M16C/64A,64C,65,65C,6C,5LD,56D,5L,56,5M,57 Groups

Real-Time Clock (100-Year Calendar)

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1. Abstract

This document describes the settings for creating a 100-year calendar using the real-time clock.

2. Introduction

The application example described in this document applies to the following microcomputers (MCUs):

MCU(s): M16C/64A,64C,65,65C,6C,5LD,56D,5L,56,5M,57 Groups

This application note can be used with other M16C Family MCUs which have the same special function registers (SFRs) as the above group. Check the hardware manual for any modifications to functions. Careful evaluation is recommended before using the program described in this application note.

3. Application Example

In this document, “date” includes the day of the week unless otherwise specified.

3.1 Explanation

This document describes the settings for creating a 100-year calendar using a real-time clock.

After reset, the current time data (values in registers, RTCSEC, RTCMIN, RTCHR, and RTCWK), time and date data (values in RAM), and alarm time and date data are initialized to transit to wait mode.
A real-time clock compare interrupt occurs every hour, and the MCU exits wait mode. After exiting wait mode, the current time data, and time and date data are updated to determine whether the time and date data and alarm time and date data match. When the data match, the clock enters time and date display mode.
In time and date display mode, the time data, and time and date data are updated, and their data is displayed on the LED.

Figure 3.1 shows the State Transition Example.

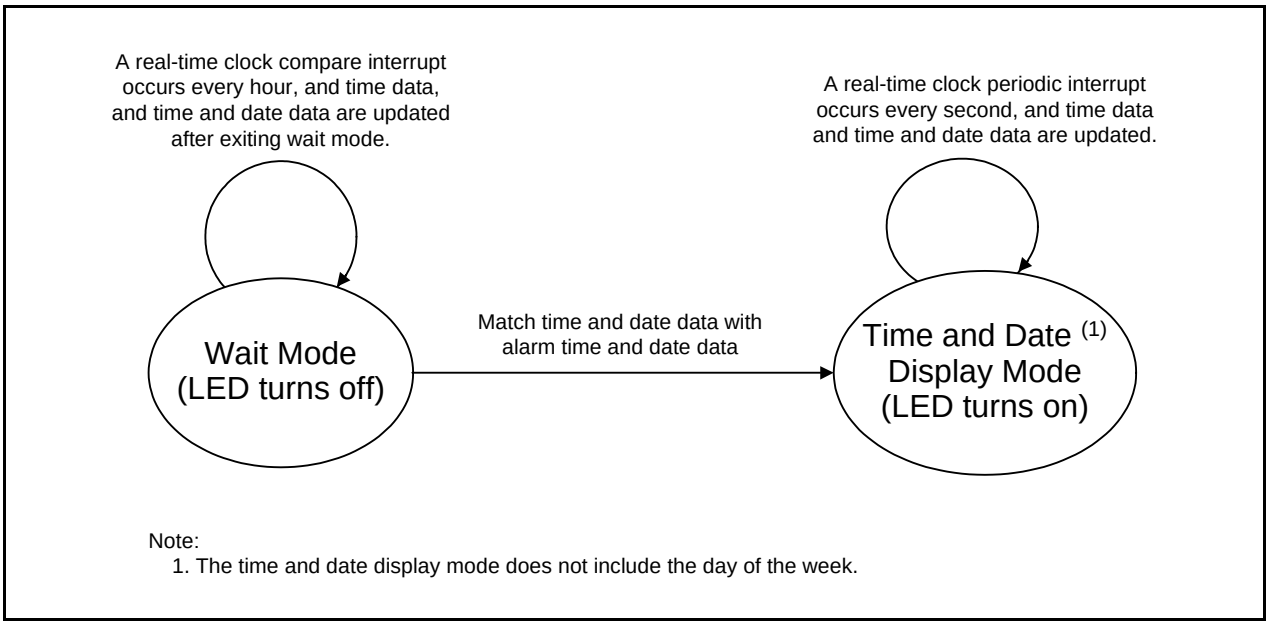


Figure 3.1 State Transition Example

3.2 Operations in Application Example

Figure 3.2 shows an operation example when setting the time data (values in registers RTCSEC, RTCMIN, RTCHR, and RTCWK), time and date data (variable in RAM) for “Thursday, January 1, 2009, 00:00:00”, and setting the alarm time and date data for “April 1, 2009”.

(1) The time data, time and date data, and alarm time and date data are initialized, and the real-time clock is set.
(2) The real-time clock starts.
(3) The MCU enters the wait mode.
(4) When the RTCSEC register value matches the RTCCSEC register value, and the RTCMIN register value matches the RTCCMIN register value, the MCU exits wait mode through the real-time clock compare interrupt, and then the time data, and time and date data are updated.
(5) Determine whether the time and date data and alarm time and date data match. If the data do not match, return to step (3). If the data match, continue on to the next step.
(6) The time data, and time and date data are updated within the real-time clock periodic interrupt handling, and then data is output to the LED.

