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## RL78/G10

R01AN4758EJ0100

Rev.1.00

May.31.19

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### Hand dryer

#### Introduction

This application note explains how to realize a hand dryer using RL78/G10

#### Target Device

RL78/G10

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

**Contents**

|                                          |    |
|------------------------------------------|----|
| 1. Specifications .....                  | 3  |
| 1.1 Temperature Sensor.....              | 4  |
| 1.2 Fan Control circuit .....            | 4  |
| 1.3 Heater Control circuit.....          | 4  |
| 1.4 Human Sensor.....                    | 4  |
| 2. Operation Check Conditions .....      | 5  |
| 3. Hardware Descriptions .....           | 6  |
| 3.1 Hardware Configuration .....         | 6  |
| 3.2 List of Pins used .....              | 6  |
| 4. Software Descriptions.....            | 7  |
| 4.1 Operation Summary .....              | 7  |
| 4.2 List of Option Byte Setting .....    | 7  |
| 4.3 List of Variables .....              | 7  |
| 4.4 List of Functions (Subroutines)..... | 7  |
| 4.5 Function Specifications .....        | 8  |
| 4.6 Flowcharts .....                     | 10 |
| 4.6.1 Initial Setting Function .....     | 10 |
| 4.6.2 System Function.....               | 11 |
| 4.6.3 I/O Port Setup.....                | 12 |
| 4.6.4 CPU Clock Setup.....               | 13 |
| 4.6.5 A/D converter Setup .....          | 14 |
| 4.6.6 Interrupt Setup.....               | 15 |
| 4.6.7 Main Processing.....               | 16 |
| 4.6.8 Initialization Function .....      | 17 |
| 4.6.9 Enable Interrupt Setting.....      | 17 |
| Revision History .....                   | 20 |

## 1. Specifications

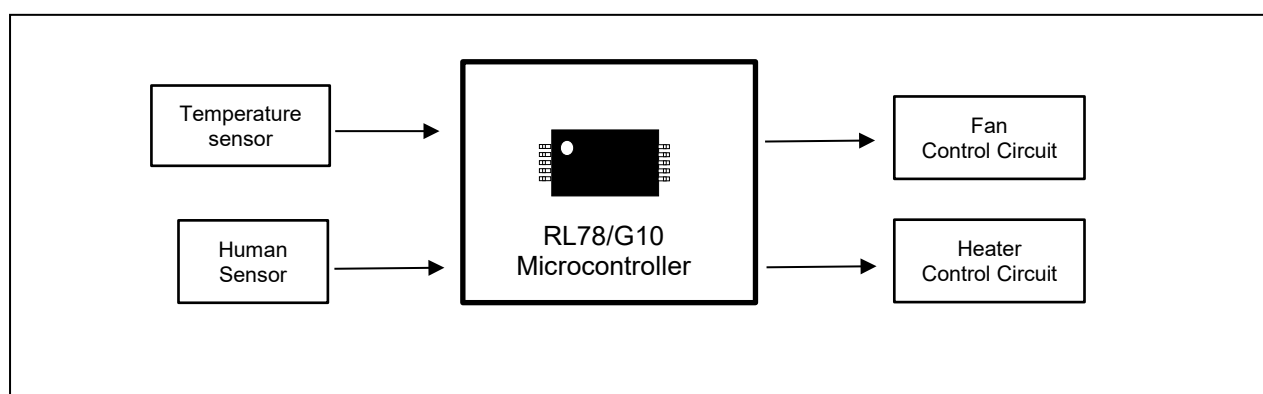
In this application note, when the hand dryer is turned on, external interrupt from the human sensor is enabled. When the human sensor detects the hand, it turns on the fan(P03=H). Also, control heater power according to the room temperature. When the room temperature is below 20°C, turn on the heater(P04=H). When the room temperature exceeds 20°C, turn off the heater(P04=L).

When the human sensor detects no hand, the fan and heater are turned off (P03=L, P04=L).

**Table 1.1 Room Temperature and port's output of List**

| Human Sensor   | Room Temperature | Fan           | Heater        |
|----------------|------------------|---------------|---------------|
| No detection   | —                | OFF (P03 = L) | OFF (P04 = L) |
| With detection | Over 20°C        | ON (P03 = H)  | ON (P04 = L)  |
|                | 20°C or Less     | ON (P03 = H)  | ON (P04 = H)  |

Figure 1.1 shows the system configuration outline.



**Figure 1.1 the system configuration**

## 1.1 Temperature Sensor

In this application note, a temperature sensor is used having an output that changes in proportion to the change in temperature. When actually designing the circuit, be sure to satisfy the electrical characteristics.

Temperature sensor used:

Measurement temperature range: -40°C to +125°C

Relationship between voltage and temperature:  $V_{out} = 10\text{mV}/^{\circ}\text{C} \times (\text{Temperature}^{\circ}\text{C}) + 500\text{mV}$

For example, 700 mV at 20°C.

## 1.2 Fan Control circuit

In this application note, an AC fan motor is used. Since AC fan motor cannot be directly connected to the microcontroller for be connected to AC power, use a photo triac coupler in the fan control circuit. The AC fan motor connected to the AC power supply is controlled ON/OFF with the port output of microcomputer through the photo triac coupler.

## 1.3 Heater Control circuit

In this application note, the heater is connected to AC power. The heater connected to the AC power supply is controlled ON/OFF with the port output of microcomputer through the photo triac coupler.

## 1.4 Human Sensor

This application system uses a module with a pyroelectric infrared sensor (hereinafter called a human sensor). According to the specifications, the system begins to monitor all around the sensor at some seconds after power on and changes the output level of the signal to low when an object of approximately 35°C such as a human move. When actually preparing application circuits, make sure to design them to satisfy the electrical characteristics.

