

RL78/G13

Multiplier and Divider/Multiply-Accumulator (A/D Converter in Sequential Conversion Mode)

R01AN0741EJ0100

Rev. 1.00

Jan. 31, 2012

Introduction

This application note explains how to use the multiplier and divider/multiply-accumulator in the multiply-accumulator mode (unsigned). The sample application covered in this application note multiplies the conversion results (for four channels) provided by the A/D converter by different multipliers and accumulates their calculation results for each channel. The application turns on the LED when all of the accumulated values of all the channels exceed a predetermined value.

Target Device

RL78/G13

When applying the sample program covered in this application note to another microcomputer, modify the program according to the specifications for the target microcomputer and conduct an extensive evaluation of the modified program.

Contents

1.	Specifications	3
2.	Operation Check Conditions	5
3.	Related Application Note.....	5
4.	Description of the Hardware	6
4.1	Hardware Configuration Example	6
4.2	List of Pins to be Used	6
5.	Description of the Software	7
5.1	Operation Outline	7
5.2	List of Option Byte Settings.....	8
5.3	List of Constants.....	8
5.4	List of Variables	8
5.5	List of Functions.....	9
5.6	Function Specifications	9
5.7	Flowcharts	11
5.7.1	Initialization Function.....	12
5.7.2	System Initialization Function	13
5.7.3	I/O Port Setup	14
5.7.4	CPU Clock Setup.....	17
5.7.5	A/D Converter Setup	18
5.7.6	Main Processing.....	24
5.7.7	Enabling A/D Voltage Comparator.....	28
5.7.8	Starting A/D Conversion.....	28
5.7.9	Getting A/D Conversion Results.....	29
5.7.10	Stopping A/D Conversion.....	29
6.	Sample Code	30
7.	Documents for Reference	30
	Revision Record	31
	General Precautions in the Handling of MPU/MCU Products	32

1. Specifications

This application note explains how to use the multiplier and divider/multiply-accumulator in the multiply-accumulator mode (unsigned). The sample application covered in this application note sets up the multiplier and divider/multiply-accumulator for multiply-accumulator mode (unsigned) operation, multiplies the conversion results (ANI0, ANI1, ANI2, and ANI3) from the A/D converter by the multipliers (10, 11, 12, and 13) assigned to the respective analog input channels, and accumulates their calculation results for each channel. When all of the accumulated values of all the channels exceed a predetermined value (10,000), the application turns on the LED, stops the A/D converter to place in the HALT mode.

Table 1.1 shows the peripheral functions to be used and their uses. Figure 1.1 shows the outline of the multiply-accumulator operation.

Table 1.1 Peripheral Functions to be Used and their Uses

Peripheral Function	Use
Multiplier and divider/multiply-accumulator	Performs multiply-accumulator operation on the A/D conversion results.
A/D converter	Converts the level of the analog signal inputs to pins P20/ANI0 to P23/ANI3.

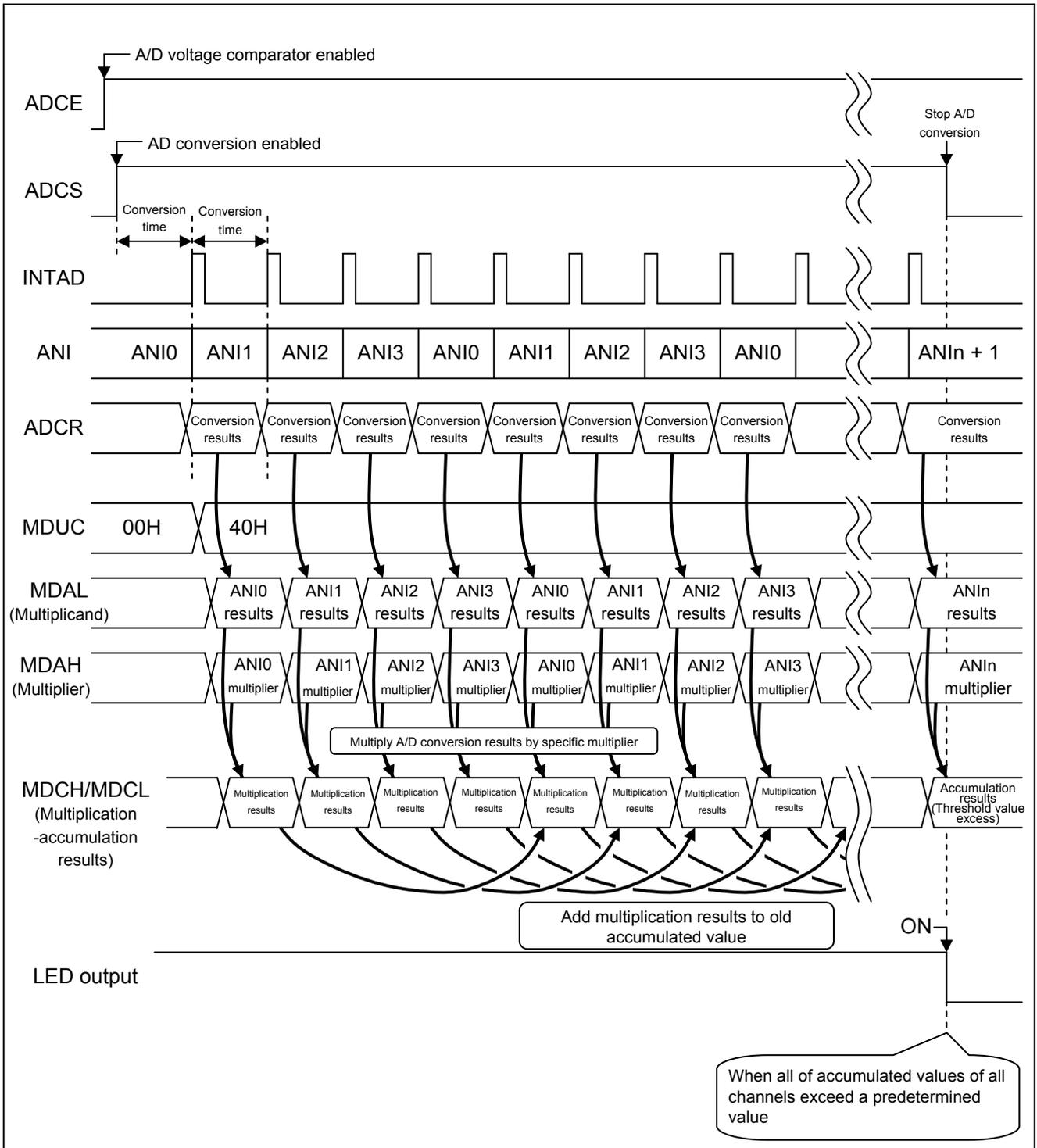


Figure 1.2 Outline of Multiplication-Accumulation Operation

2. Operation Check Conditions

The sample code contained in this application note has been checked under the conditions listed in the table below.

Table 2.1 Operation Check Conditions

Item	Description
Microcontroller used	RL78/G13 (R5F100LEA)
Operating frequency	<ul style="list-style-type: none">• High-speed on-chip oscillator (HOCO) clock: 32 MHz• CPU/peripheral hardware clock: 32 MHz
Operating voltage	5.0 V (can run on a voltage range of 2.9 V to 5.5 V.) LVD operation (V_{LVI}): Reset mode 2.81 V (2.76 V to 2.87 V)
Integrated development environment	CubeSuite + V1.00.01 from Renesas Electronics Corp.
C compiler	CA78K0R V1.20 from Renesas Electronics Corp.

3. Related Application Note

The application notes that are related to this application note are listed below for reference.

RL78/G13 Initialization (R01AN0451E) Application Note

RL78/G13 A/D Converter (Software Trigger and Sequential Conversion Modes) (R01AN0452E) Application Note

4. Description of the Hardware

4.1 Hardware Configuration Example

Figure 4.1 shows an example of hardware configuration that is used for this application note.