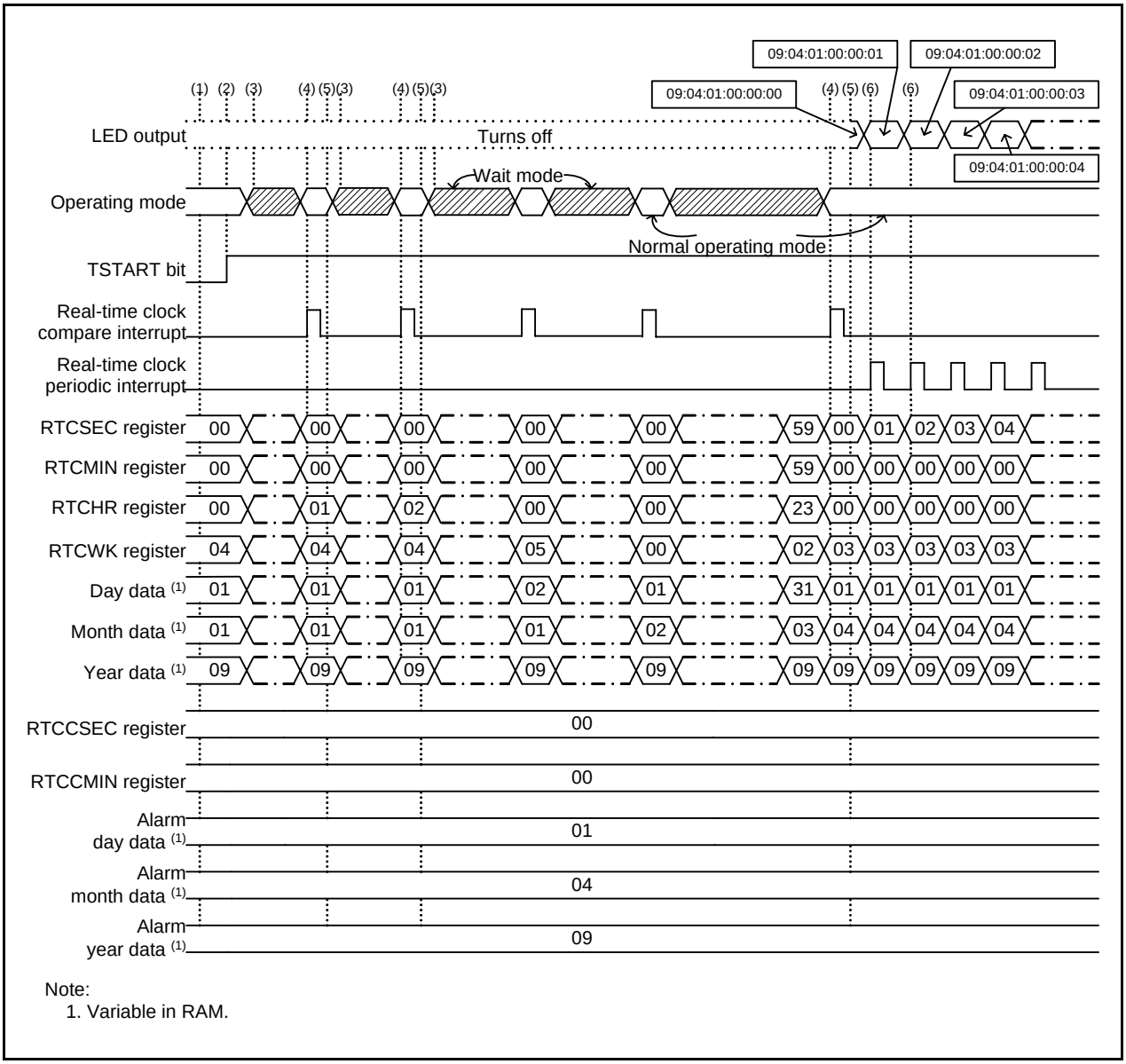


Figure 3.2 Operation Example

4. Time Reading Procedure of Real-Time Clock Mode and Compare Data Writing Procedure

In real-time clock mode, read time data bits (1) when the BSY bit in the RTCSEC register is 0 (not while data is updated).
When reading multiple registers, if data is rewritten between reading registers, incorrect time data will be read.
As with the time data bits, write to the compare data (2) bits when the BSY bit is 0.

Notes:
1. Time data bits are as follows:
   Bits SC12 to SC10 and SC03 to SC00 in the RTCSEC register
   Bits MN12 to MN10 and MN03 to MN00 in the RTCMIN register
   Bits HR11 to HR10 and HR03 to HR00 in the RTCHR register
   Bits WK2 to WK0 in the RTCWK
   The RTCPM bit in the RTCCR1 register
2. Compare data bits are as follows:
   Bits SCMP12 to SCMP10 and SCMP03 to SCMP00 in the RTCCSEC register
   Bits MCMP12 to MCMP10 and MCMP03 to MCMP00 in the RTCCMIN register
   The PMCMP bit, bits HCMP11 to HCMP10, and HCMP03 to HCMP00 in the RTCCHR register

The following are read and write sample procedures to avoid misreading time data.

Using an interrupt
In the real-time clock periodic interrupt routine, read the necessary contents of the time data bits and write the necessary contents of the compare data bits.

Monitoring by a program 1
Monitor the IR bit in the RTCTIC register by a program. After the IR bit becomes 1, read the necessary contents of the time data bits and write the necessary contents of compare data bits.

Monitoring by a program 2
Read and write data according to Figure 4.1 Time Data Reading/Compare Data Writing.

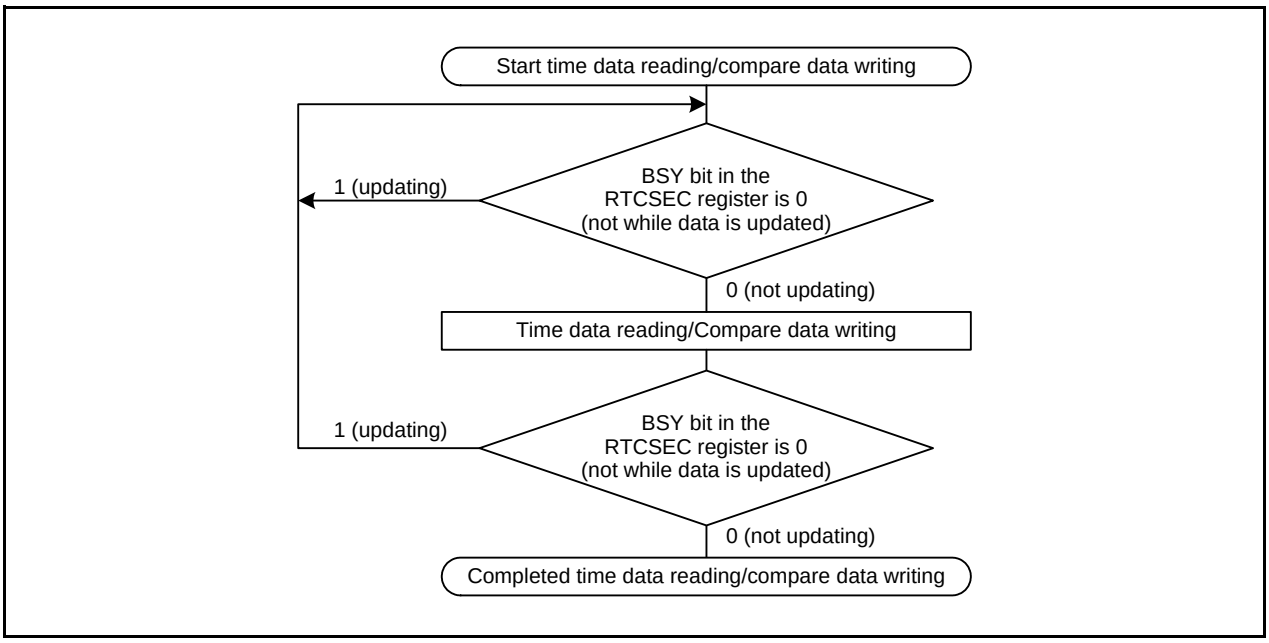


Figure 4.1 Time Data Reading/Compare Data Writing

Also, when reading or writing multiple registers, read or write to them as continuously as possible.
In the example described in this application note, an interrupt is used to read the time data.

