS22 | HS21 | HS20 | 0 | 0 | 0 | 0 | 0 | ? | ? | ? |
| 258 ₁₆ | SPRITE OSD control register (SC) | | | SC5 | SC4 | SC3 | SC2 | SC1 | SC0 | 0016 | | | | | | | |

Internal State of Processor Status Register and
 Program Counter at Reset

| | | |
|--------------------------------|---|--|
| | <p>Bit allocation</p> <div> <div></div> <div>Name</div> </div> <div> <div></div> <div></div> <div>0</div> <div>1</div> </div> | <p>State immediately after reset</p> <div> <div>0</div> <div>1</div> <div>?</div> </div> <div> <div></div> <div></div> <div></div> </div> |
| | <p>Function bit</p> <p>No function bit</p> <p>Fix to this bit to “0” (do not write to “1”)</p> <p>Fix to this bit to “1” (do not write to “0”)</p> | <p>“0” immediately after reset</p> <p>“1” immediately after reset</p> <p>Indeterminate immediately after reset</p> |
| Register | <p>Bit allocation</p> <div> <div>b7</div> <div>N</div> <div>V</div> <div>T</div> <div>B</div> <div>D</div> <div>I</div> <div>Z</div> <div>C</div> <div>b0</div> </div> <div> <div></div> <div></div> </div> | <p>State immediately after reset</p> <div> <div>b7</div> <div>?</div> <div>?</div> <div>?</div> <div>?</div> <div>?</div> <div>1</div> <div>?</div> <div>?</div> <div>b0</div> </div> <div> <div>Contents of address FFFF₁₆</div> <div>Contents of address FFFE₁₆</div> </div> |
| Processor status register (PS) | | |
| Program counter (PCH) | | |
| Program counter (PCL) | | |

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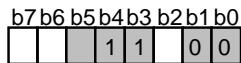
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Structure of Register

The figure of each register structure describes its functions, contents at reset, and attributes as follows:

<Example>

CPU Mode Register




Bits

Values immediately after reset release (Note 1)

Bit attributes (Note 2)

| B | Name | Functions | After reset | R:W |
|------|--|---|-------------|-----|
| 0, 1 | Processor mode bits (CM0, CM1) | b1 b0 0 0: Single-chip mode 0 1: } Not available 1 0: } 1 1: } | 0 | R:W |
| 2 | Stack page selection bit (See note) (CM2) | 0: 0 page 1: 1 page | 0 | R:W |
| 3, 4 | Fix these bits to "1." | | 1 | R:W |
| 5 | Nothing is assigned. This bit is write disable bit. When this bit is read out, the value is "0." | | 1 | R:W |
| 6, 7 | Clock switch bits (CM6, CM7) | b7 b6 0 0: f(XIN) = 8 MHz 0 1: f(XIN) = 12 MHz 1 0: f(XIN) = 16 MHz 1 1: Do not set | 0 | R:W |

 : Bit in which nothing is assigned

Notes 1: Values immediately after reset release

0 "0" after reset release

1 "1" after reset release

Indeterminate.....Indeterminate after reset

release

2: Bit attributes.....The attributes of control register bits are classified into 3 types : read-only, write-only and read and write. In the figure, these attributes are represented as follows :

R.....Read

RRead enabled

–Read disabled

W.....Write

WWrite enabled

–Write disabled

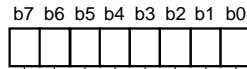
* "0" can be set by software, but "1" cannot be set.

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Address 00C1₁₆, 00C3₁₆, 00C5₁₆

Port Pi Direction Register

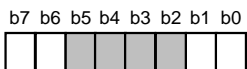


Port Pi direction register (Di) (i=0,1,2) [Addresses 00C1₁₆, 00C3₁₆, 00C5₁₆]

| B | Name | Functions | After reset | R | W |
|---|----------------------------|---|-------------|---|---|
| 0 | Port Pi direction register | 0 : Port Pi ₀ input mode 1 : Port Pi ₀ output mode | 0 | R | W |
| 1 | | 0 : Port Pi ₁ input mode 1 : Port Pi ₁ output mode | 0 | R | W |
| 2 | | 0 : Port Pi ₂ input mode 1 : Port Pi ₂ output mode | 0 | R | W |
| 3 | | 0 : Port Pi ₃ input mode 1 : Port Pi ₃ output mode | 0 | R | W |
| 4 | | 0 : Port Pi ₄ input mode 1 : Port Pi ₄ output mode | 0 | R | W |
| 5 | | 0 : Port Pi ₅ input mode 1 : Port Pi ₅ output mode | 0 | R | W |
| 6 | | 0 : Port Pi ₆ input mode 1 : Port Pi ₆ output mode | 0 | R | W |
| 7 | | 0 : Port Pi ₇ input mode 1 : Port Pi ₇ output mode | 0 | R | W |

Address 00C7₁₆

Port P3 Direction Register



Port P3 direction register (D3) [Address 00C7₁₆]

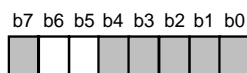
| B | Name | Functions | After reset | R | W |
|--------|---|---|-------------|---|---|
| 0 | Port P3 direction register | 0 : Port P3 ₀ input mode 1 : Port P3 ₀ output mode | 0 | R | W |
| 1 | | 0 : Port P3 ₁ input mode 1 : Port P3 ₁ output mode | 0 | R | W |
| 2 to 5 | Nothing is assigned. These bits are write disable bits. When these bits are read out, the values are "0." | | 0 | R | — |
| 6 | Timer 3 count source selection bit (T3SC) | Refer to Timer section. | 0 | R | W |
| 7 | Ports P6 ₃ , P6 ₄ selection bits (P6IM) | Refer to clock control register (address 0216 ₁₆). | 0 | R | W |

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Address 00C7₁₆

Port P4 Direction Register

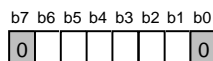


Port P3 direction register (D4) [Address 00C7₁₆]

| B | Name | Functions | After reset | R | W |
|--------|---|---|-------------|---|---|
| 0 | Fix this bit to "0" | | 0 | R | W |
| 1 to 4 | Nothing is assigned. These bits are write disable bits. When these bits are read out, the values are "0." | | 0 | R | W |
| 5 | Port P4 direction register | 0 : Port P4 ₅ input mode 1 : Port P4 ₅ output mode | 0 | R | — |
| 6 | | 0 : Port P4 ₆ input mode 1 : Port P4 ₇ output mode | 0 | R | W |
| 7 | Nothing is assigned. This bit is write disable bit. When this bit is read out, the values is "0." | | 0 | R | W |

Address 00CB₁₆

OSD Port Control Register



OSD port control register (PF) [Address 00CB₁₆]

| b | Name | Functions | After reset | R | W |
|---|---|---|-------------|---|---|
| 0 | Fix this bit to "0" | | 0 | R | W |
| 1 | R, G, B output method selection bit (RGB2BIT) | 0 : 4-adjustment-level analog is output from pins R, G, B. 1 : Value which is converted from 4-adjustment-level analog to 2-bit digital is output as below: High-order: from R1, G1, B1 Low-order: from R0, G0, B0 | 0 | R | W |
| 2 | Port P5 ₂ output signal selection bit (R) | 0 : R signal output 1 : Port P5 ₂ output | 0 | R | W |
| 3 | Port P5 ₃ output signal selection bit (G) | 0 : G signal output 1 : Port P5 ₃ output | 0 | R | W |
| 4 | Port P5 ₄ output signal selection bit (B) | 0 : B signal output 1 : Port P5 ₄ output | 0 | R | W |
| 5 | Port P5 ₅ output signal selection bit (OUT1) | 0 : OUT1 signal output 1 : Port P5 ₅ output | 0 | R | W |
| 6 | Port P1 ₀ output signal selection bit (OUT2) | 0 : Port P1 ₀ signal output 1 : OUT2 output | 0 | R | W |
| 7 | Fix this bit to "0" | | 0 | R | W |

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Address 00CE₁₆

OSD Control Register 1

b7 b6 b5 b4 b3 b2 b1 b0

OSD control register 1 (OC1) [Address 00CE₁₆]

| B | Name | Functions | After reset | R:W |
|------|---|---|-------------|-----|
| 0 | OSD control bit (OC10) (See note 1) | 0 : All-blocks display off 1 : All-blocks display on | 0 | R:W |
| 1 | Scan mode selection bit (OC11) | 0 : Normal scan mode 1 : Bi-scan mode | 0 | R:W |
| 2 | Border type selection bit (OC12) | 0 : All bordered 1 : Shadow bordered (See note 2) | 0 | R:W |
| 3 | Flash mode selection bit (OC13) | 0 : Color signal of character background part does not flash 1 : Color signal of character background part flashes | 0 | R:W |
| 4 | Automatic solid space control bit (OC14) | 0 : OFF 1 : ON | 0 | R:W |
| 5 | Vertical window/blank control bit (OC15) | 0 : OFF 1 : ON | 0 | R:W |
| 6, 7 | Layer mixing control bits (OC16, OC17) (See note 3) | b7 b6 0 0: Logic sum (OR) of layer 1's color and layer 2's color 0 1: Layer 1's color has priority 1 0: Layer 2's color has priority 1 1: Do not set. | 0 | R:W |

- Notes 1 :** Even this bit is switched during display, the display screen remains unchanged until a rising (falling) of the next V_{SYNC}.
2 : Shadow border is output at right and bottom side of the font.
3 : OUT2 is always ORed, regardless of values of these bits.