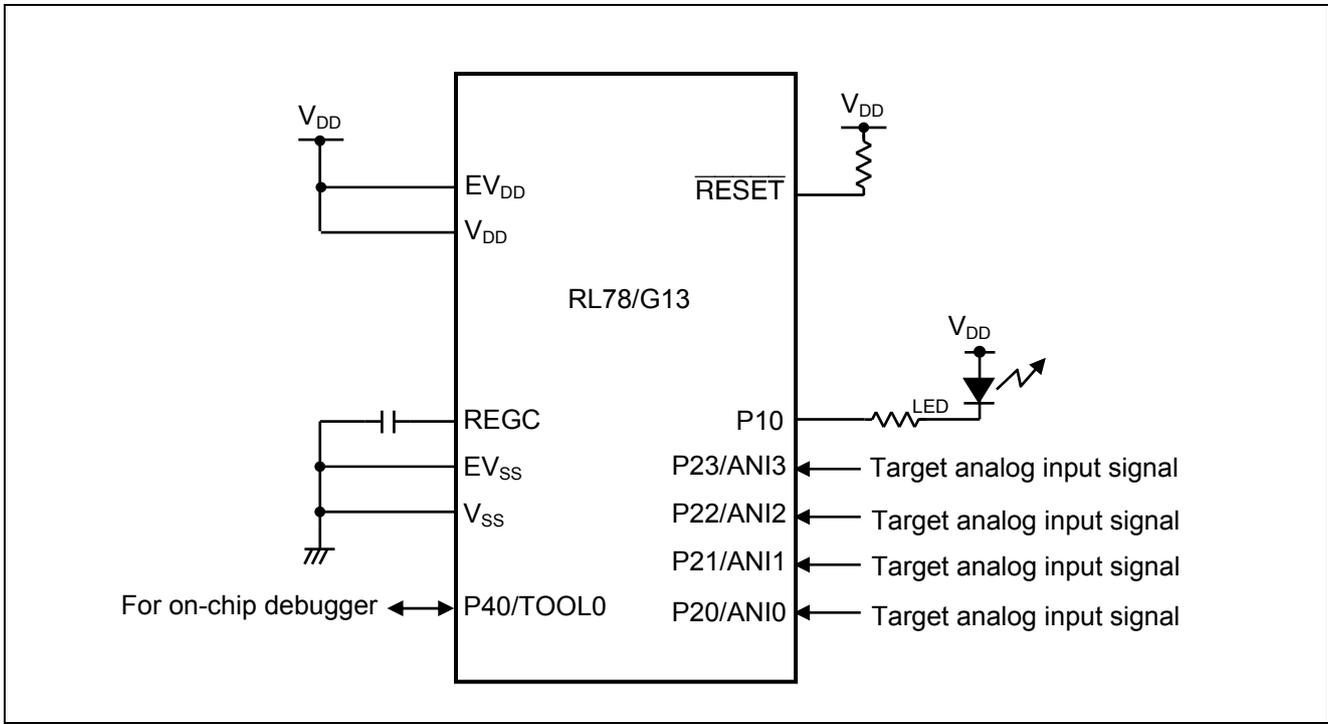


Figure 4.1 Hardware Configuration

- Cautions:
1. The purpose of this circuit is only to provide the connection outline and the circuit is simplified accordingly. When designing and implementing an actual circuit, provide proper pin treatment and make sure that the hardware's electrical specifications are met (connect the input-only ports separately to V_{DD} or V_{SS} via a resistor).
 2. Connect any pins whose name begins with EV_{SS} to V_{SS} and any pins whose name begins with EV_{DD} to V_{DD} , respectively.
 3. V_{DD} must be held at not lower than the reset release voltage (V_{LVI}) that is specified as LVD.

4.2 List of Pins to be Used

Table 4.1 lists the pins to be used and their functions.

Table 4.1 Pins to be Used and their Functions

Pin Name	I/O	Description
P20/ANI0 to P23/ANI3	Input	A/D converter analog input port
P10	Output	LED lighting control port

5. Description of the Software

5.1 Operation Outline

This application note explains how to use the multiplier and divider/multiply-accumulator in the multiply-accumulator mode (unsigned). The sample application covered in this application note sets up the multiplier and divider/multiply-accumulator for multiply-accumulator mode (unsigned) operation, multiplies the conversion results (ANI0, ANI1, ANI2, and ANI3) from the A/D converter by the multipliers (10, 11, 12, and 13) assigned to the respective analog input channels, and accumulates their calculation results for each channel. When all of the accumulated values of all the channels exceeds a predetermined value (10,000), the application turns on the LED, stops the A/D converter to place in the HALT mode.

(1) Initialize the A/D converter.

<Conditions for setting>

- Use pins P20/ANI0 to P23/ANI3 for the analog inputs.
- Set A/D conversion channel selection mode to scan mode.
- Set A/D conversion operation mode to sequential conversion mode.
- Start A/D conversion by using the software trigger.
- Set A/D conversion time to 19 us.
- Use the A/D conversion end interrupt (INTAD).

(2) The sample program sets the ADCS bit in the ADM0 register to 1 (A/D conversion start) to start A/D conversion and executes the HALT instruction to enter the HALT mode and waits for an A/D conversion end interrupt (INTAD).

(3) When the A/D conversion on one channel is completed, its A/D conversion results are transferred to the ADCR register. The HALT mode is exited by the occurrence of an A/D conversion end interrupt (INTAD).

(4) The application places the multiplier and divider/multiply-accumulator in multiply-accumulator mode and multiplies the A/D conversion results by preassigned multiplier. It stores the results of the multiplication in the on-chip RAM, sets up the HALT mode again, and waits for an A/D conversion end interrupt (INTAD).

(5) Subsequently, the application repeats, for each channel, the cycle of multiplying the A/D conversion results by a preassigned multiplier and accumulating its results on each completion of A/D conversion on one channel. When the results of the accumulated values exceed 10,000, the application stops the multiplication-accumulation cycle.

(6) When all of the accumulated values of all channels exceed 10,000, the application turns on the LED connected to P10. The application then stops the A/D converter and transitions to the HALT mode.

5.2 List of Option Byte Settings

Table 5.1 summarizes the settings of the option bytes.

Table 5.1 Option Byte Settings

Address	Value	Description
000C0H/010C0H	01101110B	Disables the watchdog timer. (Stops counting after the release from the reset status.)
000C1H/010C1H	01111111B	LVD reset mode, 2.81 V (2.76 V to 2.87 V)
000C2H/010C2H	11101000B	HS mode HOCO: 32 MHz
000C3H/010C3H	10000100B	Enables the on-chip debugger.

5.3 List of Constants

Table 5.2 lists constants that are used by this sample program.

Table 5.2 Constants for the Sample Program

Constant	Setting	Description
CHNUM	4	Number of analog input channels to be used
BUFSIZE	64	Size of buffer to store accumulation results
THRESHOLD	0x00010000	Threshold of accumulation results
multiplier_table[4]	10,11,12,13	Values to be used as multipliers

5.4 List of Variables

Table 5.3 lists the global variables that are used by this sample program.

Table 5.3 Global Variable

Type	Variable Name	Contents	Function Used
uint16_t	adc_buffer[4]	Buffer to store A/D conversion results	main()
uint8_t	ch_counter	Counter for the analog input channels	main()
uint32_t	mac_buffer[4] [64]	Buffer to store accumulation results	main()
uint8_t	mac_counter	Counter for counting the number of accumulation	main()
uint8_t	threshold_flag[4]	Threshold value excess flag	main()

5.5 List of Functions

Table 5.4 lists the functions that are used in this sample program.

Table 5.4 Functions

Function Name	Outline
R_ADC_Set_OperationOn	Enables the A/D voltage comparator for operation.
R_ADC_Start	Starts A/D conversion.
R_ADC_Get_Result	Gets the A/D conversion results.
R_ADC_Stop	Stops A/D conversion.

5.6 Function Specifications

This section describes the specifications for the functions that are used in the sample code.

[Function Name] R_ADC_Set_OperationOn

Synopsis	Enable A/D voltage comparator
Header	r_cg_adc.h
Declaration	void R_ADC_Set_OperationOn(void)
Explanation	This function enables the A/D voltage comparator for operation.
Arguments	None
Return value	None
Remarks	None

[Function Name] R_ADC_Start

Synopsis	Starts A/D conversion.
Header	r_cg_adc.h
Declaration	void R_ADC_Start(void)
Explanation	This function starts the A/D conversion operation.
Arguments	None
Return value	None
Remarks	None

[Function Name] R_ADC_Get_Result

Synopsis	Gets the A/D conversion results.	
Header	r_cg_adc.h	
Declaration	void R_ADC_Get_Result(uint16_t *buffer)	
Explanation	This function gets the A/D conversion results.	
Arguments	buffer	: Address of RAM area to store conversion results
Return value	None	
Remarks	None	

[Function Name] R_ADC_Stop

Synopsis	Stops A/D conversion.	
Header	r_cg_adc.h	
Declaration	void R_ADC_Stop(void)	
Explanation	This function stops the A/D conversion operation.	
Arguments	None	
Return value	None	
Remarks	None	

5.7 Flowcharts

Figure 5.1 shows the overall flow of the sample program described in this application note.

