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H8/300H SLP Series

Clock Display on the LCD Panel Using RTC

Introduction

The RTC function and LCD controller/driver function display the clock on an LCD panel. The clock function counts up at intervals of one second and the time is displayed on the LCD panel in the 24-hour mode.

Target Device

H8/38076R

Contents

1. Specifications 2
2. Description of Functions 3
3. Principles of Operation 8
4. Description of Software 9
5. Flowchart 16

1. Specifications

- The RTC function and LCD controller/driver function display the time on an LCD panel.
- The clock function counts up at intervals of 1 second and the time is displayed on the LCD panel in the 24-hour mode.
- In this sample task, the time starts at 0 hours 0 minutes 0 seconds.
- Figure 1 shows an example of connecting an LCD panel.

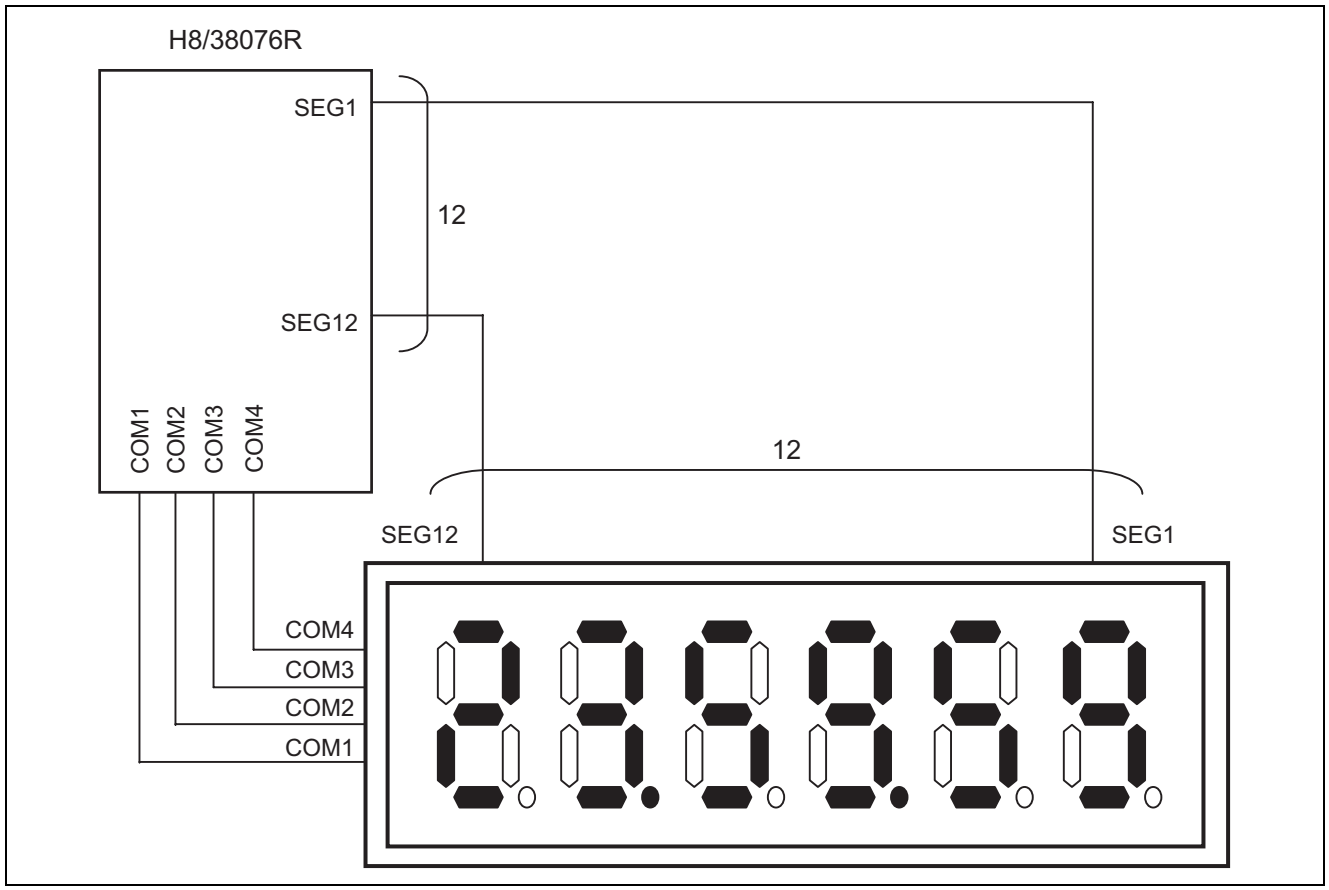


Figure 1 Example of Connection for LCD Panel

2. Description of Functions

2.1 Description of the RTC Function

This sample task uses the RTC function for displaying the time on the LCD panel. Figure 2 is a block diagram of the RTC. The following describes the block diagram.

