RL78/G10

Trash Can with Automatic Operating Lid CC-RL

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Introduction

This application note describes how the trash can with automatic operating lid is implemented by using the infrared LED, infrared receiver, and a motor.

This application uses the RL78/G10 timer array unit, 12-bit interval timer, and external interrupts.

Target Device

RL78/G10

When applying the sample program covered in this application note to another microcomputer, modify the program according to the specifications for the target microcomputer and conduct an extensive evaluation of the modified program.

Contents

1. Specifications

This application uses the RL78/G10 timer array unit, 12-bit interval timer, and external interrupts. The system initially controls the motor to close the lid; turns on the LED (CLOSE) for one second; and executes standby mode. After that, the system branches either to standby mode, manual mode, or automatic mode depending on the operation state.

- Standby mode

In this mode, the system performs the infrared detection process every 200 ms. If the system has detected infrared light, the system branches to automatic mode. If the system has detected no infrared light, the system turns on the LED (CLOSE) every four seconds for 5 ms.

When the switch (OPEN) is pressed, the system controls the motor to open the lid; turns on the LED (OPEN) for one second; and shifts to manual mode.

- Manual mode

In this mode, the system turns on the LED (OPEN) every four seconds for 5 ms.

When the switch (CLOSE) is pressed, the system controls the motor to close the lid; turns on the LED (CLOSE) for one second; and shifts to standby mode.

- Automatic mode

In this mode, the system initially controls the motor to open the lid, and turns on the LED (OPEN). The system then performs the infrared detection process every 200 ms. If the system has detected no infrared light for five seconds, the system controls the motor to close the lid; turns off the LED (OPEN); and shifts to standby mode.

When the switch (OPEN) is pressed, the system turns off the LED (OPEN) and shifts to manual mode. When the switch (CLOSE) is pressed, the system controls the motor to close the lid; turns on the LED (CLOSE) for one second; and shifts to standby mode

For motor control, the port outputs and timer array units are used to provide PWM output. Similarly, in the infrared detection process, the timer array units are used to output 25.6-us rectangular waves to the infrared LED.

Table 1.1 shows the required peripheral functions and their uses. Figure 1.1 shows the outline of the operations.

Table 1.1 Peripheral Functions and Applications

Peripheral Function	Application
Timer array unit channel 0	Used for PWM output of motor control signal 2.
Timer array unit channel 1	Used for PWM output of motor control signal 2.
Timer array unit channel 2	Counts the output period for the infrared LED and others.
Timer array unit channel 3	Counts the output width of rectangular wave for the infrared LED.
12-bit interval timer	Counts 200 ms.
P137/INTP0	Switch input to close the lid
P41/INTP2	Switch input to open the lid
P00	Output port for LED (CLOSE) display
P01	Output port for LED (OPEN) display
P02	Turns on/off the infrared receiver.
P03	Inputs the signal from the infrared receiver.
P04/TO01	Outputs motor control signal 2.
P05	Outputs motor control signal 1.
P07/TO03	Outputs the signal to the infrared LED.

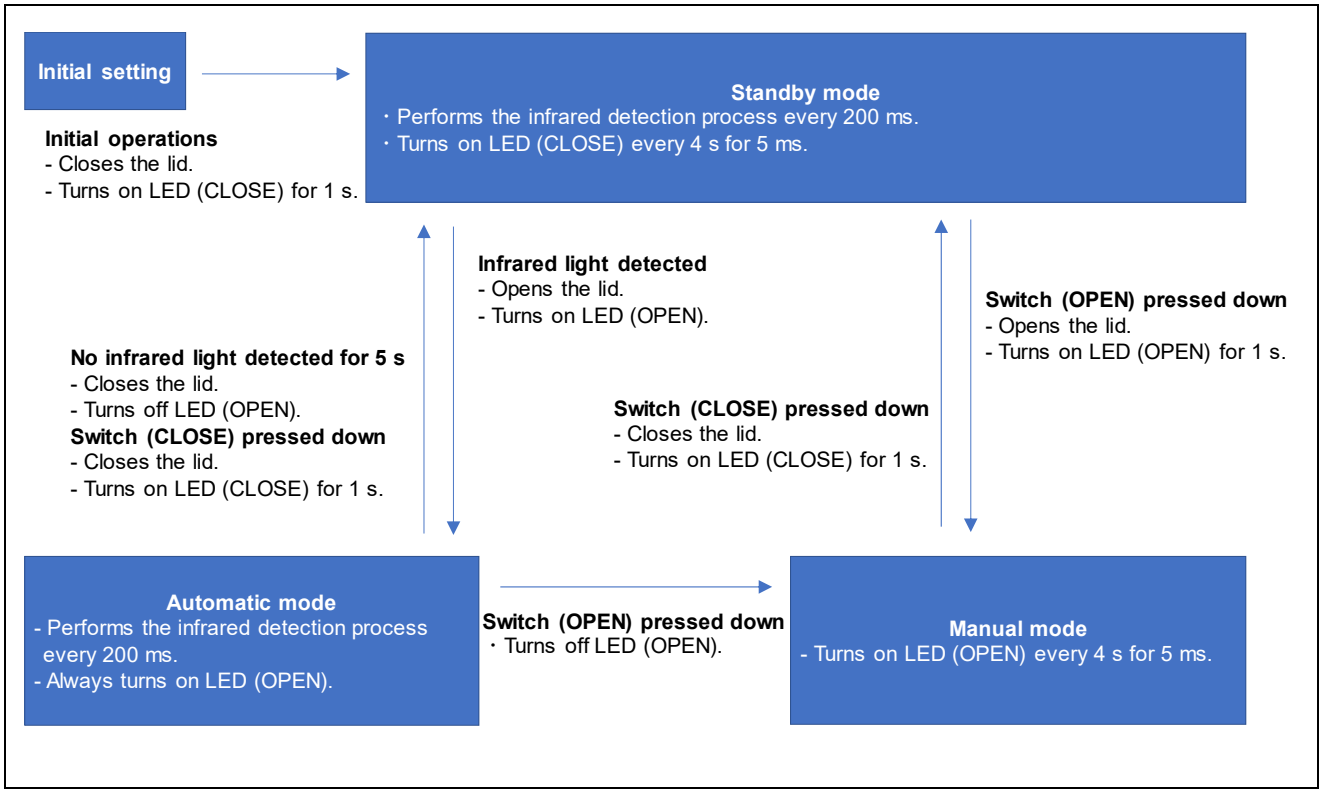

Figure 1.1 Overview of the Operation

1.1.1 Infrared Detection

With the application described in this note, the rectangular wave output function of the timer array unit is used to output the approximately 38-kHz rectangular wave to suit to the 38-kHz center frequency of the infrared receiver.

When the infrared receiver receives 38-kHz infrared light, it sets the output signal to the low level. This signal is input to P03 and is used to determine whether infrared light has been detected.

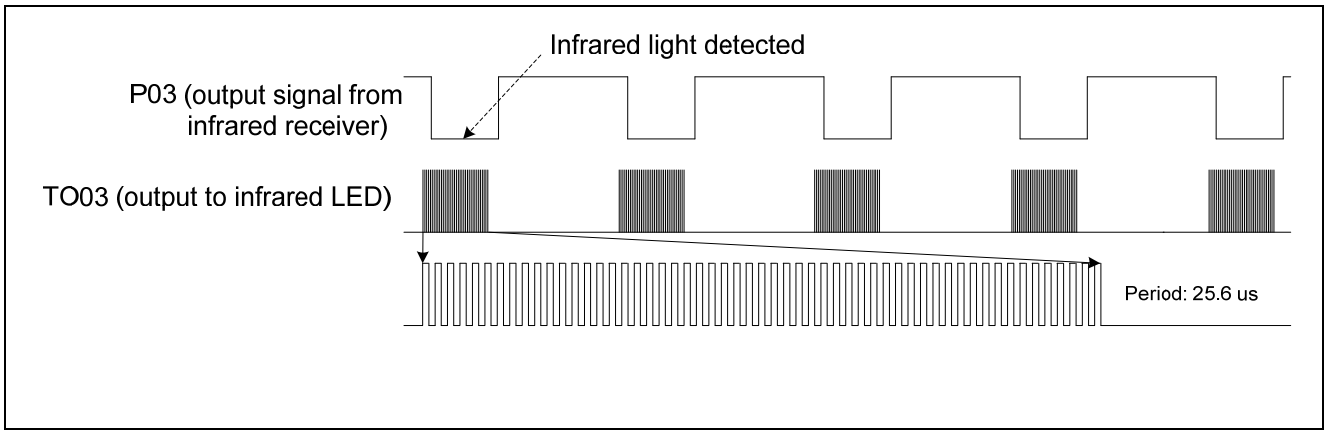

Figure 1.2 Infrared Detection

1.1.2 Motor Control

Figure 1.3 shows the motor control signal for closing the lid, and figure 1.4 shows the motor control signal for opening the lid. The motor control signals in the figure are assumed to be output to the motor driver that involves the operations listed in table 1.2. Motor control signal 1 is output from the port, and motor control signal 2 is output by using the PWM output function of the timer array unit. The duty cycle of the PWM output of motor control signal 2 is changed by changing the setting values of TDR01H and TDR01L registers after generation of the interrupt request of the timer array unit that is currently performing the motor control process.

