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M16C/63 Group

The Use Example of the Real-time Clock

1. Abstract

This document describes an example of using the M16C/63 to provide a real-time clock (RTC).

2. Introduction

The application example described in this document applies to the following MCU:

- MCU: M16C/63 Group

The sample program in 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 manual for any modifications to functions. Careful evaluation is recommended before using the program described in this application note.

3. Application Example

3.1 Explanation

This explains how to use the real-time clock periodic interrupt and the real-time clock alarm interrupt.
After reset, the LED turns off and the MCU enters to wait mode.
When a real-time clock alarm interrupt occurs, the clock enters to date/time display mode after the MCU exits the wait mode. The following is an explanation of a reference program example where a real-time clock periodic interrupt occurs every second, and the date and time data is retrieved within the interrupt process, causing the LED to turn on.

Figure 3.1 shows a state transition example of the reference program.

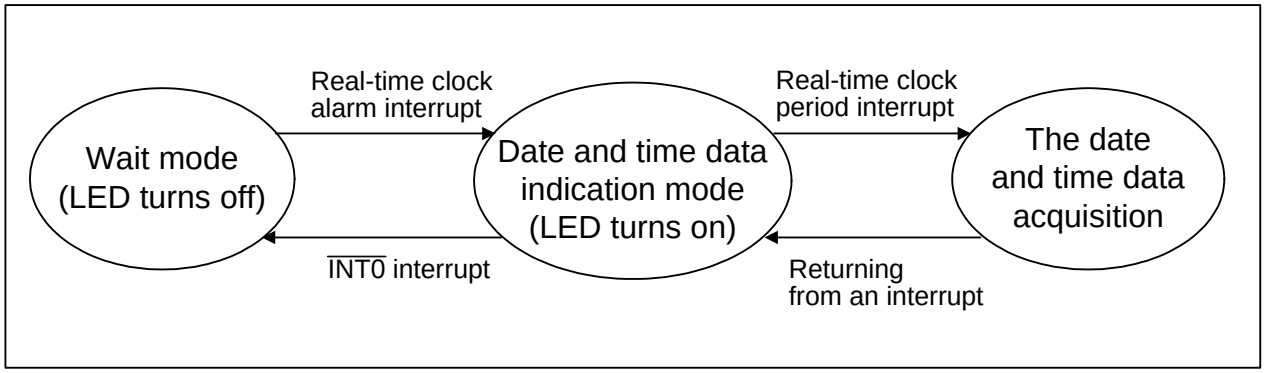


Figure 3.1 State Transition Example

3.2 The Operations in Application Example

The following explains the operations of this application note.

(1) The current time is initialized and the real-time clock is set.
(2) The real-time clock starts.
(3) The alarm data is set at three minutes after the current time. The minute alarm and the hour alarm are enabled. Bits ILVL2 to ILVL0 in the RTCTIC register are specified as 000b (interrupt disabled). The $\overline{\text{INT0}}$ interrupt is also disabled.
(4) The LED turns off and the MCU enters the wait mode.
(5) When the current time and alarm data match, the MCU exits the wait mode through the real-time clock alarm interrupt.
(6) The $\overline{\text{INT0}}$ interrupt priority level is set to 7.
(7) The date and time data are output to the port.
(8)-1 The real-time clock periodic interrupt occurs every second, and the date and time data is stored in a variable within the real-time clock periodic interrupt process, then the program returns to step (7).
(8)-2 If an $\overline{\text{INT0}}$ interrupt occurs, the program returns to step (3).

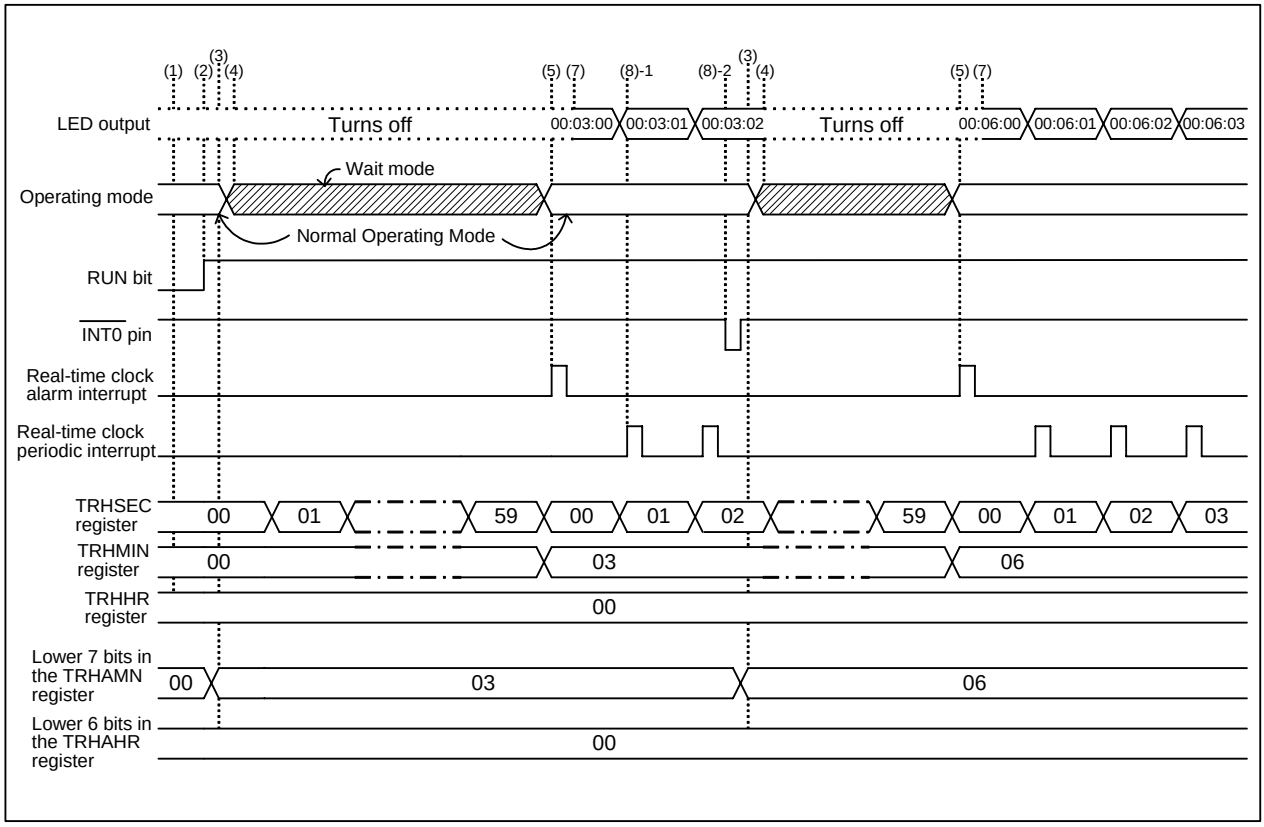


Figure 3.2 Operations Example

4. Time Reading Procedure of Real-Time Clock Mode / Alarm Data Writing Procedure

In real-time clock mode, read time data bits(1) when the BSY bit in the TRHSEC register is 0 (not while data is updated).
When reading multiple registers, if data is rewritten between reading registers, an errant time will be read.
The same pertains to the alarm data(2) bits.Write to the bits for alarm data when the BSY bit is 0, same as the bits for time data