5. Flowchart

Figure 5.1 shows the Main Program Flowchart.

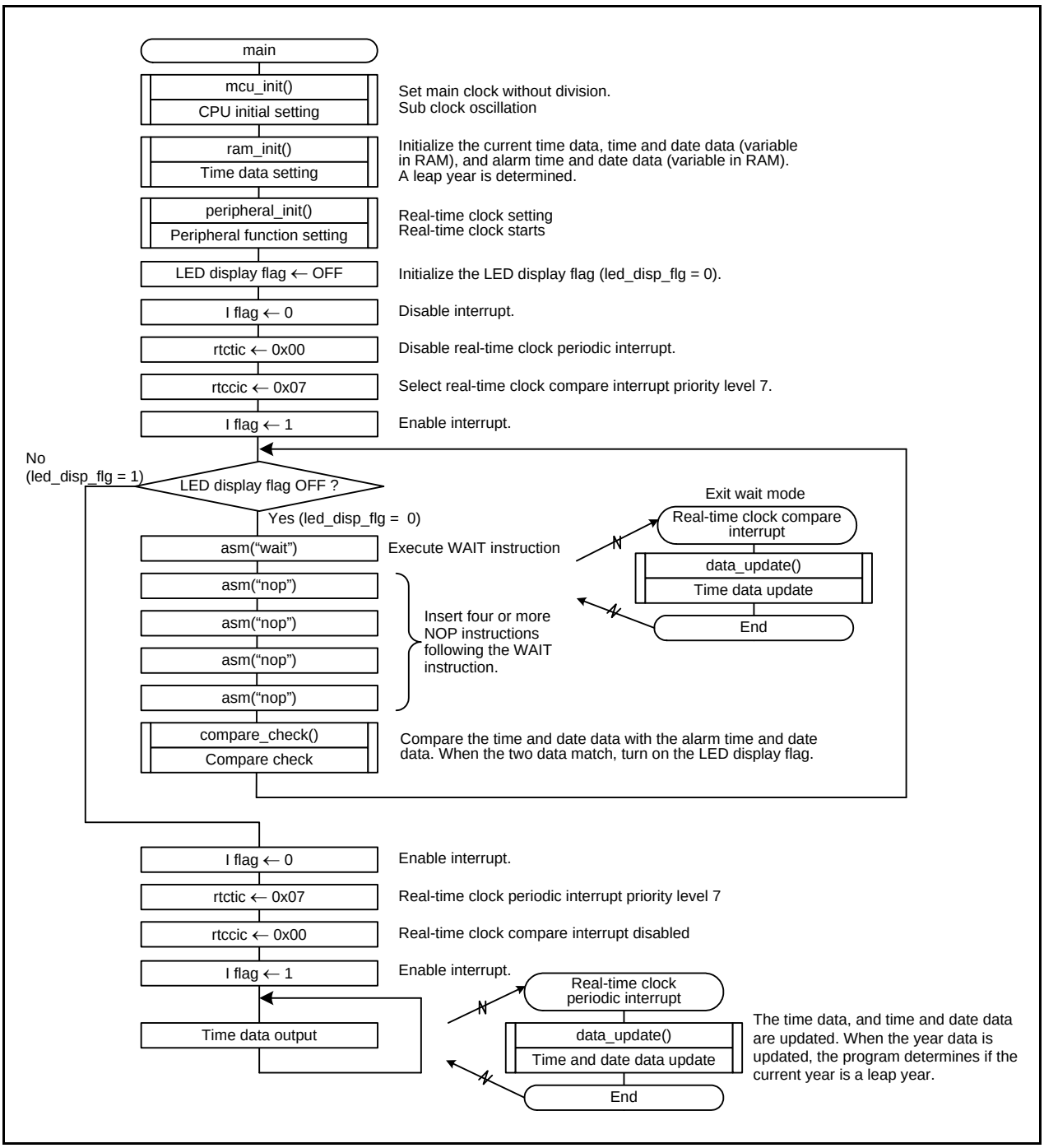


Figure 5.1 Main Program Flowchart

Figure 5.2 shows the Flowchart of the Time Data Obtaining Function.

