M32C/84, 85, 87, 88, 8A, 8B Groups

Real-Time Port Output Using the DMAC and Ports

R01AN0670EJ0100
Rev. 1.00
Aug. 31, 2012

Abstract

This document describes a method to change port output at each specified cycle using the timer interrupt request as the DMAC transfer request source.

Products

M32C/84 Group
M32C/85 Group
M32C/87 Group
M32C/88 Group
M32C/8A Group
M32C/8B Group

When using this application note with other Renesas MCUs, careful evaluation is recommended after making modifications to comply with the alternate MCU.

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1. Specifications

Each time timer A0 underflows, real-time port output is performed through ports P0_0 to P0_3 using the DMAC. Table 1.1 lists the Peripheral Functions and Their Applications. Figure 1.1 shows the Block Diagram.

Table 1.1 Peripheral Functions and Their Applications

Peripheral Function	Application
DMAC (DMA0)	Transfer the value to be set to port P0
Timer A (timer A0)	Generate the real-time port output cycle
$\overline{\text{INT0}}$ interrupt	Lengthen the real-time port output cycle 1 ms
$\overline{\text{INT1}}$ interrupt	Shorten the real-time port output cycle 1 ms

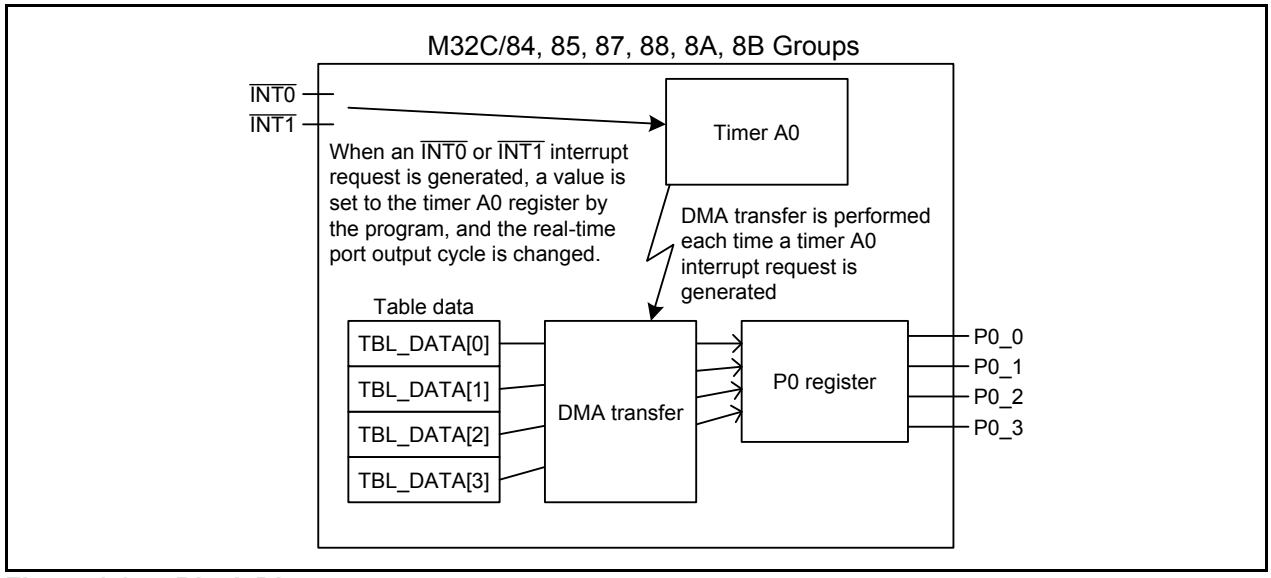

Figure 1.1 Block Diagram

2. Operation Confirmation Conditions

The sample code accompanying this application note has been run and confirmed under the conditions below.