## 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**

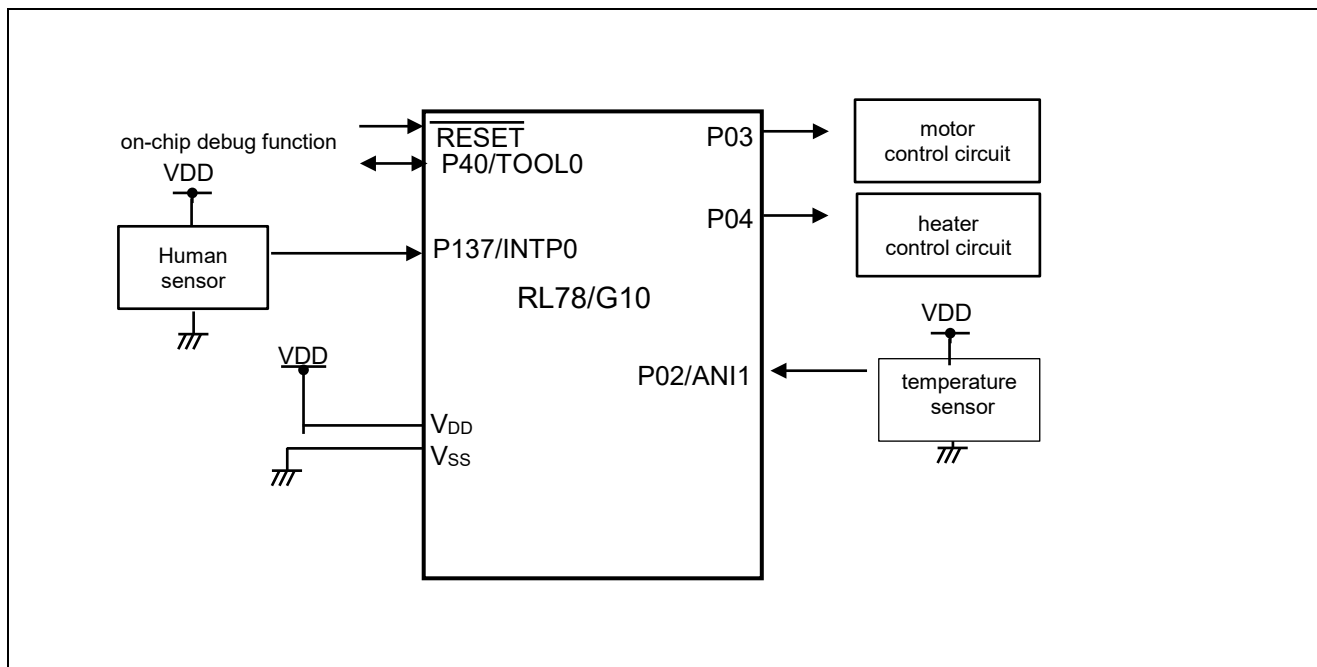
| Item                                                       | Description                                                                                                                                      |
|------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|
| Microcontroller used                                       | RL78/G10 (R5F10Y47ASP)                                                                                                                           |
| Operating frequency                                        | <ul style="list-style-type: none"><li>High-speed on-chip oscillator (HOCO) clock: 20 MHz</li><li>CPU/peripheral hardware clock: 20 MHz</li></ul> |
| Operating voltage                                          | 5.0 V (can run on a voltage range of 2.7 V to 5.5 V.)<br>SPOR operation: Max 2.90 V at rise(2.76~3.02V)<br>Min 2.84 V at fall(2.70~2.96V)        |
| Integrated development environment (CS+)                   | CS+ for CC V6.01.00 from Renesas Electronics Corp.                                                                                               |
| C compiler (CS+)                                           | CC-RL V1.06.00 from Renesas Electronics Corp.                                                                                                    |
| Integrated development environment (e <sup>2</sup> studio) | e <sup>2</sup> studio V5.1.0.022 from Renesas Electronics Corp.                                                                                  |
| C compiler (e <sup>2</sup> studio)                         | CC-RL V1.06.00 from Renesas Electronics Corp.                                                                                                    |

Caution: The code in this application note applies only to the RL78/G10 (R5F10Y47ASP).

### 3. Hardware Descriptions

#### 3.1 Hardware Configuration

Figure 3.1 shows an example of the hardware configuration for the system described in this application note.



**Figure 3.1 the hardware configuration used for this application**

Notes: 1. The above figure is a simplified circuit image for showing the outline of the connections. The actual circuit should be designed so that the pins are handled appropriately and that the electrical characteristics are satisfied (input-only ports should be each connected to V<sub>DD</sub> or V<sub>SS</sub> via a resistor).

2. V<sub>DD</sub> must be equal to or greater than the reset release voltage (V<sub>SPOR</sub>) specified with SPOR.

#### 3.2 List of Pins used

Table 3.1 lists the pins used and their functions.

**Table 3.1 Pin Used and Their Functions**

| Pin Name   | I/O    | Description                       |
|------------|--------|-----------------------------------|
| P137/INTP0 | Input  | Signal input from human sensor    |
| P02/ANI1   | Input  | Analog input port for temperature |
| P03        | Output | Fan drive port(output)            |
| P04        | Output | Heater drive port(output)         |

## 4. Software Descriptions

### 4.1 Operation Summary

In this application note, used port function, A/D converter and interrupt function of RL78/G10. Port function control to the fan and heater of ON/OFF. output voltage from temperature sensor is converted by A/D converter. Interrupt detects the signal from human sensor.

### 4.2 List of Option Byte Setting

Table 4.1 shows the option byte settings.

**Table 4.1 Option Byte Settings**

| Address | Setting   | Description                                                                           |
|---------|-----------|---------------------------------------------------------------------------------------|
| 000C0H  | 11101111B | Disables the watchdog timer. (Stops counting after the release from the reset state.) |
| 000C1H  | 11100111B | SPOR detection voltage: 2.90 V at fall; 2.84 V at rise                                |
| 000C2H  | 11111001B | HOCO: 20 MHz                                                                          |
| 000C3H  | 10000101B | Enables the on-chip debugger.                                                         |

### 4.3 List of Variables

Table 4.2 lists the global variables.

**Table 4.2 Global Variables**

| Type    | Variable Name     | Contents         | Function Used |
|---------|-------------------|------------------|---------------|
| int16_t | temperature_value | Temperature data | main()        |
| uint8_t | g_flag_Intp       | Interrupt        | main()        |

### 4.4 List of Functions (Subroutines)

lists the functions (subroutines).

| Function (Subroutine) Name      | Outline                              |
|---------------------------------|--------------------------------------|
| R_MAIN_UserInit <sup>note</sup> | User application initialization      |
| R_ADC_Start                     | A/D converter start                  |
| R_ADC_Get_Result()              | Function of getting temperature data |

Note These functions are automatically generated by the integrated development environment.