Notes:
1. Time data bits are shown below.
   Bits SC12 to SC10 and SC03 to SC00 in the TRHSEC register
   Bits MN12 to MN10 and MN03 to MN00 in the TRHMIN register
   Bits HR11 to HR10 and HR03 to HR00 in the TRHHR register
   Bits WK2 to WK0 in the TRHWK
   The PM bit in the TRHCR register
   Bits DY11 to DY10 and DY03 to DY00 in the TRHDY register
   Bits MO10 and MO03 to MO00 in the TRHMON register
   Bits YR13 to YR10 and YR03 to YR00 in the TRHYR register
2. Alarm data bits are shown below.
   Bits AMN6 to AMN4 and AMN3 to AMN0 in the TRHAMN register
   Bits AHR5 to AHR4 and AHR3 to AHR0 in the TRHAHR register
   The APM bit in the TRHAHR register
   Bits AWK2 to AWK0 in the TRHAWK register

The following is a description of sample read and write procedures that enable the user to avoid the use of incorrect time.

[Using an interrupt]
Read necessary contents of time data bits in the real-time clock periodic interrupt routine.
Similarly, write necessary contents of alarm data bits.

[Monitoring by a program 1]
Monitor the IR bit in the RTCTIC register by a program and read necessary contents of time data bits after the IR bit becomes 1 (periodic interrupt requested).
Similarly, write necessary contents of alarm data bits.

[Monitoring by a program 2]
Read and write data according to Figure 4.1 “Time Data Reading / Alarm Data Writing”.

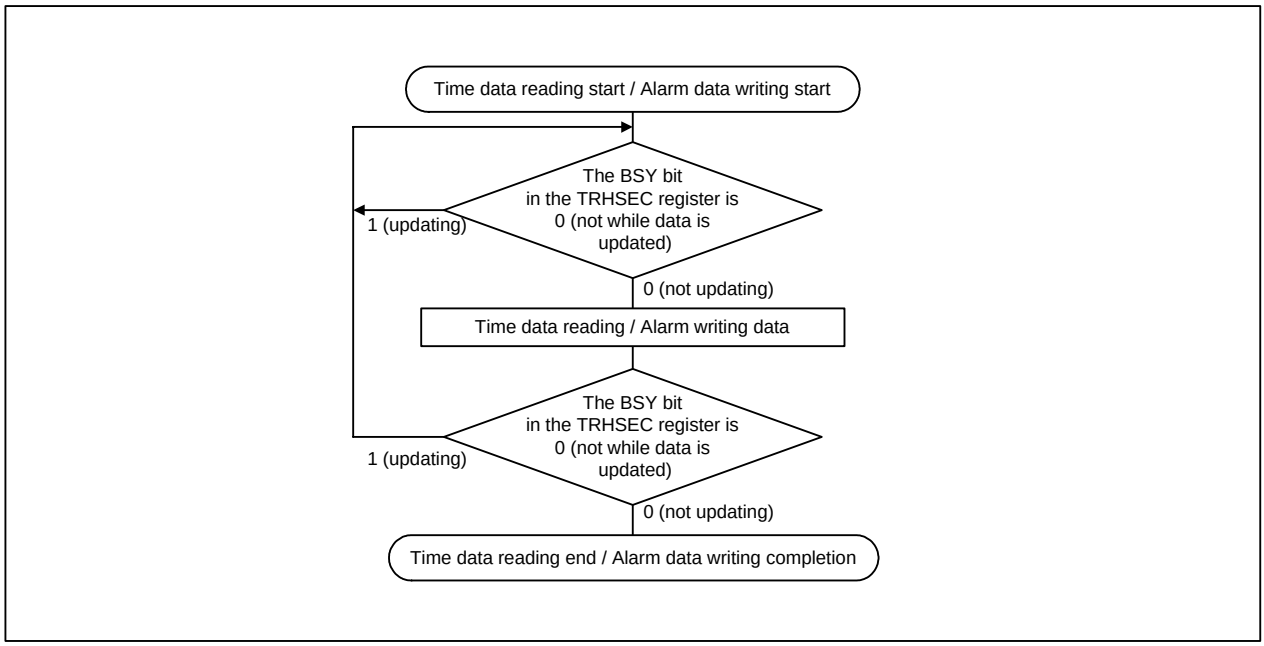


Figure 4.1 Time Data Reading / Alarm Data Writing

Also, when reading or writing several registers, read or write them as continuously as possible.

In the example described in this application note, time data read by Using an interrupt, and alam data write by Monitoring by a program 2.

5. Flowchart

Figure 5.1 shows a flowchart of the main program.