Table 2.1 Operation Confirmation Conditions

Item	Contents
MCU used	M3087BFLGP (M32C/87 Group)
Operating frequencies	• Main clock: 32 MHz • CPU clock: 32 MHz
Operating voltage	5 V
Integrated development environment	Renesas Electronics Corporation High-performance Embedded Workshop Version 4.07
C compiler	Renesas Electronics Corporation M32C Series Compiler V.5.42 Release 00
	Compile options -D__STACKSIZE__=0X300 -D__ISTACKSIZE__=0X300 -DVECTOR_ADR=0x0fe0000 -D__E8__ -D__WORK_RAM__=0x100 -c -finfo -dir "$(CONFIGDIR)" -M82 (Default setting is used in the integrated development environment.)
Operating mode	Single-chip mode
Sample code version	Version 1.00

3. Hardware

3.1 Pins Used

Table 3.1 lists the Pins Used and Their Functions.

Table 3.1 Pins Used and Their Functions

Pin Name	I/O	Function
P0_0	Output	Real-time port output
P0_1		
P0_2		
P0_3		
P8_2/$\overline{\text{INT0}}$	Input	$\overline{\text{INT0}}$ interrupt input
P8_3/$\overline{\text{INT1}}$	Input	$\overline{\text{INT1}}$ interrupt input

4. Software

Each time timer A0 underflows, real-time port output is performed through ports P0_0 to P0_3 using the DMAC. Set the real-time output cycle to 4 ms in the initial setting. Each time the falling edge is input to the INT0 pin, the real-time port output cycle is lengthened by 1 ms. Each time the falling edge is input to the INT1 pin, the real-time port output cycle is shortened by 1 ms. The minimum cycle for the real-time port output is 1 ms, and the maximum cycle for the real-time port output is 8 ms.

DMA0 settings

- Transfer source: Timer A0 interrupt
- Transfer mode: Repeat transfer
- Transfer unit: 8 bits
- Number of transfers: 4
- Transfer source address: Forward address (RTP_TABLE)
- Transfer destination address: Fixed address (P0 register)

Timer A0 settings

- Operating mode: Timer mode
- Count source: f8
- Cycle: 1 ms to 8 ms (can be changed in 1 ms intervals).

Table 4.1 shows the Real-Time Port Output Table used in the sample code.

Table 4.1 Real-Time Port Output Table

Table Name	Value	Output Value			
		P0_3	P0_2	P0_1	P0_0
RTP_TABLE[0]	09h	High	Low	Low	High
RTP_TABLE[1]	03h	Low	Low	High	High
RTP_TABLE[2]	06h	Low	High	High	Low
RTP_TABLE[3]	0Ch	High	High	Low	Low

4.1 Operation Overview

The sample program performs the following:

(1) Initial setting
The initial setting for port P0, timer A0, and DMA0 is performed.

(2) Timer A0 count starts
The TA0S bit in the TABSR register is set to 1 (timer A0 count starts).

(3) DMA transfer
When the timer A0 interrupt request is generated, the values in the real-time port output table are transferred to the port P0 register.

(4) $\overline{\text{INT0}}$ pin falling edge input
A value is set to the timer A0 register, and the real-time port output cycle is lengthened by 1 ms (up to a maximum of 8 ms).

(5) $\overline{\text{INT1}}$ pin falling edge input
A value is set to the timer A0 register, and the real-time port output cycle is shortened by 1 ms (down to a minimum of 1 ms).

Figure 4.1 shows the Timing Diagram.

