RL78/L12

Thermometer with UART Communication Functions

Introduction

This application note explains a method of realization of a thermometer using a temperature sensor.

Target Device

RL78/L12

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

This application note explains a method of realizing a thermometer using a temperature sensor and an LCD controller/driver that is mounted on an RL78/L12.

When power is input, the RL78/L12 acquires temperature data from the temperature sensor. Using the LCD controller/driver, temperature data obtained from the temperature sensor is stored in an LCD display data/memory area, and temperatures are displayed. Temperature measurements are performed constantly.

In this application note, it is assumed that the thermometer is installed in each room of an office. Suitable temperatures for rooms are taken to be between 17°C and 28°C, and when temperature data obtained from a temperature sensor is lower than 17°C or exceeds 28°C, "ALARM" is displayed, and the RL78/L12 uses a serial array unit (UART communication) to transmit temperature data to an opposing device.

Table 1.1 shows the LCD display list.

Table 1.1 LCD Display List

Temperature	LCD Display
Under 17°C	Temperature and ALARM
17°C to 28°C inclusive	Temperature
Above 28°C	Temperature and ALARM

Figure 1.1 shows the system configuration outline.
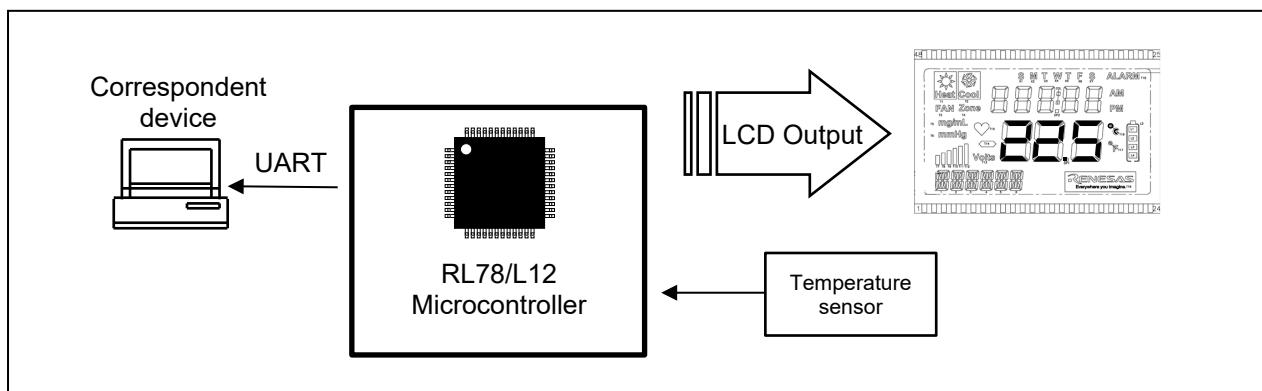
Figure 1.1 System Configuration Outline

1.1 Temperature Sensor

The system described in this application note uses the temperature sensor that outputs the value in proportion to the voltage. When actually designing the circuits, be sure to satisfy the electrical characteristics.

The measurement temperature range of the used temperature sensor is -40°C to +125°C.

The relationship between the voltage and temperature is expressed as follows:

Vout = 10 mV/°C × (Temperature°C) + 500 mV.

For example, 865mV (+36.5°C)

2. Operation Confirmation Conditions

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

Item	Contents
MCU used	RL78/L12(R5F10RLCA)
Operating frequencies	• High-speed on-chip oscillator (HOCO) clock: 24MHz • CPU/peripheral hardware clock: 24MHz

Operating voltage	3.3 V (operating range 2.7 V to 5.5V)
	LVD operation (V_{LVD}): Reset mode TYP. 2.75 V
	  At power on 2.76 V to 2.87 V
	  At power off 2.70 V to 2.81 V

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 (e² studio)	e2studio V5.1.0.022 from Renesas Electronics Corp.
C compiler (e² studio)	CC-RL V1.06.00 from Renesas Electronics Corp.
Board used	RSKRL78/L12 R0K5010RLC001BR

LCD module	RSK LCD APP V2 R0K0APPBDB030BE
	• 48 pins, 176 segments
	• Number of pins used: 13 (pin nos.: 7-10, 21-27, 29)
	• Number of symbols used: 6
	    2 temperature digits, decimal, 1 temperature digit (to the first decimal place),
	    ALARM
	• Internal step-up method
	• 1/4 duty cycle
	• 4.05 V operation, 1/3 bias
	• Viewing direction 6 o'clock, reflective positive display

Caution: The code in this application note applies only to the RL78/L12 (64 pins: R5F10RLCA).

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.
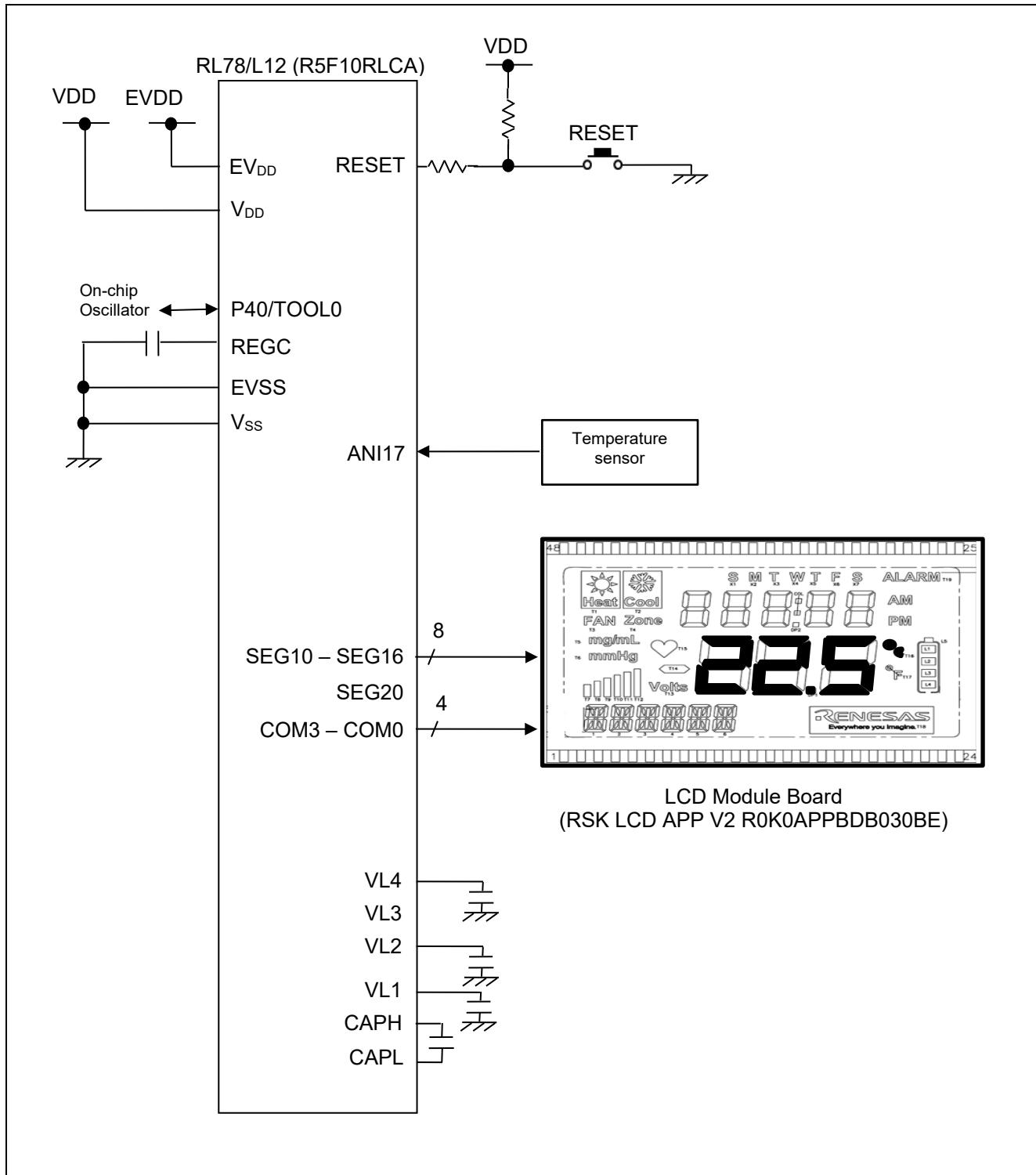
Figure 3.1 Hardware Configuration

Cautions:

1. The above figure is simplified to show an overview of the hardware connection. 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. V_{DD} must be held at not lower than the reset release voltage (V_{LVD}) that is specified as LVD.

Table 3.1 shows a list of pin connections of the RL78/L12 to the LCD module and the LCD module board.

Table 3.1 List of Pin Connections of RL78/L12 to LCD Module and LCD Module Board

RL78/L12 Pin Name	LCD Module Pin No.	LCD Module Board Pin No.
SEG10	17	21
SEG11	18	22
SEG12	19	23
SEG13	20	24
SEG14	21	25
SEG15	22	26
SEG16	23	27
SEG20	25	29

