R7F0C809

6-Digit 8-Segment LED Display

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Introduction

This application note describes the sample program for 6-digit 8-segment LED control by using high current pin of R7F0C809 MCU.

Target Device

R7F0C809

When applying the sample program covered in this application note to another microcomputer with the same SFR (Special Function Register), modify the program according to the specifications for the target microcomputer and conduct an extensive evaluation of the modified program.

Contents

1. Specifications

This document introduces the application of R7F0C809 MCU driving directly 6-digit 8-segment LED using the high current I/O port. The scan frequency of LED is controlled by the interval timer mode of Timer Array Unit (TAU). The display characters are decided by the received ASCII code from device on the opposite side through the UART mode of Serial Array Unit (SAU).

R7F0C809 microcontroller has 6 ports (P-ch open-drain output) to control the LED digits (COM pins), and 8 ports (N-ch open-drain) to control the LED segments (SEG pins). The highest output current of 6 ports (P-ch open-drain output) can reach 120mA in the output mode of P-ch open-drain, and the highest output current of 8 ports (N-ch open-drain) can reach 15mA in the output mode of N-ch open-drain. Additionally, please pay attention to that the number of COM pins that output 1 at the same time is not more than 1.

Table 1.1 lists the Peripheral Functions and Their Applications.

Table 1.1 Peripheral Functions and Their Applications

Peripheral Function	Use
Timer Array Unit 0 Chanel 0	Control the interval period of the scan of LED
Serial Array Unit 0 Chanel 0	Receive data from RxD0 pin
P00 to P05	Control COM ports of LED
P06 to P07, P10 to P15	Control SEG ports of LED

2. Operating Conditions

The sample code contained in this application note has been tested under the conditions below.

Table 2.1 Operation Confirmation Conditions

Item	Contents
MCU used	R7F0C809
Operating frequency	• High-speed on-chip oscillator clock (f_{HOCO}): 20 MHz • CPU/peripheral hardware clock (f_{CLK}): 20 MHz
Operating voltage	5.0 V (operation enabled from 4.5 to 5.5 V) SPOR detection operation (V_{SPOR}): rising edge 4.28 V(typ.), falling edge 4.00 V (min.)
Integrated development environment	Renesas Electronics Corporation CubeSuite+ V2.01.00
C compiler	Renesas Electronics Corporation CA78K0R V1.60

3. Related Application Note

The application notes that are related to this application note are listed below for reference.

- R7F0C809 Key Matrix Input and 4-Digit 8-Segment LED Display (R01AN2006E) Application Note
- R7F0C809 4-Digit 8-Segment LED Display with A/D Key Read (R01AN2007E) Application Note

4. Description of the Hardware

4.1 Hardware Configuration Example

This application note uses 6-digital 8-segment common-anode LED, and connects a resistor to SEG port, to ensure that the current of SEG port doesn't exceed 15mA.

Figure 4.1 shows an example of hardware configuration that is used for this application note.

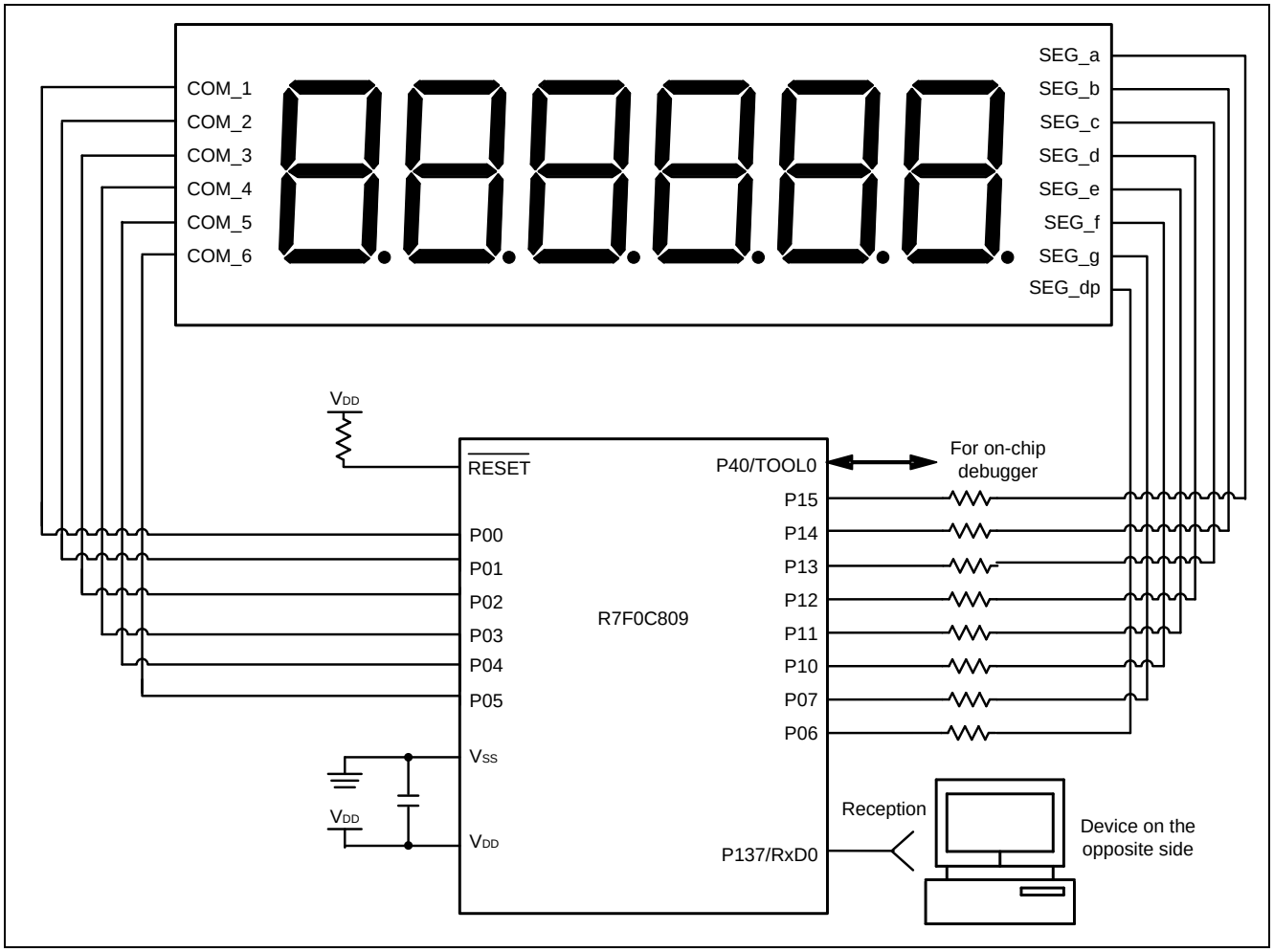

Figure 4.1 Hardware Configuration

Notes: 1. The purpose of this circuit is only to provide the connection outline and the circuit is simplified accordingly. 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- dedicated 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_{SPOR}) that is specified as SPOR.

4.2 List of Pins to be Used

Table 4.1 lists the pins to be used and their functions.

Table 4.1 Pins to be Used and Their Functions

Pin Name	I/O	Description
P00	Output	Control COM_1 port of LED
P01	Output	Control COM_2 port of LED
P02	Output	Control COM_3 port of LED
P03	Output	Control COM_4 port of LED
P04	Output	Control COM_5 port of LED
P05	Output	Control COM_6 port of LED
P06	Output	Control SEG_dp port of LED
P07	Output	Control SEG_g port of LED
P10	Output	Control SEG_f port of LED
P11	Output	Control SEG_e port of LED
P12	Output	Control SEG_d port of LED
P13	Output	Control SEG_c port of LED
P14	Output	Control SEG_b port of LED
P15	Output	Control SEG_a port of LED
P137/RxD0	Input	Data reception pin

5. Description of the Software

5.1 Operation Overview

This document explains how to control the scan time using the interval timer mode of Timer Array Unit (TAU) and control the display character using UART0. The valid received characters: ASCII code of 0 to 9, other characters will not be displayed. The scan frequency of 6-digital 8-segment LED is defined as 60 Hz, the display time of every digit is T = (1 / 60 Hz) / 6 ≈ 2.77 ms.

(1) Initialize ports.
- Set the pins that are used for LED display as digit input/output mode.
- Set the pins that control the COM ports of LED as P-ch open drain mode, and set the pins that control SEG ports of LED as N-ch open drain mode.
- Set the initial status of LED not to working, that is, set the pins that control LED's COM ports and LED's SEG ports as output inactive level.
- Set the pins that are used for LED as output mode.
- Set peripheral I/O redirection function: RxD0 is assigned to P137.

(2) Initialize TAU0
- Disable the timer interrupt (INTTM00) servicing of Timer Channel 0.
- Set TAU0 as interval timer mode.
- Set timer data register 0 (TDR00H, TDR00L) so that the interval period is 2.77 ms.

(3) Initialize SAU0
- Set the channel 0 and the channel 1 of SAU0 as UART mode.
- Use the UART0 reception transfer end interrupt (INTSR0).
- Set parity check as even parity.
- Set the data transfer sequence as LSB first.
- Set the data length as 8-bit.
- Set the UART baud rate as 9600 bps.
- Set the priority level of INTSR0 interrupt as level 3 (low priority).
- Enable INTSR0 interrupt servicing
- Set the serial channel start register to make MCU enter the communication wait status.