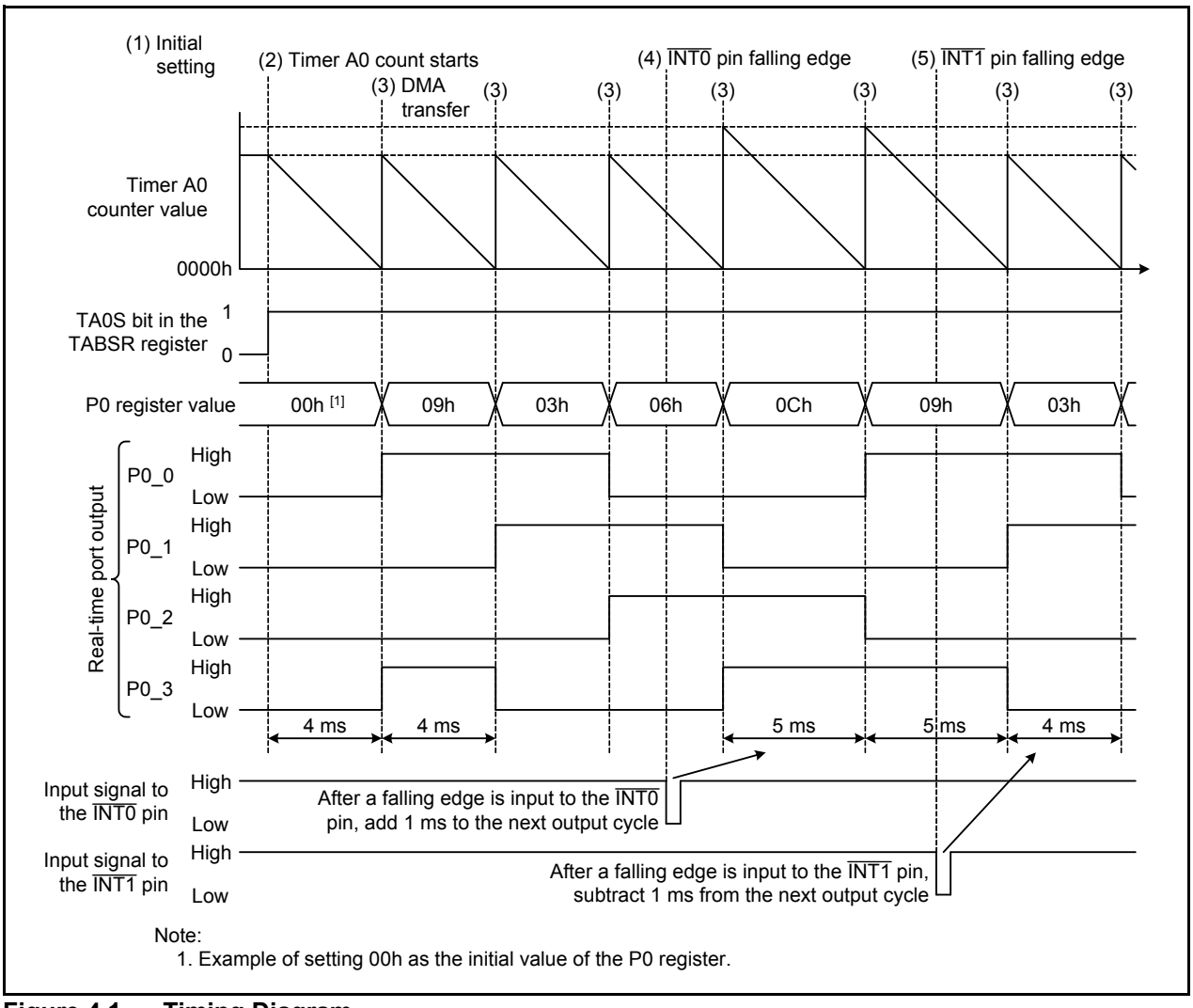

Figure 4.1 Timing Diagram

4.2 Constants

Table 4.2 lists the Constants Used in the Sample Code.

Table 4.2 Constants Used in the Sample Code

Constant Name	Setting Value	Contents
XIN_CLOCK	32000000	Main clock frequency
TIMER_1MS	XIN_CLOCK ÷ (8*1000)	Timer setting value
DEFAULT_CYCLE	3	Initial value of the real-time port output cycle (4 ms)
MIN_CYCLE	0	Shortest cycle of the real-time port (1 ms)
MAX_CYCLE	7	Longest cycle of the real-time port (8 ms)

4.3 Variable

Table 4.3 lists the Global Variable.

