To our customers,

Old Company Name in Catalogs and Other Documents

On April 1st, 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: http://www.renesas.com

April 1st, 2010
Renesas Electronics Corporation

Issued by: Renesas Electronics Corporation (http://www.renesas.com)

Send any inquiries to 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 depends 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.

M16C/62P Group

Example Application for Timer Pulse Output when Timer A is Insufficient

1. Abstract

This document describes the procedure and example usage for performing timer output using timer B and DMAC when timer A is insufficient to produce the timer output.

2. Introduction

The explanation of this issue is applied to the following condition:
Applicable MCU: M16C/62P Group

This program can also be used when operating other microcomputers within the M16C family, provided they have the same SFR (Special Function Registers) as the M16C/62P microcomputers. However, some functions may have been modified.
Refer to the User's Manual for details. Use functions covered in this Application Note only after careful evaluation.

3. Explain of Example Usage

The following shows an example of how to use timer B and the DMAC in the M16C/62P group to produce timer pulse output.

Specification:

- System
  XIN=16MHz, VCC1=VCC2=5V
- DMAC
  DMA request factor=TB0 interrupt request, transfer mode=repeat transfer, transfer unit=8 bit, source address direction=forward (pulse output data), destination address direction=fix (port P0)
- TB0
  timer mode, count source=f1, timer period=1ms (timer value=16000-1)

Operation:

The output level of P0_0 functioning as an output port in DMA transfer is changed each time timer B0 underflows in 1 ms cycle. Figure 1 shows timing chart.

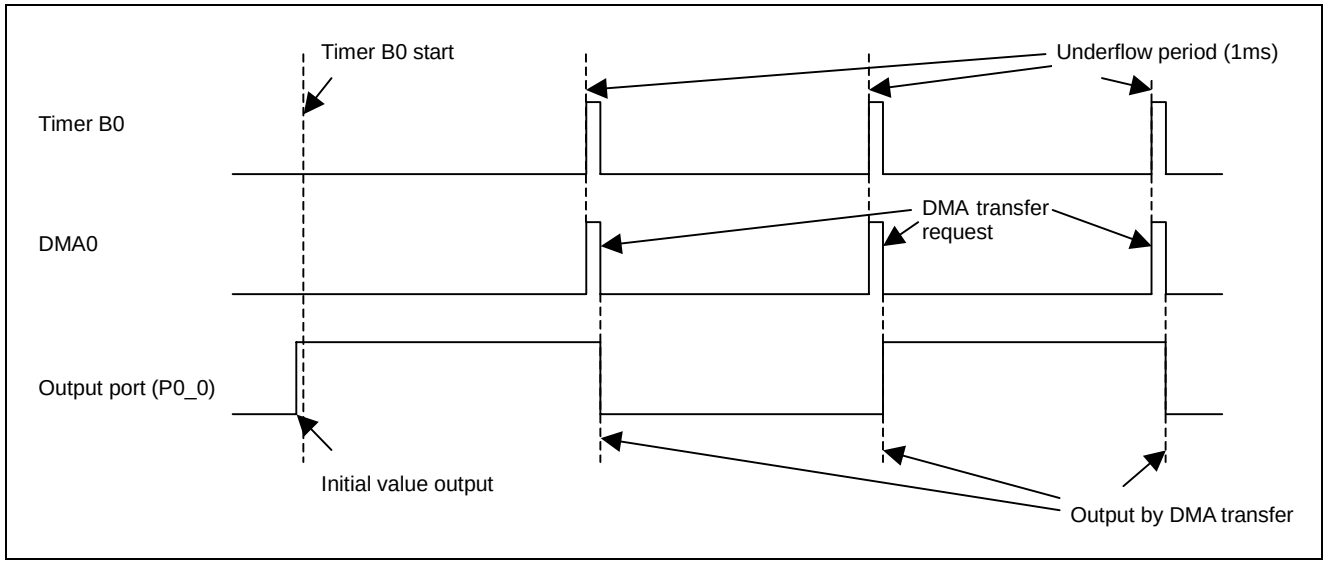
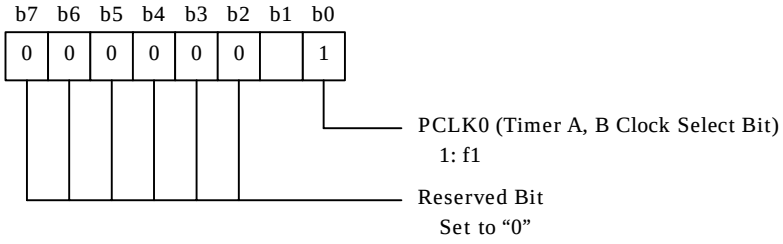