(4) Each time that the host computer sends data, MCU enters the interrupt serving of transfer end interrupt (INTSR0).
- When INTSR0 occurs, read the received data, and the data in display array (g_Display[]) shift backwardly in turn. And the received data are stored in the first element of display array.

(5) Set timer channel start register to start the counting of the interval timer.

(6) Wait for the interval timer interrupt request flag (TMIF00) becoming 1.
- When TMIF00 is 1, clear timer interrupt flag, enter the LED display routine..

(7) LED display processing
- Change LED display count value (s_COM), the change rule of s_COM's value: 0 → 1 → 2 → 3 → 4 → 5 → 0 →.....
- According to the value of s_COM, set the corresponding COM port, and display the corresponding elements in the array g_Display[].

(8) Return (6) to (7)

5.2 Timing

Figure 5.1 shows LED display timing.

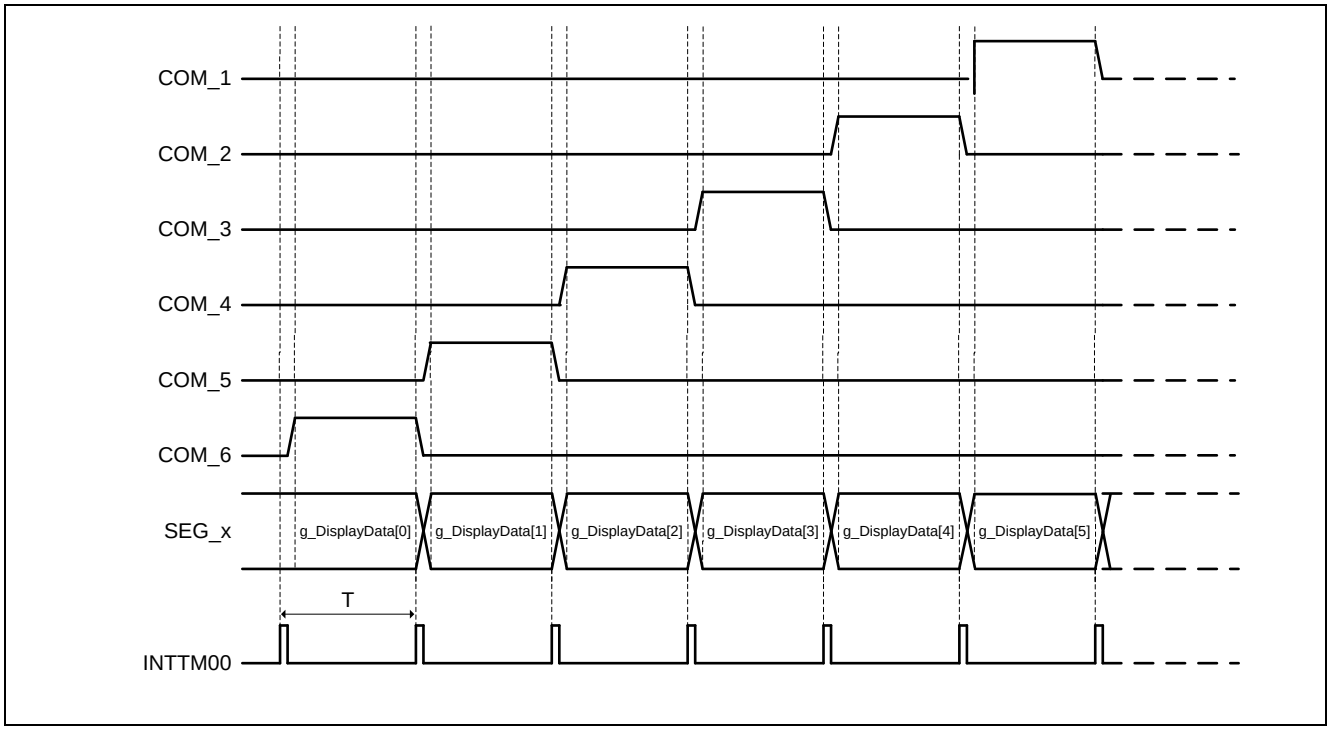

Figure 5.1 LED Display Timing

Notes: 1. g_Display[] is display array that is defined in the RAM and store the received data by UART0.
2. Set TAU0 interval timer so that the interval period (INTTM00 interrupt) is T (2.77ms in this case).

5.3 List of Option Byte Settings

Table 5.1 summarizes the settings of the option bytes.

Table 5.1 Option Byte Settings

Address	Value	Description
000C0H	11101110B	Watchdog timer operation is stopped. (Count is stopped after reset.)
000C1H	11110011B	SPOR detection voltage: rising edge 4.28 V (typ.), falling edge 4.00 V (min.) P125/KR1/$\overline{\text{RESET}}$ pin: RESET input
000C2H	11111001B	HOCO: 20 MHz
000C3H	10000101B	On-chip debugging is enabled.

5.4 List of Constants

Table 5.2 lists the constants that are used in this sample program.

Table 5.2 Constants for the Sample Program

Constant	Setting	Description
c_COM_Data[6]	0x20 0x10 0x08 0x04 0x02 0x01	Control COM ports of LED

5.5 List of Variables

Table 5.3 lists the global variables that are used in this sample program.

Table 5.3 Global Variables for the Sample Program

Type	Variable Name	Contents	Function Used
uint8_t	g_DisplayData[6]	Data receiving array for the LED display	UART0_Interrupt_Receive() LED_Display()

Table 5.4 lists the static variables that are used in this sample program.

Table 5.4 Static Variables for the Sample Program

Type	Variable Name	Contents	Function Used
uint8_t	s_COM	LED display count value	LED_Display()

5.6 List of Functions

Table 5.5 summarizes the functions that are used in this sample program.

Table 5.5 Functions

Function Name	Outline
System_Init	System function
PORT_Init	Initial setting of I/O ports
TAU0_Init	Initial setting of TAU0
UART0_Init	Initial setting of UART0
main	Main processing
TAU0_Channel0_Start	TAU0 operation start function
UART0_Interrupt_Receive	UART0 reception transfer end interrupt processing function
LED_Display	LED display function

5.7 Function Specifications

This section describes the specifications for the functions that are used in this sample code.

[Function Name] System_Init

Synopsis	System function
Header	userdefine.h led.h serial.h timer.h
Declaration	void System_Init (void)
Explanation	Call the initialization function of every function module.
Arguments	None
Return value	None
Remarks	None

[Function Name] PORT_Init

Synopsis	Initial setting of I/O ports
Header	userdefine.h
Declaration	void PORT_Init (void)
Explanation	PORTs' initialization setting.
Arguments	None
Return value	None
Remarks	None

[Function Name] TAU0_Init

Synopsis	Initial setting of TAU0
Header	timer.h userdefine.h
Declaration	void TAU0_Init (void)
Explanation	TAU0 module's initialization setting.
Arguments	None
Return value	None
Remarks	None

[Function Name] UART0_Init

Synopsis	Initial setting of UART0
Header	serial.h userdefine.h
Declaration	void UART0_Init (void)
Explanation	UART0 module's initialization setting.
Arguments	None
Return value	None
Remarks	None

[Function Name] main

Synopsis	Main processing
Header	userdefine.h led.h serial.h timer.h
Declaration	void main (void)
Explanation	Do main function processing.
Arguments	None
Return value	None
Remarks	None

[Function Name] TAU0_Channel0_Start

Synopsis	TAU0 operation start function
Header	timer.h userdefine.h
Declaration	void TAU0_Channel0_Start (void)
Explanation	Clear TAU0 channel 0 interrupt request flag, disable interrupt, and begin count operation.
Arguments	None
Return value	None
Remarks	None

[Function Name] UART0_Interrupt_Receive

Synopsis	UART0 reception transfer end interrupt processing
Header	serial.h userdefine.h
Declaration	__interrupt void UART0_Interrupt_Receive (void)
Explanation	Response based on the received data (update the display data).
Arguments	None
Return value	None
Remarks	None

[Function Name] LED_Display

Synopsis	LED display function
Header	led.h userdefine.h
Declaration	void LED_Display(void)
Explanation	Control the display of LED.
Arguments	None
Return value	None
Remarks	None

5.8 Flowcharts

5.8.1 System Function

Figure 5.2 shows the flowchart for the system function.

