

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.

H8SX Family

Outputting Two Groups of 4-Bit Signals

Introduction

Asynchronous pulses are output as two groups of 4-bit signals by using the programmable pulse generator (PPG) outputs.

Target Device

H8SX/1653F

Contents

1. Specifications	2
2. Conditions for Application	3
3. Description of Modules Used	4
4. Description of Operation	5
5. Description of Software	7
6. Flowchart.....	9

1. Specifications

- Asynchronous pulses are output as two groups of 4-bit signals by using the programmable pulse generator (PPG) outputs as shown in figure 1.
- The PPG is activated by compare match of the timer pulse unit (TPU).

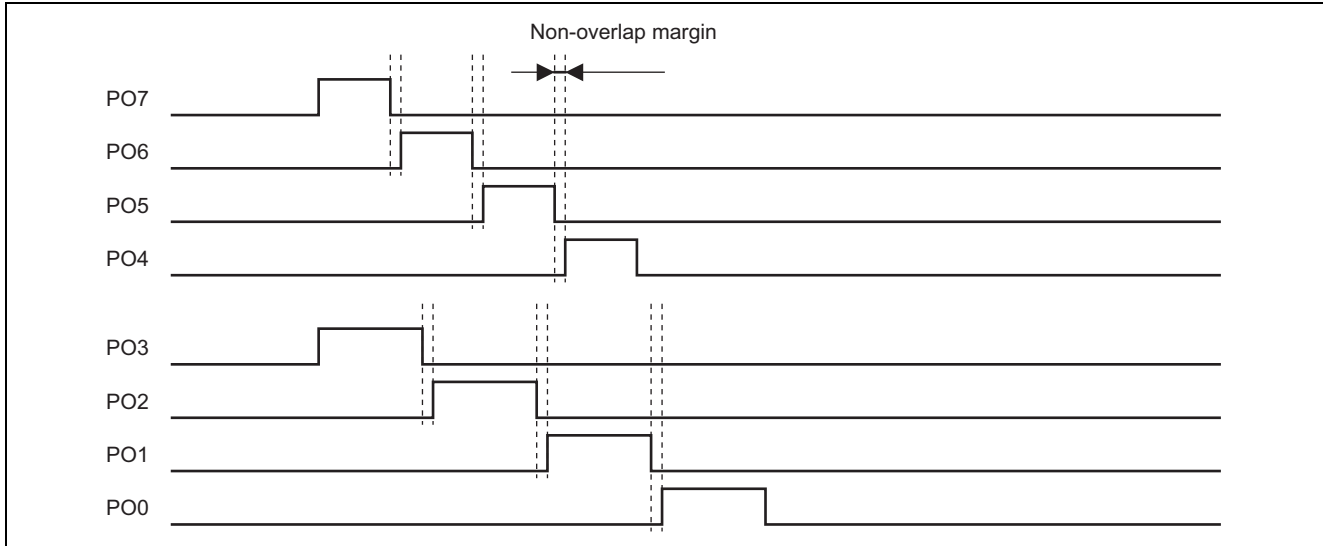


Figure 1 Example Output of Two Groups of 4-Bit Signals

2. Conditions for Application

Table 1 Conditions for Application

Item	Contents
Operating frequency	Input clock: 16 MHz System clock (I ϕ): 16 MHz Peripheral module clock (P ϕ): 16 MHz External bus clock (B ϕ): 16 MHz
Operating mode	Mode 6 (MD2 = 1, MD1 = 1, MD0 = 0) MD_CLK = 0
Development tool	High-performance Embedded Workshop Version 4.00.02
C/C++ compiler	H8S, H8/300 Series C/C++ Compiler Version 6.01.00 (from Renesas Technology Corp.)
Compile option	-cpu = h8sxa:24:md, -code = machinecode, -optimize = 1, -regparam = 3, -speed = (register, shift, struct, expression)

Table 2 Section Settings

Address	Section Name	Description
H'001000	P	Program area
	C	Data table storage
H'FF2000	B	Non-initialized data area (RAM area)

3. Description of Modules Used

In this sample task, asynchronous pulses are output as two groups of 4-bit signals using channels 0 and 1 of the TPU and PPG output groups 0 and 1.