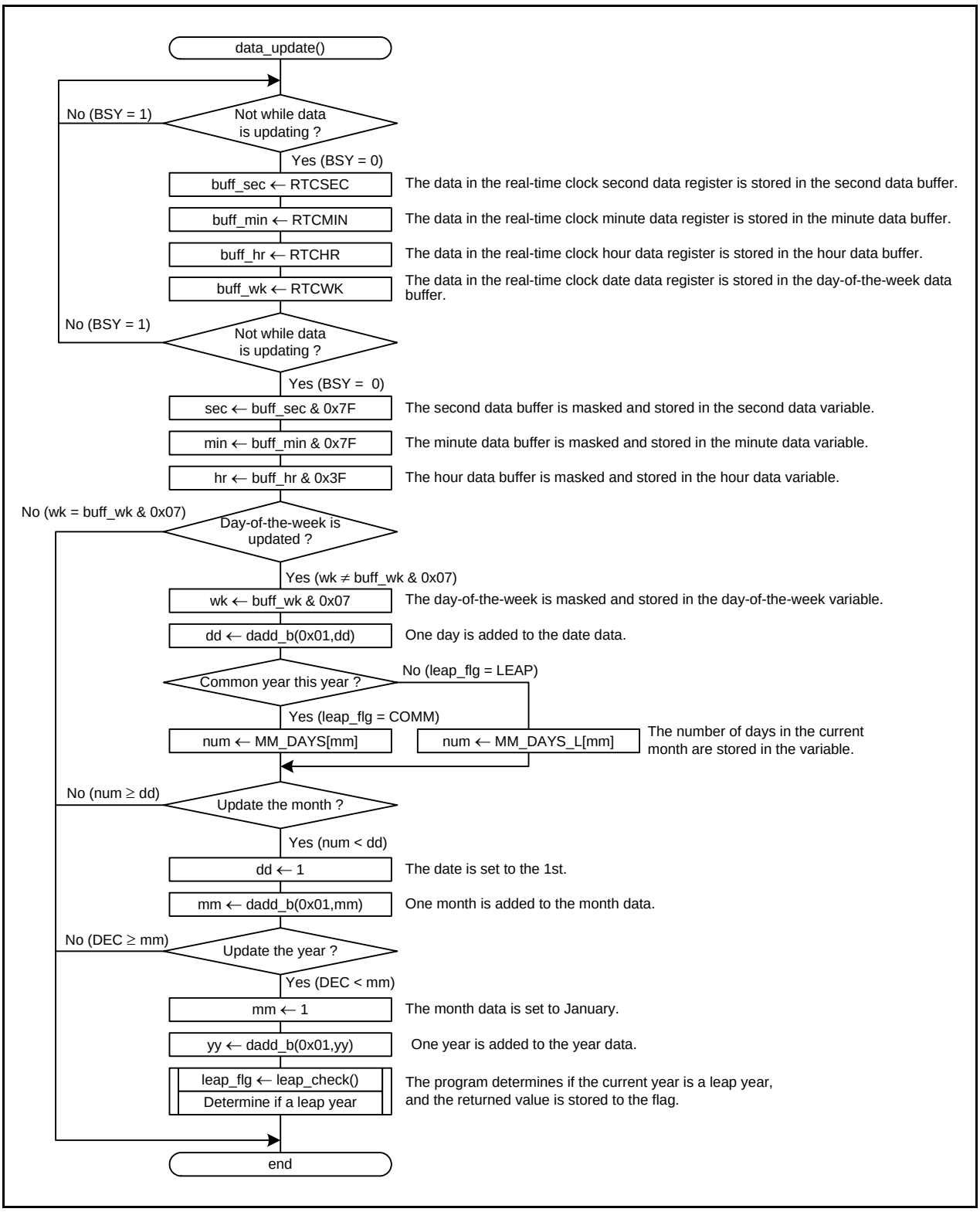


Figure 5.2 Flowchart of the Time Data Obtaining Function

Figure 5.3 shows the Flowchart of the Leap Year Determination Function.

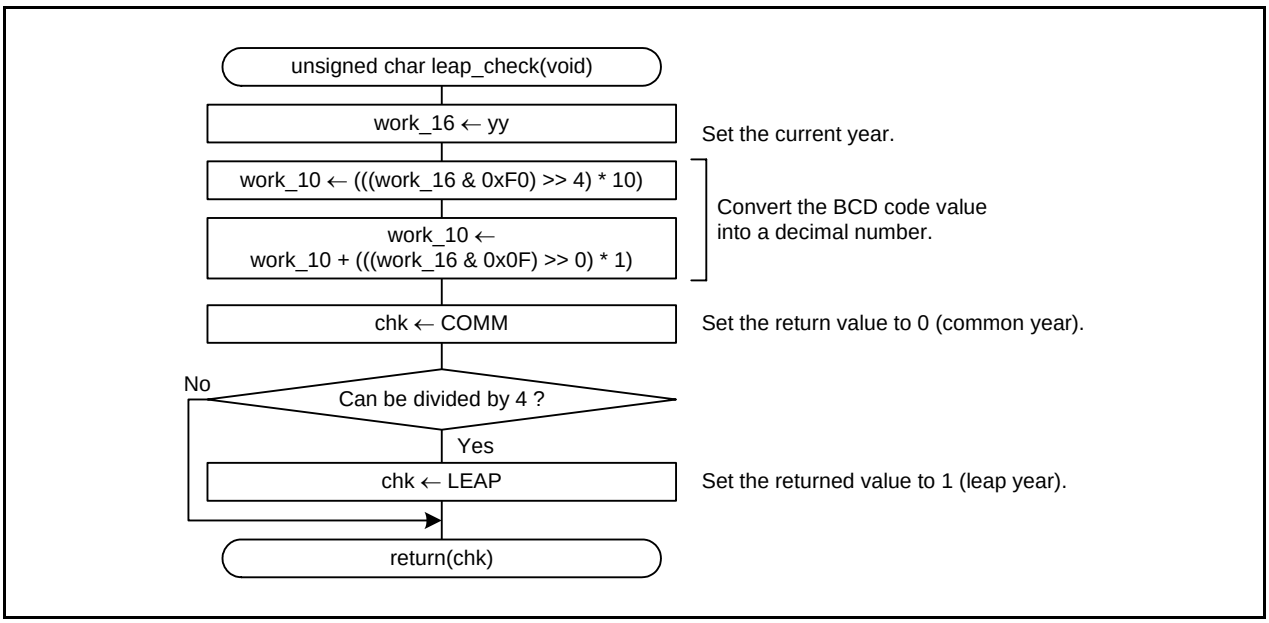


Figure 5.3 Flowchart of the Leap Year Determination Function

6. Function Tables

Declaration	void ram_init(void)	
Outline	Time data setting function	
Argument	None	
Variable (global)	Variable name	Contents
	unsigned char yy	Year data storage variable
	unsigned char mm	Month data storage variable
	unsigned char dd	Date data storage variable
	unsigned char wk	Day-of-the-week data storage variable
	unsigned char ampm	a.m./p.m. data storage variable
	unsigned char hr	Hour data storage variable
	unsigned char min	Minute data storage variable
	unsigned char sec	Second data storage variable
	unsigned char alarm_yy	Alarm year data variable
	unsigned char alarm_mm	Alarm month data variable
	unsigned char alarm_dd	Alarm date data variable
	unsigned char leap_flg	Leap year determination result flag
Returned value	None	
Function	The current time data, time and date data, and alarm time and date data are initialized. In the reference program, the time data, and time and date data are set to “Thursday, January 1, 2009, 00:00:00”, and the alarm time and date data is set to “April 1, 2009”.	

Declaration	void peripheral_init(void)	
Outline	Peripheral setting function	
Argument	None	
Variable (global)	Variable name	Contents
	unsigned char wk	Day-of-the-week data storage variable
	unsigned char ampm	a.m./p.m. data storage variable
	unsigned char hr	Hour data storage variable
	unsigned char min	Minute data storage variable
	unsigned char sec	Second data storage variable
Returned value	None	
Function	Initialize the port. Set the real-time clock and the current time data, and set the compare minute data and compare second data to the register to start the real-time clock.	

