R8C/M12A Group

A/D Converter in One-Shot Mode

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Abstract

This document describes the setting method to perform A/D conversion on analog voltage using the R8C/M12A Group A/D converter in one-shot mode.

Product

MCU: R8C/M12A Group

When using this application note with other Renesas MCUs, careful evaluation is recommended after making modifications to comply with the alternate MCU.

Contents

1. Specifications

A/D conversion is performed on analog voltage input from an analog input pin every 5 ms using the A/D converter in one-shot mode. The highest and lowest values of the 10 conversion results are excluded, and the mean value of the remaining eight results is the final A/D converted value.

Table 1.1 lists the Peripheral Functions and Their Applications. Figure 1.1 shows a Block Diagram.

Table 1.1 Peripheral Functions and Their Applications

Peripheral Function	Application
Timer RJ2	Generate the measurement period.
A/D converter	Perform A/D conversion on analog input voltage.

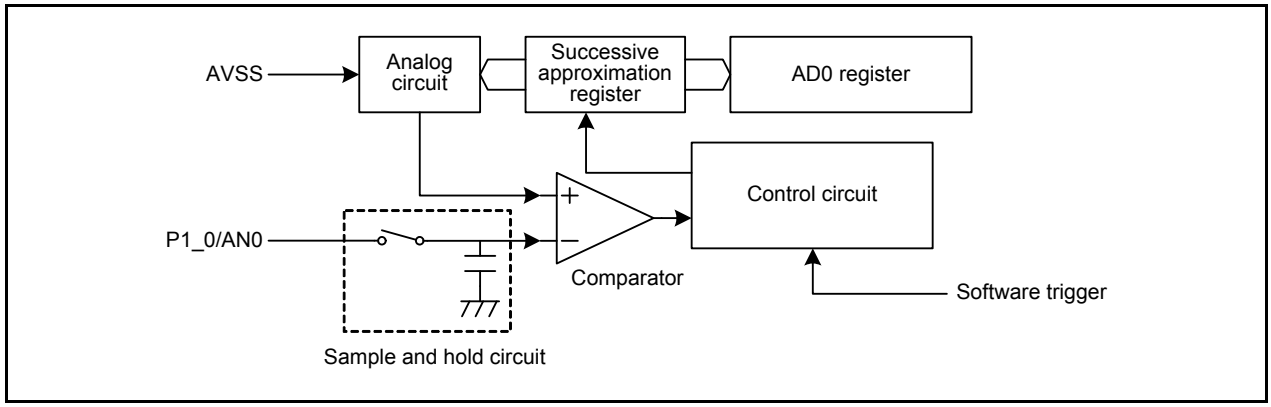


Figure 1.1 Block Diagram

2. Operation Confirmation Conditions

The sample code accompanying this application note has been run and confirmed under the conditions below.

Table 2.1 Operation Confirmation Conditions

Item	Contents
MCU used	R8C/M12A Group
Operating frequencies	High-speed on-chip oscillator clock: 20 MHz (typical) CPU clock (fs): 20 MHz System clock (f): 20 MHz
Operating voltage	5.0 V (2.7 to 5.5 V)
Integrated development environment	Renesas Electronics Corporation High-performance Embedded Workshop Version 4.07
C compiler	Renesas Electronics Corporation M16C Series, R8C Family C Compiler V.5.45 Release 01
	Compile options -D__UART0__ -c -finfo -dir "$(CONFIGDIR)" -R8C (Default setting is used in the integrated development environment)

3. Hardware

3.1 Pin Used

Table 3.1 lists the Pin Used and Its Function.

Table 3.1 Pin Used and Its Function

Pin Name	I/O	Function
P1_0/AN0	Input	A/D converter input (AN0)

4. Software

4.1 Operation Overview

A/D conversion is performed on analog voltage input from AN0 every 5 ms using the A/D converter in one-shot mode. Timer RJ2 timer mode is used to generate a 5 ms period.

Measurement conditions

- Use the P1_0/AN0 pin for analog input.
- Use one-shot mode for the A/D operating mode.
- Use fAD for the A/D conversion clock.
- Use a software trigger for the A/D conversion start condition.
- Use timer RJ2 to generate the measurement period.

(1) Perform the initial setting of the A/D converter.

After the A/D conversion described in steps (2) to (4) is performed 10 times every 5 ms, calculate the final A/D conversion value in step (5).

