V850E2/ML4

A/D converter

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Abstract

This document describes how to set up the A/D converter (ADC) and also gives an outline of the operation and describes the procedures for using a sample program for the V850E2/ML4.

The features of the function or operation are described below.

- Conversion by one-shot mode
- Software triggered
- Conversion by the scan list of channel group (CG)0
- Continuous conversions by restarting in the A/D conversion end interrupt.

Products

V850E2/ML4

Integrated development environments

CubeSuite+, GHS MULTI V5.1.7D, and IAR for V850 Kickstart V3.80.

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

The sample program converts the scan list of CG0 by using the software trigger in one-shot mode. The number of times conversion of the scan list is repeated can be set from one to four per CG in a specific register for a given channel, but is set to one in the sample program. Having finished converting the scan list, the sample program turns on an LED to reflect the result.

Table 1.1 lists the Peripheral Functions and their Applications and Figure 1.1 shows the Usage Example.

Table 1.1 Peripheral Functions and their Applications

Peripheral Function	Application
Ports(P1_4, P1_5, P4_3, P4_4)	Connected to LEDs, and light on or off LEDs.
ADC	ADC converts analog input from ANI00 pins.

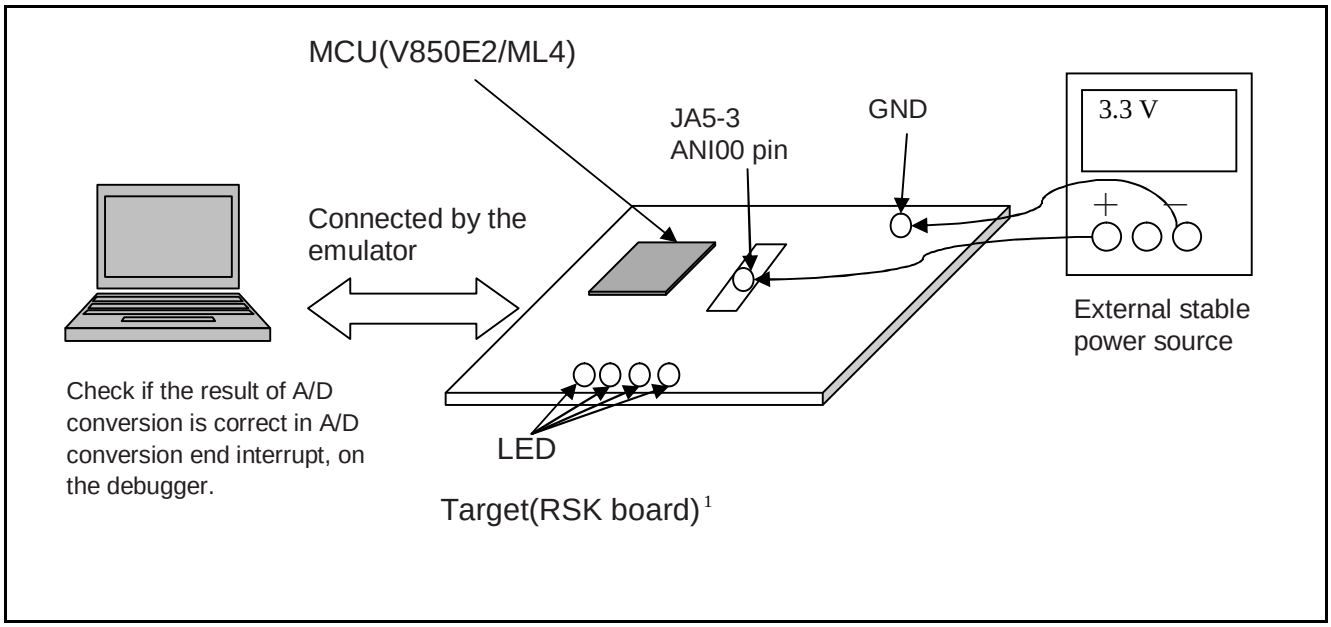

Figure 1.1 Usage Example[1]

[1] Mass production of RSK board will start in August, 2012.

