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.

SH7046 Group

PWM 4-Phase Output

1. Specifications

Using MTU PWM mode 1, 4-phase PWM output is performed based on a set duty value and period.

In PWM mode 1, an arbitrary period can be set for each channel. Two outputs are possible for each of ch0, ch3, and ch4, and one output for each of ch1 and ch2. Thus for ch0, ch3, and ch4, waveforms can be generated with a different high width within the same period.

A duty of 0% to 100% can be set with a 1/65,535 resolution.

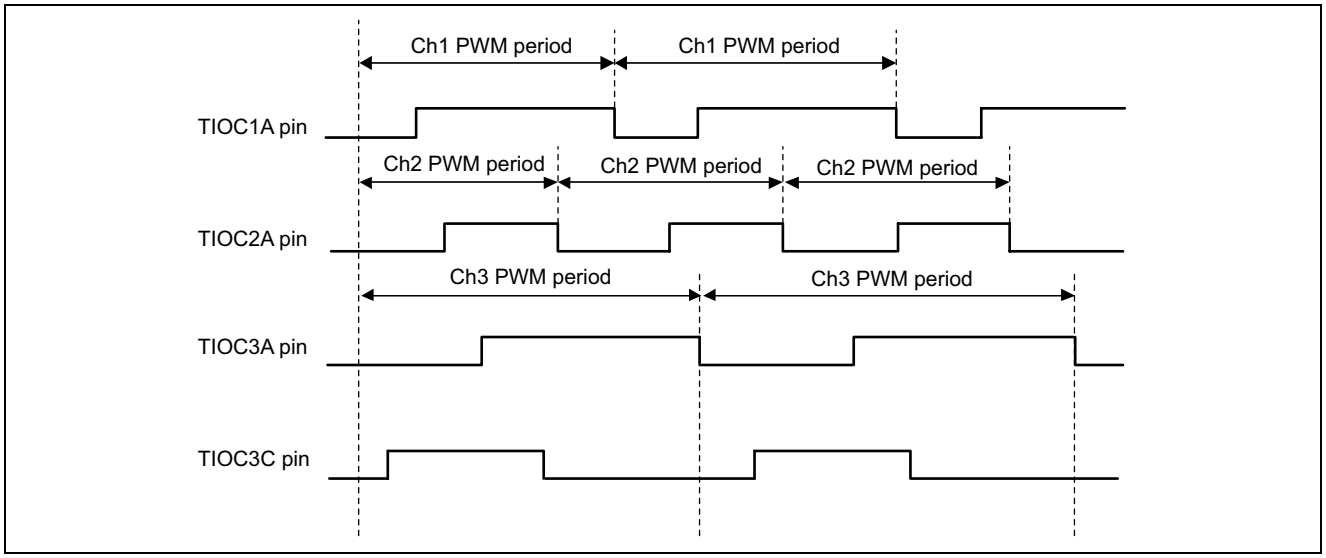


Figure 1 Example of PWM Output

2. Functions Used

In this sample task, 4-phase PWM output is performed using MTU ch1 to ch3.

In PWM mode 1, PWM output is generated with TGRA paired with TGRB, and TGRC paired with TGRD. By using ch0 to ch4, a maximum of 8-phase PWM output is possible.

Figure 2 shows a block diagram of the MTU as used in this sample task.