Address 00CF₁₆

Horizontal Position Register

b7 b6 b5 b4 b3 b2 b1 b0

Horizontal position register (HP) [Address 00CF₁₆]

| B | Name | Functions | After reset | R:W |
|--------|---|---|-------------|-----|
| 0 to 7 | Control bits of horizontal display start positions (HP0 to HP7) | Horizontal display start positions $4T_{osc} \times$ (setting value of high-order 4 bits $\times 16^1$ + setting value of low-order 4 bits $\times 16^0$) | 0 | R:W |

- Notes 1.** The setting value synchronizes with the V_{SYNC}.
2. T_{osc} = OSD oscillation period.

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Address 00D0₁₆ to 00DF₁₆

Block Control Register i

b7 b6 b5 b4 b3 b2 b1 b0

Block control register i (BCi) (i=1 to 16) [Addresses 00D0₁₆ to 00DF₁₆]

| B | Name | Functions | | | | | After reset | R | W | |
|------|---|---------------------------------|----|-------------|------------|---------------------------|---------------|---------------|---|-------------------------|
| 0, 1 | Display mode selection bits (BCi0, BCi1) | b1 | b0 | Functions | | | Indeterminate | R | W | |
| | | 0 | 0 | Display OFF | | | | | | |
| | | 0 | 1 | OSD mode | | | | | | |
| | | 1 | 0 | CC mode | | | | | | |
| | | 1 | 1 | CDOSD mode | | | | | | |
| 2 | Border control bit (BCi2) | 0 : Border OFF 1 : Border ON | | | | | Indeterminate | R | W | |
| 3, 4 | Dot size selection bits (BCi3, BCi4) | b6 | b5 | b4 | b3 | Pre-divide ratio | Dot size | Indeterminate | R | W |
| | | 0 | 0 | 0 | 0 | × 1 | 1Tc × 1/2H | | | |
| | | | | 0 | 1 | | 1Tc × 1H | | | |
| | | | | 1 | 0 | | 2Tc × 2H | | | |
| | | | | 1 | 1 | | 3Tc × 3H | | | |
| 0 | 1 | 0 | 0 | × 2 | 1Tc × 1/2H | | | | | |
| | | 0 | 1 | | 1Tc × 1H | | | | | |
| | | 1 | 0 | | 2Tc × 2H | | | | | |
| | | 1 | 1 | | 3Tc × 3H | | | | | |
| 5, 6 | Pre-divide ratio selection bit (BCi5, BCi6) | 1 | 1 | 0 | 0 | 1.5Tc × 1/2H (See note 3) | Indeterminate | R | W | |
| | | | | 0 | 1 | | | | | 1.5Tc × 1H (See note 3) |
| | | 1 | 1 | 0 | 0 | × 3 | | | | 1Tc × 1/2H |
| 0 | 1 | | | 1Tc × 1H | | | | | | |
| 1 | 0 | | | 2Tc × 2H | | | | | | |
| 1 | 1 | | | 3Tc × 3H | | | | | | |
| 7 | Nothing is assigned. This bit is a write disable bit. When this bit is read out, the value is indeterminate. | | | | | | Indeterminate | R | — | |

Notes 1: Tc : OSD clock cycle divided in pre-divide circuit

2: H : HSYNC

3: This character size is available only in Layer 2. At this time, set layer 1's pre-divide ratio = × 2, layer 1's horizontal dot size = 1Tc.

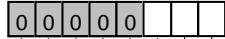
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Address 00E0₁₆

Data Slicer Control Register 1

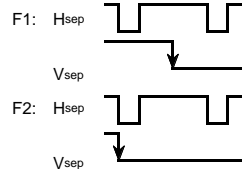
b7 b6 b5 b4 b3 b2 b1 b0



Data slicer control register 1 (DSC1) [Address 00E0₁₆]

| B | Name | Functions | After reset | R | W |
|--------|--|------------------------------------|-------------|---|---|
| 0 | Data slicer and timing signal generating circuit control bit (DSC10) | 0: Stopped 1: Operating | 0 | R | W |
| 1 | Selection bit of data slice reference voltage generating field (DSC11) | 0: F2 1: F1 | 0 | R | W |
| 2 | Reference clock source selection bit (DSC12) | 0: Video signal 1: Hsync signal | 0 | R | W |
| 3 to 7 | Fix these bits to "0." | | 0 | R | W |

Definition of fields 1 (F1) and 2 (F2)



Address 00E1₁₆

Data Slicer Control Register 2

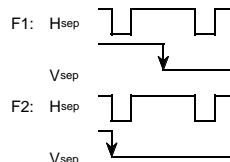
b7 b6 b5 b4 b3 b2 b1 b0



Data slicer control register 2 (DSC2) [Address 00E1₁₆]

| B | Name | Functions | After reset | R | W |
|---|--|--|---------------|---|---|
| 0 | Caption data latch completion flag 1 (DSC20) | 0: Data is not latched yet and a clock-run-in is not determined. 1: Data is latched and a clock-run-in is determined. | Indeterminate | R | — |
| 1 | Fix this bit to "0." | | 0 | R | W |
| 2 | Test bit | Read-only | Indeterminate | R | — |
| 3 | Field determination flag (DSC23) | 0: F2 1: F1 | Indeterminate | R | — |
| 4 | Vertical synchronous signal (Vsep) generating method selection bit (DSC24) | 0: Method (1) 1: Method (2) | 0 | R | W |
| 5 | V-pulse shape determination flag (DSC25) | 0: Match 1: Mismatch | Indeterminate | R | — |
| 6 | Fix this bit to "0." | | 0 | R | W |
| 7 | Test bit | Read-only | Indeterminate | R | — |

Definition of fields 1 (F1) and 2 (F2)

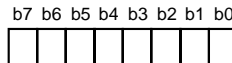


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Address 00E6₁₆

Caption Position Register

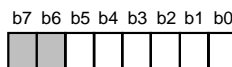


Caption Position Register (CPS) [Address 00E6₁₆]

| B | Name | Functions | After reset | R | W |
|--------|--|--|---------------|---|---|
| 0 to 4 | Caption position bits(CPS0 to CPS4) | | 0 | R | W |
| 5 | Caption data latch completion flag 2 (CPS5) | 0: Data is not latched yet and a clock-run-in is not determined. 1: Data is latched and a clock-run-in is determined. | Indeterminate | R | — |
| 6, 7 | Slice line mode specification bits (in 1 field) (CPS6, CPS7) | Refer to the corresponding Table (Table 12.10.1). | 0 | R | W |

Address 00E9₁₆

Sync Pulse Counter Register

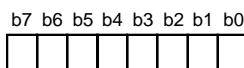


Sync pulse counter register (HC) [Address 00E9₁₆]

| B | Name | Functions | After reset | R | W |
|--------|---|---|---------------|---|---|
| 0 to 4 | Count value (HC0 to HC4) | | Indeterminate | R | — |
| 5 | Count source (HC5) | 0: Hsync signal 1: Composite sync signal | 0 | R | W |
| 6, 7 | Nothing is assigned. These bits are write disable bits. When these bits are read out, the values are "0." | | 0 | R | — |

Address 00E4₁₆

Clock Run-in Detect Register



Clock run-in detect register (CRD) [Address 00E4₁₆]

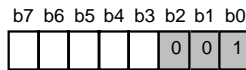
| B | Name | Functions | After reset | R | W |
|--------|--|--|-------------|---|---|
| 0 to 2 | Test bits | Read-only | 0 | R | — |
| 3 to 7 | Clock run-in detection bit(CRD3 to CRD7) | Number of reference clocks to be counted in one clock run-in pulse period. | 0 | R | — |

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Address 00EB₁₆

Data Clock Position Register

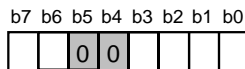


Data clock position register (DPS) [Address 00EB₁₆]

| B | Name | Functions | After reset | R | W |
|--------|---|-----------|-------------|---|---|
| 0 | Fix these bits to "1." | | 1 | R | W |
| 1,2 | Fix this bit to "0." | | 0 | R | W |
| 3 | Data clock position set bits (DPS3 to DPS7) | | 1 | R | W |
| 4 to 7 | | | 0 | | |

Address 00ED₁₆

Bank Control Register



Bank control register (BK) [Address 00ED₁₆]