- System clock (ϕ)
  10-MHz reference clock for operating the CPU and peripheral functions
- Prescalar S (PSS)
  13-bit counter using ϕ as input that counts up for each cycle
- RTC interrupt flag register (RTCFLG)
  Register indicating the status of each interrupt request. In this sample task, when a periodic second, minute, or hour interrupt is generated, the corresponding flag is set to 1. Each flag is not automatically cleared when the relevant interrupt is accepted. To clear the flag, write 0.
- Second data register/free running counter data register (RSECDR)
  RSECDR counts seconds. The contents of RSECDR are given in the BCD code. RSECDR counts from 0 to 59.
- Minute data register (RMINDR)
  When a carry is generated in RSECDR, RMINDR counts a minute. The contents of RMINDR are given in the BCD code. RMINDR counts from 0 to 59.
- Hour data register (RHRDR)
  When a carry is generated in RMINDR, RHRDR counts an hour. The contents of RHRDR are given in the BCD code. RHRDR counts from 0 to 11 or 23 according to the setting of the 12/24 bit of RTCCR1.
- RTC control register 1 (RTCCR1)
  RTCCR1 controls the start and stop of RTC operation, the operating mode, and reset.
- RTC control register 2 (RTCCR2)
  RTCCR2 controls whether to enable or disable each interrupt request. In this sample task, periodic second interrupts are enabled.
- Clock source select register (RTCCSR)
  RTCCSR selects a clock source. In this sample task, RTC operation is selected.
- Interrupt enable register (IENR1)
  IENR1 controls whether to enable or disable each interrupt request. In this sample task, an RTC interrupt request is enabled.

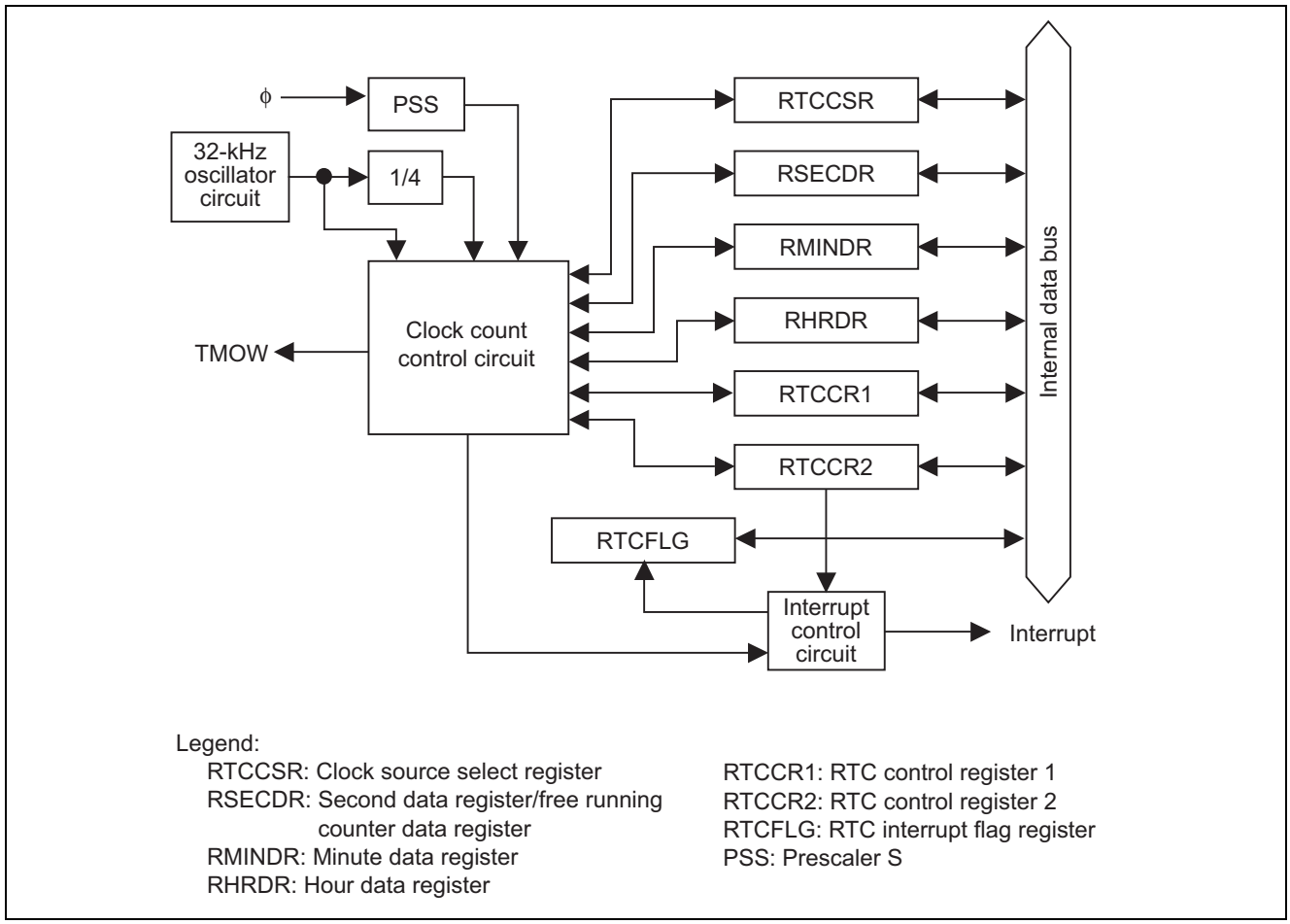


Figure 2 Block Diagram of the RTC

2.2 Description of the LCD

The LCD panel used in this sample task is driven at 1/4 duty cycle at a frame frequency of 64 Hz. Figure 3 shows the name of each LCD panel segment. Table 1 is a list of the relationships between the LCD panel segment signals and LCD RAM. Table 2 is a list of LCD panel display data. The following describes the H8/38076R LCD controller/driver function.