Figure 2 shows a block diagram of the pulse output generation using TPU channels 0, 1 and PPG groups 0, 1. This sample task uses the following features of the TPU and PPG.

- An output trigger signal can be selected for each 4-bit group and up to two 4-bit groups can be output.
- An output trigger signal can be selected for each group from among the compare-match signals on the four channels of the TPU.
- A non-overlapping margin can be set between the multiple pulse outputs.

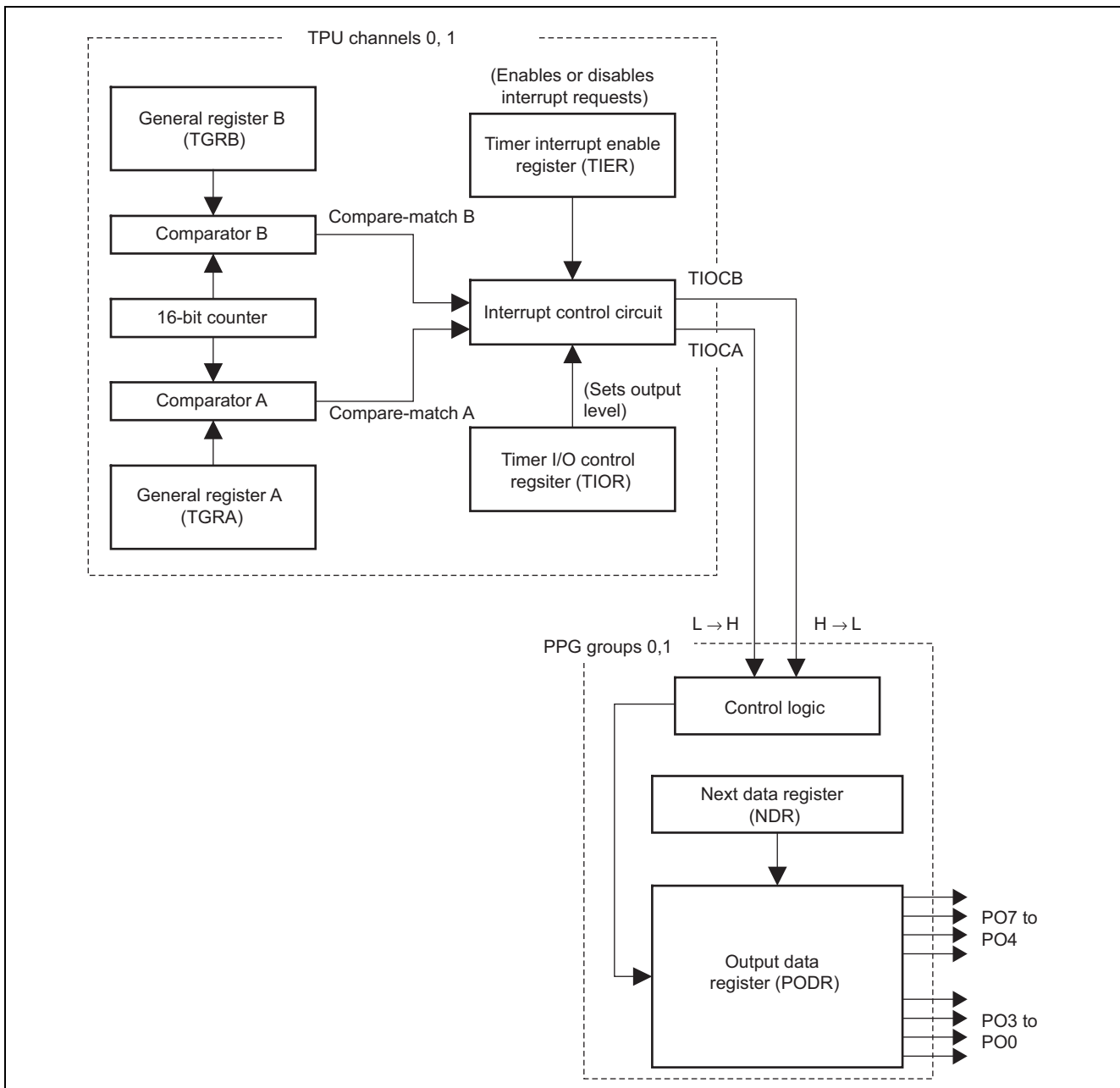


Figure 2 Block Diagram of the Output of Two 4-Bit Signals (Groups 0 and 1)

4. Description of Operation

Figure 3 illustrates the principles of the data output operation using PPG output group 0 as an example. The hardware processing and software processing of figure 3 are explained in table 3.

