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 .................................................................................................................. 3
2. Operation Confirmation Conditions .............................................................................. 4
3. Reference Application Notes ........................................................................................ 4
4. Hardware .......................................................................................................................... 4
   4.1 Pins Used .................................................................................................................... 4
5. Software ............................................................................................................................ 5
   5.1 Operation Overview .................................................................................................... 6
   5.2 Constants ..................................................................................................................... 7
   5.3 Variable ....................................................................................................................... 7
   5.4 Flowcharts .................................................................................................................. 8
      5.4.1 Main Processing .................................................................................................. 8
6. Sample Code ...................................................................................................................... 10
7. Reference Documents ...................................................................................................... 10
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>
<thead>
<tr>
<th>Peripheral Function</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>DMAC (DMA0)</td>
<td>Transfers the value to be set to port P0</td>
</tr>
<tr>
<td>Timer A (timer A0)</td>
<td>Generates a real-time port output period</td>
</tr>
<tr>
<td>INT0 interrupt</td>
<td>Extends the real-time port output period by 1 ms</td>
</tr>
<tr>
<td>INT1 interrupt</td>
<td>Shortens the real-time port output period by 1 ms</td>
</tr>
</tbody>
</table>

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>
<thead>
<tr>
<th>Table 2.1 Operation Confirmation Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Item</strong></td>
</tr>
<tr>
<td>----------------------------</td>
</tr>
<tr>
<td>MCU used</td>
</tr>
</tbody>
</table>
| 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    | Renesas Electronics Corporation  
| environment                | 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=0x0FFFFFFFBDC  
|                            | -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>
<thead>
<tr>
<th>Table 4.1 Pins Used and Their Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pin Name</strong></td>
</tr>
<tr>
<td>----------------</td>
</tr>
<tr>
<td>P0_0</td>
</tr>
<tr>
<td>P0_1</td>
</tr>
<tr>
<td>P0_2</td>
</tr>
<tr>
<td>P0_3</td>
</tr>
<tr>
<td>P8_2/INT0</td>
</tr>
<tr>
<td>P8_3/INT1</td>
</tr>
</tbody>
</table>
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 INT0 pin. The real-time port output period is shortened by 1 ms each time a falling edge is input to the 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>
<thead>
<tr>
<th>Table Name</th>
<th>Value</th>
<th>Output Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>P0_3</td>
</tr>
<tr>
<td>RTP_TABLE[0]</td>
<td>09h</td>
<td>High</td>
</tr>
<tr>
<td>RTP_TABLE[1]</td>
<td>03h</td>
<td>Low</td>
</tr>
<tr>
<td>RTP_TABLE[2]</td>
<td>06h</td>
<td>Low</td>
</tr>
<tr>
<td>RTP_TABLE[3]</td>
<td>0Ch</td>
<td>High</td>
</tr>
</tbody>
</table>
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. 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. 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.

![Timing Diagram](image)

Figure 5.1 Timing Diagram

Note:
1. This diagram assumes an initial value of 00h is set to the P0 register.
5.2 Constants

Table 5.2 lists the Constants Used in the Sample Code.

### Table 5.2 Constants Used in the Sample Code

<table>
<thead>
<tr>
<th>Constant Name</th>
<th>Setting Value</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>PERIPHERAL_CLOCK</td>
<td>25000000</td>
<td>Peripheral clock frequency</td>
</tr>
<tr>
<td>TIMER_1MS</td>
<td>PERIPHERAL_CLOCK ÷ (8 x 1000)</td>
<td>Timer setting value</td>
</tr>
<tr>
<td>DEFAULT_CYCLE</td>
<td>3</td>
<td>Initial value (4 ms) for the real-time port output period</td>
</tr>
<tr>
<td>MIN_CYCLE</td>
<td>0</td>
<td>Shortest real-time port period (1 ms)</td>
</tr>
<tr>
<td>MAX_CYCLE</td>
<td>7</td>
<td>Longest real-time port period (8 ms)</td>
</tr>
</tbody>
</table>

5.3 Variable

Table 5.3 lists the Global Variable.

### Table 5.3 Global Variable

<table>
<thead>
<tr>
<th>Type</th>
<th>Variable Name</th>
<th>Contents</th>
<th>Function Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>uint8_t</td>
<td>p_cycle</td>
<td>Real-time port output period setting</td>
<td>main()</td>
</tr>
</tbody>
</table>
5.4 Flowcharts