- LCD RAM
  The relationships between the LCD RAM and the display segments differ depending on the duty cycle setting. After the registers required for display have been set, by writing data in the locations corresponding to the given duty cycle using the same instructions as those for writing to ordinary RAM, and then turning the display on, display automatically starts.
- LCD port control register (LPCR)
  LPCR selects the duty cycle, the LCD driver, and pin functions.
- LCD control register (LCR)
  LCR controls the LCD drive power supply and display data, and selects the frame frequency.
- LCD control register 2 (LCR2)
  LCR2 switches between A and B waveforms, selects a step-up clock for the 3-V constant-voltage circuit, and controls connection of the LCD power supply split-resister and on/off of the 3-V constant-voltage power supply.

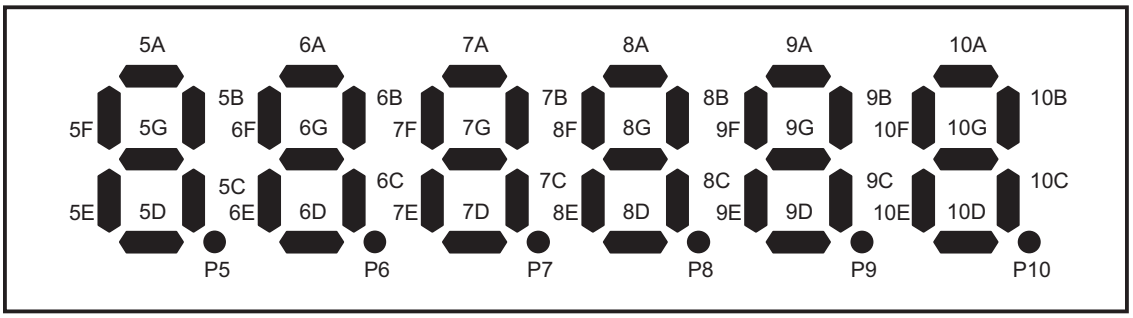


Figure 3 LCD Panel Segment Names

Table 1 LCD Panel Segment Signals and LCD RAM (when Driven at 1/4 Duty Cycle)

LCD RAM Address	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	COM4	COM3	COM2	COM1	COM4	COM3	COM2	COM1
H′F370	SEG2	SEG2	SEG2	SEG2	SEG1	SEG1	SEG1	SEG1
	10D	10E	10G	10F	P10	10C	10B	10A
H′F371	SEG4	SEG4	SEG4	SEG4	SEG3	SEG3	SEG3	SEG3
	9D	9E	9G	9F	P9	9C	9B	9A
H′F372	SEG6	SEG6	SEG6	SEG6	SEG5	SEG5	SEG5	SEG5
	8D	8E	8G	8F	P8	8C	8B	8A
H′F373	SEG8	SEG8	SEG8	SEG8	SEG7	SEG7	SEG7	SEG7
	7D	7E	7G	7F	P7	7C	7B	7A
H′F374	SEG10	SEG10	SEG10	SEG10	SEG9	SEG9	SEG9	SEG9
	6D	6E	6G	6F	P6	6C	6B	6A
H′F375	SEG12	SEG12	SEG12	SEG12	SEG11	SEG11	SEG11	SEG11
	5D	5E	5G	5F	P5	5C	5B	5A

Table 2 LCD Panel Display Data and LCD RAM

Display	LCD RAM Data								Hexadecimal
	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	
	D	E	F	G	P	C	B	A	H′D7
	1	1	0	1	0	1	1	1	
	D	E	F	G	P	C	B	A	H′06
	0	0	0	0	0	1	1	0	
	D	E	F	G	P	C	B	A	H′E3
	1	1	1	0	0	0	1	1	
	D	E	F	G	P	C	B	A	H′A7
	1	0	1	0	0	1	1	1	
	D	E	F	G	P	C	B	A	H′36
	0	0	1	1	0	1	1	0	
	D	E	F	G	P	C	B	A	H′B5
	1	0	1	1	0	1	0	1	
	D	E	F	G	P	C	B	A	H′F5
	1	1	1	1	0	1	0	1	
	D	E	F	G	P	C	B	A	H′17
	0	0	0	1	0	1	1	1	
	D	E	F	G	P	C	B	A	H′F7
	1	1	1	1	0	1	1	1	
	D	E	F	G	P	C	B	A	H′B7
	1	0	1	1	0	1	1	1	
	D	E	F	G	P	C	B	A	H′08
	0	0	0	0	1	0	0	0	

Note: [A] to [G] and [P] in the table indicate the corresponding LCD panel segment names. For the correspondence, see figure 3, LCD Panel Segment Names.

2.3 Assignment of Functions

Table 3 is a list of the assignment of functions. The functions are assigned as listed in the table and the RTC function and LCD controller/driver function are used to display the time on the LCD panel. The clock function counts up at intervals of one second and the time is displayed on the LCD panel in the 24-hour mode.

Table 3 Assignment of Functions

Elements	Description
RTCFLG	Periodic second, minute, and hour interrupt request flags
RSECDR	Second data register
RMINDR	Minute data register
RHRDR	Hour data register
RTCCR1	Controls the start and stop of RTC operation, operating mode, and reset.
RTCCR2	Enables periodic second, minute, and hour interrupts.
RTCCSR	Selects RTC operation.
LCDRAM	Stores LCD display data.
LPCR	Selects the duty cycle, the LCD driver, and pin functions.
LCR	Controls the LCD drive power supply and display data, and selects the frame frequency.
LCR2	Selects the A waveform for driving, and controls connection of the LCD power supply split-resistor and on/off of the 3-V constant-voltage power supply.
IENR1	Enables an RTC interrupt request.