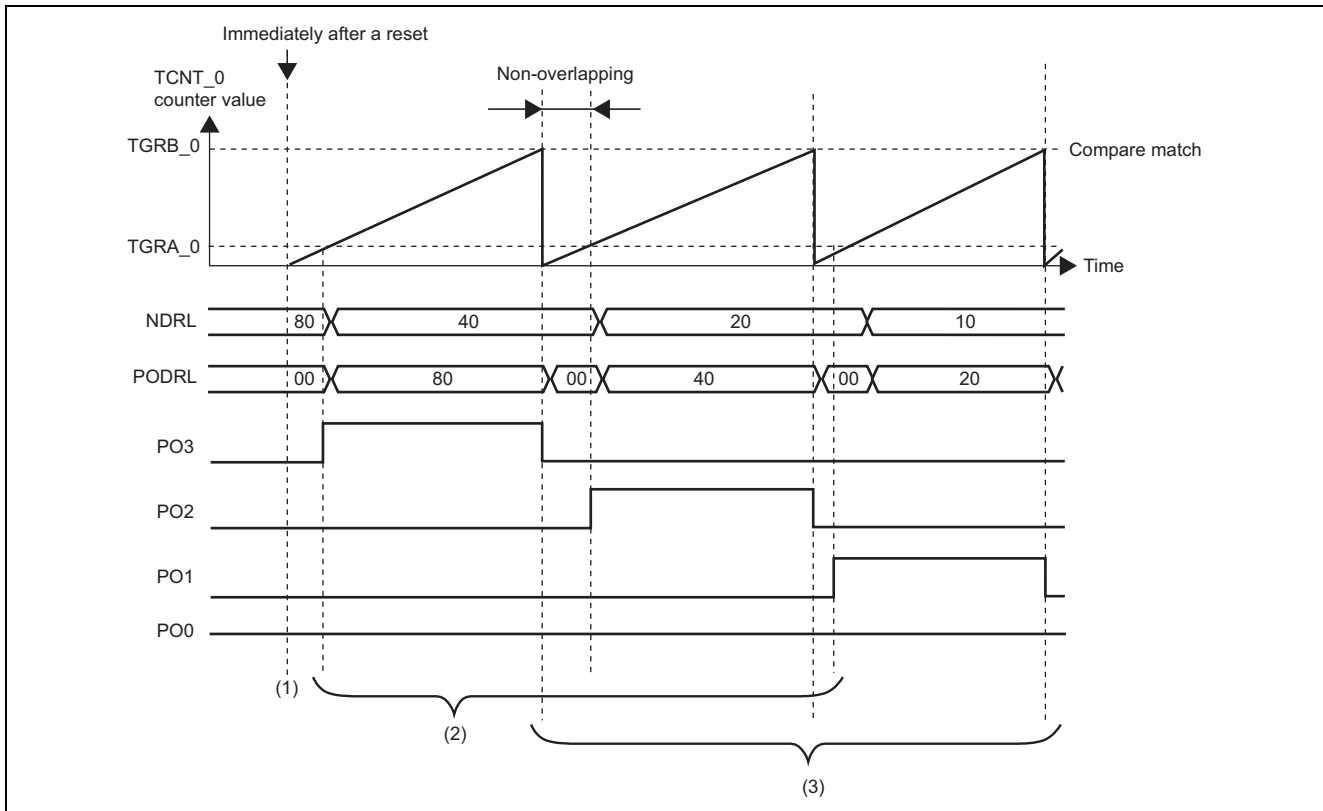


Figure 3 Operation Principles of Outputting Two Groups of 4-Bit Signals (Group 0)