5.4.1 Main Processing

Figure 5.2 and Figure 5.3 show the main processing.

```
main

Disable maskable interrupts
I flag ← 0

PLL clock setting
SetPLLClk()

Clock frequencies are set while in PLL mode.

Set ports

P0 register ← 00h
P0_0 bit = 0: Low
P0_1 bit = 0: Low
P0_2 bit = 0: Low
P0_3 bit = 0: Low
P00 register ← 0fh
P0_0 bit = 1: Output port
P0_1 bit = 1: Output port
P0_2 bit = 1: Output port
P0_3 bit = 1: Output port

Set timer A0 initial value for
DMA0 request source

TA0MR register ← 40h
Bits TMOD1 and TMOD0 = 00b: Timer mode
Bits MR2 and MR1 = 00b: No gate function
Bits TCK1 and TCK0 = 01b: f8
TA0 register ← 30D3h: Timer A0 period is 4 ms

Set DMA0

DM00 register ← 00000000h
Bits MD01 and MD00 = 00b: DMA transfer disabled
D00SL register ← 03h
Bits DSEL4 to DSEL0 = 00011b: Timer A0 interrupt request
DCT0 register ← 00000004h: The number of transfers is four
DCR0 register ← 00000004h: The reload value for the number of transfers is four
DDA0 register ← P0_addr: Transfer destination is set (port P0 register)
DSR0 register ← P0_addr: Transfer destination reload value is set
DAR0 register ← RTP_TABLE: Transfer source is set
DAR0 register ← RTP_TABLE: Transfer source reload value is set

Set DMA0 transfer complete interrupt

DM00C register ← 00h
Bits ILVL2 to ILVL0 = 000b: Level 0 (interrupt disabled)
IR bit = 0: No interrupt requested

Insert dummy cycle (2)

Set DMA0 mode register

DM000 register ← 00000010h
Bits MD01 and MD00 = 00b: DMA transfer disabled
Bits BW01 and BW00 = 00b: 8 bits
USA0 bit = 1: Source addressing mode is incrementing addressing
UDA0 bit = 0: Destination addressing mode is non-incrementing addressing
DM000 register ← 00000013h
Bits MD01 and MD00 = 11b: Repeat transfer

Clear the INT0 and INT1
interrupt request bits

INT0C register ← 00h
IR bit = 0: No interrupt requested
INT1C register ← 00h
IR bit = 0: No interrupt requested

Start timer A0 which is used as
the DMA0 request source

TABS register
TA0S bit ← 1: Start the timer A0 count

Notes:
1. When setting registers associated with the DMAC, set bits MD01 and MD00 for the channels used to 00b (DMA transfer disabled), and then select 01b (single transfer) or 11b (repeat transfer).
2. After setting registers DM0SL and DM0SL2, wait for at least 6 cycles of the peripheral bus clock before enabling DMA transfer.
```

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.

Website and Support
Renesas Electronics website
http://www.renesas.com/
Inquiries
http://www.renesas.com/contact/
<table>
<thead>
<tr>
<th>Rev.</th>
<th>Date</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.00</td>
<td>Aug. 2, 2013</td>
<td>First edition issued</td>
</tr>
</tbody>
</table>

All trademarks and registered trademarks are the property of their respective owners.
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.
Notice

1. Descriptions of circuits, software and other related information in this document are provided only to illustrate the operation of semiconductor products and application examples. You are fully responsible for the incorporation of these circuits, software, and information in the design of your equipment. Renesas Electronics assumes no responsibility for any losses incurred by you or third parties arising from the use of these circuits, software, or information.

2. Renesas Electronics has used reasonable care in preparing the information included in this document, but Renesas Electronics does not warrant that such information is error free. Renesas Electronics assumes no liability whatsoever for any damages incurred by you resulting from errors or omissions from the information included herein.

3. Renesas Electronics does not assume any liability for infringement of patents, copyrights, or other intellectual property rights of third parties by or arising from the use of Renesas Electronics products or technical information described in this document. No license, express, implied or otherwise, is granted hereby under any patents, copyrights or other intellectual property rights of Renesas Electronics or others.

4. You should not alter, modify, copy, or otherwise misappropriate any Renesas Electronics product, whether in whole or in part. Renesas Electronics assumes no responsibility for any losses incurred by you or third parties arising from such alteration, modification, copy or otherwise misappropriation of Renesas Electronics product.

5. Renesas Electronics products are classified according to the following two quality grades: “Standard” and “High Quality”. The recommended applications for each Renesas Electronics product depends on the product’s quality grade, as indicated below.

“Standard”:
- Computers, office equipment, communications equipment, test and measurement equipment, audio and visual equipment, home electronics appliance, machine tools, personal electronic equipment, and industrial robots etc.
- “High Quality”:
  - Transportation equipment (automobile, train, ship, etc.);
  - Traffic control systems; anti-disaster systems; anti-crim systems; and safety equipment etc.

Renesas Electronics products are neither intended nor authorized for use in products or systems that may pose a direct threat to human life or bodily injury (artificial life support devices or systems, surgical implantations etc.) or may cause serious property damage (nuclear reactor control systems, military equipment etc.). You must check the quality grade of each Renesas Electronics product before using it in a particular application. You may not use any Renesas Electronics product for any application for which it is not intended. Renesas Electronics shall not be in any way liable for any damages or losses incurred by you or third parties arising from the use of any Renesas Electronics product for which the product is not intended by Renesas Electronics.

6. You should use the Renesas Electronics products described in this document within the range specified by Renesas Electronics, especially with respect to the maximum rating, operating supply voltage range, movement power voltage range, heat radiation characteristics, installation and other product characteristics. Renesas Electronics shall have no liability for malfunctions or damage arising out of the use of Renesas Electronics products beyond such specified ranges.