3.2 LCD Module

The LCD module used in this application note is explained
The RL78/L12 and the LCD module are connected as in Figure 3.2
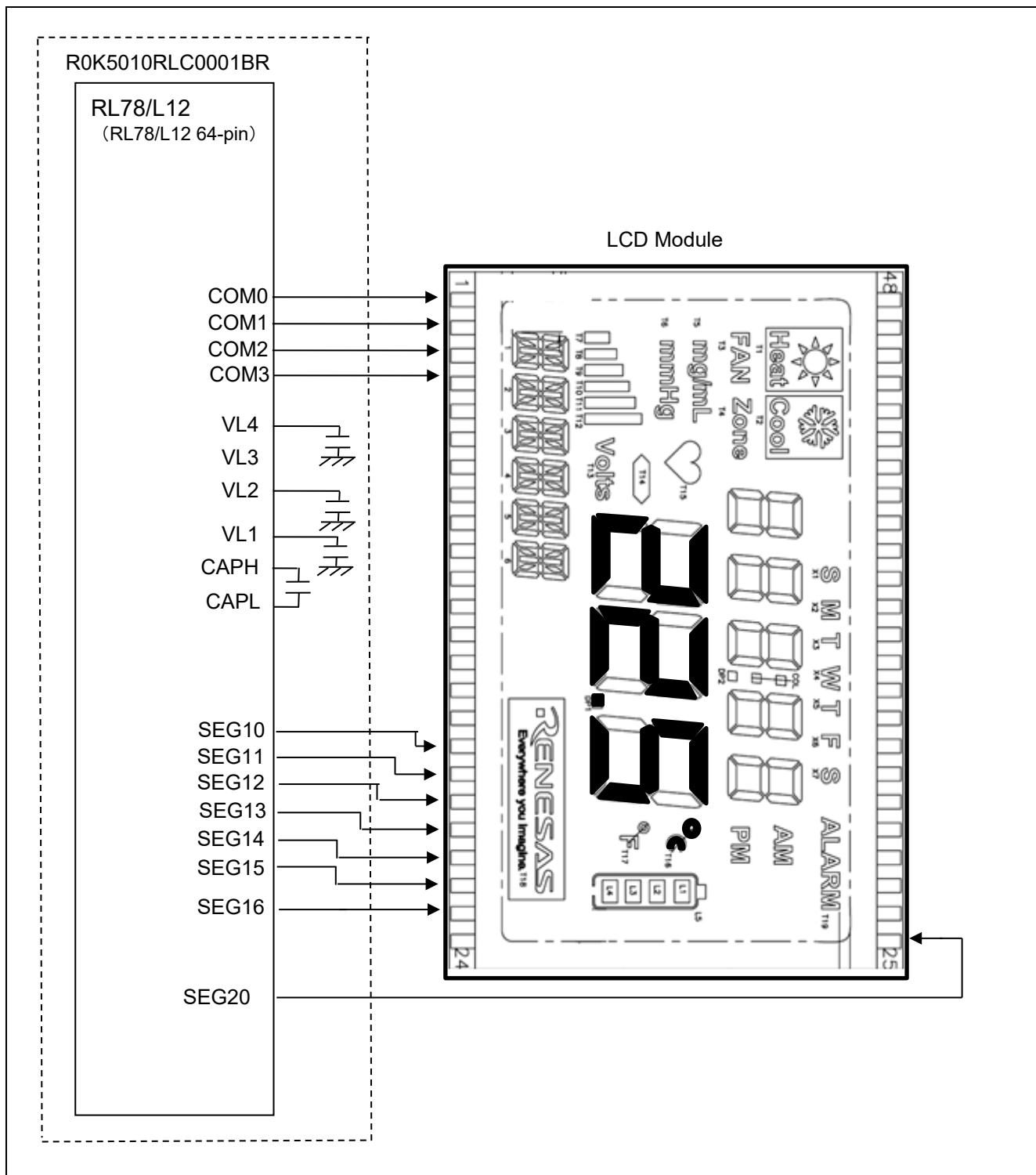
Figure 3.2 Connection between RL78/L12 and LCD Module
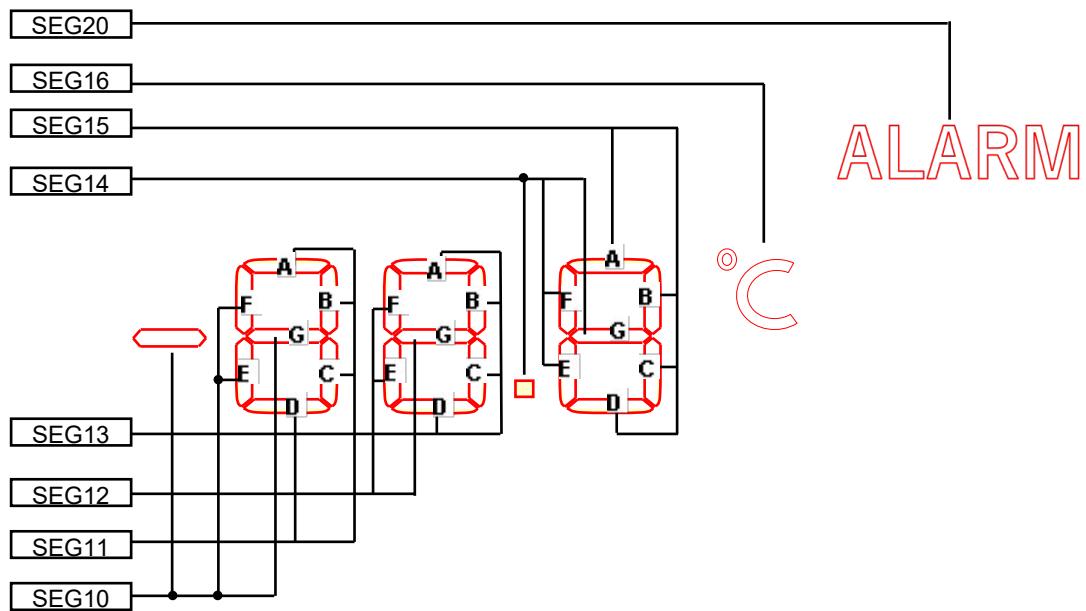
Figure 3.3 shows the connection diagram for symbols and segment (SEG) pins.
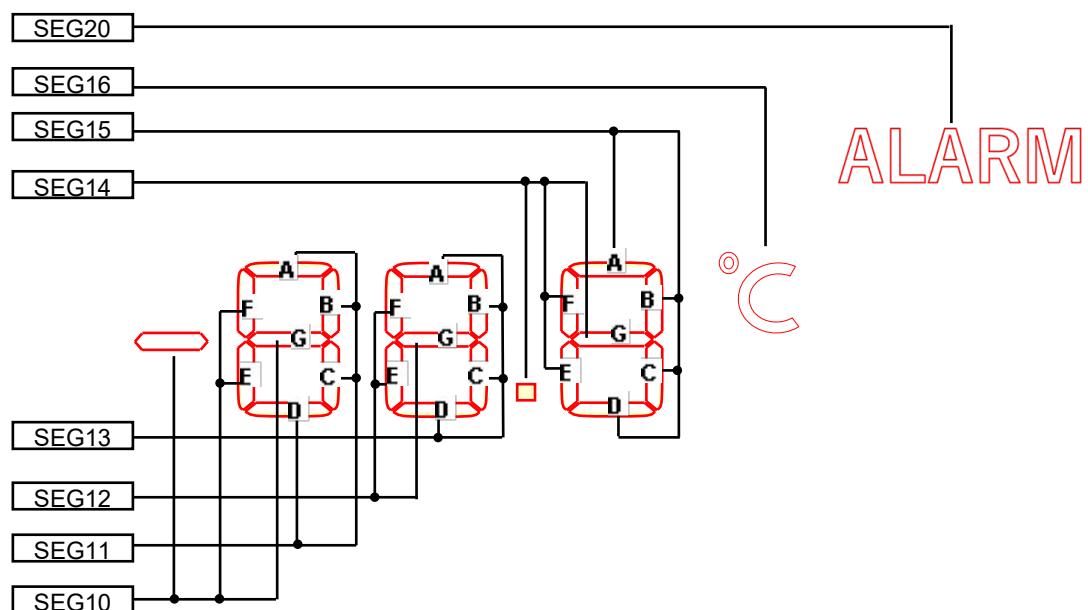
Figure 3.3 Connection Diagram for Symbols and Segments (SEG)

Table 3.2 shows a list of correspondences between LCD display data segments (SEG) and common outputs (COM).

Table 3.2 List of Correspondences between LCD Display Data Segments (SEG) and Common Outputs (COM)

LCD Display Data Segment (SEG)	Address	COM3	COM2	COM1	COM0
		bit3	bt2	bit1	bit0
SEG10	F040AH	Temperature tens place E	Minus (-)	Temperature tens place G	Temperature tens place F
SEG11	F040BH	Temperature tens place C	Temperature tens place D	Temperature tens place B	Temperature tens place A
SEG12	F040CH	Temperature ones place E	unused	Temperature ones place G	Temperature ones place F
SEG13	F040DH	Temperature ones place C	Temperature ones place D	Temperature ones place B	Temperature ones place A
SEG14	F040EH	Temperature first decimal place E	Decimal	Temperature first decimal place G	Temperature first decimal place F
SEG15	F040FH	Temperature first decimal place C	Temperature first decimal place D	Temperature first decimal place B	Temperature first decimal place A
SEG16	F0410H	Units (°C)	unused	unused	unused
SEG20	F0414H	unused	unused	ALARM	unused

Table 3.3 and Table 3.4 show register settings for temperature display data.

Table 3.3 Register Settings for Temperature and Minus Sign Display Data

	Register Setting							
Temperature tens place	SEG11(F040BH)				SEG10(F040AH)[Note]			
Temperature ones place	SEG13(F040DH)				SEG12(F040CH)			
Temperature first decimal place	SEG15(F040FH)							
Bit position	bit3	bit2	bit1	bit0	bit3	bit2	bit1	bit0
Segment	C	D	B	A	E	Note	G	F
0 display	1	1	1	1	1	0 [Note]	0	1
1 display	1	0	1	0	0	0 [Note]	0	0
2 display	0	1	1	1	1	0 [Note]	1	0
3 display	1	1	1	1	0	0 [Note]	1	0
4 display	1	0	1	0	0	0 [Note]	1	1
5 display	1	1	0	1	0	0 [Note]	1	1
6 display	1	1	0	1	1	0 [Note]	1	1
7 display	1	0	1	1	0	0 [Note]	0	0
8 display	1	1	1	1	1	0 [Note]	1	1
9 display	1	1	1	1	0	0 [Note]	1	1

Note: When the temperature is a negative value, bit 2 of SEG10 are all set to 1.

Table 3.4 Register Settings for Temperature and Decimal Display Data

	Register Setting		
Temperature first decimal place	SEG14(F040EH)		
Bit position	bit3	bit2	bit1	bit0
Segment	E	Decimal	G	F
0 display	1	1	0	1
1 display	0	1	0	0
2 display	1	1	1	0
3 display	0	1	1	0
4 display	0	1	1	1
5 display	0	1	1	1
6 display	1	1	1	1
7 display	0	1	0	0
8 display	1	1	1	1
9 display	0	1	1	1

Table 3.5 shows register settings for temperature unit (°C) display data.

Table 3.5 Register Settings for Temperature Unit (°C) Display Data

°C	Register Setting			
	SEG16（F0410H）			
Bit position	bit3	bit2	bit1	bit0
°C display	1	0	0	0

Table 3.6 shows settings for ALARM display data.

Table 3.6 Register Settings for ALARM Display Data

ALARM	Register Setting			
	SEG20（F0414H）			
Bit position	bit3	bit2	bit1	bit0
ALARM display	0	0	1	0

3.3　List of Pins to be Used

Table 3.7 lists the pins to be used and their functions.

