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.

H8/300H Tiny Series

Brush-Type DC Motor

Introduction

A brush-type DC motor can be controlled using the 14-bit PWM function.

Target Device

H8/300H Tiny Series H8/3687 CPU

Contents

1. Specifications

- The 14-bit PWM function, an H8/3687 on-chip function, is used to control a brush-type DC motor.
- This sample task steps the operation status from a stop, through rotation with 50% output, rotation with 75% output, rotation with 100% output, rotation with 75% output, rotation with 50% output, and then stop, each time the IRQ1 switch is pressed.
- Figure 1 shows the connections needed to enable brush-type DC motor control.

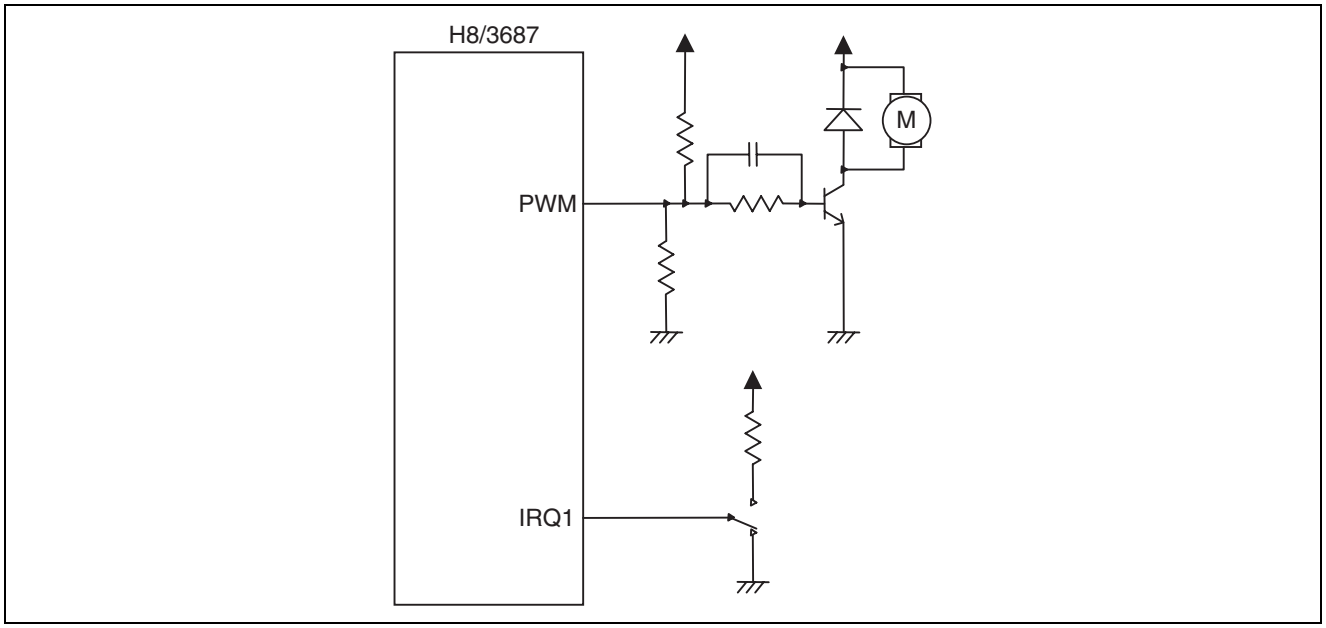


Figure 1 Configuration of This Sample Task

2. Description of Functions

1. In this sample task, a brush-type DC motor designed for models (Mabuchi Motor FA-130) is used. Table 1 lists the specifications of the FA-130.

Table 1 Specifications of the FA-130

Item	Value
Model name	FA-130
Threshold voltage [V]	1.5 to 3.0
Proper voltage [V]	1.5
Proper load [g·cm]	5.4
Rotational speed at no load [rpm]	8500
Rotational speed at proper load [rpm]	5900
Current consumption at proper load [mA]	640

2. The H8/3687 functions used for brush-type DC motor control are explained below. Figure 3 is a block diagram of the functions used in this sample task.