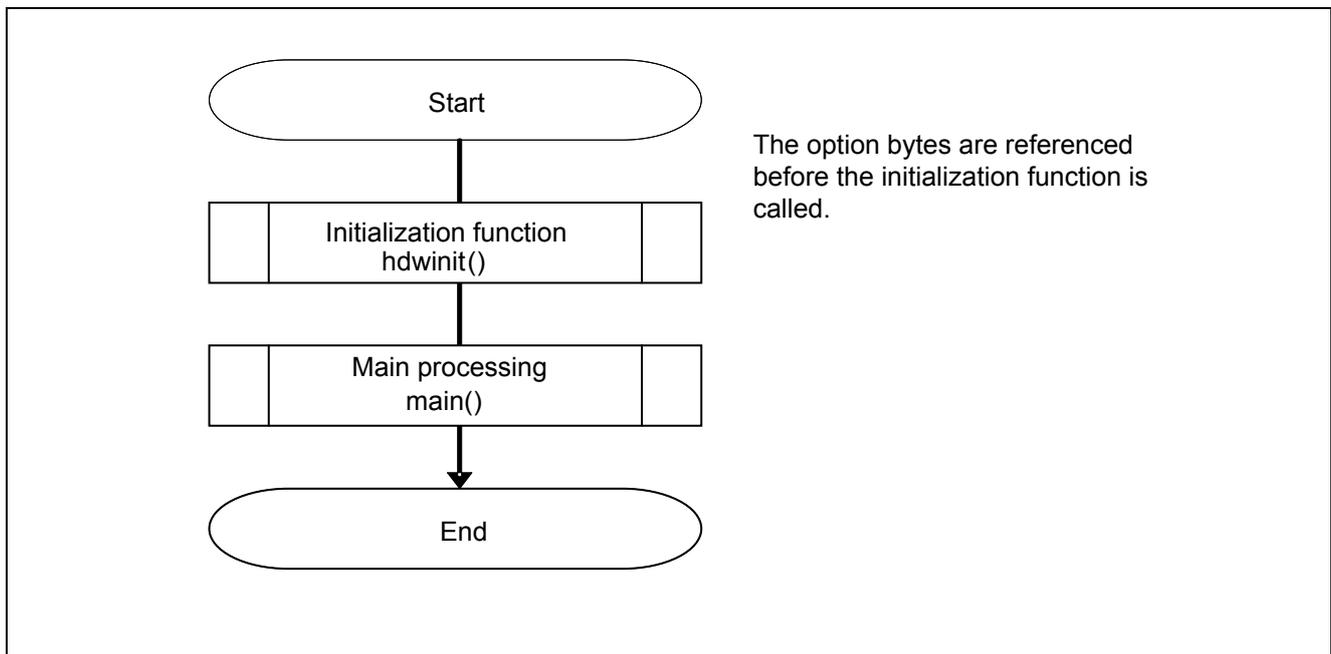


Figure 5.1 Overall Flow

5.7.1 Initialization Function

Figure 5.2 shows the flowchart for the initialization function.

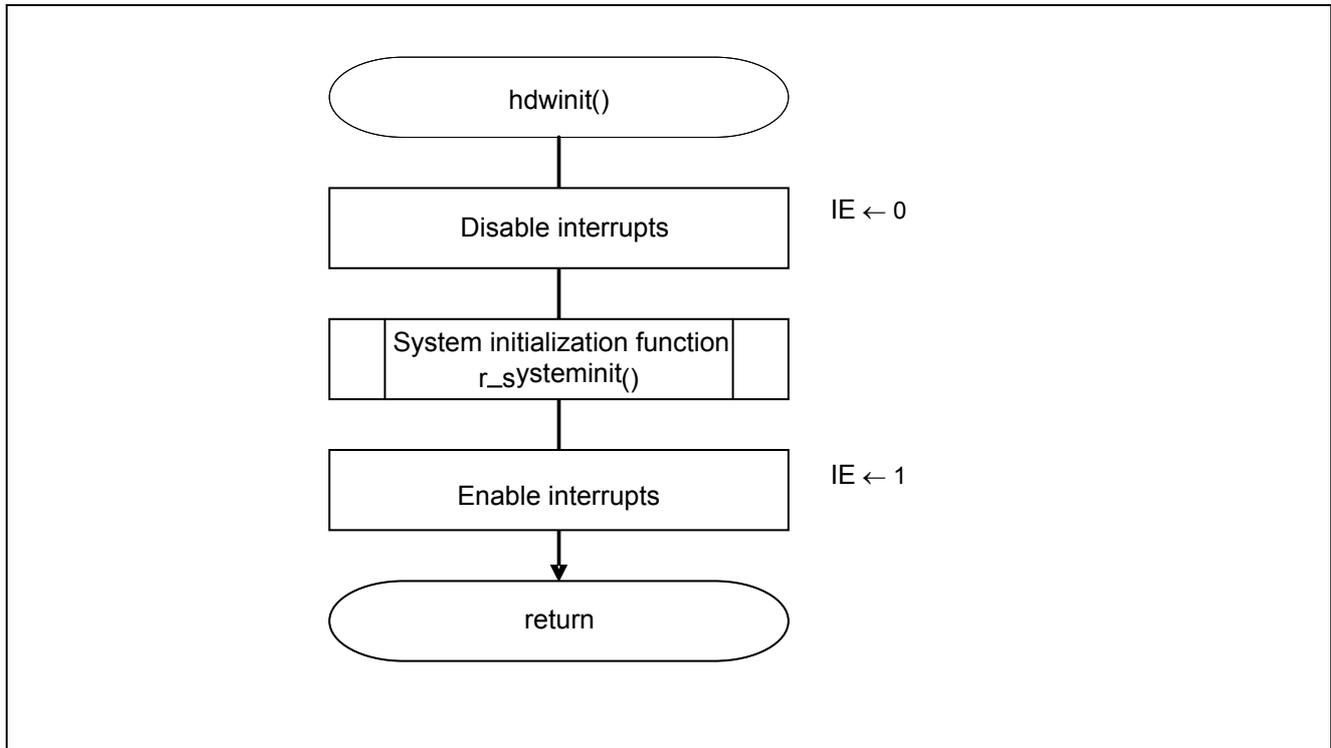


Figure 5.2 Initialization Function

5.7.2 System Initialization Function

Figure 5.3 shows the flowchart for the system initialization function.

