RX210 Group

Setting A/D Conversion Using Group Scan Function in Double Trigger Mode

R01AN1205EJ0100
Rev.1.00
Jul 02, 2012

Abstract

This application note describes performing A/D conversion using the RX210's double trigger mode.

Products

RX210 Group

When using the code presented in this application note with a different microcontroller, modify the code according to the specifications of that microcontroller and test the code thoroughly.

Contents

1. Specifications

This sample program accepts A/D conversion request from multifunction timer unit 2a (MTU2a) and performs the A/D conversion. It uses the group scan function of the 12-bit A/D converter (S12AD) and acquires A/D conversion values for group A and group B with different timings.

Table 1.1 lists the peripheral functions used and their applications and figure 1.1 presents an overview of this operation.

Table 1.1 Peripheral Functions Used and Their Applications

Peripheral function	Application
S12AD	A/D conversion
MTU2a	Generates A/D conversion requests and a complementary PWM output.

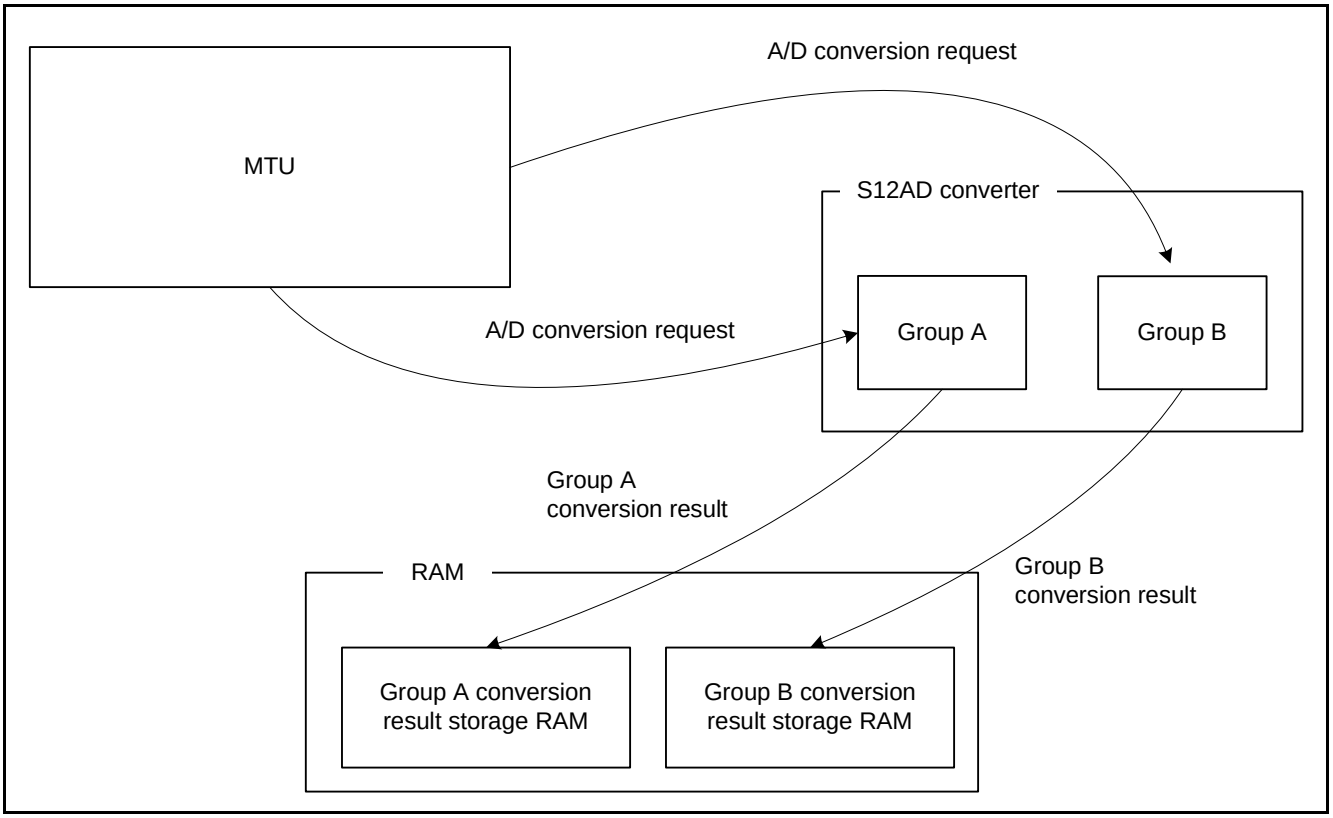

Figure 1.1 Operational Overview

2. Confirmed Operating Condition

Operation of the sample code in this application note has been verified under the following conditions.

Table 2.1 Confirmed Operating Condition

Item	Description
Microcontroller used	R5F52108ADFP (RX210 Group)
Operating frequency	Main clock: 20.0 MHz Sub-clock: 32.768 kHz PLL: Main clock divided by 2 and multiplied by 10 System clock (ICLK): 50 MHz (PLL divided by 2) Peripheral module clock B (PCLKB): 25 MHz (PLL divided by 4)
Operating voltage	5.0 V is supplied from E1.
Integrated development environment	Renesas Electronics Corporation High-performance Embedded Workshop Version 4.09.00.007
C compiler	RX Family C/C++ Compiler V.1.02
	-cpu=rx200 -output=obj="$(CONFIGDIR)\$(FILELEAF).obj" -debug –nologo (The integrated development environment default settings are used.)
iodefine.h version	Version 1.0B
Endian order	Little endian
Operating mode	Single-chip mode
Processor mode	Supervisor mode
Sample code version	Version 1.00
Board used	Renesas Starter Kit for RX210 (Product number: R0K505210C000BE)

3. Related Application Note

The following application note contains information related to this application note and should be read in conjunction with this application note.

RX210 Group Initial Setting Rev.1.00 (R01AN1002EJ0100_RX210)

The initialization functions from the above application note are used by the sample code in this application note. The revision number shown is the one used when this application note was written.

If there is a more recent version, use the latest version. Check the Renesas Electronics Corporation web site to verify and download the latest version.

4. Hardware

4.1 Pins Used

Table 4.1 lists the pins used and their functions.