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	V850E2/ML4
Operating frequency	200MHz (PLL multiplies the oscillator input frequency (fx: 10MHz) by 20.)
Operating voltage	3.3V
Integrated development environment	CubeSuite+ V1.00
	GHS MULTI V5.1.7D
	IAR for V850 Kickstart V3.80.1
C compiler	CX V1.20(CubeSuite+), optimization: default
	C-V850E 5.1.7 RELEASE(GHS MULTI) , optimization: default
	IAR C/C++ Compiler for V850 3.80.1 [Kickstart] (3.80.1.30078), optimization: default
Operating mode	Normal operation mode
Sample code version	V1.00
Board used	RSK board
Device used	E1 emulator or MINICUBE, stable power source(KENWOOD product)
Tool used	none

3. Hardware

3.1 Hardware Configuration

Figure 3.1 shows a Connection Example.

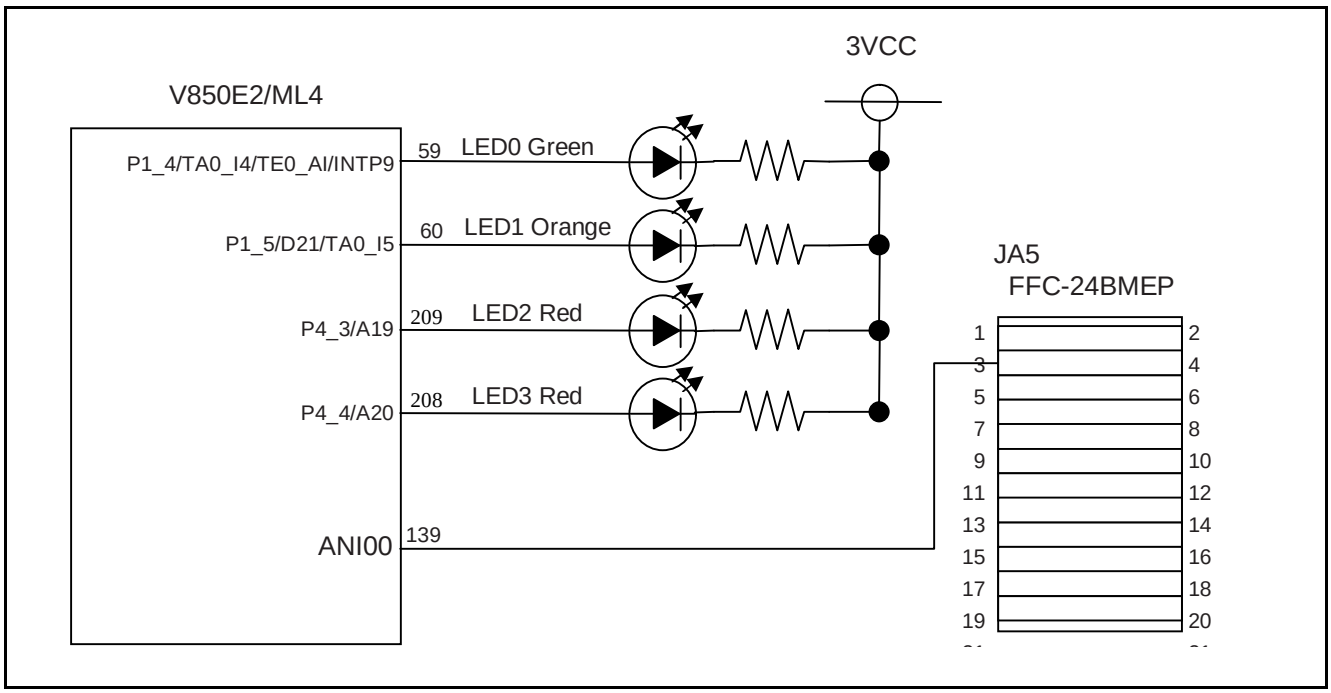

Figure 3.1 Connection Example on RSK board

3.2 Pin(s) Used

Table 3.1 lists the Pins Used and Its Function.

Table 3.1 Pins Used and Its Functions

Pin Name	I/O	Function
PORT P1_4	output	Port mode, output, LED0
PORT P1_5	output	Port mode, output, LED1
PORT P4_3	output	Port mode, output, LED2
PORT P4_4	output	Port mode, output, LED3
ANI00	input	External input to ADC

4. Software

4.1 Operation Overview

[Explain operation]

Figure 4.1 shows the Sequence Diagram.