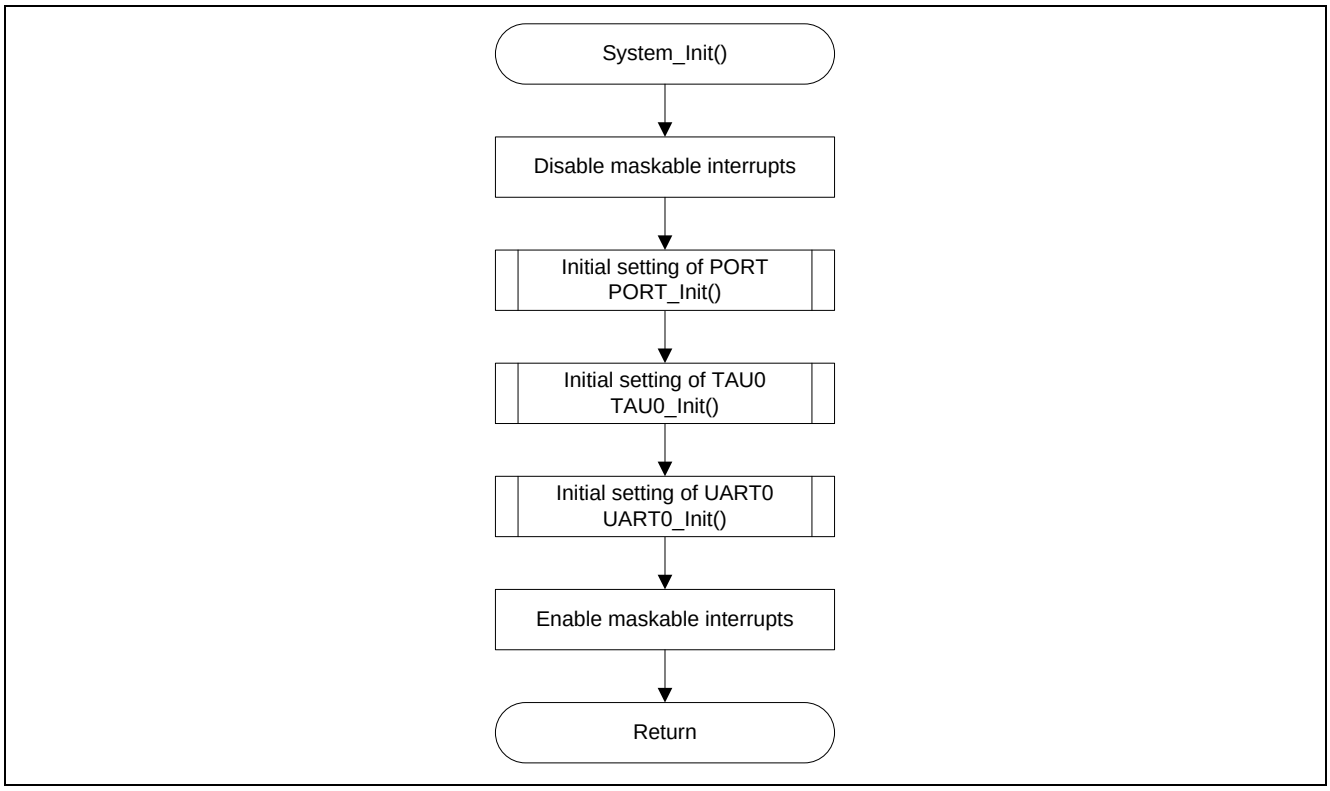

Figure 5.2 System Function

5.8.2 Initial Setting of I/O ports

Figure 5.3 shows the flowchart for initial setting of I/O ports.

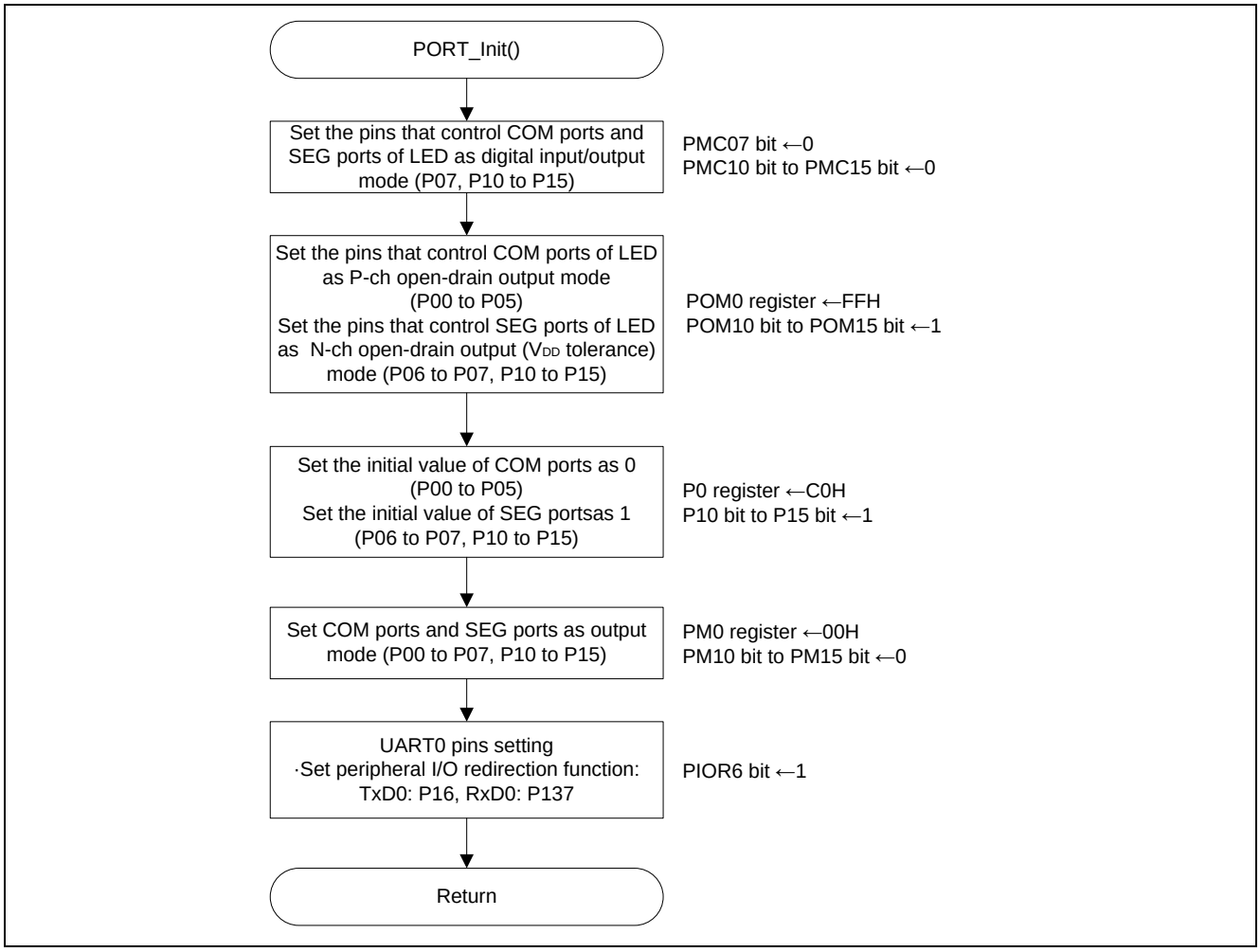

Figure 5.3 Initial Setting of I/O ports

Set up port

- Port Mode Control Register 0 (PMC0)

  Set port as digit I/O mode.

- Port Mode Control Register 0 (PMC1)

  Set port as digit I/O mode.

Symbol: PMC0

7	6	5	4	3	2	1	0
PMC07	1	1	1	1	1	1	1
0	-	-	-	-	-	-	-

Bit 7

PMC07	P07 pin digital I/O/analog input selection
0	**Digital I/O (alternate function other than analog input)**
1	Analog I/O

Symbol: PMC1

7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
1	PMC16	PMC15	PMC14	PMC13	PMC12	PMC11	PMC10
-	x	**0**	**0**	**0**	**0**	**0**	**0**

Bits 5 to 0

PMC1n	P1n pin digital I/O/analog input selection (n = 0 ~ 5)
0	**Digital I/O (alternate function other than analog input)**
1	Analog I/O

- Port Output Mode Register 0 (POM0)

  Set port as P-ch open-drain output mode or N-ch open-drain output mode.

- Port Output Mode Register 0 (POM1)

  Set port as P-ch open-drain output mode or N-ch open-drain output mode.

Symbol: POM0

7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
POM07	POM06	POM05	POM04	POM03	POM02	POM01	POM00
1	**1**	**1**	**1**	**1**	**1**	**1**	**1**

Bits 7 to 0

POM0n	P0n pin output mode selection (n = 0 ~ 7)
0	Normal output mode
1	**N-ch open-drain output (V_{DD} tolerance) mode (P06~P07 pins)** **P-ch open-drain output (V_{DD} tolerance) mode (P00~P05 pins)**

Refer to the R7F0C806-809 user's manual (hardware) for details on individual registers.
Initial values of individual bits
x: Bits not used in this application; blank spaces: bits that do not change; -: reserved bits or bits that have nothing assigned.

Symbol: POM1

7	6	5	4	3	2	1	0
0	0	POM15	POM14	POM13	POM12	POM11	POM10
-	-	**1**	**1**	**1**	**1**	**1**	**1**

Bits 5 to 0

POM1n	P1n pin output mode selection (n = 0 ~ 5)
0	Normal output mode
1	**N-ch open-drain output (V_{DD} tolerance) mode (P10~P15 pins)**

- Port Register 0 (P0)

  Set the output latch value of a port.

- Port Register 0 (P1)

  Set the output latch value of a port.

Symbol: P0

7	6	5	4	3	2	1	0
P07	P06	P05	P04	P03	P02	P01	P00
1	**1**	**0**	**0**	**0**	**0**	**0**	**0**

Bits 5 to 0

P0n	Output data control (in output mode) (n = 0 ~ 5)
0	**Output 0**
1	Output 1

Bits 7 to 6

P0n	Output data control (in output mode) (n = 6 ~ 7)
0	Output 0
1	**Output 1**

Symbol: P1

7	6	5	4	3	2	1	0
0	P16	P15	P14	P13	P12	P11	P10
-	x	**1**	**1**	**1**	**1**	**1**	**1**

Bits 5 to 0

P1n	Output data control (in output mode) (n = 0 ~ 5)
0	Output 0
1	**Output 1**

Refer to the R7F0C806-809 user's manual (hardware) for details on individual registers.
Initial values of individual bits
x: Bits not used in this application; blank spaces: bits that do not change; -: reserved bits or bits that have nothing assigned.