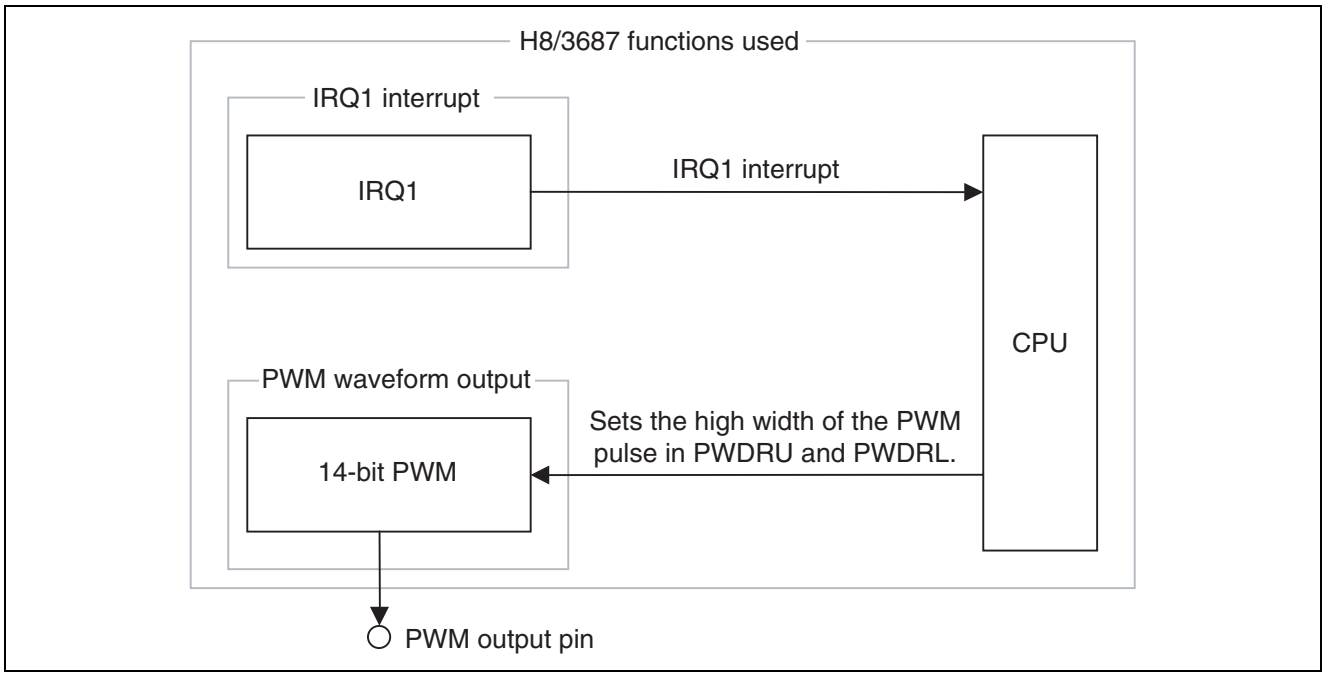


Figure 2 H8/3687 Functions Used

3. Each 14-bit PWM function is explained below. Figure 3 is a block diagram of the 14-bit PWM function. Each item in the block diagram is explained below:
   - — System clock (ϕ)
     This reference clock is used to control the CPU and peripheral functions at a clock rate of 16 MHz.
   - — Prescaler S (PSS)
     This 13-bit counter counts up each cycle using ϕ as input.
   - — PWM data register U and L (PWDRU and PWDRL)
     14-bit write-only register. PWDRU is the upper six bits and PWDRL is the lower eight bits. Both PWDRU and PWDRL are for byte access only. When 16-bit data is written, the contents of PWDRU and PWDRL are fetched into the PWM waveform generation section and data for generating a PWM waveform is updated. Always write PWDRL first, followed by PWDRU.
   - — PWM control register (PWCR)
     8-bit write-only register that selects an input clock
   - — Port mode register 1 (PMR1)
     Specifies a function for each pin of port 1. Sets the P15/$\overline{\text{IRQ1}}$/TMIB1 pins as $\overline{\text{IRQ1}}$ input pins according to bit 5 of PMR1 (P15/$\overline{\text{IRQ1}}$/TMIB1 pin function switch (IRQ1)). Sets the P11/PWM pins as output pins according to bit 2 of PMR1 (P11/PWM pin function switch (PWM)).