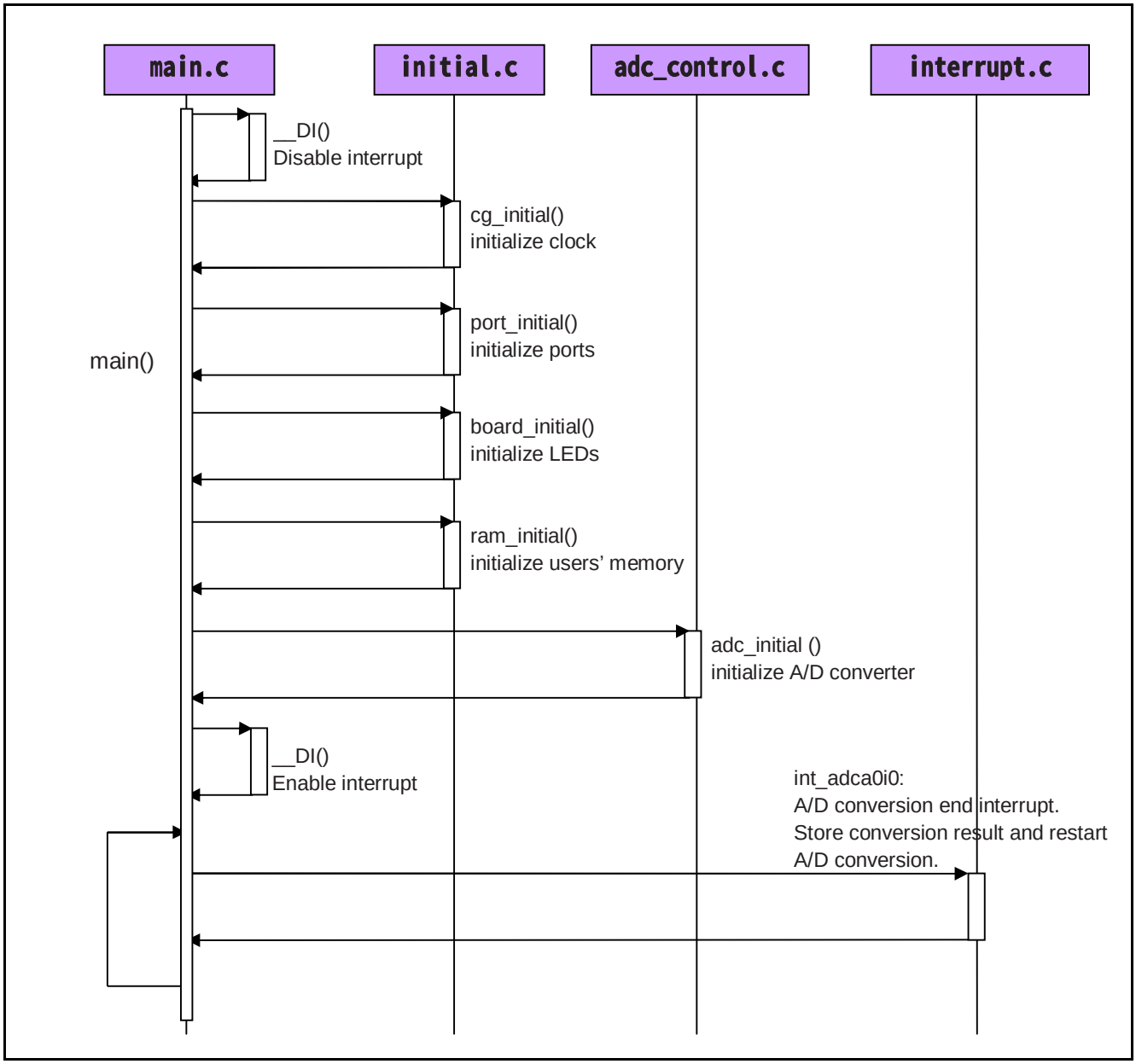

Figure 4.1 Sequence Diagram

4.2 Required Memory Size

Table 4.1 lists the Required Memory Size. (CubeSuite+, optimization=default)

Table 4.1 Required Memory Size

Memory Used	Size	Remarks
ROM	2304	Shown as ROM area size in map file
RAM	4128	Shown as RAM area size in map file
Maximum user stack usage	4	CubeSuite+ stack estimation tool calculated.
Maximum interrupt stack usage	68	The same as above.