## 4.5 Function Specifications

This section gives the specifications of the functions used in the sample program.

|                                 |                                                                         |
|---------------------------------|-------------------------------------------------------------------------|
| [Function Name] R_MAIN_UserInit |                                                                         |
| <b>Synopsis</b>                 | User Application Initialization                                         |
| <b>Header</b>                   | r_cg_macrodriver.h<br>r_cg_userdefine.h                                 |
| <b>Declaration</b>              | void R_MAIN_UserInit(void)                                              |
| <b>Explanation</b>              | Performs initialization necessary for the operation of the application. |
| <b>Arguments</b>                | None                                                                    |
| <b>Return value</b>             | None                                                                    |
| <b>Remarks</b>                  | None                                                                    |

|                             |                                                       |
|-----------------------------|-------------------------------------------------------|
| [Function Name] R_ADC_Start |                                                       |
| <b>Synopsis</b>             | A/D converter conversion start                        |
| <b>Header</b>               | r_cg_macrodriver.h<br>r_cg_adc.h<br>r_cg_userdefine.h |
| <b>Declaration</b>          | void R_ADC_Start(void)                                |
| <b>Explanation</b>          | Enables A/D converter conversion.                     |
| <b>Arguments</b>            | None                                                  |
| <b>Return value</b>         | None                                                  |
| <b>Remarks</b>              | None                                                  |

|                                  |                                                       |
|----------------------------------|-------------------------------------------------------|
| [Function Name] R_ADC_Get_Result |                                                       |
| <b>Synopsis</b>                  | Temperature data get                                  |
| <b>Header</b>                    | r_cg_macrodriver.h<br>r_cg_adc.h<br>r_cg_userdefine.h |
| <b>Declaration</b>               | void R_ADC_Get_Result (void)                          |
| <b>Explanation</b>               | A/D converter result                                  |
| <b>Arguments</b>                 | None                                                  |
| <b>Return value</b>              | None                                                  |
| <b>Remarks</b>                   | None                                                  |

|                               |                                                        |
|-------------------------------|--------------------------------------------------------|
| [Function Name] R_INTC0_Start |                                                        |
| <b>Synopsis</b>               | Interrupt start                                        |
| <b>Header</b>                 | r_cg_macrodriver.h<br>r_cg_intp.h<br>r_cg_userdefine.h |
| <b>Declaration</b>            | void R_INTC0_Start (void)                              |
| <b>Explanation</b>            | Interrupt start                                        |
| <b>Arguments</b>              | None                                                   |
| <b>Return value</b>           | None                                                   |
| <b>Remarks</b>                | None                                                   |

|                      |                                               |
|----------------------|-----------------------------------------------|
| [Function Name] main |                                               |
| <b>Synopsis</b>      | Main function                                 |
| <b>Header</b>        | —                                             |
| <b>Declaration</b>   | Main processing function for the sample codes |
| <b>Explanation</b>   | None                                          |
| <b>Arguments</b>     | None                                          |
| <b>Return value</b>  | None                                          |

4.6 Flowcharts

Figure 4.1 shows an overall flow of the sample program described in this application note.

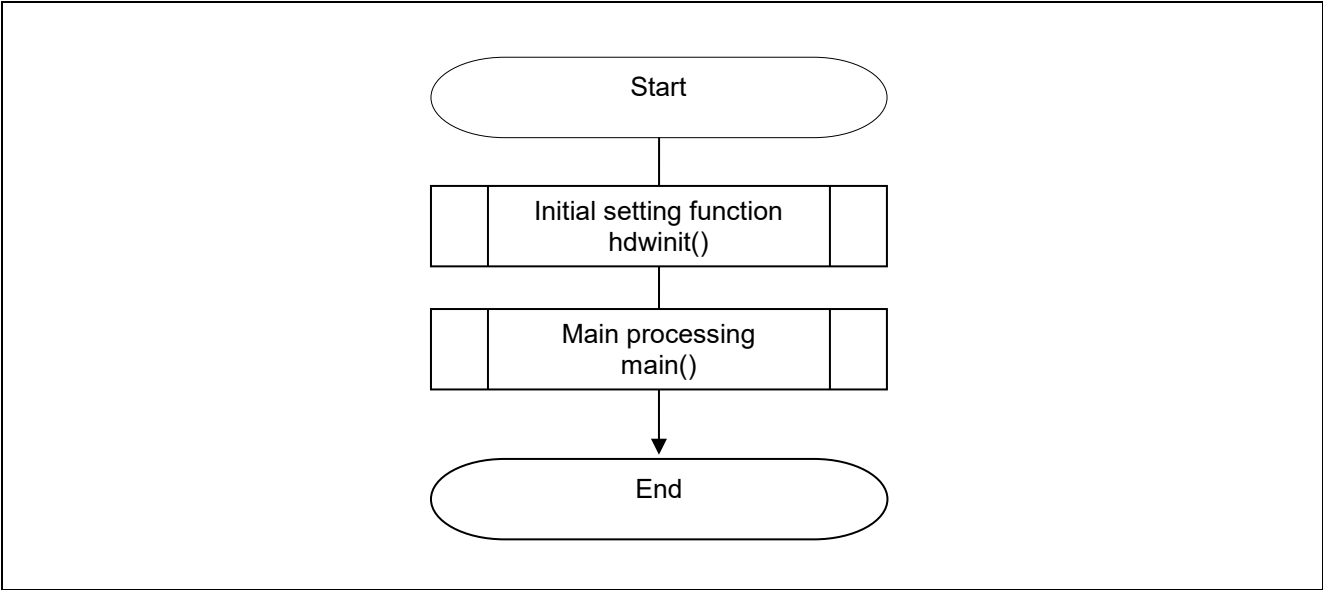


Figure 4.1 the overall flow

4.6.1 Initial Setting Function

Figure 4.2 shows the flowchart of the initial setting function.