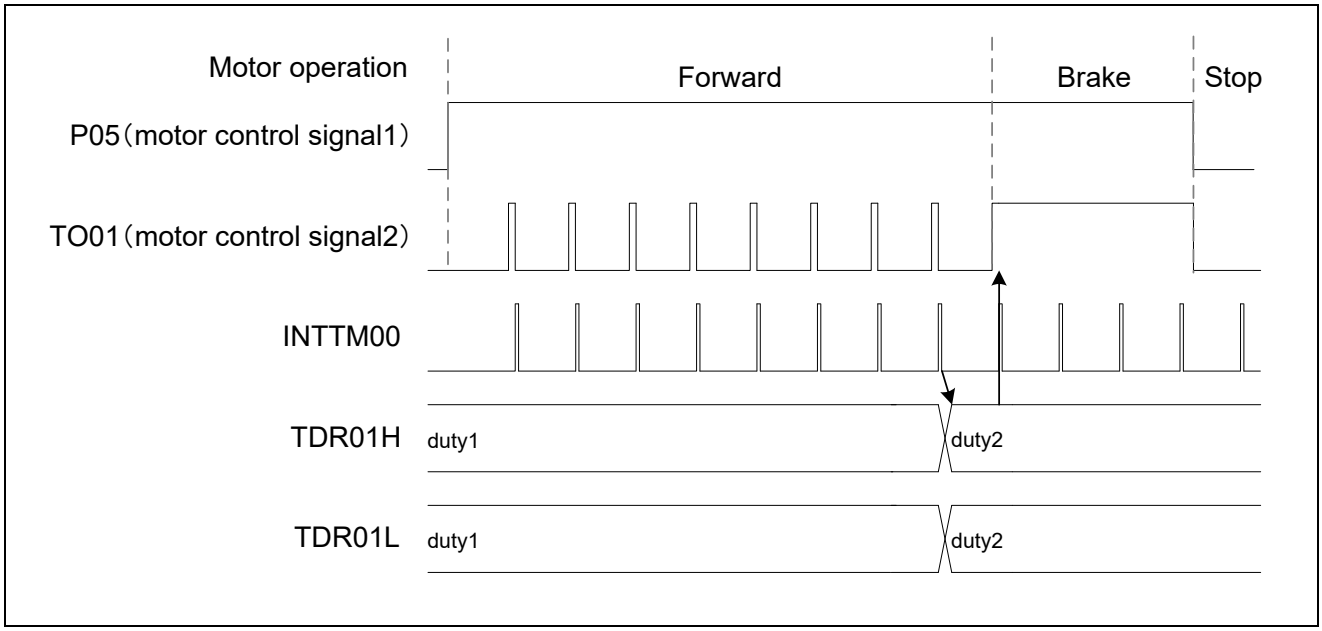

Figure 1.3 Motor Control to Close the Lid

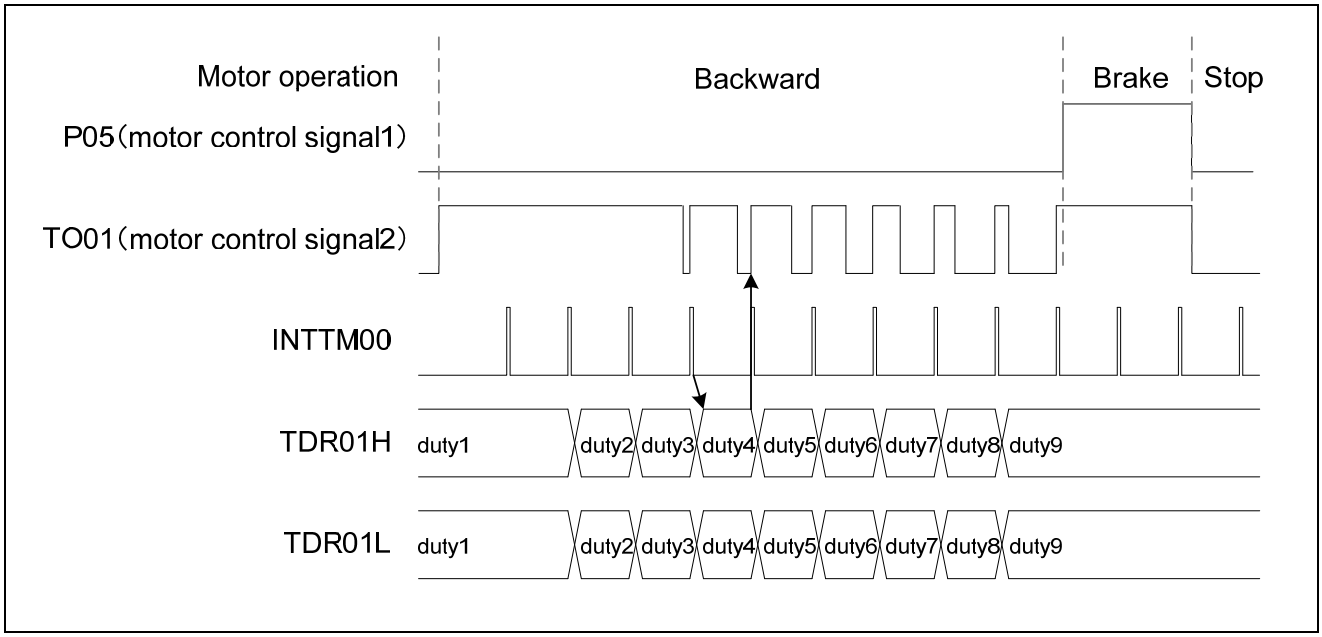

Figure 1.4 Motor Control to Open the Lid

Table 1.2 Operation of motor driver

Operation	IN1	IN2	OUT1	OUT2
Stop	0	0	Hi-Z	Hi-Z
Forward	1	0	1	0
Backward	0	1	0	1
Brake	1	1	0	0

2. Operation Confirmation Conditions

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

Table 2.1 Operation Confirmation Conditions

Item	Contents
MCU used	RL78/G10 (R5F10Y47Y)
Operating frequencies	● High-speed on-chip oscillator clock：1.25MHz ● CPU/peripheral hardware clock： 1.25MHz
Operating voltage	3.6V（operating range 2.2V to 5.5V） SPOR detection voltage: Falling edge: 2.11V Rising edge: 2.16V
Integrated development environment (CS+)	CS+ for CC V6.00.00 from Renesas Electronics Corp.
C compiler (CS+)	CC-RL V1.05.00 from Renesas Electronics Corp.
Integrated development environment (e^2 studio)	e^2 studio V5.4.0.018 from Renesas Electronics Corp.
C compiler (e^2 studio)	CC-RL V1.05.00 from Renesas Electronics Corp.

3. Related Application Notes

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

RL78/G10 Initialization CC-RL (R01AN2668J) Application Note
RL78/G10 Timer Array Unit (Interval Timer) CC-RL (R01AN3839J) Application Note
RL78/G10 Timer Array Unit (PWM Output) CC-RL (R01AN2667J) Application Note

4. Hardware Explanation

4.1 Hardware Configuration Example

Figure 4.1 shows an example of the hardware configuration used in this application note.

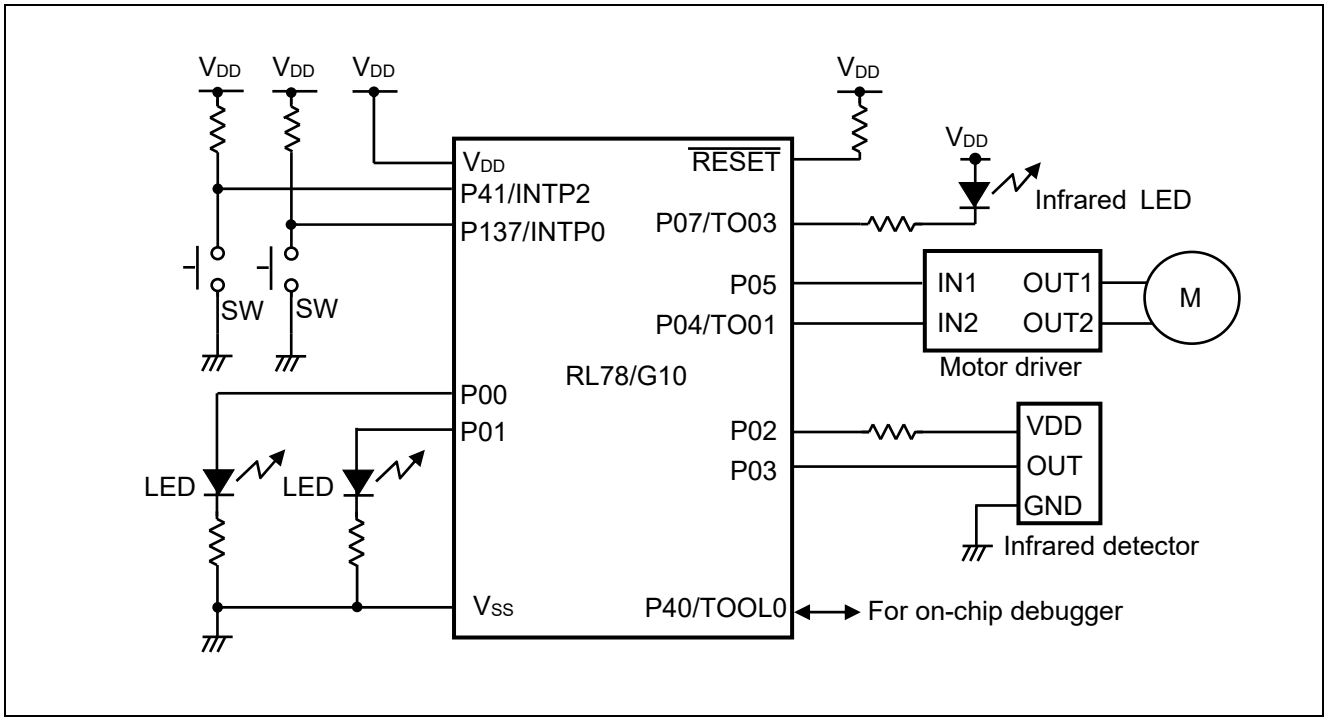

Figure 4.1 Hardware Configuration

Cautions: 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-only ports separately to V_{DD} or V_{SS} via a resistor).