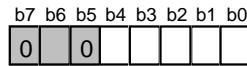
| B | Name | Functions | | | | After reset | R | W |
|--------|----------------------------------|---|----|----------|--|-------------|---|---|
| 0 to 3 | Bank selection bits (BK0 to BK3) | Bank number is selected (bank 11 to 15) | | | | 0 | R | W |
| 4, 5 | Fix these bits to "0". | | | | | 0 | R | W |
| 6, 7 | Bank control bits (BK6, BK7) | b7 | b6 | Bank ROM | Address 1000 ₁₆ level access | 0 | R | W |
| | | 0 | X | Not used | Read out from extra area (programmable) | | | |
| | | 1 | 0 | Used | Read out the data from area specified by the bank selection bits | | | |
| | | 1 | 1 | Used | Read out from extra area (data-dedicated) | | | |

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Address 00EF₁₆

A-D Control Register



A-D control register (ADCON) [Address 00EF₁₆]

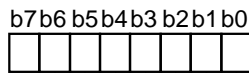
| B | Name | Functions | After reset | R | W |
|--------|--|--|---------------|---|---|
| 0 to 2 | Analog input pin selection bits (ADIN0 to ADIN2) | b2 b1 b0 0 0 0 : AD1 0 0 1 : AD2 0 1 0 : AD3 0 1 1 : AD4 1 0 0 : AD5 1 0 1 : AD6 1 1 0 : AD7 1 1 1 : AD8 | 0 | R | W |
| 3 | A-D conversion completion bit (ADSTR) | 0: Conversion in progress 1: Conversion completed | 1 | R | W |
| 4 | Vcc connection selection bit (ADVREF) | 0: OFF 1: ON | 0 | R | W |
| 5 | Fix this bit to "0." | | 0 | R | W |
| 6 | Nothing is assigned. This bit is a write disable bit. When this bit is read out, the value is indeterminate. | | Indeterminate | R | — |
| 7 | Fix this bit to "0." | | 0 | R | W |

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Address 00F4₁₆

Timer Mode Register 1



Timer mode register 1 (TM1) [Address 00F4₁₆]

| B | Name | Functions | After reset | R | W |
|---|--|---|-------------|---|---|
| 0 | Timer 1 count source selection bit 1 (TM10) | 0: f(X _{IN})/16 or f(X _{CIN})/16 (Note) 1: Count source selected by bit 5 of TM1 | 0 | R | W |
| 1 | Timer 2 count source selection bit 1 (TM11) | 0: Count source selected by bit 4 of TM1 1: External clock from TIM2 pin | 0 | R | W |
| 2 | Timer 1 count stop bit (TM12) | 0: Count start 1: Count stop | 0 | R | W |
| 3 | Timer 2 count stop bit (TM13) | 0: Count start 1: Count stop | 0 | R | W |
| 4 | Timer 2 count source selection bit 2 (TM14) | 0: f(X _{IN})/16 or f(X _{CIN})/16 (See note) 1: Timer 1 overflow | 0 | R | W |
| 5 | Timer 1 count source selection bit 2 (TM15) | 0: f(X _{IN})/4096 or f(X _{CIN})/4096 (See note) 1: External clock from TIM2 pin | 0 | R | W |
| 6 | Timer 5 count source selection bit 2 (TM16) | 0: Timer 2 overflow 1: Timer 4 overflow | 0 | R | W |
| 7 | Timer 6 internal count source selection bit (TM17) | 0: f(X _{IN})/16 or f(X _{CIN})/16 (See note) 1: Timer 5 overflow | 0 | R | W |

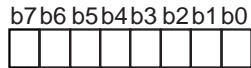
Note: Either f(X_{IN}) or f(X_{CIN}) is selected by bit 7 of the CPU mode register.

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Address 00F5₁₆

Timer Mode Register 2



Timer mode register 2 (TM2) [Address 00F5₁₆]

| B | Name | Functions | After reset | R | W |
|------|--|--|-------------|---|---|
| 0 | Timer 3 count source selection bit (TM20) | (b6 at address 00C7 ₁₆) ↓ b0 0 0 : f(X _{IN})/16 or f(X _{CIN})/16 (See note) 1 0 : f(X _{CIN}) 0 1 : } External clock from TIM3 pin 1 1 : } | 0 | R | W |
| 1, 4 | Timer 4 count source selection bits (TM21, TM24) | b4 b1 0 0 : Timer 3 overflow signal 0 1 : f(X _{IN})/16 or f(X _{CIN})/16 (See note) 1 0 : f(X _{IN})/2 or f(X _{CIN})/2 (See note) 1 1 : f(X _{CIN}) | 0 | R | W |
| 2 | Timer 3 count stop bit (TM22) | 0: Count start 1: Count stop | 0 | R | W |
| 3 | Timer 4 count stop bit (TM23) | 0: Count start 1: Count stop | 0 | R | W |
| 5 | Timer 5 count stop bit (TM25) | 0: Count start 1: Count stop | 0 | R | W |
| 6 | Timer 6 count stop bit (TM26) | 0: Count start 1: Count stop | 0 | R | W |
| 7 | Timer 5 count source selection bit 1 (TM27) | 0: f(X _{IN})/16 or f(X _{CIN})/16 (See note) 1: Count source selected by bit 6 of TM1 | 0 | R | W |

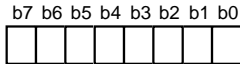
Note: Either f(X_{IN}) or f(X_{CIN}) is selected by bit 7 of the CPU mode register.

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SINGLE-CHIP 8-BIT CMOS MICROCOMPUTER with CLOSED CAPTION DECODER
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Address 00F6₁₆

I²C Data Shift Register



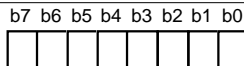
I²C data shift register 1 (S0) [Address 00F6₁₆]

| B | Name | Functions | After reset | R | W |
|--------------|----------|--|---------------|---|---|
| 0 to 7 | D0 to D7 | This is an 8-bit shift register to store receive data and write transmit data. | Indeterminate | R | W |

Note: To write data into the I²C data shift register after setting the MST bit to "0" (slave mode), keep an interval of 8 machine cycles or more.

Address 00F7₁₆

I²C Address Register



I²C address register (S0D) [Address 00F7₁₆]

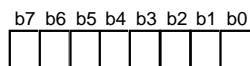
| B | Name | Functions | After reset | R | W |
|--------------|------------------------------|---|-------------|---|---|
| 0 | Read/write bit (RBW) | 0: Read 1: Write | 0 | R | — |
| 1 to 7 | Slave address (SAD0 to SAD6) | The address data transmitted from the master is compared with the contents of these bits. | 0 | R | W |

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Address 00F8₁₆

I²C Status Register



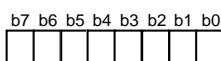
I²C status register (S1) [Address 00F8₁₆]

| B | Name | Functions | After reset | R | W |
|------|---|---|---------------|---|---|
| 0 | Last receive bit (LRB) (See note) | 0 : Last bit = "0" 1 : Last bit = "1" (See note) | Indeterminate | R | — |
| 1 | General call detecting flag (AD0) (See note) | 0 : No general call detected 1 : General call detected (See note) | 0 | R | — |
| 2 | Slave address comparison flag (AAS) (See note) | 0 : Address match 1 : Address mismatch (See note) | 0 | R | — |
| 3 | Arbitration lost detecting flag (AL) (See note) | 0 : Not detected 1 : Detected (See note) | 0 | R | — |
| 4 | I ² C-BUS interface interrupt request bit (PIN) | 0 : Interrupt request issued 1 : No interrupt request issued | 0 | R | W |
| 5 | Bus busy flag (BB) | 0 : Bus free 1 : Bus busy | 0 | R | W |
| 6, 7 | Communication mode specification bits (TRX, MST) | b7 b6 0 0 : Slave receive mode 0 1 : Slave transmit mode 1 0 : Master receive mode 1 1 : Master transmit mode | 0 | R | W |

Note : These bits and flags can be read out, but cannot be written.