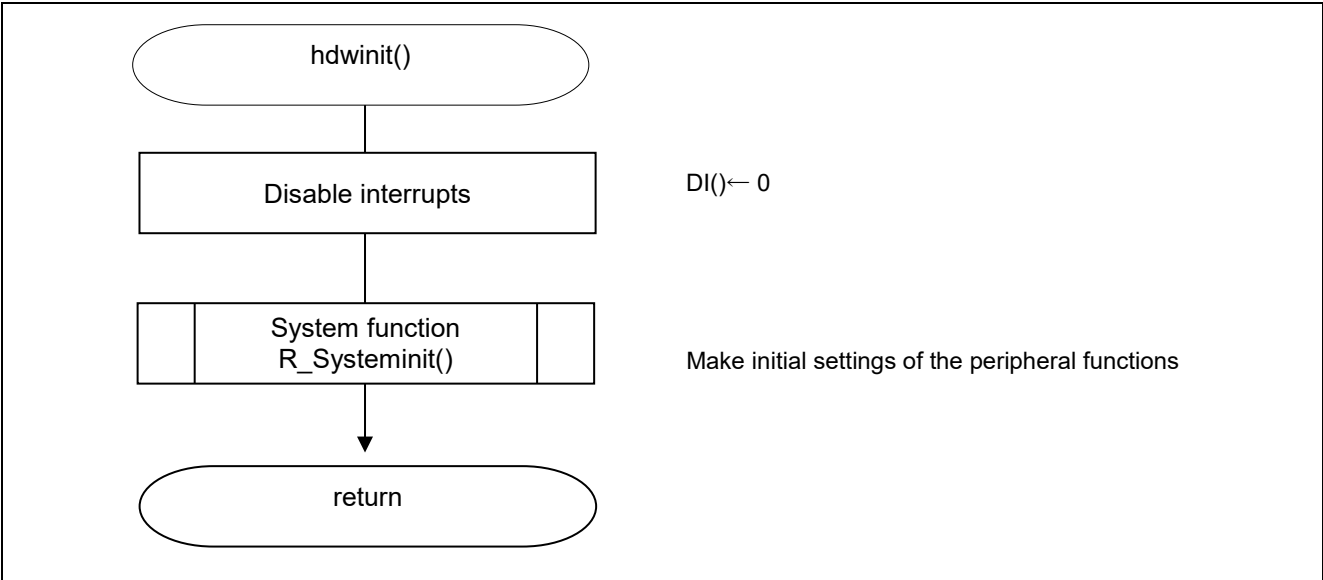


Figure 4.2 Initial Setting Function

4.6.2 System Function

Figure 4.3 shows the flowchart of the system function.

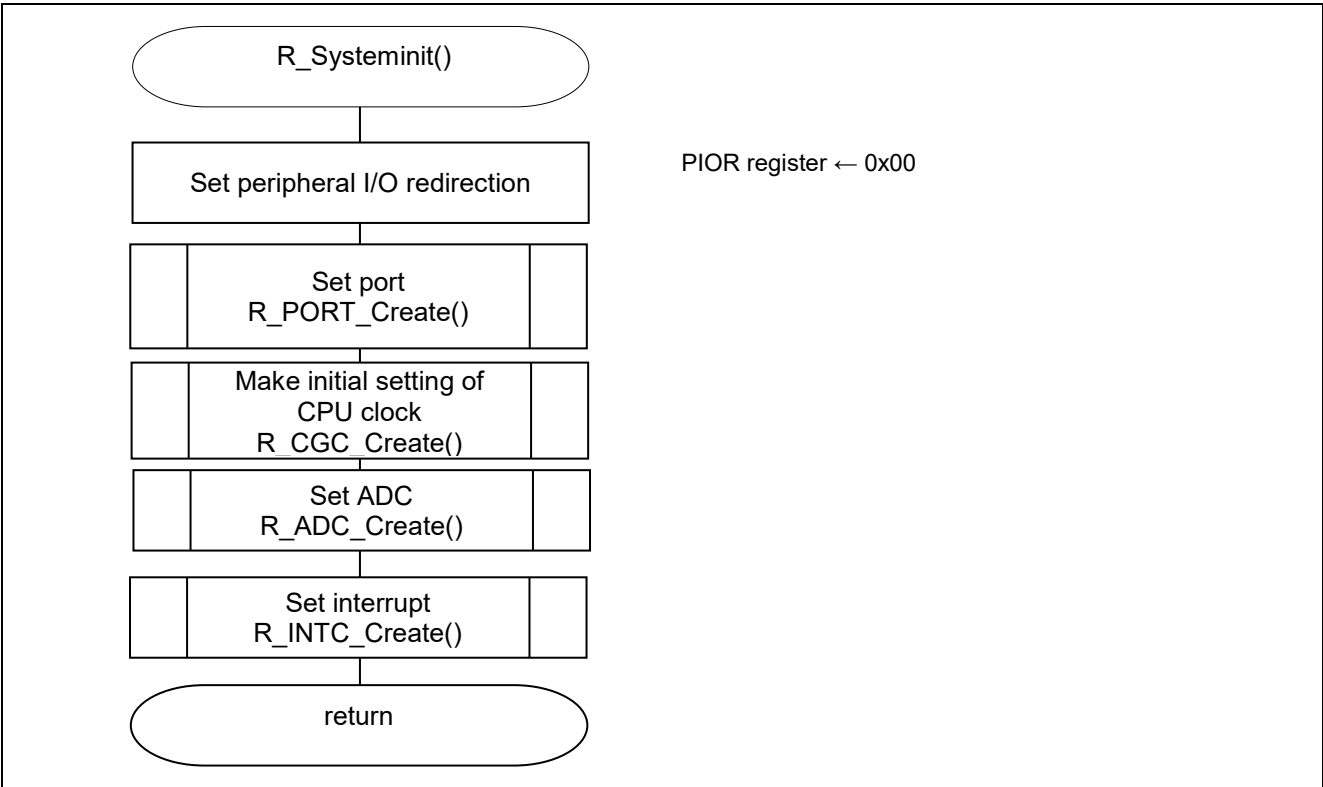
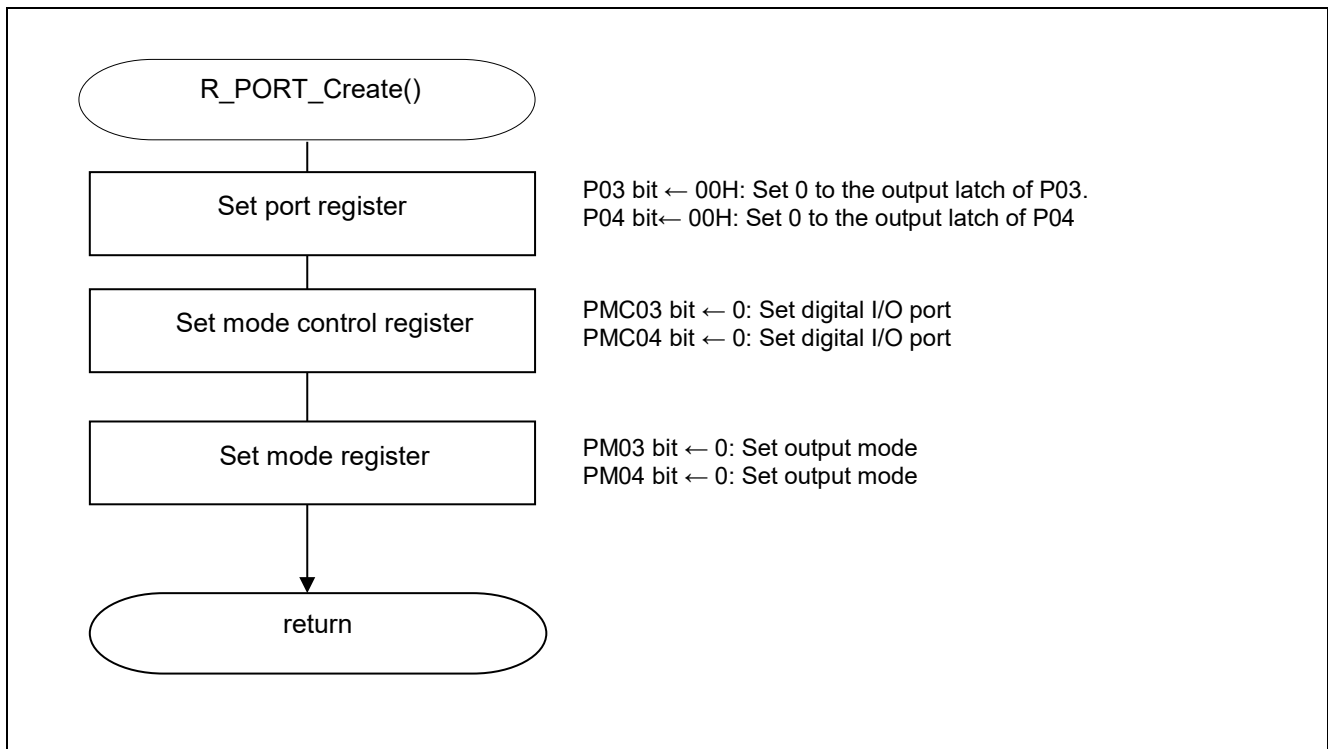