Table 4.3 Global Variable

Type	Variable Name	Contents	Function Used
unsigned char	p_cycle	For setting the real-time port output cycle	main()

4.4 Flowcharts

4.4.1 Main Processing

Figure 4.2 and Figure 4.3 show the main processing.

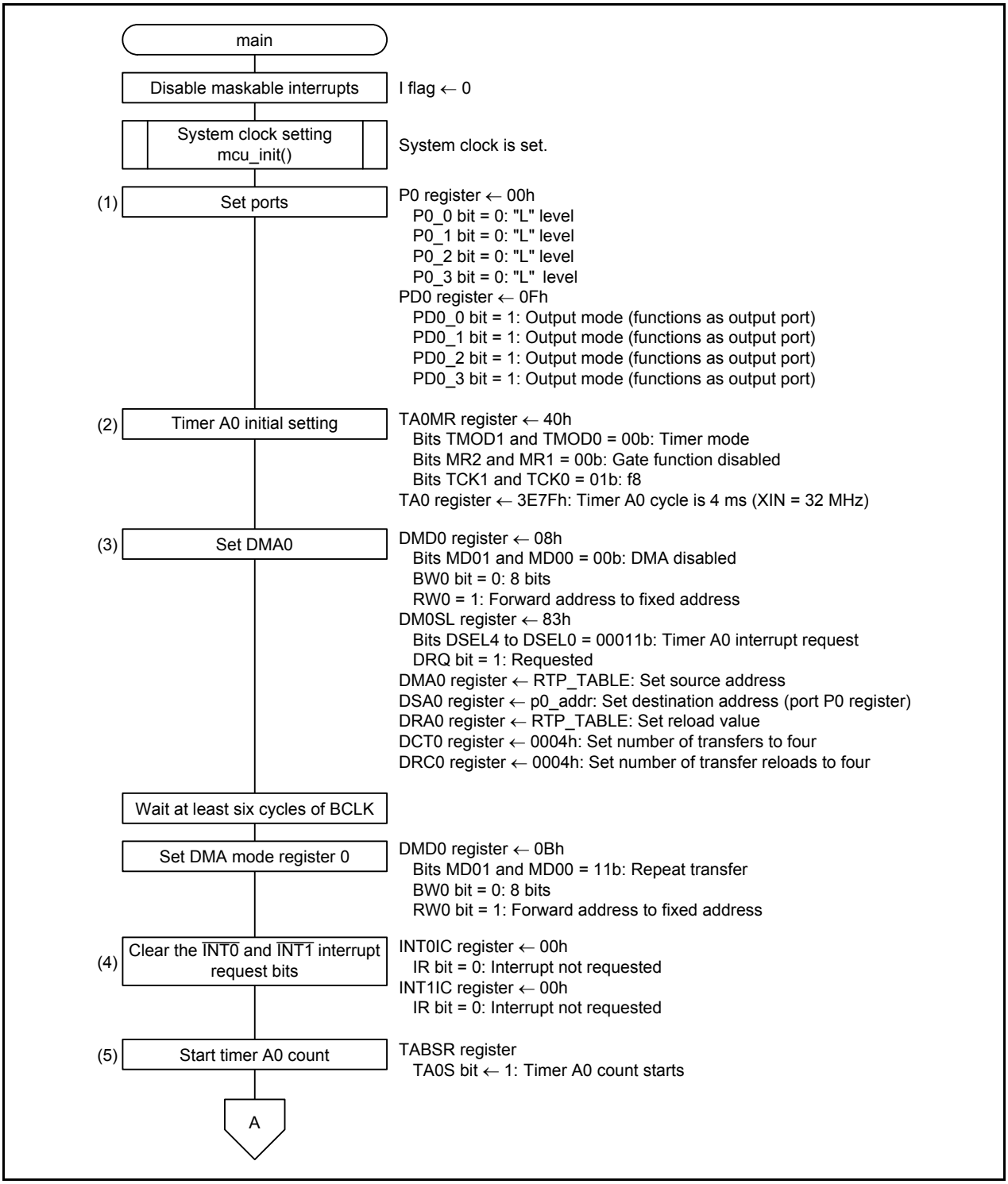

Figure 4.2 Main Processing (1/2)