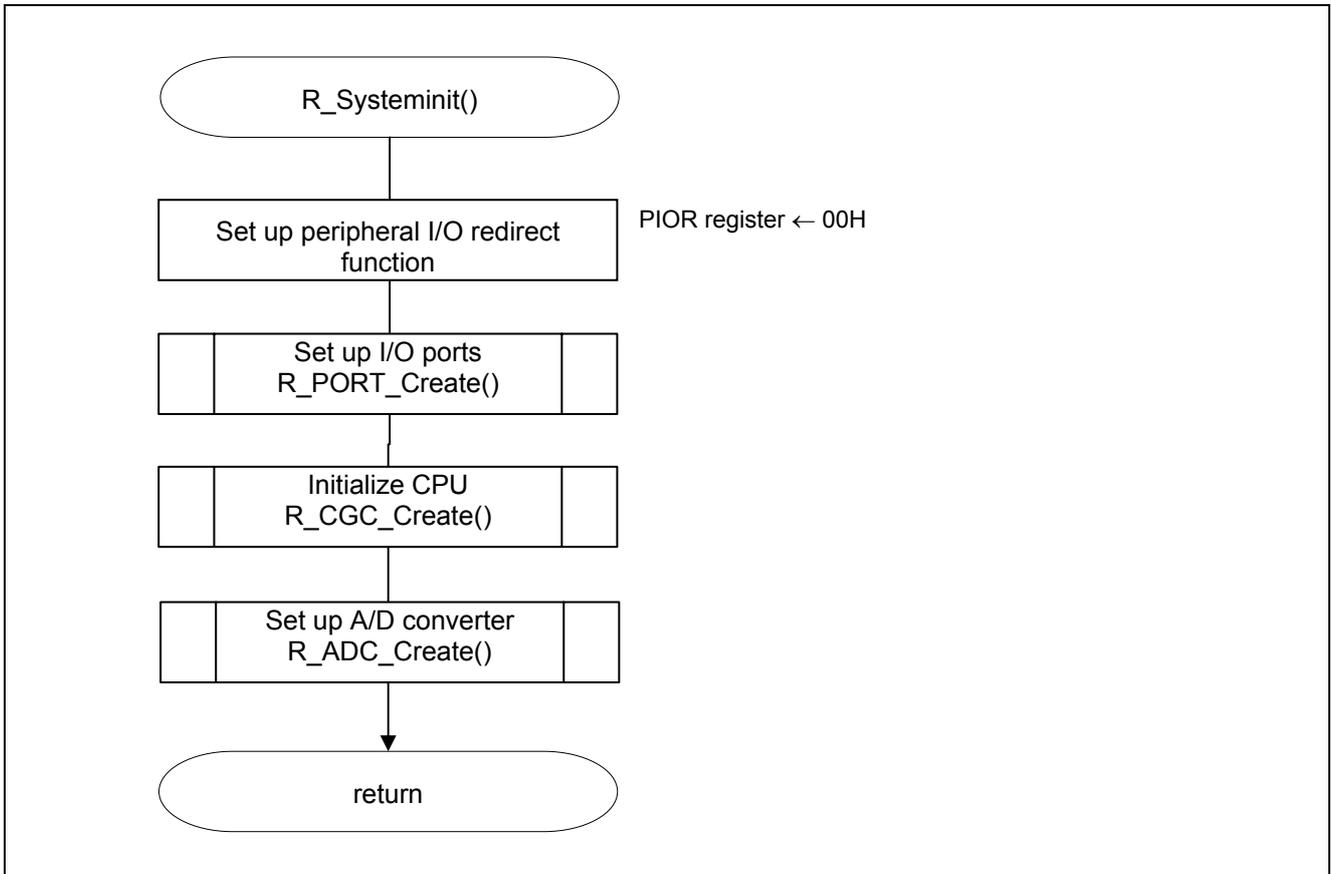


Figure 5.3 System Initialization Function

5.7.3 I/O Port Setup

Figure 5.4 shows the flowchart for setting up the I/O ports.

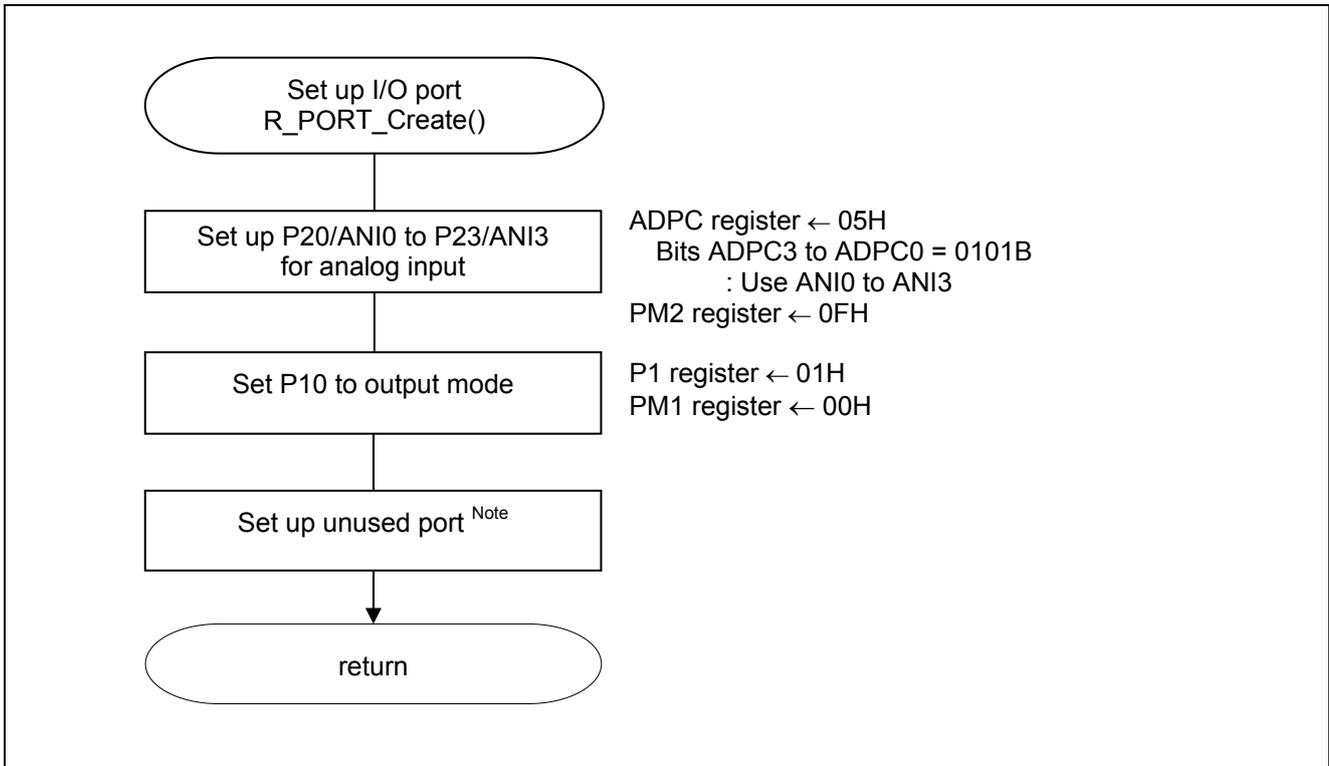


Figure 5.4 I/O Port Setup

Note: Refer to the section entitled "Flowcharts" in RL78/G13 Initialization Application Note (R01AN0451E) for the configuration of the unused ports.

Caution: Provide proper treatment for unused pins so that their electrical specifications are met. Connect each of any unused input-only ports to V_{DD} or V_{SS} via a separate resistor.

Setting up the channel to be used for A/D conversion

- A/D port configuration register (ADPC)
Switches between A/D converter analog input and port digital I/O.
- Port mode register 2 (PM2)
Selects the I/O mode of each port.

Symbol: ADPC

7	6	5	4	3	2	1	0
0	0	0	0	ADPC3	ADPC2	ADPC1	ADPC0
0	0	0	0	0	1	0	1

Bits 3 to 0

ADPC3	ADPC2	ADPC1	ADPC0	Available analog input
0	0	0	0	ANI0 to ANI14
0	0	0	1	None
0	0	1	0	ANI0
0	0	1	1	ANI0 to ANI1
0	1	0	0	ANI0 to ANI2
0	1	0	1	ANI0 to ANI3
0	1	1	0	ANI0 to ANI4
0	1	1	1	ANI0 to ANI5
1	0	0	0	ANI0 to ANI6
1	0	0	1	ANI0 to ANI7
1	0	1	0	ANI0 to ANI8
1	0	1	1	ANI0 to ANI9
1	1	0	0	ANI0 to ANI10
1	1	0	1	ANI0 to ANI11
1	1	1	0	ANI0 to ANI12
1	1	1	1	ANI0 to ANI13
Other than above				Setting prohibited

Symbol: PM2

7	6	5	4	3	2	1	0
PM27	PM26	PM25	PM24	PM23	PM22	PM21	PM20
x	x	x	x	1	1	1	1

Bits 3 to 0

PM23 to PM20	P23 to P20 I/O mode selection
0	Output mode (output buffer on)
1	Input mode (output buffer off)

Caution: For details on the register setup procedures, refer to RL78/G13 User's Manual: Hardware.

Setting up LED ports

- Port register 1 (P1)
- Port mode register 1 (PM1)

Symbol: P0

7	6	5	4	3	2	1	0
P17	P16	P15	P14	P13	P12	P11	P10
0	0	0	0	0	0	0	1

Bit 0

P10	P10 pin output data control (in output mode)
0	Output 0
1	Output 1

Symbol: PM0

7	6	5	4	3	2	1	0
PM17	PM16	PM15	PM14	PM13	PM12	PM11	PM10
1	0	0	0	0	0	0	0

Bit 0

PM10	P10 pin I/O mode selection
0	Output mode (output buffer on)
1	Input mode (output buffer off)

Caution: For details on the register setup procedures, refer to RL78/G13 User's Manual: Hardware.

5.7.4 CPU Clock Setup

Figure 5.5 shows the flowchart for setting up the CPU clock.