3. Principles of Operation

- Figure 4 describes the operation. By hardware and software processing as shown in the figure, the RTC clock function and LCD controller/driver function are used to display the time on the LCD panel. The clock function counts up at intervals of 1 second and the time is displayed on the LCD panel in the 24-hour mode.

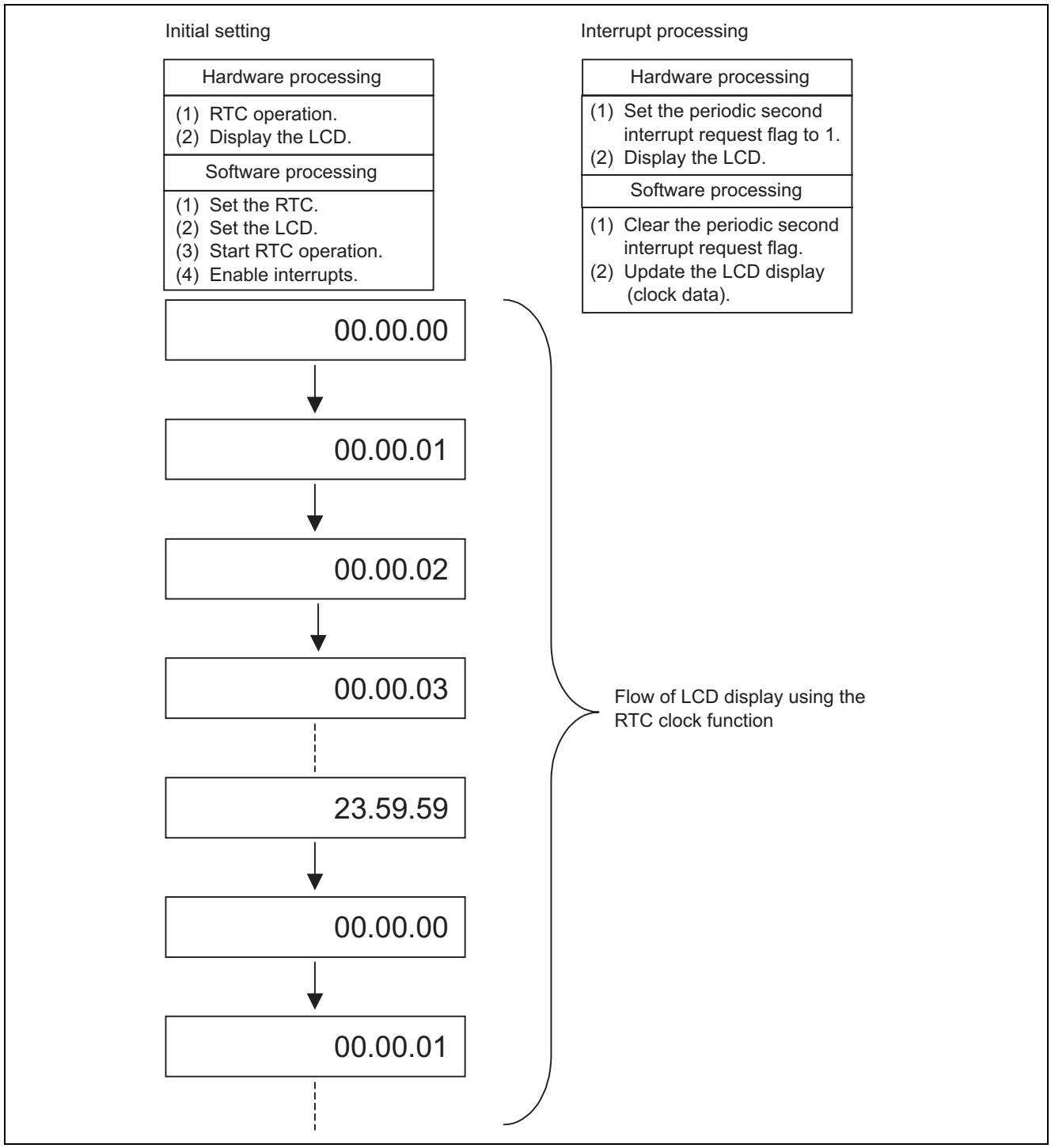


Figure 4 Principles of Operation

4. Description of Software

4.1 Description of Modules

Table 4 is a list of the modules used in this sample task.

Table 4 Description of Modules

Function Name	Function
main	Performs RTC and LCD controller/driver initial settings, LCD display control, and enables interrupts.
second_int	Processes RTC periodic second interrupts, clears the SEIFG flag, and updates the LCD display data.

4.2 Description of Arguments

No arguments are used in this sample task.

4.3 Description of Internal Registers

The following lists the internal registers used in this sample task.

- RTCFLG RTC interrupt flag register Address: H′F067

Bit	Bit Name	Setting	R/W	Function
2	SEIFG	0	R/W*	[Setting condition] A periodic second interrupt is generated. [Clearing condition] When SEIFG = 1, a value of 0 is written in SEIFG.

* Only a value of 0 can be written to clear the flag.