Table 4.1 Pin Functions

Pin	I/O	Function
P14/MTIOC3A	Output	Toggle output synchronized with the PWM period
PB7/MTIOC3B	Output	PWM output 1
PB6/MTIOC3D	Output	PWM output 1' (a negative phase waveform that is in a non-overlapping relationship with PWM output 1)
PE2/MTIOC4A	Output	PWM output 2
PE1/MTIOC4C	Output	PWM output 2' (a negative phase waveform that is in a non-overlapping relationship with PWM output 2)
PE3/MTIOC4B	Output	PWM output 3
PE4/MTIOC4D	Output	PWM output 3' (a negative phase waveform that is in a non-overlapping relationship with PWM output 3)
P40/AN000	Input	A/D conversion
P41/AN001	Input	A/D conversion

5. Software

5.1 Operational Overview

The sample code performs A/D conversions using the MTU2a and S12AD together.

The MTU2a outputs a complementary PWM waveform with a 5 kHz carrier frequency and a 4 µs dead time.

The S12AD performs A/D conversions with different timings for group A and group B using the group scan function. (The sample code allocates AN000 to group A and AN001 to group B.)

Double trigger mode is used for group A and A/D conversion is started on the compare match timing of MTU4.TCNT with MTU4.TADCORA or MTU4.TADCORB.

For group B, A/D conversion is started with the timing of the underflow of MTU4.TCNT.

The results of these conversions are stored in RAM by the TGRA3 and MTU3.TCNT compare match interrupt.

Figure 5.1 shows the timing for MTU2a operation and A/D conversion.

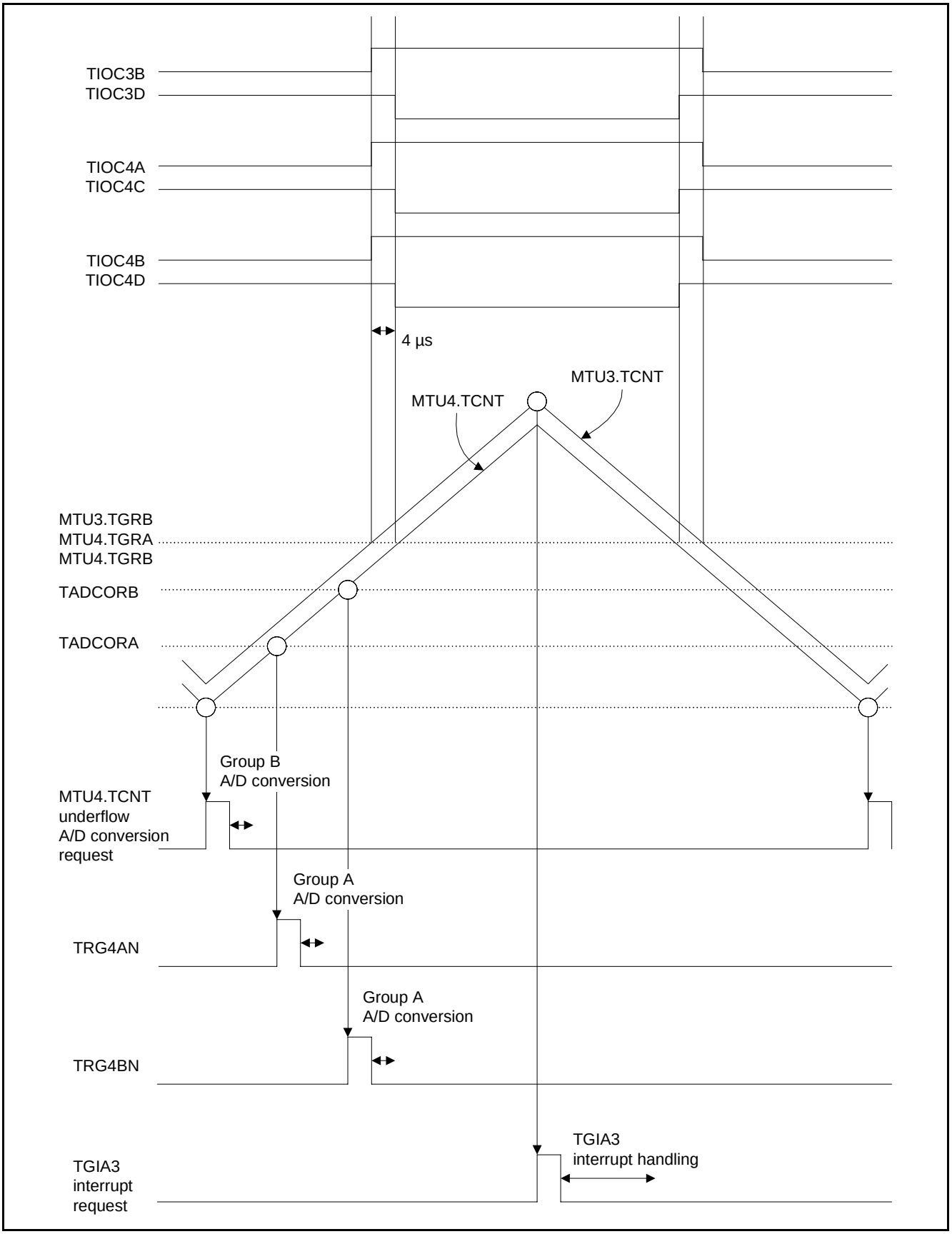

Figure 5.1 MTU2a Operation and A/D Conversion Timing

5.2 File Composition

Table 5.1 lists the files used for the sample code. Note that the files generated automatically by the integrated development environment are not shown.

Table 5.1 File Composition

File	Overview	Remarks
main.c	Main processing	
non_existent_port_init.c	Nonexistent port initialization	
non_existent_port_init.h	External reference include header for nonexistent port initialization	
clock_init.c	Clock initialization	
clock_init.h	External reference include header for clock initialization	
intprg.c	Interrupt handling	

5.3 Option Settings Memory

Table 5.2 lists the states of the option settings memory used by the sample code. Set these locations to appropriate values for your user system as required.

Table 5.2 Option Settings Memory Set by the Sample Code

Symbol	Address	Set Value	Description
OFS0	FFFF FF8Fh – FFFF FF8Ch	FFFF FFFFh	Stops IWDT after a reset Stops WDT after a reset
OFS1	FFFF FF8Bh – FFFF FF88h	FFFF FFFFh	Disables voltage monitoring resets after a reset Disables HOCOC operation after a reset
MDES	FFFF FF83h – FFFF FF80h	FFFF FFFFh	Little endian (in single-chip mode)

5.4 Constants

Table 5.3 lists the constants used in the sample code.