Table 3.7 Pins to be Used and Their Functions

Pin Name	I/O	Description
P120/ANI17	Input	A/D conversion of temperature data from temperature sensors
P40/TOOL0	Input	For on-chip debugging
RESET	Input	Reset port
P53/SEG10, P54/SEG11 P74/SEG12, P73/SEG13 P72/SEG14, P71/SEG15 P70/SEG16, P61/SEG20	Output	LCD controller/driver segment signal
COM0~COM3	Output	Static mode

4.   Description of the Software

4.1   Operation Outline

In this application note, the A/D converter of the RL78/L12 is used to acquire temperature data from temperature sensors. Temperatures are displayed using the LCD controller/driver. When temperature data obtained from a temperature sensor is under 17°C or above 28°C, the serial array unit (UART communication) is used to transmit temperature data to the opposing device.

<Option Byte Settings>

- Forbid watchdog timer operation
- Fast internal oscillation clock frequency set to 24 MHz
- LVI default start function enabled
- On-chip debugging operation enabled

<Settings in Initialization after Reset>

(1)   UART initialization:

- SAU channel 0 used as UART
- Data length set to 8 bits
- Data transfer direction set to LSB first
- Parity: none
- Reception data level set to standard
- Transfer rate set to 9600 bps
- Reception completed interrupt (INTSR0), transmission completed interrupt (INTST0) set
- INTSR0, INTST0 interrupt priorities set to lowest priorities (level 3)

(2)   LCD initialization:

- Set input/output ports
  - Set SEG10-SEG16, SEG20 for segment output
  - Set COM0-COM3 for common output
  - Set P137, P120 to input mode
- Set CPU/peripheral hardware clocks to 24 MHz
- Stop X1 oscillation circuit
- Stop operation of XT1 oscillation circuit
- Set 12-bit interval timer
  - Set to 100 ms interval
- Set LCD controller/driver
  - Select internal step-up in LCD driving voltage generation circuit
  - Set LCD display mode to 4-time-slice, 1/3 bias
  - Set LCD display data to RAM area
  - Set display data to display only in A-pattern area

    LCD source clock (f_{LCD}) is set to f_{SUB}, LCD clock is set to $f_{LCD}/2^7$

    (LCD clock: 256 Hz, frame frequency: 64 Hz)
  - Set the LCD step-up level reference voltage to 1.40 V (LCD driving voltage (V_{L4}) = 4.20 V)
- Set the INTP0 valid edge to falling edge detection

(3) A/D converter initialization:
- Enable comparator operation
- 10-bit resolution
- VREF(+) is set to VDD, VREF(-) is set to VSS
- Software trigger mode set
- Operation mode is sequential conversion mode
- ANI17 is set to analog input
- Conversion time: 25.33333 (608/fCLK)
- Conversion time mode: standard 1
- Conversion result upper limit value (ADUL) is 255, lower limit value (ADLL) is 0
- A/D interrupts enabled (INTAD)

4.2   List of Option Byte Settings

Table 4.1 shows the option byte settings.

Table 4.1 Option Byte Settings

Address	Setting	Description
000C0H/010C0H	11101111B	Disables the watchdog timer. (Stops counting after the release from the reset state.)
000C1H/010C1H	01111111B	LVD detection voltage(V_{LVD}): Reset mode TYP.2.75V 2.76 V~2.87V at fall 2.70 V~2.81V at rise
000C2H/010C2H	11100000B	HS mode, HOCO: 24 MHz
000C3H/010C3H	10000101B	Enables the on-chip debugger.

4.3   List of Constants

Table 4.2 lists the constants that are used in this sample program.

Table 4.2 Constants for the Sample Program

Constant	Setting	Description
LCD_DATA_0	0x090F	LCD display data (0)
LCD_DATA_1	0x000A	LCD display data (1)
LCD_DATA_2	0x0A07	LCD display data (2)
LCD_DATA_3	0x020F	LCD display data (3)
LCD_DATA_4	0x030A	LCD display data (4)
LCD_DATA_5	0x030D	LCD display data (5)
LCD_DATA_6	0x0B0D	LCD display data (6)
LCD_DATA_7	0x000B	LCD display data (7)
LCD_DATA_8	0x0B0F	LCD display data (8)
LCD_DATA_9	0x030F	LCD display data (9)
LCD_DATA14_0	0x0D0F	LCD display data (SEG14) (0)
LCD_DATA14_1	0x040A	LCD display data (SEG14) (1)
LCD_DATA14_2	0x0E07	LCD display data (SEG14) (2)
LCD_DATA14_3	0x060F	LCD display data (SEG14) (3)
LCD_DATA14_4	0x070A	LCD display data (SEG14) (4)
LCD_DATA14_5	0x070D	LCD display data (SEG14) (5)
LCD_DATA14_6	0x0F0D	LCD display data (SEG14) (6)
LCD_DATA14_7	0x040B	LCD display data (SEG14) (7)
LCD_DATA14_8	0x070F	LCD display data (SEG14) (8)
LCD_DATA14_9	0x0F0F	LCD display data (SEG14) (9)

4.4   List of Variables

Table 4.3 lists the static variables that are used in this sample program.

Table 4.3 static Variables

Type	Variable Name	Contents	Function Used
uint16_t	g_font_data[10]	LCD font data	main()
uint16_t	g_font_data14[10]	LCD font data (SEG14)	main()
uint8_t	g_uart_TxData[3]	Transmission data	main()
uint8_t	g_ten_Data	Temperature tens place data	main()
uint8_t	g_one_Data	Temperature ones place data	main()
uint8_t	g_zero_Data	Temperature first decimal place data	main()

4.5   List of Functions (Subroutines)

Table 4.4 summarizes the functions (subroutines) that are used in this sample program.

Table 4.4 Functions (Subroutines)

Function (Subroutine) Name	Outline
R_MAIN_UserInit[Note]	User application initialization
R_LCD_Set_VoltageOn1	LCD step-up circuit operation start processing
R_LCD_Start	LCD display enable processing
R_LCD_Stop	LCD display stop processing
R_UART0_Start	UART0 transmission enable processing
R_ADC_Start	A/D converter conversion start

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

4.6   Function Specifications

The following tables list the sample code function specifications.

[Function Name] R_MAIN_UserInit	
Outline	User application initialization
Header	r_cg_macrodriver.h r_cg_userdefine.h
Declaration	void R_MAIN_UserInit(void)
Description	Initializes the peripheral functions necessary for using application.
Arguments	None
Return Value	None
Remarks	None

[Function Name] R_LCD_Set_VoltageOn1	
Outline	LCD step-up circuit operation start processing
Header	r_cg_macrodriver.h r_cg_lcd.h r_cg_userdefine.h
Declaration	void R_LCD_Set_VoltageOn1(void)
Description	Starts LCD step-up circuit operation (VLCON = 1).
Arguments	None
Return Value	None
Remarks	None

[Function Name] R_LCD_Start	
Outline	LCD display enable processing
Header	r_cg_macrodriver.h r_cg_lcd.h r_cg_userdefine.h
Declaration	void R_LCD_Start (void)
Description	Enables LCD display (LCDON = 1).
Arguments	None
Return Value	None
Remarks	None

[Function Name] R_LCD_Stop	
Outline	LCD display stop processing
Header	r_cg_macrodriver.h r_cg_lcd.h r_cg_userdefine.h
Declaration	void R_LCD_Stop(void)
Description	Stops LCD display.
Arguments	None
Return Value	None
Remarks	None

[Function Name] R_UART0_Start	
Outline	UART0 transmission enable processing
Header	r_cg_macrodriver.h r_cg_sau.h r_cg_userdefine.h
Declaration	void R_UART0_Start(void)
Description	Enables UART0 transmission.
Arguments	None
Return Value	None
Remarks	None

[Function Name] R_ADC_Start	
Outline	A/D converter conversion start
Header	r_cg_macrodriver.h r_cg_adc.h r_cg_userdefine.h
Declaration	void R_ADC_Start(void)
Description	Enables A/D converter conversion.
Arguments	None
Return Value	None
Remarks	None

[Function Name] main	
Outline	Main function
Header	—
Declaration	Main processing function for the sample codes
Description	None
Arguments	None
Return Value	None

4.7 Flowcharts

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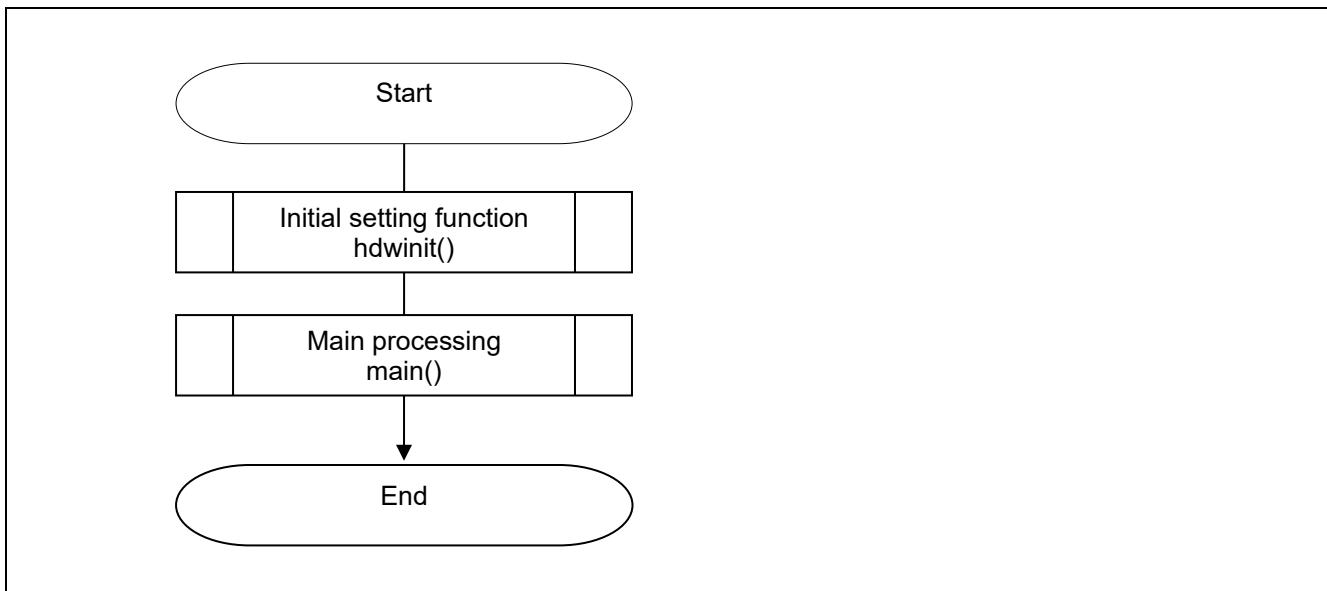