- RSECDR Second data register/free running counter register Address: H′F068

Bit	Bit Name	Setting	R/W	Function
7	BSY	0	R	RTC busy This bit is set to 1 when the RTC is updating (operating) the values of the second, minute, and hour data registers. When this bit is 0, the values of the second, minute, and hour data registers must be used.
6	SC12	0	R/W	Counting tens position of seconds
5	SC11	0	R/W	Counts from 0 to 5 for 60-second counting.
4	SC10	0	R/W	
3	SC03	0	R/W	Counting one's position of seconds
2	SC02	0	R/W	Counts from 0 to 9 once per second. When a carry is generated,
1	SC01	0	R/W	the tens position of seconds is incremented by 1.
0	SC00	0	R/W	

- RMINDR Minute data register Address: H′F069

Bit	Bit Name	Setting	R/W	Function
7	BSY	0	R	RTC busy This bit is set to 1 when the RTC is updating (operating) the values of the second, minute, and hour data registers. When this bit is 0, the values of the second, minute, and hour data registers must be used.
6	MN12	0	R/W	Counting tens position of minutes
5	MN11	0	R/W	Counts from 0 to 5 for 60-minute counting.
4	MN10	0	R/W	
3	MN03	0	R/W	Counting one's position of minutes
2	MN02	0	R/W	Counts from 0 to 9 once per minute. When a carry is generated,
1	MN01	0	R/W	the tens position of minutes is incremented by 1.
0	MN00	0	R/W	

- RHRDR Hour data register Address: H′F06A

Bit	Bit Name	Setting	R/W	Function
7	BSY	0	R	RTC busy This bit is set to 1 when the RTC is updating (operating) the values of the second, minute, and hour data registers. When this bit is 0, the values of the second, minute, and hour data registers must be used.
5	HR11	0	R/W	Counting tens position of hours
4	HR10	0	R/W	Counts from 0 to 2.
3	HR03	0	R/W	Counting one's position of hours
2	HR02	0	R/W	Counts from 0 to 9 once per hour. When a carry is generated, the
1	HR01	0	R/W	tens position of hours is incremented by 1.
0	HR00	0	R/W	

- RTCCR1 RTC control register 1 Address: H′F06C

Bit	Bit Name	Setting	R/W	Function
7	RUN	1	R/W	RTC operation start 0: Stops RTC operation. 1: Starts RTC operation.
6	12/24	1	R/W	Operating mode 0: The RTC operates in the 12-hour mode. RHRDR counts from 0 to 11. 1: The RTC operates in the 24-hour mode. RHRDR counts from 0 to 23.
4	RST	0	R/W	Reset 0: Normal operation 1: Resets all registers and control circuits other than RTCCSR and this bit. After setting this bit to 1, be sure to clear it to 0.

- RTCCR2 RTC control register 2 Address: H′F06D

Bit	Bit Name	Setting	R/W	Function
2	1SEIE	1	R/W	Periodic 1 second interrupt enable 0: Disables a periodic 1 second interrupt. 1: Enables a periodic 1 second interrupt.

- RTCCSR Clock source register Address: H′F06F

Bit	Bit Name	Setting	R/W	Function
3	RCS3	1	R/W	Clock source select
2	RCS2	0	R/W	0000: ϕ/8 ..... Free running counter operation
1	RCS1	0	R/W	0001: ϕ/32 ..... Free running counter operation
0	RCS0	0	R/W	0010: ϕ/128 ..... Free running counter operation
				0011: ϕ/256 ..... Free running counter operation
				0100: ϕ/512 ..... Free running counter operation
				0101: ϕ/2048 ..... Free running counter operation
				0110: ϕ/4096 ..... Free running counter operation
				0111: ϕ/8192 ..... Free running counter operation
				1xxx: 32.768 kHz ..... RTC operation

Note: x: Don't care.

- LCD RAM Addresses: H′F370 to H′F37F

Label Name	Address	Setting	R/W	Function
SECOND1	H′F370	H′D7	R/W	After the registers required for display have been set, by writing data in the locations corresponding to the given duty cycle using the same instructions as those for writing to ordinary RAM, and then turning the display on, display automatically starts. For details, see section 2.2, Description of the LCD.
SECOND10	H′F371	H′D7	R/W	
MINUTE1	H′F372	H′DF	R/W	
MINUTE10	H′F373	H′D7	R/W	
HOUR1	H′F374	H′DF	R/W	
HOUR10	H′F375	H′D7	R/W	

- LPCR LCD port control register Address: H′FFA0

Bit	Bit Name	Setting	R/W	Function
7	DTS1	1	R/W	Duty cycle select 1 and 0
6	DTS0	1	R/W	Common function select
5	CMX	0	R/W	Selects a duty cycle from among static, 1/2, 1/3, and 1/4 by the settings of DTS1 and DTS0 in combination. CMX selects whether to output the same waveform from several pins in order to increase the common drivability when common pins are not used with the given duty cycle. **DTS1** 1 **DTS0** 1 **CMX** - **Duty Cycle** 1/4 duty cycle **Common Driver** COM4 to COM1 -: Don't care
3	SGS3	0	R/W	Segment driver select 3 to 0
2	SGS2	0	R/W	Selects the segment driver to be used.
1	SGS1	1	R/W	For details, see table 5.
0	SGS0	1	R/W	

Table 5 Segment Driver Selection

Bit 3	Bit 2	Bit 1	Bit 0	SEG32 to SEG1 Pin Function							
SGS3	SGS2	SGS1	SGS0	SEG32 to SEG29	SEG28 to SEG25	SEG24 to SEG21	SEG20 to SEG17	SEG16 to SEG13	SEG12 to SEG9	SEG8 to SEG5	SEG4 to SEG1
0	0	1	1	Port	Port	Port	Port	Port	SEG	SEG	SEG