- Port Mode Register 0 (PM0)

  Set port as input mode or output mode.

- Port Mode Register 0 (PM1)

  Set port as input mode or output mode.

Symbol: PM0

7	6	5	4	3	2	1	0
PM07	PM06	PM05	PM04	PM03	PM02	PM01	PM00
0	**0**	**0**	**0**	**0**	**0**	**0**	**0**

Bits 7 to 0

PM0n	P0n pin I/O mode selection (n = 0 ~ 7)
0	**Output mode (output buffer on)**
1	Input mode (output buffer off)

Symbol: PM1

7	6	5	4	3	2	1	0
1	PM16	PM15	PM14	PM13	PM12	PM11	PM10
-	x	**0**	**0**	**0**	**0**	**0**	**0**

Bits 5 to 0

PM1n	P1n pin I/O mode selection (n = 0 ~ 5)
0	**Output mode (output buffer on)**
1	Input mode (output buffer off)

- Peripheral I/O redirection Register (PIOR)

  Set pins that used for TxD0 pin and RxD0 pin.

Symbol: PIOR

7	6	5	4	3	2	1	0
0	PIOR6	PIOR5	PIOR4	PIOR3	PIOR2	PIOR1	PIOR0
-	**1**	x	x	x	x	x	x

Bit 6

PIOR6	Enable or disable the UAR0 redirect function
0	Enable the redirect function TxD0: P06, RxD0: P07
1	**Disable the redirect function** **TxD0: P16, RxD0: P137**

Refer to the R7F0C806-809 user's manual (hardware) for details on individual registers.
Initial values of individual bits
x: Bits not used in this application; blank spaces: bits that do not change; -: reserved bits or bits that have nothing assigned.

5.8.3 Initial Setting of Timer Array Unit

Figure 5.4 shows the flowchart for the initial setting of Timer Array Unit.

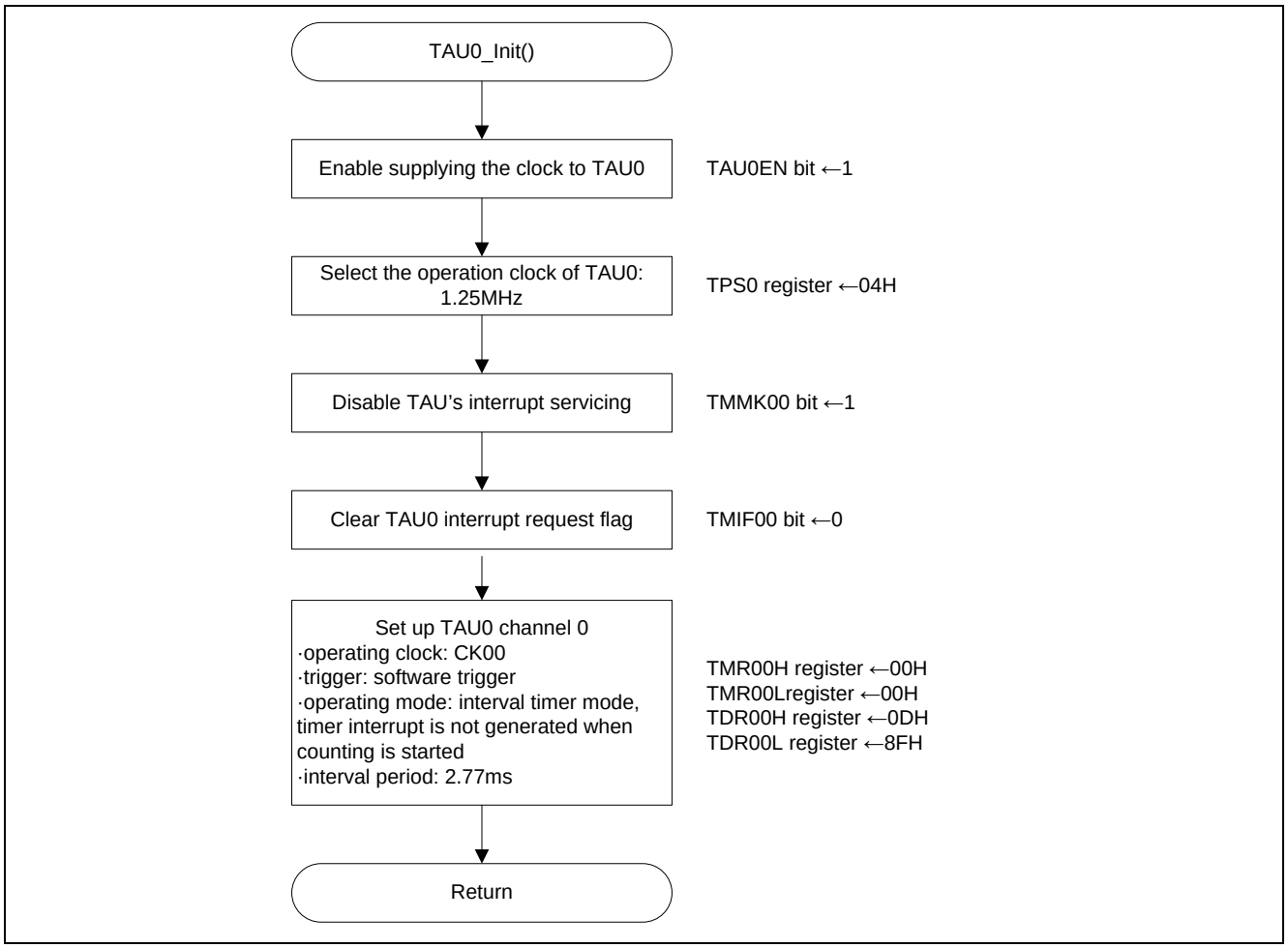

Figure 5.4 Initial Setting of Timer Array Unit

Enable supplying the clock to the Timer Array Unit 0

- Peripheral enable register 0 (PER0)

Enable supplying the clock to the Timer Array Unit 0.

Symbol: PER0

7	6	5	4	3	2	1	0
TMKAEN	RTOEN	ADCEN	0	0	SAU0EN	0	TAU0EN
x	x	x	-	-		-	**1**

Bit 0

TAU0EN	Control of timer array unit input clock supply
0	Stops input clock supply. • SFR used by timer array unit cannot be written. • Timer array unit is in the reset status.
1	**Enables input clock supply.** **• SFR used by timer array unit can be read and written.**

Configuring the timer clock frequency

- Timer clock select register 0 (TPS0)

Select the operation clock for Timer Array Unit 0.

Symbol: TPS0

7	6	5	4	3	2	1	0
PRS013	PRS012	PRS011	PRS010	PRS003	PRS002	PRS001	PRS000
x	x	x	x	**0**	**1**	**0**	**0**

Bits 3 to 0

PRS003	PRS002	PRS001	PRS000	Selection of operation clock (CK00)					
					f_{CLK} = 1.25 MHz	f_{CLK} = 2.5 MHz	f_{CLK} = 5 MHz	f_{CLK} = 10 MHz	f_{CLK} = 20 MHz
0	0	0	0	f_{CLK}	1.25 MHz	2.5 MHz	5 MHz	10 MHz	20 MHz
0	0	0	1	$f_{CLK}/2$	625 kHz	1.25 MHz	2.5 MHz	5 MHz	10 MHz
0	0	1	0	$f_{CLK}/2^2$	313 kHz	625 kHz	1.25 MHz	2.5 MHz	5 MHz
0	0	1	1	$f_{CLK}/2^3$	156 kHz	313 kHz	625 kHz	1.25 MHz	2.5 MHz
0	**1**	**0**	**0**	**$f_{CLK}/2^4$**	78.1 kHz	156 kHz	313 kHz	625 kHz	**1.25 MHz**
0	1	0	1	$f_{CLK}/2^5$	39.1 kHz	78.1 kHz	156 kHz	313kHz	625 kHz
0	1	1	0	$f_{CLK}/2^6$	19.5 kHz	39.1 kHz	78.1 kHz	156 kHz	313 kHz
0	1	1	1	$f_{CLK}/2^7$	9.77 kHz	19.5 kHz	39.1 kHz	78.1 kHz	156 kHz
1	0	0	0	$f_{CLK}/2^8$	4.88 kHz	9.77 kHz	19.5 kHz	39.1 kHz	78.1 kHz
1	0	0	1	$f_{CLK}/2^9$	2.44 kHz	4.88 kHz	9.77 kHz	19.5 kHz	39.1 kHz
1	0	1	0	$f_{CLK}/2^{10}$	1.22 kHz	2.44 kHz	4.88 kHz	9.77 kHz	19.5 kHz
1	0	1	1	$f_{CLK}/2^{11}$	610 Hz	1.22 kHz	2.44 kHz	4.88 kHz	9.77 kHz
1	1	0	0	$f_{CLK}/2^{12}$	305 Hz	610 Hz	1.22 kHz	2.44 kHz	4.88 kHz
1	1	0	1	$f_{CLK}/2^{13}$	153 Hz	305 Hz	610 Hz	1.22 kHz	2.44 kHz
1	1	1	0	$f_{CLK}/2^{14}$	76.3 Hz	153 Hz	305 Hz	610 Hz	1.22 kHz
1	1	1	1	$f_{CLK}/2^{15}$	38.1 Hz	76.3 Hz	153 Hz	305 Hz	610 Hz

Refer to the R7F0C806-809 user's manual (hardware) for details on individual registers.
Initial values of individual bits
x: Bits not used in this application; blank spaces: bits that do not change; -: reserved bits or bits that have nothing assigned.