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

4.3 File Composition

Table 4.2 lists the File(s) Used in the Sample Code. Files not generated by the integrated development environment should not be listed in this table.

Table 4.2 File(s) Used in the Sample Code

File Name	Outline	Remarks
crtE.s	Initialize hardware	Only in the project for CubeSuite+
startup.s		Only in the project for GHS MULTI
V850E2ML4.dir	Linker directive file	Only in the project for CubeSuite+
V850E2_ML4 ADC.ld		Only in the project for GHS MULTI
vector.s	Vector table	Only in the project for GHS MULTI
adc.h	Declare variables and functions.	
df4022_800.h	Declare register macros for V850E2/ML4	Only in the project for GHS MULTI
main.c	Main routine	
initial.c	Initialize software	
adc_control.c	Initialize ADC	
interrupt.c	Interrupt routines	

4.4 Option-Setting Memory

This sample does not specify any option-bytes. Specify them if necessary.

4.5 Variable(s)

Table 4.3 lists the Global Variable(s).

Table 4.3 Global Variable(s)

Type	Variable Name	Contents	Function Used
unsigned short	adc_result[10]	Buffer for A/D converted data	__interrupt void int_adca0i0(void); void ram_initial(void);

4.6 Function(s)

Table 4.4 lists the Function(s).

Table 4.4 Function(s)

Function Name	Outline
void port_initial(void)	Sets up ports and their mode.
void cg_initial(void)	Initializes the special clock frequency control register.
void hbus_initial(void)	Initializes the AHB bus
void board_initial(void)	Initializes the LEDs
void ram_initial(void)	Sets up the initial state of the user RAM
void adc_initial(void)	Sets up the operation of the ADC.
interrupt void int_adca0err(void)	Processes A/D conversion end interrupt.
interrupt void int_adca0i0(void)	Processes A/D conversion end interrupt.
void main(void)	Calls necessary initialization functions before entering an infinite loop.

4.7 Function Specification(s)

The following table(s) list(s) the sample code function specification(s).

[Function Name]		
Outline	Main routine	
Header	—	
Declaration	void main(void)	
Description	Calls initializing functions, enters infinite loop and waits A/D conversion interrupt.	
Arguments	none	-
Return Value	none	

[Function Name]		
Outline	Sets up ports and their mode.	
Header	adc.h	
Declaration	void port_initial (void)	
Description	Sets up ports in port-mode, output, for controlling LEDs.	
Arguments	none	-
Return Value	none	

[Function Name]		
Outline	Initialize clock	
Header	adc.h	
Declaration	void cg_initial(void)	
Description	Initializes the special clock frequency control register.	
Arguments	none	-
Return Value	none	

[Function Name]		
Outline	Initialize H-bus	
Header	adc.h	
Declaration	void hbus_initial(void)	
Description	Initializes AHB-bus	
Arguments	none	-
Return Value	none	

[Function Name]		
Outline	Initialize board	
Header	adc.h	
Declaration	void board_initial(void)	
Description	Initialize LED on the board.	
Arguments	—	—
Return Value	—	

[Function Name]	
Outline	Initialize users' memory.
Header	adc.h
Declaration	void ram_initial(void)
Description	Initialize LED on the board.
Arguments	— —
Return Value	—

[Function Name]	
Outline	Initialize ADC.
Header	adc.h
Declaration	void adc_initial(void)
Description	Initialize ADC and its mode.
Arguments	— —
Return Value	—

[Function Name]	
Outline	Processes A/D conversion end interrupt.
Header	—
Declaration	__interrupt void int_adca0i0(void)
Description	Stores the conversion result in users' memory area, and restarts A/D conversion.
Arguments	— —
Return Value	—

[Function Name]	
Outline	Processes A/D conversion error interrupt.
Header	—
Declaration	__interrupt void int_adca0err(void)
Description	Stops A/D conversion and turn LED2 on.
Arguments	— —
Return Value	—

4.8 Flowchart(s)

4.8.1 Main Processing

Figure 4.1 shows the Main Processing.

