To our customers,

Old Company Name in Catalogs and Other Documents

On April 1\textsuperscript{st}, 2010, NEC Electronics Corporation merged with Renesas Technology Corporation, and Renesas Electronics Corporation took over all the business of both companies. Therefore, although the old company name remains in this document, it is a valid Renesas Electronics document. We appreciate your understanding.

Renesas Electronics website: \url{http://www.renesas.com}

April 1\textsuperscript{st}, 2010
Renesas Electronics Corporation

Issued by: Renesas Electronics Corporation (\url{http://www.renesas.com})
Send any inquiries to \url{http://www.renesas.com/inquiry}.
Notice

1. All information included in this document is current as of the date this document is issued. Such information, however, is subject to change without any prior notice. Before purchasing or using any Renesas Electronics products listed herein, please confirm the latest product information with a Renesas Electronics sales office. Also, please pay regular and careful attention to additional and different information to be disclosed by Renesas Electronics such as that disclosed through our website.

2. 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.

3. You should not alter, modify, copy, or otherwise misappropriate any Renesas Electronics product, whether in whole or in part.

4. 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.

5. When exporting the 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. You should not use Renesas Electronics products or the 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. Renesas Electronics products and technology may not be used for or incorporated into any products or systems whose manufacture, use, or sale is prohibited under any applicable domestic or foreign laws or regulations.

6. 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 in or omissions from the information included herein.

7. Renesas Electronics products are classified according to the following three quality grades: “Standard”, “High Quality”, and “Specific”. The recommended applications for each Renesas Electronics product depend on the product’s quality grade, as indicated below. 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 categorized as “Specific” without the prior written consent of Renesas Electronics. Further, you may not use any Renesas Electronics product for any application for which it is not intended without the prior written consent of Renesas Electronics. 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 an application categorized as “Specific” or for which the product is not intended where you have failed to obtain the prior written consent of Renesas Electronics. The quality grade of each Renesas Electronics product is “Standard” unless otherwise expressly specified in a Renesas Electronics data sheets or data books, etc.

   “Standard”: Computers; office equipment; communications equipment; test and measurement equipment; audio and visual equipment; home electronic appliances; machine tools; personal electronic equipment; and industrial robots.

   “High Quality”: Transportation equipment (automobiles, trains, ships, etc.); traffic control systems; anti-disaster systems; anti-crime systems; safety equipment; and medical equipment not specifically designed for life support.

   “Specific”: Aircraft; aerospace equipment; submersible repeaters; nuclear reactor control systems; medical equipment or systems for life support (e.g. artificial life support devices or systems), surgical implantations, or healthcare intervention (e.g. excision, etc.), and any other applications or purposes that pose a direct threat to human life.

8. 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 damages arising out of the use of Renesas Electronics products beyond such specified ranges.

9. 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 them against the possibility of physical injury, and injury 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.

10. 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.

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.
H8SX Series
One-Shot Pulse Output

Introduction

As well as having an architecture that is upward-compatible with each CPU of the H8/300, H8/300H, and H8S series, so as to inherit a full complement of peripheral functions, the H8SX microcomputer series has a maximum operating frequency of 50 MHz and uses a 32-bit H8SX core CPU as well as an on-chip multiplier/divider to improve performance.

This H8SX series Application Note provides information you may need during software and hardware design. This is a basic edition that provides operation examples that each use a single H8SX series on-chip peripheral function.

Although the operation of each program, circuit, and other aspects covered by this application note has been checked, make sure that you conduct your own operation checks before actually using the H8SX series.

Contents

1. Overview .................................................................................................................... 2
2. Configuration ........................................................................................................... 2
3. Sample Program ..................................................................................................... 5
1. Overview

One channel of the 16-bit timer pulse unit (TPU) of the H8SX series is used to output a one-shot pulse in synchronization with an external signal. The input capture detects the falling edge of the external trigger signal while the output compare match controls the output delay and pulse width of the one-shot pulse, as well as the buffer operation.