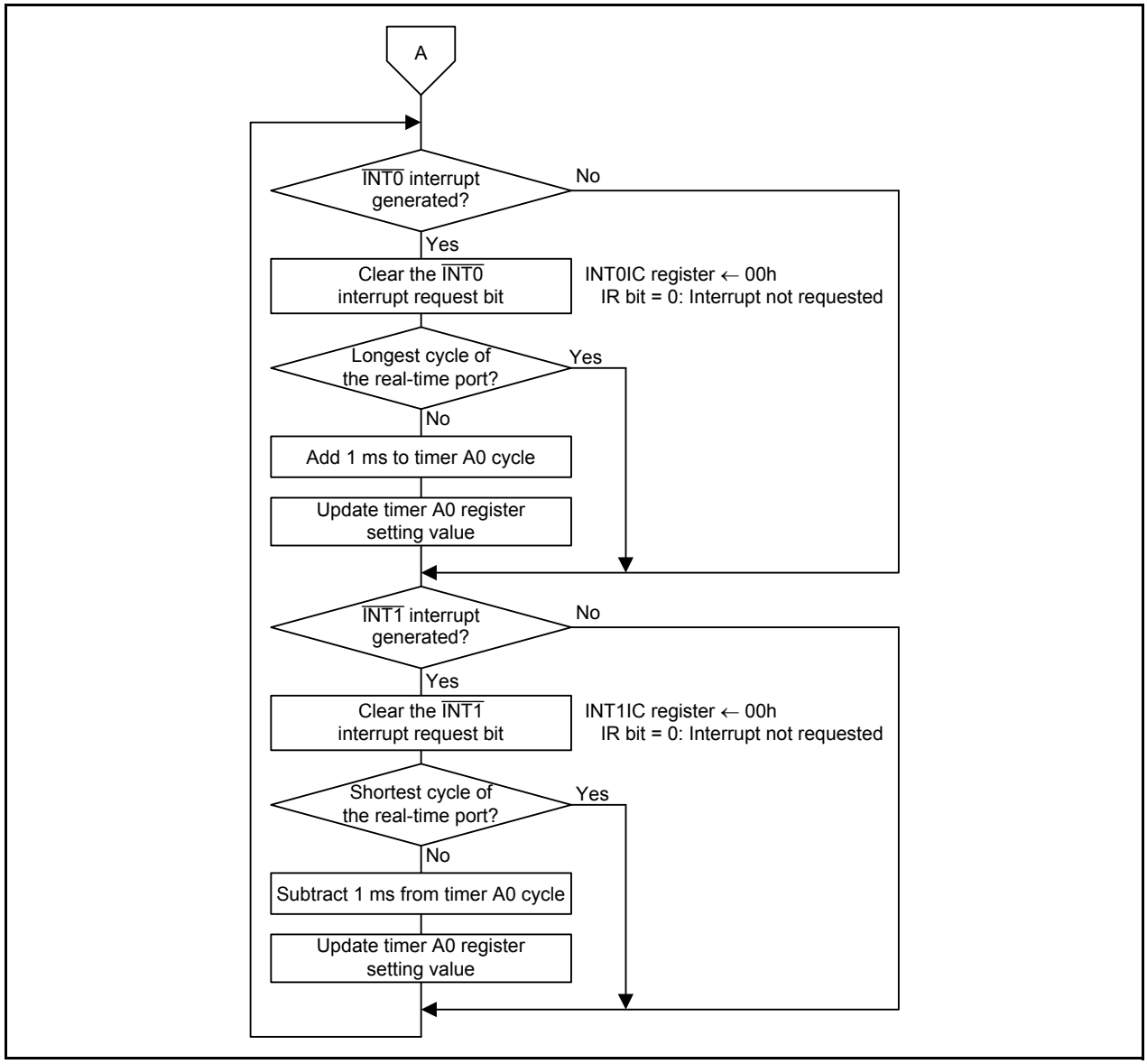

Figure 4.3 Main Processing (2/2)

5. Sample Code

Sample code can be downloaded from the Renesas Electronics website.