(2) Set the ADST bit in the ADCON0 register to 1 (A/D conversion started) to start A/D conversion.
(3) When A/D conversion is completed, the ADST bit automatically becomes 0 (A/D conversion stopped) and the ADF bit in the ADICSR register becomes 1 (interrupt request). Then, the converted result is transferred to the AD0 register.
(4) Set the ADF bit to 0 (no interrupt request) to add the A/D converted result to the variable of the sum of the A/D converted values. When the AD0 register value is greater than the highest value of the previous converted results, store the AD0 register value to the variable of the highest A/D converted value. Or when the AD0 register value is smaller than the lowest value, store the AD0 register value to the variable of the lowest A/D converted value.
(5) The highest and lowest values of the 10 conversion results are excluded, and the mean value of the remaining eight results is the final A/D converted value.

Figure 4.1 shows the Timing Diagram in One-Shot Mode.

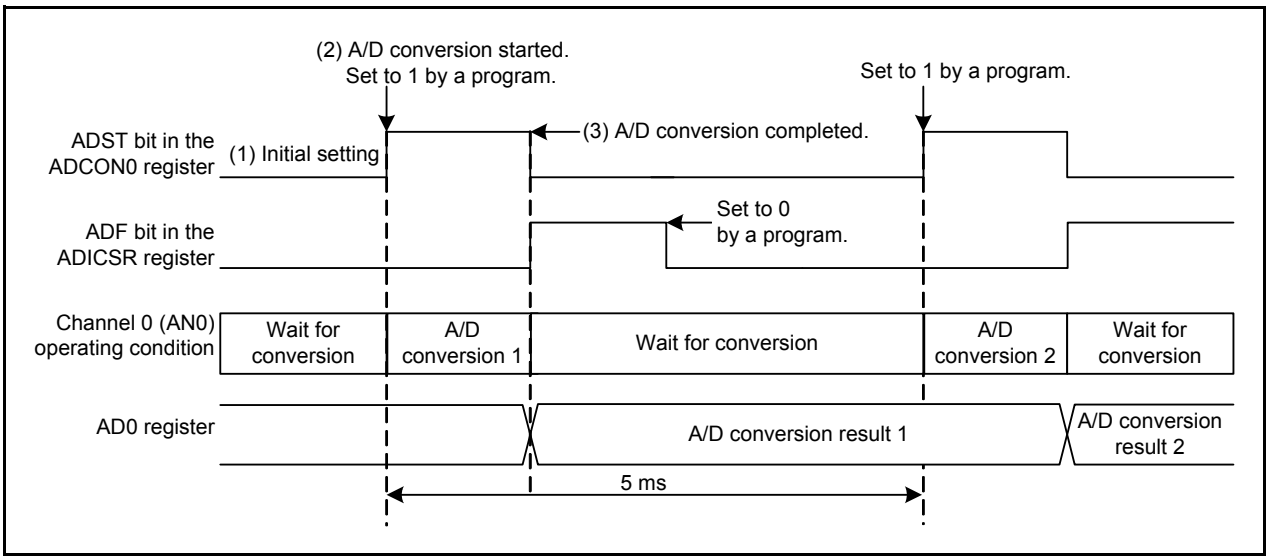


Figure 4.1 Timing Diagram in One-Shot Mode

4.2 Required Memory Size

Table 4.1 lists the Required Memory Size.

Table 4.1 Required Memory Size

Memory Used	Size	Remarks
ROM	335 bytes	In the r01an0373_src.c module
RAM	12 byte	In the r01an0373_src.c module
Maximum user stack usage	10 bytes	
Maximum interrupt stack usage	0 bytes	

The required memory size varies depending on the C compiler version and compile options.

4.3 Variables

Table 4.2 lists the Global Variables and Table 4.3 lists the static Variables.

Table 4.2 Global Variables

Type	Variable Name	Contents	Function Used
unsigned char	f_ad_fix	A/D converted value determination flag	ad_in
unsigned short	ad_fix	A/D converted final value	ad_in

Table 4.3 static Variables

Type	Variable Name	Contents	Function Used
unsigned short	ad_sum	Sum of A/D converted values	ad_in
unsigned char	ad_cnt	Number of A/D converted values	ad_in
unsigned short	ad_max	Highest A/D converted value	ad_in
unsigned short	ad_min	Lowest A/D converted value	ad_in
unsigned short	ad_buf	A/D converted value	ad_in

4.4 Functions

Table 4.4 lists the Functions.