Figure 1. Pulse Output Timing Chart

Note that for reasons of SFR bit assignments, operation in this sample program may involve manipulating some bits whose functions are unused. Make sure the values of these bits are set according to the working condition in the user system.

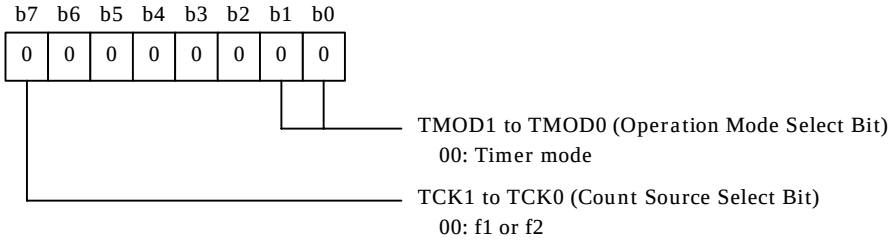
(1) Timer B0 Setting

• Select f1 for the timer A and B clocks using the PCLKR register (peripheral clock select register). Note 1

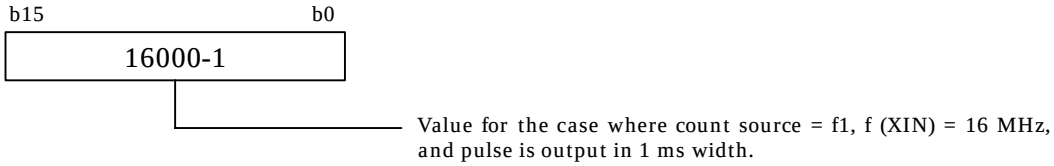


Note 1: Write to this register after setting the PRC0 bit in the PRCR register to "1" (write enable).

• Set up the TB0MR register (timer B0 mode register).

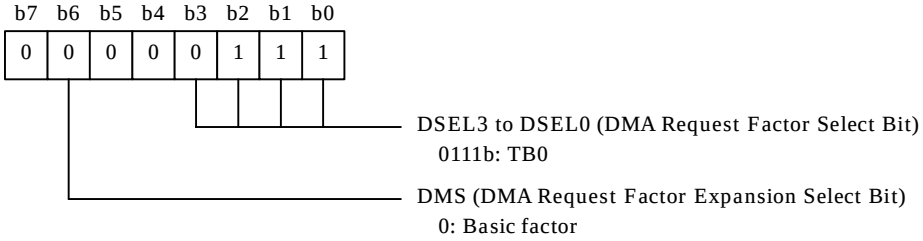


• Set a timer value (pulse output width) in the TB0 register (timer B0 register).