7. Although Renesas Electronics endeavors to improve the quality and reliability of its products, semiconductor products have specific characteristics such as the occurrence of failure at a certain rate and malfunctions under certain use conditions. Further, Renesas Electronics products are not subject to radiation-resistance design. Please be sure to implement safety measures to guard against the possibility of physical injury, fire, or damage caused by fire in the event of the failure of a Renesas Electronics product, such as safety design for hardware and software including but not limited to redundancy, fire control and malfunction prevention, appropriate treatment for aging degradation or any other appropriate measures. Because the evaluation of microcomputer software alone is very difficult, please evaluate the safety of the final products or system manufactured by you.

8. Please contact a Renesas Electronics sales office for details as to environmental matters such as the environmental compatibility of each Renesas Electronics product. Please use Renesas Electronics products in compliance with all applicable laws and regulations that regulate the inclusion or use of controlled substances, including without limitation, the EU RoHS Directive. Renesas Electronics assumes no liability for damages or losses occurring as a result of your noncompliance with applicable laws and regulations.

9. Renesas Electronics products and technology may not be used for or incorporated into any products or systems where manufacture, use, or sale is prohibited under any applicable domestic or foreign laws or regulations. You should not use Renesas Electronics products or technology described in this document for any purpose relating to military applications or use by the military, including but not limited to the development of weapons of mass destruction. When reporting the Renesas Electronics products or technology described in this document, you should comply with the applicable export control laws and regulations and follow the procedures required by such laws and regulations.

10. It is the responsibility of the buyer or distributor of Renesas Electronics products, who distributes, disposes of, or otherwise places the product with a third party, to notify such third party in advance of the contents and conditions set forth in this document. Renesas Electronics assumes no responsibility for any losses incurred by you or third parties as a result of unauthorized use of Renesas Electronics products.

11. This document may not be reproduced or duplicated in any form, in whole or in part, without prior written consent of Renesas Electronics.

12. Please contact a Renesas Electronics sales office if you have any questions regarding the information contained in this document or Renesas Electronics products, or if you have any other inquiries.

(Note 1) “Renesas Electronics” as used in this document means Renesas Electronics Corporation and also includes its majority-owned subsidiaries.

(Note 2) “Renesas Electronics product(s)” means any product developed or manufactured by or for Renesas Electronics.

SALES OFFICES
Renesas Electronics Corporation
http://www.renesas.com

Renesas Electronics America Inc.
2880 Scott Boulevard, Santa Clara, CA 95050-2554, U.S.A.
Tel: +1-408-588-6000, Fax: +1-408-588-6130

Renesas Electronics Canada Limited
1750 Nathan Road, Kowloon, Ontario, L3V 9C3, Canada
Tel: +1-647-434-0401, Fax: +1-647-996-3220

Renesas Electronics Europe Limited
Dukes Meadow, Millboard Road, Bourne End, Buckinghamshire, SL8 5FH, U.K
Tel: +44-1628-651-700, Fax: +44-1628-651-804

Renesas Electronics Europe GmbH
Arcadisallee 15, 40472 Düsseldorf, Germany
Tel: +49-211-6503-0, Fax: +49-211-6503-1327

Renesas Electronics (China) Co., Ltd.
7th Floor, Quantum Plaza, No.57 29th Chunchi Haidian District, Beijing 100083, P.R.China
Tel: +86-10-8225-1163, Fax: +86-10-8225-7679

Renesas Electronics (Shanghai) Co., Ltd.
Unit 204, B25, ASIA Centre, No.1020 Xujiahui Ring Rd, Pudong District, Shanghai 200120, China
Tel: +86-21-5877-1818, Fax: +86-21-6887-7858 / 7898

Renesas Electronics Hong Kong Limited
Unit 1601-1613, 16/F., Tower 2, Grand Century Place, 193 Prince Edward Road West, Mongkok, Kowloon, Hong Kong
Tel: +852-2285-4510, Fax: +852-2286-9230/44

Renesas Electronics Taiwan Co., Ltd.
1/F, ROC, 385, Fu Shih North Road, Taipei, Taiwan
Tel: +886-2-8175-9600, Fax: +886-2-8175-9670

Renesas Electronics Singapore Pte. Ltd.
85 Bendemeer Road, Unit 456-02 Huffs Innovation Centre Singapore 339949
Tel: +65-6213-0020, Fax: +65-6213-0500

Renesas Electronics Malaysia Sdn.Bhd.
Unit 906, Block B, Menara Aman, Ampco Trade Centre, No. 18, Jln Persiaran Barat, 46050 Petaling Jaya, Selangor Darul Ehsan, Malaysia
Tel: +603-7955-9500, Fax: +603-7955-9510

Renesas Electronics Korea Co., Ltd.
11F., Renesas Legend Building, 720-2 Teikum-Dong, Kangnam-Ku, Seoul 135-080, Korea
Tel: +82-2-558-3737, Fax: +82-2-558-5141

© 2013 Renesas Electronics Corporation. All rights reserved.
Colophon 2.2