Table 4.4 Functions

Function Name	Outline
mcu_init	System clock setting
timer_rj2_init	Initial setting of timer RJ2
ad_init	Initial setting of A/D converter
ad_in	A/D conversion and determination

4.5 Function Specifications

The following tables list the sample code function specifications.

mcu_init	
Outline	System clock setting
Header	None
Declaration	void mcu_init(void)
Explanation	Set the system clock.
Argument	None
Returned value	None
Remark	—

timer_rj2_init	
Outline	Initial setting of timer RJ2
Header	None
Declaration	void timer_rj2_init(void)
Explanation	Perform initial setting to use timer RJ2 in timer mode.
Argument	None
Returned value	None
Remark	—

ad_init	
Outline	Initial setting of A/D converter
Header	None
Declaration	void ad_init(void)
Explanation	Perform initial setting to use the A/D converter in one-shot mode.
Argument	None
Returned value	None
Remark	—

ad_in	
Outline	A/D conversion and determination
Header	None
Declaration	void ad_in(void)
Explanation	Perform A/D conversion and calculate the A/D conversion final value. The highest and lowest values of the 10 conversion results are excluded, and the mean value of the remaining eight results is the A/D conversion value.
Argument	None
Returned value	None
Remark	—

4.6 Flowcharts

4.6.1 Main Processing

Figure 4.2 shows the Main Processing.