Table 5.3 Constants Used in the Sample Code

Constant	Set Value	Description
DEAD_TIME	25	Dead time (4 µs)
CYCLE	1250	Time for 1 carrier (200 µs)
C_CYCLE	CYCLE/2(625)	Time for 1/2 carrier (100 µs)
PUL_CYCLE	C_CYCLE+DEAD_TIME(650)	Time for 1/2 carrier + dead time

5.5 Variables

Table 5.4 lists the global variables.

Table 5.4 Global Variables

Type	Name	Description	Function
unsigned short	buf_an000a	Stores the result of group A A/D conversion performed with the timing of the MTU4.TCNT and TADCORA compare match	TGIA3_INT
unsigned short	buf_an000b	Stores the result of group A A/D conversion performed with the timing of the MTU4.TCNT and TADCORB compare match	TGIA3_INT
unsigned short	buf_an001	Stores the result of group B A/D conversion performed with the timing of the MTU4.TCNT underflow.	TGIA3_INT

5.6 Functions

Table 5.5 lists the functions.

Table 5.5 Functions

Function	Description
main	Main processing
port_init	Port initialization
non_existent_port_init	Nonexistent port initialization
clock_init	Clock initialization
peripheral_init	Peripheral function initialization
ad_init	S12AD initialization
mtu_init	MTU2 initialization
TGIA3_INT	TGIA3 interrupt handler

5.7 Function Specifications

This section lists the specifications of the functions in the sample code.

main	
Main processing	Main processing
Header	None
Declaration	void main(void)
Description	Initializes the ports, clocks, and peripheral functions used.
Arguments	None
Return values	None

port_init	
Overview	Port initialization
Header	None
Declaration	void port_init(void)
Description	Initializes the ports.
Arguments	None
Return values	None

non_existent_port_init	
Overview	Nonexistent port initialization
Header	non_existent_port_init.h
Declaration	void non_existent_port_init(void)
Description	Initializes the nonexistent ports.
Arguments	None
Return values	None
Remarks	This function is described in detail in the RX210 Group Initial Setting (Revision 1.00) application note. Refer to that application note for details. There are cases where ports that do not exist must be initialized due to the number of pins in the particular microcontroller product used. This processing is not required for products that include the RSK used by this system.

clock_init	
Overview	Clock initialization
Header	clock_init.h
Declaration	void clock_init(void)
Description	Initializes the clocks.
Arguments	None
Return values	None
Remarks	This function is described in detail in the Sample Code 2 section in the RX210 Group Initial Setting (Revision 1.00) application note. Refer to that application note for details.

peripheral_init	
Overview	Peripheral function initialization
Header	None
Declaration	void peripheral_init(void)
Description	Initializes the used peripheral functions.
Arguments	None
Return values	None

ad_init	
Overview	S12AD initialization
Header	None
Declaration	void ad_init(void)
Description	Initializes the S12AD. • Group scan mode • Double trigger mode
Arguments	None
Return values	None

mtu_init	
Overview	MTU2 initialization
Header	None
Declaration	void mtu_init(void)
Description	Initializes the MTU2. • Complementary PWM mode
Arguments	None
Return values	None

TGIA3_INT	
Overview	TGIA3 interrupt handler
Header	None
Declaration	void TGIA3_INT(void)
Description	Acquires the A/D conversion result.
Arguments	None
Return values	None

5.8 Flowcharts

5.8.1 Main Processing

Figure 5.2 shows the flowchart for the main processing.