2. V_{DD} must supply not lower than the reset release voltage (V_{SPOR}) that is specified as SPOR.

4.2 Used Pin List

Table 4.1 provides List of Pins and Functions.

Table 4.1 List of Pins and Functions

Pin/ Name	Input/Output	Function
P00	Output	Controls LED (CLOSE).
P01	Output	Controls LED (OPEN).
P02	Output	Turns on/off the infrared receiver.
P03	Input	Inputs the signal from the infrared receiver.
P04/TO01	Output	Motor control signal 2
P05	Output	Motor control signal 1
P07	Output	Controls the infrared LED.
P41/INTP2	Input	Switch input (to close the lid).
P137/INTP0	Input	Switch input (to open the lid).

5. Software Explanation

5.1 Operation Outline

With this application, after making the initial settings (timer array unit, 12-bit interval timer, and external interrupts), the system initially controls the motor to close the lid; turns on the LED (CLOSE) for one second; and shifts to STOP mode.

The system returns from STOP mode by an external interrupt or a 12-bit interval timer interrupt, which is generated every 200 ms.

After returning from STOP mode, the system executes standby mode. After that, the system branches either to standby mode, manual mode, or automatic mode depending on the operation state.

- Standby mode (operation status: STANDBY)

  After returning from STOP mode, the system performs the infrared detection process. If the system has detected infrared light, the system sets the operation status to AUTOMATIC. If the system has detected no infrared light and the 200-ms counter value is 20 (four seconds have passed), the system turns on the LED (CLOSE) for 5 ms and clears the 200-ms counter.

- Manual mode (operation status: MANUAL)

  After returning from STOP mode, the system turns on the LED (OPEN) for 5 ms and clears the 200-ms counter.

- Automatic mode (operation status: AUTOMATIC)

  After returning from STOP mode, the system performs the infrared detection process. If the system has detected infrared light, the system clears the 200-ms counter. If the system has detected no infrared light and the 200-ms counter value is 25 (five seconds have passed), the system closes the lid; turns off the LED (OPEN); clears the 200-ms counter; and sets the operation status to STANDBY.

  After shifting from standby mode, the system turns on the LED (OPEN) and opens the lid.

If the switch (OPEN) is pressed while the lid is closed, the system turns on the LED (OPEN); opens the lid; turns off the LED (OPEN); and sets the operation status to MANUAL.

If the switch (OPEN) is pressed while the lid is open, the system turns off the LED (OPEN) and sets the operation status to MANUAL.

If the switch (CLOSE) is pressed, the system turns on the LED (CLOSE); closes the lid, turns off the LED (CLOSE); and sets the operation status to STANDBY. After that, the system waits for 600 ms to prevent erroneous infrared detection.

1. Makes the initial settings for the timer array unit.

<Conditions for setting channel 0>

- Sets the timer operation mode to PWM output (master) mode.
- Sets timer data register 00 (TDR00) to 20 ms as the initial value.
- Sets the timer output enable register to disable operation.
- Uses the timer channel 0 timer interrupt (INTTM00).

<Conditions for setting channel 1>

- Sets the timer operation mode to PWM output (slave) mode.
- Sets timer data register 01 (TDR01) to 18 ms as the initial value.
- Sets the timer output enable register to enable operation.
- Does not use the timer channel 1 timer interrupt (INTTM01).

<Conditions for setting channel 2>

- Sets the timer operation mode to interval timer mode.
- Sets timer data register 02 (TDR02) to 10 ms as the initial value.
- Sets the timer output enable register to disable operation.
- Uses the timer channel 2 timer interrupt (INTTM02).

<Conditions for setting channel 3>

- Sets the timer operation mode to interval timer mode.
- Sets timer data register 03 (TDR03) to 25.6 us as the initial value.
- Sets the timer output enable register to enable operation.
- Does not use the timer channel 3 timer interrupt (INTTM03).

2. Makes the initial settings for the external interrupts.

<Conditions for setting the external interrupts>

- Uses the P137/INTP0 pin.
- Sets the falling edge as the valid edge for the INTP0 pin.
- Uses the P41/INTP2 pin.
- Sets the falling edge as the valid edge for the INTP2 pin.

3. Makes the initial settings for the external interrupts of the 12-bit interval timer.

<Conditions for setting the 12-bit interval timer>

- Sets 0BB7H as the compare value so that a compare-match interrupt request is generated approximately every 200 ms.

4. Turns on the LED (CLOSE) after making the initial settings.
5. Controls the motor to close the lid.
6. Turns off the LED (CLOSE).

7. Starts the 12-bit interval timer operation.
8. Enables the external interrupts.
9. Enables the maskable interrupts.
10. Shifts to STOP mode.
11. Returns from STOP mode upon generation of the 12-bit interval timer interrupt after 200 ms or upon generation of the external interrupt. In the 12-bit interval timer interrupt process, increments the 200-ms counter.
12. Disables the maskable interrupts.
13. Disables the external interrupts.
14. Operates as described below according to the operation state.

<Standby mode (operation status: STANDBY)>

A) Performs the infrared detection process.

B) If having detected infrared light, sets the operation status to AUTOMATIC.

C) If having detected no infrared light and the 200-ms counter value is 20 (approximately four seconds have passed), turns on the LED (CLOSE) for 5 ms and clears the 200-ms counter.

<Manual mode (operation status: MANUAL)>

A) If the 200-ms counter value is 20 (approximately four seconds have passed), turns on the LED (OPEN) for 5 ms and clears the 200-ms counter.

<Automatic mode (operation status: AUTOMATIC)>

A) Initially turns on the LED (OPEN), controls the motor to open the lid, and clears the 200-ms counter.

B) Performs the infrared detection process.

C) If having detected infrared light, clears the 200-ms counter.

D) If having detected no infrared light and the 200-ms counter value is 25 (approximately five seconds have passed), controls the motor to close the lid; turns off the LED (OPEN); and clears the 200-ms counter.

The motor control process is described below.

1. Sets motor control signal 1. While the lid is closed, sets motor control signal 1 to the low level; and sets motor control signal 2 to the high level while the lid is open.
2. Sets the width and duty cycle of the PWM output of timer array unit channels 0 and 1.
3. Disables the 12-bit interval timer interrupt.
4. Starts the PWM output operation of timer array unit channels 0 and 1.
5. Shifts to HALT mode.
6. Returns from HALT mode by an interrupt request of timer array unit channel 0.
7. Increments the count and changes the duty cycle of the PWM output according to the count.
8. Repeats steps 5 to 7 until the count reaches 20 while the lid is closed, and until 51 while the lid is open.
9. Stops the PWM output of timer array unit channels 0 and 1.
10. Sets motor control signals 1 and 2 to the low level.

The infrared detection process is described below.

1. Sets P02 to the high level and starts power supply to the infrared receiver.
2. Starts the operation of timer array unit channel 2.
3. Shifts to HALT mode.
4. Returns from HALT mode after 5 ms by an interrupt request of timer array unit channel 2.
5. Stops the operation of timer array unit channel 2.
6. Checks the P03 input level. When low, determines that infrared light has been erroneously detected and terminates the infrared detection process.
7. Sets the interval time of timer array unit channel 2 to 620 us.
8. Starts the operation of timer array unit channels 2 and 3.
9. Shifts to HALT mode.
10. Returns from HALT mode after 620 us by an interrupt request of timer array unit channel 2.
11. Checks the P03 input level. When low, determines that infrared light has been detected.
12. When the P03 input level is low, repeats steps 8 to 10 five times, determining that infrared light has been detected. When high, terminates the infrared detection process.
13. Stops the operation of timer array unit channels 2 and 3.
14. Sets the interval time of timer array unit channel 2 to 5 ms.
15. If having detected infrared light, repeats steps 8 to 12 five times. If having detected no infrared light, terminates the process.
16. Sets P02 to the low level and stops power supply to the infrared receiver.

The operation when the switch (OPEN) is pressed is described below.

1. An external interrupt occurs.
2. Disables the external interrupts.
3. Executes either of the following operations depending on whether the lid is open or closed.

<When lid is open>

A) Turns on the LED (OPEN).
B) Controls the motor to open the lid.
C) Turns off the LED (OPEN).
D) Changes the operation status to MANUAL.
E) Clears the 200-ms counter.
F) Enables the 12-bit interval timer interrupt.
G) Shifts to HALT mode.
H) Returns from HALT mode upon generation of an interrupt request of the 12-bit interval timer.

<When lid is closed>

A) Turns off the LED.
B) Changes the operation status to MANUAL.

4. Clears the external interrupt request.

The operation when the switch (CLOSE) is pressed is described below.

1. An external interrupt occurs.
2. Disables the external interrupts.
3. Turns on the LED (CLOSE).
4. Controls the motor to close the lid.
5. Turns off the LED (CLOSE).
6. Changes the operation status to STANDBY.
7. Enables the 12-bit interval timer interrupt.
8. Shifts to HALT mode.
9. Returns from HALT mode upon generation of an interrupt request of the 12-bit interval timer.
10. Performs steps 7 and 8 three times.
11. Sets the 200-ms counter to 2.
12. Clears the external interrupt request flag.

5.2 Option Byte Settings

Table 5.1 lists the option byte settings.