- LCR LCD control register Address: H′FFA1

Bit	Bit Name	Setting	R/W	Function
6	PSW	1	R/W	LCD drive power supply control The LCD drive power supply can be turned off when the LCD display is not used in the power-down mode or when an external power supply is used. When the ACT bit is set to 0 or when the microcomputer is in the standby mode, the LCD drive power supply is turned off regardless of the setting of this bit. 0: Turns the LCD drive power supply off. 1: Turns the LCD drive power supply on.
5	ACT	1	R/W	Display function activate Selects whether to use the LCD controller/driver. By clearing this bit to 0, the LCD controller/driver stops operation. In addition, the LCD drive power supply is turned off regardless of the value of PSW. However, the contents of the register are retained. 0: Stops the LCD controller/driver. 1: Operates the LCD controller/driver.
4	DISP	1	R/W	Display data control DISP selects whether to display data in LCD RAM or display blank data regardless of the contents of LCD RAM. 0: Displays blank data. 1: Displays LCD RAM data.
3	SKS3	0	R/W	Frame frequency select 3 to 0
2	SKS2	0	R/W	Selects a clock to be used and frame frequency.
1	SKS1	1	R/W	
0	SKS0	1	R/W	**Bit 3** **Bit 2** **Bit 1** **Bit 0** **Clock Used** **Frame Frequency** **CKS3** **CKS2** **CKS1** **CKS0** 0 - 0 1 ϕw/2 64 Hz* -: Don't care * Frame frequency when ϕw = 32.768 kHz

- LCR2 LCD control register 2 Address: H′FFA2

Bit	Bit Name	Setting	R/W	Function
7	LCDAB	0	R/W	A waveform/B waveform switching control Selects whether to use the A or B waveform as the LCD drive waveform. 0: Drives the LCD using the A waveform. 1: Drives the LCD using the B waveform.
6	HCKS	0	R/W	Step-up clock select for the 3-V constant-voltage circuit Selects a step-up clock for the 3-V constant-voltage circuit. As the step-up clock, the clock selected using the CKS3 to CKS0 bits of LCR is divided by 4 or 8. 0: Uses the LCD clock divided by 4 as the step-up clock. 1: Uses the LCD clock divided by 8 as the step-up clock.
5	CHG	1	R/W	Connection control of the LCD power supply split-resistor Selects whether to connect the LCD power supply split-resistor to or disconnect it from the LCD drive power supply. 0: Disconnects the split-resistor. 1: Connects the split-resistor.
4	SUPS	1	R/W	3-V constant-voltage power supply control The 3-V constant-voltage power supply can be turned off when the LCD display is not used in the power-down mode or when an external power supply is used. 0: Turns the 3-V constant-voltage power supply off. 1: Turns the 3-V constant-voltage power supply on.

- IENR1 Interrupt enable register 1 Address: H′FFF3

Bit	Bit Name	Setting	R/W	Function
7	IENRTC	1	R/W	RTC interrupt request enable 0: Disables an RTC interrupt request. 1: Enables an RTC interrupt request.

4.4 Description of Constants

Table 6 is a list of the constants used in this sample task.

Table 6 Constants

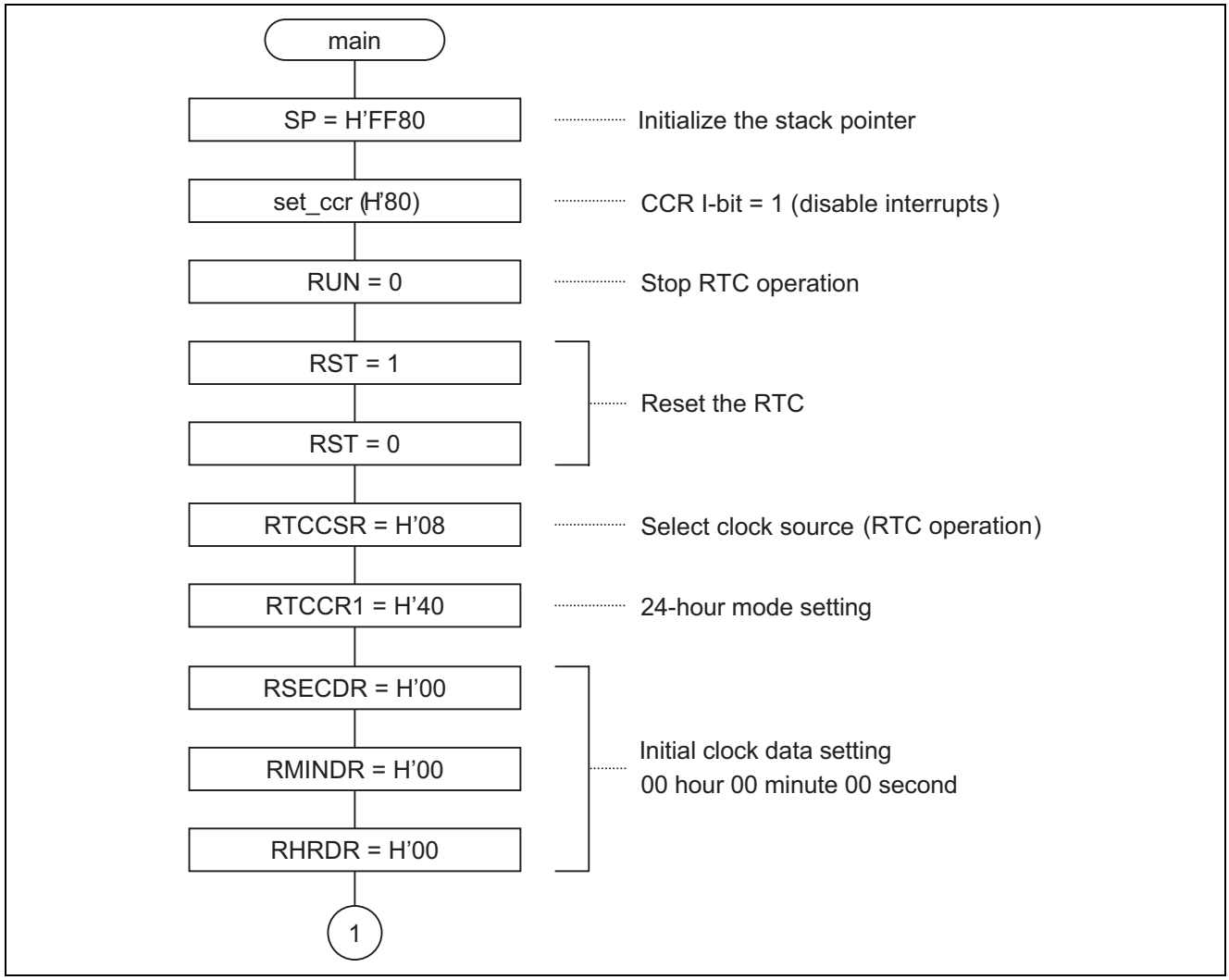
Buffer Name	Constant Value	Function (LCD Panel Display Data)	Used Function Names
LCD[0]	H′D7	0	main
LCD[1]	H′06	1	second_int
LCD[2]	H′E3	2	minute_int
LCD[3]	H′A7	3	hour_int
LCD[4]	H′36	4	
LCD[5]	H′B5	5	
LCD[6]	H′F5	6	
LCD[7]	H′17	7	
LCD[8]	H′F7	8	
LCD[9]	H′B7	9	