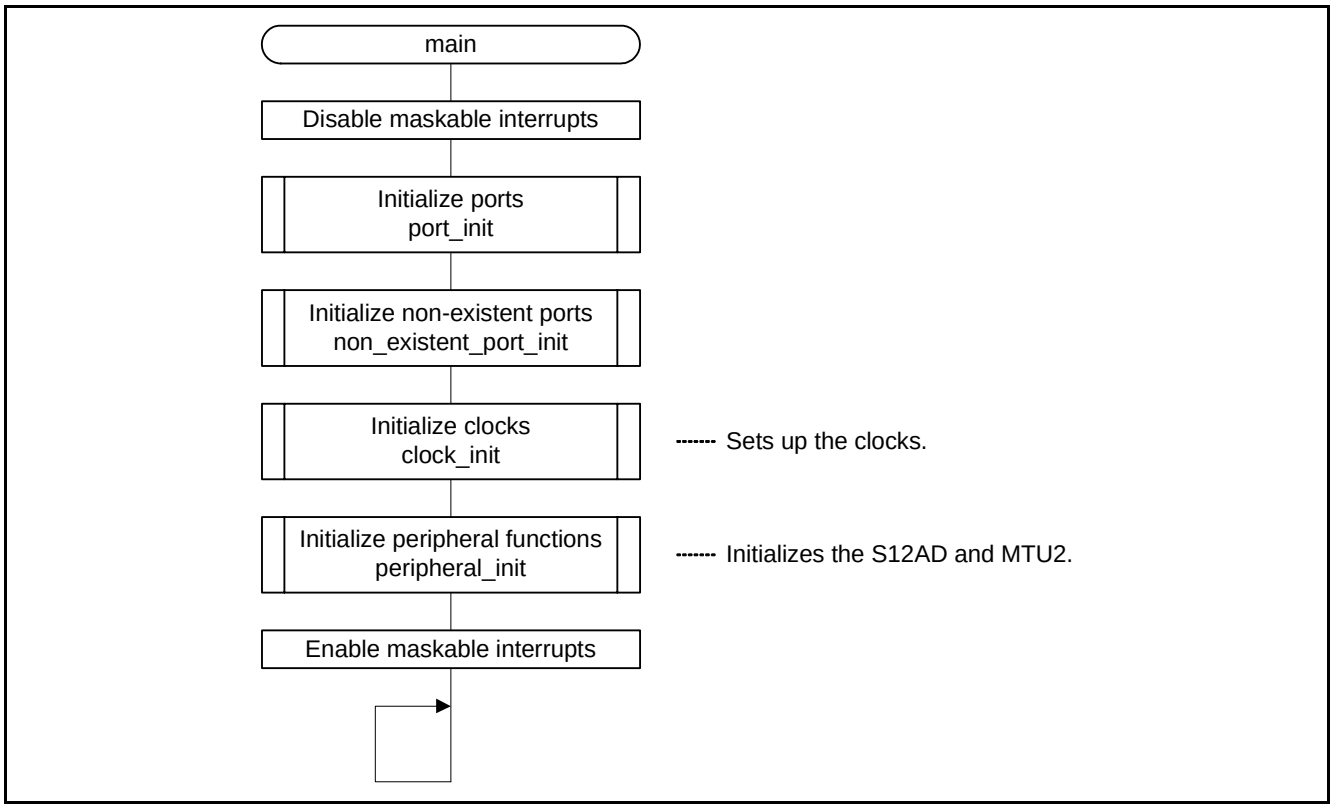

Figure 5.2 Main Processing

5.8.2 Port Initialization

Figure 5.3 shows the flowchart for port initialization.

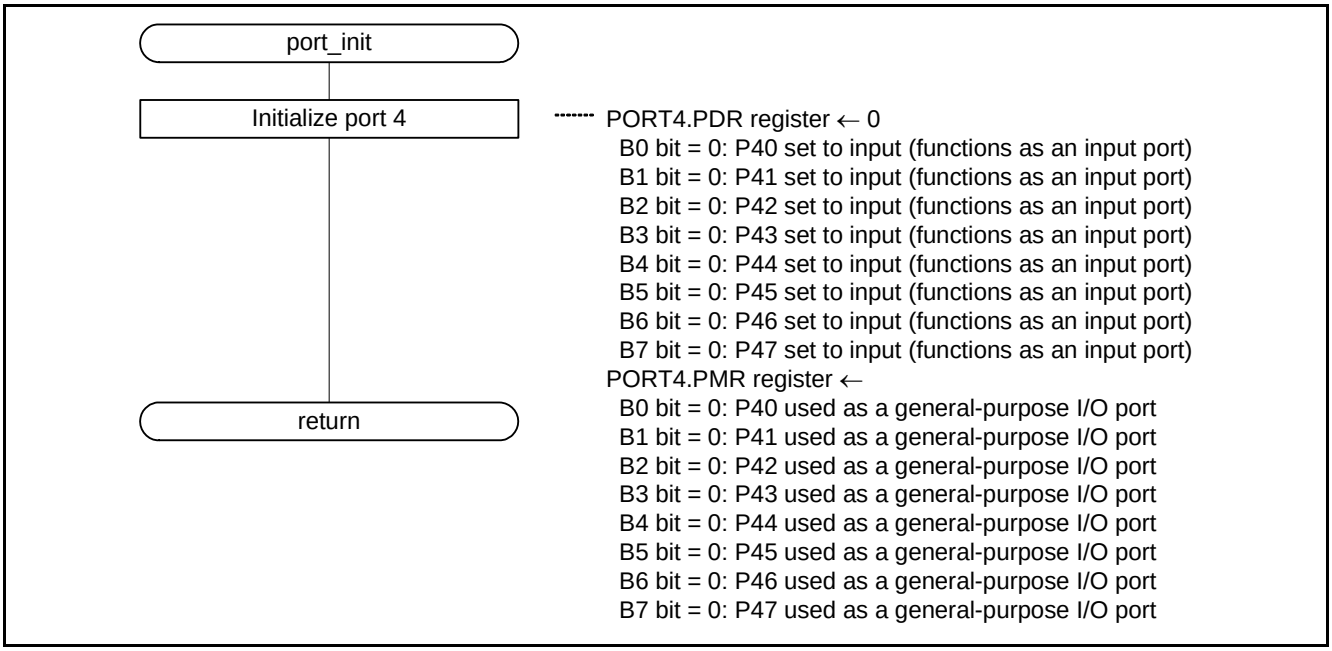

Figure 5.3 Port Initialization

5.8.3 Peripheral Function Initialization

Figure 5.4 shows the flowchart for peripheral function initialization.

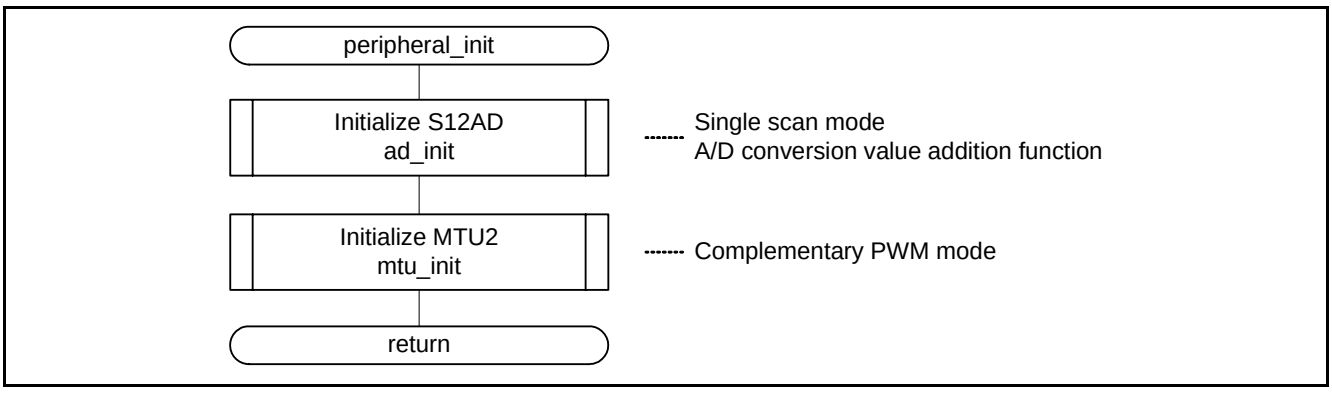

Figure 5.4 Peripheral Function Initialization

5.8.4 S12AD Initialization

Figure 5.5 shows the flowchart for S12AD initialization.