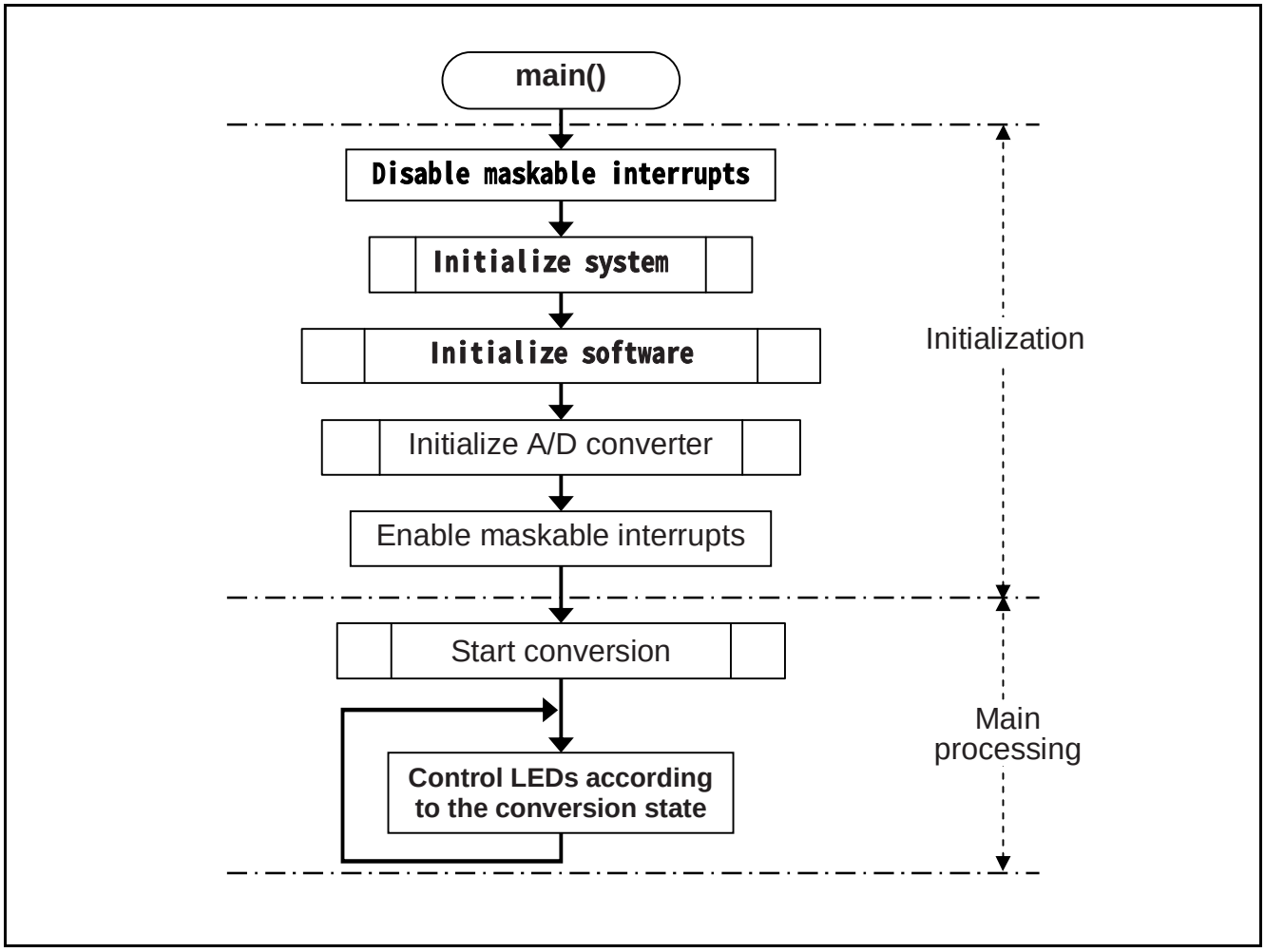

Figure 4.1 Main Processing

4.8.2 Main Processing

Figure 4.2 shows the Main Processing.