Address 00F9₁₆

I²C Control Register



I²C control register (S1D) [Address 00F9₁₆]

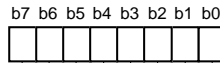
| B | Name | Functions | After reset | R | W |
|--------|--|--|-------------|---|---|
| 0 to 2 | Bit counter (Number of transmit/receive bits) (BC0 to BC2) | b2 b1 b0 0 0 0: 8 0 0 1: 7 0 1 0: 6 0 1 1: 5 1 0 0: 4 1 0 1: 3 1 1 0: 2 1 1 1: 1 | 0 | R | W |
| 3 | I ² C-BUS interface use enable bit (ESO) | 0: Disabled 1: Enabled | 0 | R | W |
| 4 | Data format selection bit(ALS) | 0: Addressing format 1: Free data format | 0 | R | W |
| 5 | Addressing format selection bit (10BIT SAD) | 0: 7-bit addressing format 1: 10-bit addressing format | 0 | R | W |
| 6, 7 | Connection control bits between I ² C-BUS interface and ports (BSEL0, BSEL1) | b7 b6 Connection port (See note) 0 0: None 0 1: SCL1, SDA1 1 0: SCL2, SDA2 1 1: SCL1, SDA1, SCL2, SDA2 | 0 | R | W |

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Address 00FA₁₆

I²C Clock Control Register



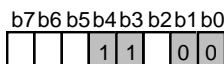
I²C clock control register (S2) [Address 00FA₁₆]

| B | Name | Functions | | | After reset | R | W |
|---------------------------------|---|--|---------------------|-----------------------|-------------|---|---|
| 0 to 4 | SCL frequency control bits (CCR0 to CCR4) | Setup value of CCR4-CCR0 | Standard clock mode | High speed clock mode | 0 | R | W |
| | | 00 to 02 | Setup disabled | Setup disabled | | | |
| | | 03 | Setup disabled | 333 | | | |
| | | 04 | Setup disabled | 250 | | | |
| | | 05 | 100 | 400 (See note) | | | |
| | | 06 | 83.3 | 166 | | | |
| | | : | 500/CCR value | 1000/CCR value | | | |
| | | 1D | 17.2 | 34.5 | | | |
| | | 1E | 16.6 | 33.3 | | | |
| | | 1F | 16.1 | 32.3 | | | |
| (at $\phi = 4$ MHz, unit : kHz) | | | | | | | |
| 5 | SCL mode specification bit (FAST MODE) | 0: Standard clock mode 1: High-speed clock mode | | | 0 | R | W |
| 6 | ACK bit (ACK BIT) | 0: ACK is returned. 1: ACK is not returned. | | | 0 | R | W |
| 7 | ACK clock bit (ACK) | 0: No ACK clock 1: ACK clock | | | 0 | R | W |

Note: At 400 kHz in the high-speed clock mode, the duty is as below .
 "0" period : "1" period = 3 : 2
 In the other cases, the duty is as below.
 "0" period : "1" period = 1 : 1

Address 00FB₁₆

CPU Mode Register



CPU mode register (CM) [Address 00FB₁₆]

| B | Name | Functions | After reset | R | W |
|------|---|---|-------------|---|---|
| 0, 1 | Processor mode bits (CM0, CM1) | b1 b0 0 0: Single-chip mode 0 1: } 1 0: } Not available 1 1: } | 0 | R | W |
| 2 | Stack page selection bit (CM2) (See note) | 0: 0 page 1: 1 page | 1 | R | W |
| 3, 4 | Fix these bits to "1." | | 1 | R | W |
| 5 | Xcout drivability selection bit (CM5) | 0: LOW drive 1: HIGH drive | 1 | R | W |
| 6 | Main Clock (XIN-XOUT) stop bit (CM6) | 0: Oscillating 1: Stopped | 0 | R | W |
| 7 | Internal system clock selection bit (CM7) | 0: XIN-XOUT selected (high-speed mode) 1: XCIN-XCOUT selected (low-speed mode) | 0 | R | W |

Note: This bit is set to "1" after the reset release.

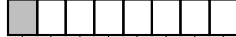
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SINGLE-CHIP 8-BIT CMOS MICROCOMPUTER with CLOSED CAPTION DECODER
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Address 00FC₁₆

Interrupt Request Register 1

b7 b6 b5 b4 b3 b2 b1 b0



Interrupt request register 1 (IREQ1) [Address 00FC₁₆]

| B | Name | Functions | After reset | R | W |
|---|--|---|-------------|---|---|
| 0 | Timer 1 interrupt request bit (TM1R) | 0 : No interrupt request issued 1 : Interrupt request issued | 0 | R | * |
| 1 | Timer 2 interrupt request bit (TM2R) | 0 : No interrupt request issued 1 : Interrupt request issued | 0 | R | * |
| 2 | Timer 3 interrupt request bit (TM3R) | 0 : No interrupt request issued 1 : Interrupt request issued | 0 | R | * |
| 3 | Timer 4 interrupt request bit (TM4R) | 0 : No interrupt request issued 1 : Interrupt request issued | 0 | R | * |
| 4 | OSD interrupt request bit (OSDR) | 0 : No interrupt request issued 1 : Interrupt request issued | 0 | R | * |
| 5 | VSYNC interrupt request bit (VSCR) | 0 : No interrupt request issued 1 : Interrupt request issued | 0 | R | * |
| 6 | A-D conversion • INT3 interrupt request bit (ADR) | 0 : No interrupt request issued 1 : Interrupt request issued | 0 | R | * |
| 7 | Nothing is assigned. This bit is a write disable bit. When this bit is read out, the value is "0." | | 0 | R | — |

*: "0" can be set by software, but "1" cannot be set.

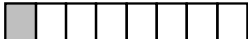
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SINGLE-CHIP 8-BIT CMOS MICROCOMPUTER with CLOSED CAPTION DECODER
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Address 00FC₁₆

Interrupt Request Register 1

b7 b6 b5 b4 b3 b2 b1 b0



Interrupt request register 1 (IREQ1) [Address 00FC₁₆]

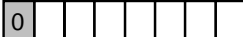
| B | Name | Functions | After reset | R | W |
|---|--|---|-------------|---|---|
| 0 | Timer 1 interrupt request bit (TM1R) | 0 : No interrupt request issued 1 : Interrupt request issued | 0 | R | * |
| 1 | Timer 2 interrupt request bit (TM2R) | 0 : No interrupt request issued 1 : Interrupt request issued | 0 | R | * |
| 2 | Timer 3 interrupt request bit (TM3R) | 0 : No interrupt request issued 1 : Interrupt request issued | 0 | R | * |
| 3 | Timer 4 interrupt request bit (TM4R) | 0 : No interrupt request issued 1 : Interrupt request issued | 0 | R | * |
| 4 | OSD interrupt request bit (OSDR) | 0 : No interrupt request issued 1 : Interrupt request issued | 0 | R | * |
| 5 | VSynch interrupt request bit (VSCR) | 0 : No interrupt request issued 1 : Interrupt request issued | 0 | R | * |
| 6 | A-D conversion • INT3 interrupt request bit (ADR) | 0 : No interrupt request issued 1 : Interrupt request issued | 0 | R | * |
| 7 | Nothing is assigned. This bit is a write disable bit. When this bit is read out, the value is "0." | | 0 | R | — |

*: "0" can be set by software, but "1" cannot be set.

Address 00FD₁₆

Interrupt Request Register 2

b7 b6 b5 b4 b3 b2 b1 b0



Interrupt request register 2 (IREQ2) [Address 00FD₁₆]

| B | Name | Functions | After reset | R | W |
|---|---|---|-------------|---|---|
| 0 | INT1 interrupt request bit (IN1R) | 0 : No interrupt request issued 1 : Interrupt request issued | 0 | R | * |
| 1 | Data slicer interrupt request bit (DSR) | 0 : No interrupt request issued 1 : Interrupt request issued | 0 | R | * |
| 2 | Serial I/O interrupt request bit (SIOR) | 0 : No interrupt request issued 1 : Interrupt request issued | 0 | R | * |
| 3 | f(X _{IN})/4096 • SPRITE OSD interrupt request bit (CKR) | 0 : No interrupt request issued 1 : Interrupt request issued | 0 | R | * |
| 4 | INT2 interrupt request bit (IN2R) | 0 : No interrupt request issued 1 : Interrupt request issued | 0 | R | * |
| 5 | Multi-master I ² C-BUS interrupt request bit (IICR) | 0 : No interrupt request issued 1 : Interrupt request issued | 0 | R | * |
| 6 | Timer 5 • 6 interrupt request bit (TM56R) | 0 : No interrupt request issued 1 : Interrupt request issued | 0 | R | * |
| 7 | Fix this bit to "0." | | 0 | R | W |

*: "0" can be set by software, but "1" cannot be set.