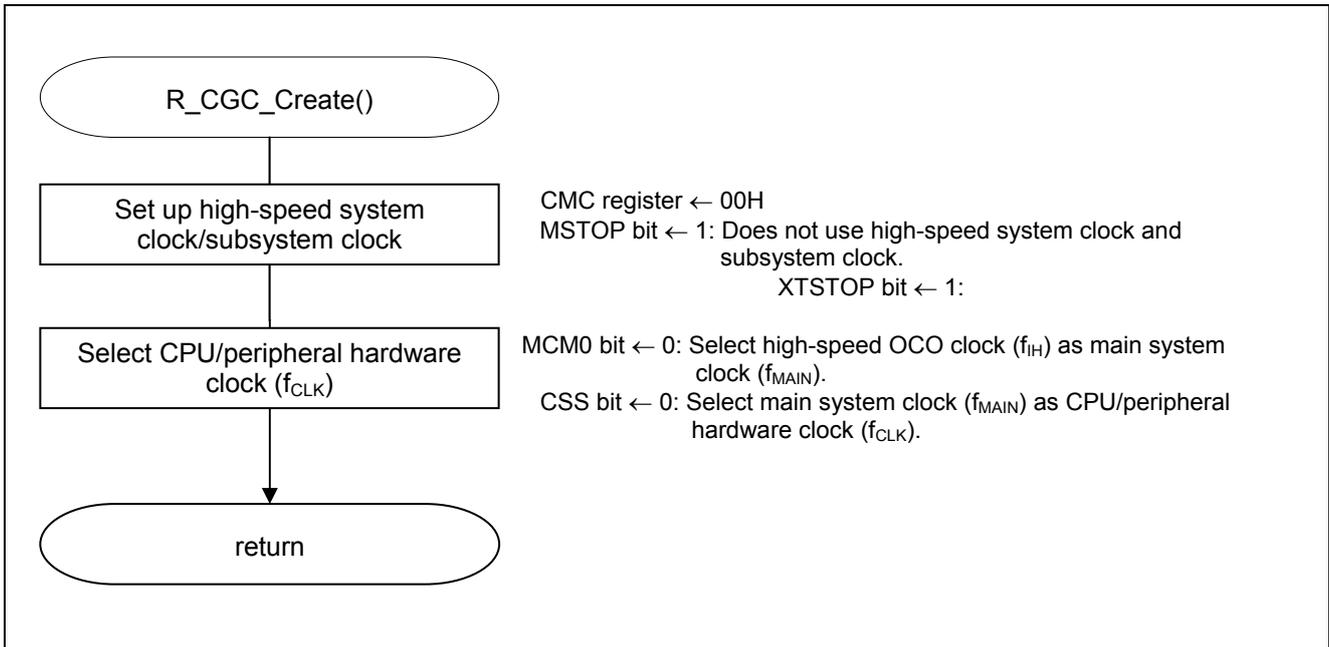


Figure 5.5 CPU Clock Setup

Caution: For details on the procedure for setting up the CPU clock (R_CGC_Create ()), refer to the section entitled "Flowcharts" in RL78/G13 Initialization Application Note (R01AN0451E).

5.7.5 A/D Converter Setup

Figure 5.6 shows the flowchart for setting up the A/D converter.

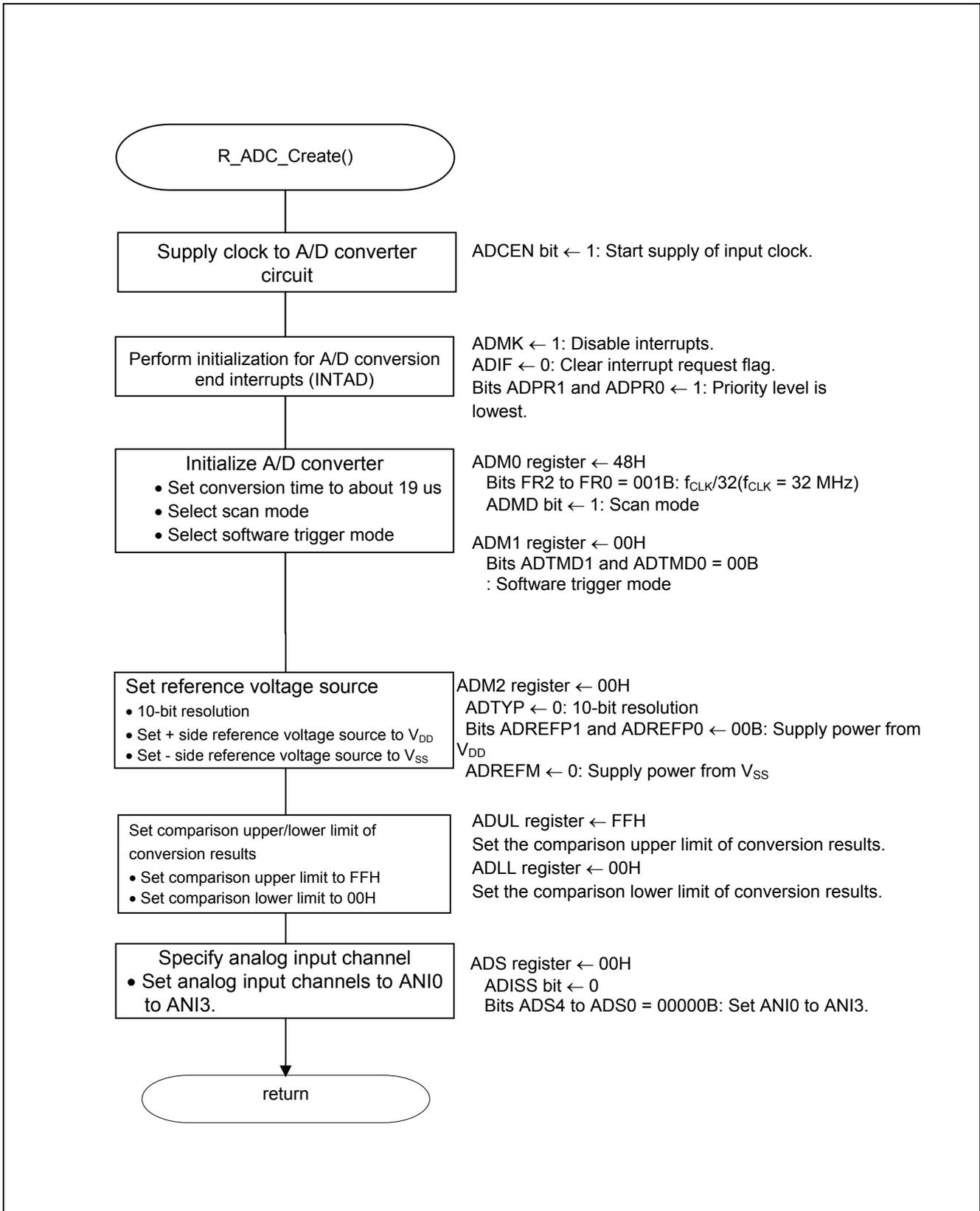


Figure 5.6 A/D Converter Setup

Starting the supply of clock to the A/D converter

- Peripheral enable register 0 (PER0)
Starts the supply of the clock to the A/D converter.

Symbol: PER0

7	6	5	4	3	2	1	0
RTCEN	IICA1EN	ADCEN	IICA0EN	SAU1EN	SAU0EN	TAU1EN	TAU0EN
x	x	1	x	x	x	x	x

Bit 5

ADCEN	A/D converter input clock control
0	Stops supply of input clock.
1	Starts supply of input clock.

Caution: For details on the register setup procedures, refer to RL78/G13 User's Manual: Hardware.

Setting up the A/D conversion time and operating mode

- A/D converter mode register 0 (ADM0)
Controls the A/D conversion operation.
Specifies the A/D channel selection mode.

Symbol: ADM0

7	6	5	4	3	2	1	0
ADCS	ADMD	FR2	FR1	FR0	LV1	LV0	ADCE
x	1	0	0	1	0	0	x

Bit 6

ADMD	Specification of the A/D channel selection mode
0	Select mode
1	Scan mode

Bits 5 to 1

ADM0					Mode	Conversion Time Selection						Conversion Clock (f _{AD})				
FR2	FR1	FR0	LV1	LV0		f _{CLK} = 1 MHz	f _{CLK} = 2 MHz	f _{CLK} = 4 MHz	f _{CLK} = 8 MHz	f _{CLK} = 16 MHz	f _{CLK} = 32 MHz					
0	0	0	0	0	Normal 1	Setting prohibited	Setting prohibited	Setting prohibited	Setting prohibited	Setting prohibited	38 μs	f _{CLK} /64				
0	0	1									38 μs	19 μs	f_{CLK}/32			
0	1	0									38 μs	19 μs	9.5 μs	f _{CLK} /16		
0	1	1									38 μs	19 μs	9.5 μs	4.75 μs	f _{CLK} /8	
1	0	0									28.5 μs	14.25 μs	7.125 μs	3.5625 μs	f _{CLK} /6	
1	0	1									23.75 μs	11.875 μs	5.938 μs	2.9688 μs	f _{CLK} /5	
1	1	0									38 μs	19 μs	9.5 μs	4.75 μs	2.375 μs	f _{CLK} /4
1	1	1									38 μs	19 μs	9.5 μs	4.75 μs	2.375 μs	Setting prohibited
0	0	0	0	1	Normal 2	Setting prohibited	Setting prohibited	Setting prohibited	Setting prohibited	Setting prohibited	34 μs	f _{CLK} /64				
0	0	1									34 μs	17 μs	f _{CLK} /32			
0	1	0									34 μs	17 μs	8.5 μs	f _{CLK} /16		
0	1	1									34 μs	17 μs	8.5 μs	4.25 μs	f _{CLK} /8	
1	0	0									25.5 μs	12.75 μs	6.375 μs	3.1875 μs	f _{CLK} /6	
1	0	1									21.25 μs	10.625 μs	5.3125 μs	2.6536 μs	f _{CLK} /5	
1	1	0									34 μs	17 μs	8.5 μs	4.25 μs	2.125 μs	f _{CLK} /4
1	1	1									34 μs	17 μs	8.5 μs	4.25 μs	2.125 μs	Setting prohibited
x	x	x	1	0	Low-voltage 1	Setting prohibited						—				
x	x	x	1	1	Low-voltage 2	Setting prohibited						—				

Caution: For details on the register setup procedures, refer to RL78/G13 User's Manual: Hardware.