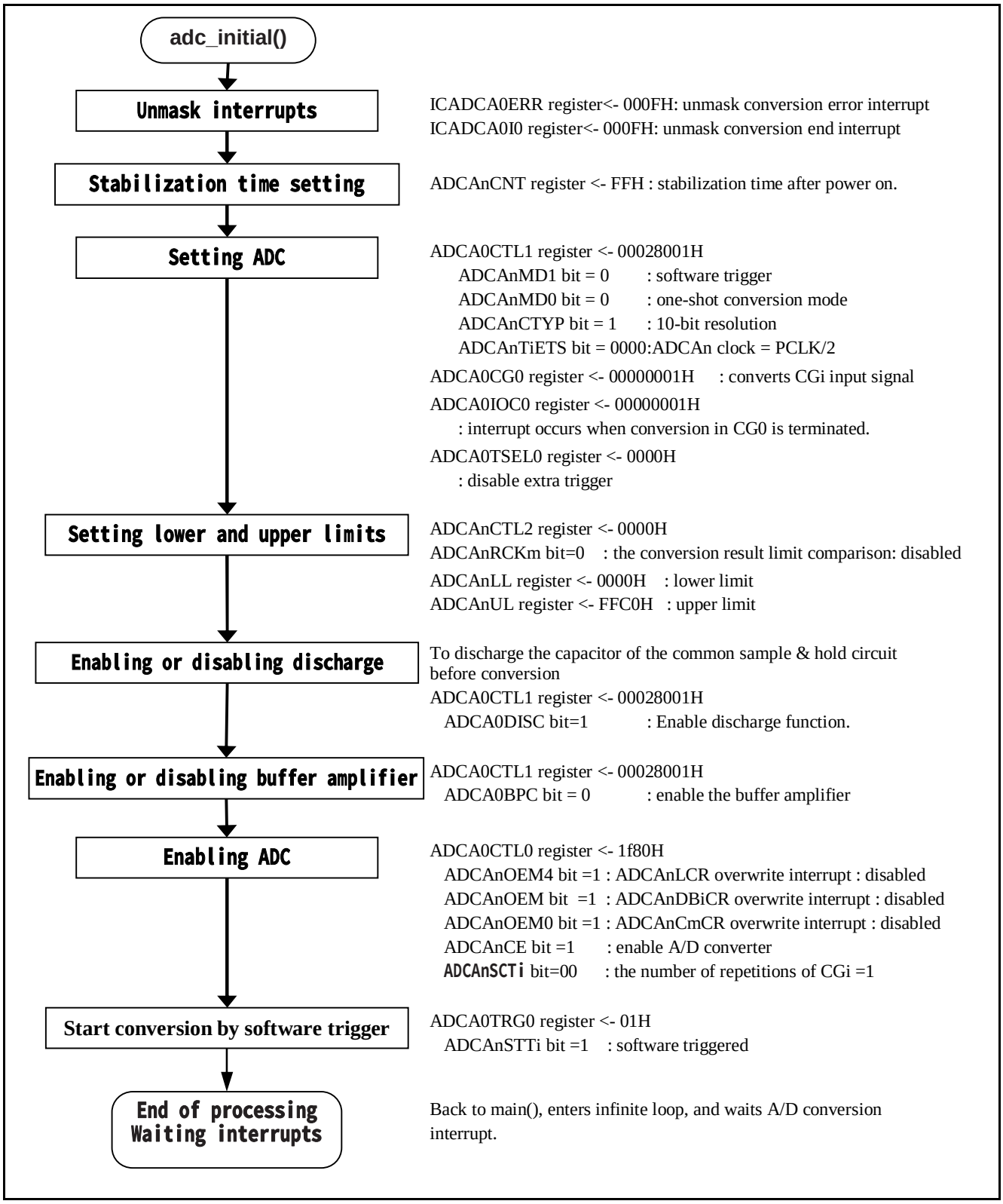

Figure 4.2 Initializing ADC

4.8.3 Interrupt Processing

Figure 4.3 shows the Interrupt operation.