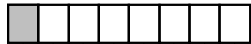
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Address 00FE₁₆

Interrupt Control Register 1

b7 b6 b5 b4 b3 b2 b1 b0



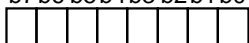
Interrupt control register 1 (ICON1) [Address 00FE₁₆]

| B | Name | Functions | After reset | R | W |
|---|--|---|-------------|---|---|
| 0 | Timer 1 interrupt enable bit (TM1E) | 0 : Interrupt disabled 1 : Interrupt enabled | 0 | R | W |
| 1 | Timer 2 interrupt enable bit (TM2E) | 0 : Interrupt disabled 1 : Interrupt enabled | 0 | R | W |
| 2 | Timer 3 interrupt enable bit (TM3E) | 0 : Interrupt disabled 1 : Interrupt enabled | 0 | R | W |
| 3 | Timer 4 interrupt enable bit (TM4E) | 0 : Interrupt disabled 1 : Interrupt enabled | 0 | R | W |
| 4 | OSD interrupt enable bit (OSDE) | 0 : Interrupt disabled 1 : Interrupt enabled | 0 | R | W |
| 5 | VSNC interrupt enable bit (VSCE) | 0 : Interrupt disabled 1 : Interrupt enabled | 0 | R | W |
| 6 | A-D conversion • INT3 interrupt enable bit (ADE) | 0 : Interrupt disabled 1 : Interrupt enabled | 0 | R | W |
| 7 | Nothing is assigned. This bit is a write disable bit. When this bit is read out, the value is "0." | | 0 | R | — |

Address 00FF₁₆

Interrupt Control Register 2

b7 b6 b5 b4 b3 b2 b1 b0



Interrupt control register 2 (ICON2) [Address 00FF₁₆]

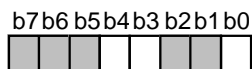
| B | Name | Functions | After reset | R | W |
|---|---|---|-------------|---|---|
| 0 | INT1 interrupt enable bit (IN1E) | 0 : Interrupt disabled 1 : Interrupt enabled | 0 | R | W |
| 1 | Data slicer interrupt enable bit (DSE) | 0 : Interrupt disabled 1 : Interrupt enabled | 0 | R | W |
| 2 | Serial I/O interrupt enable bit (SIOE) | 0 : Interrupt disabled 1 : Interrupt enabled | 0 | R | W |
| 3 | f(X _{IN})/4096 • SPRITE OSD interrupt enable bit (CKE) | 0 : Interrupt disabled 1 : Interrupt enabled | 0 | R | W |
| 4 | INT2 interrupt enable bit (IN2E) | 0 : Interrupt disabled 1 : Interrupt enabled | 0 | R | W |
| 5 | Multi-master I ² C-BUS interface interrupt enable bit (IICE) | 0 : Interrupt disabled 1 : Interrupt enabled | 0 | R | W |
| 6 | Timer 5 • 6 interrupt enable bit (TM56E) | 0 : Interrupt disabled 1 : Interrupt enabled | 0 | R | W |
| 7 | Timer 5 • 6 interrupt switch bit (TM56S) | 0 : Timer 5 1 : Timer 6 | 0 | R | W |

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Address 020A₁₆

PWM Mode Register 1

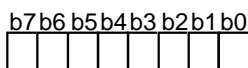


PWM mode register 1 (PN) [Address 020A₁₆]

| B | Name | Functions | After reset | R | W |
|--------|---|--|-------------|---|---|
| 0 | PWM counts source selection bit (PN0) | 0 : Count source supply 1 : Count source stop | 0 | R | W |
| 1, 2 | Nothing is assigned. These bits are write disable bits. When these bits are read out, the values are "0." | | 0 | R | — |
| 3 | PWM output polarity selection bit (PN3) | 0 : Positive polarity 1 : Negative polarity | 0 | R | W |
| 4 | P03/PWM7 output selection bit (PN4) | 0 : P03 output 1 : PWM7 output | 0 | R | W |
| 5 to 7 | Nothing is assigned. These bits are write disable bits. When these bits are read out, the values are "0." | | 0 | R | — |

Address 020B₁₆

PWM Mode Register 2



PWM mode register 2 (PW) [Address 020B₁₆]

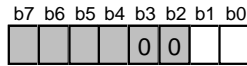
| B | Name | Functions | After reset | R | W |
|---|-------------------------------------|-----------------------------------|-------------|---|---|
| 0 | P04/PWM0 output selection bit (PW0) | 0 : P04 output 1 : PWM0 output | 0 | R | W |
| 1 | P05/PWM1 output selection bit (PW1) | 0 : P05 output 1 : PWM1 output | 0 | R | W |
| 2 | P06/PWM2 output selection bit (PW2) | 0 : P06 output 1 : PWM2 output | 0 | R | W |
| 3 | P07/PWM3 output selection bit (PW3) | 0 : P07 output 1 : PWM3 output | 0 | R | W |
| 4 | P00/PWM4 output selection bit (PW4) | 0 : P00 output 1 : PWM4 output | 0 | R | W |
| 5 | P01/PWM5 output selection bit (PW5) | 0 : P01 output 1 : PWM5 output | 0 | R | W |
| 6 | P02/PWM6 output selection bit (PW6) | 0 : P02 output 1 : PWM6 output | 0 | R | W |
| 7 | P50/PWM7 output selection bit (PW7) | 0 : P50 output 1 : PWM7 output | 0 | R | W |

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Address 0210₁₆

ROM Correction Enable Register

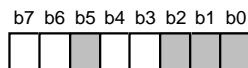


ROM correction enable register (RCR) [Address 0210₁₆]

| B | Name | Functions | After reset | R | W |
|--------|---|---------------------------|-------------|---|---|
| 0 | Block 1 enable bit (RCR0) | 0: Disabled 1: Enabled | 0 | R | W |
| 1 | Block 2 enable bit (RCR1) | 0: Disabled 1: Enabled | 0 | R | W |
| 2, 3 | Fix these bits to "0." | | 0 | R | W |
| 4 to 7 | Nothing is assigned. These bits are write disable bits. When these bits are read out, the values are "0." | | 0 | R | — |

Address 0212₁₆

Interrupt Input Polarity Register



Interrupt input polarity register (IP) [Address 0212₁₆]

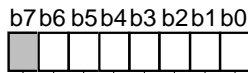
| B | Name | Functions | After reset | R | W |
|--------|---|--|-------------|---|---|
| 0 to 2 | Nothing is assigned. These bits are write disable bits. When these bits are read out, the values are "0." | | 0 | R | — |
| 3 | INT1 polarity switch bit (POL1) | 0: Positive polarity 1: Negative polarity | 0 | R | W |
| 4 | INT2 polarity switch bit (POL2) | 0: Positive polarity 1: Negative polarity | 0 | R | W |
| 5 | Nothing is assigned. This bit is write disable bit. When this bit is read out, the value is "0." | | 0 | R | — |
| 6 | INT3 polarity switch bit (POL3) | 0: Positive polarity 1: Negative polarity | 0 | R | W |
| 7 | A-D conversion • INT3 interrupt source selection bit (AD/INT3SEL) | 0: INT3 interrupt 1: A-D conversion interrupt | 0 | R | W |

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Address 0213₁₆

Serial I/O Mode Register



Serial I/O mode register (SM) [Address 0213₁₆]

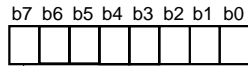
| B | Name | Functions | After reset | R | W |
|------|--|---|-------------|---|---|
| 0, 1 | Internal synchronous clock selection bits (SM0, SM1) | b1 b0 0 0: f(X _{IN})/8 or f(X _{CIN})/8 0 1: f(X _{IN})/16 or f(X _{CIN})/16 1 0: f(X _{IN})/32 or f(X _{CIN})/32 1 1: f(X _{IN})/64 or f(X _{CIN})/64 | 0 | R | W |
| 2 | Synchronous clock selection bit (SM2) | 0: External clock 1: Internal clock | 0 | R | W |
| 3 | Port function selection bit (SM3) | 0: P11, P13 1: SCL1, SDA1 | 0 | R | W |
| 4 | Port function selection bit (SM4) | 0: P12, P14 1: SCL2, SDA2 | 0 | R | W |
| 5 | Transfer direction selection bit (SM5) | 0: LSB first 1: MSB first | 0 | R | W |
| 6 | SIN pin switch bit (SM6) | 0: P17 is SIN pin. 1: P72 is SIN pin. | 0 | R | W |
| 7 | Nothing is assigned. This bit is a write disable bit. When this bit is read out, the value is "0." | | 0 | R | — |

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Address 0215₁₆

OSD Control Register 2



OSD control register 2 (OC2) [Address 0215₁₆]

| B | Name | Functions | At reset | R | W |
|------|--|--|----------|---|---|
| 0, 1 | Display layer selection bits (OC20, OC21) | b1 b0 Layer 1 Layer 2 | 0 | R | W |
| | | 0 0 CC, OSD, CDOSD — | | | |
| | | 0 1 CC, OSD CDOSD | | | |
| | | 1 0 CC, CDOSD OSD | | | |
| | | 1 1 CC CDOSD OSD | | | |
| 2 | R, G, B signal output selection bit(OC22) | 0: Digital output (See note) 1: Analog output (4 gradations) | 0 | R | W |
| 3 | Solid space output bit (OC23) | 0: OUT1 output 1: OUT2 output | 0 | R | W |
| 4 | Horizotal window/blank control bit (OC24) | 0: OFF 1: ON | 0 | R | W |
| 5 | Window/blank selection bit 1 (horizontal) (OC25) | 0: Horizontal blank function 1: Horizontal window function | 0 | R | W |
| 6 | Window/blank selection bit 2 (vertical) (OC26) | 0: Vertical blank function 1: Vertical window function | 0 | R | W |
| 7 | OSD interrupt request selection bit (OC27) | 0: At completion of layer 1 block display 1: At completion of layer 2 block display | 0 | R | W |

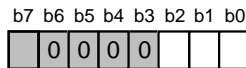
Note: When setting bit 1 of the OSD port control register to "1," the value which is converted from the 4-adjustment-level analog to the 2-bit digital is output regardless of this bit value as follows : the high-order bit (R1, G1 and B1) is output from pins P5₂, P5₃ and P5₄, and the low-order bit is (R0, G0 and B0) output from pins P1₇, P1₅ and P1₆. And besides, when not using OSD function, the low-power dissipation can realize by setting this bit to "0."

