Abstract

This document describes timer A operation using a two-phase pulse signal and quadrupled processing in event counter mode with the R32C/100 Series.

Products

MCUs: R32C/116 Group, R32C/117 Group, and 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.
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1. Specifications

When using the event counter mode of timer A4, the timer counts a two-phase pulse signal applied to pins TA4IN and TA4OUT using quadrupled processing. When an overflow or underflow occurs, a high is output from the corresponding port.

Table 1.1 lists the Peripheral Function and Its Application. Figure 1.1 shows the Overview of Quadrupled Processing.

Table 1.1 Peripheral Function and Its Application

<table>
<thead>
<tr>
<th>Peripheral Function</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Timer A (timer A4)</td>
<td>Counts a two-phase pulse signal applied to pins TA4IN and TA4OUT</td>
</tr>
</tbody>
</table>

Figure 1.1 Overview of Quadrupled Processing
2. **Operation Confirmation Conditions**

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

<table>
<thead>
<tr>
<th>Item</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>MCU used</td>
<td>R5F64189DFD (R32C/118 Group)</td>
</tr>
</tbody>
</table>
| Operating frequencies | Main clock: 16 MHz  
PLL clock: 100 MHz  
Base clock: 50 MHz  
CPU clock: 50 MHz  
Peripheral bus clock: 25 MHz  
Peripheral function clock source: 25 MHz |
| Operating voltage | 5 V |
| Integrated development environment | Renesas Electronics Corporation  
High-performance Embedded Workshop Version 4.07 |
| 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=0x0FFFFFFFBDC -c -finfo -dir "$(CONFIGDIR)"  
(Default setting is used in the integrated development environment.) |
| Operating mode | Single-chip mode |
| Sample code version | Version 1.00 |
| Board used | Renesas Starter Kit for R32C/118 (product name: R0K564189S000BE) |

3. **Reference Application Note**

The application note associated with this application note is listed below. Refer to the following application note for additional information.

- R32C/100 Series Configuring PLL Mode (REJ05B1221-0100)

4. **Hardware**

4.1 **Pins Used**

Table 4.1 lists the Pins Used and Their Functions.

<table>
<thead>
<tr>
<th>Pin Name</th>
<th>I/O</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>P8_0/TA4OUT</td>
<td>Input</td>
<td>Two-phase pulse input of timer A4</td>
</tr>
<tr>
<td>P8_1/TA4IN</td>
<td>Input</td>
<td>Two-phase pulse input of timer A4</td>
</tr>
<tr>
<td>P4_0</td>
<td>Output</td>
<td>Output to confirm counter overflow</td>
</tr>
<tr>
<td>P4_1</td>
<td>Output</td>
<td>Output to confirm counter underflow</td>
</tr>
</tbody>
</table>
5. Software

5.1 Operation Overview

The timer counts a two-phase pulse signal applied to pins TA4IN and TA4OUT. If the counter overflows or underflows, a timer A4 interrupt is generated.

(1) Timer A4 initial settings

Table 5.1 and Table 5.2 list the Timer A4 Settings and Initial Pin Settings to Confirm Overflow or Underflow, respectively.

Table 5.1 Timer A4 Settings

<table>
<thead>
<tr>
<th>Item</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating mode</td>
<td>Event counter mode</td>
</tr>
<tr>
<td>Two-phase processing operation</td>
<td>Quadrupled processing operation</td>
</tr>
<tr>
<td>Count operation type</td>
<td>Free-running type</td>
</tr>
</tbody>
</table>

Table 5.2 Initial Pin Settings to Confirm Overflow or Underflow

<table>
<thead>
<tr>
<th>Pin</th>
<th>Initial Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>P4_0 (output to confirm overflow)</td>
<td>0</td>
</tr>
<tr>
<td>P4_1 (output to confirm underflow)</td>
<td>0</td>
</tr>
</tbody>
</table>

(2) Timer A4 count starts

Set the timer A4 count start bit in the count start register to 1 (start counter).

(3) When the counter overflows or underflows

When the counter overflows or underflows, the interrupt request flag of timer A4 becomes 1 (interrupt requested). The counter continues counting without reloading the value in the reload register. In the timer A4 interrupt handler, set each pin as output to confirm overflow or underflow. Table 5.3 lists the Setting Pins as Output to Confirm Overflow or Underflow.

Table 5.3 Setting Pins as Output to Confirm Overflow or Underflow

<table>
<thead>
<tr>
<th>Item</th>
<th>Setting Value for Port P4_0</th>
<th>Setting Value for Port P4_1</th>
</tr>
</thead>
<tbody>
<tr>
<td>When the counter overflows</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>When the counter underflows</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>
Figure 5.1 shows the Operation Timing.

![Operation Timing Diagram]

- **TA4OUT pin**: Set to 1 by a program.
- **TA4IN pin**: Set to 0 by an interrupt request acceptance or by a program.
- **Counter value**: 0000h to FFFFh
- **Timer A4 count start bit**: 1
- **Timer A4 interrupt request flag**: 1
- **Port P4_0**: 1
- **Port P4_1**: 1

(1) Initial setting
(2) Start counter: Set to 1 by a program.
(3) Underflow: Set to 0 by an interrupt request acceptance or by a program.
(3) Overflow: Change the setting value by an interrupt handler.
5.2 Flowchart

5.2.1 Main Processing

Figure 5.2 and Figure 5.3 show Main Processing (1) and Main Processing (2), respectively.

![Flowchart]

Figure 5.2 Main Processing (1)
Enable maskable interrupts

Start timer A4 counter

Set pins to confirm overflow or underflow

P4 register ← 00h
P4_0 bit = 0
P4_1 bit = 0

P4_0S register ← 00h
Bits PSEL2 to PSEL0 = 000b
NOD bit = 0

P4_1S register ← 00h
Bits PSEL2 to PSEL0 = 000b
NOD bit = 0

PD4 register
PD4_0 bit ← 1
PD4_1 bit ← 1

TA4S bit = 1

Start counter

I/O port P4_0
Push-pull output

I/O port P4_1
Push-pull output

Output port

Output port

Output port

Output port

Figure 5.3  Main Processing (2)
5.2.2 Timer A4 Interrupt Handler

Figure 5.4 shows the Timer A4 Interrupt Handler.

![Diagram of Timer A4 Interrupt Handler]

(1) Counter overflowed?
   Yes
   (2) Set pin as output to confirm overflow
       return
   No
   (3) Set pin as output to confirm underflow
6. **Sample Code**
   Sample code can be downloaded from the Renesas Electronics website.

7. **Reference Documents**
   R32C/118 Group User's Manual: Hardware Rev.1.10
   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/100 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.

8. **Website and Support**
   Renesas Electronics website
   http://www.renesas.com/

   Inquiries
   http://www.renesas.com/inquiry
<table>
<thead>
<tr>
<th>Rev.</th>
<th>Date</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.00</td>
<td>Jan. 14, 2011</td>
<td>First edition issued</td>
</tr>
</tbody>
</table>
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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