Setting up interrupt

- Interrupt mask flag register (MK0L)

  Disable the corresponding maskable interrupt servicing.

- Interrupt request flag register (IF0L)

  Clear interrupt request flag.

Symbol: MK0L

7	6	5	4	3	2	1	0
TMMK00	TMMK01H	SREMK0	SRMK0	STMK0 CSIMK00	PMK1	PMK0	WDTIMK
1	x	x		x	x	x	x

Bit 7

TMMK00	Interrupt servicing control
0	Interrupt servicing enabled
1	**Interrupt servicing disabled**

Symbol: IF0L

7	6	5	4	3	2	1	0
TMIF00	TMIF01H	SREIF0	SRIF0	STIF0 CSIIF00	PIF1	PIF0	WDTIIF
0	x	x		x	x	x	x

Bit 7

TMIF00	Interrupt request flag
0	**No interrupt request signal is generated**
1	Interrupt request signal is generated, interrupt request status

Refer to the R7F0C806-809 user's manual (hardware) for details on individual registers.
Initial values of individual bits
x: Bits not used in this application; blank spaces: bits that do not change; -: reserved bits or bits that have nothing assigned.

Setting up the operation mode of Timer Array Unit channel 0

- Timer mode register 00 (TMR00H, TMR00L)

Select the operation clock (f_{MCK}).

Select the count clock.

Select the software trigger start.

Select the operation mode.

Symbol: TMR00H

7	6	5	4	3	2	1	0
CKS001	0	0	CCS00	0	STS002	STS001	STS000
0	-	-	**0**	-	**0**	**0**	**0**

Bit 7

CKS001	Selection of operation clock (f_{MCK}) of channel 0
0	**Operation clock CK00 set by timer clock select register 0 (TPS0)**
1	Operation clock CK01 set by timer clock select register 0 (TPS0)

Bit 4

CCS00	Selection of count clock (f_{TCLK}) of channel 0
0	**Operation clock (f_{MCK}) specified by the CKS001 bit**
1	Valid edge of input signal input from the TI00 pin

Bits 2 to 0

STS002	STS001	STS000	Setting of start trigger or capture trigger of channel 0
0	**0**	**0**	**Only software trigger start is valid (other trigger sources are unselected).**
0	0	1	Valid edge of the TI00 pin input is used as the start trigger and capture trigger.
0	1	0	Both the edges of the TI00 pin input are used as a start trigger and a capture trigger.
1	0	0	When the channel is used as a slave channel with the one-shot pulse output, PWM output function, or multiple PWM output function: The interrupt request signal of the master channel (INTTM00) is used as the start trigger.
1	1	0	When the channel is used as a slave channel in two-channel input with one-short pulse output function: The Interrupt request signal of the master channel (INTTM00) is used as the start trigger. A valid edge of the TI03 pin input of the slave channel is used as the end trigger.
Other than above			Setting prohibited

Refer to the R7F0C806-809 user's manual (hardware) for details on individual registers.
Initial values of individual bits
x: Bits not used in this application; blank spaces: bits that do not change; -: reserved bits or bits that have nothing assigned.

Symbol: TMR00L

7	6	5	4	3	2	1	0
CIS001	CIS000	0	0	MD003	MD002	MD001	MD000
x	x	-	-	**0**	**0**	**0**	**0**

Bits 3 to 0

MD003	MD002	MD001	MD000	Setting of operation mode of channel 0	Corresponding function	Count operation of TCR
0	**0**	**0**	**1/0**	**Interval timer mode**	**Interval timer/Square wave output/Divider function/PWM output (master)**	**Down count**
0	1	0	1/0	Capture mode	Input pulse interval measurement/Two-channel input with one-shot pulse output function (slave)	Up count
0	1	1	0	Event counter mode	External event counter	Down count
1	0	0	1/0	One-count mode	Delay counter/One-shot pulse output/Two-channel input with one-shot pulse output function (master)/PWM output (slave)	Down count
1	1	0	0	Capture & one-count mode	Measurement of high-/low-level width of input signal	Up count
Other than above				Setting prohibited		

The operation of each mode changes depending on the operation of MD000 bit (see the table below).

Operation mode (Value set by the MD003 to MD001 bits)	MD000	Setting of starting counting and interrupt
Interval timer mode (0, 0, 0)	**0**	**Timer interrupt is not generated when counting is started (timer output does not change, either).**
Capture mode (0, 1, 0)	1	Timer interrupt is generated when counting is started (timer output also changes).
Event counter mode (0, 1, 1)	0	Timer interrupt is not generated when counting is started (timer output does not change, either).
One-count mode (1, 0, 0)	0	Start trigger is invalid during counting operation. At that time, a timer interrupt is not generated.
	1	Start trigger is valid during counting operation. At that time, a timer interrupt is not generated.
Capture & one-count mode (1, 1, 0)	0	Timer interrupt is not generated when counting is started (timer output does not change, either). Start trigger is invalid during counting operation.At that time, a timer interrupt is not generated.
Other than above		Setting prohibited

Refer to the R7F0C806-809 user's manual (hardware) for details on individual registers.
Initial values of individual bits
x: Bits not used in this application; blank spaces: bits that do not change; -: reserved bits or bits that have nothing assigned.

Setting up interval timer period

- Timer data register 00 (TDR00H, TDR00L)

  Setting up interval timer compare value.

Symbol: TDR00H

7	6	5	4	3	2	1	0
0	0	0	0	1	1	0	1

Symbol: TDR00L

7	6	5	4	3	2	1	0
1	0	0	0	1	1	1	1

Generation period of INTTM00 (Timer interrupt) = Period of count clock × (Set value of TDR00 + 1)

= 1 / 1.25 MHz × (0x0d8f + 1) = 2.77 ms

Refer to the R7F0C806-809 user's manual (hardware) for details on individual registers.
Initial values of individual bits
x: Bits not used in this application; blank spaces: bits that do not change; -: reserved bits or bits that have nothing assigned.

5.8.4 Initial Setting of Serial Array Unit

Figure 5.5 shows the flowchart for the initial setting of Serial Array Unit.

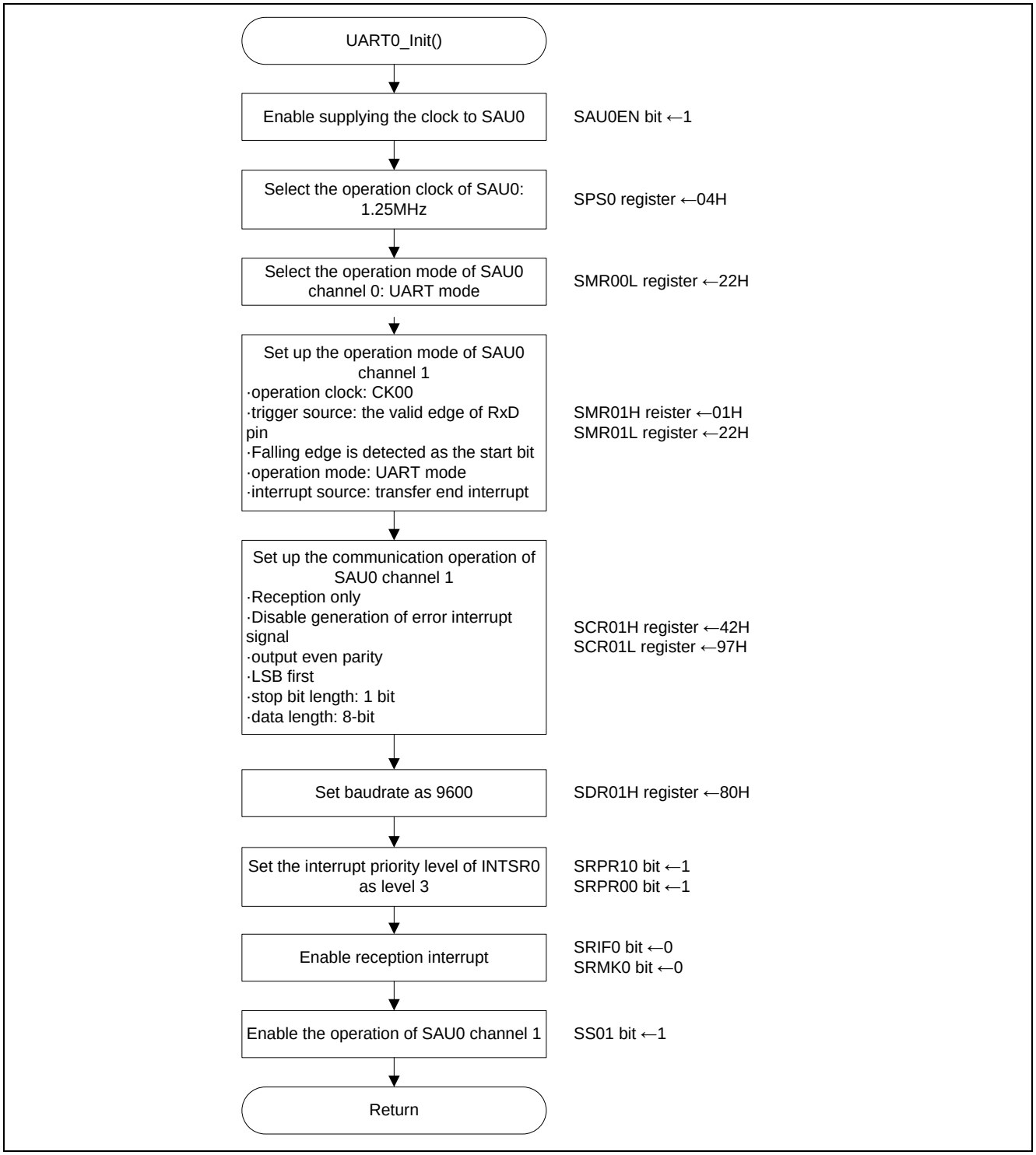

Figure 5.5 Initial Setting of Serial Array Unit

Enable supplying the clock to the Serial Array Unit 0

- Peripheral enable register 0 (PER0)

Enable supplying the clock to the Serial Array Unit 0.