2. Configuration

The following example uses channel 0 of the 16-bit timer pulse unit (TPU). This sample uses timer general register A (TGRA_0) of channel 0 as the input capture of the external trigger signal to control the following two times with the output compare match of timer general register B (TGRB_0): Pulse output delay and pulse width. This sample also uses timer general register D (TGRD_0) as the TGRB_0 buffer register and timer general register C (TGRC_0) to control the disabling of one-shot pulse output (after one-shot pulse output). You can set any pulse output delay and pulse output width within the range of values that can be set in the timer general registers. When the peripheral module clock (Pφ) is 25 MHz and the count clock is Pφ/1, you can set up to 2.62 msec in the timer general registers. In the following explanation, channel 0 of the 16-bit timer pulse unit is called TPU0. Figure 1 is a block diagram.
Figure 1  Block Diagram of One-Shot Pulse Output
Figure 2 illustrates one-shot pulse output.

Figure 2   Example of One-Shot Pulse Output
3. Sample Program

3.1 Function

This sample program outputs pulses according to the timer counter values for the following two times for the one-shot pulse to be output:

- Delay between the falling edge of the external trigger signal and the start of high output of the pulse
- High width of the pulse to be output

You can calculate the timer values for the two times by using the following equations:

\[
\text{delay} = \text{timer-value} \times \text{TPU0-count-clock} \\
\text{high-width} = \text{timer value} \times \text{TPU0-count clock}
\]

Assume that the TPU0 count clock is peripheral module \((P\phi)/1\). When \(P\phi\) is 25 MHz, the TPU0 count clock is 40 nsec. Figure 3 shows an example of operation.

![Figure 3   Example of One-Shot Pulse Output Operation](image)

- **TCNT_0 value**
- **Start of operation**
- **0 × FFFF**
- **0 × 0000**
- **External trigger signal**
- **TI0CA0**
- **One-shot pulse**
- **TI0CB0**
- **Time**

Figure 3: Example of One-Shot Pulse Output Operation
Table 1 lists the function allocations of channel 0 of the 16-bit timer pulse unit (TPU).

### Table 1  Function Allocation of TPU0

<table>
<thead>
<tr>
<th>Type</th>
<th>Name</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Register</td>
<td>MSTPCRA</td>
<td>Cancels TPU module stop mode.</td>
</tr>
<tr>
<td></td>
<td>TSTR</td>
<td>Specifies whether to start or stop TPU0 timer count operation.</td>
</tr>
<tr>
<td></td>
<td>TMDR_0</td>
<td>Sets TPU0 operating mode (buffer operation).</td>
</tr>
<tr>
<td></td>
<td>TCR_0</td>
<td>Sets the TCNT_0 count clock and counter clear factor.</td>
</tr>
<tr>
<td></td>
<td>TGRB_0</td>
<td>Compare match counter value for the pulse output delay time</td>
</tr>
<tr>
<td></td>
<td>TGRD_0</td>
<td>Compare match counter value for the pulse output high width</td>
</tr>
<tr>
<td></td>
<td>TGRC_0</td>
<td>Compare match counter value for the pulse output prohibit timing</td>
</tr>
<tr>
<td></td>
<td>TIER_0</td>
<td>Enables interrupts by input capture A and compare match B.</td>
</tr>
<tr>
<td></td>
<td>TIORH_0</td>
<td>Sets TGRA_0 to the input capture and TGRB_0 and TGRC_0 to the compare</td>
</tr>
<tr>
<td></td>
<td>TIORL_0</td>
<td>matches. Sets the output level when a compare match occurs.</td>
</tr>
</tbody>
</table>

### Input pin
- TIOCA0: Input capture input pin

### Output pin
- TIOCB0: Compare match output pin

### 3.2 Function Specifications

The functions that set pulse output are shown as a sample program. The function specifications are listed below.

1. Routine for setting one-shot pulse output

   ```c
   void oneshot_set ( unsigned short  delay_count, unsigned short  high_count )
   ```

   **Argument**
   - **delay_count**: Specifies the timer value for the delay between the falling edge of the external trigger signal and the start of one-shot pulse output (high output). The count clock is fixed to Pφ/1.
   - **high_count**: Specifies the timer value for the high width of one-shot pulse output. The count clock is fixed to Pφ/1.