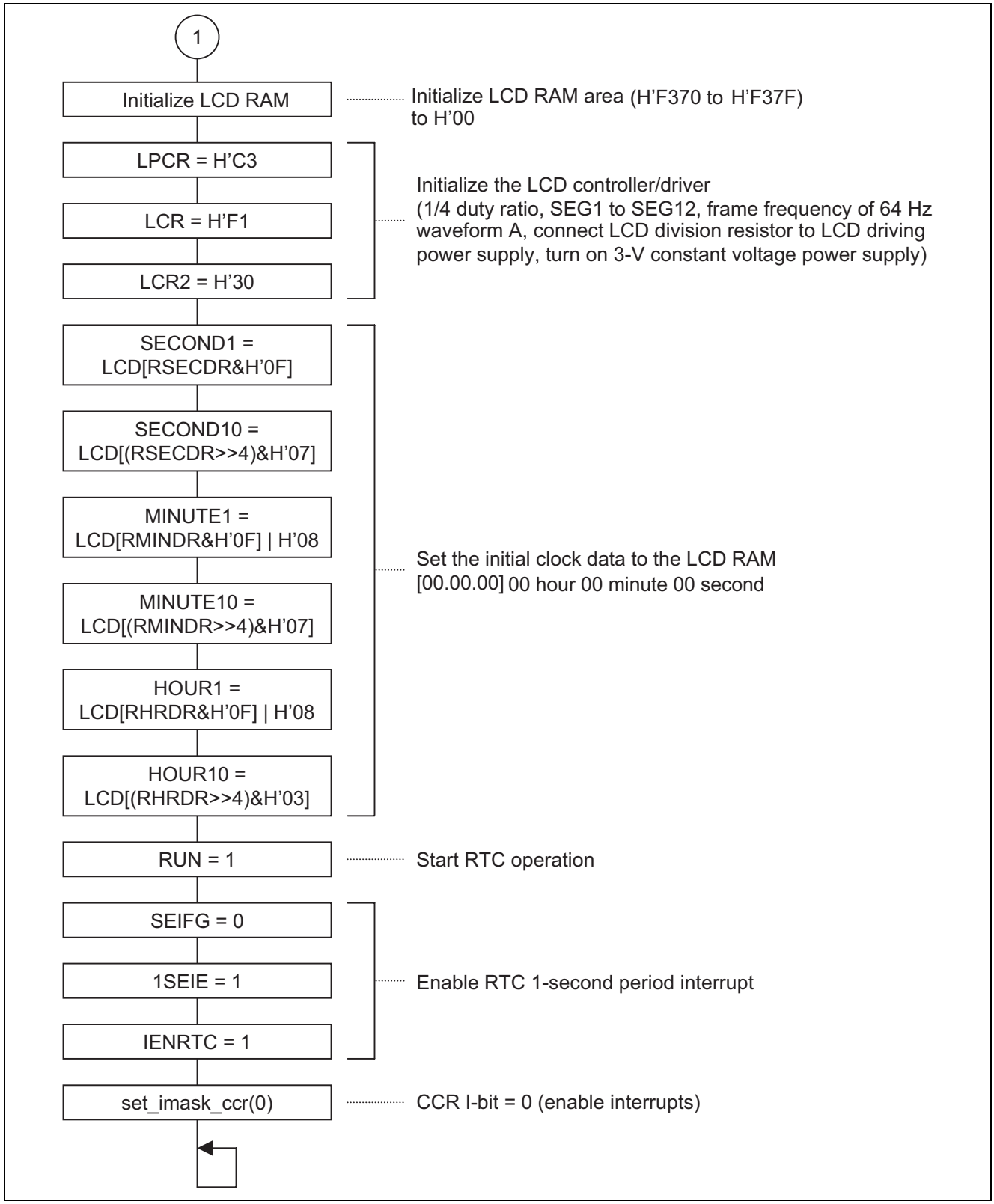
4.5 RAM Usage

This sample task does not cover RAM usage.