Table 3 Hardware and Software Processing

Hardware Processing	Software Processing
(1) No processing	Initial settings Processing for the TPU: (a) Set the non-overlapping margin in TGRA_0 and the PPG output trigger cycle in TGRB_0. (b) Set up the TGIA interrupt. (c) Start counting by TPU0 and TPU1. Processing for the PPG: (a) Set the initial output value in PODRL, and set up the PPG output. (b) Enable the PPG group 0 output, and select the trigger for transfer. (c) Select non-overlap operation for group 0. (d) Set the next pulse output value in NDRL.
(2) (a) Generate the TGRA_0 compare-match signal. (b) Transfer the value in NDRL to PODRL. (c) Output 4-bit data from the group 0 output pins of the PPG.	TGI0A interrupt processing (a) Set the next output data in the upper 4 bits of NDRL.
(3) (a) Generate the TGRB_0 compare-match signal. (b) Generate non-overlapping PPG outputs.	No processing

5. Description of Software

5.1 List of Functions

Table 4 List of Functions

Function Name	Functions
init	Initialization routine Cancels module stop mode, sets the clock, and calls the main function.
main	Main routine Initializes the PPG and TPU.
tgi0a_int	Sets the data to be output next in the lower 4 bits of NDRL (group 0).
tgi1a_int	Sets the data to be output next in the upper 4 bits of NDRL (group 1).

5.2 Arguments

This sample task does not use arguments.

5.3 Vector Table

Table 5 Exception Handling Vector Table

Exception Handling Source	Vector Number	Vector Table Address	Exception Handling Routine
Reset	0	H'000000	init
TPU_0 TGI0A	88	H'000160	tgi0a_int
TPU_1 TGI1A	93	H'000174	tgi1a_int

5.4 RAM Usage

Table 6 RAM Usage

Type	Variable Name	Description	Used In
unsigned char	cnt0	Transfer counter for PPG group 0 output	main, tgi0a_int
unsigned char	cnt1	Transfer counter for PPG group 1 output	main, tgi1a_int

5.5 Data Table

Table 7 Description of Data Table

Type	Array Name	Description	Used In
unsigned char	ndat_tab0[5]	Stores the data to be output as PPG group 0. {0xF8, 0xF4, 0xF2, 0xF1, 0xF0}	main, tgi0a_int
unsigned char	ndat_tab1[5]	Stores the data to be output as PPG group 1. {0x8F, 0x4F, 0x2F, 0x1F, 0x0F}	main, tgi1a_int

5.6 Internal Registers

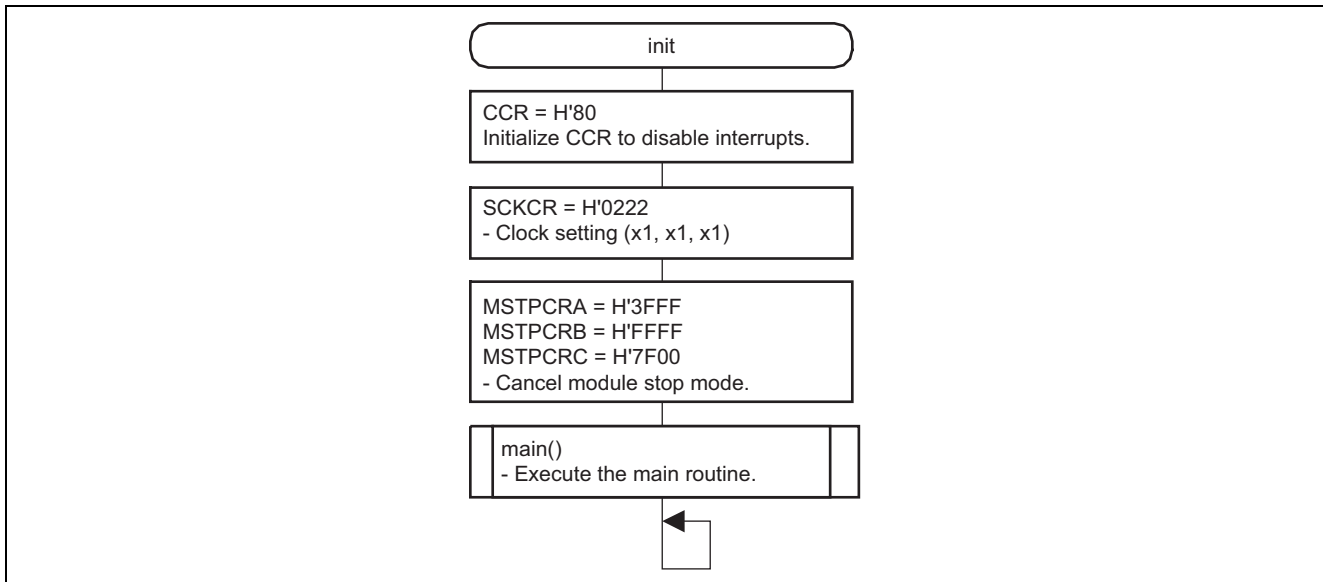
The internal registers used in this sample task are described in table 8.