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and ON-SCREEN DISPLAY CONTROLLER

Address 0216₁₆

Clock Control Register



Clock control register (CS) [Address 0216₁₆]

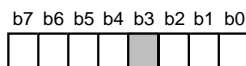
| B | Name | Functions | After reset | R : W |
|--------|---|---|-------------|-------|
| 0 | Clock selection bit (CS0) | 0: Data slicer clock 1: OSC1 clock | 0 | R : W |
| 1, 2 | OSC1 oscillating mode selection bits (CS1, CS2) | <div> <div>b2 b1</div> <div>0 0: 32kHz oscillating mode.</div> <div>0 1: Used as input port of P6₃ and P6₄ (See note 1).</div> <div>1 0: LC oscillating mode</div> <div>1 1: Ceramic • quartz-crystal oscillating mode</div> </div> | 0 | R : W |
| 3 to 6 | Fix these bits to "0." | | 0 | R : W |
| 7 | Test bit (See note 2) | | 0 | R : W |

Note 1: Set bit 7 of address 00C7₁₆ to "1", when OSC1 and OSC2 are used as P6₃ and P6₄.

2: Be sure to set bit 7 to "0" for program of the mask and the EPROM versions. For the emulator MCU version (M37280ERSS), be sure to set bit 7 to "1" when using the data slicer clock for software debugging.

Address 0217₁₆

I/O Polarity Control Register



I/O polarity control register (PC) [Address 0217₁₆]

| B | Name | Functions | After reset | R : W |
|---|--|---|-------------|-------|
| 0 | Hsync input polarity switch bit (PC0) | 0 : Positive polarity input 1 : Negative polarity input | 0 | R : W |
| 1 | Vsync input polarity switch bit (PC1) | 0 : Positive polarity input 1 : Negative polarity input | 0 | R : W |
| 2 | R, G, B output polarity switch bit (PC2) | 0 : Positive polarity output 1 : Negative polarity output | 0 | R : W |
| 3 | Nothing is assigned. This bit is a write disable bit. When this bit is read out, the value is "0". | | 0 | R : — |
| 4 | OUT1 output polarity switch bit (PC4) | 0 : Positive polarity output 1 : Negative polarity output | 0 | R : W |
| 5 | OUT2 output polarity switch bit (PC5) | 0 : Positive polarity output 1 : Negative polarity output | 0 | R : W |
| 6 | Display dot line selection bit (PC6) (See note) | <div>0 : " " at even field</div> <div>" " at odd field</div> <div>1 : " " at even field</div> <div>" " at odd field</div> | 0 | R : W |
| 7 | Field determination flag(PC7) | 0 : Even field 1 : Odd field | 1 | R : — |

Note: Refer to Fig. 12.11.19.

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SINGLE-CHIP 8-BIT CMOS MICROCOMPUTER with CLOSED CAPTION DECODER
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Address 0218₁₆

Raster Color Register

b7 b6 b5 b4 b3 b2 b1 b0

Raster color register (RC) [Address 0218₁₆]

| B | Name | Functions | At reset | R | W |
|------|--|--|----------|---|---|
| 0, 1 | Raster color R control bits (RC0, RC1) | b0 b1 0 0: No output (See note) 0 1: 1/3 V _{cc} 1 0: 2/3 V _{cc} 1 1: V _{cc} | 0 | R | W |
| 2, 3 | Raster color G control bits (RC2, RC3) | b3 b2 0 0: No output (See note) 0 1: 1/3 V _{cc} 1 0: 2/3 V _{cc} 1 1: V _{cc} | 0 | R | W |
| 4, 5 | Raster color B control bits (RC4, RC5) | b5 b4 0 0: No output (See note) 0 1: 1/3 V _{cc} 1 0: 2/3 V _{cc} 1 1: V _{cc} | 0 | R | W |
| 6 | Raster color OUT1 control bits (RC6) | 0: No output 1: Output | 0 | R | W |
| 7 | Raster color OUT2 control bits (RC7) | 0: No output 1: Output | 0 | R | W |

Note: When selecting digital output, V_{cc} is output at any other values except "00."

Address 0219₁₆

OSD Control Register 3

b7 b6 b5 b4 b3 b2 b1 b0

OSD control register 3 (OC3) [Address 0219₁₆]

| B | Name | Functions | After reset | R | W |
|------|---|--|-------------|---|---|
| 0 | CC mode character color selection bit (OC30) | 0: Color code 0 to 7 1: Color code 8 to 15 | 0 | R | W |
| 1, 2 | CC mode character background color selection bits (OC31, OC32) (See note) | b1 b1 0 0: Color code 0 to 3 0 1: Color code 4 to 7 1 0: Color code 8 to 11 1 1: Color code 12 to 15 | 0 | R | W |
| 3 | CDOSD mode character color selection bit (OC33) | 0: Color code 0 to 7 1: Color code 8 to 15 | 0 | R | W |
| 4 | SPRITE color selection bit (OC34) | 0: Color code 0 to 7 1: Color code 8 to 15 | 0 | R | W |
| 5 | OSD mode window control bit (OC35) | 0: Window OFF 1: Window ON | 0 | R | W |
| 6 | CC mode window control bit (OC36) | 0: Window OFF 1: Window ON | 0 | R | W |
| 7 | CDOSD mode window control bit (OC37) | 0: Window OFF 1: Window ON | 0 | R | W |

Note: Color pallet 8 is always selected for solid space (when OUT1 output is selected), regardless of value of this register.

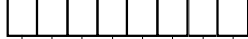
M37280MF-XXXSP, M37280MK-XXXSP M37280EKSP

SINGLE-CHIP 8-BIT CMOS MICROCOMPUTER with CLOSED CAPTION DECODER
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Address 021C₁₆

Top Border Control Register 1

b7 b6 b5 b4 b3 b2 b1 b0



Top border control register 1 (TB1) [Address 021C₁₆]

| B | Name | Functions | After reset | R | W |
|--------------|---|---|---------------|---|---|
| 0 to 7 | Control bits of top border (TB10 to TB17) | Top border position (low-order 8 bits) TH \times (setting value of low-order 2 bits of TB2 $\times 16^2$ + setting value of high-order 4 bits of TB1 $\times 16^1$ + setting value of low-order 4 bits of TB1 $\times 16^0$) | Indeterminate | R | W |

Notes 1: Do not set "00₁₆" or "01₁₆" to the TB1 at TB2 = "00₁₆."

2: TH is cycle of HSYNC.

3: TB2 is top border control register 2.

Address 021D₁₆

Bottom Border Control Register 1

b7 b6 b5 b4 b3 b2 b1 b0



Bottom border control register 1 (BB1) [Address 021D₁₆]

| B | Name | Functions | After reset | R | W |
|--------------|--|--|---------------|---|---|
| 0 to 7 | Control bits of bottom border (BB10 to BB17) | Bottom border position (low-order 8 bits) TH \times (setting value of low-order 2 bits of BB2 $\times 16^2$ + setting value of high-order 4 bits of BB1 $\times 16^1$ + setting value of low-order 4 bits of BB1 $\times 16^0$) | Indeterminate | R | W |

Notes 1: Set values fit for the following condition:

$(TB1 + TB2 \times 16^2) < (BB1 + BB2 \times 16^2)$.

2: TH is cycle of HSYNC.

3: BB2 is bottom border control register 2.

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SINGLE-CHIP 8-BIT CMOS MICROCOMPUTER with CLOSED CAPTION DECODER
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Address 021E₁₆

Top Border Control Register 2

b7 b6 b5 b4 b3 b2 b1 b0

Top border control register 2 (TB2) [Address 021E₁₆]

| B | Name | Functions | After reset | R | W |
|--------|--|---|---------------|---|---|
| 0, 1 | Control bits of top border (TB20, TB21) | Top border position (high-order 2 bits) T _H ✕ (setting value of low-order 2 bits of TB2 × 16 ² + setting value of high-order 4 bits of TB1 × 16 ¹ + setting value of low-order 4 bits of TB1 × 16 ⁰) | Indeterminate | R | W |
| 2 to 7 | Nothing is assigned. These bits are write disable bits. When these bits are read out, the values are indeterminate. | | Indeterminate | R | — |

Notes 1: Do not set "00₁₆" or "01₁₆" to the TB1 at TB2 = "00₁₆".

2: T_H is cycle of HSYNC.

3: TB1 is top border control register 1.