Table 5.1 Option Byte Settings

Address	Setting Value	Contents
000C0H/010C0H	11101111B	Watchdog timer operation is stopped (count is stopped after reset)
000C1H/010C1H	11111111B	SPOR detection voltage When reset occurs: VDD < 2.11 V When reset is released: VDD ≥ 2.16 V
000C2H/010C2H	11111101B	HS mode, High-speed on-chip oscillator clock: 1.25MHz
000C3H/010C3H	10000101B	On-chip debugging enabled

5.3 Constants

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

Table 5.2 Constants for the Sample program

Constant Name	Setting Value	Contents
LED_OPEN_ON	02H	P0 register setting value (to turn on LED (OPEN))
LED_CLOSE_ON	01H	P0 register setting value (to turn on LED (CLOSE))
LED_OFF	FCH	P0 register setting value (to turn off LED)
IR_RECEIVER_ON	04H	P0 register setting value (to start power supply to the infrared receiver)
IR_RECEIVER_OFF	FBH	P0 register setting value (to stop power supply to the infrared receiver)
MOTOR_SIGNAL1_LOW	DFH	P0 register setting value (to output low-level motor control signal 1)
MOTOR_SIGNAL1_HIGH	20H	P0 register setting value (to output high-level motor control signal 1)
MOTOR_STOP	CFH	P0 register setting value (to output low-level motor control signals 1 and 2)
STANDBY	0	Operation status setting value (standby mode)
AUTOMATIC	1	Operation status setting value (automatic mode)
MANUAL	2	Operation status setting value (manual mode)
DETECTED	0	Value used for determining infrared detection
START	0	Infrared detection process status
END	1	Infrared detection process status
g_pwm_duty_h[20]	00H, 00H, 00H, 00H, 00H, 00H, 13H, 21H, 32H, 42H, 52H, 61H, 6FH, 7EH, 8EH, 9EH, ADH, 00H, 00H, 00H	TDR01H register setting value Sets PWM output width of motor control signal 2.
g_pwm_duty_l[20]	00H, 00H, 00H, 00H, 00H, 00H, 87H, 33H, C7H, 67H, 07H, A7H, 53H, F3H, 93H, 33H, D3H, 00H, 00H, 00H	TDR01L register setting value Sets PWM output width of motor control signal 2.

5.4 Variables

Table 5.3 lists the variables.

Table 5.3 Variables

Type	Variable Name	Contents	Function Used
uint8_t	g_operation_status	Operation status	main()、r_main_led_light()、r_intc0_interrupt()、r_intc2_interrupt()
uint8_t	g_open_flag	Open/close flag	main()、R_MAIN_UserInit()、r_main_motor_control()、r_intc0_interrupt()、r_intc2_interrupt()
uint8_t	g_ir_flag	Infrared detection flag	main()、r_main_infrared_detection()
uint8_t	g_motor_control_flag	Motor control flag	r_main_motor_control()
uint8_t	g_200ms_counter	Number of occurrences of 12-bit interval timer interrupt	main()、r_it_interrupt()、r_intc0_interrupt()、r_intc2_interrupt()

5.5 Functions

Table 5.4 lists the functions.

Table 5.4 Functions

Function Name	Outline
main	Main processing
R_MAIN_Userinit	Main initial setting
R_INTC0_Start	External interrupt enable function of INTP0
R_INTC2_Start	External interrupt enable function of INTP2
R_IT_Start	12-bit interval timer operation start function
R_TAU0_Channel0_Start	Timer array unit channel0 operation start function
R_TAU0_Channel0_Stop	Timer array unit channel0 operation stop function
R_TAU0_Channel2_Start	Timer array unit channel2 operation start function
R_TAU0_Channel2_Stop	Timer array unit channel2 operation stop function
R_TAU0_Channel3_Start	Timer array unit channel3 operation start function
R_TAU0_Channel3_Stop	Timer array unit channel3 operation stop function
r_it_interrupt	Interval timer signal detection interrupt function
r_intc0_interrupt	External interrupt processing of INTP0
r_intc2_interrupt	External interrupt processing of INTP2
r_main_motor_control	Motor control function
r_main_infrared_detection	Infrared detection processing
r_main_led_light	LED blinking processing

5.6 Function Specifications

This part describes function specifications of the sample code.

[Function name] main

Outline	Main processing
Header	r_cg_macrodriver.h、r_cg_cgc.h、r_cg_port.h、r_cg_tau.h、r_cg_it.h、r_cg_intp.h、r_cg_userdefine.h
Declaration	—
Description	After executing the main user initialization function, this function shifts the system to STOP mode, performs the infrared detection process approximately every 200 ms. If infrared light has been detected, controls the motor to open the lid and turns on/off the LED. If no infrared light has been detected for five seconds, controls the motor to close the lid.
Arguments	None
Return value	None
Remarks	None

[Function name] R_MAIN_UserInit

Outline	Main initial setting
Header	r_cg_macrodriver.h、r_cg_cgc.h、r_cg_port.h、r_cg_tau.h、r_cg_it.h、r_cg_intp.h、r_cg_userdefine.h
Declaration	static void R_MAIN_UserInit(void);
Description	This function enables the interrupts by using the EI instruction. The function then controls the motor to close the lid and turns on/off the LED.
Arguments	None
Return value	None
Remarks	None

[Function name] R_INTC0_Start

Outline	External interrupt enable function of INTP0
Header	r_cg_macrodriver.h、r_cg_intp.h、r_cg_userdefine.h
Declaration	void R_INTC0_Start(void);
Description	This function is used for setting to enable operation of the external interrupt of INTP0.
Arguments	None
Return value	None
Remarks	None

[Function name] R_INTC2_Start

Outline	External interrupt enable function of INTP2
Header	r_cg_macrodriver.h、r_cg_intp.h、r_cg_userdefine.h
Declaration	void R_INTC2_Start(void);
Description	This function is used for setting to enable operation of the external interrupt of INTP2.
Arguments	None
Return value	None
Remarks	None

[Function name] R_IT_Start

Outline	12-bit interval timer operation start function
Header	r_cg_macrodriver.h、r_cg_it.h、r_cg_userdefine.h
Declaration	void R_IT_Start(void);
Description	This function is used for setting to enable activation of the 12-bit interval timer.
Arguments	None
Return value	None
Remarks	None

[Function name] R_TAU0_Channel0_Start

Outline	Timer array unit channel0 operation start function
Header	r_cg_macrodriver.h、r_cg_tau.h、r_cg_userdefine.h
Declaration	void R_TAU0_Channel0_Start(void);
Description	This function is used for setting to enable count operation of channel 0 of the timer array unit.
Arguments	None
Return value	None
Remarks	None

[Function name] R_TAU0_Channel0_Stop

Outline	Timer array unit channel0 operation stop function
Header	r_cg_macrodriver.h、r_cg_tau.h、r_cg_userdefine.h
Declaration	void R_TAU0_Channel0_Stop(void);
Description	This function is used for setting to disable count operation of channel 0 of the timer array unit.
Arguments	None
Return value	None
Remarks	None

[Function name] R_TAU0_Channel2_Start

Outline	Timer array unit channel2 operation start function
Header	r_cg_macrodriver.h、r_cg_tau.h、r_cg_userdefine.h
Declaration	void R_TAU0_Channel2_Start(void);
Description	This function is used for setting to enable count operation of channel 2 of the timer array unit.
Arguments	None
Return value	None
Remarks	None

[Function name] R_TAU0_Channel2_Stop

Outline	Timer array unit channel2 operation stop function
Header	r_cg_macrodriver.h、r_cg_tau.h、r_cg_userdefine.h
Declaration	void R_TAU0_Channel2_Stop(void);
Description	This function is used for setting to disable count operation of channel 2 of the timer array unit.
Arguments	None
Return value	None
Remarks	None

[Function name] R_TAU0_Channel3_Start

Outline	Timer array unit channel3 operation start function
Header	r_cg_macrodriver.h、r_cg_tau.h、r_cg_userdefine.h
Declaration	void R_TAU0_Channel3_Start(void);
Description	This function is used for setting to enable count operation of channel 3 of the timer array unit.
Arguments	None
Return value	None
Remarks	None

[Function name] R_TAU0_Channel3_Stop

Outline	Timer array unit channel3 operation stop function
Header	r_cg_macrodriver.h、r_cg_tau.h、r_cg_userdefine.h
Declaration	void R_TAU0_Channel3_Stop(void);
Description	This function is used for setting to disable count operation of channel 3 of the timer array unit.
Arguments	None
Return value	None
Remarks	None

[Function name] r_it_interrupt

Outline	Interval timer signal detection interrupt dunction
Header	r_cg_macrodriver.h、r_cg_it.h、r_cg_userdefine.h
Declaration	#pragma interrupt r_it_interrupt(vect=INTIT)
Description	This function increments the 200-ms counter variable.
Arguments	None
Return value	None
Remarks	None

[Function name] r_intc0_interrupt

Outline	External interrupt processing of INTP0
Header	r_cg_macrodriver.h、r_cg_intp.h、r_cg_userdefine.h
Declaration	#pragma interrupt r_intc0_interrupt(vect=INTP0)
Description	This function controls the motor to close the lid and turns on/off the LED.
Arguments	None
Return value	None
Remarks	None

[Function name] r_intc2_interrupt

Outline	External interrupt processing of INTP2
Header	r_cg_macrodriver.h、r_cg_intp.h、r_cg_userdefine.h
Declaration	#pragma interrupt r_intc2_interrupt(vect=INTP2)
Description	This function controls the motor to open the lid and turns on/off the LED.
Arguments	None
Return value	None
Remarks	None

[Function name] r_main_motor_control

Outline	Motor control function
Header	r_cg_macrodriver.h、r_cg_cgc.h、r_cg_port.h、r_cg_tau.h、r_cg_it.h、r_cg_intp.h、r_cg_userdefine.h
Declaration	void r_main_motor_control(void);
Description	This function controls the motor to open and close the lid.
Arguments	None
Return value	None
Remarks	None

[Function name] r_main_infrared_detection

Outline	Infrared detection processing
Header	r_cg_macrodriver.h、r_cg_cgc.h、r_cg_port.h、r_cg_tau.h、r_cg_it.h、r_cg_intp.h、r_cg_userdefine.h
Declaration	static void r_main_infrared_detection(void);
Description	This function performs the infrared detection process.
Arguments	None
Return value	None
Remarks	None

[Function name] r_main_led_light

Outline	LED blinking processing
Header	r_cg_macrodriver.h、r_cg_cgc.h、r_cg_port.h、r_cg_tau.h、r_cg_it.h、r_cg_intp.h、r_cg_userdefine.h
Declaration	static void r_main_led_light(void);
Description	This function performs the LED blinking process.
Arguments	None
Return value	None
Remarks	None

5.7 Flowcharts

Figure 5.1 shows an overall flow of the sample code.