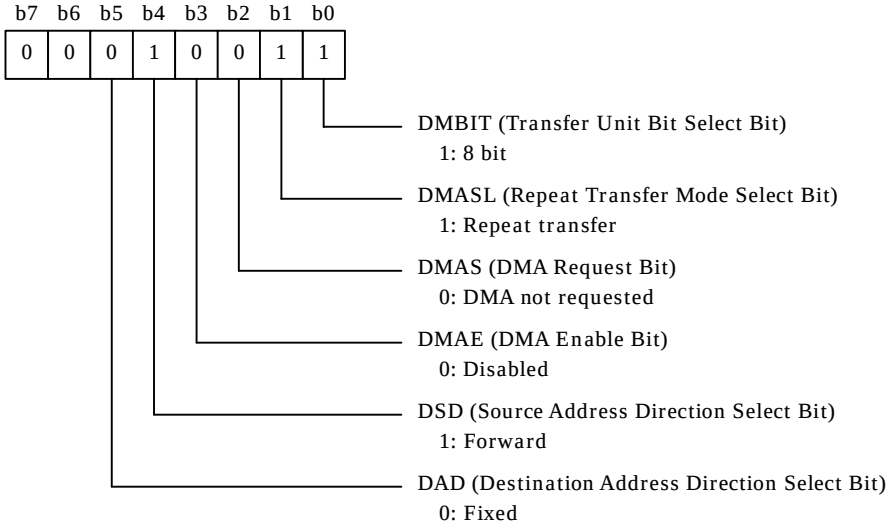


(2) DMAC Setting

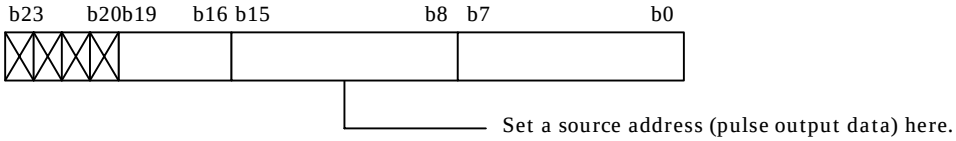
• Set up the DM0SL register (DMA0 request factor select register).



• Set up the DM0CON register (DMA0 control register)



• Set up the SAR0 register (DMA0 source pointer).



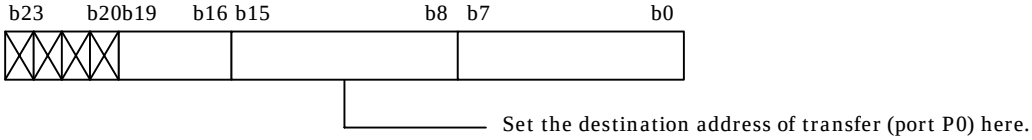
Set the data for pulse output as shown below.
• If initial output = low

```
char    pulse_data[2] = {0x00, 0x01};
```

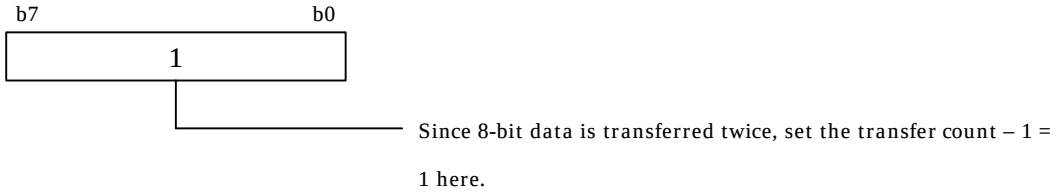
• If initial output = high

```
char    pulse_data[2] = {0x01, 0x00};
```

• Set up the DAR0 register (DMA0 destination pointer)

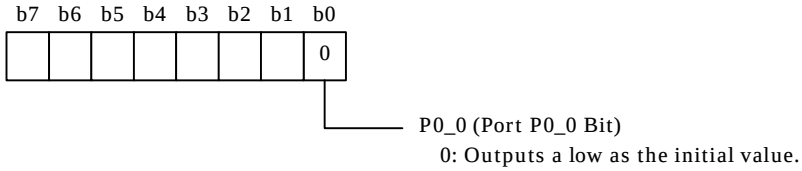


• Set up the TCR0 register (DMA0 transfer counter)

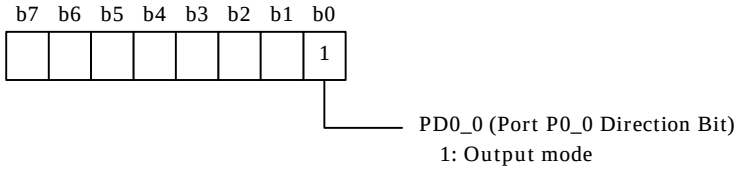


(3) Set the port P0_0 as an output port for pulse output.

