R32C/100 Series

Using the DMAC and Ports for Real-Time Port Output

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Abstract

This document describes using a timer interrupt request as the DMA request source, to change the port output each time a specific period elapses.

Products

R32C/116 Group
R32C/117 Group
R32C/118 Group

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

Contents

1. Specifications

Each time timer A0 underflows, the DMAC is used for real-time port output from pins P0_0 to P0_3. Table 1.1 lists the Peripheral Functions and Their Applications. Figure 1.1 shows a Block Diagram.

Table 1.1 Peripheral Functions and Their Applications

Peripheral Function	Application
DMAC (DMA0)	Transfers the value to be set to port P0
Timer A (timer A0)	Generates a real-time port output period
$\overline{\text{INT0}}$ interrupt	Extends the real-time port output period by 1 ms
$\overline{\text{INT1}}$ interrupt	Shortens the real-time port output period by 1 ms

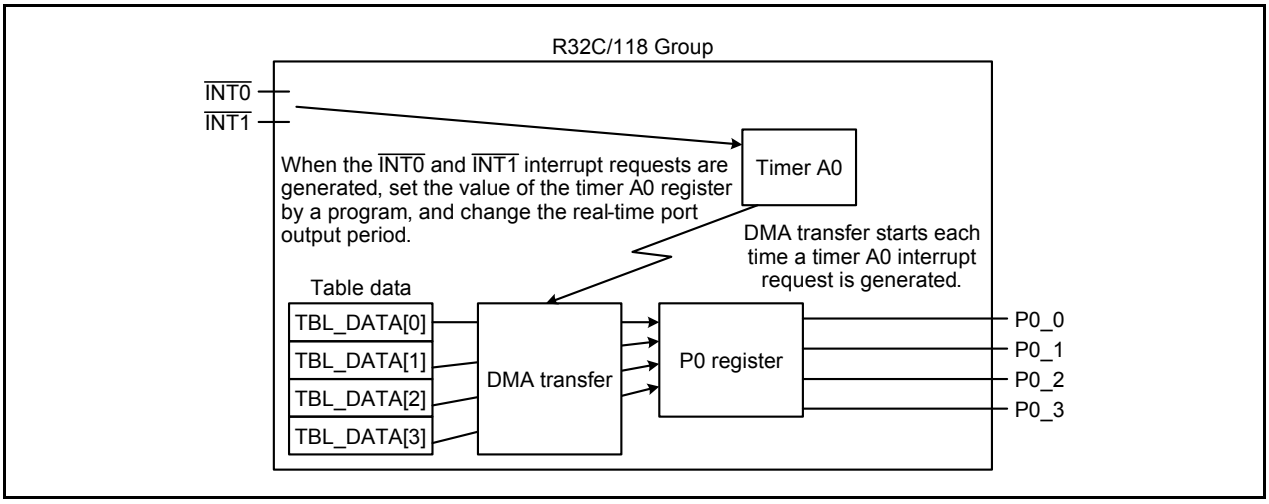

Figure 1.1 Block Diagram

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	R5F64189DFD (R32C/118 Group)
Operating frequencies	• XIN clock: 16 MHz • PLL clock: 100 MHz • Base clock: 50 MHz • CPU clock: 50 MHz • Peripheral bus clock: 25 MHz • Peripheral clock: 25 MHz
Operating voltage	5 V
Integrated development environment	Renesas Electronics Corporation High-performance Embedded Workshop Version 4.09
C compiler	Renesas Electronics Corporation R32C/100 Series C Compiler V.1.02 Release 01
	Compile options -D__STACKSIZE__=0X300 -D__ISTACKSIZE__=0X300 -DVECTOR_ADR=0x0FFFFFBDC -c -finfo -dir “$(CONFIGDIR)” The default setting is used in the integrated development environment.
Operating mode	Single-chip mode
Sample code version	1.00
Board used	Renesas Starter Kit for R32C/118 (device part no.: R0K564189S000BE)

3. Reference Application Notes

Application notes associated with this application note are listed below. Refer to these application notes for additional information.