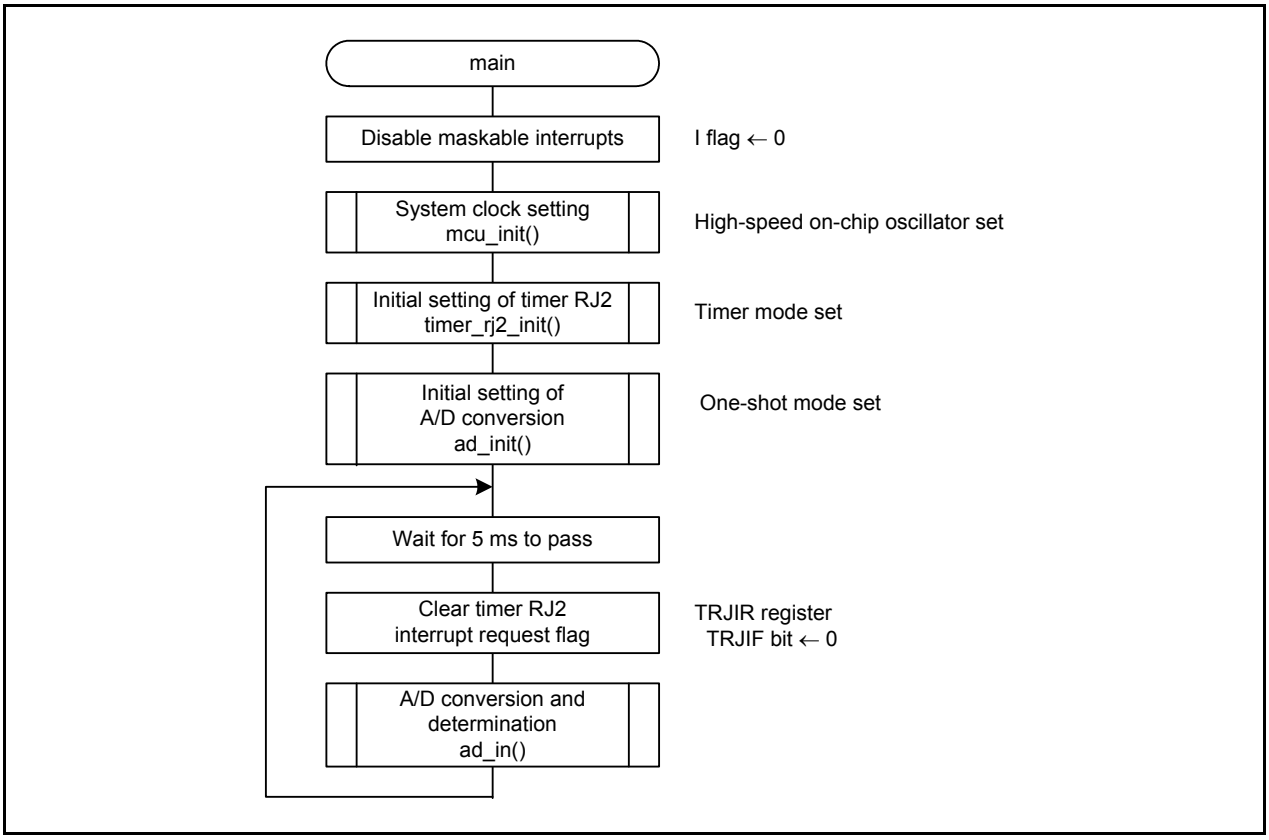


Figure 4.2 Main Processing

4.6.2 System Clock Setting

Figure 4.3 shows the System Clock Setting.