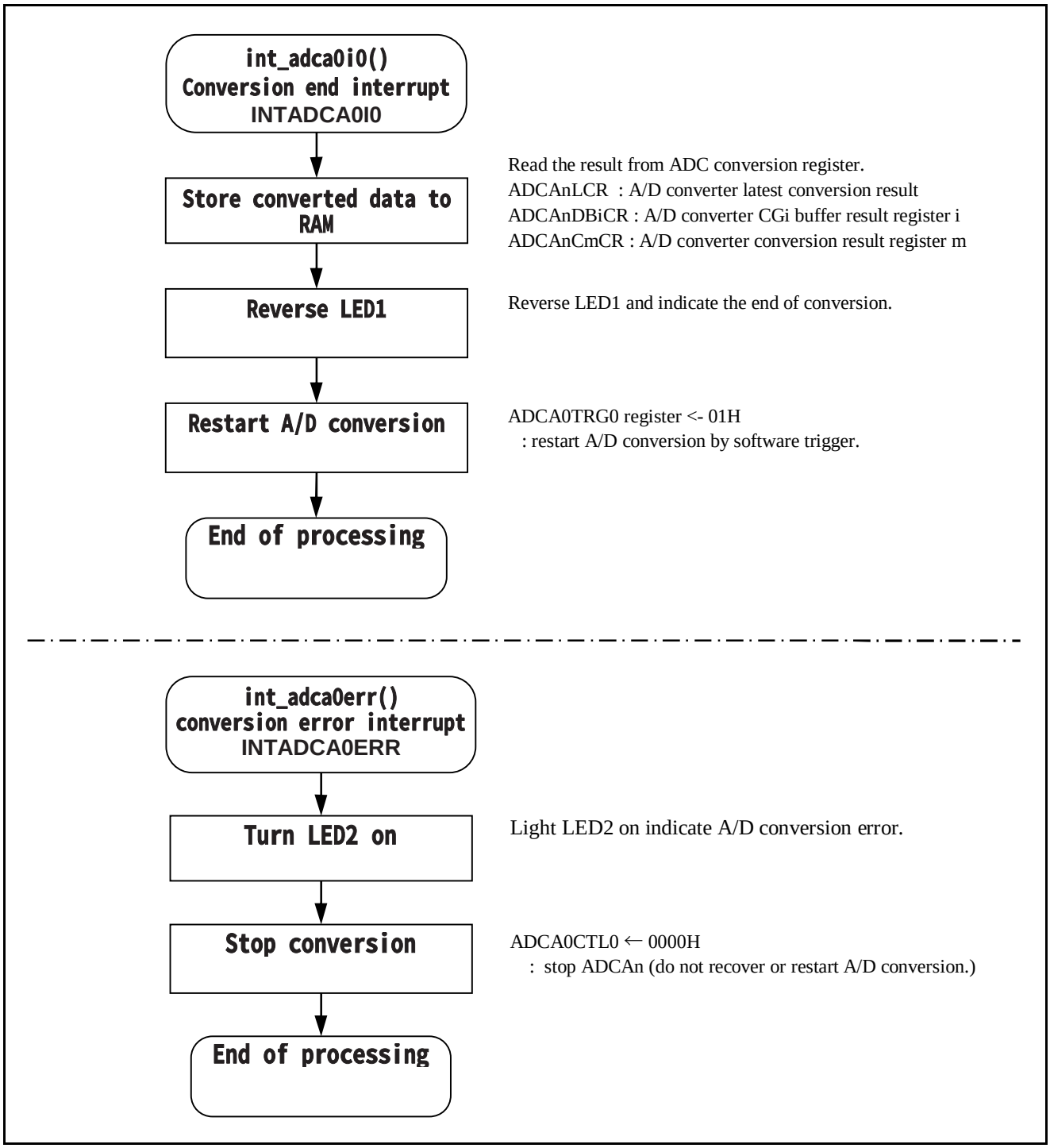

Figure 4.3 Interrupt operation

5. Sample Code

Sample code can be downloaded from the Renesas Electronics website.

6. Reference Documents

User's Manual: Hardware

V850E2/ML4 User's Manual: Hardware (R01UH0262EJ)

The latest version can be downloaded from the Renesas Electronics website.

Technical Update/Technical News

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REVISION HISTORY	V850E2/ML4 Application Note A/D converter

Rev.	Date	Description	
		Page	Summary
1.00	Jun. 22, 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 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 type number, confirm that the change will not lead to problems.
   The characteristics of MPU/MCU in the same group but having different type numbers may differ because of the differences in internal memory capacity and layout pattern. When changing to products of different type numbers, implement a system-evaluation test for each of the products.

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