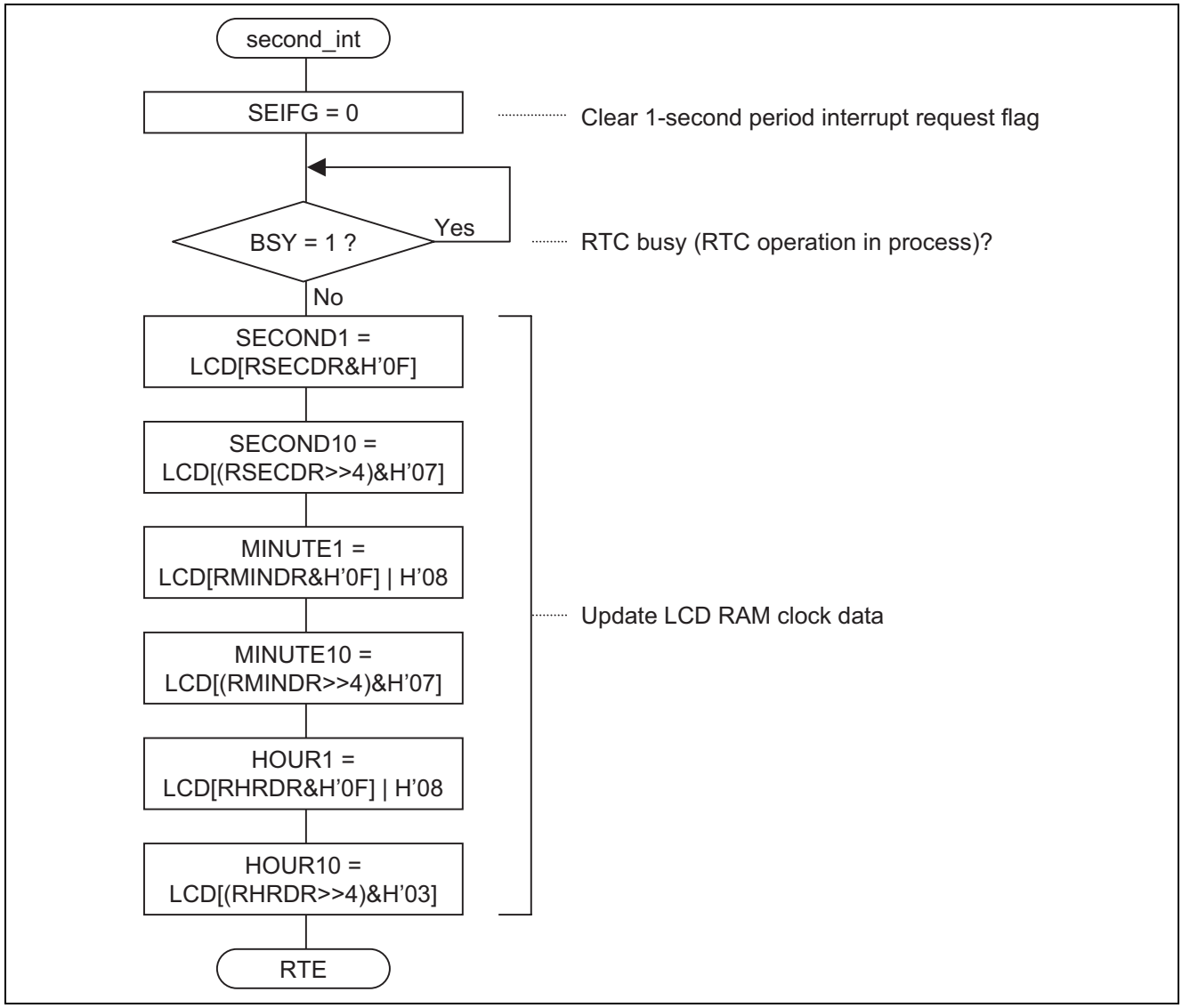
5. Flowchart

5.1 main




1
Initialize LCD RAM
Initialize LCD RAM area (H'F370 to H'F37F) to H'00
LPCR = H'C3
LCR = H'F1
LCR2 = H'30
Initialize the LCD controller/driver (1/4 duty ratio, SEG1 to SEG12, frame frequency of 64 Hz waveform A, connect LCD division resistor to LCD driving power supply, turn on 3-V constant voltage power supply)
SECOND1 = LCD[RSECDR&H'0F]
SECOND10 = LCD[(RSECDR>>4)&H'07]
MINUTE1 = LCD[RMINDR&H'0F] | H'08
MINUTE10 = LCD[(RMINDR>>4)&H'07]
HOUR1 = LCD[RHRDR&H'0F] | H'08
HOUR10 = LCD[(RHRDR>>4)&H'03]
Set the initial clock data to the LCD RAM [00.00.00] 00 hour 00 minute 00 second
RUN = 1
Start RTC operation
SEIFG = 0
1SEIE = 1
IENRTC = 1
Enable RTC 1-second period interrupt
set_imask_ccr(0)
CCR I-bit = 0 (enable interrupts)

5.2 second_int



- Link address specifications

Section Name	Address
CV1	H'0000
CV2	H'002A
P	H'0100
CLCD	

Revision Record

		Description	
Rev.	**Date**	**Page**	**Summary**
1.00	Sep.16.04	—	First edition issued

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