- R32C/100 Series Configuring PLL Mode (REJ05B1221)
- R32C/100 Series Using DMAC in Repeat Transfer Mode (R01AN0448EJ)

4. Hardware

4.1 Pins Used

Table 4.1 lists the Pins Used and Their Functions.

Table 4.1 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

5. Software

Each time timer A0 underflows, DMAC is used for real-time port output from pins P0_0 to P0_3. In the initial settings, the real-time port output period is set to 4 ms. The real-time port output period is extended by 1 ms each time a falling edge is input to the $\overline{\text{INT0}}$ pin. The real-time port output period is shortened by 1 ms each time a falling edge is input to the $\overline{\text{INT1}}$ pin. The shortest real-time port output period is 1 ms, and the longest is 8 ms.

DMA0 settings
- The timer A0 interrupt is used as the request source.
- Repeat transfer is used for the transfer mode.
- The transfer size is 8 bits.
- The number of transfers is set to four.
- The transfer source address is set to increment (RTP_TABLE).
- The transfer destination address is set to a fixed address (P0 register).

Timer A0 settings
- Timer mode is used as the operating mode.
- f8 is used as the count source.
- The period is 1 to 8 ms (can be changed in 1 ms intervals).

Table 5.1 lists the real-time port output table used in the sample code.

Table 5.1 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

5.1 Operation Overview

The sample program operates as follows.

(1) Initial settings
Port P0, timer A0, and DMA0 are initialized.

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

(3) DMA transfer
When a 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 period is extended by 1 ms (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 period is shortened by 1 ms (minimum of 1 ms).

Figure 5.1 shows the Timing Diagram.