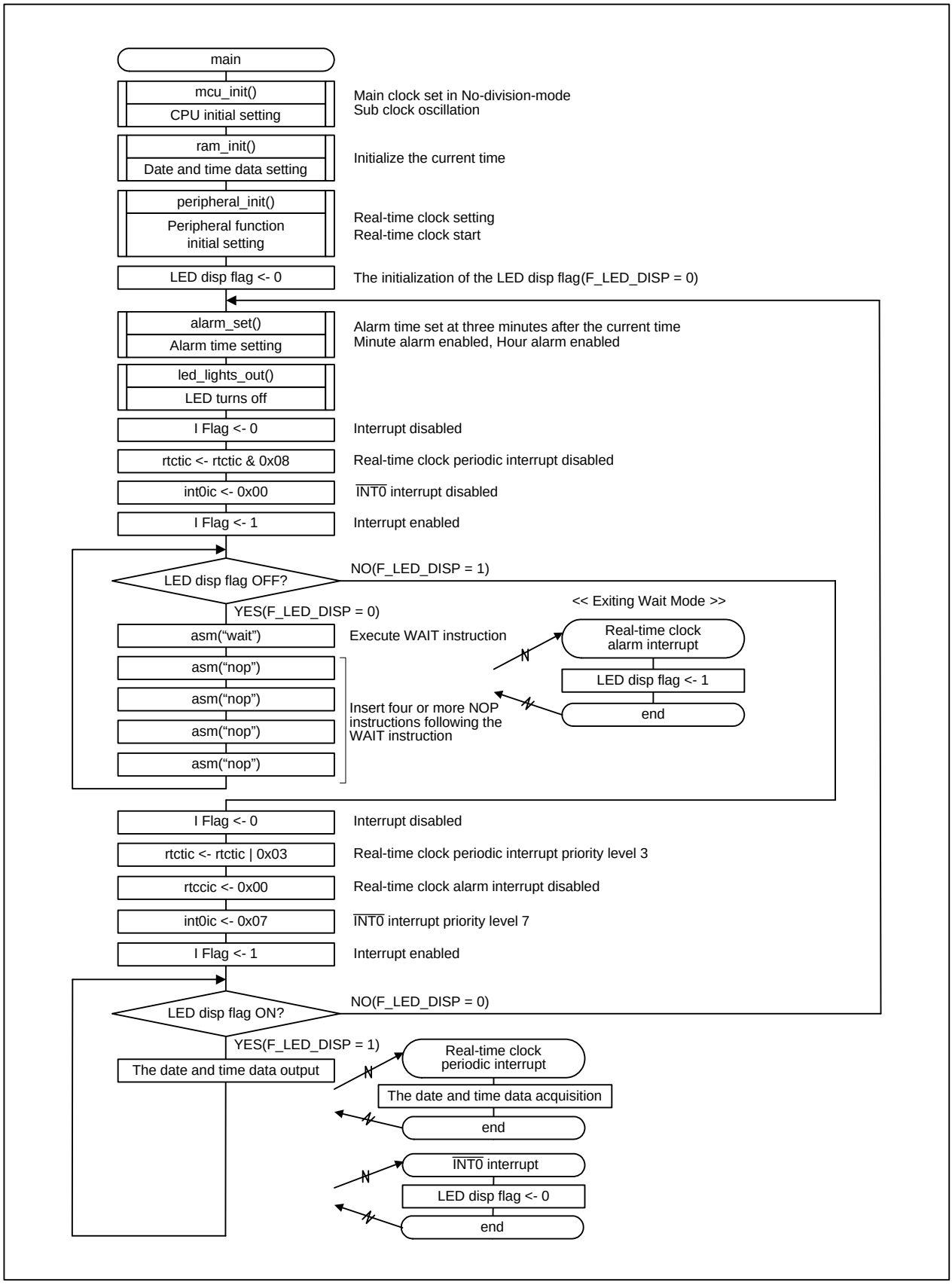
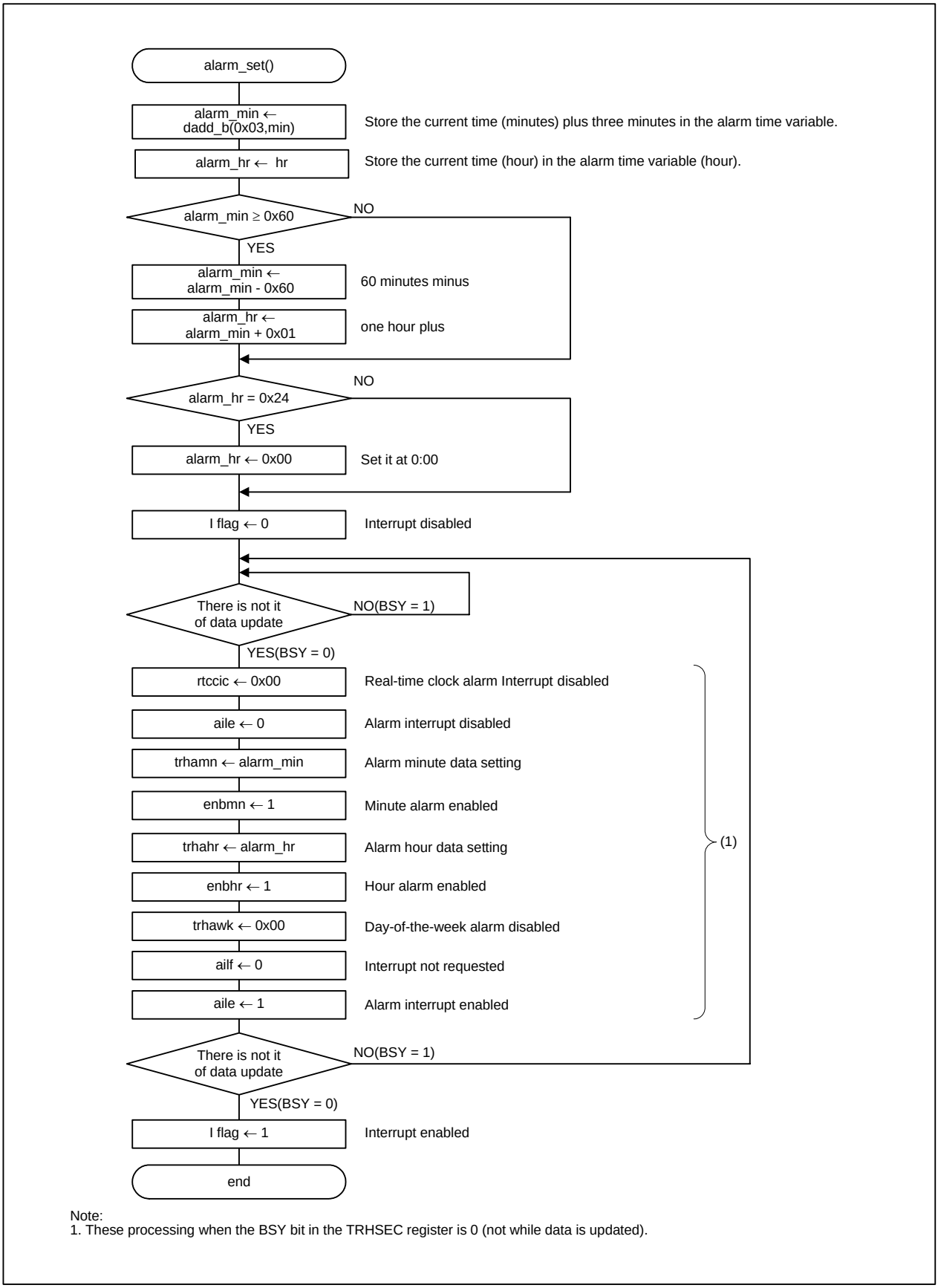


Figure 5.1 Main Program Flowchart

Figure 5.2 shows a flowchart of the function to setting alarm time.



Note:
1. These processing when the BSY bit in the TRHSEC register is 0 (not while data is updated).