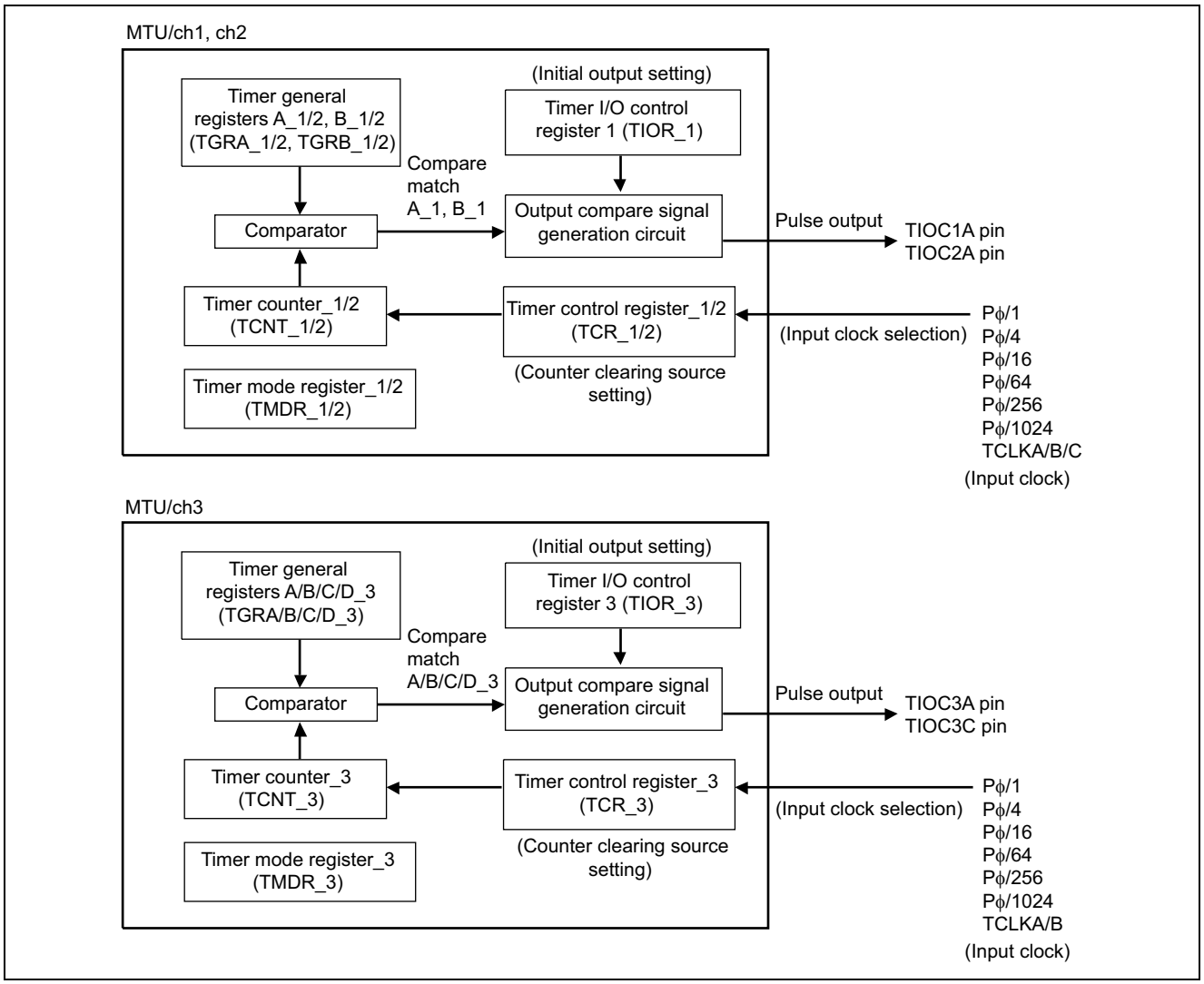


Figure 2 Block Diagram of MTU/ch1, ch2, ch3

Table 1 shows the function assignments used in this sample task. PWM pulses are output by assigning MTU functions as shown in the table.

Table 1 Function Assignments

Pin or Register Name	Function	Function Assignment
TIOC1A TIOC2A TIOC3A TIOC3C	Pins	PWM pulse output pins
TCR_1 TCR_2 TCR_3	Registers	Selection of ch1 to ch3 timer counter clearing sources and input clocks
TMDR_1 TMDR_2 TMDR_3	Registers	Operation of ch1 to ch3 in PWM mode 1
TGRA_1 TGRA_2 TGRA_3	Registers	PWM period setting
TGRB_1 TGRB_2 TGRB_3 TGRC_3 TGRD_3	Registers	Duty value setting

3. Operation

Figure 3 illustrates the principles of operation of this sample task. Four-phase PWM output is performed from the ch1 to ch3 PWM output pins (TIOC1A, TIOC2A, TIOC3A/C) by SH7046 hardware and software processing as shown in the figure.