Figure 4.1 the hardware configuration used for this application

4.7.1 Initial Setting Function

Figure 4.2 shows the flowchart of the initial setting function.
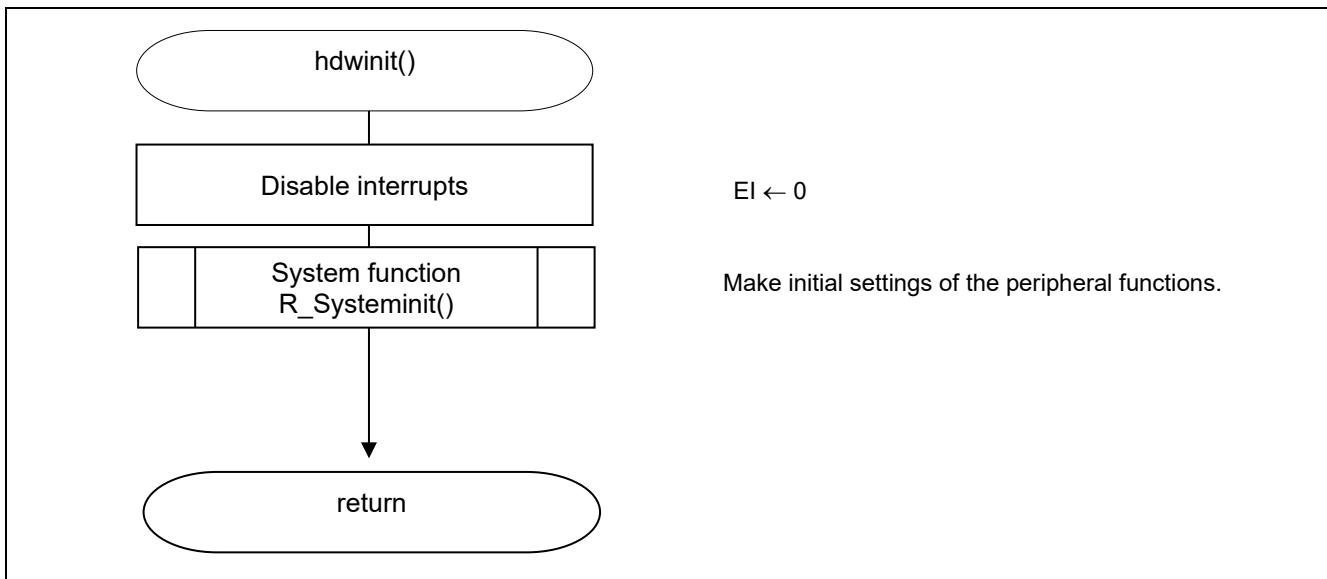
Figure 4.2 Initial Setting Function

4.7.2 System Function

Figure 4.3 shows the flowchart of the system function.
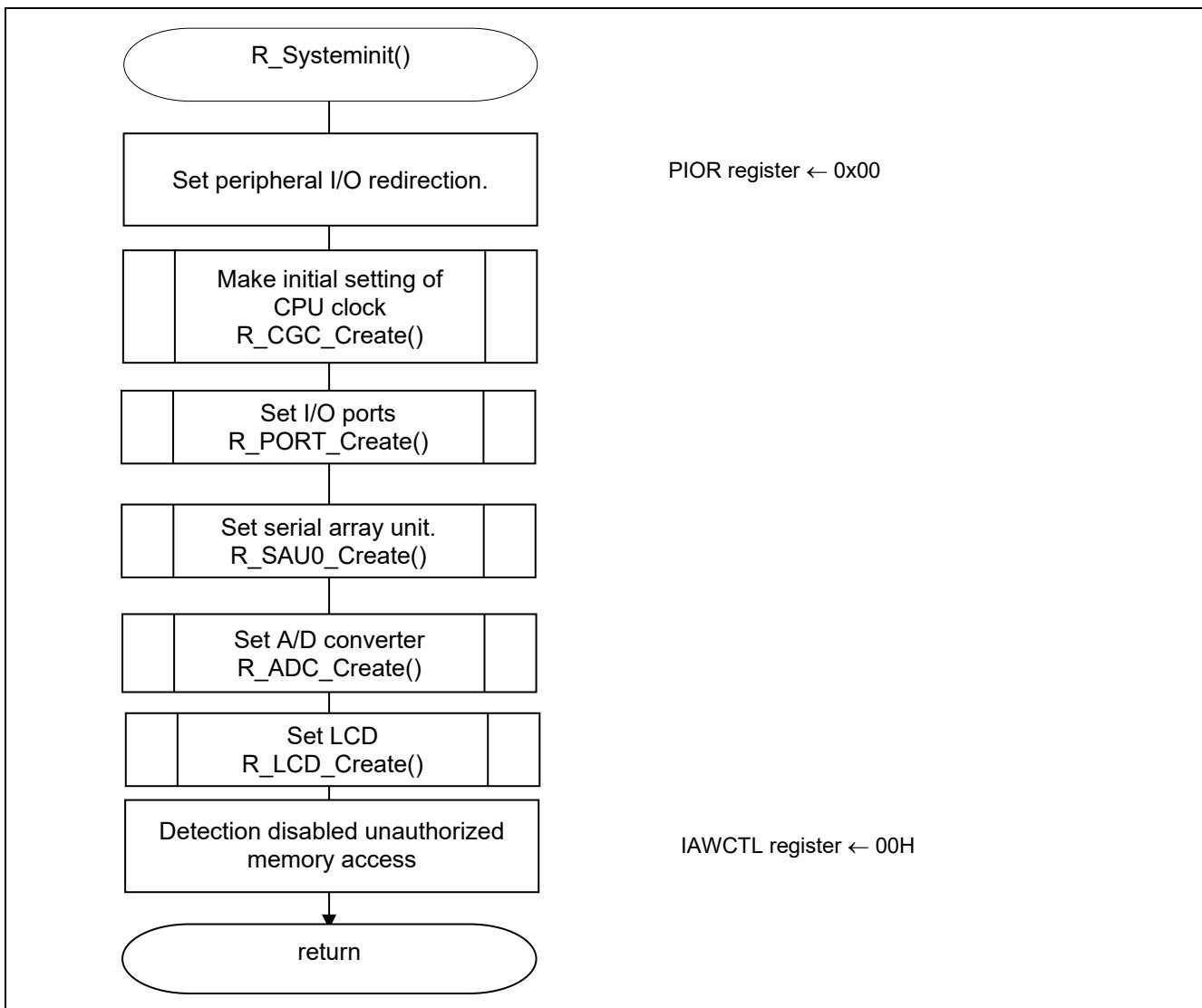
Figure 4.3 System Function

4.7.3 CPU clock Setting

Figure 4.4 shows the flowchart for the CPU clock setting.

Inside the flowchart:

R_CGC_Create()

Set high-speed system clock/subsystem clock
- CMC register ← 00H :
  High-speed clock : input port mode
  MSTOP bit ← 1 : X1 oscillator stopped
- MCM0 bit ← 0 : Select high-speed on-chip oscillator clock(f_{IH})
  as main system clock (f_{MAIN})

Set clock operation control
- XTSTOP bit ← 1

Set operation speed mode
- OSMC register ← 10H :

Select CPU/peripheral hardware (f_{CLK})
- CSS bit ← 0 : Select main system clock(f_{MAIN}) to
  CPU/peripheral hardware clock(f_{CLK})
- HIOSTOP bit ← 0 : High-speed on-chip oscillator operation

return

Figure 4.4 the CPU clock setting

4.7.4 I/O Port Setup

Figure 4.5 shows the flowchart for setting up the I/O ports.
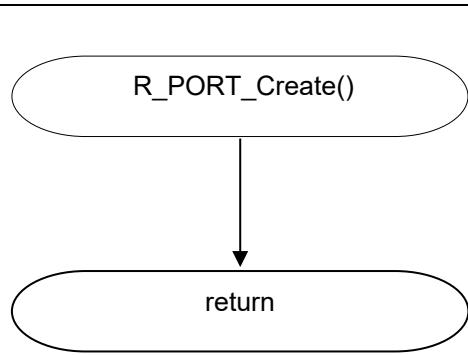
Figure 4.5 I/O Port Setup

Notes: 1. For details on register setting when using the ports as the alternate functions of the peripheral functions, refer to the RL78/L12 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 V_{DD} or V_{SS} via a separate resistor.

4.7.5   Serial Array Unit (UART0) Setting

Figure 4.6 ~ Figure 4.8 show the flowcharts for setting up the serial array unit.
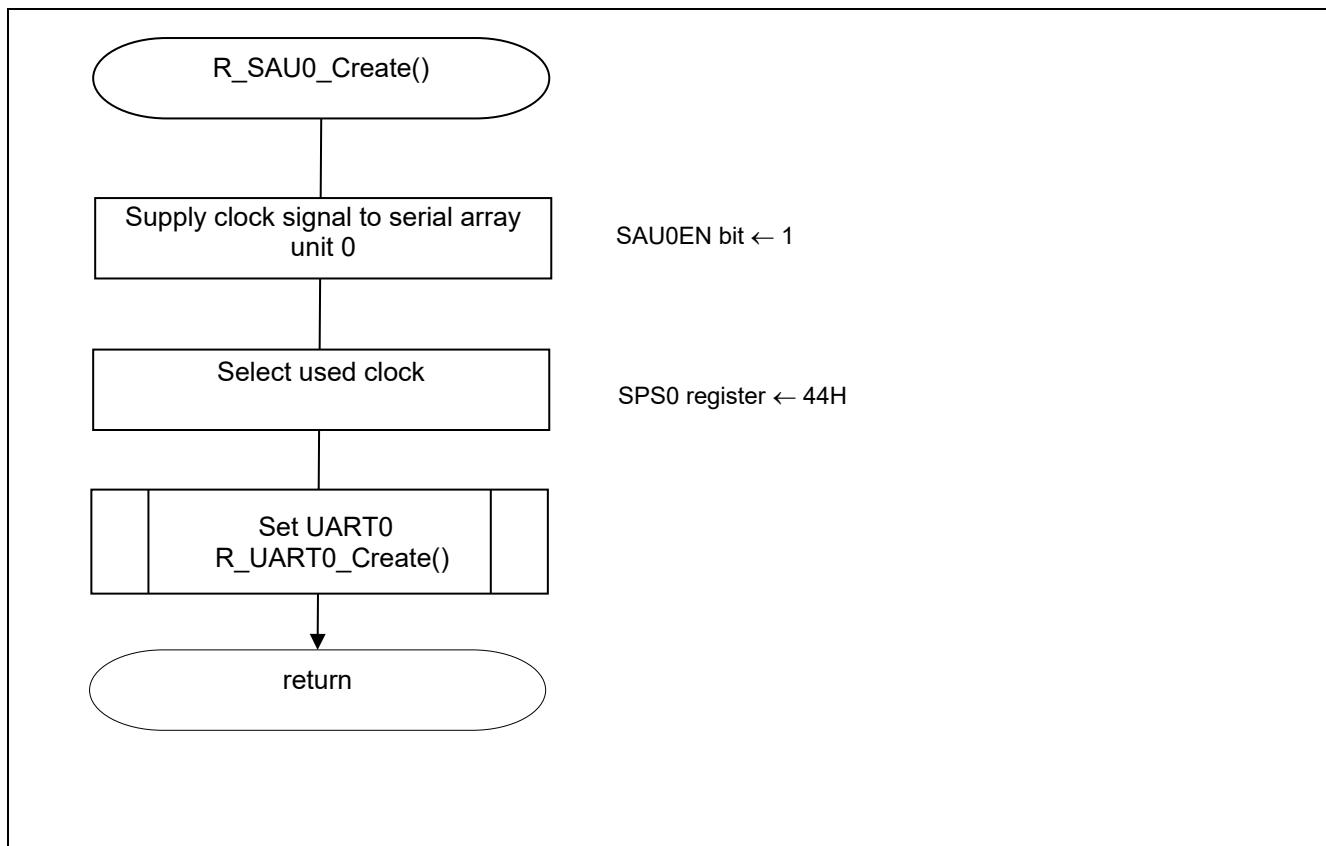