Setting up the A/D conversion trigger

- A/D converter mode register 1 (ADM1)
Selects the A/D conversion trigger mode.
Selects the A/D conversion operating mode.

Symbol: ADM1

7	6	5	4	3	2	1	0
ADTMD1	ADTMD0	ADSCM	0	0	0	ADTRS1	ADTRS0
0	0	0	0	0	0	0	0

Bits 7 and 6

ADTMD1	ADTMD0	Selection of the A/D conversion trigger mode
0	—	Software trigger mode
1	0	Hardware trigger no-wait mode
1	1	Hardware trigger wait mode

Bit 5

ADSCM	Selection of the A/D conversion mode
0	Sequential conversion mode
1	One-shot conversion mode

Caution: For details on the register setup procedures, refer to RL78/G13 User's Manual: Hardware.

Setting up the reference voltage

- A/D converter mode register 2 (ADM2)
Sets up the reference voltage source.

Symbol: ADM2

7	6	5	4	3	2	1	0
ADREFP1	ADREFP0	ADREFM	0	ADCRK	AWC	0	ADTYP
0	0	0	0	0	0	0	0

Bits 7 and 6

ADREFP1	ADREFP0	Selection of the + side reference voltage source of the A/D converter
0	0	Supplied from V _{DD}
0	1	Supplied from P20/AV _{REFP} /ANI0
1	0	Supplied from internal reference voltage (1.45 V)
1	1	Setting prohibited

Bit 5

ADREFM	Selection of the - side reference voltage source of the A/D converter
0	Supplied from V _{SS}
1	Supplied from P21/AV _{REFM} /ANI1

Bit 3

ADCRK	Checking the upper limit and lower limit conversion result values
0	Interrupt signal (INTAD) occurs when ADLL register \leq ADCR register \leq ADUL register.
1	Interrupt signal (INTAD) occurs when ADCR register < ADLL register and ADUL register < ADCR register.

Bit 2

AWC	Specification of the wakeup (SNOOZE mode) function
0	Does not use the SNOOZE mode function.
1	Uses the SNOOZE mode function.

Bit 0

ADTYP	Selection of the A/D conversion resolution
0	10-bit resolution
1	8-bit resolution

Caution: For details on the register setup procedures, refer to RL78/G13 User's Manual: Hardware.

Setting up the conversion result comparison upper limit/lower limit

- Conversion result comparison upper limit setting register (ADUL)
- Conversion result comparison lower limit setting register (ADLL)
Sets up the conversion result comparison upper and lower limits.

Symbol: ADUL

7	6	5	4	3	2	1	0
ADUL7	ADUL6	ADUL5	ADUL4	ADUL3	ADUL2	ADUL1	ADUL0
1	1	1	1	1	1	1	1

Symbol: ADLL

7	6	5	4	3	2	1	0
ADLL7	ADLL6	ADLL5	ADLL4	ADLL3	ADLL2	ADLL1	ADLL0
0	0	0	0	0	0	0	0

Specifying the input channel

- Analog input channel register (ADS)
Specifies the input channel for the analog signal to be subjected to A/D.

Symbol: ADS

7	6	5	4	3	2	1	0
ADISS	0	0	ADS4	ADS3	ADS2	ADS1	ADS0
0	0	0	0	0	0	0	0

Bits 7 and 4 to 0

ADISS	ADS4	ADS3	ADS2	ADS1	ADS0	Analog Input Channel			
						Scan 0	Scan 1	Scan 2	Scan 3
0	0	0	0	0	0	ANI0	ANI1	ANI2	ANI3
0	0	0	0	0	1	ANI1	ANI2	ANI3	ANI4
0	0	0	0	1	0	ANI2	ANI3	ANI4	ANI5
0	0	0	0	1	1	ANI3	ANI4	ANI5	ANI6
:						:			
0	0	1	0	1	0	ANI10	ANI11	ANI12	ANI13
0	0	1	0	1	1	ANI11	ANI12	ANI13	ANI14
Other than above						Setting prohibited			

Caution: For details on the register setup procedures, refer to RL78/G13 User's Manual: Hardware.

5.7.6 Main Processing

Figures 5.7 show the flowchart for the main processing.

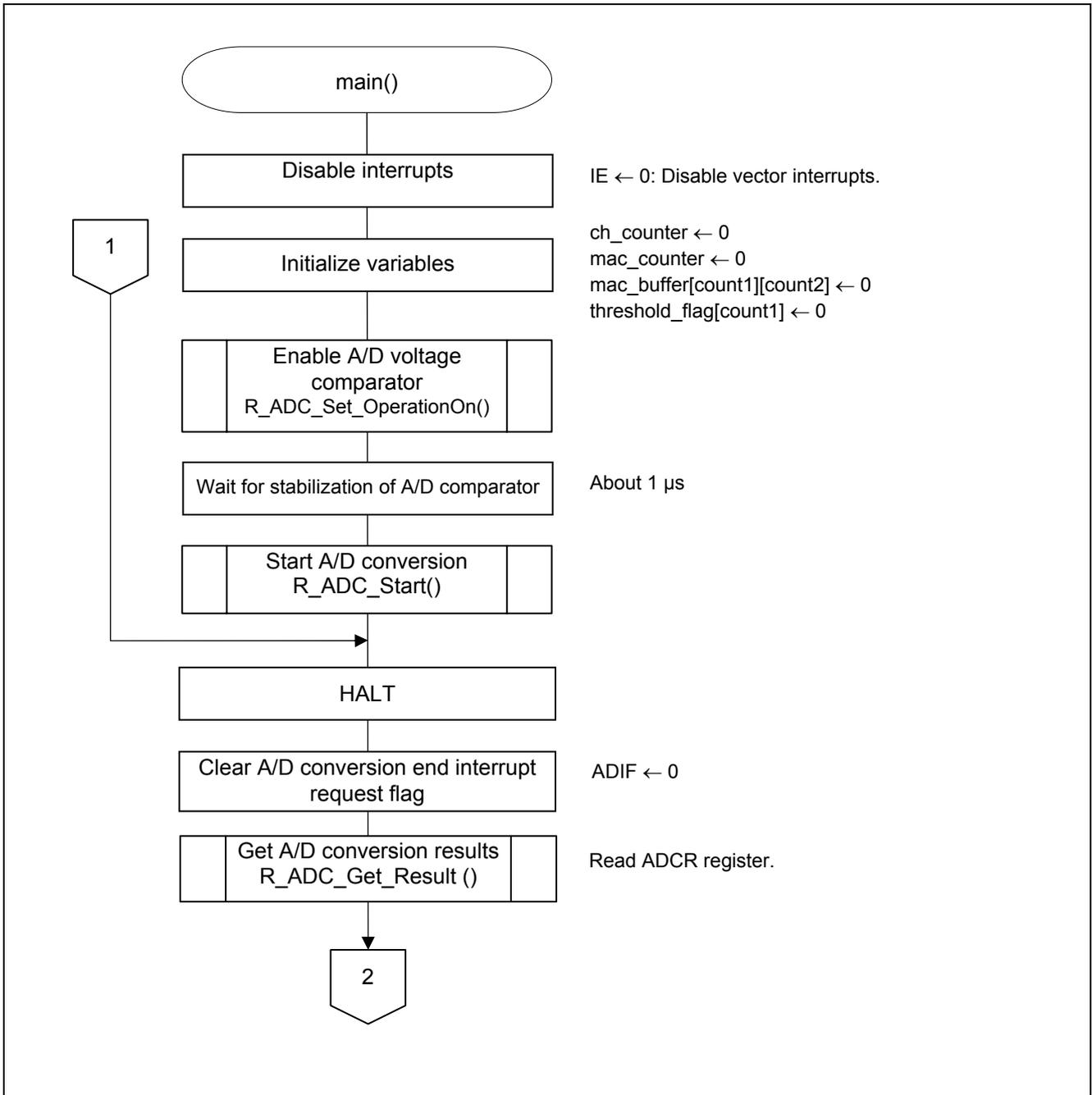


Figure 5.7 Main Processing (1/2)