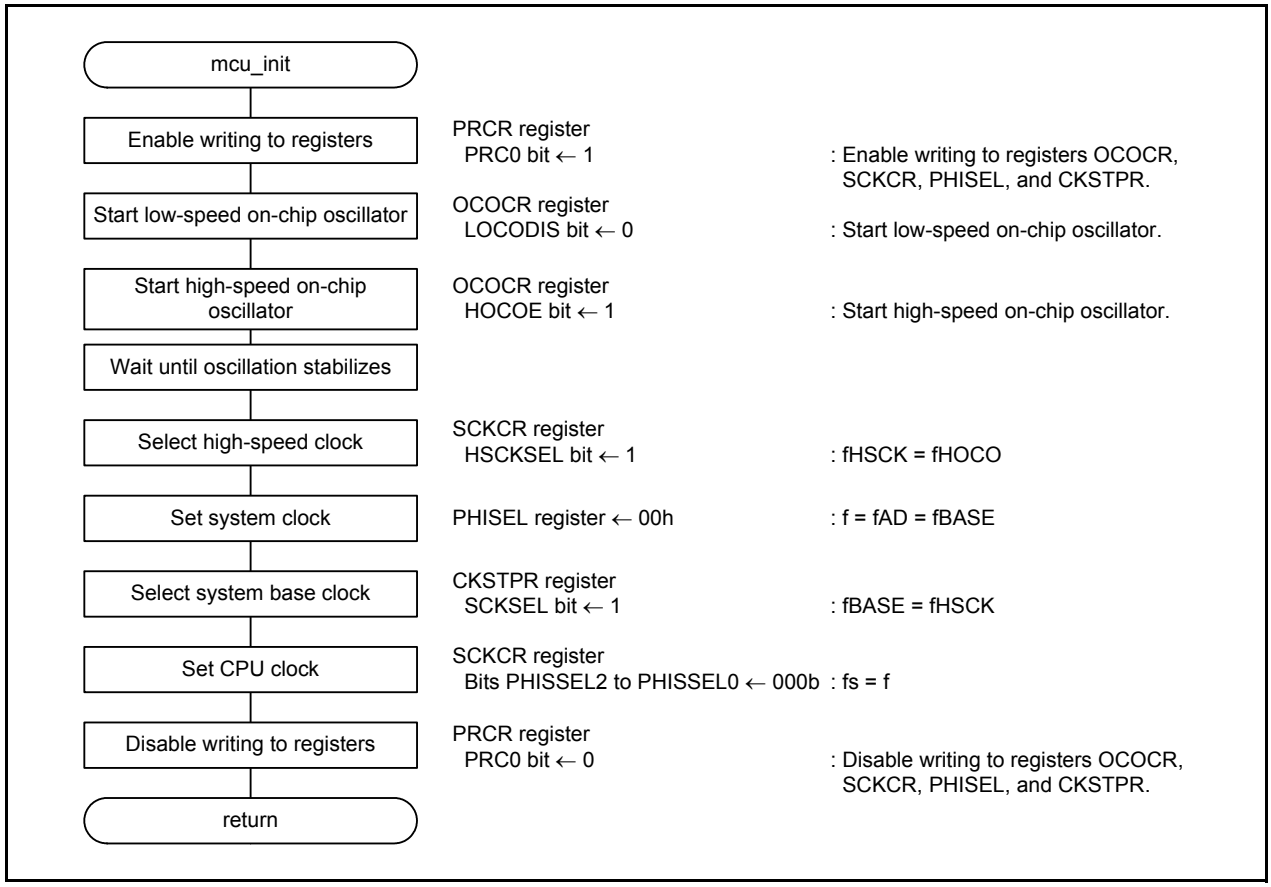


Figure 4.3 System Clock Setting

4.6.3 Initial Setting of Timer RJ2

Figure 4.4 shows the Initial Setting of Timer RJ2.