Table 8 Description of Internal Registers

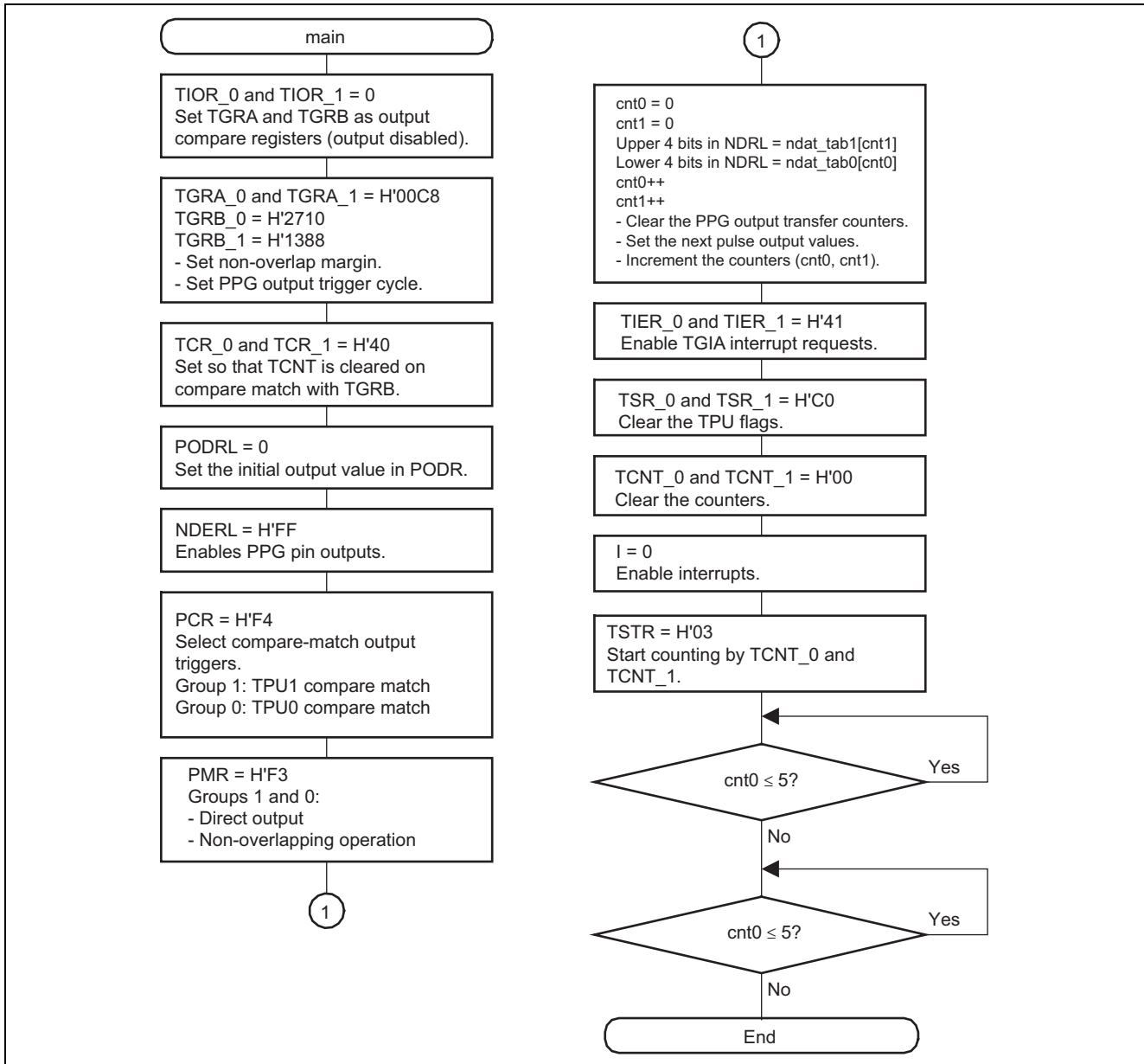
Register Name	Function	
PPG	PMR	Specifies PO7 to PO4 and PO3 to PO0 for non-overlapping outputs.
	PCR	Selects a pulse output trigger signal for each group. Group 1: Compare match on TPU channel 1 Group 0: Compare match on TPU channel 0
	NDERL	Enables PPG outputs on PO7 to PO4 and PO3 to PO0.
	PODRL	The value in NDRL is transferred here and output from PO7 to PO4 and PO3 to PO0.
	NDRL	Sets the next pattern to be output on PO7 to PO4 and PO3 to PO0.
	TPU	TGRA_0, TGRA_1
TGRB_0, TGRB_1		These registers set PPG output trigger cycles.
TCR_0, TCR_1		These registers are set such that the corresponding counters are cleared upon compare match with TGRB, and counting is driven by internal clock P ϕ .
TSR_0, TSR_1		These registers indicate the occurrence of compare match.
TIER_0, TIER_1		These registers enable TGIA interrupts.
TSTR		Enables counting by TCNT.
MSTPCRA, MSTPCRB, MSTPCRC	These registers cancel module stop mode of the TPU and PPG.	
SCKCR	Sets the frequency multipliers for I ϕ , P ϕ , and B ϕ .	