Declaration	void data_update(void)	
Outline	Time data update function	
Argument	None	
Variable (global)	Variable name	Contents
	unsigned char yy	Year data storage variable
	unsigned char mm	Month data storage variable
	unsigned char dd	Date data storage variable
	unsigned char wk	Day-of-the-week data storage variable
	unsigned char hr	Hour data storage variable
	unsigned char min	Minute data storage variable
	unsigned char sec	Second data storage variable
	unsigned char leap_flg	Leap year determination result flag
Returned value	None	
Function	Update the time data. When the day of the week changes, update the time and date data. When the year data is updated, the program calls the leap_check function to determine if the current year is a leap year.	

Declaration	void leap_check(void)	
Outline	Leap year determination function	
Argument	None	
Variable (global)	Variable name	Contents
	unsigned char yy	Year data storage variable
Returned value	Type	Meaning
	COMM	Common year
	LEAP	Leap year
Function	Determine if the current year is common year or a leap year and the value is returned.	

Declaration	void compare_check(void)	
Outline	Compare data determination function	
Argument	None	
Variable (global)	Variable name	Contents
	unsigned char yy	Year data storage variable
	unsigned char mm	Month data storage variable
	unsigned char dd	Date data storage variable
	unsigned char alarm_yy	Alarm year data storage variable
	unsigned char alarm_mm	Alarm month data storage variable
	unsigned char alarm_dd	Alarm date data storage variable
	unsigned char led_disp_flag	LED display flag
Returned value	None	
Function	Determine whether the current time and date data, and alarm time and date data match. When they match, turn on the LED display flag.	

7. Flowcharts

This section describes the procedure and values to execute the examples shown in “3. Application Example”. The examples are explained below using the M16C/65 Group. For details of each register, refer to the Hardware Manuals.

7.1 Real-Time Clock Setting

Figure 7.1 to Figure 7.4 show the settings for the real-time clock.