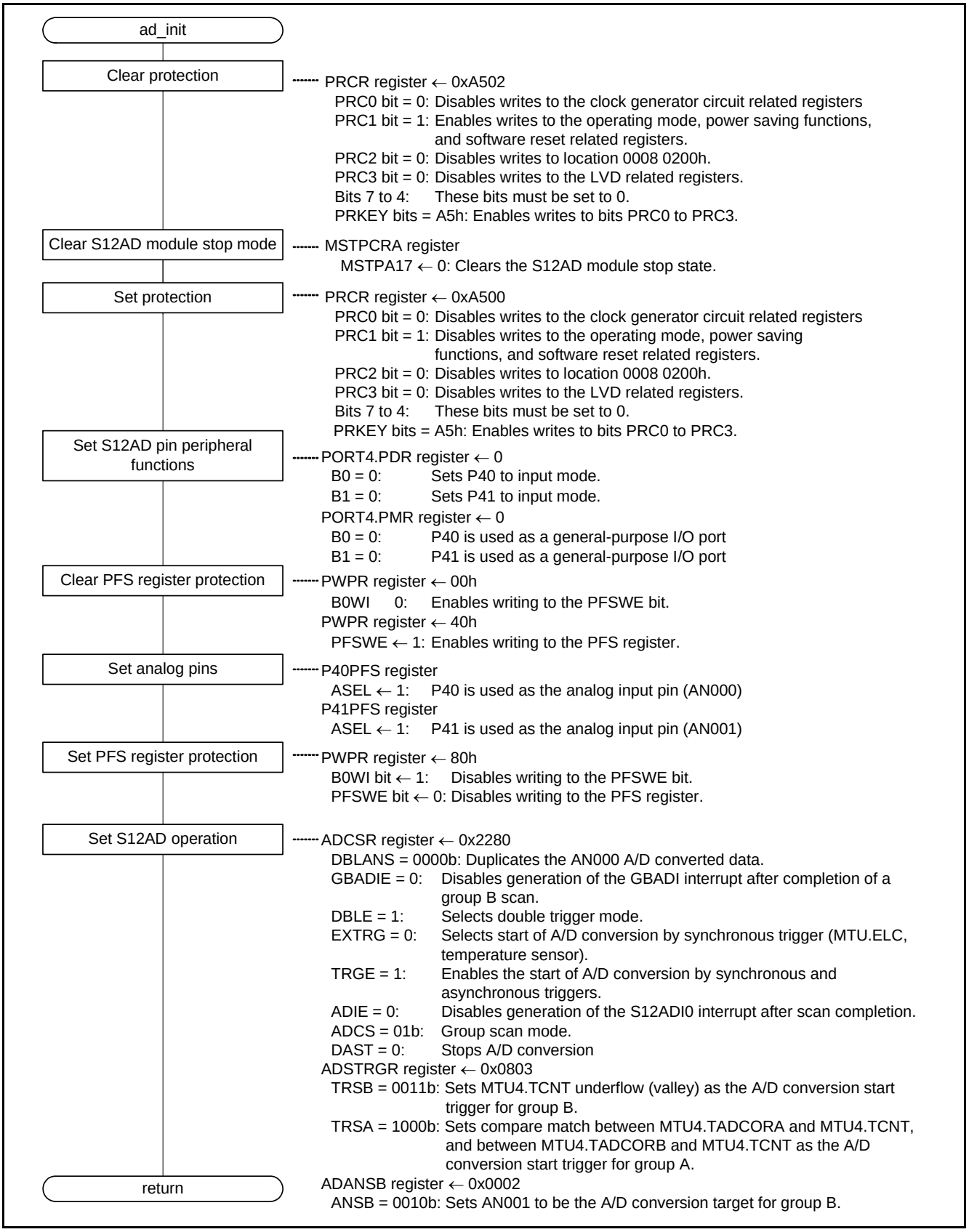

Figure 5.5 S12AD Initialization

5.8.5 MTU2 Initialization

Figures 5.6 to 5.8 show the flowchart for MTU2 initialization.