Symbol: PER0

7	6	5	4	3	2	1	0
TMKAEN	RTOEN	ADCEN	0	0	SAU0EN	0	TAU0EN
x	x	x	-	-	**1**	-	

Bit 2

SAU0EN	Control of serial array unit 0 input clock supply
0	Stops input clock supply. • SFR used by the serial array unit cannot be written. • The serial array unit is in the reset status.
1	**Enables input clock supply.** **• SFR used by the serial array unit 0 can be read and written.**

Configuring the timer clock frequency

- Serial clock select register 0 (SPS0)

Select the operation clock for Serial Array Unit 0.

Symbol: SPS0

7	6	5	4	3	2	1	0
PRS013	PRS012	PRS011	PRS010	PRS003	PRS002	PRS001	PRS000
x	x	x	x	**0**	**1**	**0**	**0**

Bits 3 to 0

PRS003	PRS002	PRS001	PRS000	Selection of operation clock (CK00)					
					f_{CLK} = 1.25 MHz	f_{CLK} = 2.5 MHz	f_{CLK} = 5 MHz	f_{CLK} = 10 MHz	f_{CLK} = 20 MHz
0	0	0	0	f_{CLK}	1.25 MHz	2.5 MHz	5 MHz	10 MHz	20 MHz
0	0	0	1	$f_{CLK}/2$	625 kHz	1.25 MHz	2.5 MHz	5 MHz	10 MHz
0	0	1	0	$f_{CLK}/2^2$	313 kHz	625 kHz	1.25 MHz	2.5 MHz	5 MHz
0	0	1	1	$f_{CLK}/2^3$	156 kHz	313 kHz	625 kHz	1.25 MHz	2.5 MHz
0	**1**	**0**	**0**	**$f_{CLK}/2^4$**	78 kHz	156 kHz	313 kHz	625 kHz	**1.25 MHz**
0	1	0	1	$f_{CLK}/2^5$	39 kHz	78 kHz	156 kHz	313kHz	625 kHz
0	1	1	0	$f_{CLK}/2^6$	19.5 kHz	39 kHz	78 kHz	156 kHz	313 kHz
0	1	1	1	$f_{CLK}/2^7$	9.8 kHz	19.5 kHz	39 kHz	78 kHz	156 kHz
1	0	0	0	$f_{CLK}/2^8$	4.9 kHz	9.8 kHz	19.5 kHz	39 kHz	78 kHz
1	0	0	1	$f_{CLK}/2^9$	2.5 kHz	4.9 kHz	9.8 kHz	19.5 kHz	39 kHz
1	0	1	0	$f_{CLK}/2^{10}$	1.22 kHz	2.5 kHz	4.9 kHz	9.8 kHz	19.5 kHz
1	0	1	1	$f_{CLK}/2^{11}$	625 Hz	1.22 kHz	2.5 kHz	4.9 kHz	9.8 kHz
1	1	0	0	$f_{CLK}/2^{12}$	313 Hz	625 Hz	1.22 kHz	2.5 kHz	4.9 kHz
1	1	0	1	$f_{CLK}/2^{13}$	152 Hz	313 Hz	625 Hz	1.22 kHz	2.5 kHz
1	1	1	0	$f_{CLK}/2^{14}$	78 Hz	152 Hz	313 Hz	625 Hz	1.22 kHz
1	1	1	1	$f_{CLK}/2^{15}$	39 Hz	78 Hz	152 Hz	313 Hz	625 Hz

Refer to the R7F0C806-809 user's manual (hardware) for details on individual registers.
Initial values of individual bits
x: Bits not used in this application; blank spaces: bits that do not change; -: reserved bits or bits that have nothing assigned.

Setting up the operation mode of Serial Array Unit channel 0

- Serial mode register 00L (SMR00L)

Select the operation mode.

Symbol: SMR00L

7	6	5	4	3	2	1	0
0	SIS000	1	0	0	0	MD001	MD000
-	0	-	-	-	-	**1**	0

Bit 1

MD001	Setting of operation mode of channel 0
0	CSI mode
1	**UART mode**

Setting up the operation mode of Serial Array Unit channel 1

- Serial mode register 01 (SMR01H, SMR01L)

Select f_{MCK}.

Select the transfer clock.

Select the interrupt source.

Select the operation mode.

Symbol: SMR01H

7	6	5	4	3	2	1	0
CKS01	CCS01	0	0	0	0	0	STS01
0	**0**	-	-	-	-	-	**1**

Bit 7

CKS01	Selection of operation clock (f_{MCK}) of channel 1
0	**Operation clock CK00 set by the SPS0 register**
1	Operation clock CK01 set by the SPS0 register

Bit 6

CCS01	Selection of transfer clock (f_{TCLK}) of channel 1
0	**Divided operation clock f_{MCK} specified by the CKS01 bit**
1	Clock input f_{SCK} from the SCKp pin (slave transfer in CSI mode)

Bit 0

STS01	Selection of start trigger source
0	Only software trigger is valid (selected for CSI and UART transmission).
1	**Valid edge of the RXD0 pin (selected for UART reception)**

Refer to the R7F0C806-809 user's manual (hardware) for details on individual registers.
Initial values of individual bits
x: Bits not used in this application; blank spaces: bits that do not change; -: reserved bits or bits that have nothing assigned.

Symbol: SMR01L

7	6	5	4	3	2	1	0
0	SIS010	1	0	0	0	MD011	MD010
-	**0**	-	-	-	-	**1**	**0**

Bit 6

SIS010	Controls inversion of level of receive data of UART0
0	**Falling edge is detected as the start bit.** **The input communication data is captured as is.**
1	Rising edge is detected as the start bit. The input communication data is inverted and captured.

Bit 1

MD011	Setting of operation mode of channel 1
0	CSI mode
1	**UART mode**

Bit 0

MD010	Selection of interrupt source of channel 1
0	**Transfer end interrupt**
1	Buffer empty interrupt (Occurs when data is transferred from the SDR01L register to the shift register.)

Setting up the serial communication operation of transmit channel

- Serial communication operation setting register 01 (SCR01H, SCR01L)

Set data length.

Select the transfer sequence.

Select whether mask the communication error interrupt signal.

Select the operation mode.

Symbol: SCR01H

7	6	5	4	3	2	1	0
TXE01	RXE01	DAP01	CKP01	0	EOC01	PTC011	PTC010
0	**1**	x	x	-	**0**	**1**	**0**

Bits 7 ~ 6

TXE01	RXE01	Setting of operation mode of channel 1
0	0	Disable communication.
0	**1**	**Reception only**
1	0	Transmission only
1	1	Transmission/reception

Refer to the R7F0C806-809 user's manual (hardware) for details on individual registers.
Initial values of individual bits
x: Bits not used in this application; blank spaces: bits that do not change; -: reserved bits or bits that have nothing assigned.

Bit 2

EOC01	Selection of masking of error interrupt signal (INTSRE0)
0	**Disables generation of error interrupt INTSRE0 (INTSR0 is generated).**
1	Enables generation of error interrupt INTSRE0 (INTSR0 is not generated if an error occurs).

Bits 1 ~ 0

PTC011	PTC010	Setting of parity bit in UART mode	
		Transmission	Reception
0	0	Does not output the parity bit.	Receives without parity
0	1	Outputs 0 parity.	No parity judgment
1	**0**	Outputs even parity.	**Judged as even parity**
1	1	Outputs odd parity.	Judges as odd parity.

Symbol: SCR01L

7	6	5	4	3	2	1	0
DIR01	0	SLC011	SLC010	0	1	1	DLS010
1	-	**0**	**1**	-	-	-	**1**

Bit 7

DIR01	Selection of data transfer sequence in CSI and UART modes
0	Inputs/outputs data with MSB first.
1	**Inputs/outputs data with LSB first.**

Bits 5 to 4

SLC011	SLC010	Setting of stop bit in UART mode
0	0	No stop bit
0	**1**	**Stop bit length = 1 bit**
1	0	Stop bit length = 2 bits (channel 0 only)
1	1	Setting prohibited

Bit 0

DLS010	Setting of data length in CSI and UART modes
0	7-bit data length (stored in bits 0 to 6 of the SDR01L register)
1	**8-bit data length (stored in bits 0 to 7 of the SDR01L register)**

Refer to the R7F0C806-809 user's manual (hardware) for details on individual registers.
Initial values of individual bits
x: Bits not used in this application; blank spaces: bits that do not change; -: reserved bits or bits that have nothing assigned.