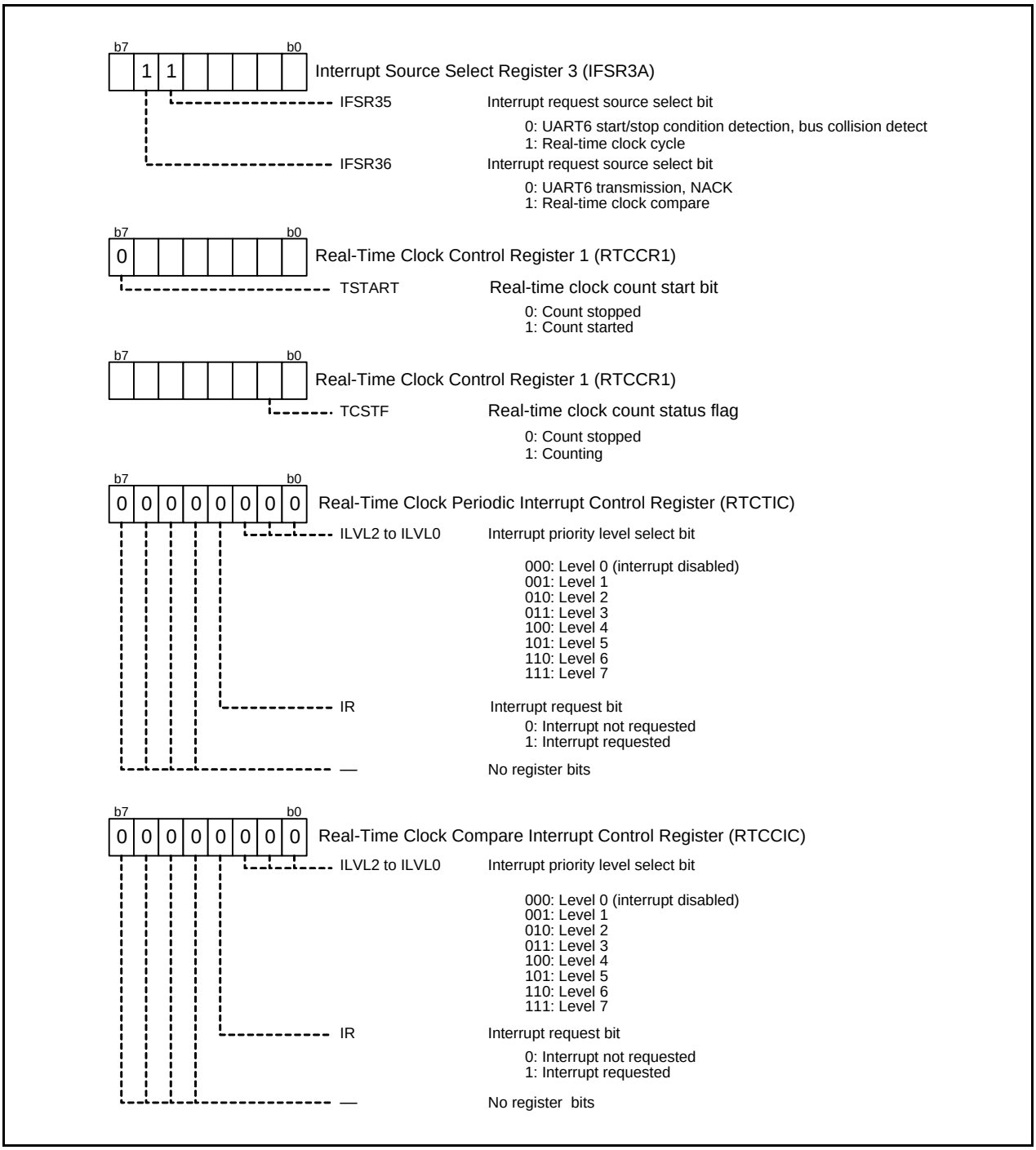
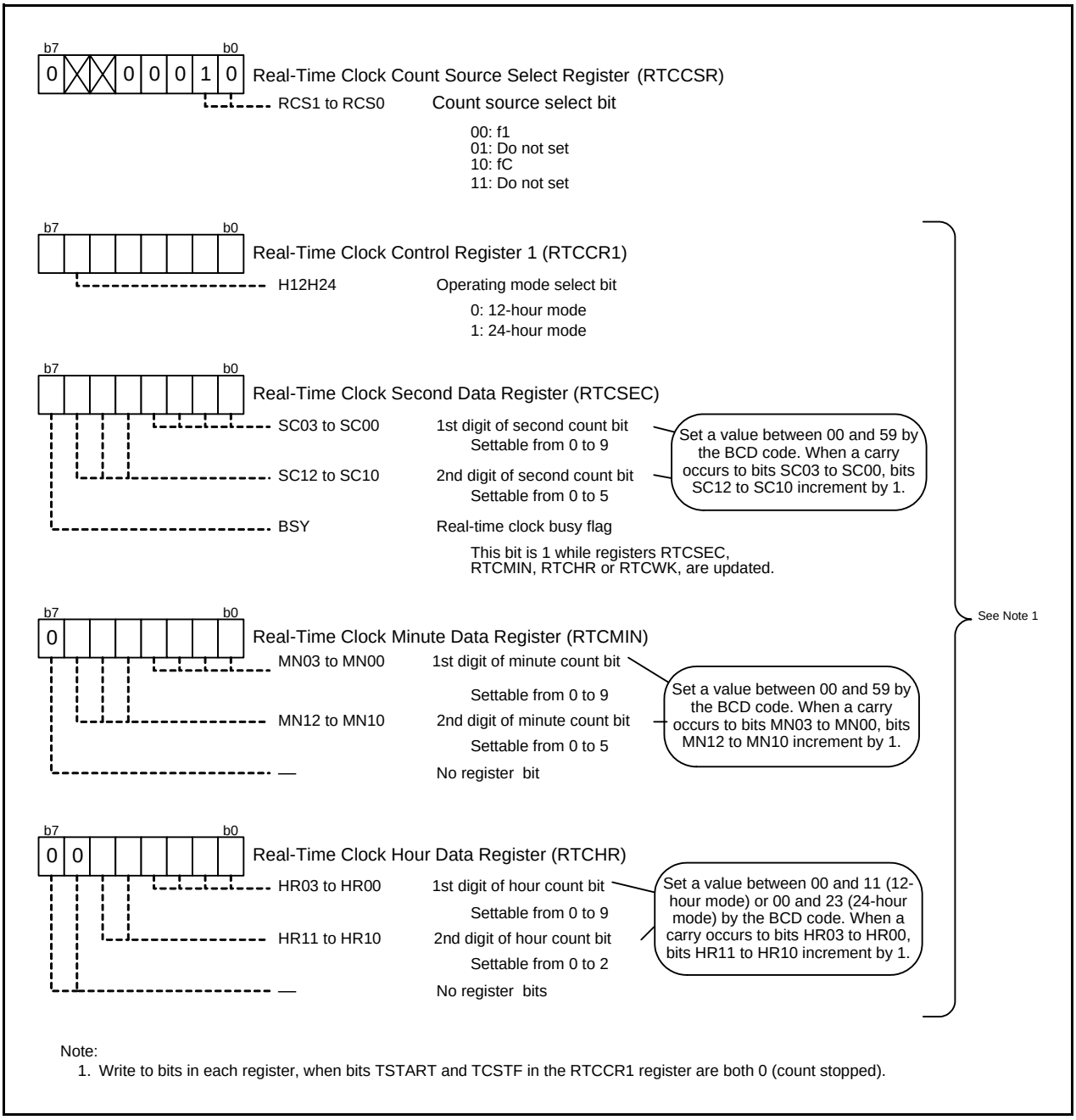
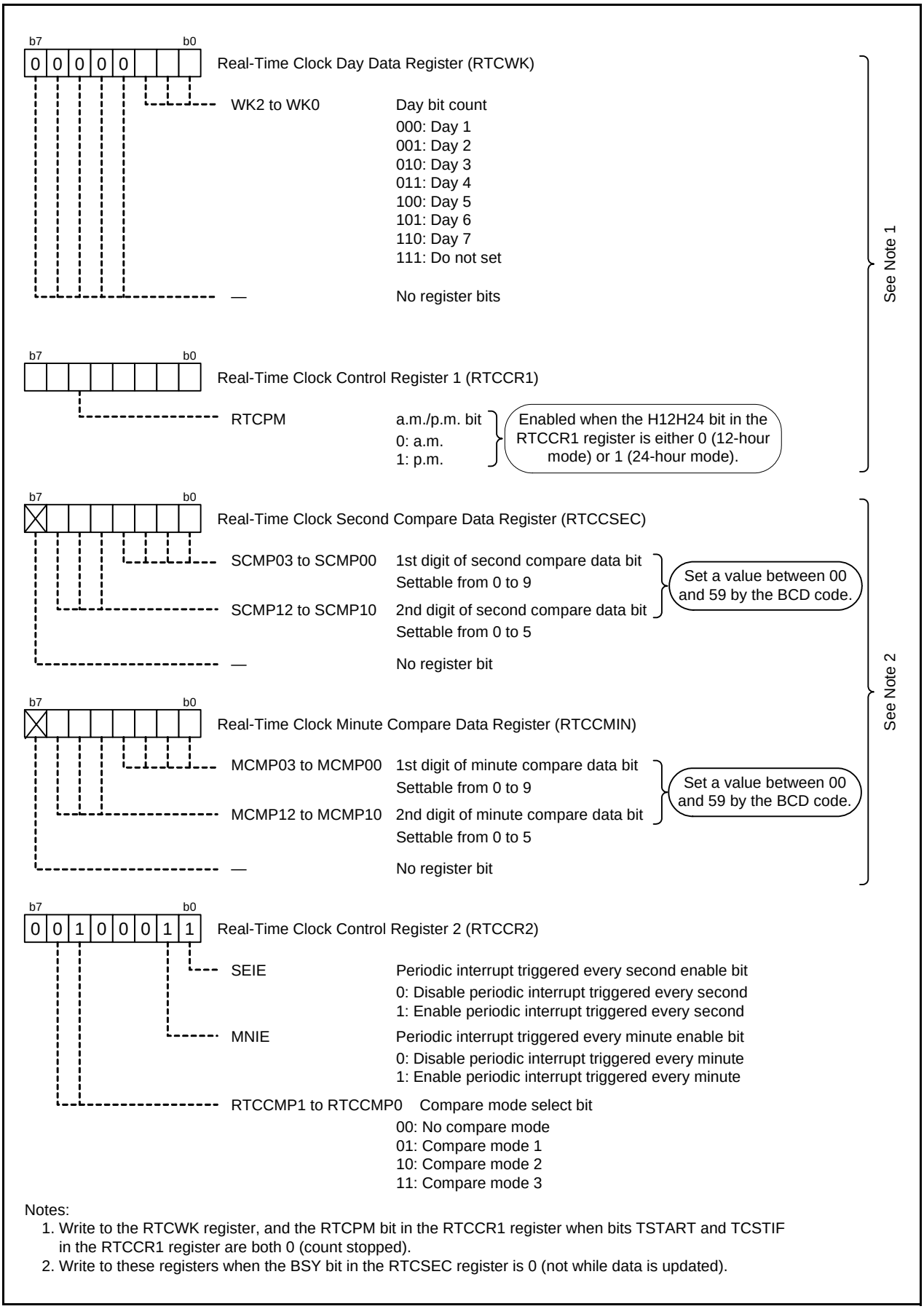


Figure 7.1 Real-Time Clock Setting (1/4)



Note:
1. Write to bits in each register, when bits TSTART and TCSTF in the RTCCR1 register are both 0 (count stopped).