Figure 4.6 Serial Array Unit Setting
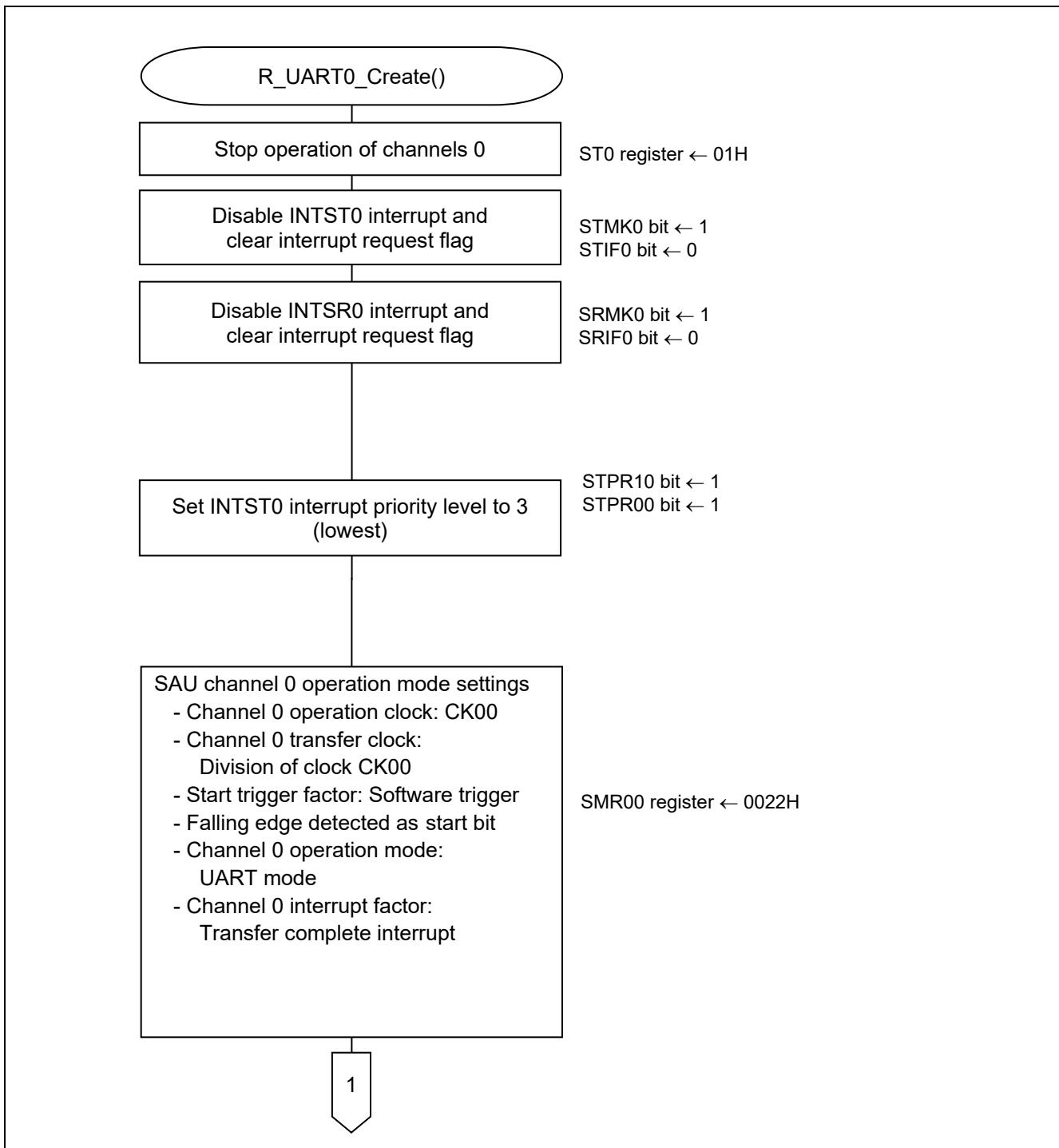
Figure 4.7 Serial Array Unit (UART0) Setting (1/2)
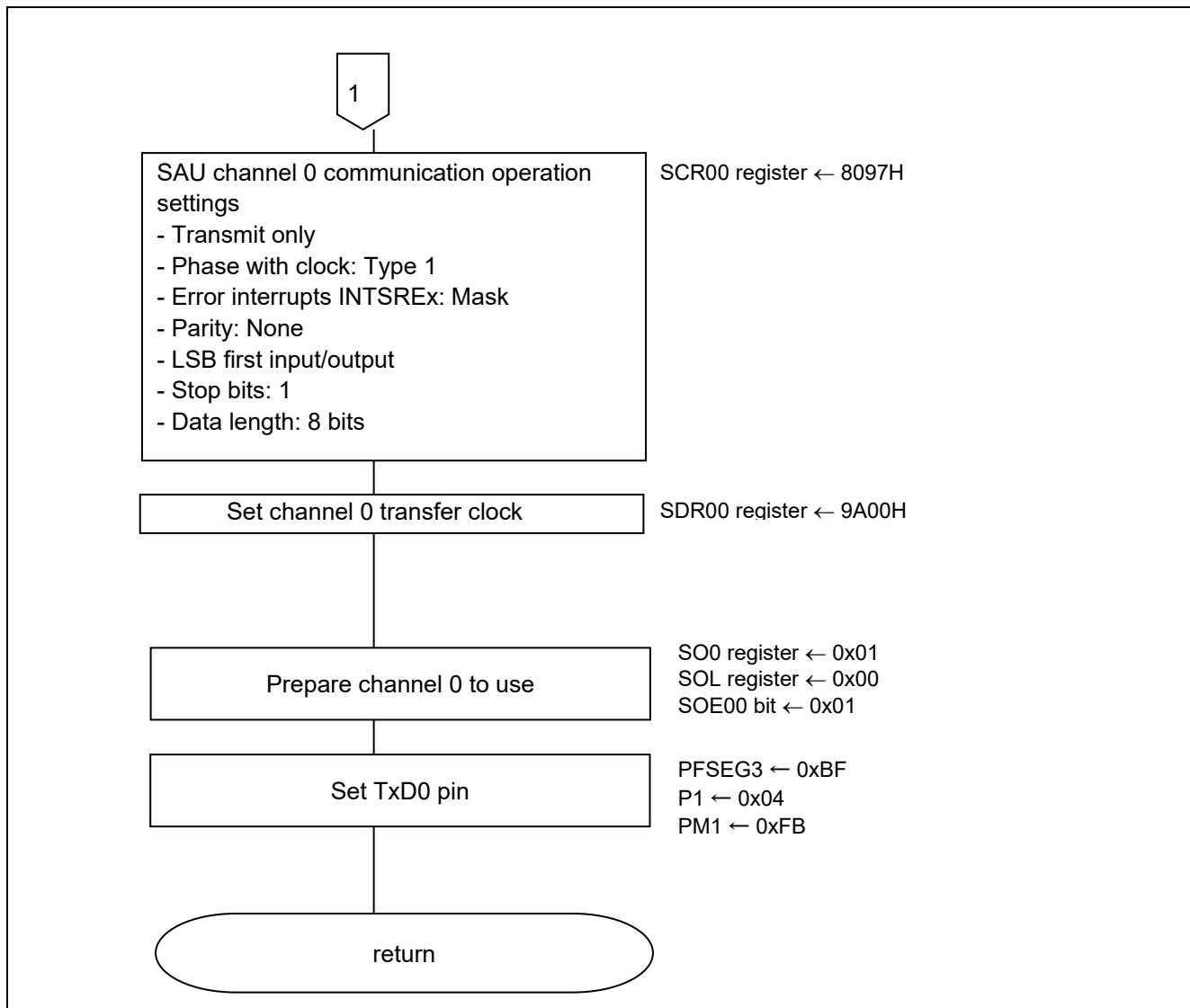
Figure 4.8 Serial Array Unit (UART0) Setting (2/2)

4.7.6   A/D converter Setup

Figure 4.9 shows the flowchart for setting up the A/D converter.

```
                    ┌─────────────────────────┐
                    │      R_ADC_Create()     │
                    └─────────────────────────┘
                                │
        ┌───────────────────────────────┐
        │  Supply clock to A/D converter │        ADCEN bit ← 1: Start supply of input clock.
        └───────────────────────────────┘
                                │
        ┌───────────────────────────────┐
        │     Initialize A/D converter   │        ADM0 register ← 18H
        │ • Set conversion time to        │
        │   about 4.6 μs                 │
        └───────────────────────────────┘
                                │
        ┌───────────────────────────────┐
        │     Disable interrupt INTAD     │        ADMK  bit ← 1
        │   Clear interrupt INTAD flug    │        ADIF bit ← 0
        └───────────────────────────────┘
                                │
        ┌───────────────────────────────┐
        │        Set INTAD priority       │        ADPR1 bit ← 1
        └───────────────────────────────┘        ADPR0 bit ← 1
                                │
        ┌───────────────────────────────┐        PFSEG3 register ← 0x02
        │                                 │        PMC12 register ← 0x01
        │ Set A/D converter of channel     │        PM12 register ← 0x01
        │ ANI17                           │        ADM0 register ← 08H
        │                                 │        ADM1 register ← 00H
        │                                 │        ADM2 register ← 00H
        │                                 │        ADUL register ← FFH
        └───────────────────────────────┘        ADLL register ← 00H
                                │
        ┌───────────────────────────────┐
        │   Specify analog input channel  │        ADS register ← 0x11
        │ • Set analog input channel to    │
        │   ANI0                          │
        └───────────────────────────────┘
        ┌───────────────────────────────┐
        │  Permit A/D conversion operation│
        │  (Conversion operation status)  │        ADCE bit ← 1
        └───────────────────────────────┘
                                │
                    ┌─────────────────────────┐
                    │          return         │
                    └─────────────────────────┘
```