6. Reference Documents

M32C/84 Group (M32C/84, M32C/84T) User's Manual: Hardware Rev.1.01
M32C/85 Group (M32C/85, M32C/85T) User's Manual: Hardware Rev.1.03
M32C/87 Group (M32C/87, M32C/87A, M32C/87B) User's Manual: Hardware Rev.1.51
M32C/88 Group (M32C/88T) User's Manual: Hardware Rev.1.10
M32C/8A Group User's Manual: Hardware Rev.1.01
M32C/8B Group User's Manual: Hardware Rev.1.00
The latest versions can be downloaded from the Renesas Electronics website.

Technical Update/Technical News
The latest information can be downloaded from the Renesas Electronics website.

C Compiler Manual
M32C Series C Compiler Package
C Compiler User's Manual Rev.2.00
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Revision History	M32C/84, 85, 87, 88, 8A, 8B Groups Real-Time Port Output Using the DMAC and Ports

Rev.	Date	Description	
		Page	Summary
1.00	Aug. 31, 2012	—	First edition issued

General Precautions in the Handling of MPU/MCU Products

The following usage notes are applicable to all MPU/MCU products from Renesas. For detailed usage notes on the products covered by this manual, refer to the relevant sections of the manual. If the descriptions under General Precautions in the Handling of MPU/MCU Products and in the body of the manual differ from each other, the description in the body of the manual takes precedence.

1. Handling of Unused Pins

   Handle unused pins in accord with the directions given under Handling of Unused Pins in the manual.

   — The input pins of CMOS products are generally in the high-impedance state. In operation with an unused pin in the open-circuit state, extra electromagnetic noise is induced in the vicinity of LSI, an associated shoot-through current flows internally, and malfunctions occur due to the false recognition of the pin state as an input signal become possible. Unused pins should be handled as described under Handling of Unused Pins in the manual.

2. Processing at Power-on

   The state of the product is undefined at the moment when power is supplied.

   — The states of internal circuits in the LSI are indeterminate and the states of register settings and pins are undefined at the moment when power is supplied.

   In a finished product where the reset signal is applied to the external reset pin, the states of pins are not guaranteed from the moment when power is supplied until the reset process is completed.

   In a similar way, the states of pins in a product that is reset by an on-chip power-on reset function are not guaranteed from the moment when power is supplied until the power reaches the level at which resetting has been specified.

3. Prohibition of Access to Reserved Addresses

   Access to reserved addresses is prohibited.

   — The reserved addresses are provided for the possible future expansion of functions. Do not access these addresses; the correct operation of LSI is not guaranteed if they are accessed.

4. Clock Signals

   After applying a reset, only release the reset line after the operating clock signal has become stable. When switching the clock signal during program execution, wait until the target clock signal has stabilized.

   — When the clock signal is generated with an external resonator (or from an external oscillator) during a reset, ensure that the reset line is only released after full stabilization of the clock signal. Moreover, when switching to a clock signal produced with an external resonator (or by an external oscillator) while program execution is in progress, wait until the target clock signal is stable.

5. Differences between Products

   Before changing from one product to another, i.e. to one with a different part number, confirm that the change will not lead to problems.

   — The characteristics of MPU/MCU in the same group but having different part numbers may differ because of the differences in internal memory capacity and layout pattern. When changing to products of different part numbers, implement a system-evaluation test for each of the products.

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