Figure 7.2 Real-Time Clock Setting (2/4)



Notes:
1. Write to the RTCWK register, and the RTCPM bit in the RTCCR1 register when bits TSTART and TCSTIF in the RTCCR1 register are both 0 (count stopped).
2. Write to these registers when the BSY bit in the RTCSEC register is 0 (not while data is updated).

Figure 7.3 Real-Time Clock Setting (3/4)

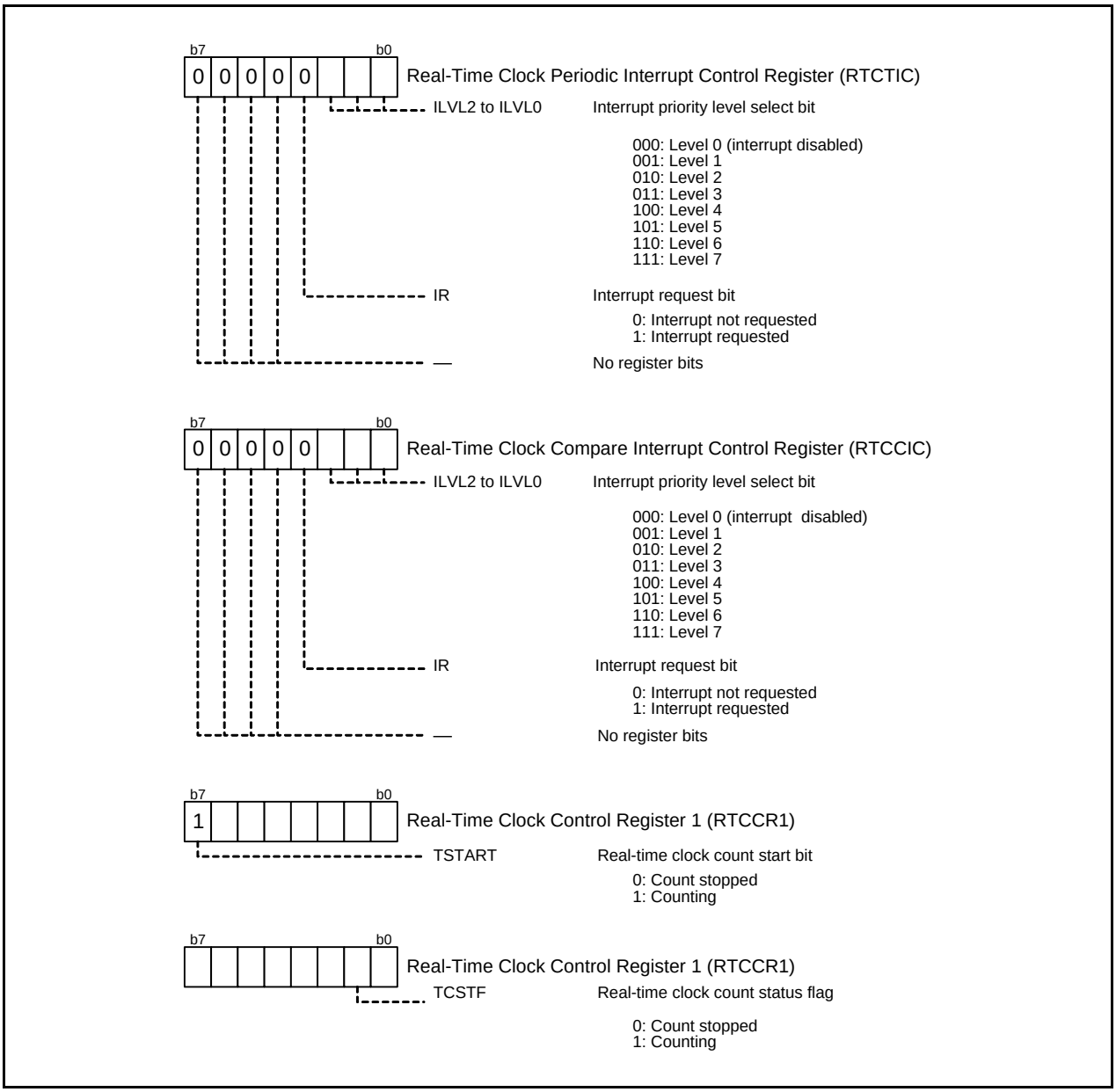


Figure 7.4 Real-Time Clock Setting (4/4)

7.2 Reading Time Data

Figure 7.5 shows the settings for reading time data.