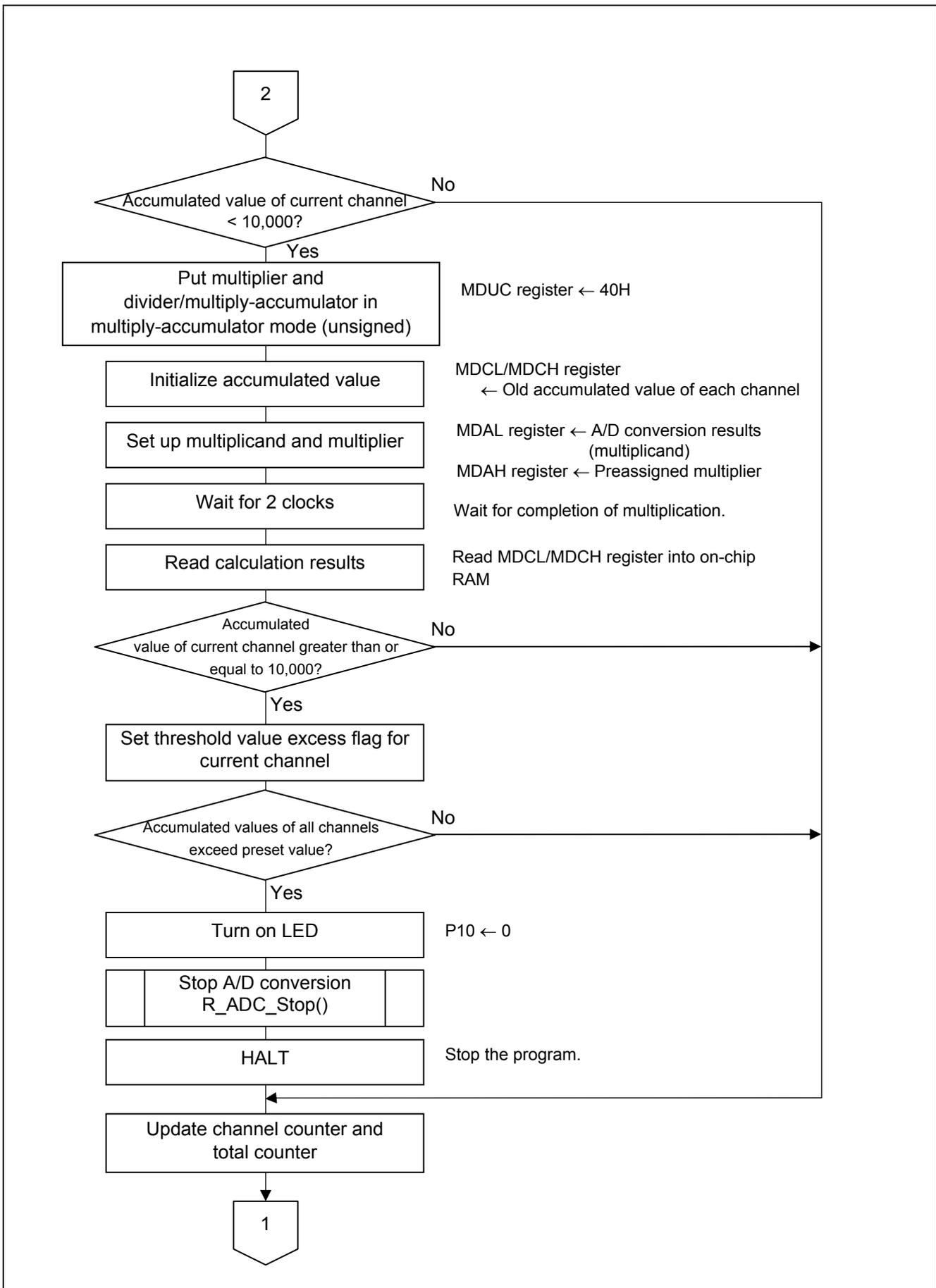


Figure 5.7 Main Processing (2/2)

Setting up multiply-accumulator mode

- Multiplication/division control register 0 (MDUC)
Control the operation of the multiplier and divider/multiply-accumulator.

Symbol: MDUC

7	6	5	4	3	2	1	0
DIVMODE	MACMODE	0	0	MDSM	MDCOF	MACSF	DIVST
0	1	0	0	0	x	x	x

Bits 7, 6 and 3

DIVMODE	MACMODE	MDSM	Operation mode select
0	0	0	Multiplication mode (unsigned) (default)
0	0	1	Multiplication mode (signed)
0	1	0	Multiply-accumulator mode (unsigned)
0	1	1	Multiply-accumulator mode (signed)
1	0	0	Division mode (unsigned), division completion interrupt (INTMD generated)
1	1	0	Division mode (unsigned), division completion interrupt (no INTMD generated)

Caution: For details on the register setup procedures, refer to RL78/G13 User's Manual: Hardware.

Setting up values for multiplication-accumulation

- Multiplication/division data register A (MDAH, MDAL)
Set up values to be used for multiplication/division.
- Multiplication/division data register C (H) (MDCH)
- Multiplication/division data register C (L) (MDCL)
Set up initial accumulated value.

Symbol: MDAH

MDA															
H15	H14	H13	H12	H11	H10	H9	H8	H7	H6	H5	H4	H3	H2	H1	H0

Symbol: MDAL

MDA															
L15	L14	L13	L12	L11	L10	L9	L8	L7	L6	L5	L4	L3	L2	L1	L0

Remarks: For multiply-accumulator mode (unsigned) operation, load MDAL with the multiplicand (unsigned) and MDAH with the multiplier (unsigned).

Note: For details on the register setup procedures, refer to RL78/G13 User's Manual: Hardware.

Symbol: MDCH

MDC															
H15	H14	H13	H12	H11	H10	H9	H8	H7	H6	H5	H4	H3	H2	H1	H0

Symbol: MDCL

MDC															
L15	L14	L13	L12	L11	L10	L9	L8	L7	L6	L5	L4	L3	L2	L1	L0

Remarks: In multiply-accumulator mode (unsigned), MDCH is loaded with the upper 16 bits of the accumulated value (unsigned) and MDCL with the lower 16 bits of the accumulated value (unsigned) after the operation is completed.

Caution: For details on the register setup procedures, refer to RL78/G13 User's Manual: Hardware.

5.7.7 Enabling A/D Voltage Comparator

Figure 5.8 shows the flowchart for enabling the A/D voltage comparator.

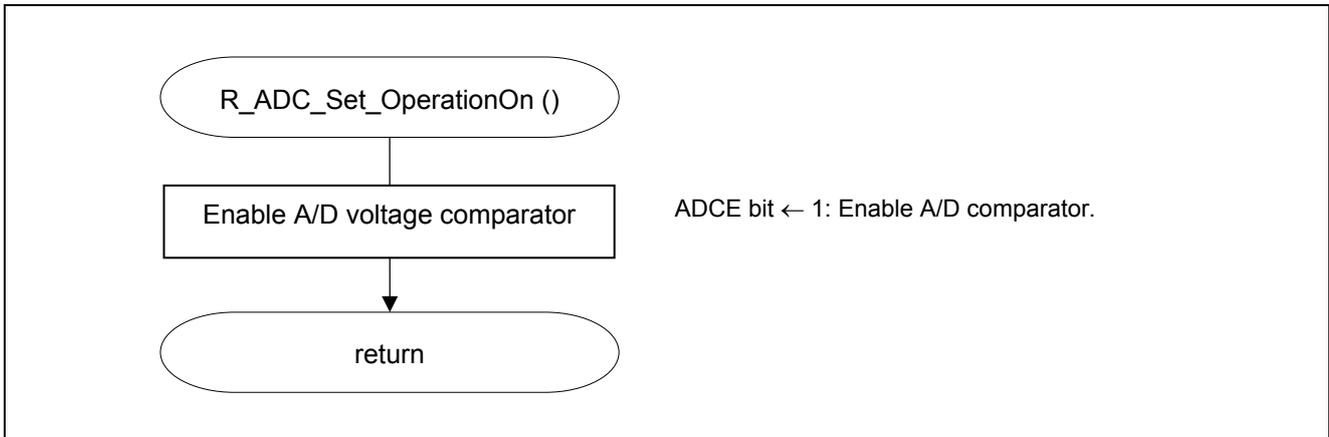


Figure 5.8 Enabling A/D Voltage Comparator

5.7.8 Starting A/D Conversion

Figure 5.9 shows the flowchart for starting A/D conversion.