Address 021F₁₆

Bottom Border Control Register 2

b7 b6 b5 b4 b3 b2 b1 b0

Bottom border control register 2 (BB2) [Address 021F₁₆]

| B | Name | Functions | After reset | R | W |
|--------|--|--|---------------|---|---|
| 0, 1 | Control bits of bottom border (BB20, BB21) | Bottom border position (high-order 2 bits) T _H ✕ (setting value of low-order 2 bits of BB2 × 16 ² + setting value of high-order 4 bits of BB1 × 16 ¹ + setting value of low-order 4 bits of BB1 × 16 ⁰) | Indeterminate | R | W |
| 2 to 7 | Nothing is assigned. These bits are write disable bits. When these bits are read out, the values are indeterminate. | | Indeterminate | R | — |

Notes 1: Set values fit for the following condition:

$$(TB1 + TB2 \times 16^2) < (BB1 + BB2 \times 16^2).$$

2: T_H is cycle of HSYNC.

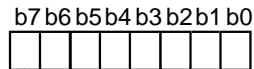
3: BB1 is bottom border control register 1.

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SINGLE-CHIP 8-BIT CMOS MICROCOMPUTER with CLOSED CAPTION DECODER
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Addresses 0220₁₆ to 022F₁₆

Vertical Position Register 1i



Vertical position register 1i (VP1i) (i = 1 to 16) [Addresses 0220₁₆ to 022F₁₆]

| B | Name | Functions | After reset | R | W |
|--------------|--|---|---------------|---|---|
| 0 to 7 | Control bits of vertical display start positions (VP1i0 to VP1i7) (See note 1) | Vertical display start positions (low-order 8 bits) T _H X (setting value of low-order 2 bits of VP2i × 16 ² + setting value of low-order 4 bits of VP1i × 16 ¹ + setting value of low-order 4 bits of VP1i × 16 ⁰) | Indeterminate | R | W |

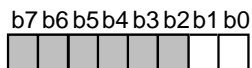
Notes 1: Do not "00₁₆" and "01₁₆" to VP1i at VP2i = "00₁₆."

2: T_H is cycle of Hsync.

3: VP2i is vertical position register 2i.

Addresses 0230₁₆ to 023F₁₆

Vertical Position Register 2i



Vertical position register 2i (VP2i) (i = 1 to 16) [Addresses 0230₁₆ to 023F₁₆]

| B | Name | Functions | After reset | R | W |
|--------------|---|--|---------------|---|---|
| 0, 1 | Control bits of vertical display start positions (VP2i0, VP2i1) (See note 1) | Vertical display start positions (high-order 2 bits) T _H X (setting value of low-order 2 bits of VP2i × 16 ² + setting value of low-order 4 bits of VP1i × 16 ¹ + setting value of low-order 4 bits of VP1i × 16 ⁰) | Indeterminate | R | W |
| 2 to 7 | Nothing is assigned. These bits are write disable bits. When these bits are read out, the values are indeterminate. | | Indeterminate | R | — |

Notes 1: Do not set "00₁₆" and "01₁₆" to VP1i at VP2i = "00₁₆."

2: T_H is cycle of Hsync.

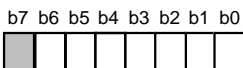
3: VP1i is vertical position register 1i.

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SINGLE-CHIP 8-BIT CMOS MICROCOMPUTER with CLOSED CAPTION DECODER
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Addresses 0241₁₆ to 0247₁₆, 0249₁₆ to 024F₁₆

Color Pallet Register i



Color pallet register i (CRIi) (i = 1 to 7, 9 to 15) [Addresses 0241₁₆ to 0247₁₆, 0249₁₆ to 024F₁₆]

| B | Name | Functions | After reset | R | W |
|------|--|--|---------------|---|---|
| 0, 1 | R signal output control bits (CRI0, CRI1) | b0 b1 0 0: No output (See note) 0 1: 1/3 Vcc 1 0: 2/3 Vcc 1 1: Vcc | Indeterminate | R | W |
| 2, 3 | G signal output control bits (CRI2, CRI3) | b3 b2 0 0: No output (See note) 0 1: 1/3 Vcc 1 0: 2/3 Vcc 1 1: Vcc | Indeterminate | R | W |
| 4, 5 | B signal output control bits (CRI4, CRI5) | b5 b4 0 0: No output (See note) 0 1: 1/3 Vcc 1 0: 2/3 Vcc 1 1: Vcc | Indeterminate | R | W |
| 6 | OUT1 signal output control bit (CRI6) | 0: No output 1: Output | Indeterminate | R | W |
| 7 | Nothing is assigned. This bit is a write disable bit. When this bit is read out, the value is indeterminate. | | Indeterminate | R | — |

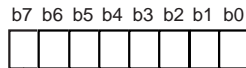
Note: When selecting digital output, the output is Vcc at all values other than "00."

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SINGLE-CHIP 8-BIT CMOS MICROCOMPUTER with CLOSED CAPTION DECODER
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Address 0250₁₆

Left Border Control Register 1



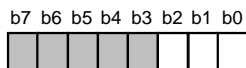
Left border control register 1 (LB1) [Address 0250₁₆]

| B | Name | Functions | After reset | R | W |
|--------|--|---|-------------|---|---|
| 0 | Control bits of left border (LB10 to LB17) | Left border position (low-order 8 bits) Tosc X (setting value of low-order 3 bits of LB2 × 16 ² + setting value of high-order 4 bits of LB1 × 16 ¹ + setting value of low-order 4 bits of LB1 × 16 ⁰) | 1 | R | W |
| 1 to 7 | | | 0 | | |

- Notes** 1: Do not set LB1 = LB2 = "00₁₆."
 2: Set values fit for the following condition:
 $(LB1 + LB2 \times 16^2) < (RB1 + RB2 \times 16^2)$.
 3: Tosc is OSD oscillation period.
 4: LB2 is left border control register 2.

Address 0251₁₆

Left Border Control Register 2



Left border control register 2 (LB2) [Address 0251₁₆]

| B | Name | Functions | After reset | R | W |
|--------|---|--|-------------|---|---|
| 0 to 2 | Control bits of left border (LB20 to LB22) | Left border position (high-order 3 bits) Tosc X (setting value of low-order 3 bits of LB2 × 16 ² + setting value of high-order 4 bits of LB1 × 16 ¹ + setting value of low-order 4 bits of LB1 × 16 ⁰) | 0 | R | W |
| 3 to 7 | Nothing is assigned. These bits are write disable bits. When these bits are read out, the values are indeterminate. | | 0 | | |

- Notes** 1: Do not set LB1 = LB2 = "00₁₆."
 2: Set values fit for the following condition:
 $(LB1 + LB2 \times 16^2) < (RB1 + RB2 \times 16^2)$.
 3: Tosc is OSD oscillation period.
 4: LB1 is left border control register 1.

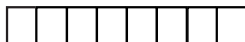
M37280MF-XXXSP, M37280MK-XXXSP M37280EKSP

SINGLE-CHIP 8-BIT CMOS MICROCOMPUTER with CLOSED CAPTION DECODER
and ON-SCREEN DISPLAY CONTROLLER

Address 0252₁₆

Right Border Control Register 1

b7 b6 b5 b4 b3 b2 b1 b0



Right border control register 1 (RB1) [Address 0252₁₆]

| B | Name | Functions | After reset | R | W |
|--------|---|--|-------------|---|---|
| 0 to 7 | Control bits of right border (RB10 to RB17) | Right border position (low-order 8 bits) Tosc X (setting value of low-order 3 bits of RB2 X 16 ² + setting value of high-order 4 bits of RB1 X 16 ¹ + setting value of low-order 4 bits of RB1 X 16 ⁰) | 1 | R | W |

Notes 1: Set values fit for the following condition:
 $(LB1 + LB2 \times 16^2) < (RB1 + RB2 \times 16^2)$.
2: TOSC is OSD oscillation period.
3: RB2 is right border control register 2.

Address 0253₁₆

Right Border Control Register 2

b7 b6 b5 b4 b3 b2 b1 b0



Right border control register 2 (RB2) [Address 0253₁₆]

| B | Name | Functions | After reset | R | W |
|--------|---|---|-------------|---|---|
| 0 to 2 | Control bits of right border (RB20 to RB22) | Right border position (high-order 3 bits) Tosc X (setting value of low-order 3 bits of RB2 X 16 ² + setting value of high-order 4 bits of RB1 X 16 ¹ + setting value of low-order 4 bits of RB1 X 16 ⁰) | 1 | R | W |
| 3 to 7 | Nothing is assigned. These bits are write disable bits. When these bits are read out, the values are "0". | | 0 | R | W |

Notes 1: Set values fit for the following condition:
 $(LB1 + LB2 \times 16^2) < (RB1 + RB2 \times 16^2)$.
2: TOSC is OSD oscillation period.
3: RB1 is right border control register 1.