Figure 4.3 System Function

### 4.6.3 I/O Port Setup

Figure 4.4 shows the flowchart for setting up the I/O ports.

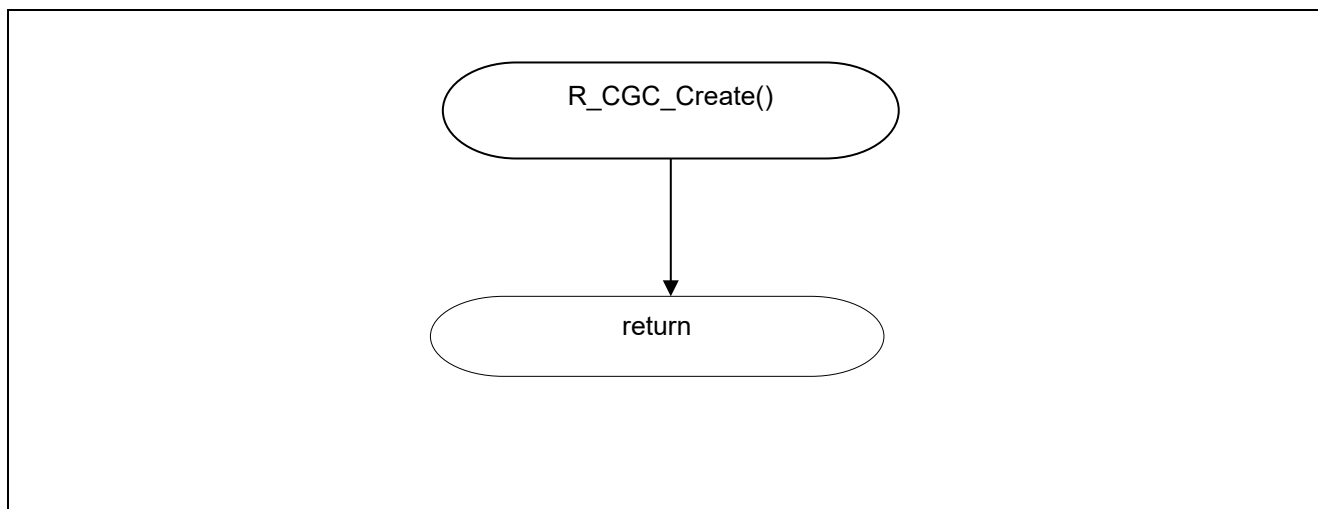


**Figure 4.4 I/O Port Setup**

- Notes:
1. For details on register setting when using the ports as the alternate functions of the peripheral functions, refer to the RL78/G10 User's Manual: Hardware.
  2. Provide proper treatment for unused pins so that their electrical specifications are observed. Connect each of unused input-only ports to VDD or VSS via a separate resistor.

#### 4.6.4 CPU Clock Setup

Figure 4.5 shows the flowchart for setting up the CPU clock.



**Figure 4.5 CPU Clock Setup**

#### 4.6.5 A/D converter Setup

Figure 4.6 shows the flowchart for setting up the A/D converter.