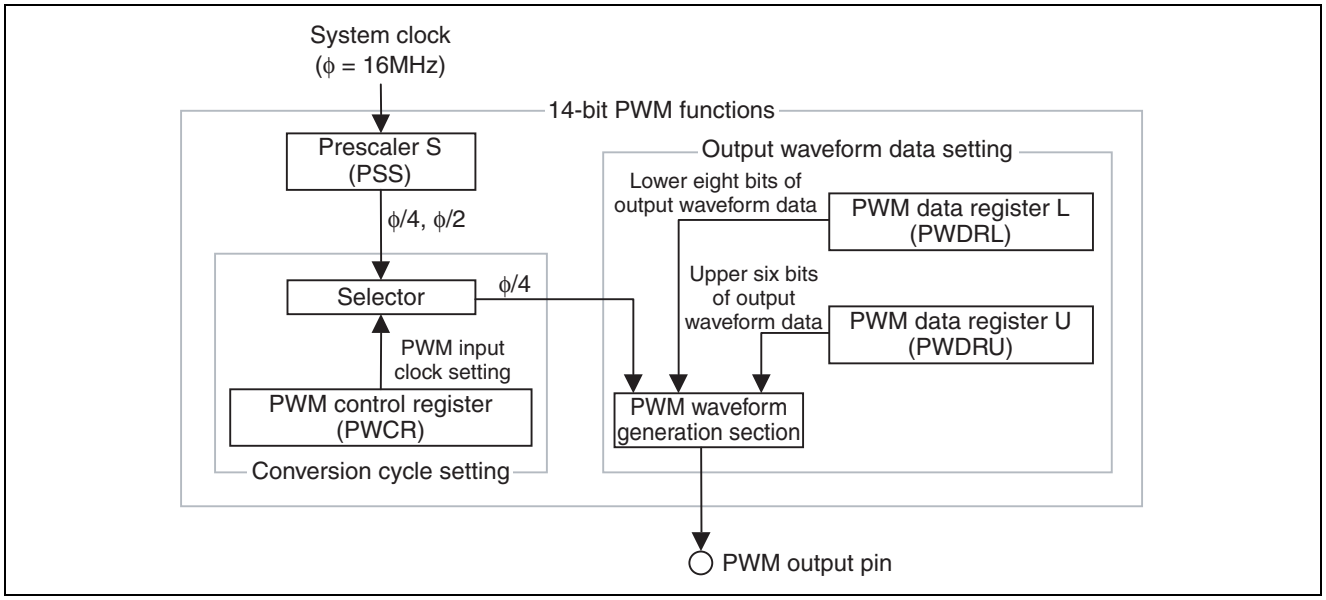


Figure 3 Block Diagram of PWM

4. Table 2 lists the function assignments for this sample task. Assign the functions as listed in Table 2 to control a brush-type DC motor according to the PWM waveform.

Table 2 Function Assignments

Function	Function assignment
PSS	13-bit up counter using the system clock (16 MHz) as input
PWDRU PWDRL	Sets PWM output waveform data.
PWCR1	Selects a clock to be supplied to the 14-bit PWM.
PWM	PWM waveform output pin
IEGR1	Enables an $\overline{\text{IRQ1}}$ pin interrupt request.
IENR1	Selects an input edge for the $\overline{\text{IRQ1}}$ pin.
IRR1	Indicates whether there is an IRQ1 interrupt.
IRQ1	Motor rotation speed switch

3. Description of Operation

1. Examples of brush-type DC motor operations
   Figure 4 shows an example of controlling the speed of a brush-type DC motor using a PWM waveform. These operations are outlined below:
   — When the duty cycle changes, the interval between on and off of the transistor changes and the average current supplied to the motor also changes. When this average current changes, the motor rotation speed also changes.
   — When the duty cycle of the PWM waveform is 50%, the motor rotates with 50% output.
   — When the duty cycle of the PWM waveform is 75%, the motor rotates with 75% output.
   — When the duty cycle of the PWM waveform is 100%, the motor rotates with 100% output (at full speed).