Setting up the transfer clock of transmit channel

- Serial data register 01H (SDR01H)

  Communication clock frequency: f_{MCK} / 130 (≈ 9600 Hz)

Symbol: SDR01H

7	6	5	4	3	2	1	0
1	**0**	**0**	**0**	**0**	**0**	**0**	0

Bits 7 to 1

SDR01H[7:1]							Transfer clock setting by dividing the operating clock
0	0	0	0	0	0	0	f_{MCK}/2
0	0	0	0	0	0	1	f_{MCK}/4
0	0	0	0	0	1	0	f_{MCK}/6
0	0	0	0	0	1	1	f_{MCK}/8
.	.	.	.	.	.	.	
1	**0**	**0**	**0**	**0**	**0**	**0**	**f_{MCK}/130**
.	.	.	.	.	.	.	
1	1	1	1	1	1	0	f_{MCK}/254
1	1	1	1	1	1	1	f_{MCK}/256

Setting up interrupt

- Interrupt request flag register (IF0L)

  Clear interrupt request flag.
- Interrupt mask flag register (MK0L)

  Disable or enable interrupt servicing.

Symbol: IF0L

7	6	5	4	3	2	1	0
TMIF00	TMIF01H	SREIF0	SRIF0	STIF0 CSIIF00	PIF1	PIF0	WDTIIF
	x	x	**0**	x	x	x	x

Bit 1

SRIF0	Interrupt request flag
0	**No interrupt request signal is generated**
1	Interrupt request is generated, interrupt request status

Refer to the R7F0C806-809 user's manual (hardware) for details on individual registers.
Initial values of individual bits
x: Bits not used in this application; blank spaces: bits that do not change; -: reserved bits or bits that have nothing assigned.

Symbol: MK0L

7	6	5	4	3	2	1	0
TMMK00	TMMK01H	SREMK0	SRMK0	STMK0 CSIMK00	PMK1	PMK0	WDTIMK
	x	x	**0**	x	x	x	x

Bit 1

SRMK0	Interrupt servicing control
0	**Interrupt servicing enabled**
1	Interrupt servicing disabled

Enters to communication standby state

- Serial channel start register 0 (SS0)

  Operation starts.

Symbol: SS0

7	6	5	4	3	2	1	0
0	0	0	0	0	0	SS01	SS00
-	-	-	-	-	-	**1**[Note]	x

Bit 1

SS01	Operation start trigger of channel 1
0	No trigger operation
1	**Sets the SE01 bit to 1 and enters the communication wait status** [Note]

Note: For the UART reception, set the RXE01 bit of SCR01H register as 1, and then be sure to set SS01 as 1 after 4 or more f_{MCK} clocks have elapsed.

Refer to the R7F0C806-809 user's manual (hardware) for details on individual registers.
Initial values of individual bits
x: Bits not used in this application; blank spaces: bits that do not change; -: reserved bits or bits that have nothing assigned.

5.8.5 Main Processing

Figure 5.6 shows the flowchart for main processing.

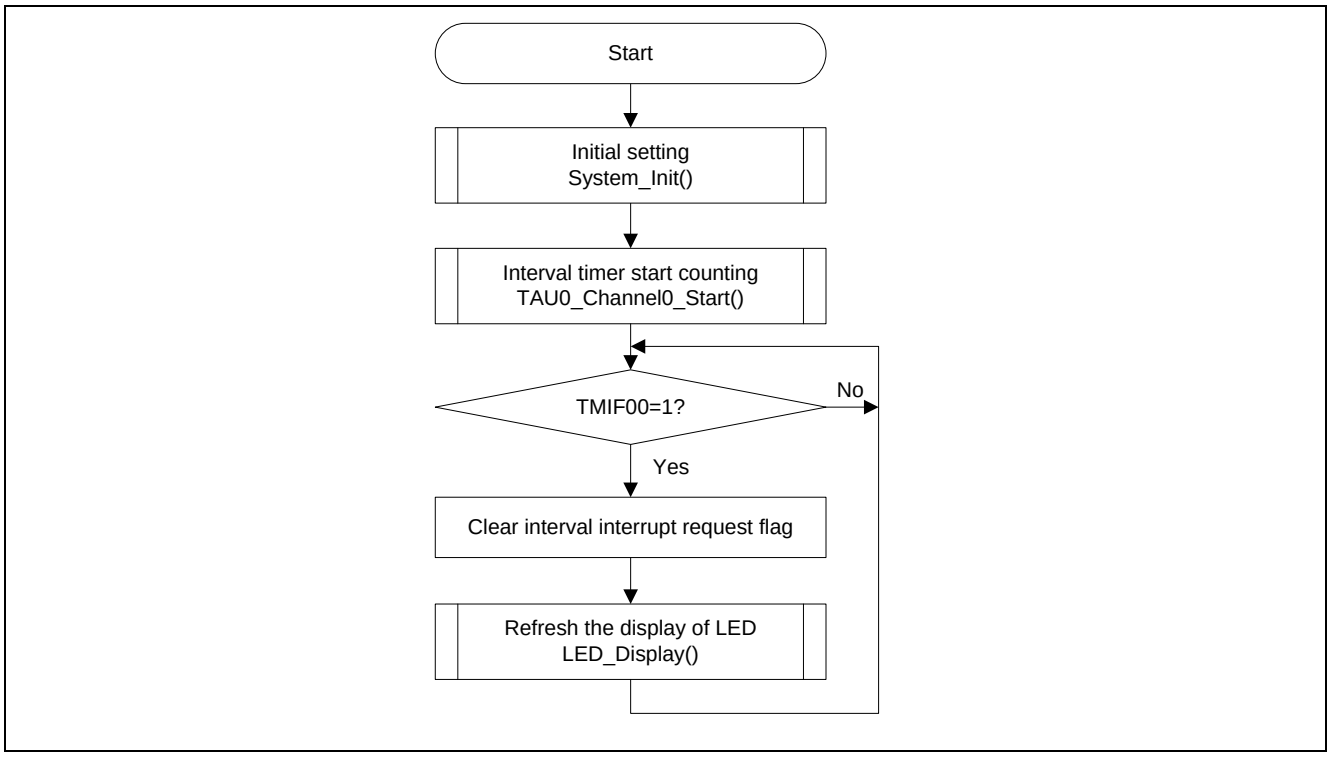

Figure 5.6 Main Processing

5.8.6 Start the Operation of Timer Array Unit 0

Figure 5.7 shows the flowchart for starting the operation of Timer Array Unit 0.

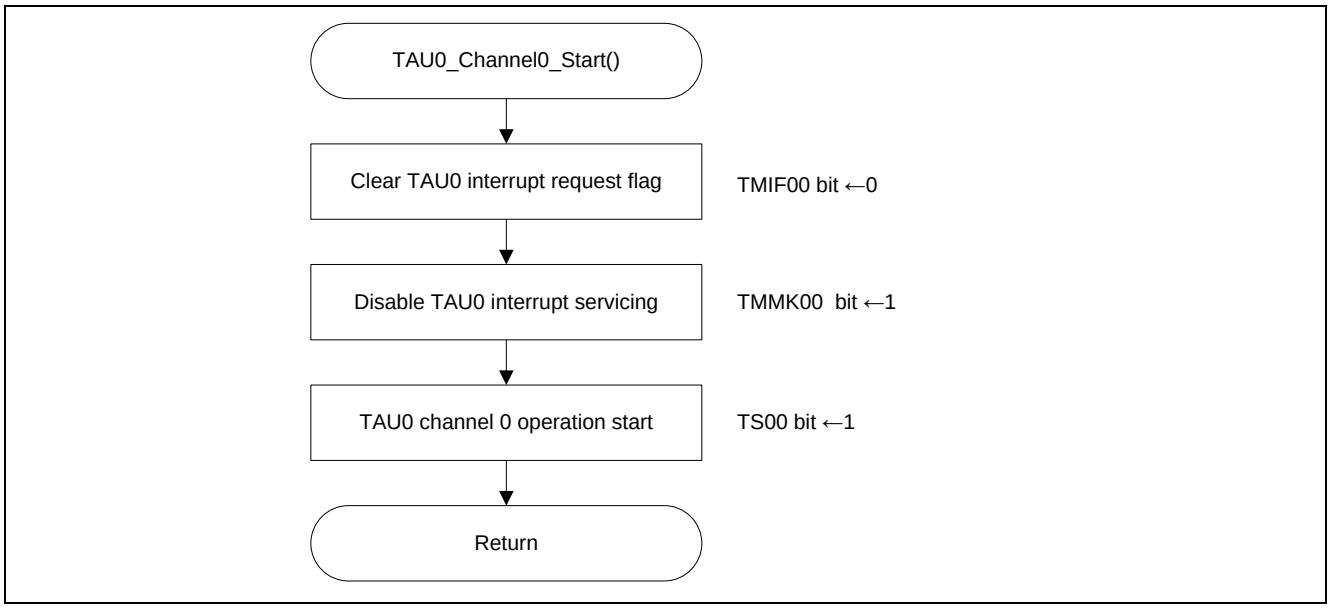

Figure 5.7 Start the Operation of Timer Array Unit 0

Setting up interrupt

- Interrupt request flag register (IF0L)
  Clear interrupt request flag.
- Interrupt mask flag register (MK0L)
  Disable or enable interrupt servicing.