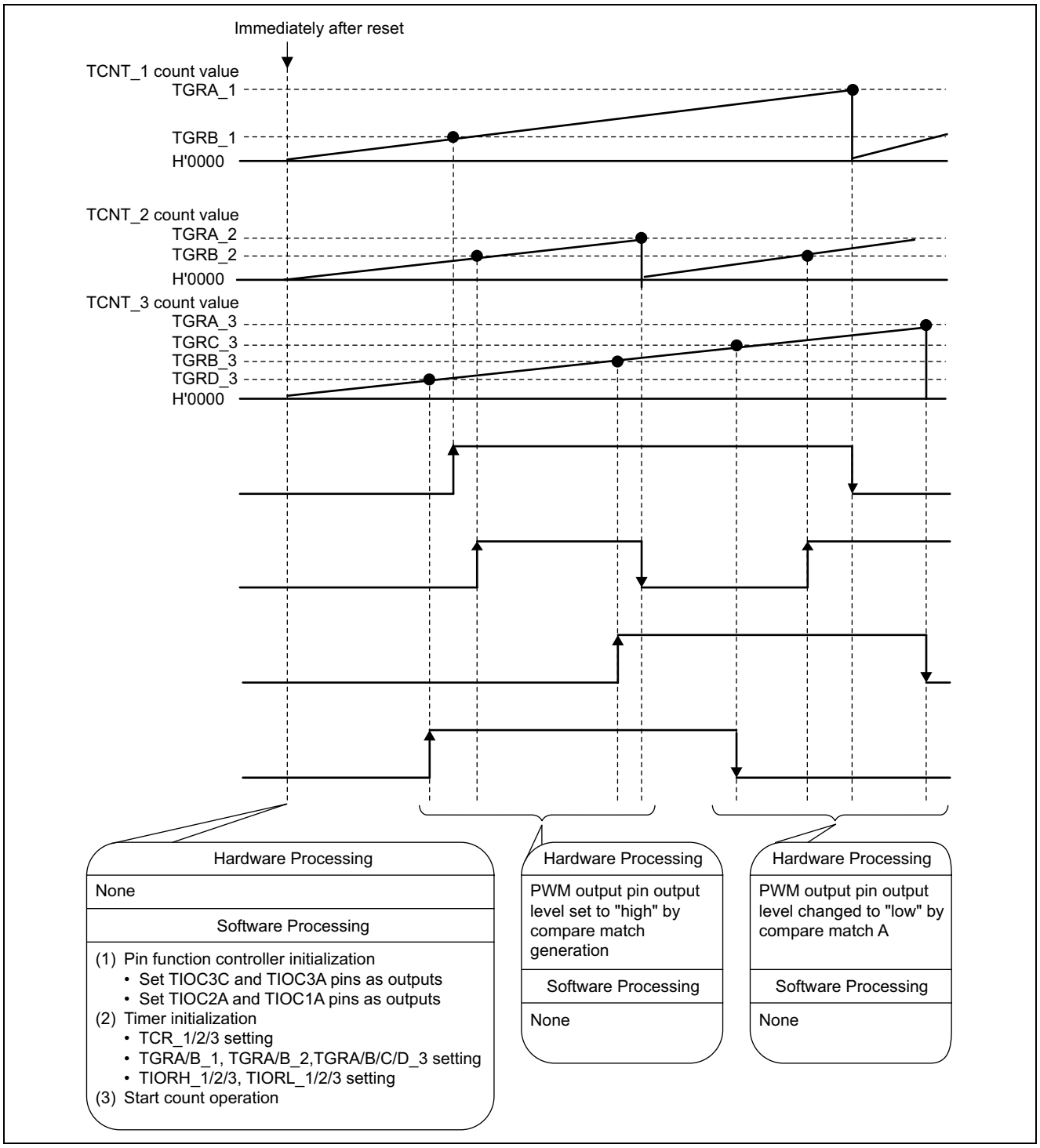


Figure 3 Principles of Operation of PWM Waveforms

4. Software

(1) Modules

Module Name	Label	Function Assignment
Main routine	pwm_1	PFC and PWM output setting

(2) Arguments

Label or Register Name	Function Assignment	Data Length	Module	Input/ Output
pul_cyc1 pul_cyc2 pul_cyc3	Used to set timer value for pulse period Pulse period is calculated using following equation: Pulse period (ns) = timer value × ϕ period (50.0 ns at 20.0 MHz operation)	1 word	Main routine	Input
pul_duty1b pul_duty2b pul_duty3b pul_duty3c pul_duty3d	Used to set TIOC pin output waveform transition timing			

(3) Internal Registers Used

Register Name	Function Assignment	Address	Set Value
P_STBY.MSTCR2	MTU module standby mode clearing	H'FFFF861E	H'd2fd
P_PORTE.PEIORL P_PORTE.PECRL1 P_PORTE.PECRL2	Multiplex pins set as timer output pins TIOC1A, TIOC2A, TIOC3A, TIOC3C	H'FFFF83B4 H'FFFF83B8 H'FFFF83BA	H'0550 H'0011 H'1100
P_MTU1.TCR_1 P_MTU2.TCR_2 P_MTU3.TCR_3	Timer counter clearing sources cleared by TGRA_1, TGRA_2, TGRA_3 compare matches Pϕ/1 selected as input clock	H'FFFF8280 H'FFFF82A0 H'FFFF8200	H'20 H'20 H'20
P_MTU1.TGRA_1	Channel 1 PWM period setting	H'FFFF8288	pul_cyc1
P_MTU1.TGRB_1	Used to set timer counter value causing high output from TIOC1A	H'FFFF828A	pul_duty1b
P_MTU2.TGRA_2	Channel 2 PWM period setting	H'FFFF82A8	pul_cyc2
P_MTU2.TGRB_2	Used to set timer counter value causing high output from TIOC2A	H'FFFF82AA	pul_duty2b
P_MTU34.TGRA_3	Channel 3 PWM period setting	H'FFFF8218	pul_cyc3
P_MTU34.TGRB_3	Used to set timer counter value causing high output from TIOC3A	H'FFFF821A	pul_duty3b
P_MTU34.TGRC_3	Used to set timer counter value causing low output from TIOC3C	H'FFFF8224	pul_duty3c
P_MTU34.TGRD_3	Used to set timer counter value causing high output from TIOC3C	H'FFFF8226	pul_duty3d