Figure 5.2 Alarm Time Setting Function Flowchart

6. Structure

Declaration	struct FLAG{ unsigned char F_LED_DISP:1; }flag;	
Variable	unsigned char F_LED_DISP:1	LED display flag
Function	Structure of the LED display flag(1-bit)	

7. Function Table

Declaration	void ram_init(void)	
Outline	Date and 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 hr	Hour data storage variable
	unsigned char min	Minute data storage variable
	unsigned char sec	Second data storage variable
Returned value	None	
Function	Initializes the current time to 00:00:00 Thursday 1 January 2009	

Declaration	void peripheral_init(void)	
Outline	Peripheral function 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 hr	Hour data storage variable
	unsigned char min	Minute data storage variable
	unsigned char sec	Second data storage variable
Returned value	None	
Function	Sets the real-time clock setting and the current time in the register	

Declaration	void alarm_set(void)	
Outline	Alarm time setting function	
Argument	None	
Variable(global)	Variable name	Contents
	unsigned char min	Minute data storage variable
	unsigned char alarm_min	Alarm minute data storage variable
	unsigned char hr	Hour data storage variable
	unsigned char alarm_hr	Alarm hour data storage variable
Returned value	None	
Function	Sets the alarm data to three minutes after the current time and enables the minute alarm and hour alarm	

Declaration	void led_lights_out(void)
Outline	LED turns off function
Argument	None
Variable(global)	None
Returned value	None
Function	Initializes the time output port value

8. Setup

This section explains the setup procedure and values for reproducing 3. “Application Example”. Refer to the M16C/63 hardware manual for more details on each register.

8.1 Setup of the Real-Time Clock

Figure 8.1 to Figure 8.4 shows the Real-time clock settings.

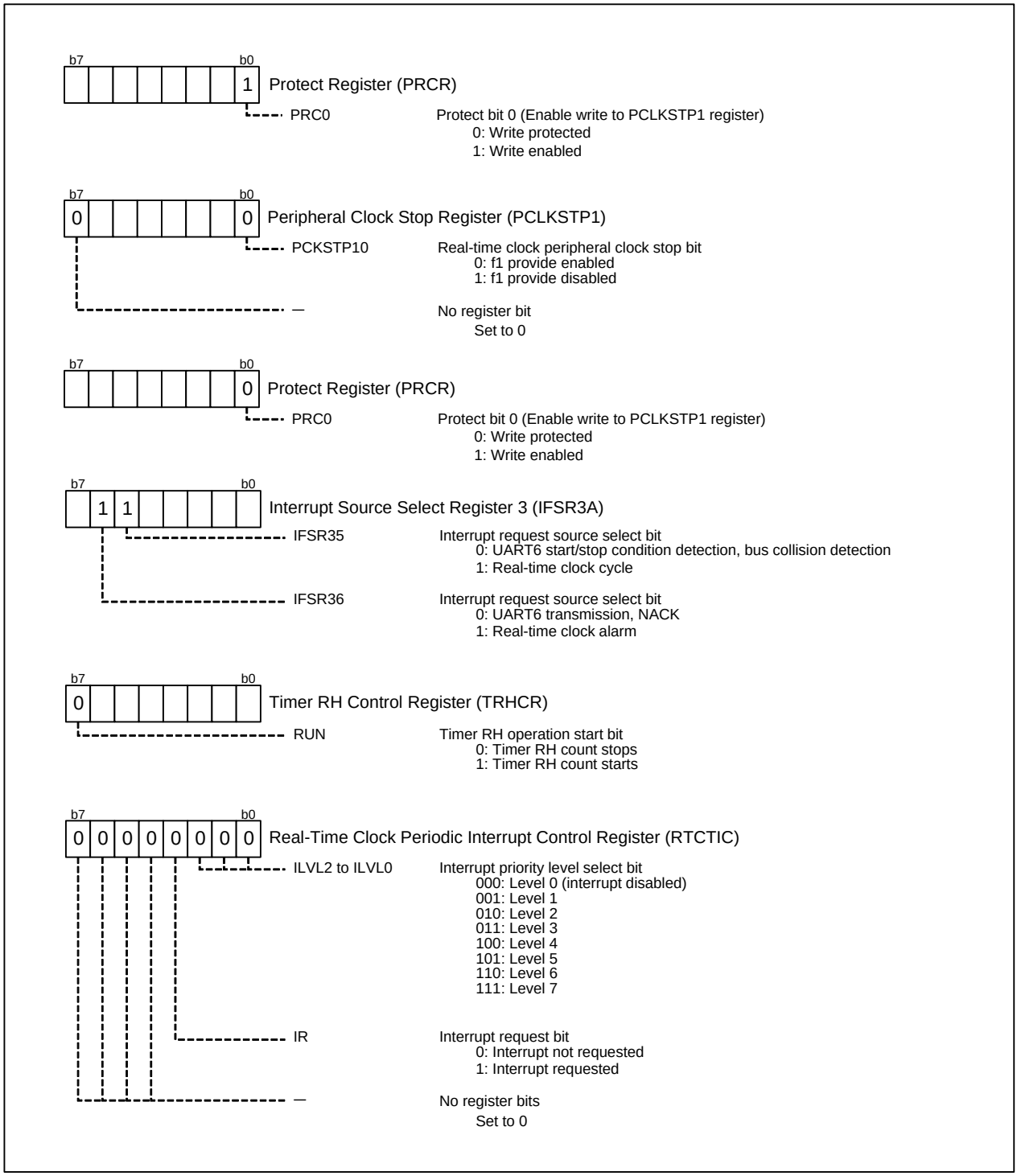


Figure 8.1 Real-Time Clock Setting(1/4)