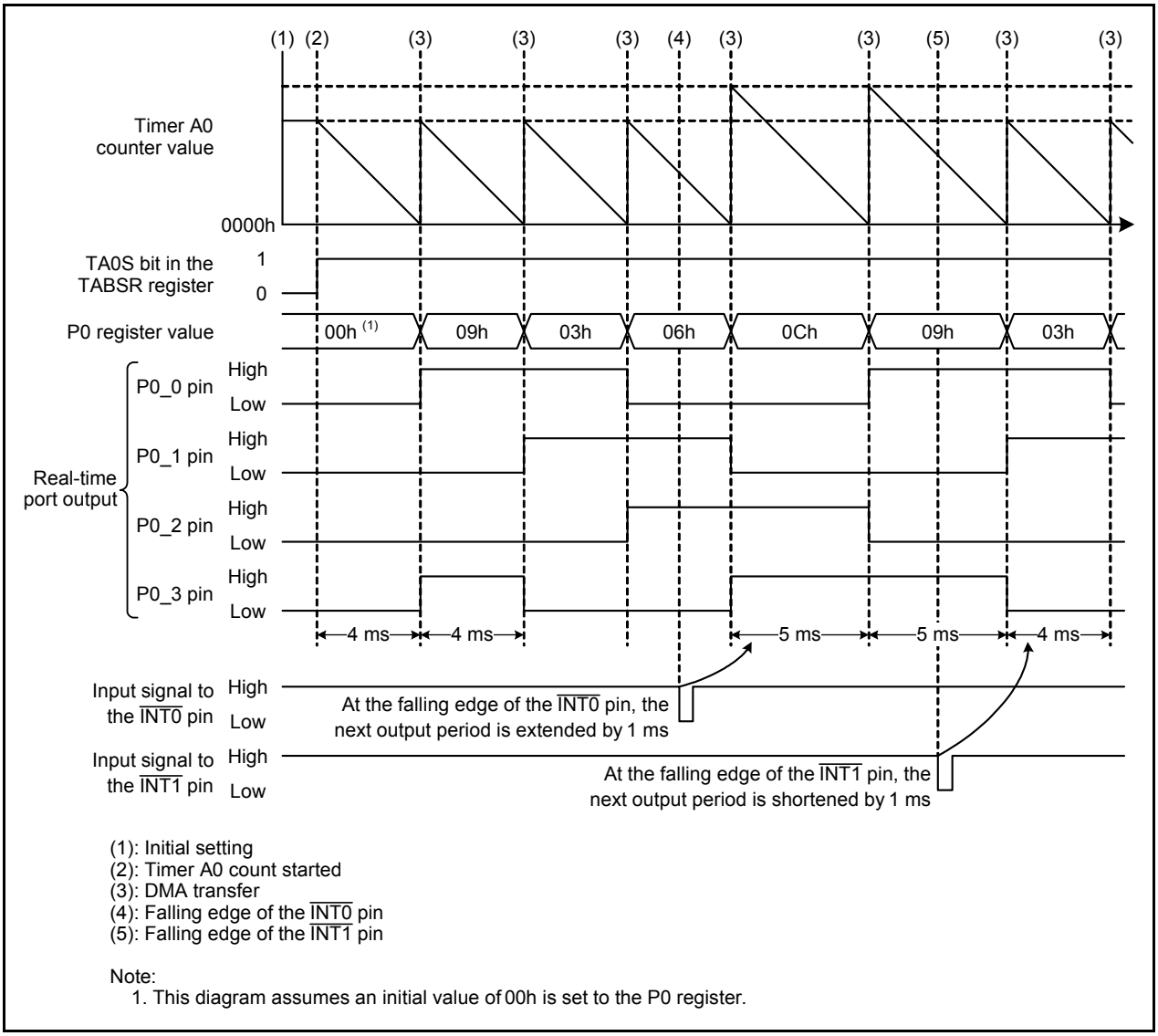

Figure 5.1 Timing Diagram

5.2 Constants

Table 5.2 lists the Constants Used in the Sample Code.

Table 5.2 Constants Used in the Sample Code

Constant Name	Setting Value	Contents
PERIPHERAL_CLOCK	25000000	Peripheral clock frequency
TIMER_1MS	PERIPHERAL_CLOCK ÷ (8 × 1000)	Timer setting value
DEFAULT_CYCLE	3	Initial value (4 ms) for the real-time port output period
MIN_CYCLE	0	Shortest real-time port period (1 ms)
MAX_CYCLE	7	Longest real-time port period (8 ms)

5.3 Variable

Table 5.3 lists the Global Variable.

Table 5.3 Global Variable

Type	Variable Name	Contents	Function Used
uint8_t	p_cycle	Real-time port output period setting	main()

5.4 Flowcharts

5.4.1 Main Processing

Figure 5.2 and Figure 5.3 show the main processing.