Register Name	Function Assignment	Address	Set Value
P_MTU1.TIOR_1	Sets TGRA_1 initial output 0, 0 output on output compare, TGRB_1 initial output 0, 1 output on output compare	H'FFFF8282	H'02
P_MTU2.TIOR_2	Sets TGRA_2 initial output 0, 0 output on output compare, TGRB_2 initial output 0, 1 output on output compare	H'FFFF82A2	H'02
P_MTU34.TIORH_3	Sets TGRA_3 initial output 0, 0 output on output compare, TGRB_3 initial output 0, 1 output on output compare	H'FFFF8204	H'02
P_MTU34.TIORL_3	Sets TGRC_3 initial output 0, 0 output on output compare, TGRD_3 initial output 0, 1 output on output compare	H'FFFF8205	H'21
P_MTU1.TMDR_1	Used to set PWM mode 1 as operating mode	H'FFFF8281	H'c2
P_MTU2.TMDR_2		H'FFFF82A1	H'c2
P_MTU34.TMDR_3		H'FFFF8202	H'c2

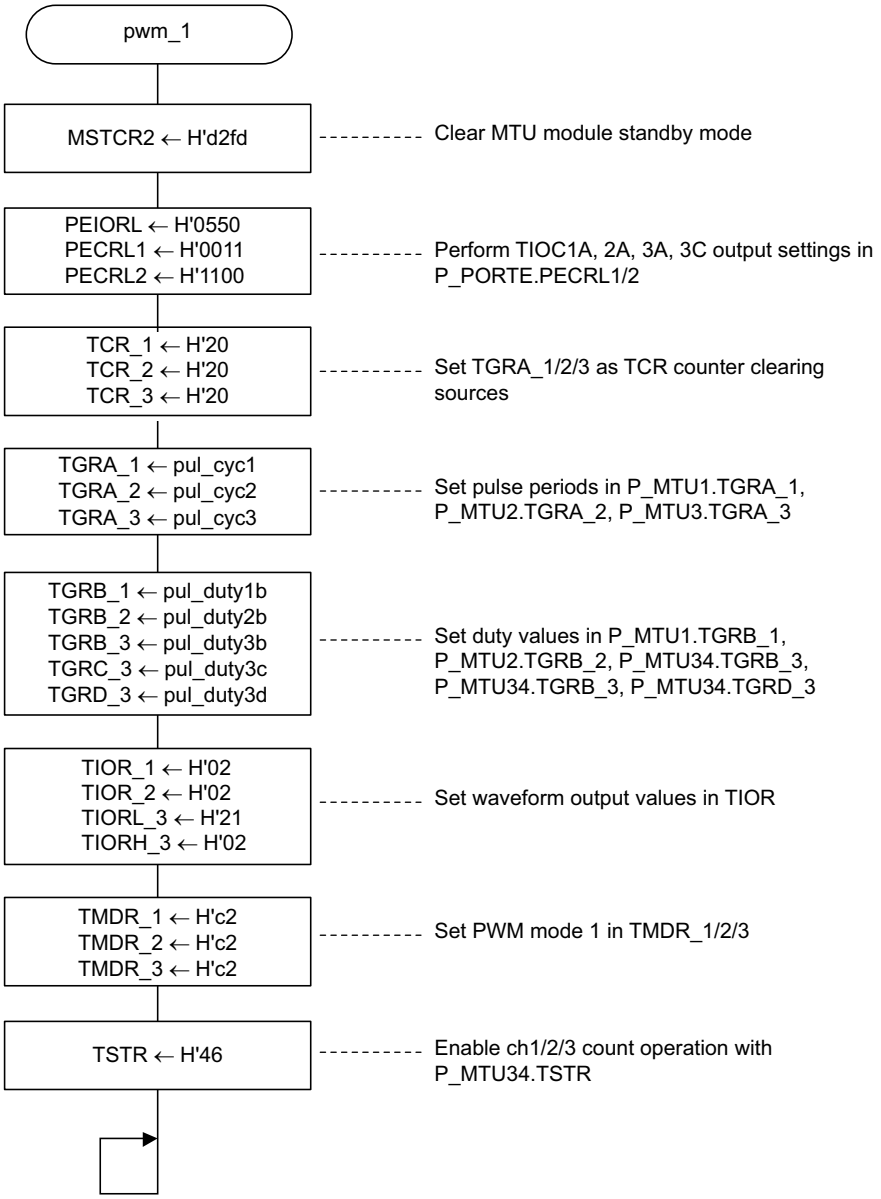
(4) RAM Used

This sample task does not use any RAM apart from the arguments.

Note: SH7046 header file names are used for register label names.

5. Flowcharts

(1) Main routine



6. Program Listing

```
/************************************************************************/
/*                                INCLUDE FILE                          */
/************************************************************************/
#include<machine.h>
#include"iodefine_7046.h"
/************************************************************************/
/*                                 PROTOTYPE                            */
/************************************************************************/
void pwm_1(void);
/************************************************************************/
/*                                RAM ALLOCATION                        */
/************************************************************************/
#define  pul_cyc1     (*(unsigned short  *)0xffffd000)
#define  pul_duty1b   (*(unsigned short  *)0xffffd002)
#define  pul_cyc2     (*(unsigned short  *)0xffffd004)
#define  pul_duty2b   (*(unsigned short  *)0xffffd006)
#define  pul_cyc3     (*(unsigned short  *)0xffffd008)
#define  pul_duty3b   (*(unsigned short  *)0xffffd00a)
#define  pul_duty3c   (*(unsigned short  *)0xffffd00c)
#define  pul_duty3d   (*(unsigend short  *)0xffffd00e)
/************************************************************************/
/*                                MAIN PROGRAM                          */