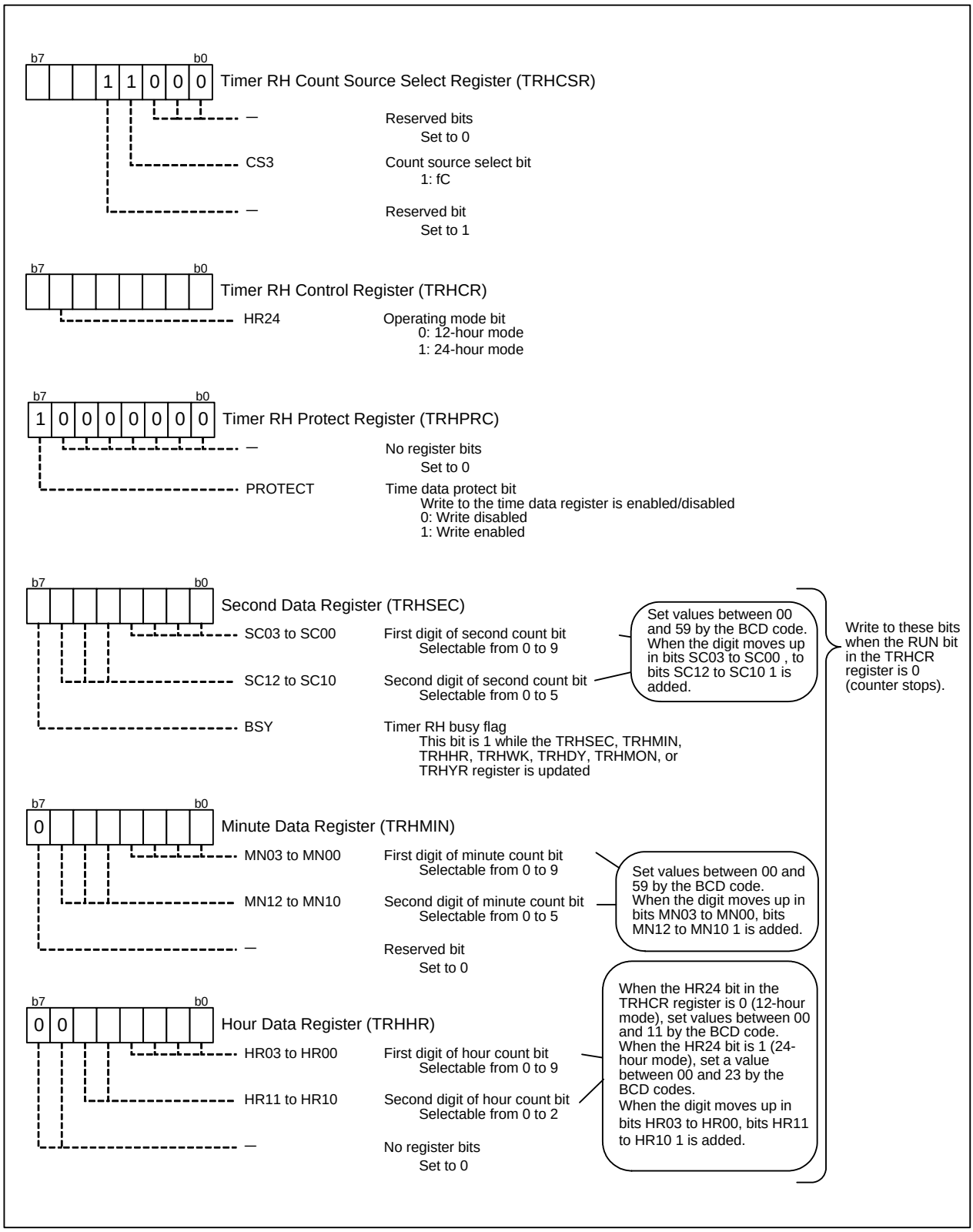


Figure 8.2 Real-Time Clock Setting(2/4)

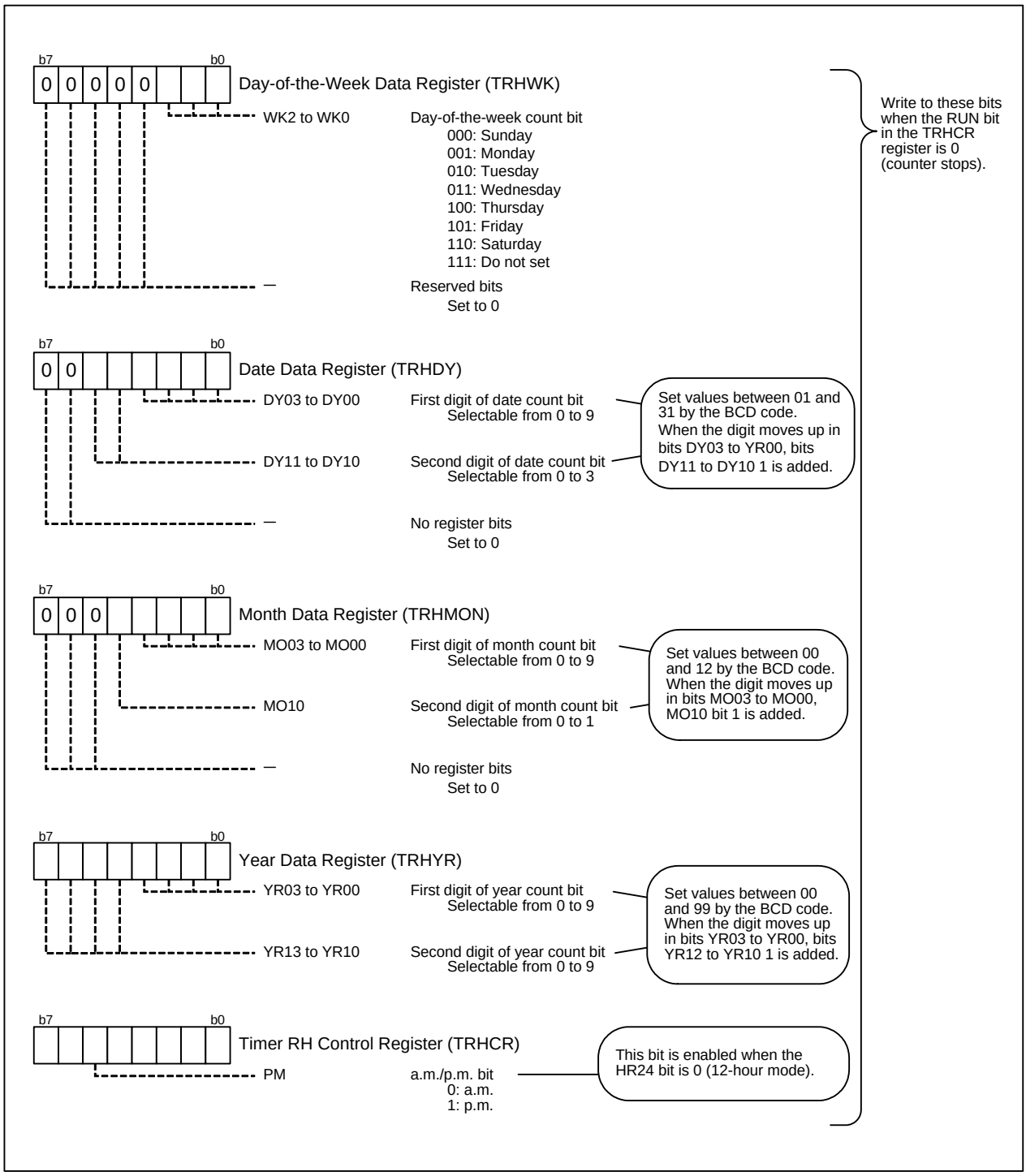


Figure 8.3 Real-Time Clock Setting(3/4)