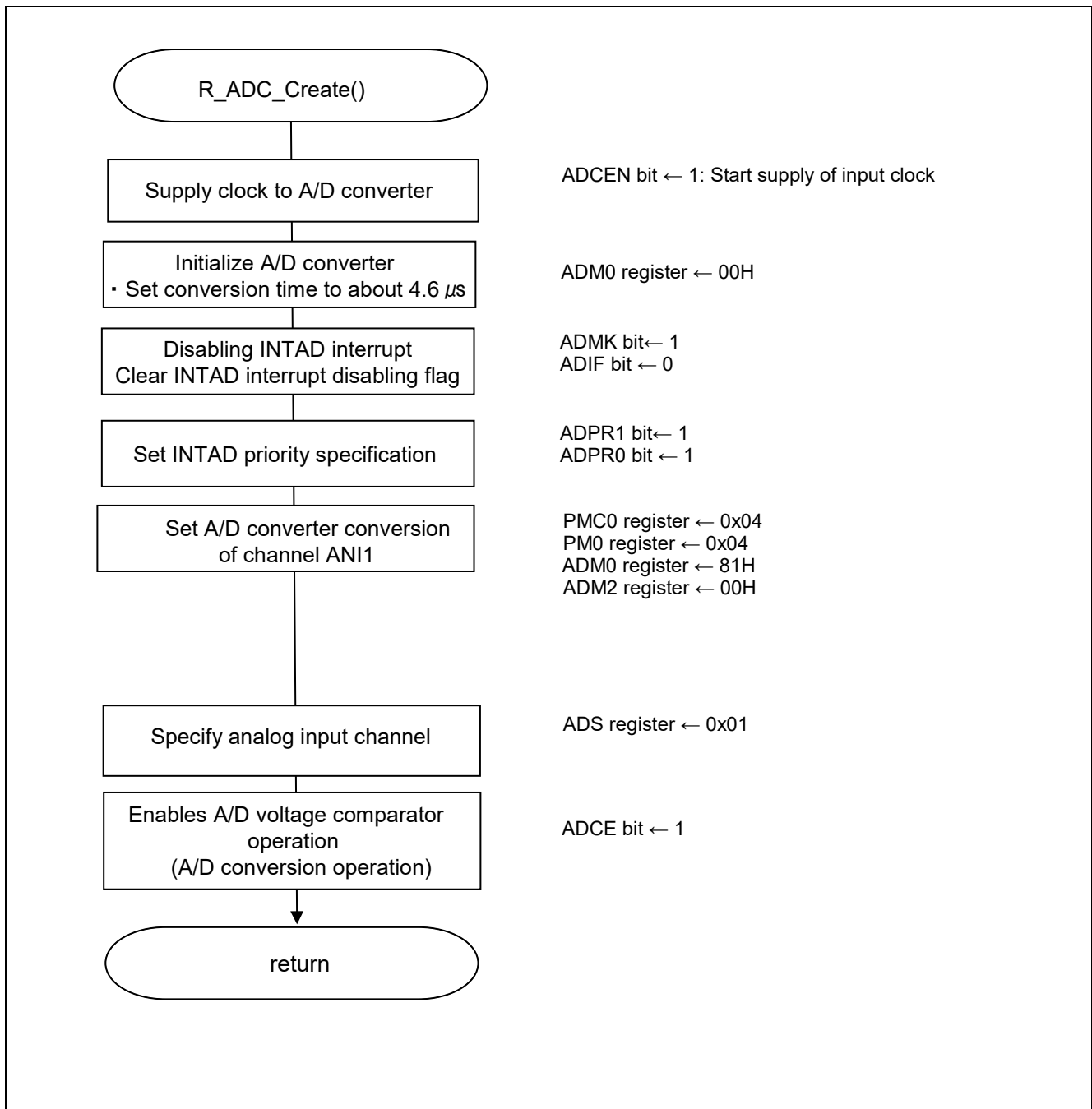


Figure 4.6 A/D Converter Setup

4.6.6 Interrupt Setup

Figure 4.7 shows the flowchart for setting up the interrupt.

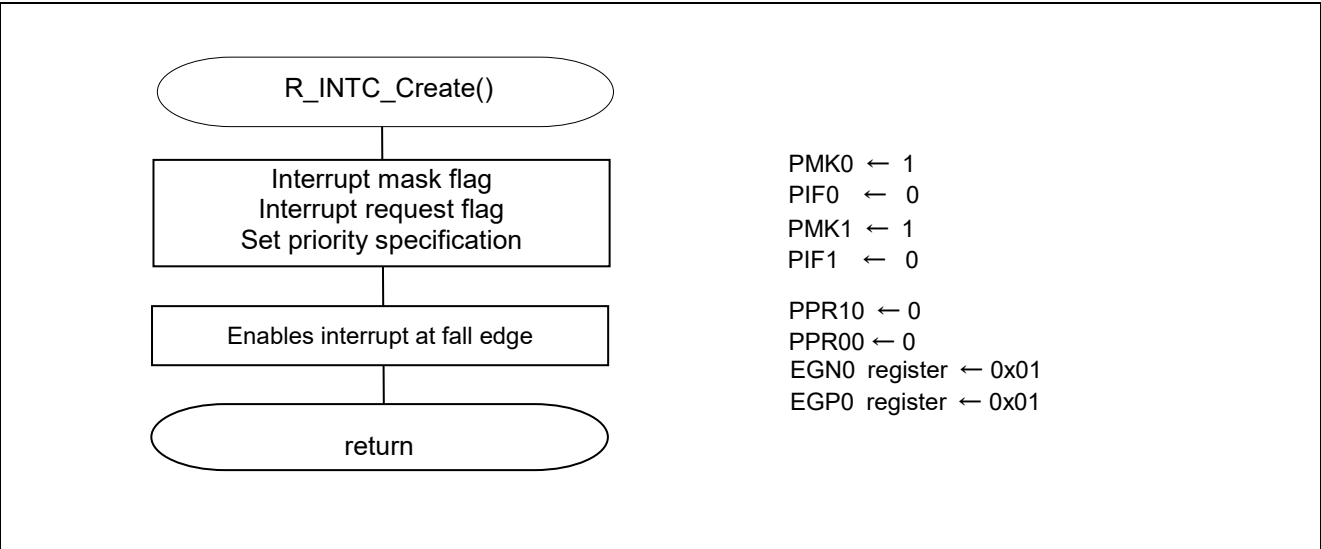


Figure 4.7 Interrupt Setup

### 4.6.7 Main Processing

Figure 4.8 shows the flowchart of the main processing.