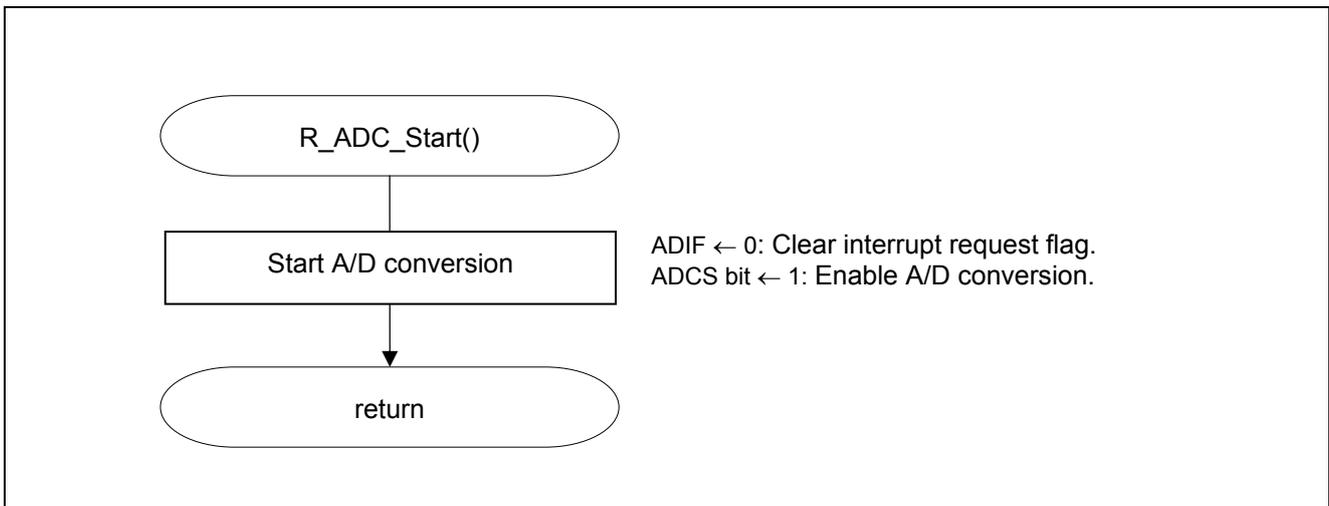


Figure 5.9 Starting A/D Conversion

5.7.9 Getting A/D Conversion Results

Figure 5.10 shows the flowchart for getting the A/D conversion results.

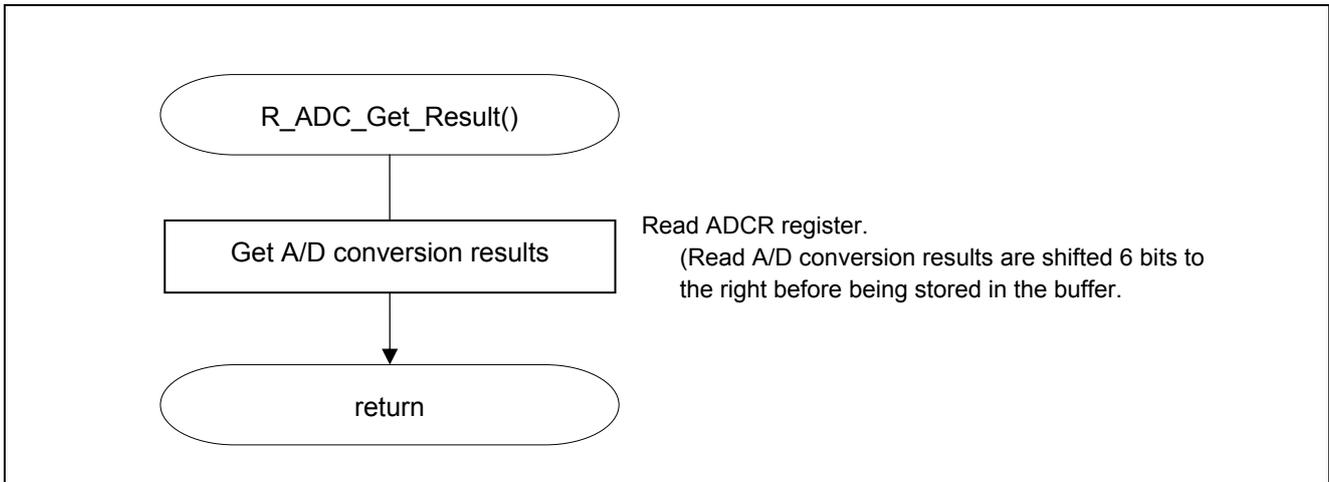


Figure 5.10 Getting A/D Conversion Results

5.7.10 Stopping A/D Conversion

Figure 5.11 shows the flowchart for stopping A/D conversion.

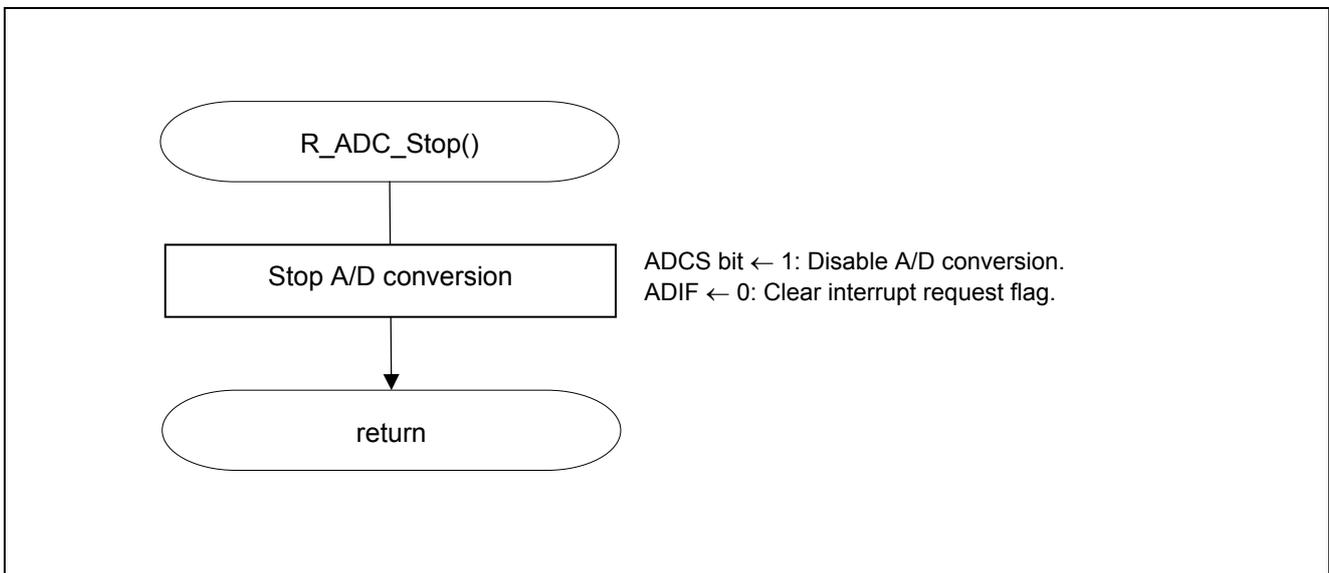


Figure 5.11 Stopping A/D Conversion

6. Sample Code

The sample code is available on the Renesas Electronics Website.

7. Documents for Reference

RL78/G13 User's Manual: Hardware (R01UH0146E)

RL78 Family User's Manual: Software (R01US0015E)

(The latest versions of the documents are available on the Renesas Electronics Website.)

Technical Updates/Technical Brochures

(The latest versions of the documents are available on the Renesas Electronics Website.)

Website and Support

Renesas Electronics Website

- <http://www.renesas.com/index.jsp>

Inquiries

- <http://www.renesas.com/contact/>

Revision Record	RL78/G13 Multiplier and Divider/Multiply-Accumulator (A/D Converter in Sequential Conversion Mode)
-----------------	--

Rev.	Date	Description	
		Page	Summary
1.00	Jan. 31, 2012	—	First edition issued.

All trademarks and registered trademarks are the property of their respective owners.

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 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.

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.



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: +44-1628-585-100, Fax: +44-1628-585-900

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.
1 harbourFront Avenue, #06-10, Keppel Bay Tower, Singapore 098632
Tel: +65-6213-0200, Fax: +65-6278-8001

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