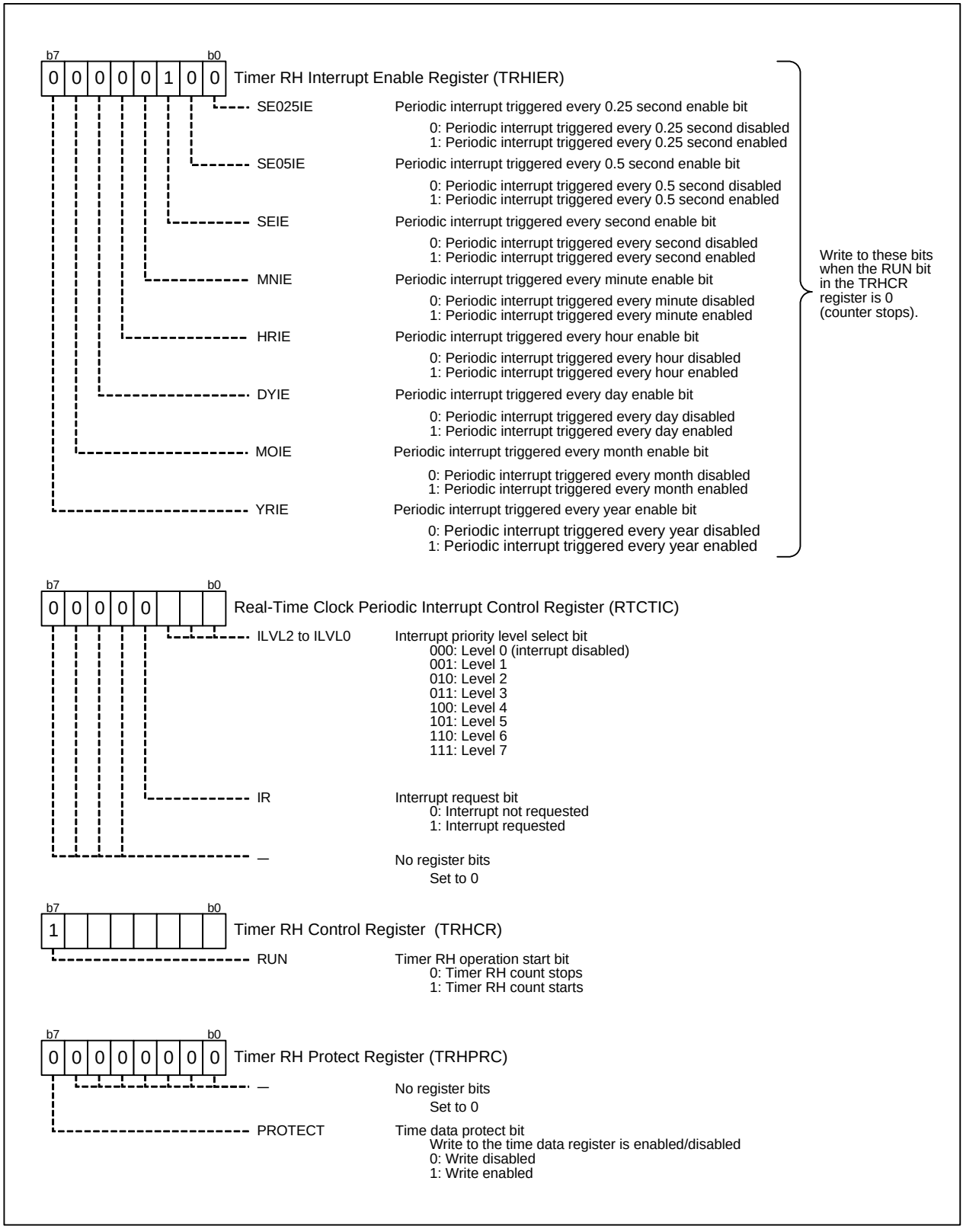


Figure 8.4 Real-Time Clock Setting(4/4)

8.2 Setup of the Alarm Data

Figure 8.5 to Figure 8.6 shows the alarm data settings.

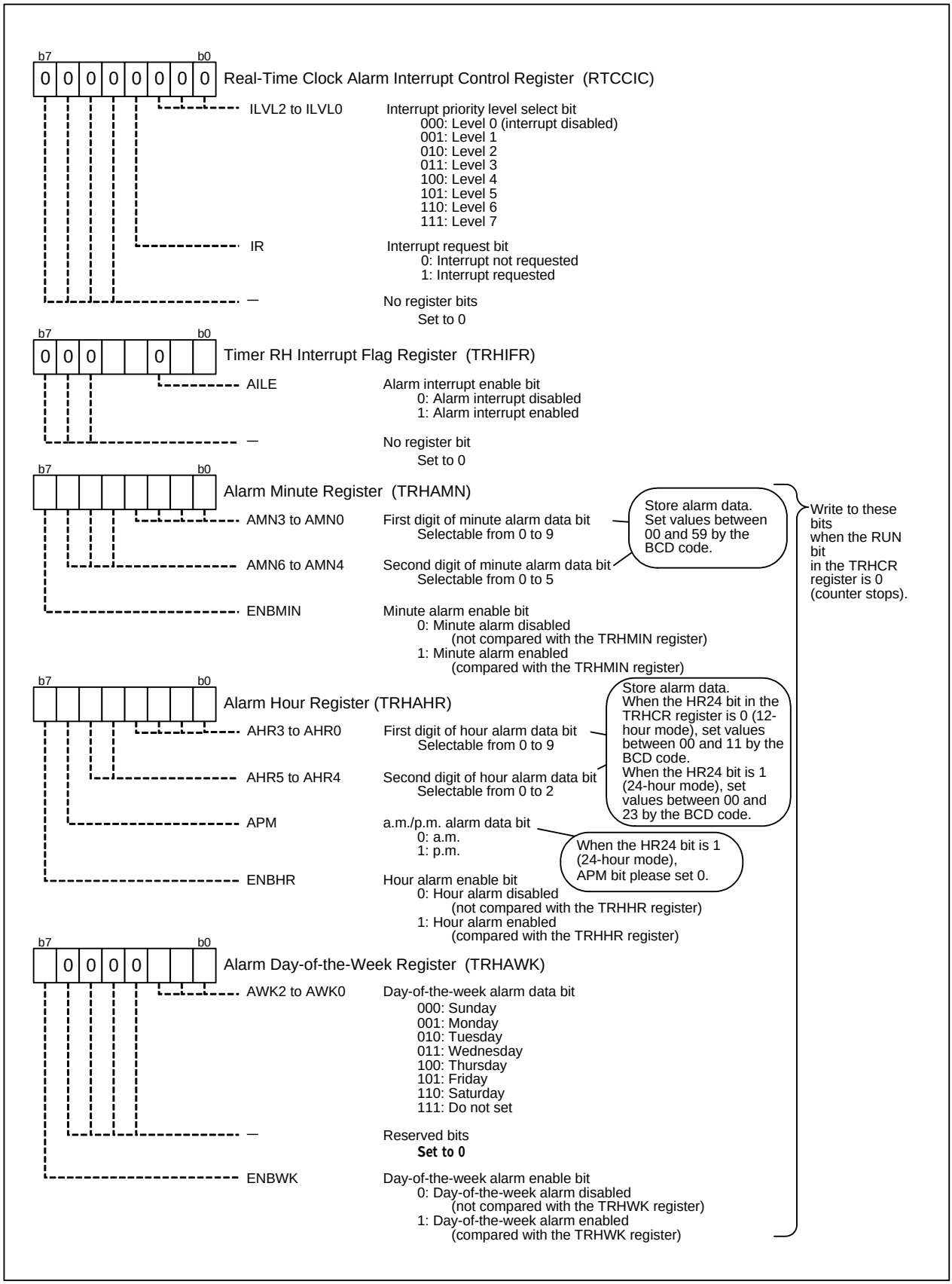


Figure 8.5 Alarm Data Setting(1/2)