Figure 4.9 A/D Converter Setup

4.7.7 LCD Controller/Driver Setting

Figure 4.10, Figure 4.11 show the flowcharts for setting the LCD controller/driver.
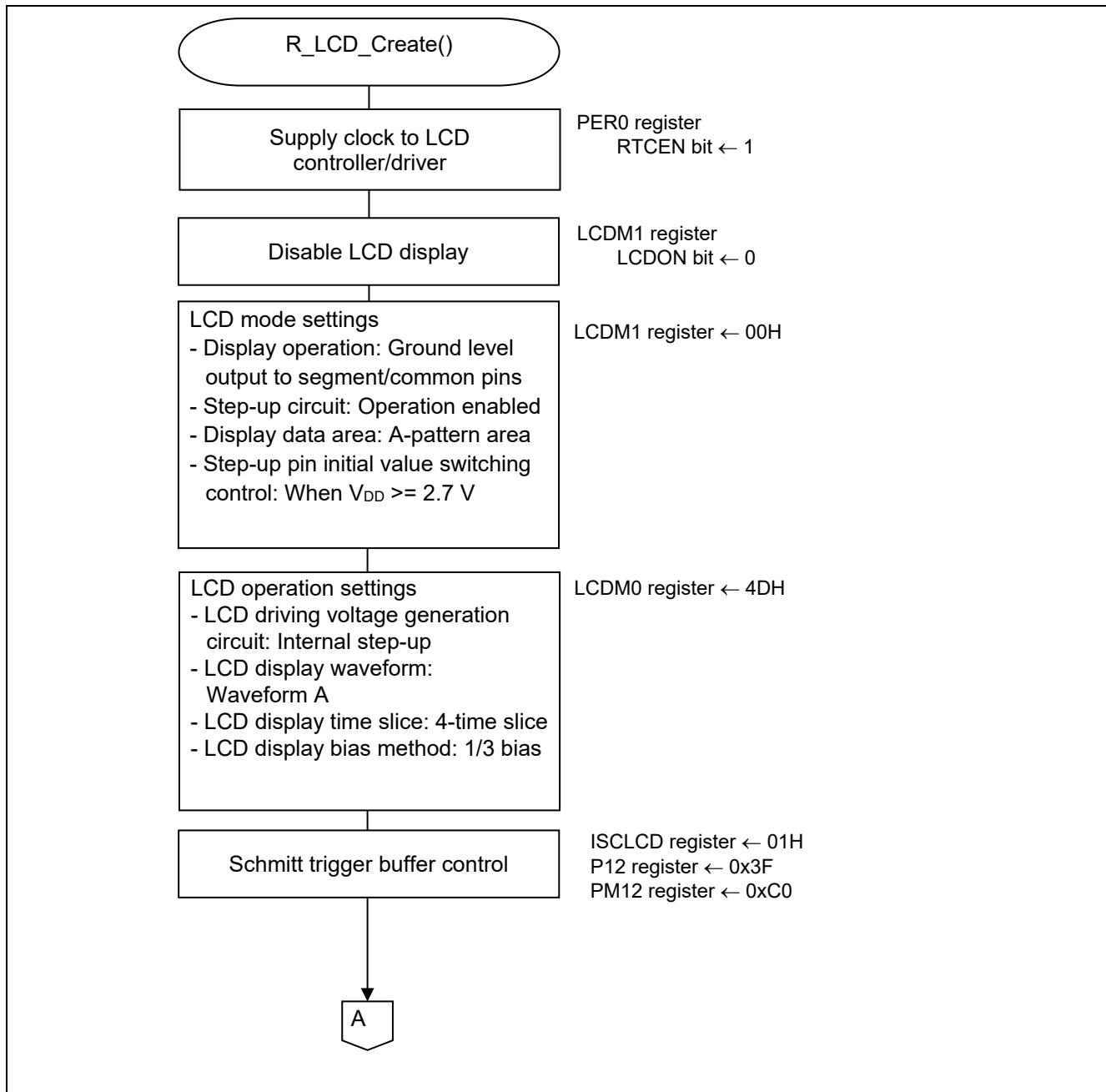


Figure 4.10 LCD Controller/Driver Setting (1/2)

A

Set segment output pins

PFSEG0 ← 0x00
PFSEG1 ← 0xFC
PFSEG2 ← 0x11
PFSEG3 ← 0x00
PFSEG4 ← 0x00

Segment output pins set to output mode, low level output

PU5 register ← 0xE7
P5∟register ← 0xE7
PM5 register ← 0xE7
P6 register ← 0xFD
PM6 register ← 0xFD
PU7 register ← 0xE0
P7 register ← 0xE0
PM7 register ← 0xE0

Set to display A-pattern area data

LCDM1 register ← 00H

Set LCD clock to $f_{SUB}/2^6$

LCDC0 register ← 05H

Set LCD step-up circuit reference voltage to 4.05 V

VLCD register ← 0BH

Wait for the reference voltage setup time, 5 ms (MIN)

return

Figure 4.11 LCD Controller/Driver Setting (2/2）

4.7.8 Main Processing

Figure 4.12 shows the flowchart for the main processing.
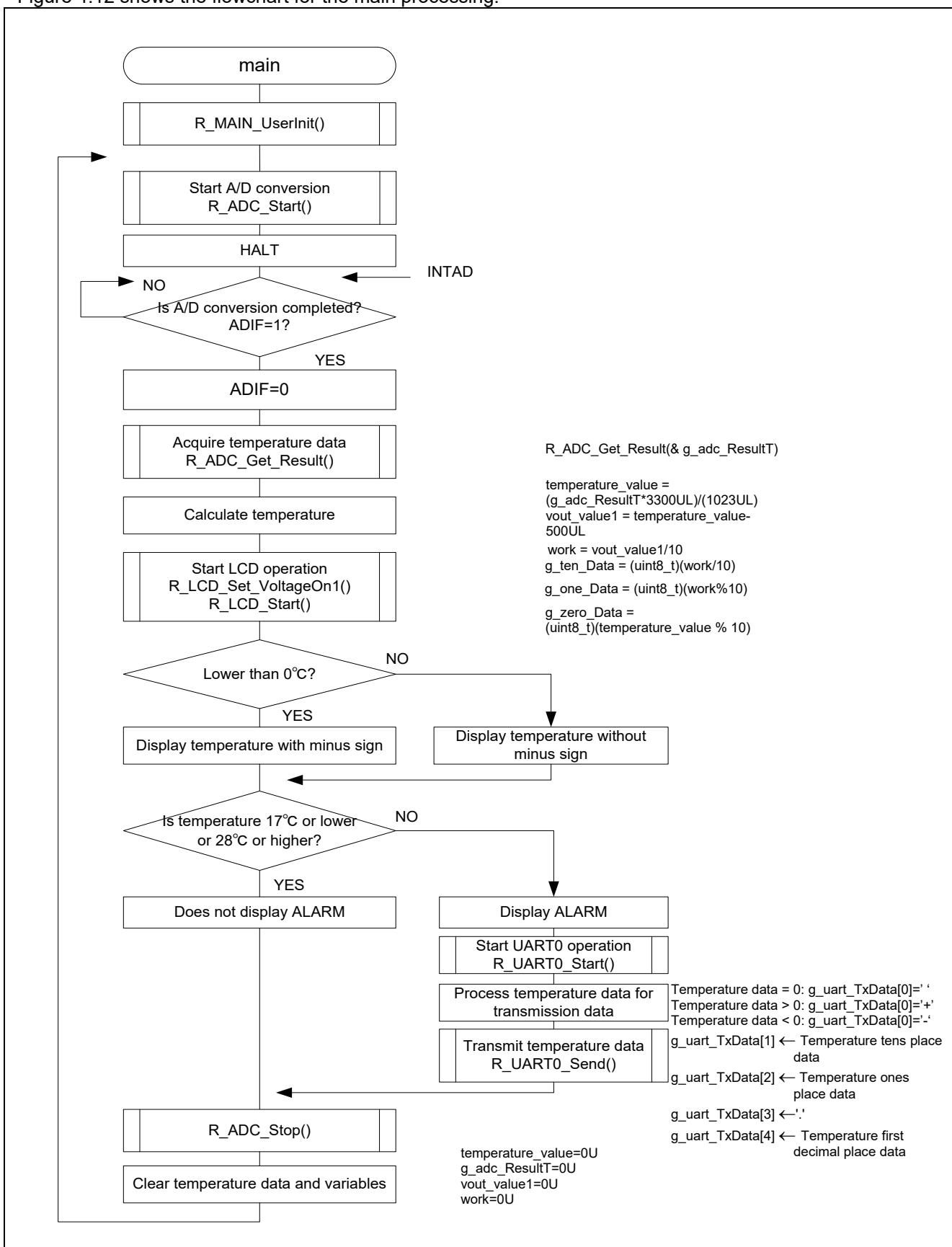
Figure 4.12 Main Processing