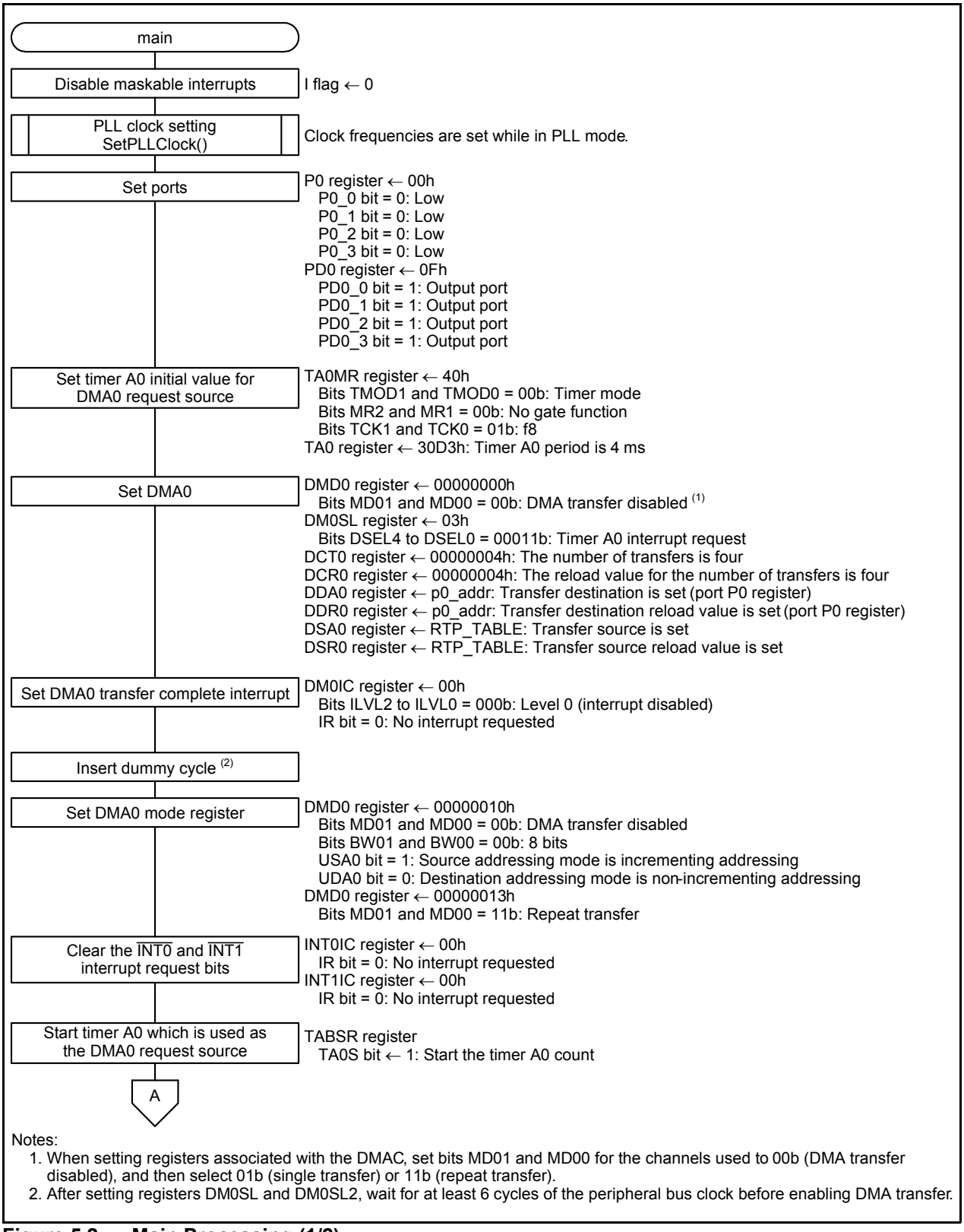

Figure 5.2 Main Processing (1/2)