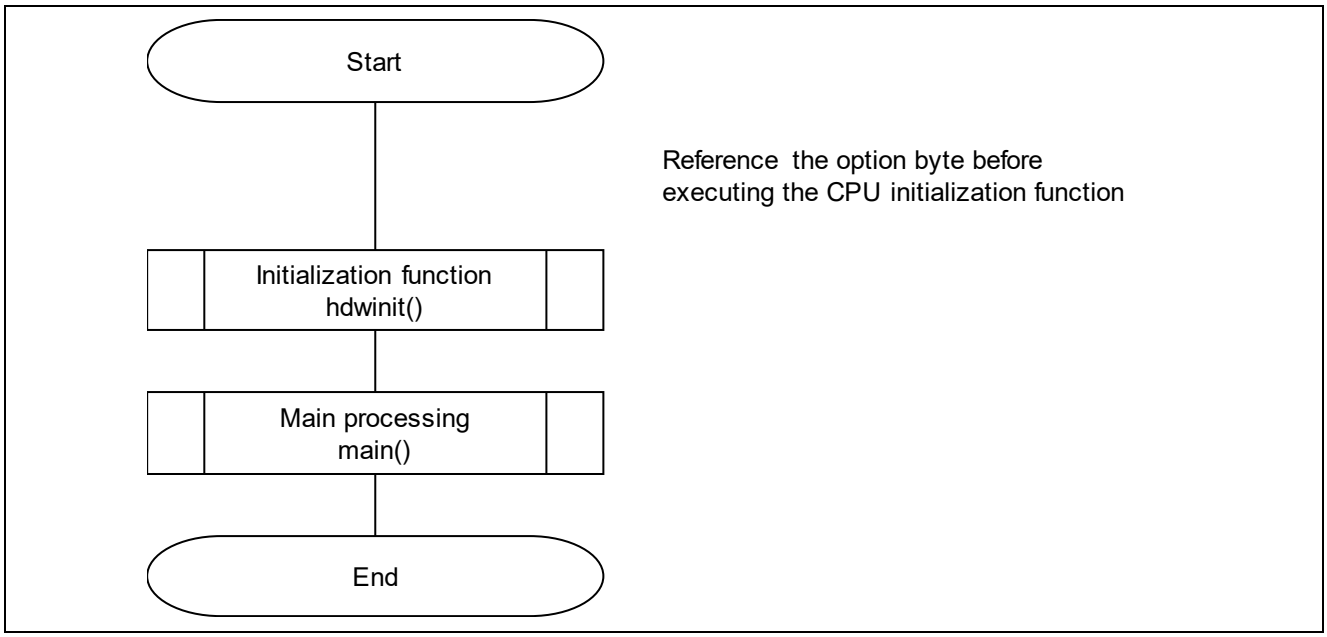

Figure 5.1 Overall Flow

5.7.1 Initialization Function

Figure 5.2 shows the flowchart for the initialization function.

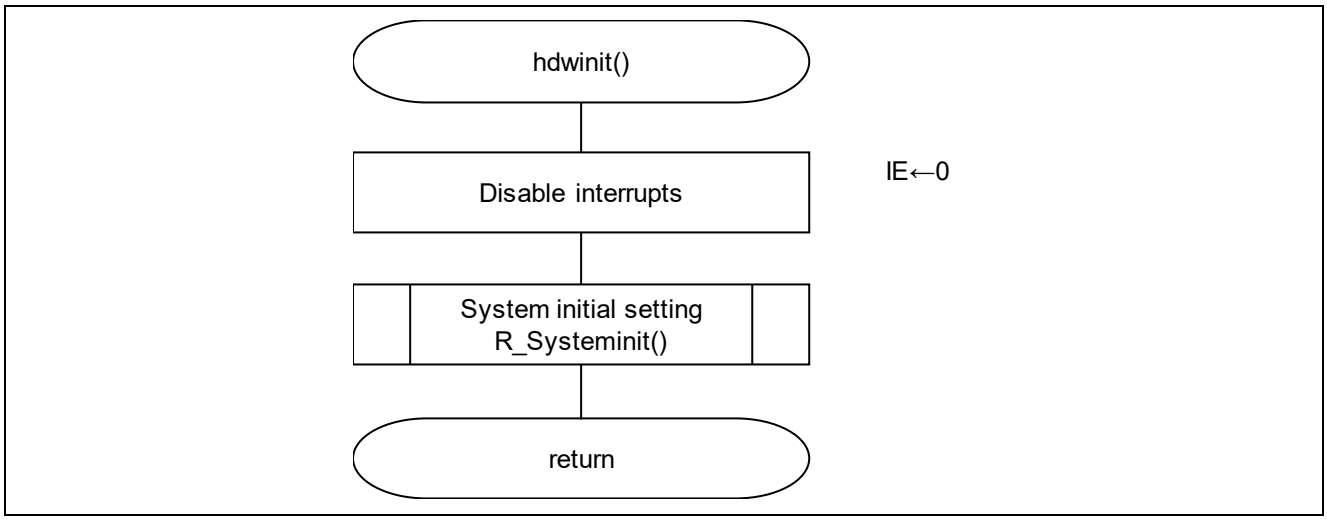

Figure 5.2 Initialization Function

5.7.2 System Initial Setting

Figure 5.3 shows the flowchart for the system initial setting.

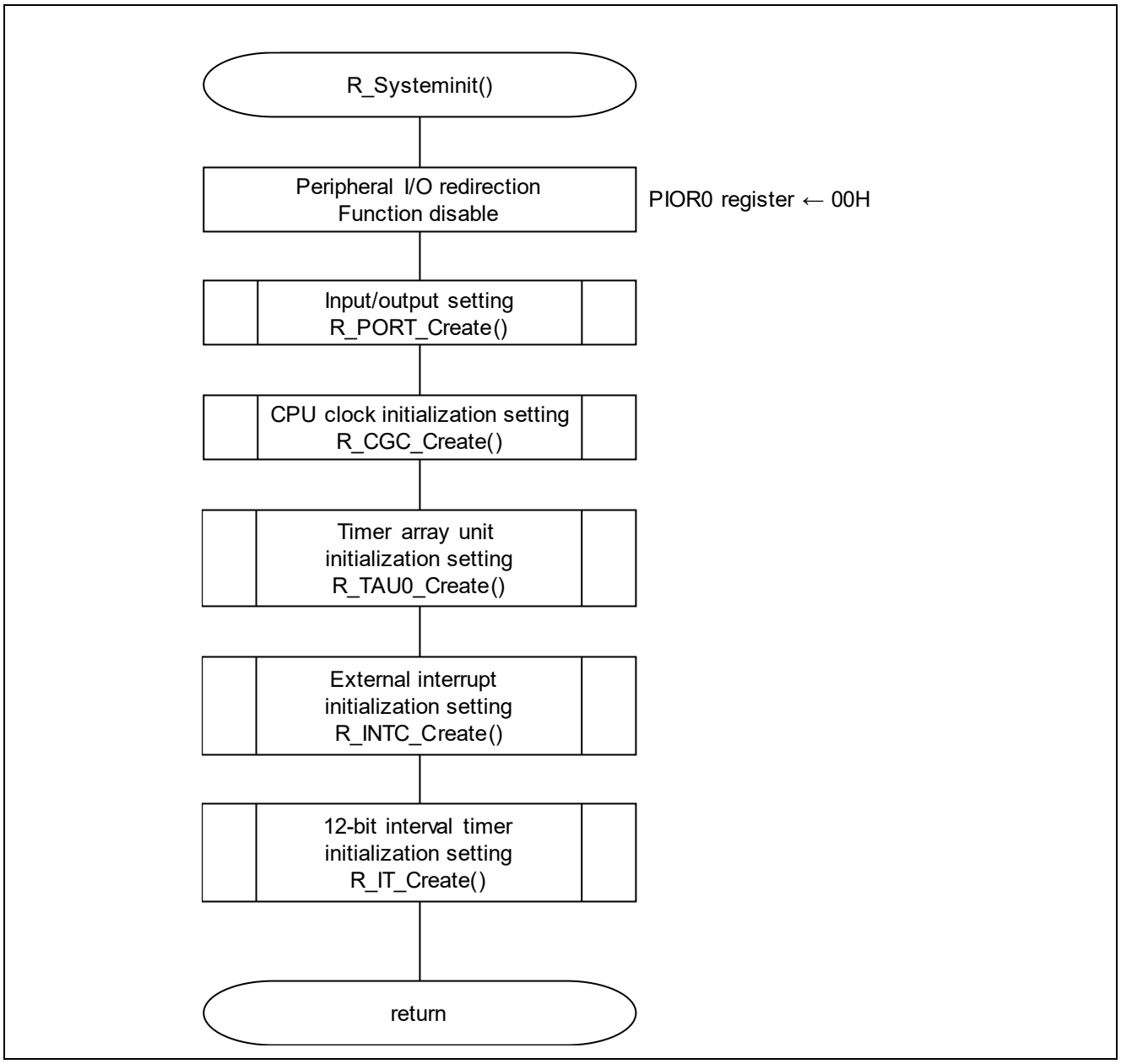

Figure 5.3 System Initial Setting

5.7.3 Ports Initial Setting

Figure 5.4 shows the flowchart for the ports initial setting.