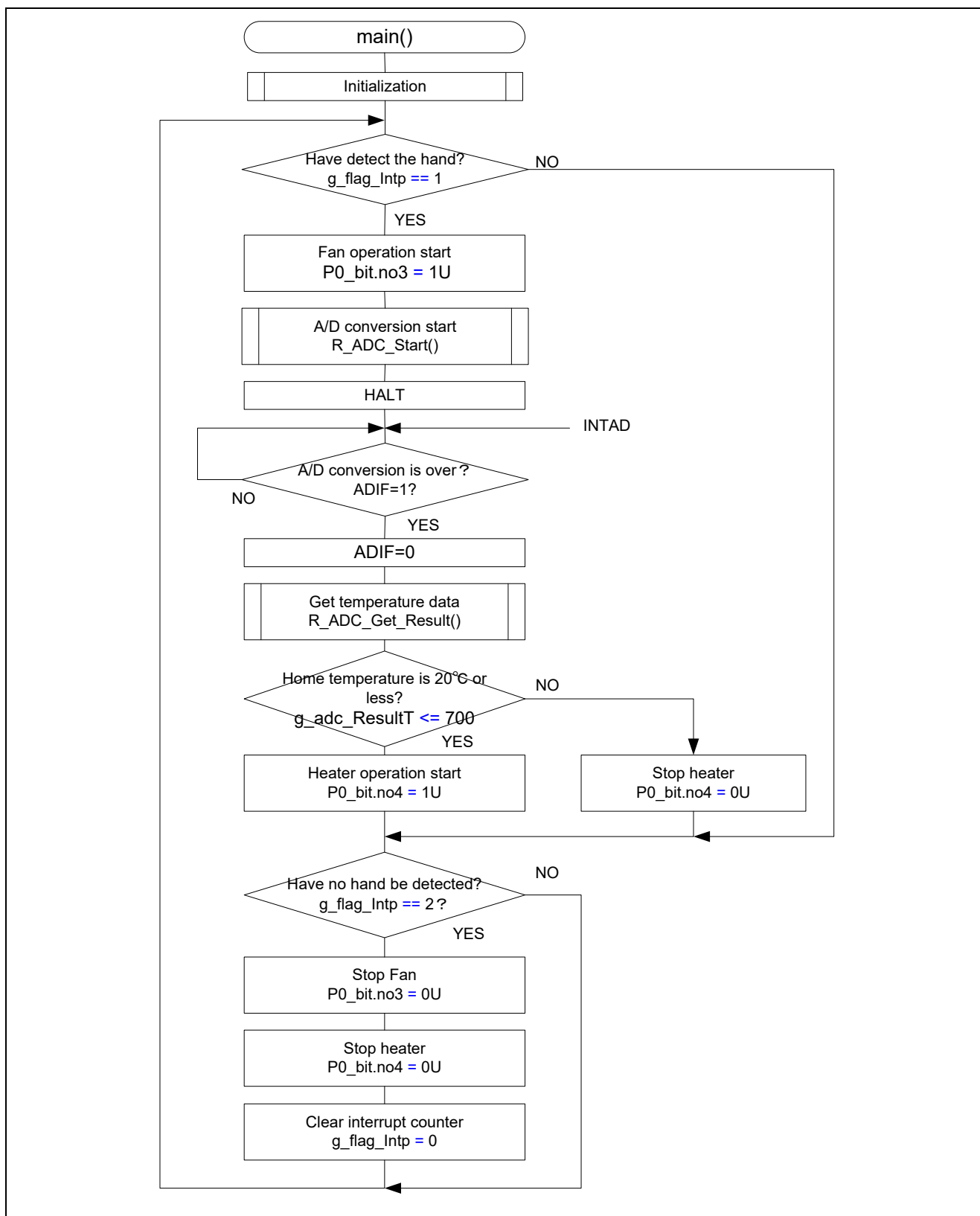


Figure 4.8 Main Processing

4.6.8 Initialization Function

Figure 4.9 shows the flowchart for setting the initialization.

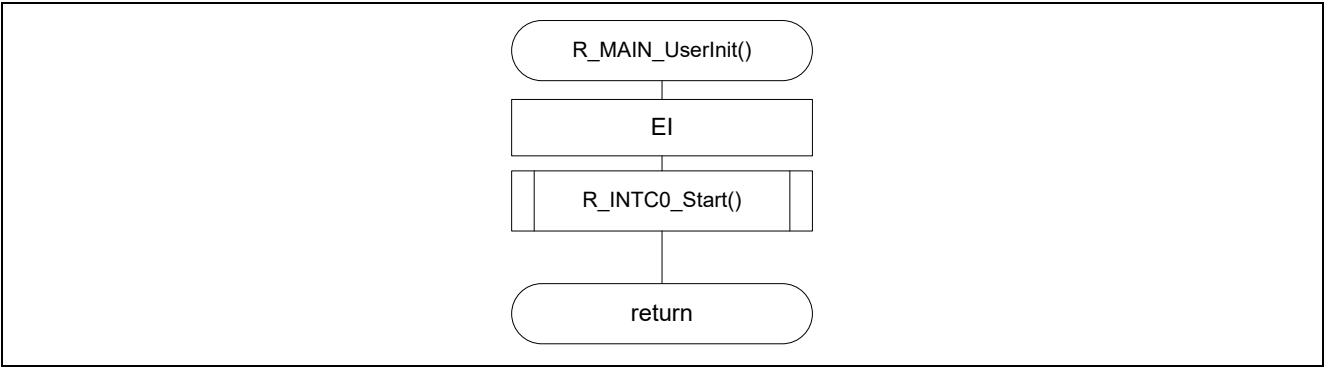


Figure 4.9 Initialization Function

4.6.9 Enable Interrupt Setting

Figure 4.10 shows the flowchart for setting the enable interrupt.

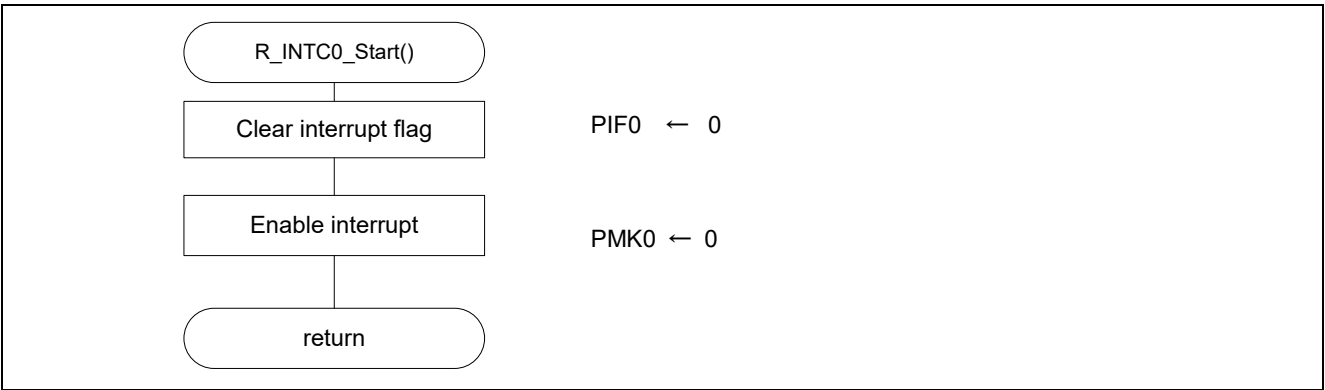


Figure 4.10 Enable Interrupt Setting

#### 4.6.10 A/D Conversion Start Setting

Figure 4.11 shows the flowchart for setting the A/D conversion start.