6. Flowchart

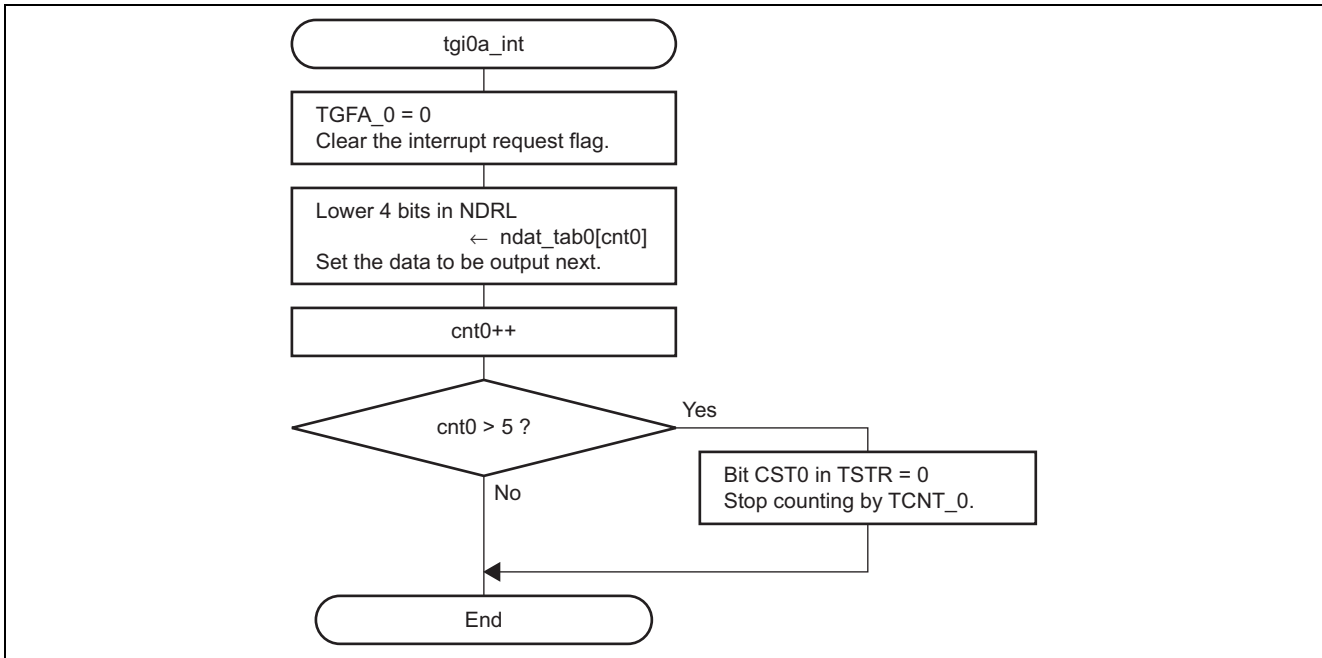
6.1 init Function



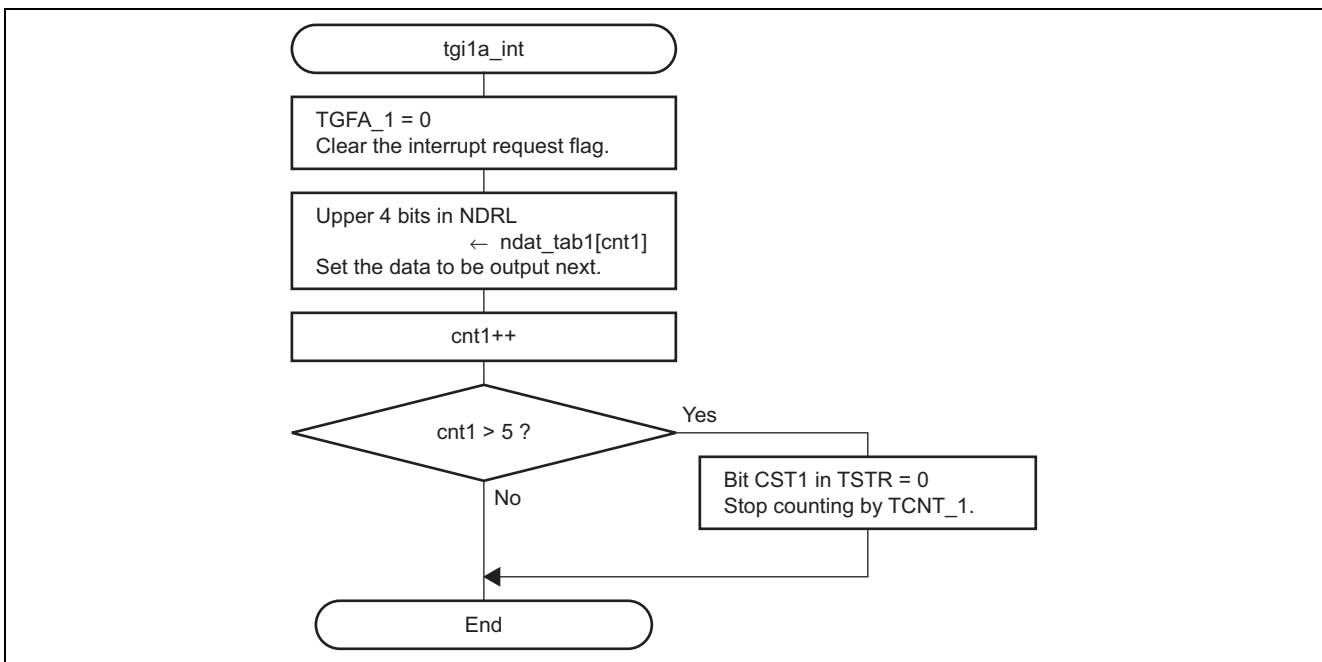
6.2 main Function



6.3 tgi0a_int Function



6.4 tgi1a_int Function



Revision Record

Rev.	Date	Description	
		Page	Summary
1.00	Mar.10.06	—	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.