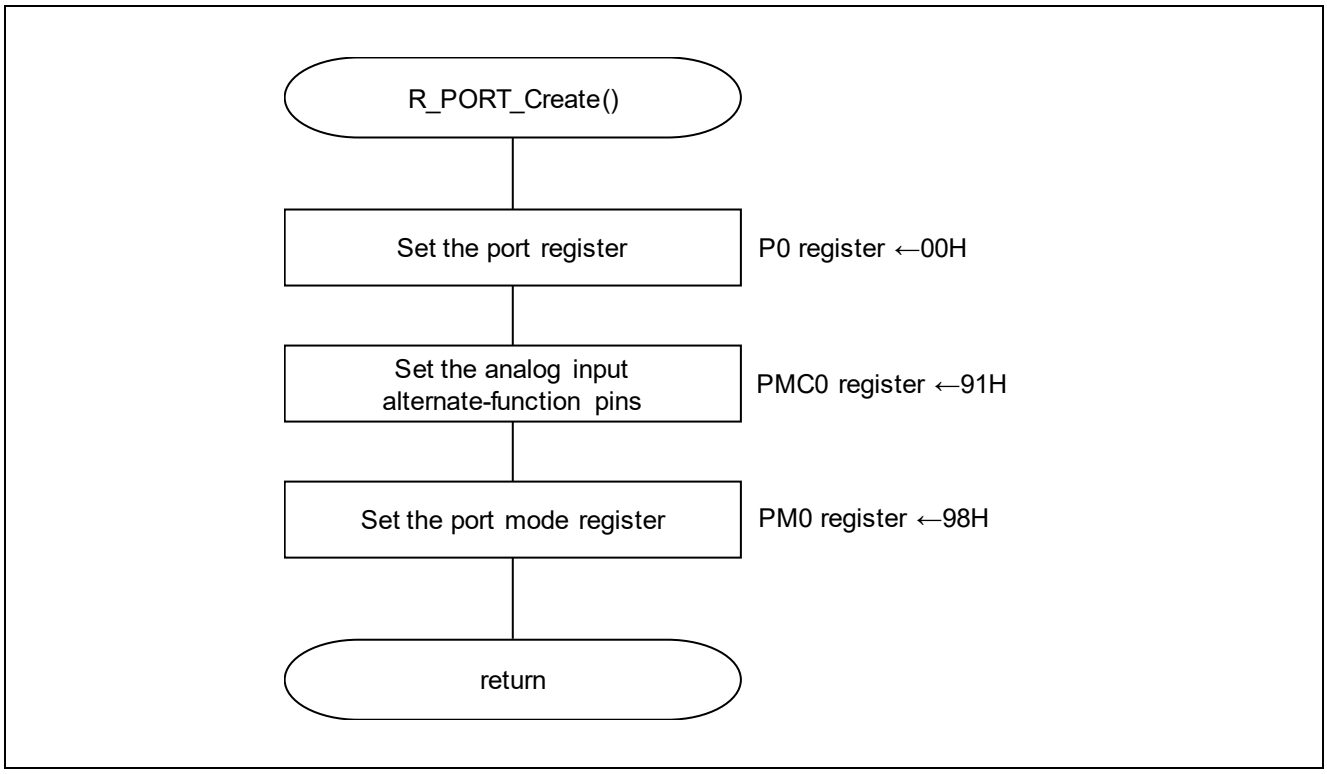

Figure 5.4 Port Initial Setting

Note: Refer to the initialization flowchart in the RL78/G10 Initialization CC-RL (R01AN2668E) Application Note for details on how to set unused ports.

Caution: When designing circuits, always make sure unused ports are properly processed and all electrical characteristics are met. Also make sure each unused input-only port is connected to VDD or VSS through a resister.

5.7.4 CPU Initial Setting

Figure 5.5 shows the flowchart for the CPU initial setting.

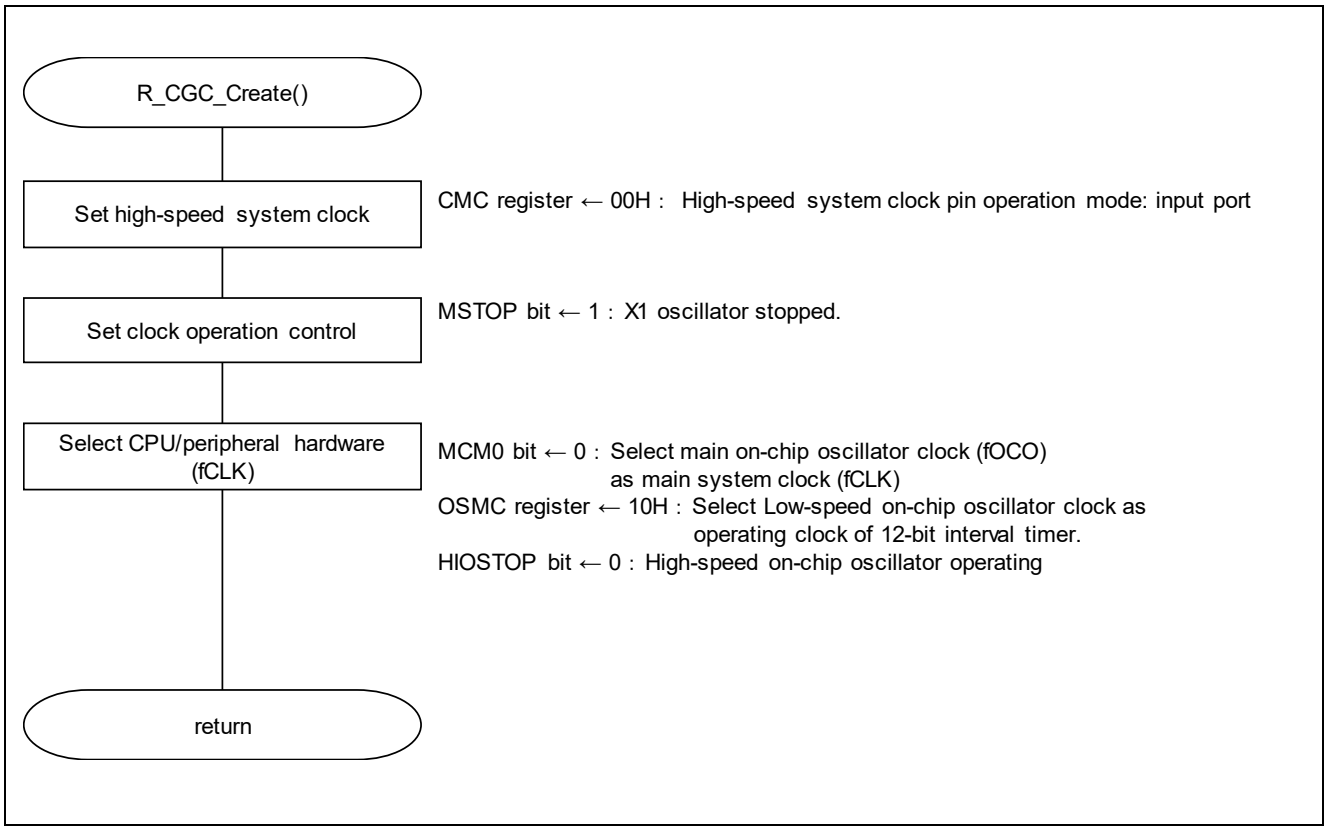

Figure 5.5 CPU Initial Setting

5.7.5 Timer Array Unit Initial Setting

Figure 5.6 and Figure 5.7 shows the flowchart for timer array unit initial setting.