   **Return value**
   - None

2. Input capture A interrupt handler

   ```c
   void inthdr_captureA ( void )
   ```

   This function has neither an argument nor a return value because it is a TPU0 interrupt handler. You must register this interrupt handler in the interrupt vector table.
(3) Compare match C interrupt handler

```c
void inthdr_compareC ( void )

This function has neither an argument nor a return value because it is an interrupt handler. You must register this interrupt handler in the interrupt vector table.

Example)

```c
#define DELAY_TIME 1000 // Delay time: 1000 µsec
#define ONSHOT_TIME 500 // High width: 500 µsec
#define P_CLOCK 25 // Pφ (MHz)

extern void oneshot_set ( unsigned short, unsigned short );
void main( void ) // Main routine
{
    unsigned long delay;
    unsigned long width;

    delay = ((unsigned long)DELAY_TIME * P_CLOCK);
    width = ((unsigned long)ONSHOT_TIME * P_CLOCK);
    // Sets one-shot pulse output.
    oneshot_set ( (unsigned short)delay, (unsigned short)width );
    ..
}
```
3.3 Flowchart

A processing flow is shown below.

(1) void oneshot_set ( unsigned short, unsigned short )

Start

Cancel TPU module stop mode (MSTPCRA)

Set TCNT_0 count clock to Pφ/1 (TCR_0)

Set TCNT_0 counter clear factor to TGRA input capture (TCR_0)

Set input capture A and compare match C (TIORH_0 and TIORL_0)

Set "delay time plus high width" of one-shot pulse to be output (TGRD_0)

For input pin (TIOCA0) set input, buffer enable (P3ICR), set output prohibit timing (TGRC_0)

Set TGRB/TGRD buffer operation (TMDR_0)

Enable interrupt by input capture A (TIER_0)

Clear CCR interrupt mask* bit

Set TPU0 timer count operation (TSTR)

End

* For interrupts, the use of interrupt control mode 0 is assumed
(2) void inthdr_captureA ( void )

Start

- Clear status flag indicating occurrence of input capture (TSR_0)

Set output delay of one-shot pulse (TGRB_0)

- When compare match B occurs, set - initial value to low output, and - toggle output for compare match (TIORH_0)

Clear status flag of compare match C (TSR_0)

Enable compare match C interrupt (TIER_0)

End
3.4 Program Listing

A source program listing is shown below. In this source program, Renesas's standard definition (file automatically generated by High-performance Embedded Workshop: iodefine.h) is used for I/O register structure definition. If you want to use a user-specified definition, change the I/O register structure in the sample program.

```c
/** **********************************************/
/* include file */
/** **********************************************/
#include <machine.h>
#include "iodefine.h"

/** **********************************************/
/* function prototype */
/** **********************************************/
void oneshot_set( unsigned short, unsigned short );

/** **********************************************/
/* static variable */
/** **********************************************/
static unsigned short save_delay_count;

/** **********************************************/
/* function definition */
/** **********************************************/
void oneshot_set( unsigned short delay_count,
                 unsigned short high_count )
{
...
P_MSTPCRA.BIT.MSTPA0 = 0;    // reset module-standby for TPU
P_TPU0.TCR.BIT.TPSC = 0;    // set TPU0 countup clock source
P_TPU0.TCR.BIT.CCLR = 1;    // set TPU0 counter clear cause
P_TPU0.TIOR.BIT.IOA = 9;    // set TPU0 capture-edge
P_TPU0.TIOR.BIT.IOC = 0;    // set TPU0 compare-match-C
P_TPU0.TGRD = (unsigned int)(delay_count+high_count);
P_TPU0.TGRC = P_TPU0.TGRD+50;
save_delay_count = delay_count;
P_P3.ICR.BIT.Pn0ICR = 1;   // set input buffer enable
P_TPU0.TMDR.BIT.BFB = 1;   // set TPU0 TGRB buffer-mode
P_TPU0.TIER.BIT.TGIEA = 1; // set TGI0A-interrupt enable
set_imask_ccr(0);            // clear interrupt mask
P_TPU.TSTR.BIT.CST0 = 1;   // start TPU0
}