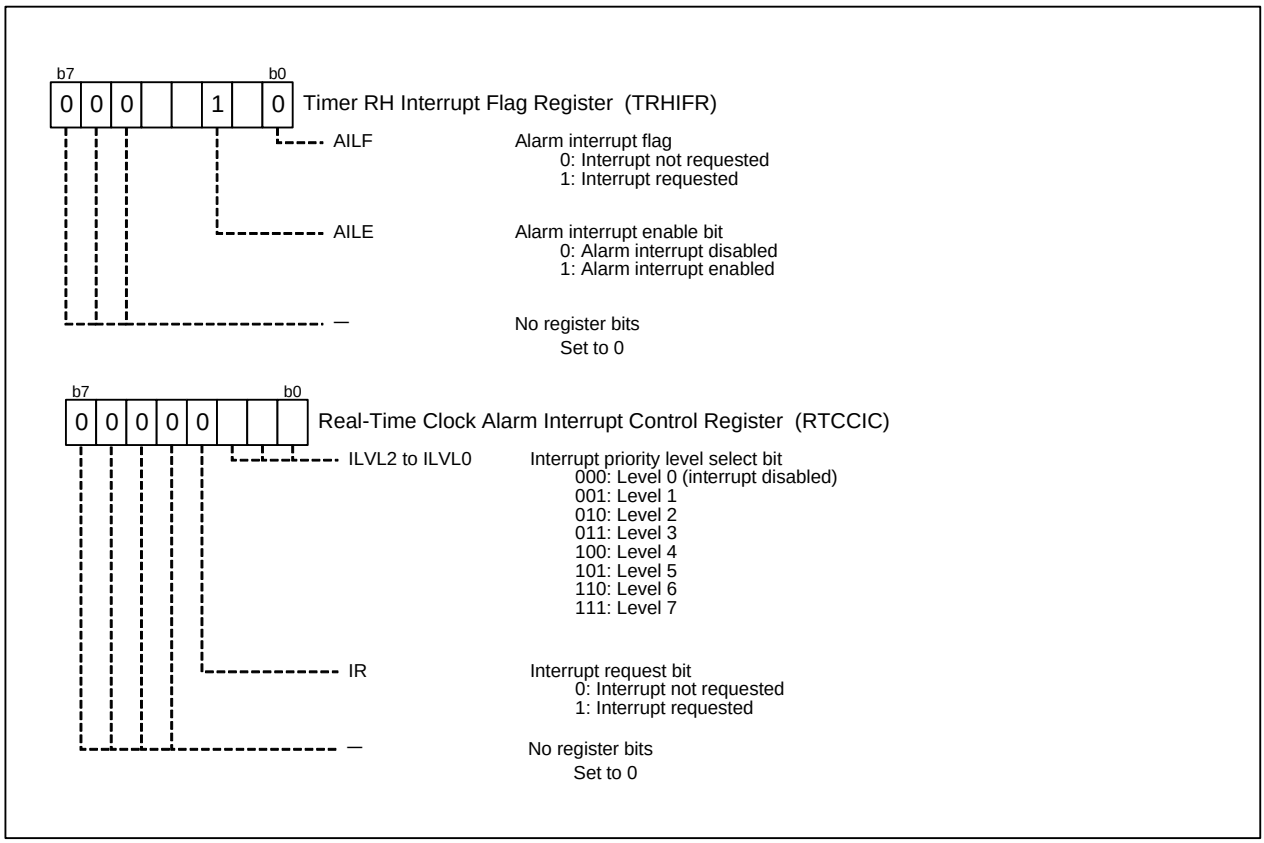


Figure 8.6 Alarm Data Setting(2/2)

8.3 Read date data

Figure 8.7 to Figure 8.8 shows the date data readings.