/************************************************************************/
void pwm_1(void)
 {
    P_STBY.MSTCR2.WORD = 0xd2fd;        /* Clear module standby mode */
    P_PORTE.PEIORL.WORD = 0x0550;            /* TIOC1A/2A/3A/3C = output */
    P_PORTE.PECRL1.WORD = 0x0011;
    P_PORTE.PECRL2.WORD = 0x1100;

    P_MTU1.TCR_1.BYTE = 0x20;         /* Counter clear by TGRA */
    P_MTU1.TGRA_1 = pul_cyc1;         /* set period */
    P_MTU1.TGRB_1 = pul_duty1b;              /* set duty */
    P_MTU1.TIOR_1.BYTE = 0x02;
    P_MTU1.TMDR_1.BYTE = 0xc2;        /* PWM mode1 */
    P_MTU1.TCNT_1 = 0x0000;

    P_MTU2.TCR_2.BYTE = 0x20;
    P_MTU2.TGRA_2 = pul_cyc2;
    P_MTU2.TGRB_2 = pul_duty2b;
    P_MTU2.TIOR_2.BYTE = 0x02;
    P_MTU2.TMDR_2.BYTE =0xc2;
    P_MTU2.TCNT_2 = 0x0000;

    P_MTU34.TCR_3.BYTE = 0x20;
    P_MTU34.TGRA_3 = pul_cyc3;
    P_MTU34.TGRB_3 = pul_duty3b;
    P_MTU34.TGRC_3 = pul_duty3c;
    P_MTU34.TGRD_3 = pul_duty3d;
    P_MTU34.TIORL_3.BYTE = 0x21;
    P_MTU34.TIORH_3.BYTE = 0x02;
    P_MTU34.TMDR_3.BYTE = 0xc2;
```

```
    P_MTU34.TCNT_3 = 0x0000;

    P_MTU34.TSTR.BYTE = 0x46;          /* Timer counter start */
    while(1);
}
```

Keep safety first in your circuit designs!

1. Renesas Technology Corp. 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 Corp. 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 Corp. or a third party.
2. Renesas Technology Corp. 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 Corp. without notice due to product improvements or other reasons. It is therefore recommended that customers contact Renesas Technology Corp. or an authorized Renesas Technology Corp. 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 Corp. 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 Corp. by various means, including the Renesas Technology Corp. 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 Corp. assumes no responsibility for any damage, liability or other loss resulting from the information contained herein.
5. Renesas Technology Corp. 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 Corp. or an authorized Renesas Technology Corp. 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 Corp. 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 Corp. for further details on these materials or the products contained therein.