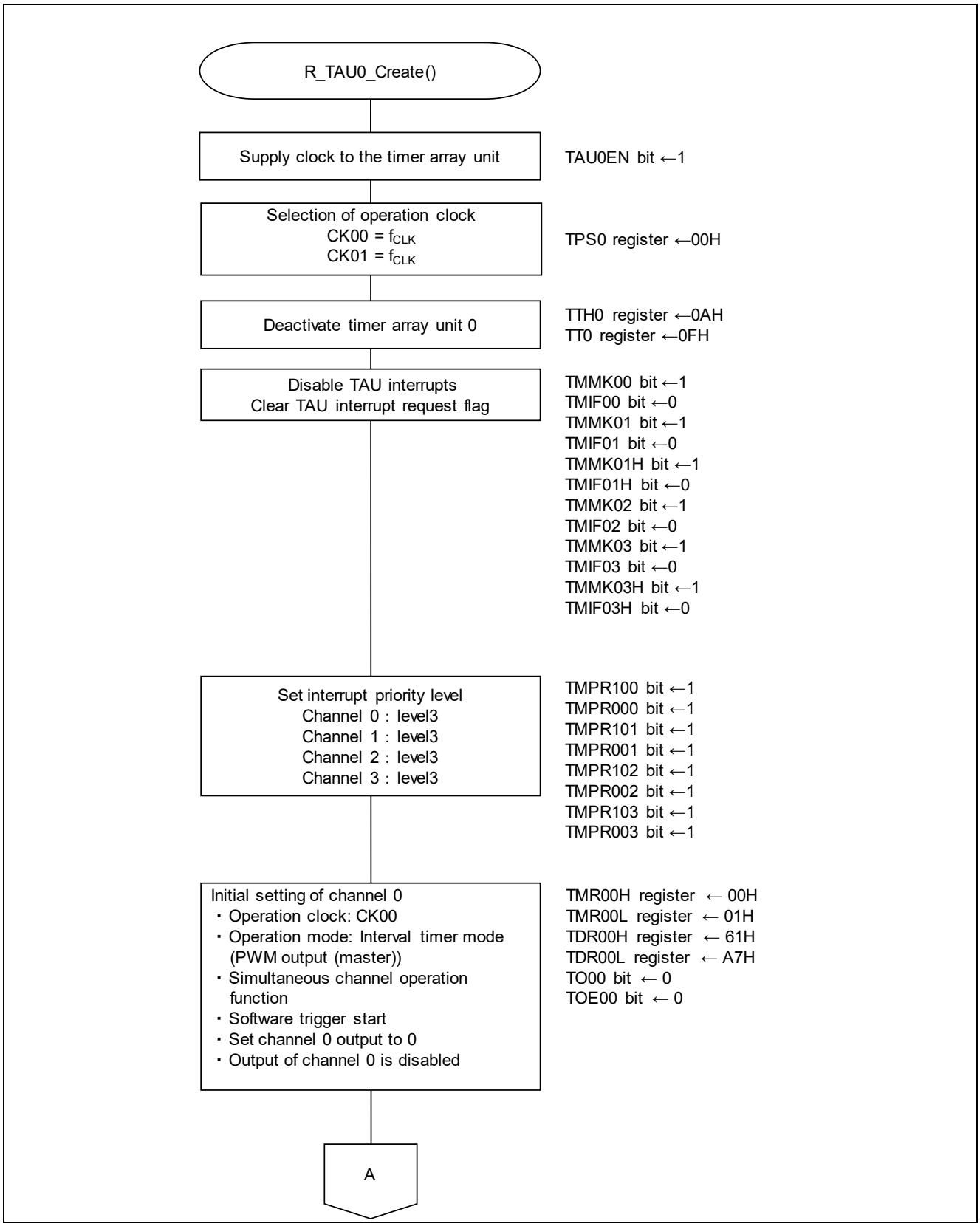

Figure 5.6 Timer Array Unit Initial Setting (1/2)

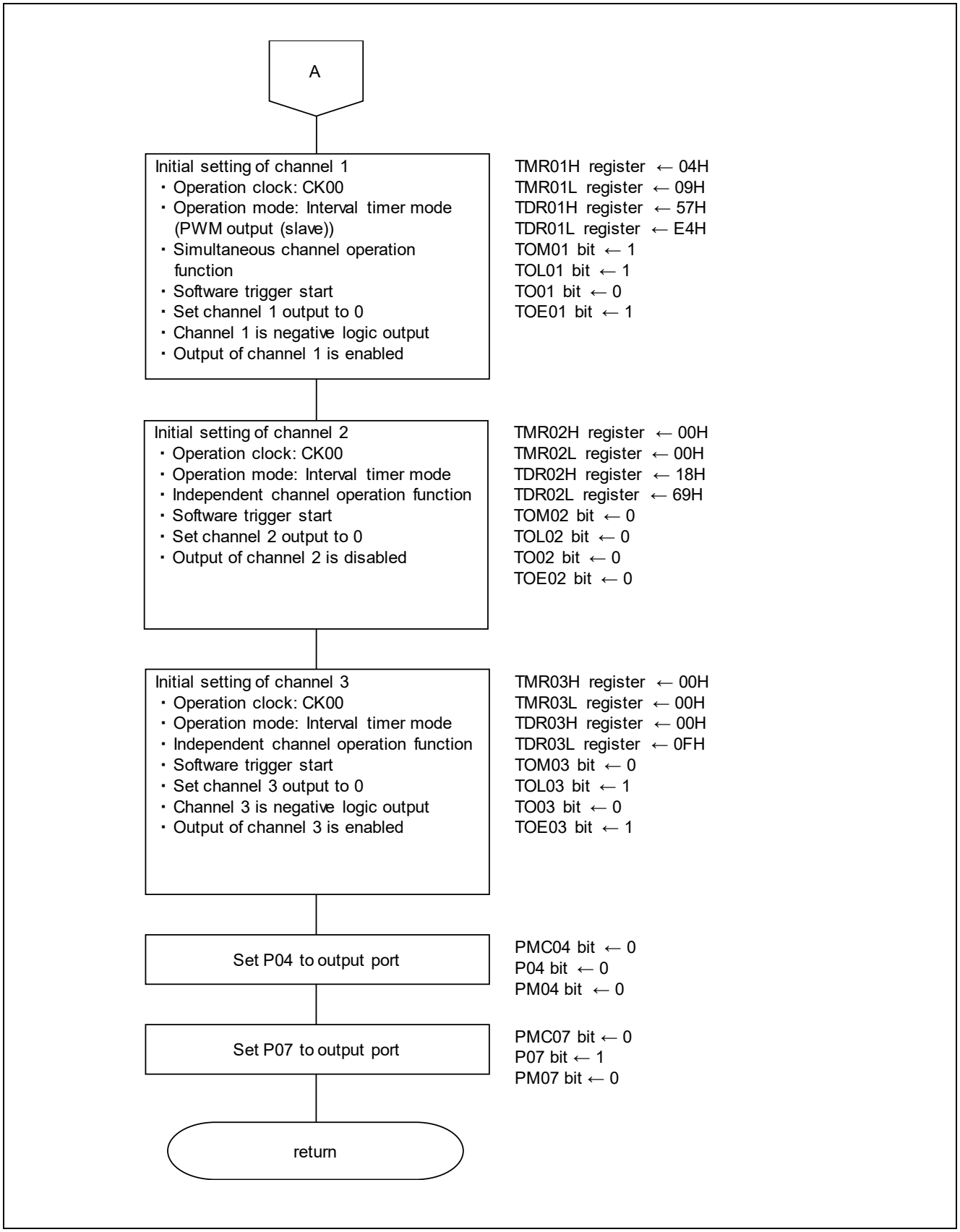

Figure 5.7 Timer Array Unit Initial Setting (2/2)

Clock supply to timer array unit started

- Peripheral enable register 0 (PER0)

Clock supply to timer array unit

Symbol: PER0

7	6	5	4	3	2	1	0
TMKAEN	CMPEN	ADCEN	IICA0EN	0	SAU0EN	0	TAU0EN
x	x	x	x	0	x	0	**1**

Bit 0

TAU0EN	Control of timer array unit input clock
0	Stops supply of input clock.
1	**Supplies input clock.**

Operation clock setting

- Timer clock select register 0 (TPS0)

Selection of operation clock (CK00)

Symbol: TPS0

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

Bit 3-0

PRS 003	PRS 002	PRS 001	PRS 000		Operation Clock (CK00) Selection				
					f_{CLK}= 1.25MHz	f_{CLK}= 2.5MHz	f_{CLK}= 5MHz	f_{CLK}= 10MHz	f_{CLK}= 20MHz
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	313 kHz	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	$f_{CLK}/2^7$	9.76 kHz	19.5 kHz	39.1 kHz	78.1 kHz	156 kHz
1	0	0	0	$f_{CLK}/2^8$	4.88 kHz	9.76 kHz	19.5 kHz	39.1 kHz	78.1 kHz
1	0	0	1	$f_{CLK}/2^9$	2.44 kHz	4.88 kHz	9.76 kHz	19.5 kHz	39.1 kHz
1	0	1	0	$f_{CLK}/2^{10}$	1.22 kHz	2.44 kHz	4.88 kHz	9.76 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

Note: Refer to the RL78/G10 User's Manual (Hardware version) for details on how to set registers.

Channel stop control

- Timer channel stop register 0 (TT0)
  Stop the counting operation of each channel

Symbol: TT0

7	6	5	4	3	2	1	0
0	0	0	0	TT03	TT02	TT01	TT00
0	0	0	0	**1**	**1**	**1**	**1**

Bit 3-0

TT0n	Operation stop trigger of channel n (n = 0 to 3)
0	No trigger operation
1	**TE0n is cleared to 0, and counting operation is stopped.**

Note: Refer to the RL78/G10 User's Manual (Hardware version) for details on how to set registers.

Setting up the channel 0 operation mode

- Timer mode register 00 (TMR00H, TMR00L)

Select an operation clock (f_{MCK}).
Select a count clock.
Select a start trigger and capture trigger.
Select a valid edge for timer input.
Set up 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	**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)**
0	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

Bit 2-0

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-shot 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

Note: Refer to the RL78/G10 User's Manual (Hardware version) for details on how to set registers.

Symbol: TMR00L

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

Bit 3-0

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

The MD000 bit operation varies depending on the operation mode (see the table below)

Operation mode (Value set by the MD003 to MD001 bits) (see table above)	MD000	TCR counting operation
• **Interval timer mode (0, 0, 0)** • **Capture mode (0, 1, 0)**	0	Timer interrupt is not generated when counting is started (timer output does not change, either).
	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, interrupt is not generated, either.
	1	Start trigger is valid during counting operation. At that time, interrupt is also 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 interrupt is not generated, either.
Other than above		Setting prohibited

Note: Refer to the RL78/G10 User's Manual (Hardware version) for details on how to set registers.

Setting up the channel 1 operation mode

- Timer mode register 01 (TMR01H, TMR01L)

Select an operation clock (f_{MCK}).
Select a count clock.
Select the 16/8-bit timer.
Select a start trigger and capture trigger.
Select a valid edge for timer input.
Set up the operation mode.

Symbol: TMR01H

7	6	5	4	3	2	1	0
CKS011	0	0	CCS01	SPLIT01	STS012	STS011	STS010
0	0	0	**0**	**0**	**1**	**0**	**0**

Bit 7

CKS011	Channel 1 operation clock (f_{MCK}) selection
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

CCS01	Selection of count clock (f_{TCLK}) of channel 1
0	**Operation clock (f_{MCK}) specified with the CKS011 bit**
1	Valid edge of the input signal from the TI01 pin

Bit 3

SPLIT01	Selection of 8 or 16-bit timer operation for channel 1
0	**Operates as 16-bit timer**
1	Operates as 8-bit timer.