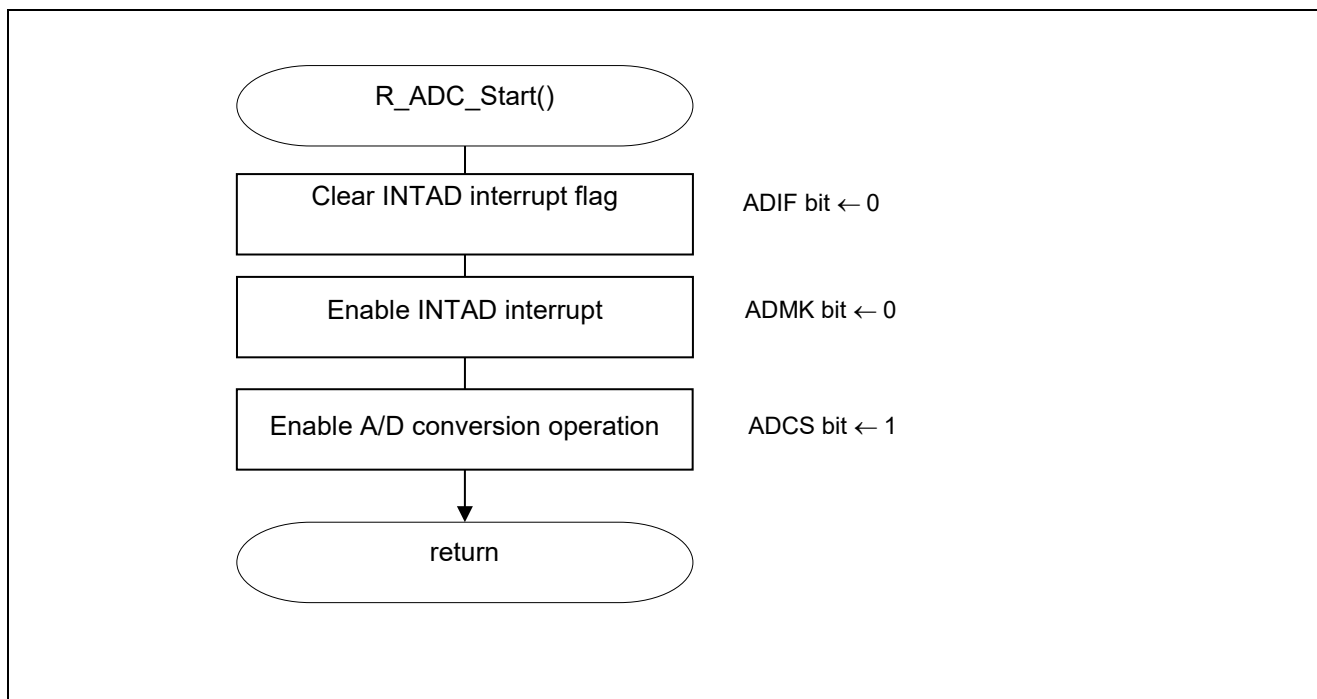


Figure 4.11 A/D Converter Operation Start Setting

4.6.11 Temperature Data Acquisition Processing

Figure 4.12 shows the flowchart for temperature data acquisition processing.

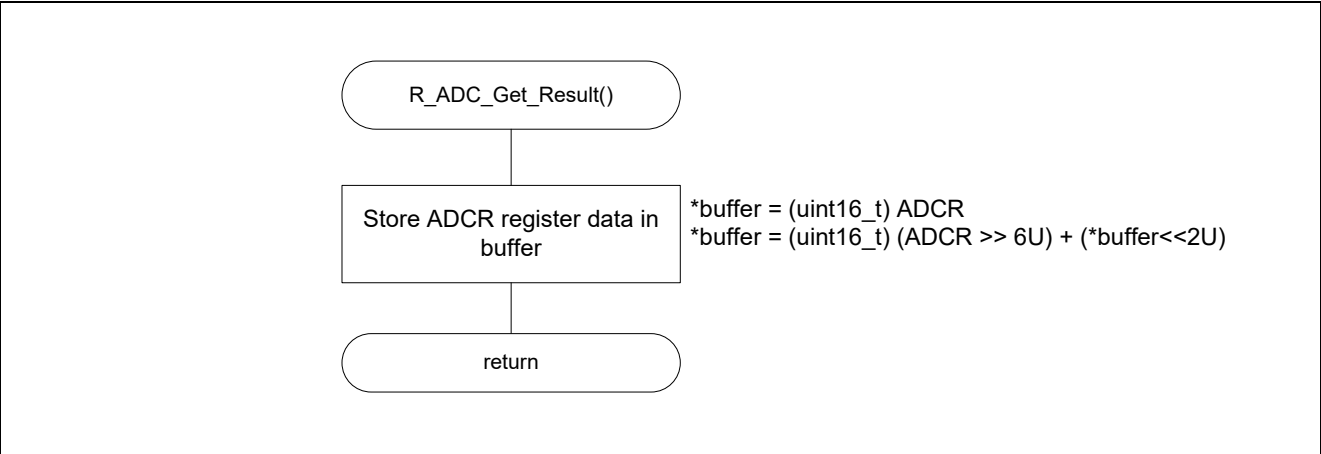


Figure 4.12 Temperature Data Acquisition Processing

Revision History

| Rev. | Date        | Description |         |
|------|-------------|-------------|---------|
|      |             | Page        | Summary |
| 1.00 | May.31.2019 | -           | -       |
|      |             |             |         |

# General Precautions in the Handling of Microprocessing Unit and Microcontroller Unit Products

The following usage notes are applicable to all Microprocessing unit and Microcontroller unit 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. Precaution against Electrostatic Discharge (ESD)

A strong electrical field, when exposed to a CMOS device, can cause destruction of the gate oxide and ultimately degrade the device operation. Steps must be taken to stop the generation of static electricity as much as possible, and quickly dissipate it when it occurs. Environmental control must be adequate. When it is dry, a humidifier should be used. This is recommended to avoid using insulators that can easily build up static electricity.

Semiconductor devices must be stored and transported in an anti-static container, static shielding bag or conductive material. All test and measurement tools including work benches and floors must be grounded. The operator must also be grounded using a wrist strap. Semiconductor devices must not be touched with bare hands. Similar precautions must be taken for printed circuit boards with mounted semiconductor devices.

## 2. Processing at power-on

The state of the product is undefined at the time 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 time 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 time 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 time when power is supplied until the power reaches the level at which resetting is specified.

## 3. Input of signal during power-off state

Do not input signals or an I/O pull-up power supply while the device is powered off. The current injection that results from input of such a signal or I/O pull-up power supply may cause malfunction and the abnormal current that passes in the device at this time may cause degradation of internal elements. Follow the guideline for input signal during power-off state as described in your product documentation.

## 4. Handling of unused pins

Handle unused pins in accordance 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 the 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.

## 5. Clock signals

After applying a reset, only release the reset line after the operating clock signal becomes stable. When switching the clock signal during program execution, wait until the target clock signal is 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. Additionally, 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.

## 6. Voltage application waveform at input pin

Waveform distortion due to input noise or a reflected wave may cause malfunction. If the input of the CMOS device stays in the area between  $V_{IL}$  (Max.) and  $V_{IH}$  (Min.) due to noise, for example, the device may malfunction. Take care to prevent chattering noise from entering the device when the input level is fixed, and also in the transition period when the input level passes through the area between  $V_{IL}$  (Max.) and  $V_{IH}$  (Min.).

## 7. Prohibition of access to reserved addresses

Access to reserved addresses is prohibited. The reserved addresses are provided for possible future expansion of functions. Do not access these addresses as the correct operation of the LSI is not guaranteed.

## 8. Differences between products

Before changing from one product to another, for example to a product with a different part number, confirm that the change will not lead to problems. The characteristics of a microprocessing unit or microcontroller unit products in the same group but having a different part number might differ in terms of 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.

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(Rev.4.0-1 November 2017)

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