RENESAS

4.7.9 LCD Initialization Display Setting

Figure 4.13 shows the flowchart for setting the LCD initialization display.
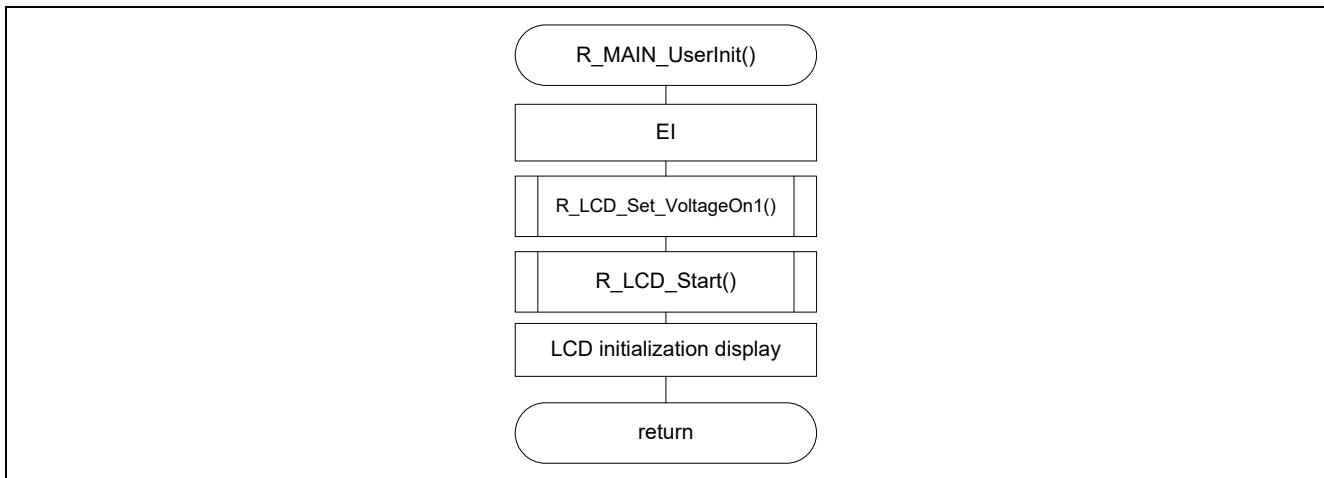
Figure 4.13 LCD Initialization Display Setting

4.7.10 A/D Conversion Start Setting

shows the flowchart for setting the A/D conversion start.
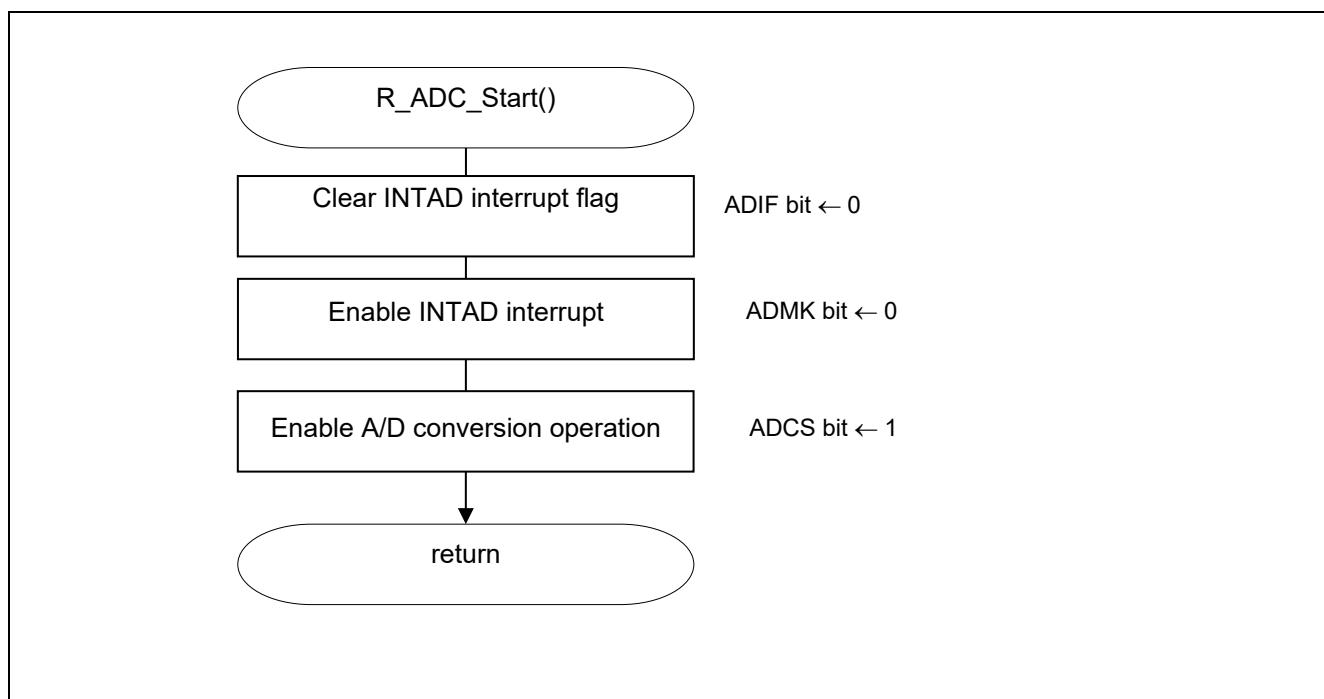
Figure 4.14 A/D Converter Operation Start Setting

4.7.11 Temperature Data Acquisition Processing

Figure 4.15 shows the flowchart for temperature data acquisition processing.
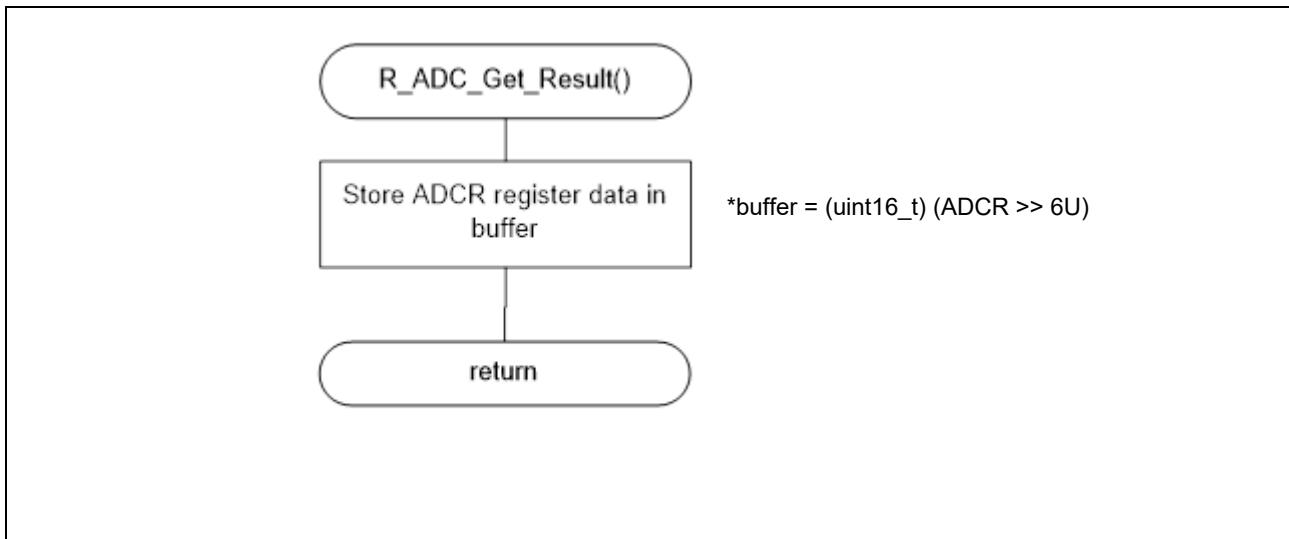
Figure 4.15 Temperature Data Acquisition Processing

4.7.12 LCD Step-Up Circuit Operation Start Processing

Figure 4.16 shows the flowchart for LCD step-up circuit operation start processing.
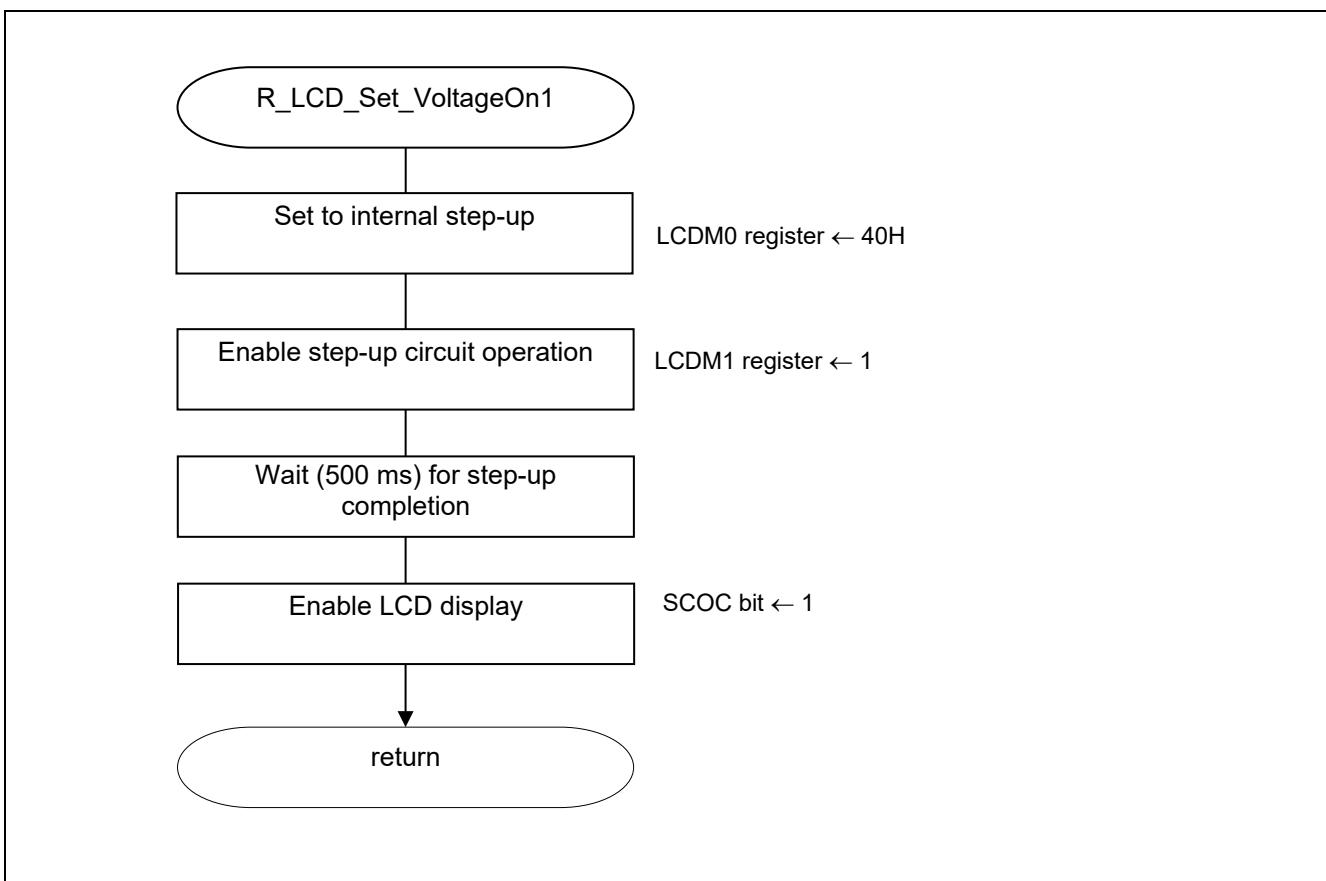
Figure 4.16 LCD Step-Up Circuit Operation Start Processing