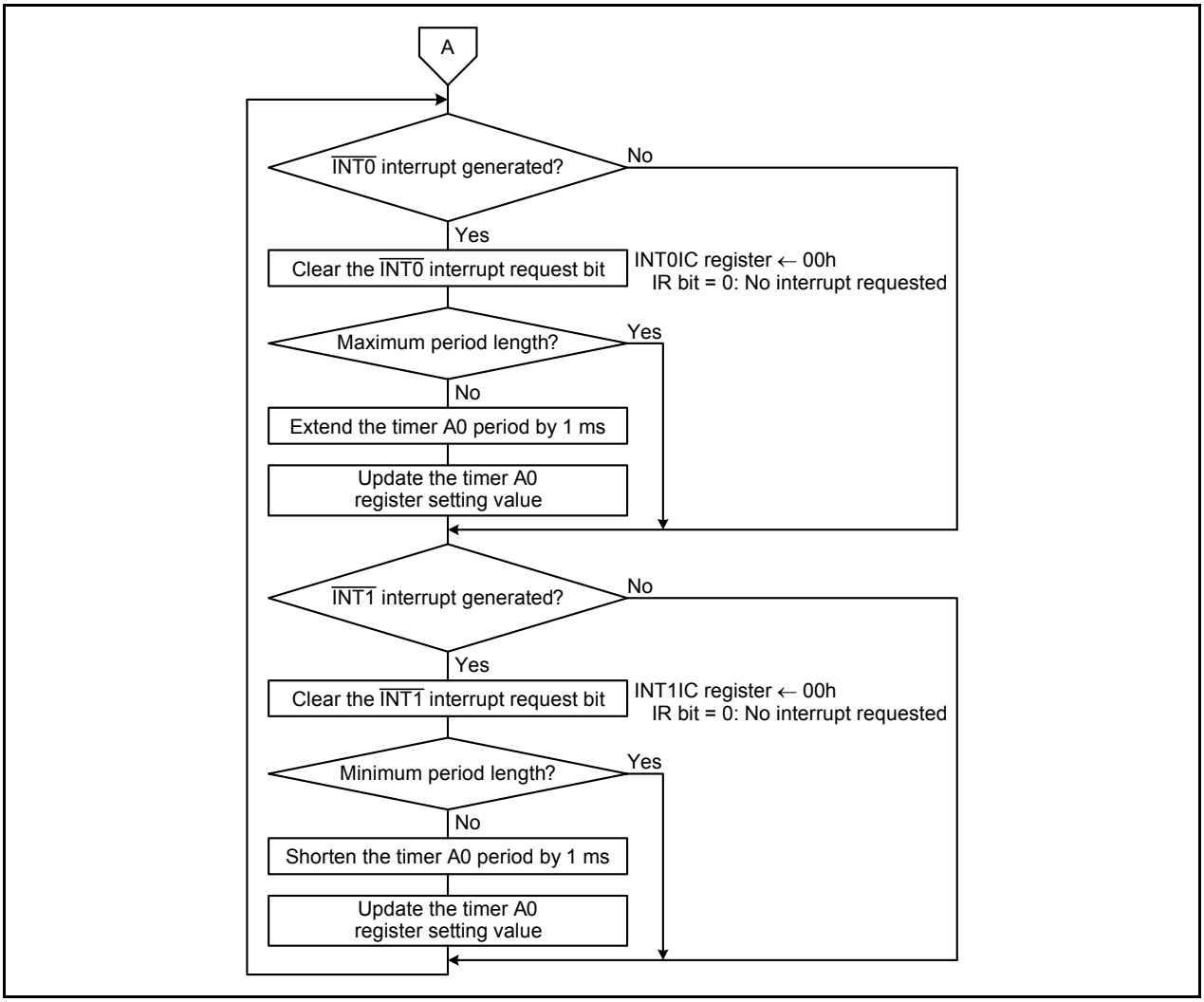

Figure 5.3 Main Processing (2/2)

6. Sample Code

Sample code can be downloaded from the Renesas Electronics website.

7. Reference Documents

R32C/116 Group User's Manual: Hardware Rev.1.20
R32C/117 Group User's Manual: Hardware Rev.1.20
R32C/118 Group User's Manual: Hardware Rev.1.20
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
R32C Series C Compiler Package V.1.02
C Compiler User's Manual Rev.2.00
The latest version can be downloaded from the Renesas Electronics website.

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Revision History	R32C/100 Series Using the DMAC and Ports for Real-Time Port Output

Rev.	Date	Description	
		Page	Summary
1.00	Aug. 2, 2013	—	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 document, refer to the relevant sections of the document as well as any technical updates that have been issued for the products.

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 a product with a different part number, confirm that the change will not lead to problems.

   — The characteristics of an MPU or MCU in the same group but having a different part number may differ in terms of the internal memory capacity, layout pattern, and other factors, which can affect the ranges of electrical characteristics, such as characteristic values, operating margins, immunity to noise, and amount of radiated noise. When changing to a product with a different part number, implement a system-evaluation test for the given product.

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