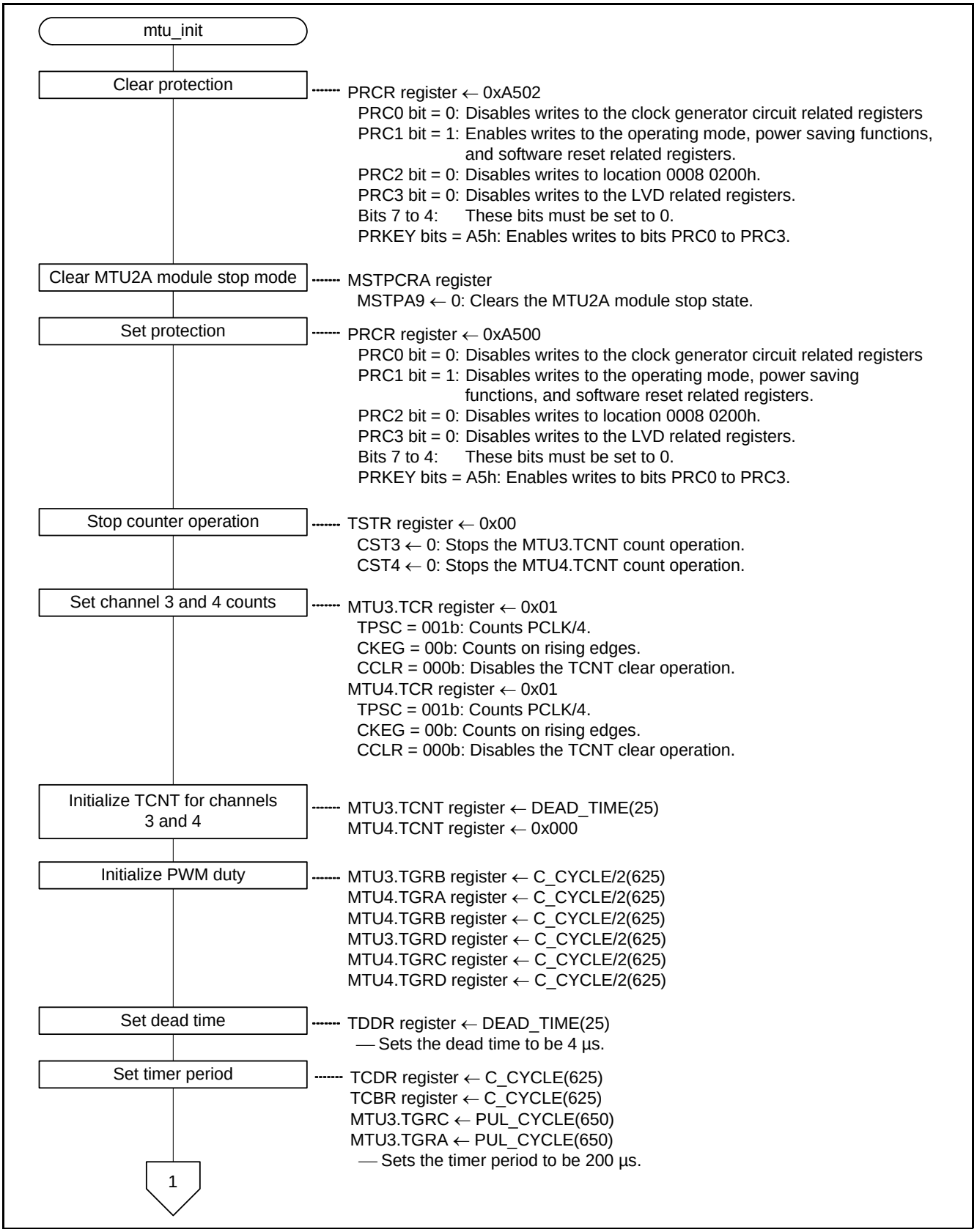

Figure 5.6 MTU2 Initialization (1/3)

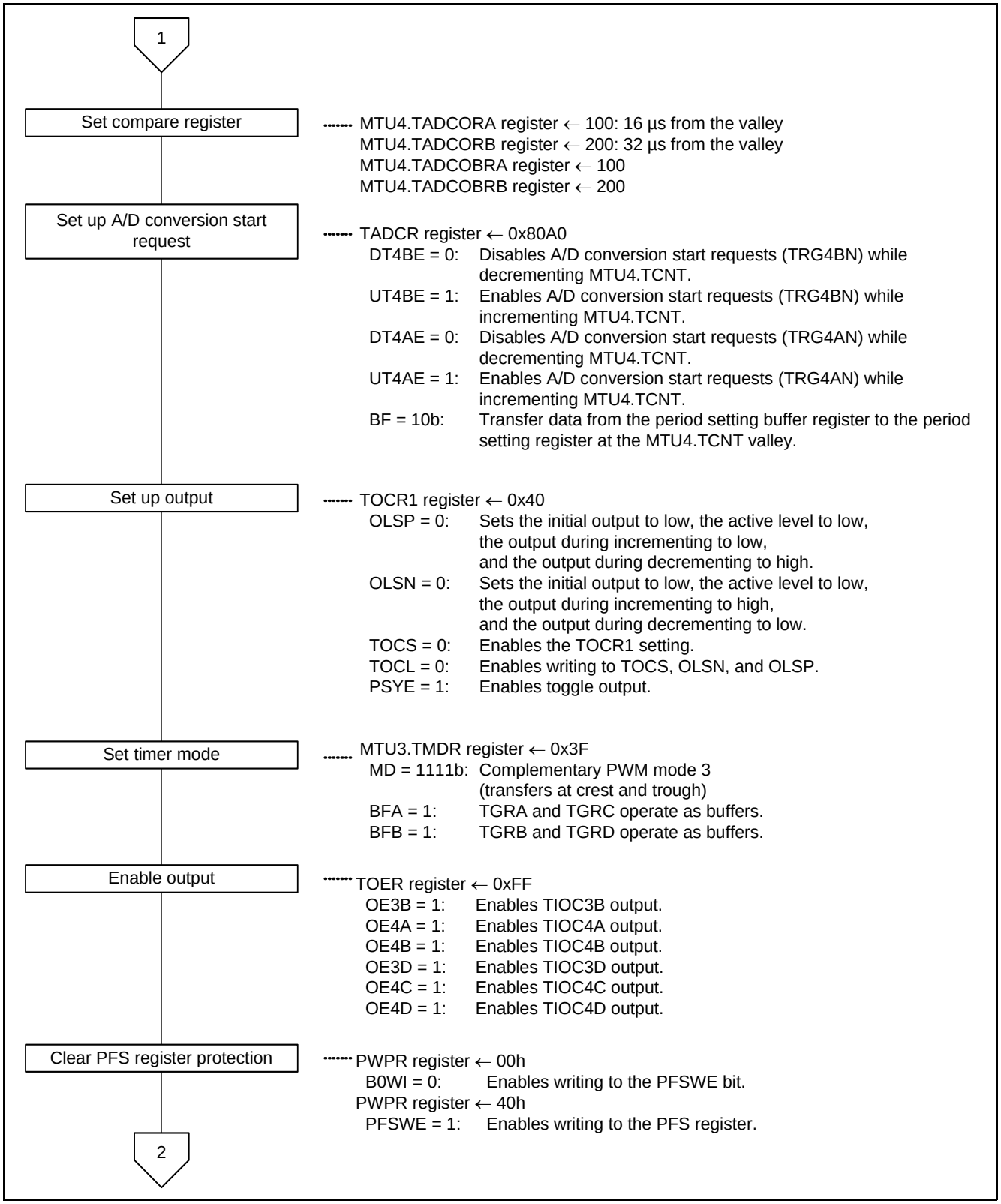

Figure 5.7 MTU2 Initialization (2/3)