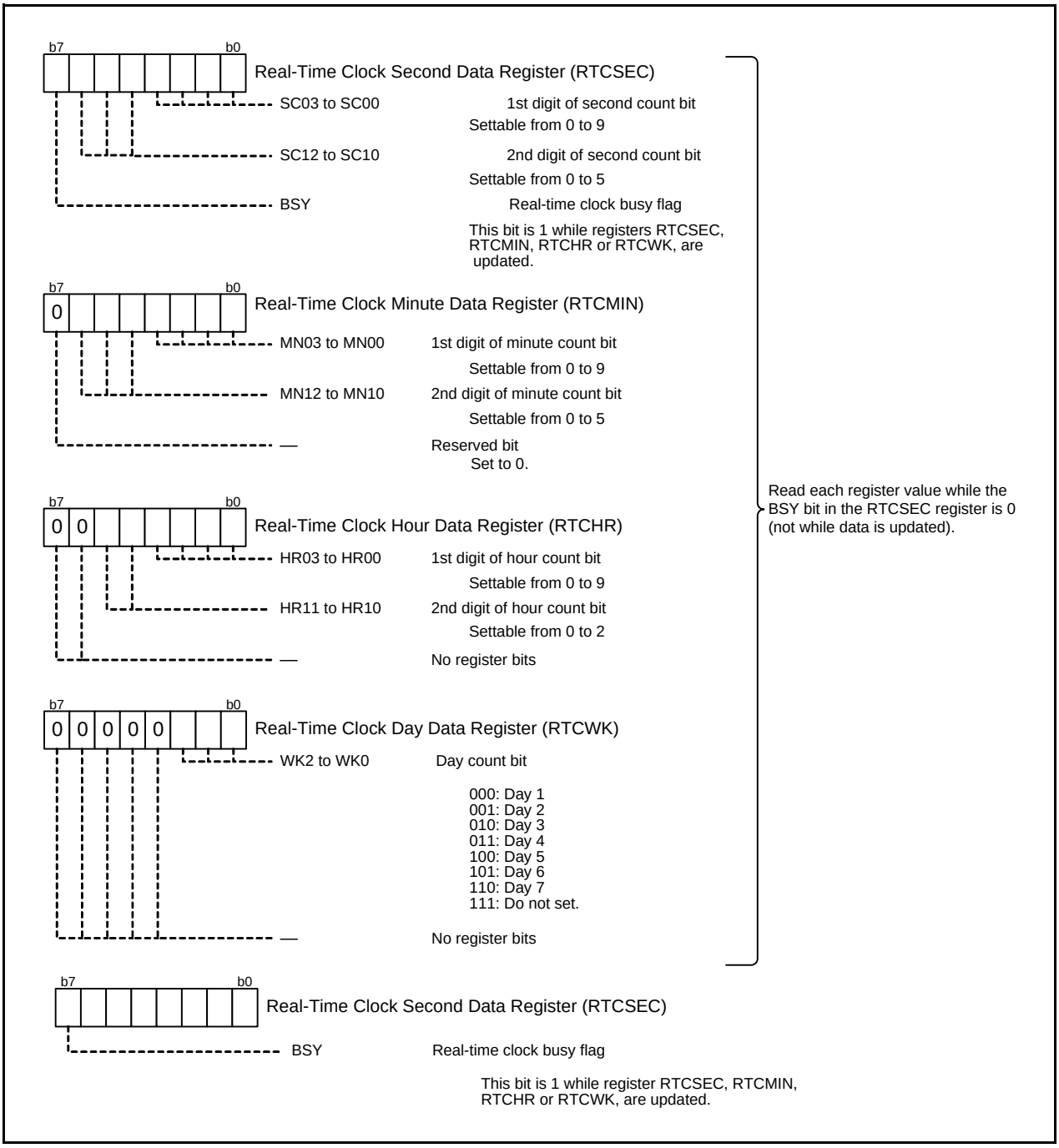


Figure 7.5 Reading Time Data

8. Sample Code

Sample code can be downloaded from the Renesas Electronics website.

9. Reference Documents

M16C/64A Group User's Manual: Hardware Rev.2.00
M16C/64C Group User's Manual: Hardware Rev.1.00
M16C/65 Group User's Manual: Hardware Rev.2.00
M16C/65C Group User's Manual: Hardware Rev.1.00
M16C/6C Group User's Manual: Hardware Rev.2.00
M16C/5LD Group, M16C/56D Group User's Manual: Hardware Rev.1.10
M16C/5L Group, M16C/56 Group User's Manual: Hardware Rev.1.00
M16C/5M Group, M16C/57 Group User's Manual: Hardware Rev.1.01
The latest version can be downloaded from the Renesas Electronics website.

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

C Compiler Manual
M16C Series, R8C Family C Compiler Package V.5.45
C Compiler User's Manual Rev.2.00
The latest version can be downloaded from the Renesas Electronics website.

10. Website and Support

Renesas Electronics website
http://www.renesas.com/

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Revision History	M16C/64A,64C,65,65C,6C,5LD,56D,5L,56,5M,57 Groups Real-Time Clock (100-Year Calendar)

Rev.	Date	Description	
		Page	Summary
1.00	Jan. 29, 2010	—	First edition issued
1.01	Apr. 28, 2011	—	Add: M16C/64C, M16C/65C, M16C/6C, M16C/5LD, M16C/56D, M16C/5L, M16C/56, M16C/5M, and M16C/57

General Precautions in the Handling of MPU/MCU Products

The following usage notes are applicable to all MPU/MCU products from Renesas. For detailed usage notes on the products covered by this manual, refer to the relevant sections of the manual. If the descriptions under General Precautions in the Handling of MPU/MCU Products and in the body of the manual differ from each other, the description in the body of the manual takes precedence.

1. Handling of Unused Pins

   Handle unused pins in accord with the directions given under Handling of Unused Pins in the manual.

   — The input pins of CMOS products are generally in the high-impedance state. In operation with an unused pin in the open-circuit state, extra electromagnetic noise is induced in the vicinity of LSI, an associated shoot-through current flows internally, and malfunctions occur due to the false recognition of the pin state as an input signal become possible. Unused pins should be handled as described under Handling of Unused Pins in the manual.

2. Processing at Power-on

   The state of the product is undefined at the moment when power is supplied.

   — The states of internal circuits in the LSI are indeterminate and the states of register settings and pins are undefined at the moment when power is supplied.

   In a finished product where the reset signal is applied to the external reset pin, the states of pins are not guaranteed from the moment when power is supplied until the reset process is completed.

   In a similar way, the states of pins in a product that is reset by an on-chip power-on reset function are not guaranteed from the moment when power is supplied until the power reaches the level at which resetting has been specified.

3. Prohibition of Access to Reserved Addresses

   Access to reserved addresses is prohibited.

   — The reserved addresses are provided for the possible future expansion of functions. Do not access these addresses; the correct operation of LSI is not guaranteed if they are accessed.

4. Clock Signals

   After applying a reset, only release the reset line after the operating clock signal has become stable. When switching the clock signal during program execution, wait until the target clock signal has stabilized.

   — When the clock signal is generated with an external resonator (or from an external oscillator) during a reset, ensure that the reset line is only released after full stabilization of the clock signal. Moreover, when switching to a clock signal produced with an external resonator (or by an external oscillator) while program execution is in progress, wait until the target clock signal is stable.

5. Differences between Products

   Before changing from one product to another, i.e. to one with a different part number, confirm that the change will not lead to problems.

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

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