• Set up the P0 register (port P0 register)

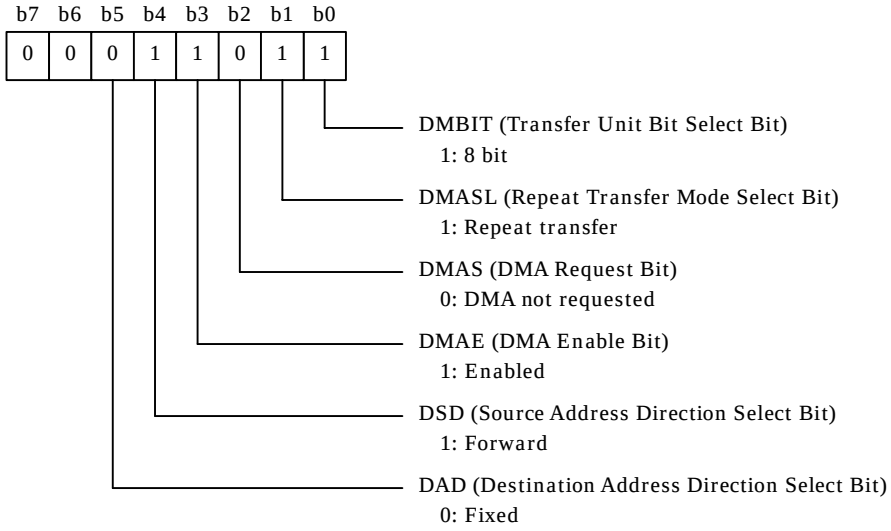


• Set up the PD0 register (port P0 direction register)



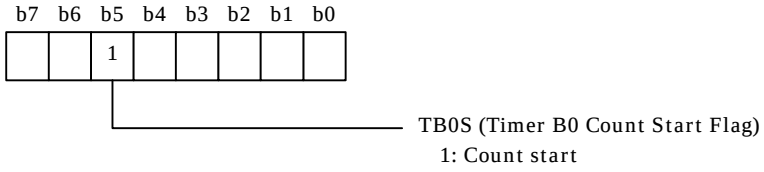
(4) DMA Enable

Set up the DM0CON register (DMA0 control register) newly again (to enable DMA).



(5) Timer B0 Start

Set the TB0S bit in the TABSR register to “1” (to let the timer start counting).



3.1 Precaution

When using timer B and the DMAC in combination to produce timer pulse output, pay attention to the following.

(1) Limitations Due to DMAC Specifications
For reasons of DMAC specifications, the following limitations apply.

- If a DMA request occurs in other interrupt sequence processing, DMA transfer is kept waiting.
- If DMA0 and DMA1 requests occur at the same time, DMA0 is serviced first because it has higher priority and DMA1 is kept waiting.