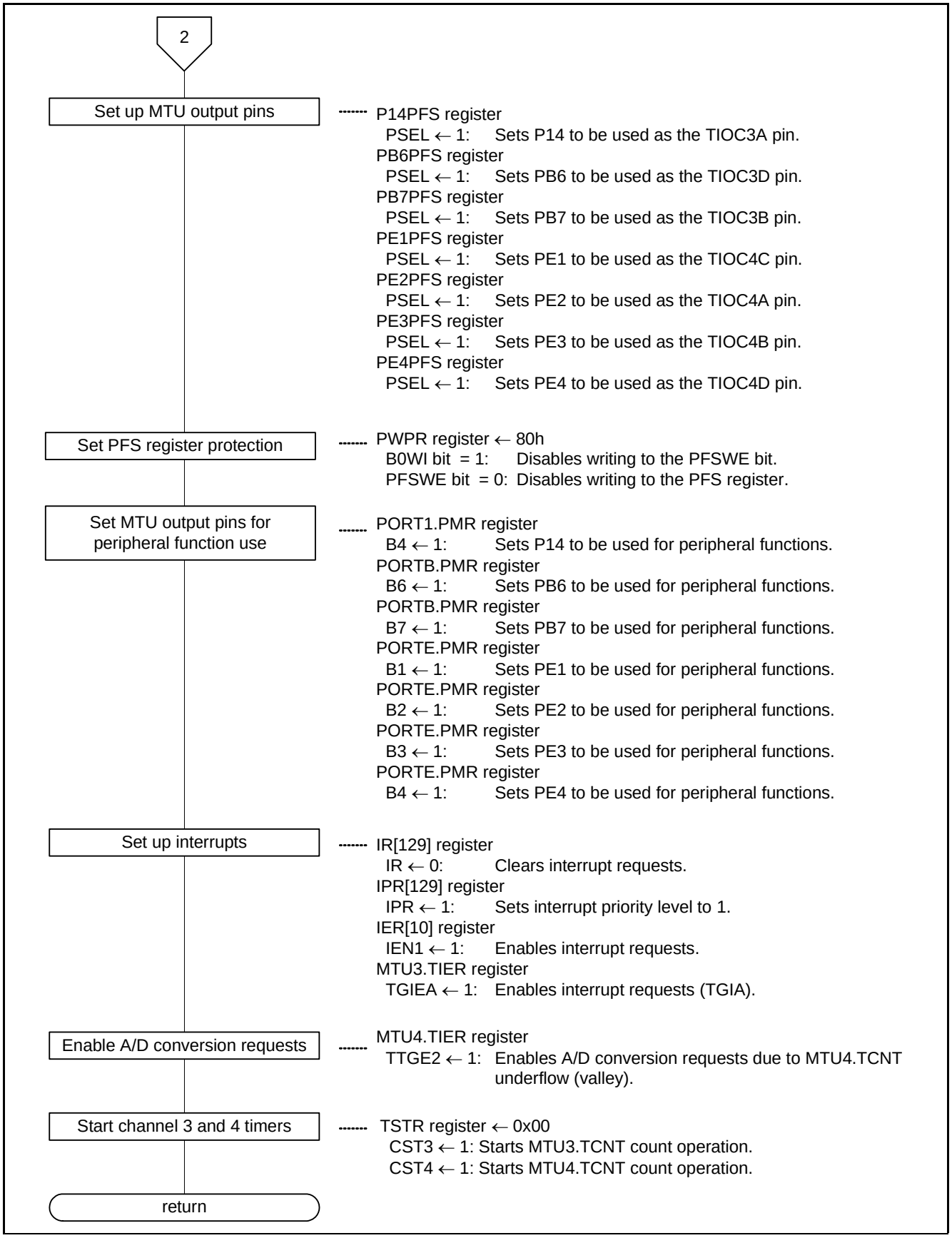

Figure 5.8 MTU2 Initialization (3/3)

5.8.6 TGIA3 Interrupt Handler

Figure 5.9 shows the flowchart for the TGIA3 interrupt handler.

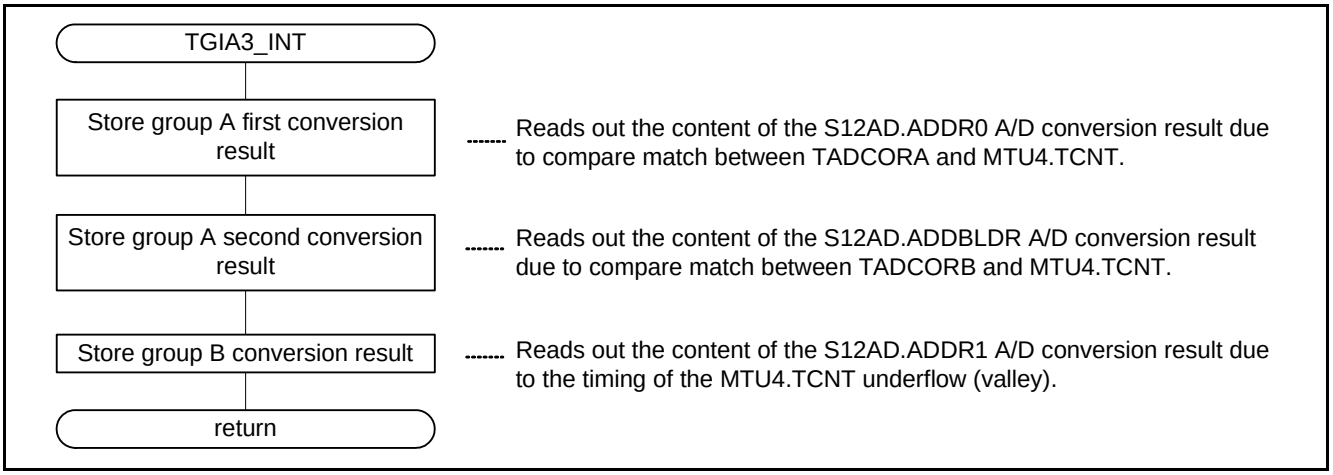

Figure 5.9 TGIA3 Interrupt Handler

6. Sample Code

Sample code can be downloaded from the Renesas Electronics website.

7. Reference Documents

Hardware manual
RX210 User's Manual: Hardware, Revision 1.10
(Download the latest version of this manual from the Renesas Electronics Corporation web site.)

Technical updates and technical news
(The latest technical information can be downloaded from the Renesas Electronics Corporation web site.)

C compiler manual
RX210 C Compiler Package, Version 1.02
C Compiler User's Manual, Revision 1.00
(Download the latest version of this manual from the Renesas Electronics Corporation web site.)

Website and Support

Renesas Electronics website
http://www.renesas.com

Inquiries
http://www.renesas.com/contact/

REVISION HISTORY	RX210 Group Application Note Setting A/D Conversion Using Group Scan Function in Double Trigger Mode

Rev.	Date	Description	
		Page	Summary
1.00	Jul.02.2012	—	First edition issued

General Precautions in the Handling of MPU/MCU Products

The following usage notes are applicable to all MPU/MCU products from Renesas. For detailed usage notes on the products covered by this document, refer to the relevant sections of the document as well as any technical updates that have been issued for the products.