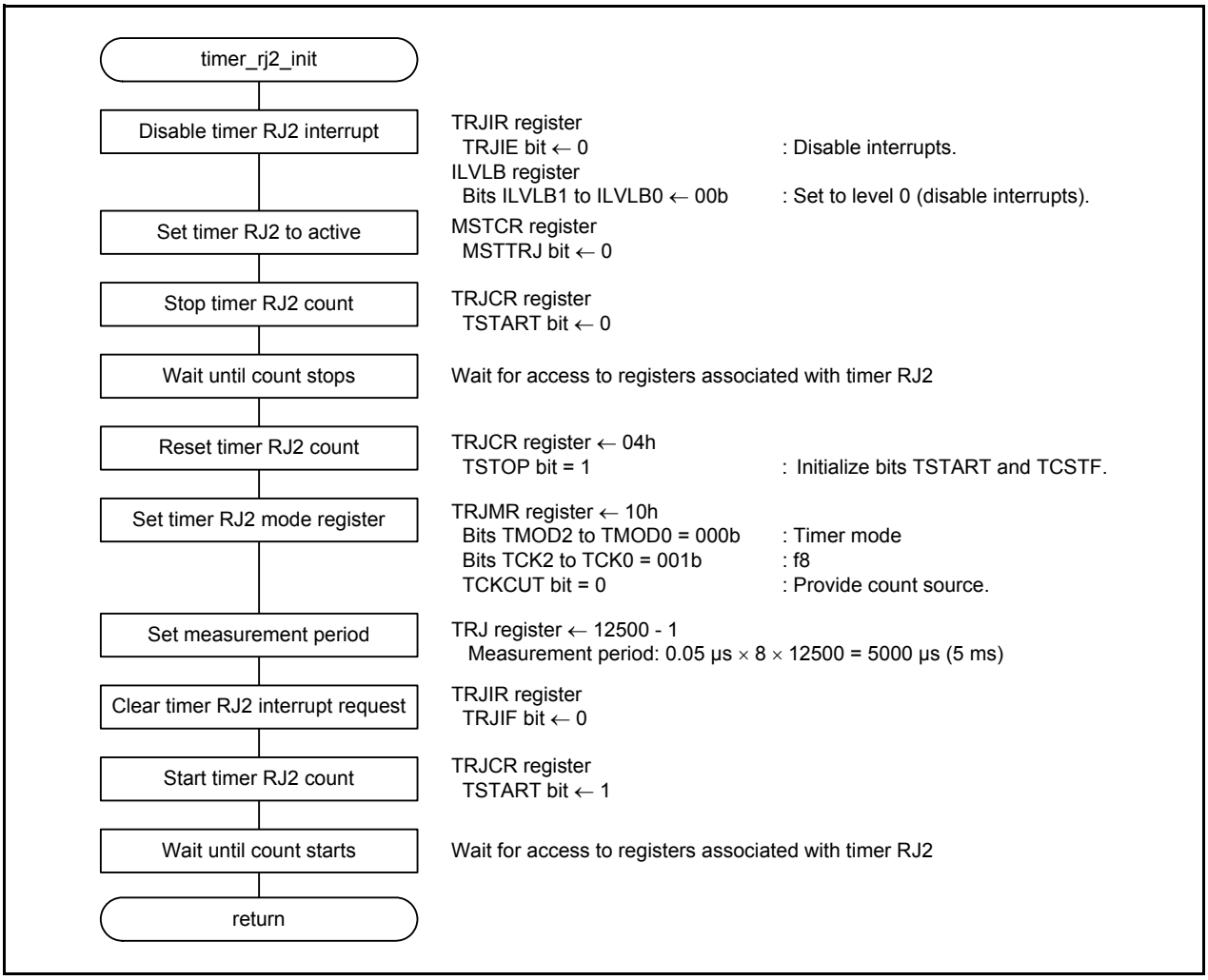
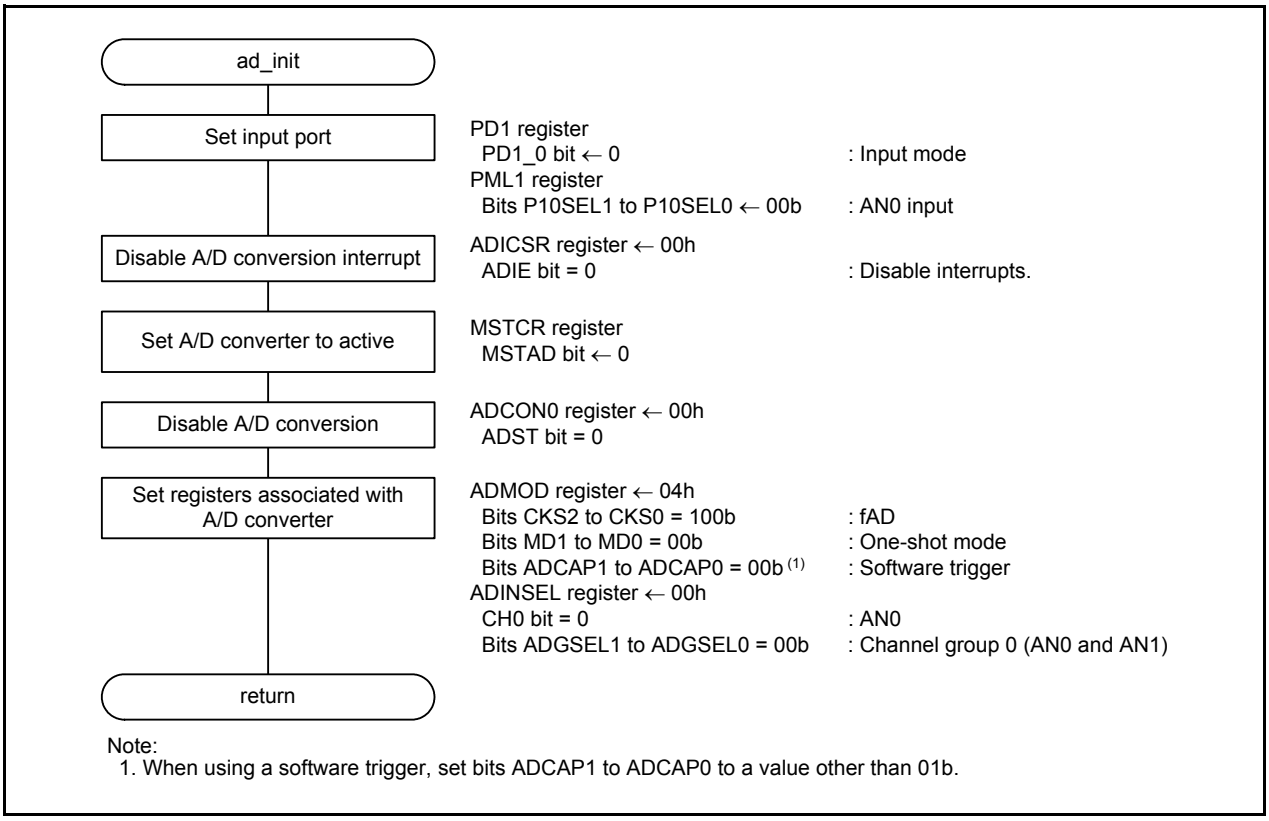