/***************************************************************/
/* interrupt handler definition                                */
/***************************************************************/
#pragma interrupt ( inthdr_captureA )
void inthdr_captureA( void )
{
  volatile unsigned char  dummy;
  dummy = P_TPU0.TSR.BYTE;      // read TPU0 interrupt status
  P_TPU0.TSR.BIT.TGFA = 0;       // clear TGI0A-interrupt status
  P_TPU0.TSR.BIT.TGFC = 0;       // clear TGI0C-interrupt status
  P_TPU0.TGRB = save_delay_count;// set TPU0 compare-match-B
  P_TPU0.TIOR.BIT.IOB = 3;
P_TPU0.TIER.BIT.TGIEC = 1;    // set TGI0C-interrupt enable
}

#pragma interrupt ( inthdr_compareC )
void inthdr_compareC( void )
{
  volatile unsigned char  dummy;
  dummy = P_TPU0.TSR.BYTE;     // read TPU0 interrupt status
  P_TPU0.TSR.BIT.TGFA = 0;       // clear TGI0A-interrupt status
  P_TPU0.TIOR.BIT.IOB = 0;       // reset TPU0 compare-match-B
  P_TPU0.TIOR.BIT.IOC = 0;       // reset TPU0 compare-match-C
  P_TPU0.TIER.BIT.TGIEC = 0;    // set TGI0C-interrupt disable
  P_TPU0.TIER.BIT.TGIEA = 0;    // set TGI0A-interrupt disable
}
## Revision Record

<table>
<thead>
<tr>
<th>Rev.</th>
<th>Date</th>
<th>Page</th>
<th>Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.00</td>
<td>Sept. 19.03</td>
<td>—</td>
<td>First edition issued</td>
</tr>
</tbody>
</table>
Keep safety first in your circuit designs!

1. Renesas Technology Corporation puts the maximum effort into making semiconductor products better and more reliable, but there is always the possibility that trouble may occur with them. Trouble with semiconductors may lead to personal injury, fire or property damage. Remember to give due consideration to safety when making your circuit designs, with appropriate measures such as (i) placement of substitutive, auxiliary circuits, (ii) use of nonflammable material or (iii) prevention against any malfunction or mishap.

Notes regarding these materials

1. These materials are intended as a reference to assist our customers in the selection of the Renesas Technology Corporation product best suited to the customer's application; they do not convey any license under any intellectual property rights, or any other rights, belonging to Renesas Technology Corporation or a third party.
2. Renesas Technology Corporation assumes no responsibility for any damage, or infringement of any third-party's rights, originating in the use of any product data, diagrams, charts, programs, algorithms, or circuit application examples contained in these materials.
3. All information contained in these materials, including product data, diagrams, charts, programs and algorithms represents information on products at the time of publication of these materials, and are subject to change by Renesas Technology Corporation without notice due to product improvements or other reasons. It is therefore recommended that customers contact Renesas Technology Corporation or an authorized Renesas Technology Corporation product distributor for the latest product information before purchasing a product listed herein.
The information described here may contain technical inaccuracies or typographical errors. Renesas Technology Corporation assumes no responsibility for any damage, liability, or other loss rising from these inaccuracies or errors.
Please also pay attention to information published by Renesas Technology Corporation by various means, including the Renesas Technology Corporation Semiconductor home page (http://www.renesas.com).
4. When using any or all of the information contained in these materials, including product data, diagrams, charts, programs, and algorithms, please be sure to evaluate all information as a total system before making a final decision on the applicability of the information and products. Renesas Technology Corporation assumes no responsibility for any damage, liability or other loss resulting from the information contained herein.
5. Renesas Technology Corporation semiconductors are not designed or manufactured for use in a device or system that is used under circumstances in which human life is potentially at stake. Please contact Renesas Technology Corporation or an authorized Renesas Technology Corporation product distributor when considering the use of a product contained herein for any specific purposes, such as apparatus or systems for transportation, vehicular, medical, aerospace, nuclear, or undersea repeater use.
6. The prior written approval of Renesas Technology Corporation is necessary to reprint or reproduce in whole or in part these materials.
7. If these products or technologies are subject to the Japanese export control restrictions, they must be exported under a license from the Japanese government and cannot be imported into a country other than the approved destination. Any diversion or reexport contrary to the export control laws and regulations of Japan and/or the country of destination is prohibited.
8. Please contact Renesas Technology Corporation for further details on these materials or the products contained therein.