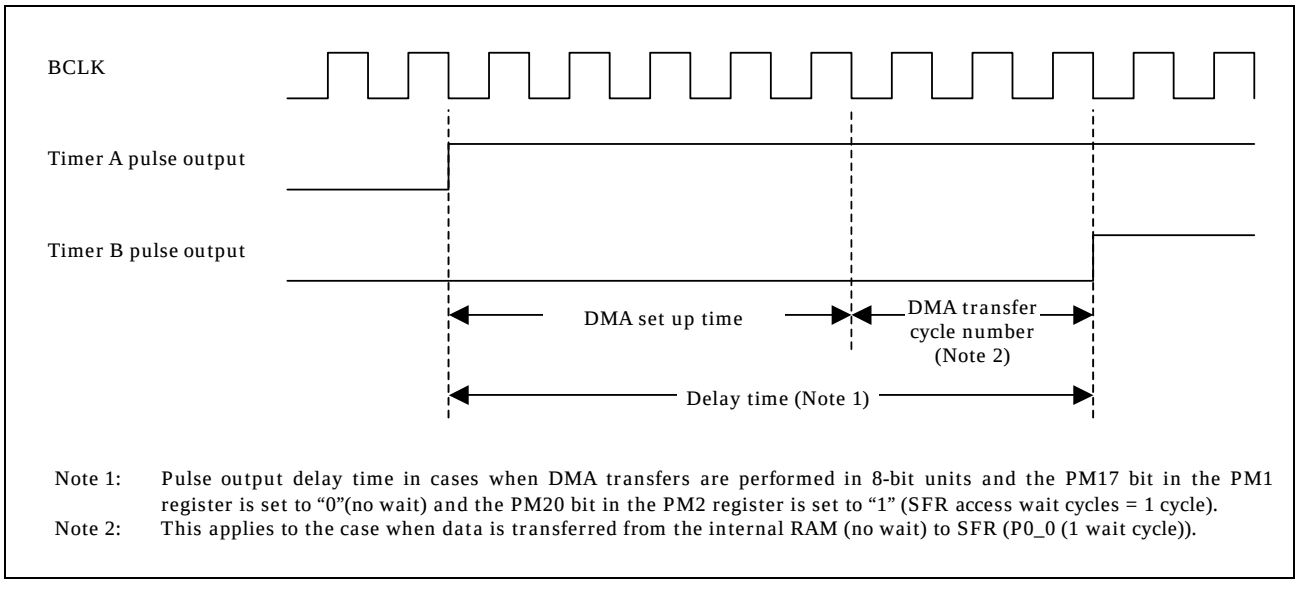
Therefore, the procedure presented here cannot be used for short-cycle, high-accuracy applications. For such applications, we recommend using timer A preferentially over the other timer.

(2) Pulse Output Delay

- Delay time at start of timer B
  For pulse output produced first at start of timer B, the instruction execution time from when the port direction register is set for output to when timer B is made to start constitutes a delay time.

- Delay Time Due to DMA Transfer
  Pulse output actually is produced a finite time after a timer B interrupt request occurred, which is equal to the DMA setup time + number of DMA transfer cycles (see paragraph (3) in 3.2). This delay time can be adjusted by adjusting the timer value.

Figure 2 shows an example of pulse output delay when the same timer value is set in timers A and B.



Note 1: Pulse output delay time in cases when DMA transfers are performed in 8-bit units and the PM17 bit in the PM1 register is set to "0"(no wait) and the PM20 bit in the PM2 register is set to "1" (SFR access wait cycles = 1 cycle).
Note 2: This applies to the case when data is transferred from the internal RAM (no wait) to SFR (P0_0 (1 wait cycle)).

Figure 2.Pulse Output Delay Example

(3) DMA Transfer Cycles

The number of DMAC transfer cycles can be calculated as follows:
Table 1 shows the number of DMA transfer cycles. Table 2 shows the Coefficient j, k.

No.of transfer cycles per transfer unit = No. of read cycles × j + No. of write cycles × k

Table 1. DMA Transfer Cycles

Transfer Unit	Bus Width	Access Address	Single-Chip Mode		Memory Expansion Mode Microprocessor Mode	
			No. of Read Cycles	No. of Write Cycles	No. of Read Cycles	No. of Write Cycles
8-bit Transfers	16-bit	Even	1	1	1	1
		Odd	1	1	1	1
	8-bit	Even	-	-	1	1
		Odd	-	-	1	1
16-bit Transfers	16-bit	Even	1	1	1	1
		Odd	2	2	2	2
	8-bit	Even	-	-	2	2
		Odd	-	-	2	2

Table 2. Coefficient j, k

	Internal Area				External Area						
	Internal ROM, RAM		SFR		Separate Bus				Multiplex Bus		
	No Wait	With Wait	1-Wait (Note 1)	2-Wait (Note 2)	No Wait	With Wait (Note 1)			With Wait (Note 1)		
						1 Wait	2 Waits	3 Waits	1 Wait	2 Waits	3 Waits
j	1	2	2	3	1	2	3	4	3	3	4
k	1	2	2	3	2	2	3	4	3	3	4

NOTES:
1. Depends on the set value of CSE register.
2. Depends on the set value of PM20 bit in the PM2 register.

(4) Limitations on Output Port

Since DMA transfers are performed in 8-bit units, no other pins (P0_1 to P0_7), except P0_0 used for timer pulse output, can be used as output ports.