Symbol: IF0L

7	6	5	4	3	2	1	0
TMIF00	TMIF01H	SREIF0	SRIF0	STIF0 CSIIF00	PIF1	PIF0	WDTIIF
0	x	x		x	x	x	x

Bit 7

TMIF00	Interrupt request flag
0	**No interrupt request signal is generated**
1	Interrupt request is generated, interrupt request status

Symbol: MK0L

7	6	5	4	3	2	1	0
TMMK00	TMMK01H	SREMK0	SRMK0	STMK0 CSIMK00	PMK1	PMK0	WDTIMK
1	x	x		x	x	x	x

Bit 7

TMMK00	Interrupt servicing control
0	Interrupt servicing enabled
1	**Interrupt servicing disabled**

Refer to the R7F0C806-809 user's manual (hardware) for details on individual registers.
Initial values of individual bits
x: Bits not used in this application; blank spaces: bits that do not change; -: reserved bits or bits that have nothing assigned.

Timer channel start

- Timer channel start register 0 (TS0)
  Operation starts.

Symbol: TS0

7	6	5	4	3	2	1	0
0	0	0	0	TS03	TS02	TS01	TS00
-	-	-	-	x	x	x	**1**

Bit 1

TS00	Operation enable (start) trigger of channel 0
0	No trigger operation
1	**The TE00 bit is set to 1 and the count operation becomes enabled.**

Refer to the R7F0C806-809 user's manual (hardware) for details on individual registers.
Initial values of individual bits
x: Bits not used in this application; blank spaces: bits that do not change; -: reserved bits or bits that have nothing assigned.

5.8.7 UART0 Interrupt Processing Function

Figure 5.8 shows the flowchart for UART0 interrupt processing function.

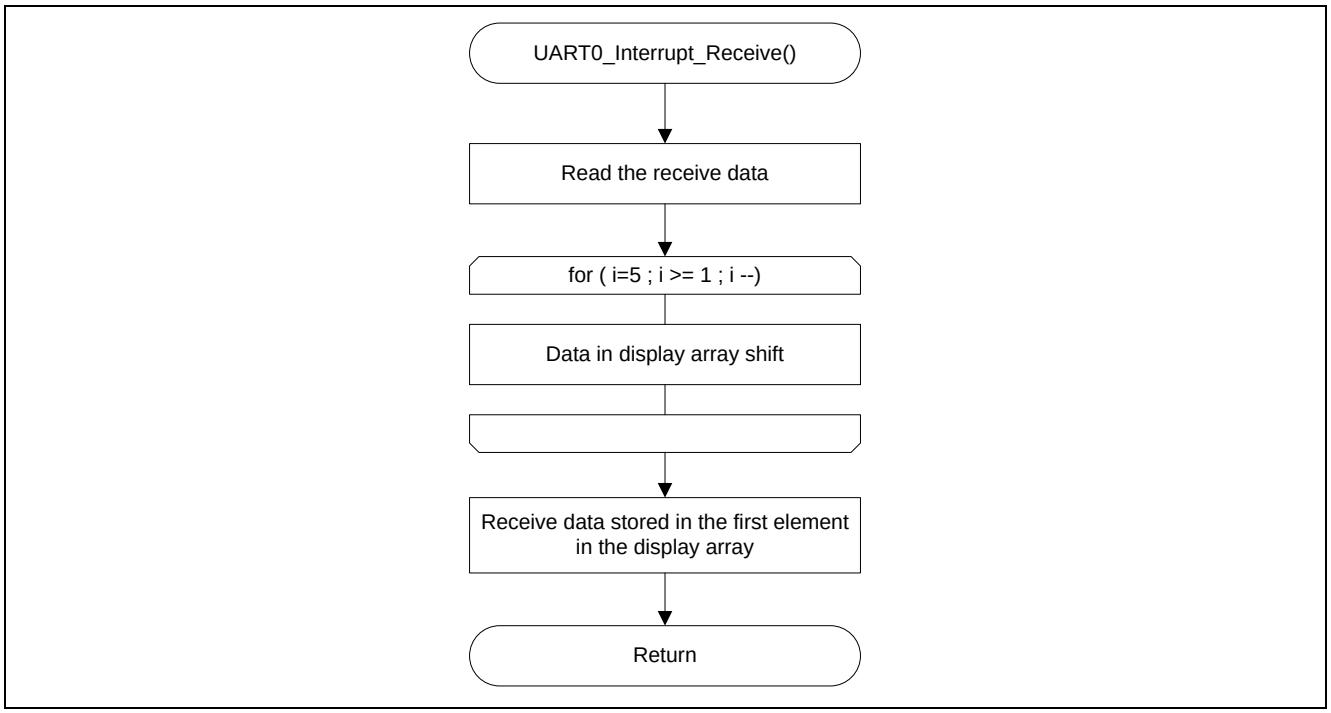

Figure 5.8 UART0 Interrupt Processing Function

5.8.8 LED Display Function

Figure 5.9 shows the flowchart for LED display function.

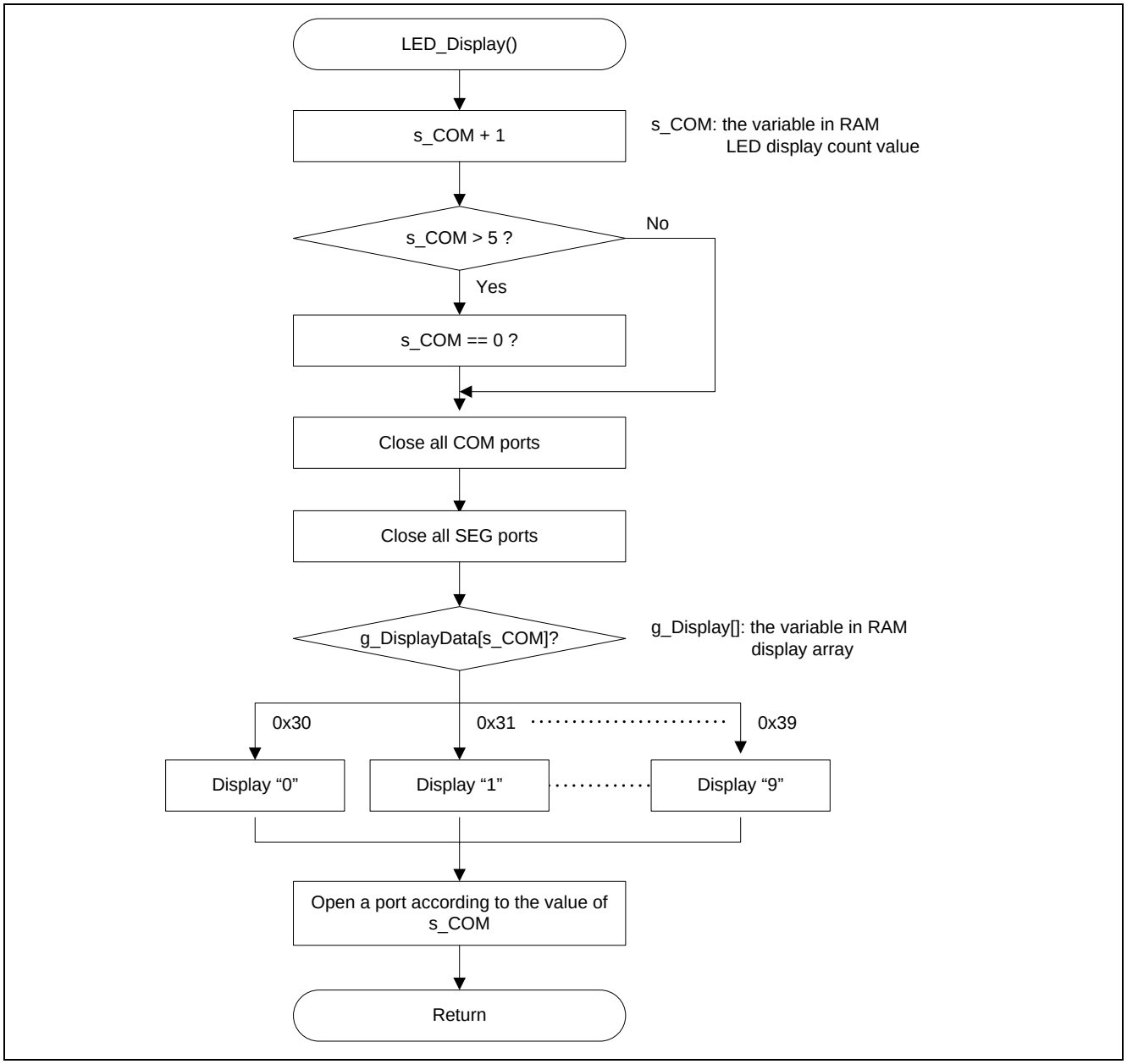

Figure 5.9 LED Display Function

6. Sample Code

The sample code is available on the Renesas Electronics Website.

7. Reference Documents

User's Manual

R7F0C806-809 User's Manual: Hardware (R01UH0481E)

RL78 Family User's Manual: Software (R01US0015E)

The latest versions of the documents are available on the Renesas Electronics Website.

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Revision History

		Description	
Rev.	**Date**	**Page**	**Summary**
1.00	Sep.30.2014	36	First edition issued

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 document, refer to the relevant sections of the document as well as any technical updates that have been issued for the products.

1. 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 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 a product with a different part number, confirm that the change will not lead to problems.

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