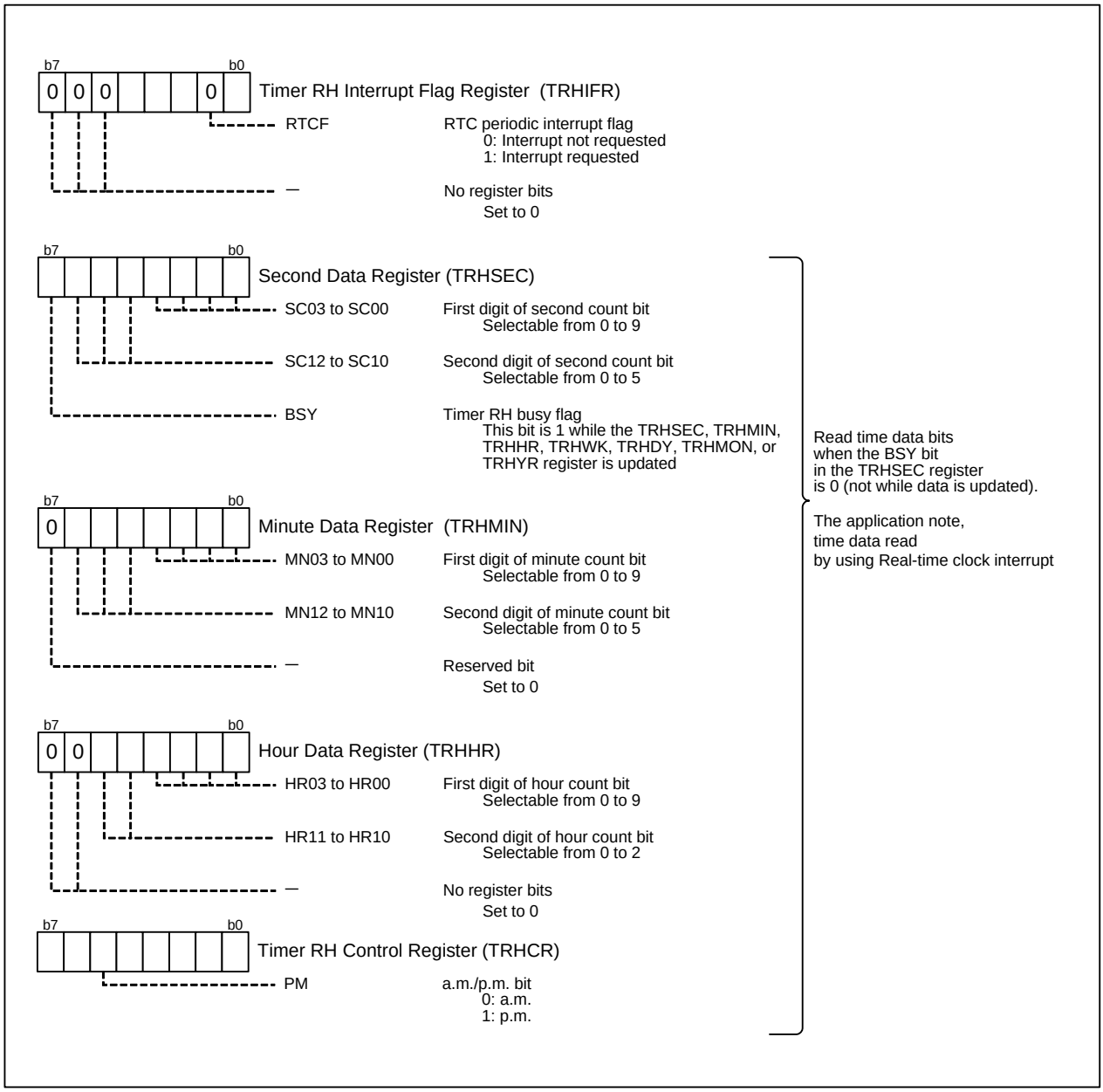


Figure 8.7 Read date data(1/2)

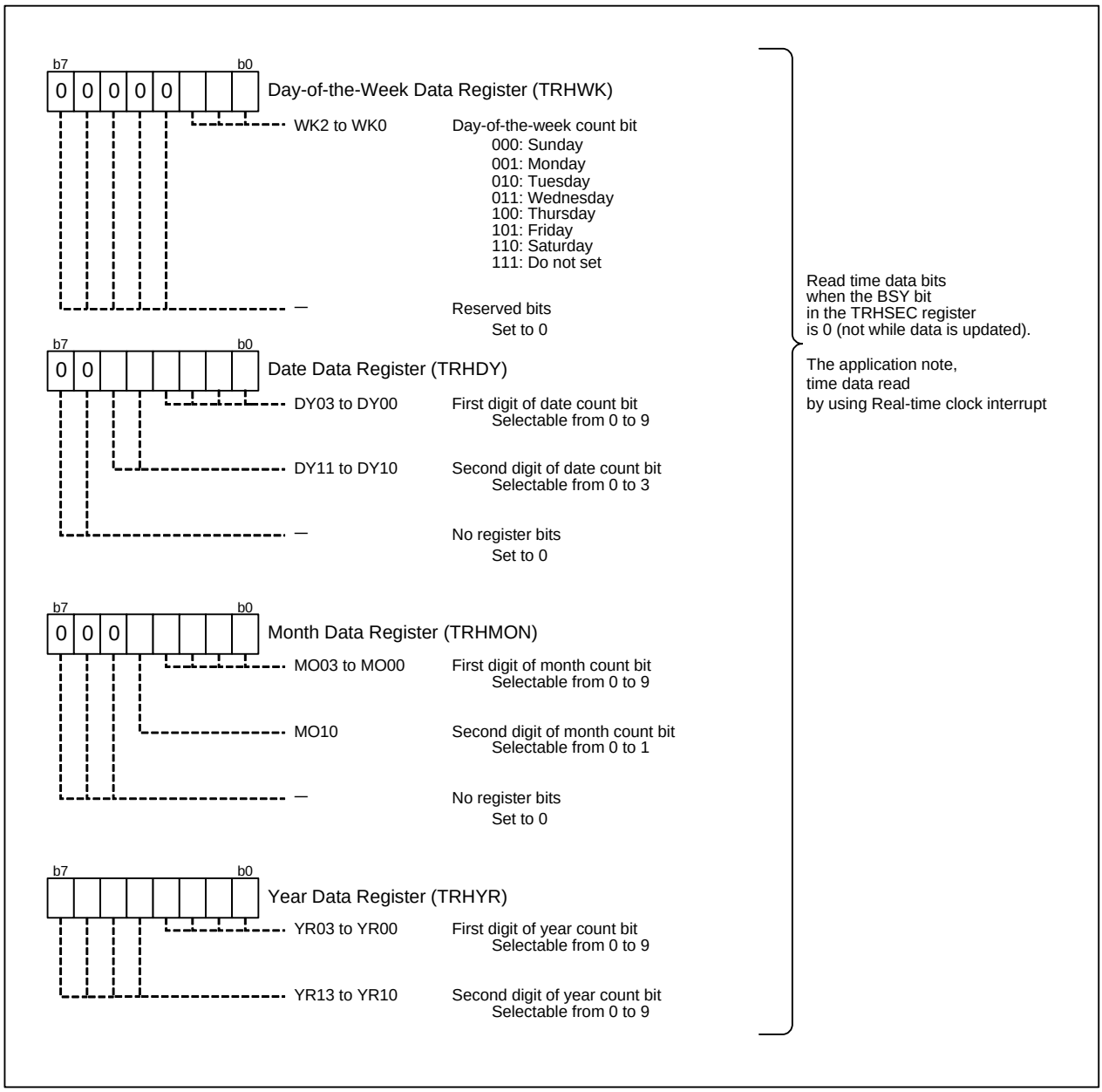


Figure 8.8 Read date data(2/2)

8.4 Real-time Clock Alarm Interrupt Processing

Figure 8.9 shows Real-time colck alarm interrupt processing.

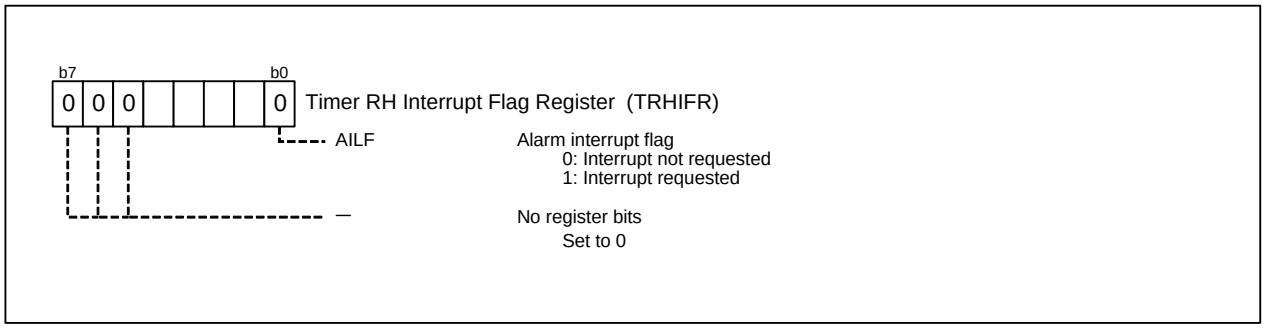


Figure 8.9 Real-time colck alarm interrupt processing

9. Sample Programs

Sample programs can be downloaded from the Renesas Technology website.
To download, click “Application Notes” in the left-hand side menu of the M16C Family page.

10. Reference Documents

Hardware Manual
M16C/63 Group Hardware Manual
The latest version can be downloaded from the Renesas Technology website.

Technical News/Technical Update
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