4. Reference

Renesas Technology Corporation Home Page
http://www.renesas.com/

E-mail Support
E-mail: support_apl@renesas.com

Hardware Manual
M16C/62P Group Hardware Manual Rev.2.30
(Use the latest version on the home page: http://www.renesas.com)

6. Sample Programming Code

The following shows a program example of how to use timer B0 and DMA0 to produce the timer output in 1 ms cycle.

Operating Conditions: XIN=16MHz, VCC1=VCC2=5V

```
/***********************************************************************/
/*                                                                     */
/*  M16C/62 Group Program Collection                                   */
/*                                                                     */
/*  FILE NAME : rjj05b0544_src.c                                       */
/*  CPU      : M16C/62P Group                                          */
/*  FUNCTION  : This program is a sample program which uses Timer-B    */
/*            and DMA and performs a timer pulse output,               */
/*            when Timer-A run short.                                  */
/*                                                                     */
/*  HISTORY   : 2004.04.01 Ver 1.00                                    */
/*                                                                     */
/*  Copyright (C) 2004. Renesas Technology Corp.                       */
/*  Copyright (C) 2004. Renesas Solutions Corp.                        */
/*  All right reserved.                                                */
/*                                                                     */
/***********************************************************************/

/*************************************/
/*   include file                    */
/*************************************/
#include "sfr62p.h"       // Special Function Register Header File

/*************************************/
/*   Global variable declaration     */
/*************************************/
                        // Timer Pulse Output data.
char   pulse_data[2] = {0x01, 0x00};

/*************************************/
/*   Main Program                    */
/*************************************/
void main(void)
{

    prc0 = 1;
    cm1 = 0x20;           // Set system clock no-divid mode.
    cm0 = 0x08;
    prc0 = 0;

    prc1 = 1;
    pm1 = 0x08;           // Set internal-ROM/RAM no-wait.
    prc1 = 0;

    prc0 = 1;
    pclkr = 0x03;          // Set PCLKR register.
                        //  <PCLK0>  : TA/TB clock = f1
                        //  <PCLK1>  : SI/O clock  = f1
    prc0 = 0;

    tb0mr = 0x00;          // Set TB0MR register.
                        //  <TMOD1-0> : Timer mode
                        //  <TCK1-0>  : Count source = f1

    tb0 = 16000-1;         // Set TB0 register.
                        //  Pulse output cycle=1ms(XIN=16MHz)

    dm0sl = 0x07;          // Set DM0SL register.
```

```
                        //  <DSEL3-0> : TB0 interrupt request
                        //  <DMS>     : Basic cause

    dm0con = 0x13;        // Set DM0CON register.
                        //  <DMBIT> : 8bit
                        //  <DMASL> : Repeat transfer
                        //  <DMAE>  : DMA disable
                        //  <DSD>   : Src  address direction=Forward
                        //  <DAD>   : Dest address direction=Fix

                        // Set DMA0 Source pointer address.
    sar0_addr.byte.low  = (char)(&pulse_data[0]);
    sar0_addr.byte.mid  = (char)((unsigned long)(&pulse_data[0]) >> 8);
    sar0_addr.byte.high = (char)((unsigned long)(&pulse_data[0]) >> 16);

                        // Set DMA0 Destination pointer address.
    dar0_addr.byte.low  = (char)(&p0);
    dar0_addr.byte.mid  = (char)((unsigned long)(&p0) >> 8);
    dar0_addr.byte.high = (char)((unsigned long)(&p0) >> 16);

                        // Set DMA0 transfer counter.
    tcr0 = 1;             //  2-byte transfer.

    p0 = 0x00;
    pd0 = 0x01;           // P0_0 is chosen as a pulse output terminal.

    dm0con = 0x1b;        // Set DM0CON register.
                        //  <DMAE>  : DMA enable

    tb0s = 1;             // TB0 start.

    while(1);

}
```

REVISION HISTORY

Rev.	Date	Description	
		Page	Summary
1.00	2005.01.14	-	First edition issued

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.