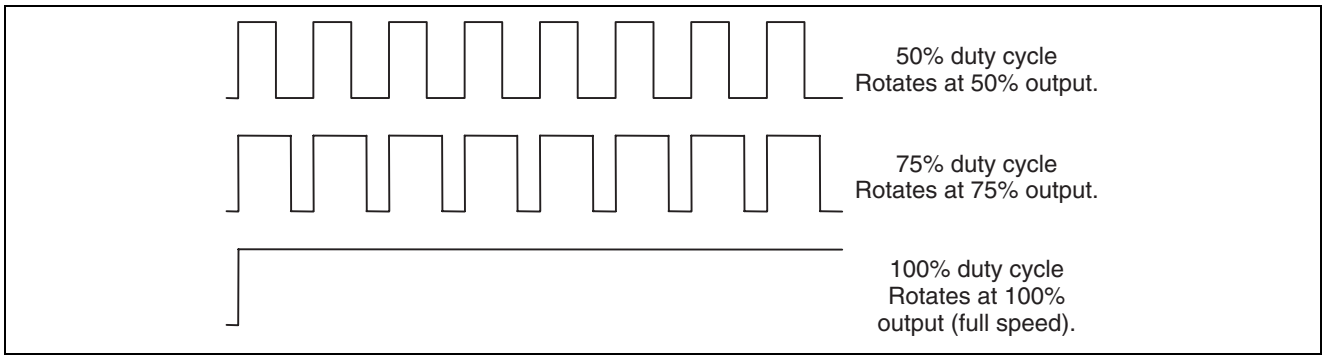


Figure 4 Example of Operating a Brush-Type DC Motor

2. Figure 5 is a flowchart illustrating brush-type DC motor control.

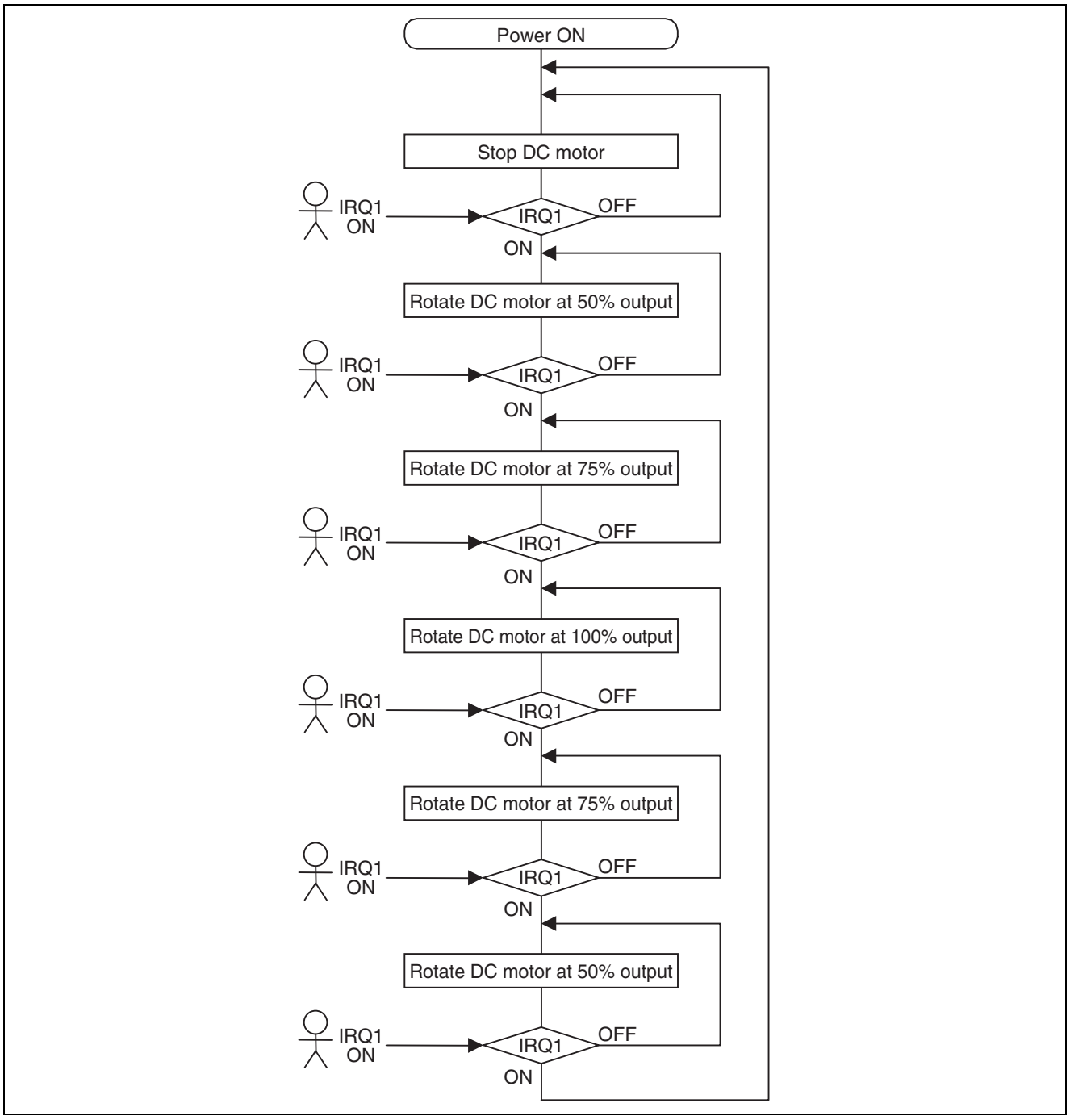


Figure 5 Flowchart of Brush-type DC Motor Control

3. Motor output and PWM waveform

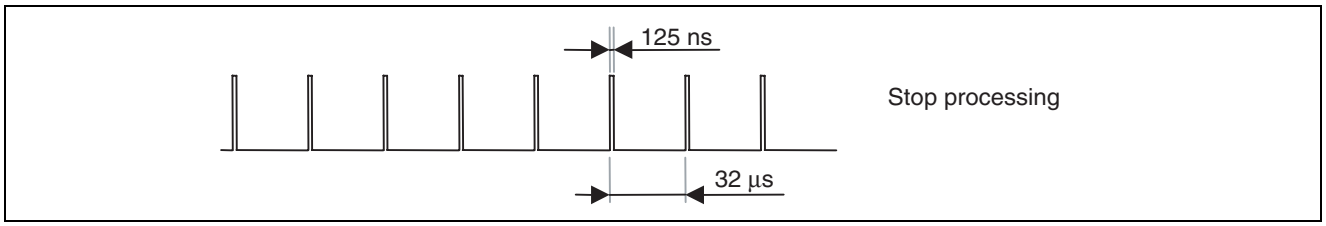


Figure 6 PWM Waveform While the Motor is Stopped

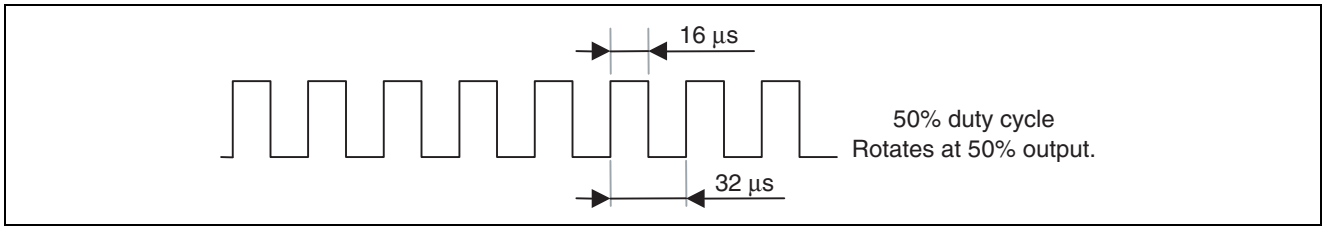


Figure 7 PWM Waveform with 50% Output

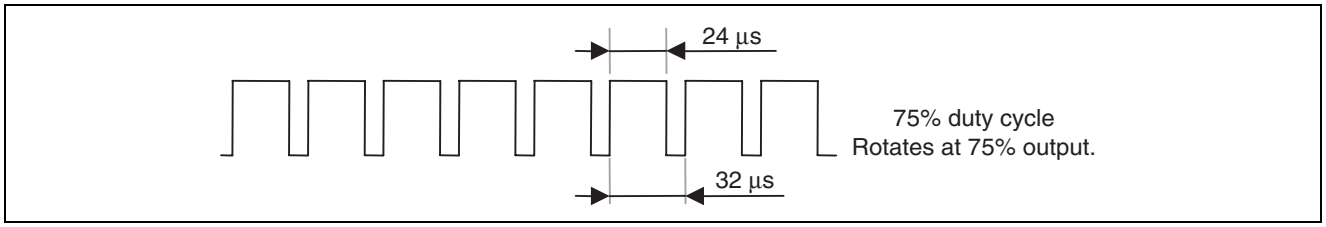


Figure 8 PWM Waveform with 75% Output

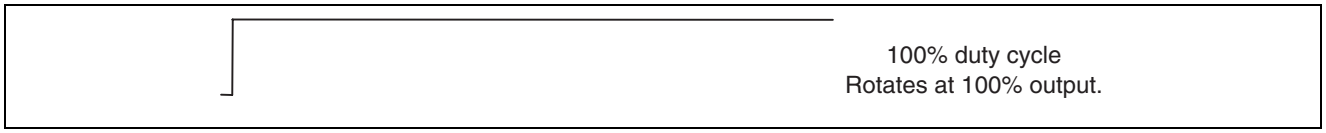


Figure 9 PWM Waveform with 100% Output

4. Description of Software

4.1 Modules

- Table 3 lists the modules used in this sample task.

Table 3 Modules

Module name	Label name	Function
Main routine	Main	Sets global variables and PWM and enables an interrupt.
IRQ1 interrupt processing	irq1int	PWM duty setting routine. Changes the rotation speed according to an IRQ1 interrupt.

4.2 Arguments

- No arguments are used in this sample task.

4.3 Internal registers

- The following internal registers are used in this sample task:

— PWDRL PWM data register L Address: H'FFBC
Function: Sets the lower eight bits of the PWM output waveform data.
Setting: H'00

— PWDRU PWM data register U Address: H'FFBD
Function: Sets the upper six bits of the PWM output waveform data.
Setting: H'00

— PWCR PWM control register Address: H'FFBE

Bit	Bit name	Setting	Function
0	PWCR0	1	Clock select PWCR0 = 0: The input clock is ϕ/2. PWCR1 = 1: The input clock is ϕ/4.

— PMR1 Port mode register 1 Address: H'FFE0

Bit	Bit name	Setting	Function
5	IRQ1	1	P15/$\overline{\text{IRQ1}}$/TMIB1 pin function switch IRQ1 = 0: Sets the P15/$\overline{\text{IRQ1}}$/TMIB1 pins as P15 I/O pins. IRQ1 = 1: Sets the P15/$\overline{\text{IRQ1}}$/TMIB1 pins as $\overline{\text{IRQ1}}$/TMIB1 input pins.
2	PWM	1	P11/PWM pin function switch PWM1 = 0: Sets the P11/PWM pins as P11 I/O pins. PWM1 = 1: Sets the P11/PWM pins as PWM output pins.

— IEGR1 Interrupt edge select register 1 Address: H'FFF2

Bit	Bit name	Setting	Function
1	IEG1	1	IRQ1 edge select IEG1 = 0: Detects the falling edge of the $\overline{\text{IRQ1}}$ pin input. IEG1 = 1: Detects the rising edge of the $\overline{\text{IRQ1}}$ pin input.