1. Handling of Unused Pins

   Handle unused pins in accord with the directions given under Handling of Unused Pins in the manual.

   — The input pins of CMOS products are generally in the high-impedance state. In operation with an unused pin in the open-circuit state, extra electromagnetic noise is induced in the vicinity of LSI, an associated shoot-through current flows internally, and malfunctions occur due to the false recognition of the pin state as an input signal become possible. Unused pins should be handled as described under Handling of Unused Pins in the manual.

2. Processing at Power-on

   The state of the product is undefined at the moment when power is supplied.

   — The states of internal circuits in the LSI are indeterminate and the states of register settings and pins are undefined at the moment when power is supplied.
   In a finished product where the reset signal is applied to the external reset pin, the states of pins are not guaranteed from the moment when power is supplied until the reset process is completed.
   In a similar way, the states of pins in a product that is reset by an on-chip power-on reset function are not guaranteed from the moment when power is supplied until the power reaches the level at which resetting has been specified.

3. Prohibition of Access to Reserved Addresses

   Access to reserved addresses is prohibited.

   — The reserved addresses are provided for the possible future expansion of functions. Do not access these addresses; the correct operation of LSI is not guaranteed if they are accessed.

4. Clock Signals

   After applying a reset, only release the reset line after the operating clock signal has become stable. When switching the clock signal during program execution, wait until the target clock signal has stabilized.

   — When the clock signal is generated with an external resonator (or from an external oscillator) during a reset, ensure that the reset line is only released after full stabilization of the clock signal. Moreover, when switching to a clock signal produced with an external resonator (or by an external oscillator) while program execution is in progress, wait until the target clock signal is stable.

5. Differences between Products

   Before changing from one product to another, i.e. to a product with a different part number, confirm that the change will not lead to problems.

   — The characteristics of an MPU or MCU in the same group but having a different part number may differ in terms of the internal memory capacity, layout pattern, and other factors, which can affect the ranges of electrical characteristics, such as characteristic values, operating margins, immunity to noise, and amount of radiated noise. When changing to a product with a different part number, implement a system-evaluation test for the given product.

Notice

1. 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.
2. 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.
3. 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.
4. You should not alter, modify, copy, or otherwise misappropriate any Renesas Electronics product, whether in whole or in part. Renesas Electronics assumes no responsibility for any losses incurred by you or third parties arising from such alteration, modification, copy or otherwise misappropriation of Renesas Electronics product.
5. Renesas Electronics products are classified according to the following two quality grades: "Standard" and "High Quality". The recommended applications for each Renesas Electronics product depends on the product's quality grade, as indicated below.
   "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 etc.
   "High Quality": Transportation equipment (automobiles, trains, ships, etc.); traffic control systems; anti-disaster systems; anti-crime systems; and safety equipment etc.
   Renesas Electronics products are neither intended nor authorized for use in products or systems that may pose a direct threat to human life or bodily injury (artificial life support devices or systems, surgical implantations etc.), or may cause serious property damages (nuclear reactor control systems, military equipment etc.). 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 for which it is not intended. 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 which the product is not intended by Renesas Electronics.
6. 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.
7. 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 systems manufactured by you.
8. 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.
9. 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. You should not use Renesas Electronics products or 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. When exporting the Renesas Electronics 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.
10. It is the responsibility of the buyer or distributor of Renesas Electronics products, who distributes, disposes of, or otherwise places the product with a third party, to notify such third party in advance of the contents and conditions set forth in this document, Renesas Electronics assumes no responsibility for any losses incurred by you or third parties as a result of unauthorized use of Renesas Electronics products.
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.

RENESAS

SALES OFFICES Renesas Electronics Corporation http://www.renesas.com

Refer to "http://www.renesas.com/" for the latest and detailed information.

Renesas Electronics America Inc.
2880 Scott Boulevard Santa Clara, CA 95050-2554, U.S.A.
Tel: +1-408-588-6000, Fax: +1-408-588-6130

Renesas Electronics Canada Limited
1101 Nicholson Road, Newmarket, Ontario L3Y 9C3, Canada
Tel: +1-905-898-5441, Fax: +1-905-898-3220

Renesas Electronics Europe Limited
Dukes Meadow, Millboard Road, Bourne End, Buckinghamshire, SL8 5FH, U.K
Tel: +44-1628-651-700, Fax: +44-1628-651-804

Renesas Electronics Europe GmbH
Arcadiastrasse 10, 40472 Düsseldorf, Germany
Tel: +49-211-65030, Fax: +49-211-6503-1327

Renesas Electronics (China) Co., Ltd.
7th Floor, Quantum Plaza, No.27 ZhiChunLu Haidian District, Beijing 100083, P.R.China
Tel: +86-10-8235-1155, Fax: +86-10-8235-7679

Renesas Electronics (Shanghai) Co., Ltd.
Unit 204, 205, AZIA Center, No.1233 Lujiazui Ring Rd., Pudong District, Shanghai 200120, China
Tel: +86-21-5877-1818, Fax: +86-21-6887-7858 / -7898

Renesas Electronics Hong Kong Limited
Unit 1601-1613, 16/F., Tower 2, Grand Century Place, 193 Prince Edward Road West, Mongkok, Kowloon, Hong Kong
Tel: +852-2886-9318, Fax: +852 2886-9022/9044

Renesas Electronics Taiwan Co., Ltd.
13F, No. 363, Fu Shing North Road, Taipei, Taiwan
Tel: +886-2-8175-9600, Fax: +886 2-8175-9670

Renesas Electronics Singapore Pte. Ltd.
80 Bendemeer Road, Unit #06-02 Hyflux Innovation Centre Singapore 339949
Tel: +65-6213-0200, Fax: +65-6213-0300

Renesas Electronics Malaysia Sdn.Bhd.
Unit 906, Block B, Menara Amcorp, Amcorp Trade Centre, No. 18, Jln Persiaran Barat, 46050 Petaling Jaya, Selangor Darul Ehsan, Malaysia
Tel: +60-3-7955-9390, Fax: +60-3-7955-9510

Renesas Electronics Korea Co., Ltd.
11F., Samik Lavied' or Bldg., 720-2 Yeoksam-Dong, Kangnam-Ku, Seoul 135-080, Korea
Tel: +82-2-558-3737, Fax: +82-2-558-5141

Colophon 2.2