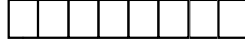
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SINGLE-CHIP 8-BIT CMOS MICROCOMPUTER with CLOSED CAPTION DECODER
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Address 0254₁₆

SPRITE Vertical Position Register 1

b7 b6 b5 b4 b3 b2 b1 b0



SPRITE vertical position register 1 (VS1) [Address 0254₁₆]

| B | Name | Functions | After reset | R | W |
|--------|---|--|-------------|---|---|
| 0 | Vertical display start position control bits of SPRITE OSD (VS10 to VS17) | Vertical display start position (low-order 8 bits) $T_H \times$ (setting value of low-order 2 bits of $VS2 \times 16^2$ + setting value of high-order 4 bits of $VS1 \times 16^1$ + setting value of low-order 4 bits of $VS1 \times 16^0$) | 1 | R | W |
| 1 to 7 | | | 0 | | |

Notes 1: Do not set "00₁₆" to the VS1 at $VS2 = "00_{16}"$.
 2: T_H is cycle of Hsync.
 3: VS2 is SPRITE vertical position register 2.

Address 0255₁₆

SPRITE Vertical Position Register 2

b7 b6 b5 b4 b3 b2 b1 b0



SPRITE vertical position register 2 (VS2) [Address 0255₁₆]

| B | Name | Functions | After reset | R | W |
|--------|---|---|-------------|---|---|
| 0, 1 | Vertical start position control bits of SPRITE OSD (VS20, VS21) | Vertical display start position (high-order 2 bits) $T_H \times$ (setting value of low-order 2 bits of $VS2 \times 16^2$ + setting value of high-order 4 bits of $VS1 \times 16^1$ + setting value of low-order 4 bits of $VS1 \times 16^0$) | 0 | R | W |
| 2 to 7 | Nothing is assigned. These bits are write disable bits. When these bits are read out, the values are "0". | | 0 | | |

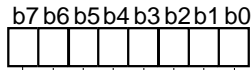
Notes 1: Do not set "00₁₆" to the VS1 at $VS2 = "00_{16}"$.
 2: T_H is cycle of Hsync.
 3: VS1 is SPRITE vertical position register 1.

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Address 0256₁₆

SPRITE Horizontal Position Register 1



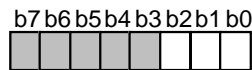
SPRITE horizontal position register 1 (HS1) [Address 0256₁₆]

| B | Name | Functions | After reset | R | W |
|--------|---|---|---------------|---|---|
| 0 to 7 | Horizontal display start position control bits of SPRITE OSD (HS10 to HS17) | Horizontal display start position (low-order 8 bits) Tosc \times (setting value of low-order 2 bits of HS2 $\times 16^2$ + setting value of high-order 4 bits of HS1 $\times 16^1$ + setting value of low-order 4 bits of HS1 $\times 16^0$) | Indeterminate | R | W |

- Notes 1:** Do not set HS1 < "30₁₆" at HS2 = "00₁₆."
2: Tosc is OSD oscillation period.
3: HS2 is SPRITE horizontal position register 2.

Address 0257₁₆

SPRITE Horizontal Position Register 2



SPRITE horizontal position register 2 (HS2) [Address 0257₁₆]

| B | Name | Functions | After reset | R | W |
|--------|---|--|---------------|---|---|
| 0 to 2 | Horizontal display start position control bits of SPRITE OSD (HS20 to HS22) | Horizontal display start position (high-order 3 bits) Tosc \times (setting value of low-order 2 bits of HS2 $\times 16^2$ + setting value of high-order 4 bits of HS1 $\times 16^1$ + setting value of low-order 4 bits of HS1 $\times 16^0$) | Indeterminate | R | W |
| 3 to 7 | Nothing is assigned. These bits are write disable bits. When these bits are read out, the values are "0." | | 0 | R | — |

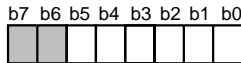
- Notes 1:** Do not set HS1 < "30₁₆" at HS2 = "00₁₆."
2: Tosc is oscillation period.
3: HS1 is SPRITE horizontal position register 1.

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SINGLE-CHIP 8-BIT CMOS MICROCOMPUTER with CLOSED CAPTION DECODER
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Address 0258₁₆

SPRITE OSD Control Register



SPRITE OSD control register (SC) [Address 0258₁₆]

| B | Name | Functions | After reset | R | W |
|------|--|---|-------------|---|---|
| 0 | SPRITE OSD control bit (SC0) | 0: Stopped 1: Operating | 0 | R | W |
| 1 | Pre-divide ratio selection bit (SC1) | 0: Pre-divide ratio 1 1: Pre-divide ratio 2 | 0 | R | W |
| 2, 3 | Dot size selection bits (SC2, SC3) | b3 b2 0 0: 1Tc × 1/2H 0 1: 1Tc × 1H 1 0: 2Tc × 1H 1 1: 2Tc × 2H | 0 | R | W |
| 4 | Interrupt occurrence position selection bit (SC4) | 0: After display of horizontal 20 dots 1: After display of horizontal 10 dots or 20 dots | 0 | R | W |
| 5 | X _{IN} /4096 • SPRITE interrupt source switch bit (SC5) | 0: X _{IN} /4096 interrupt 1: SPRITE OSD interrupt | 0 | R | W |
| 6, 7 | Nothing is assigned. This bit is a write disable bit. When this bit is read out, the value is "0". | | 0 | R | — |

Notes 1: Tc : Pre-divided clock period for OSD
 2: H : H_{SYNC}

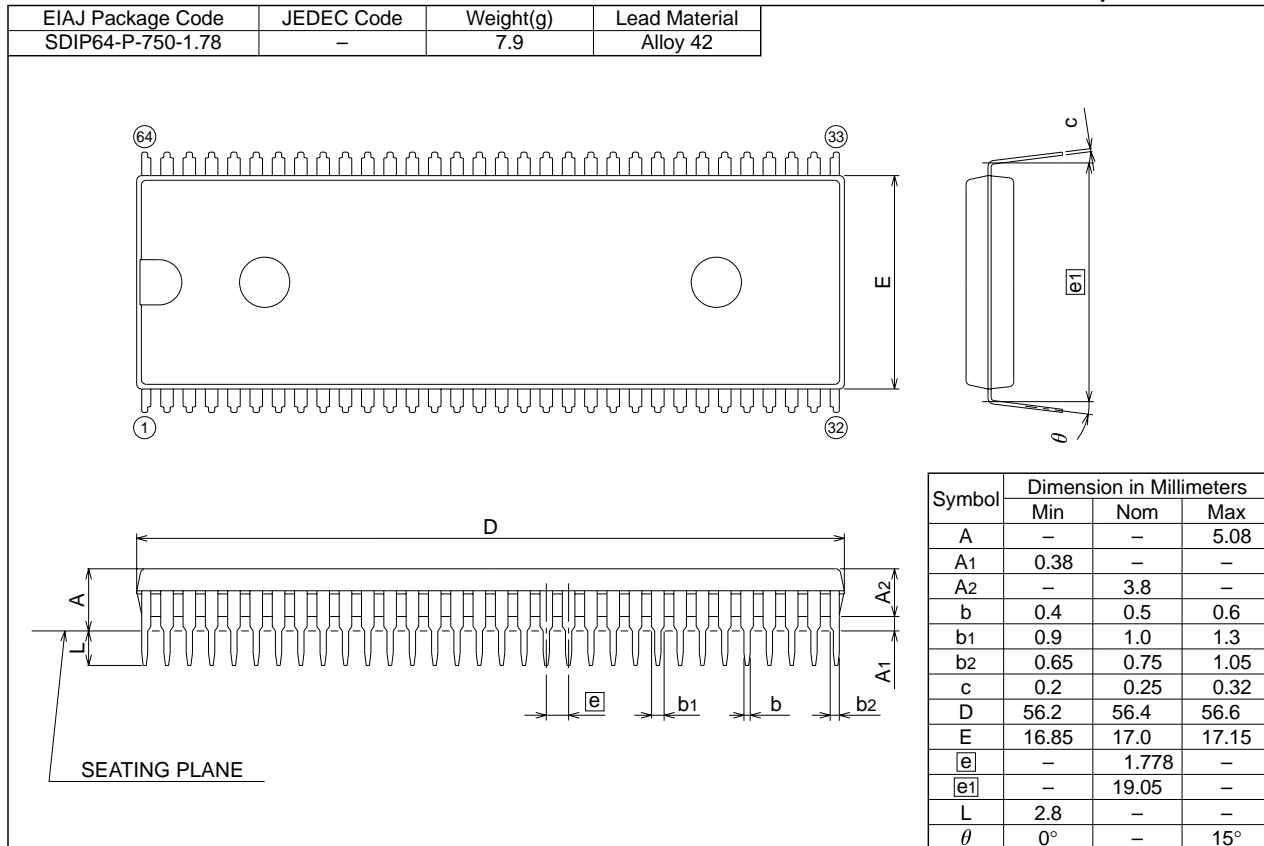
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SINGLE-CHIP 8-BIT CMOS MICROCOMPUTER with CLOSED CAPTION DECODER
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32. PACKAGE OUTLINE

64P4B

Plastic 64pin 750mil SDIP



PRELIMINARY
Notice: This is not a final specification.
Some parametric limits are subject to change.

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SINGLE-CHIP 8-BIT CMOS MICROCOMPUTER with CLOSED CAPTION DECODER
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