— IENR1 Interrupt enable register 1 Address: H'FFF4

Bit	Bit name	Setting	Function
1	IEN1	1	IRQ1 interrupt request enable IEN1 = 0: Disables an $\overline{\text{IRQ1}}$ pin interrupt request. IEN1 = 1: Enables an $\overline{\text{IRQ1}}$ pin interrupt request.

— IRR1 Interrupt flag register 1 Address: H'FFF6

Bit	Bit name	Setting	Function
1	IRRI1	1	IRQ1 interrupt request flag IRR1 = 0: No $\overline{\text{IRQ1}}$ pin interrupt is requested. IRR1 = 1: An $\overline{\text{IRQ1}}$ pin interrupt is requested.

4.4 RAM

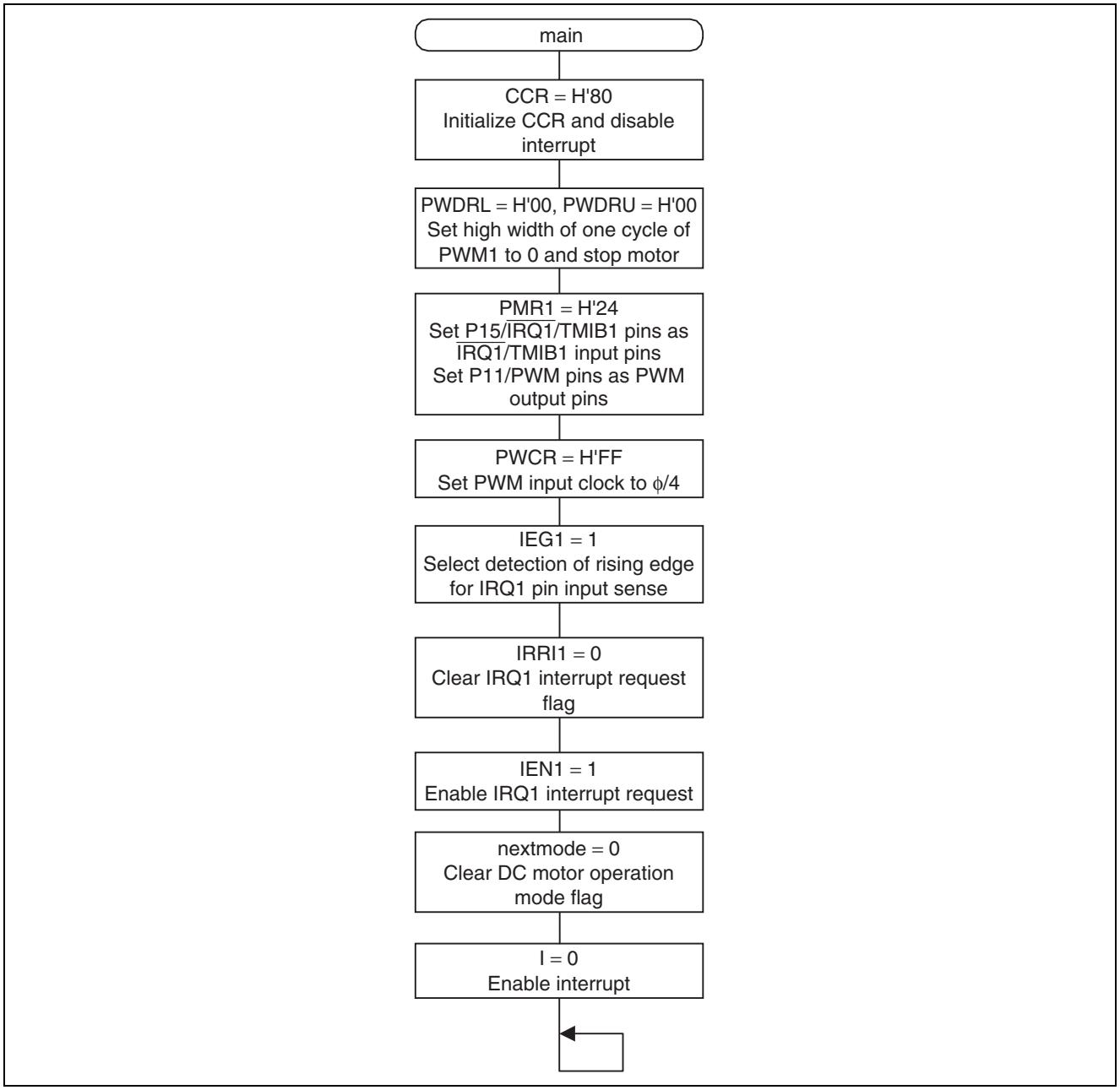
- Table 4 lists the RAM used in this sample task.