4.7.13 LCD Display Start Processing

Figure 4.17 shows the flowchart for LCD display start processing.
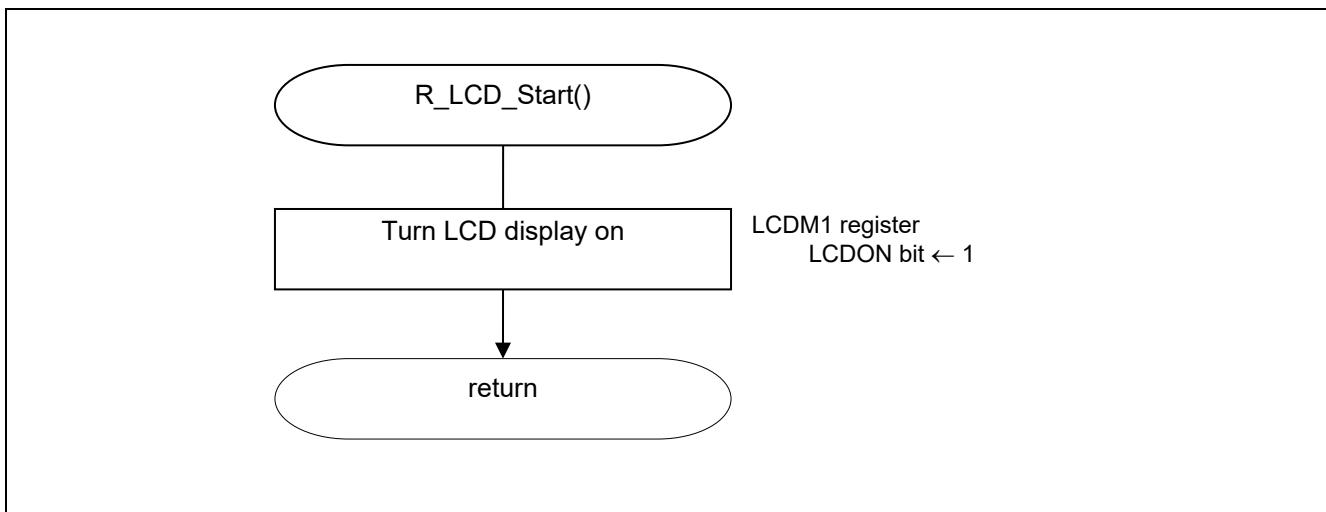
Figure 4.17 LCD Display Start Processing

4.7.14 UART0 Operation Start Function

Figure 4.18 shows the flowchart for the UART0 operation start function.
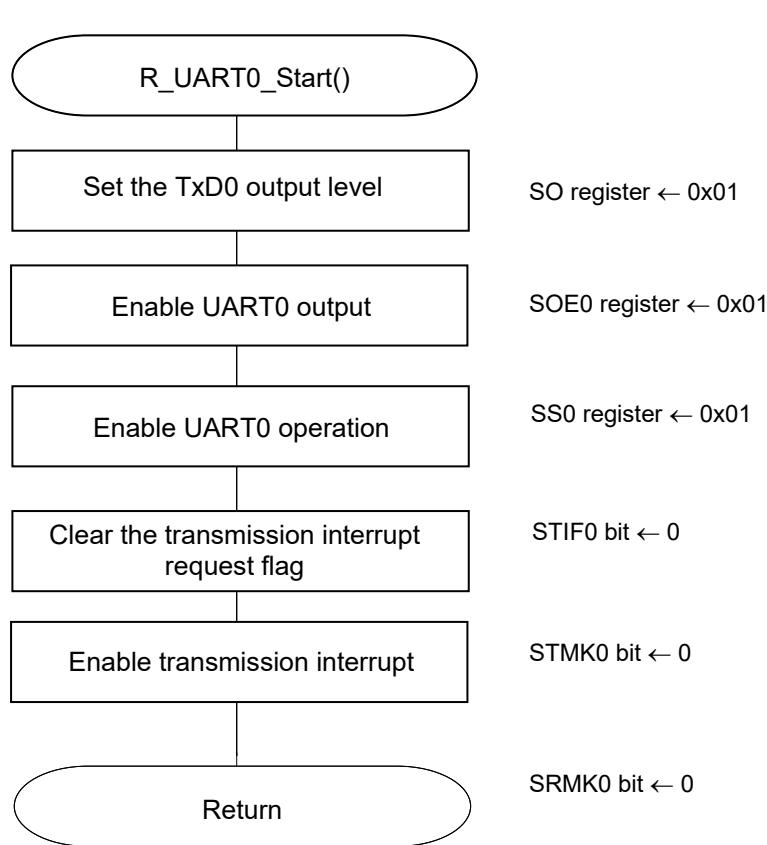
Figure 4.18 UART0 Operation Start Function

4.7.15 UART Transmission Processing

Figure 4.19 shows the flowchart for UART transmission processing.
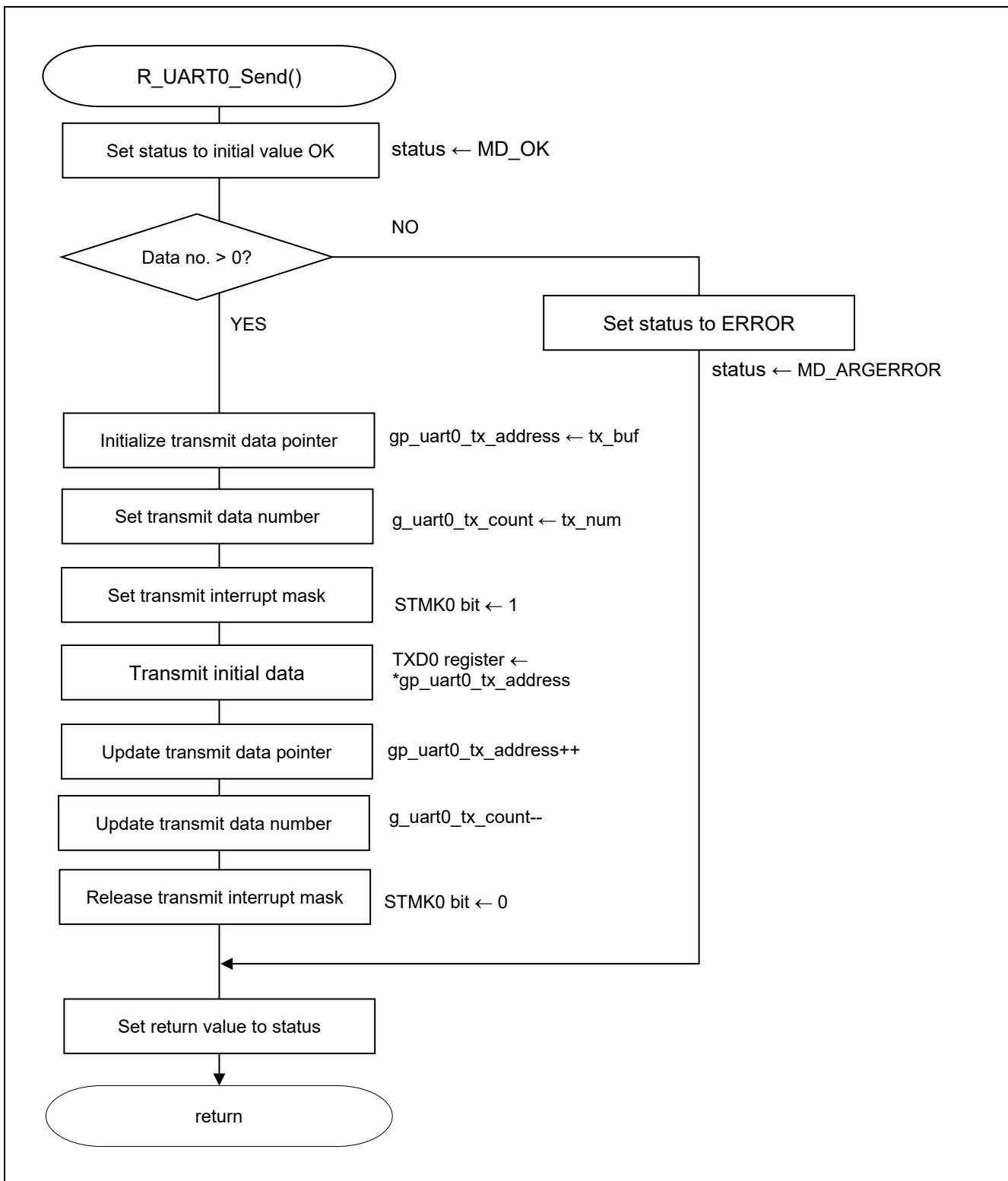
Figure 4.19 UART Transmission Processing

4.7.16 A/D Conversion Stop Setting

Figure 4.20 shows the flowchart for setting the A/D conversion stop
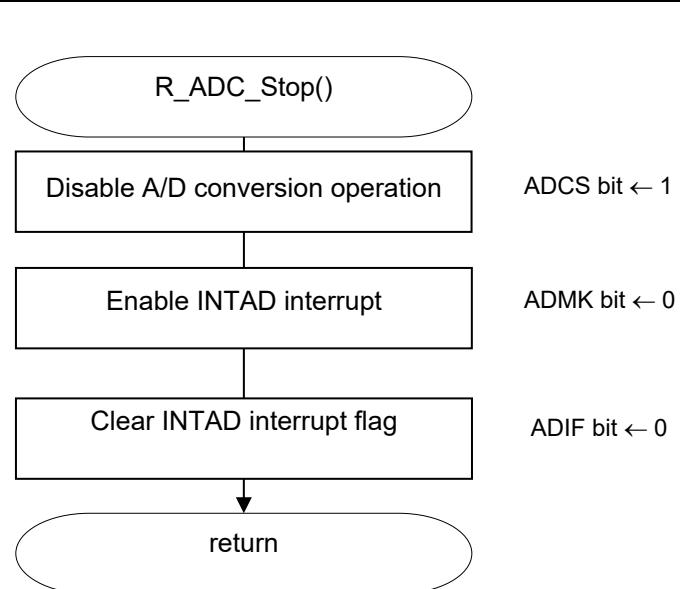
Figure 4.20 A/D converter Operation Stop Setting

Revision History

Rev.	Date	Description	
		Page	**Summary**
1.00	2019/4/26	-	-

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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