Figure 4.4 Initial Setting of Timer RJ2

4.6.4 Initial Setting of A/D Converter

Figure 4.5 shows the Initial Setting of A/D Converter.

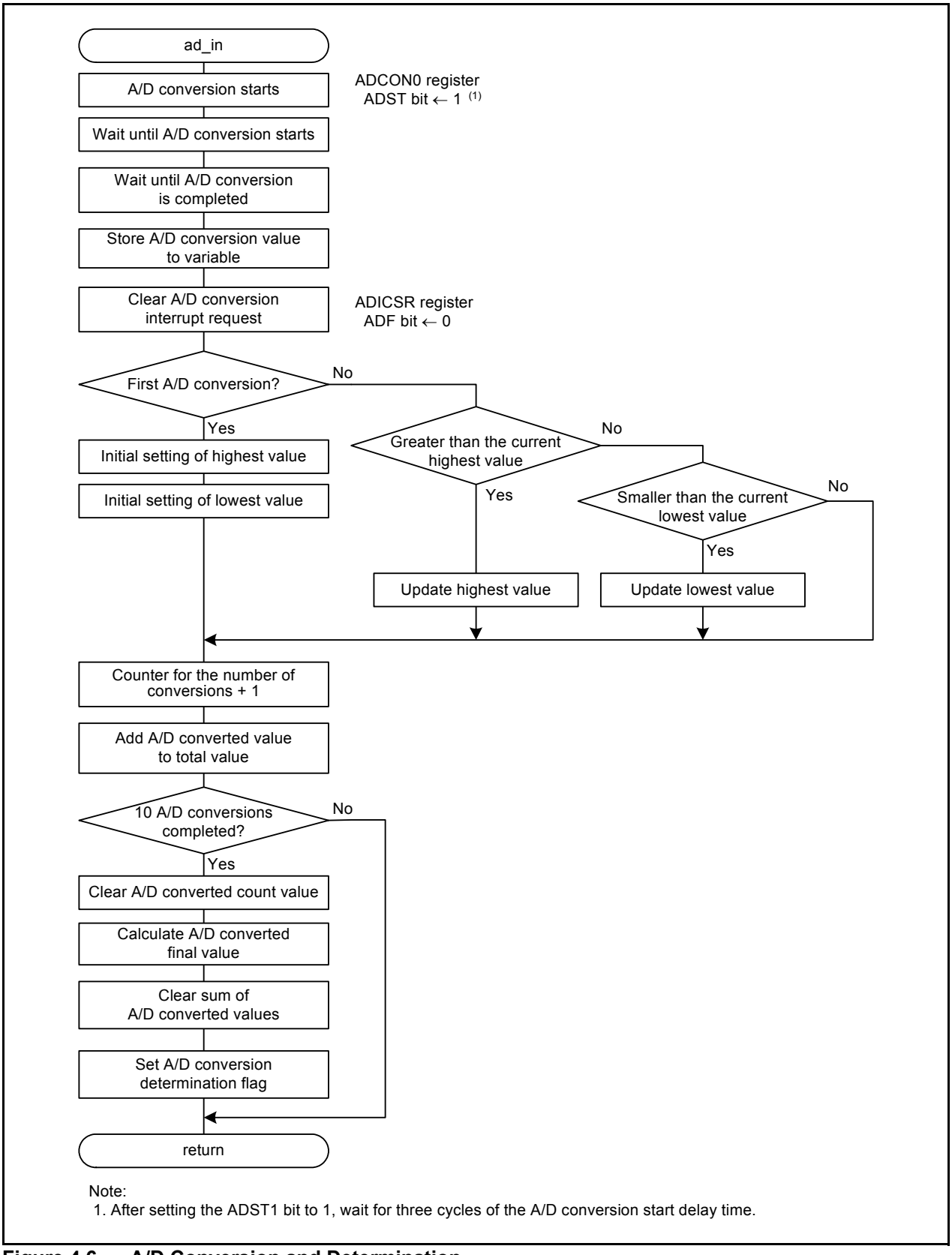


Note:
1. When using a software trigger, set bits ADCAP1 to ADCAP0 to a value other than 01b.

Figure 4.5 Initial Setting of A/D Converter

4.6.5 A/D Conversion and Determination

Figure 4.6 shows the A/D Conversion and Determination.



Note:
1. After setting the ADST1 bit to 1, wait for three cycles of the A/D conversion start delay time.

Figure 4.6 A/D Conversion and Determination

5. Sample Code

Sample code can be downloaded from the Renesas Electronics website.

6. Reference Documents

R8C/M12A Group User's Manual: Hardware Rev.1.00
The latest version can be downloaded from the Renesas Electronics website.

Technical Update/Technical News
The latest information can be downloaded from the Renesas Electronics website.

Website and Support

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Revision History	R8C/M12A Group A/D Converter in One-Shot Mode

Rev.	Date	Description	
		Page	Summary
1.00	May 23, 2011	—	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 manual, refer to the relevant sections of the manual. If the descriptions under General Precautions in the Handling of MPU/MCU Products and in the body of the manual differ from each other, the description in the body of the manual takes precedence.

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 one with a different part number, confirm that the change will not lead to problems.

   — The characteristics of MPU/MCU in the same group but having different part numbers may differ because of the differences in internal memory capacity and layout pattern. When changing to products of different part numbers, implement a system-evaluation test for each of the products.

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