Table 4 RAM

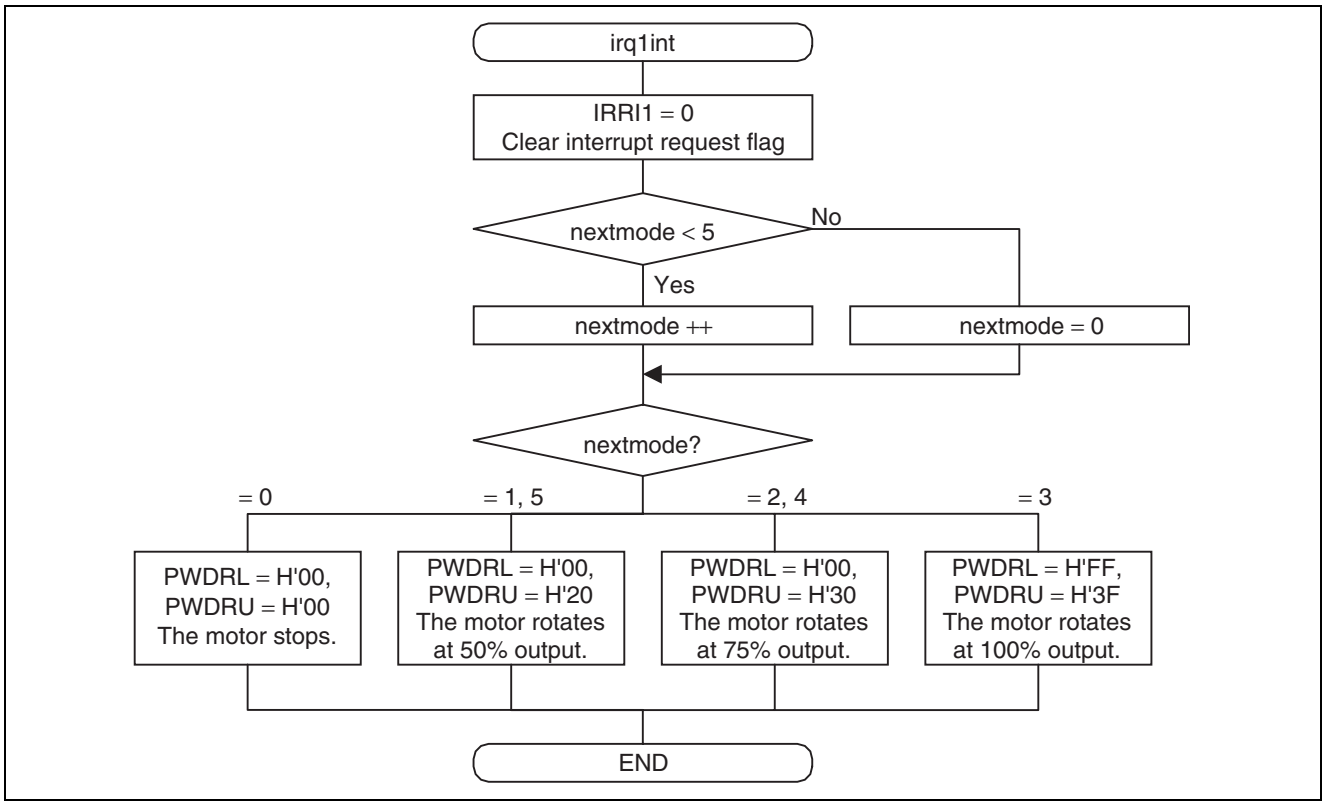
Label name	Function	Memory consumption	Names of modules using this RAM
nextmode	Changes the duty ratio of the PWM and the rotational speed of the motor.	1 byte	Main routine IRQ1 interrupt processing

5. Flowchart

5.1 Main routine



5.2 IRQ1 interrupt



- Link address specifications

Section name	Address
CV1	H'0000
CV2	H'001E
P,C	H'0100
B	H'FB80

6. Program Listing

INIT.SRC (program list)

```
    .export _INIT
    .import _main
;
    .section    P,CODE
_INIT:
    mov.w   #h'ff80,r7
    ldc.b   #b'10000000,ccr
    jmp @_main
;
    .end
```

```
/************************************************************/
/*                                                          */
/*  H8/300L Super Low Power Series                          */
/*      -H8/38024 Series-                                   */
/*  Application Note                                        */
/*                                                          */
/*  'DC Motor Function'                                     */
/*                                                          */
/*  Function                                                */
/*  : 10bit PWM                                             */
/*                                                          */
/*  External Clock : 10MHz                                  */
/*  Internal Clock : 5MHz                                   */
/*  Sub Clock      : 32.768kHz                              */
/*                                                          */
/************************************************************/

#include    <machine.h>

/************************************************************/
/*  Symbol Definition                                       */
/************************************************************/
struct BIT {
    unsigned char  b7:1;        /* bit7 */
    unsigned char  b6:1;        /* bit6 */
    unsigned char  b5:1;        /* bit5 */
    unsigned char  b4:1;        /* bit4 */
    unsigned char  b3:1;        /* bit3 */
    unsigned char  b2:1;        /* bit2 */
    unsigned char  b1:1;        /* bit1 */
    unsigned char  b0:1;        /* bit0 */
};

#define     PWCR1       *(volatile unsigned char *)0xFFD0     /* PWM Control Register             */
#define     PWDRU1      *(volatile unsigned char *)0xFFD1     /* PWM Data Register U              */
#define     PWDRL1      *(volatile unsigned char *)0xFFD2     /* PWM Data Register L              */
#define     PMR9_BIT    *(struct BIT *)0xFFEC)                /* Port Mode Register 9             */
#define     PWM1        PMR9_BIT.b0                           /* P90/PWM1 pin function switches   */
#define     IEGR1_BIT   (*(struct BIT *)0xFFF2)               /* Interrupt Edge Select Register 1 */
```

```
#define     IEG1        IEGR1_BIT.b1                        /* IEG1 Edge Select                 */
#define     IENR1_BIT   (*(struct BIT *)0xFFF3)             /* Interrupt Enable Register 1      */
#define     IEN1        IENR1_BIT.b1                        /* IEN1 Interrupt Enable            */
#define     IRR1_BIT    (*(struct BIT *)0xFFF6)             /* Interrupt Request Register 1     */
#define     IRRI1       IRR1_BIT.b1                         /* IRRI1 Interrupt Request Register */
#define     PMRB_BIT    (*(struct BIT *)0xFFEE)             /* Port mode register B             */
#define     IRQ1        PMRB_BIT.b3                         /* PB3/AN3/IRQ1 pin function switch */

#pragma interrupt  (irq1int)
/************************************************************/
/*  Function define                                         */
/************************************************************/
extern void INIT( void );                                   /* SP Set                           */
void main( void );
void irq1int( void );

/************************************************************/
/*  RAM define                                              */
/************************************************************/
unsigned int   nextmode;                                    /* Motor mode counter               */

/************************************************************/
/*  Vector Address                                          */
/************************************************************/
#pragma section    V1                                       /* VECTOR SECTION SET               */
void (*const VEC_TBL1[])(void) = {                          /* 0x00 - 0x0f                      */
    INIT                                                    /* 00 Reset                         */
};
#pragma section    V2                                       /* VECTOR SECTION SET               */
void (*const VEC_TBL2[])(void) = {
    irq1int                                                 /* 0A IRQ1  Interrupt               */
};

#pragma section                                             /* P                                */
/************************************************************/
/*  Main Program                                            */
/************************************************************/
void main( void )
{
    unsigned char   pwmu_data,pwml_data;
    unsigned char   tmp;

    set_imask_ccr(1);                                       /* Interrupt Disable                */

    PWDRL1 = 0x00;                                          /* Set PWM Output Pulse Data Higher */
    PWDRU1 = 0x00;                                          /* Set PWM Output Pulse Data Lower  */
    PWM1 = 1;                                               /* Pin function Select PWM1         */
    PWCR1 = 0xFC;                                           /* Initialize PWM Input Clock       */

    IEG1 = 1;                                               /* Rising edge of IRQ1              */
    IRRI1 = 0;                                              /* Initialize IRRI1                 */
    IEN1 = 1;                                               /* IRQ1 Interrupt Request Enable    */
    IRQ1 = 1;                                               /* Pin function Select IRQ1         */
```

```
    nextmode = 0;                                   /* Motor mode counter Clear         */
    set_imask_ccr(0);                               /* Interrupt Disable                */

    while(1);
}

/************************************************************/
/*  IRQ1 Interrupt                                          */
/************************************************************/
void irq1int( void )
{
    unsigned char tmp;

    IRRI1 = 0;                                      /* Clear IRRI0                      */

    if(nextmode < 5)                                /* Motor Mode count over 5?         */
        nextmode++;                                 /* Next mode                        */
    else
        nextmode = 0;                               /* Mode Clear                       */

    switch(nextmode){                               /* What Motor Mode?                 */
        case 0:
            PWDRL1 = 0x00;                          /* Set PWDRU1,PWDRL1                */
            PWDRU1 = 0x00;                          /* DC Motor Stop                    */
            break;

        case 1:
        case 5:
            PWDRL1 = 0x00;                          /* Set PWDRU1,PWDRL1                */
            PWDRU1 = 0x03;                          /* DC Motor 75% Power revolution    */
            break;

        case 2:
        case 4:
            PWDRL1 = 0x80;                          /* Set PWDRU1,PWDRL1                */
            PWDRU1 = 0x03;                          /* DC Motor 87.5% Power revolution  */
            break;

        case 3:
            PWDRL1 = 0xFF;                          /* Set PWDRU1,PWDRL1                */
            PWDRU1 = 0x03;                          /* DC Motor Full Power revolution   */
            break;
    }
}
```

Revision Record

		Description	
Rev.	Date	Page	Summary
1.00	Dec.20.03	—	First edition issued

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.