Bit 2-0

STS002	STS001	STS000	Setting of start trigger or capture trigger of channel 1
0	0	0	Only software trigger start is valid (other trigger sources are unselected).
0	0	1	Valid edge of the TI01 pin input is used as both the start trigger and capture trigger.
0	1	0	Both the edges of the TI01 pin input are used as a start trigger and a capture trigger.
1	**0**	**0**	**Interrupt signal of the master channel is used (when the channel is used as a slave channel with the simultaneous channel operation function).**
1	1	0	When the channel is used as a slave channel in two-channel input with one-shot pulse output function: The interrupt request signal of the master channel (INTTM0n) 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

Note: Refer to the RL78/G10 User's Manual (Hardware version) for details on how to set registers.

Symbol: TMR01L

7	6	5	4	3	2	1	0
CIS011	CIS010	0	0	MD013	MD012	MD011	MD010
0	**0**	0	0	**1**	**0**	**0**	**1**

Bit 3-0

MD013	MD012	MD011	MD010	Operation mode of channel 0	Related function	TCR counting operation
0	0	0	1/0	Interval timer mode	Interval timer / Square wave output / Divider function / PWM output (master)	Counting down
0	1	0	1/0	Capture mode	Input pulse interval measurement	Counting up
0	1	1	0	Event counter mode	External event counter	Counting down
1	**0**	**0**	**1/0**	**One-count mode**	**Delay counter / One-shot pulse output / PWM output (slave)**	**Counting down**
1	1	0	0	Capture & one-count mode	Measurement of high-/low-level width of input signal	Counting up
Other than above				Setting prohibited		

The MD000 bit operation varies depending on the operation mode (see the table below)

Operation mode (Value set by the MD003 to MD001 bits) (see table above)	MD000	TCR counting operation
• Interval timer mode (0, 0, 0) • Capture mode (0, 1, 0)	0	Timer interrupt is not generated when counting is started (timer output does not change, either).
	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, interrupt is not generated, either.
	1	**Start trigger is valid during counting operation.** **At that time, interrupt is also 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 interrupt is not generated, either.
Other than above		Setting prohibited

Note: Refer to the RL78/G10 User's Manual (Hardware version) for details on how to set registers.

Setting up the channel 2 operation mode

- Timer mode register 02 (TMR02H, TMR02L)

Select an operation clock (f_{MCK}).

Select a count clock.

Select a software trigger start.

Set up the operation mode.

Symbol: TMR02H

7	6	5	4	3	2	1	0
CKS021	0	0	CCS02	MASTER02	STS022	STS021	STS020
0	0	0	**0**	**0**	**0**	**0**	**0**

Bit 7

CKS021	Selection of operation clock (f_{MCK}) of channel 2
0	**Operation clock CK00 set by timer clock select register 0 (TPS0)**
0	Operation clock CK01 set by timer clock select register 0 (TPS0)

Bit 4

CCS02	Selection of count clock (f_{TCLK}) of channel 2
0	**Operation clock (f_{MCK}) specified by the CKS021 bit**
1	Valid edge of input signal input from the TI02 pin

Bit 3

MASTER02	Selection of independent channel operation/simultaneous channel operation (slave/master) of channel 2
0	**Operates as the slave channel in the independent channel operation function or the simultaneous channel operation function.**
1	Operates as the master channel in the simultaneous channel operation function.

Bit 2-0

STS002	STS001	STS000	Setting of start trigger or capture trigger of channel 2
0	**0**	**0**	**Only software trigger start is valid (other trigger sources are unselected).**
0	0	1	Valid edge of the TI02 pin input is used as the start trigger and capture trigger.
0	1	0	Both the edges of the TI02 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 (INTTM02) is used as the start trigger.
1	1	0	When the channel is used as a slave channel in two-channel input with one-shot pulse output function: The interrupt request signal of the master channel (INTTM02) 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

Note: Refer to the RL78/G10 User's Manual (Hardware version) for details on how to set registers.

Symbol: TMR02L

7	6	5	4	3	2	1	0
CIS021	CIS020	0	0	MD023	MD022	MD021	MD020
0	**0**	0	0	**0**	**0**	**0**	**0**

Bit 7, 6

CIS021	CIS020	Selection of TI02 pin input valid edge
0	**0**	**Falling edge**
0	1	Rising edge
1	0	Both edges (when low-level width is measured) Start trigger: Falling edge, Capture trigger: Rising edge
1	1	Both edges (when high-level width is measured) Start trigger: Rising edge, Capture trigger: Falling edge

Bit 3-0

MD023	MD022	MD021	MD020	Operation mode of channel 2	Related function	TCR counting operation
0	**0**	**0**	1/**0**	**Interval timer mode**	**Interval timer / Square wave output / Divider function / PWM output (master)**	**Counting down**
0	1	0	1/0	Capture mode	Input pulse interval measurement	Counting up
0	1	1	0	Event counter mode	External event counter	Counting down
1	0	0	1/0	One-count mode	Delay counter / One-shot pulse output / PWM output (slave)	Counting down
1	1	0	0	Capture & one-count mode	Measurement of high-/low-level width of input signal	Counting up
Other than above				Setting prohibited		

The MD020 bit operation varies depending on the operation mode (see the table below)

Operation mode (Value set by the MD023 to MD021 bits) (see table above)	MD020	TCR counting operation
• **Interval timer mode (0, 0, 0)** • **Capture mode (0, 1, 0)**	**0**	**Timer interrupt is not generated when counting is started (timer output does not change, either).**
	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, interrupt is not generated, either.
	1	Start trigger is valid during counting operation. At that time, interrupt is also 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 interrupt is not generated, either.
Other than above		Setting prohibited

Setting up the channel 3 operation mode

- Timer mode register 03 (TMR03H, TMR03L)

Select an operation clock (f_{MCK}).
Select a count clock.
Select a software trigger start.
Set up the operation mode.

Symbol: TMR03H

7	6	5	4	3	2	1	0
CKS031	0	0	CCS03	SPLIT03	STS032	STS031	STS030
0	0	0	**0**	**0**	**0**	**0**	**0**

Bit 7

CKS031	Selection of operation clock (f_{MCK}) of channel 3
0	**Operation clock CK00 set by timer clock select register 0 (TPS0)**
0	Operation clock CK01 set by timer clock select register 0 (TPS0)

Bit 4

CCS03	Selection of count clock (f_{TCLK}) of channel 3
0	**Operation clock (f_{MCK}) specified by the CKS031 bit**
1	Valid edge of input signal input from the TI03 pin

Bit 3

SPLIT03	Selection of 8 or 16-bit timer operation for channels 1 and 3 (n = 1, 3)
0	**Operates as 16-bit timer.**
1	Operates as 8-bit timer.

Bit 2-0

STS032	STS031	STS030	Setting of start trigger or capture trigger of channel 3
0	**0**	**0**	**Only software trigger start is valid (other trigger sources are unselected).**
0	0	1	Valid edge of the TI03 pin input is used as the start trigger and capture trigger.
0	1	0	Both the edges of the TI03 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 (INTTM03) is used as the start trigger.
1	1	0	When the channel is used as a slave channel in two-channel input with one-shot pulse output function: The interrupt request signal of the master channel (INTTM03) 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

Note: Refer to the RL78/G10 User's Manual (Hardware version) for details on how to set registers.

略号：TMR03L

7	6	5	4	3	2	1	0
CIS031	CIS030	0	0	MD033	MD032	MD031	MD030
0	**0**	0	0	**0**	**0**	**0**	**0**

Bit 7, 6

CIS031	CIS030	Selection of TI03 pin input valid edge
0	**0**	**Falling edge**
0	1	Rising edge
1	0	Both edges (when low-level width is measured) Start trigger: Falling edge, Capture trigger: Rising edge
1	1	Both edges (when high-level width is measured) Start trigger: Rising edge, Capture trigger: Falling edge

Bit 3-0

MD033	MD032	MD031	MD030	Operation mode of channel 3	Related function	TCR counting operation
0	**0**	**0**	1/**0**	**Interval timer mode**	**Interval timer / Square wave output / Divider function / PWM output (master)**	**Counting down**
0	1	0	1/0	Capture mode	Input pulse interval measurement	Counting up
0	1	1	0	Event counter mode	External event counter	Counting down
1	0	0	1/0	One-count mode	Delay counter / One-shot pulse output / PWM output (slave)	Counting down
1	1	0	0	Capture & one-count mode	Measurement of high-/low-level width of input signal	Counting up
Other than above				Setting prohibited		

The MD030 bit operation varies depending on the operation mode (see the table below)

Operation mode (Value set by the MD033 to MD031 bits) (see table above)	MD030	TCR counting operation
• **Interval timer mode (0, 0, 0)** • **Capture mode (0, 1, 0)**	**0**	**Timer interrupt is not generated when counting is started (timer output does not change, either).**
	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, interrupt is not generated, either.
	1	Start trigger is valid during counting operation. At that time, interrupt is also 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 interrupt is not generated, either.
Other than above		Setting prohibited

Note: Refer to the RL78/G10 User's Manual (Hardware version) for details on how to set registers.

Setting up the timer output mode

- Timer output mode register 0 (TOM0)

  Set up the timer output mode for each channel.

Symbol: TOM0

7	6	5	4	3	2	1	0
0	0	0	0	TOM03	TOM02	TOM01	0
0	0	0	0	**0**	**0**	**1**	0

Bit 1

TOM01	Control of timer output mode of channel 1
0	Used as the independent channel operation function (to produce toggle output by the interrupt request signal (INTTM01))
1	**Slave channel output mode (output is set by the interrupt request signal (INTTM00, INTTM02) of the master channel, and reset by the timer interrupt request signal (INTTM01) of the slave channel)**

Configuring the output level for the timer output pin

- Timer output level register 0 (TOL0)

  Configure the output level for the timer output pin for each channel.

Symbol: TOL0

7	6	5	4	3	2	1	0
0	0	0	0	TOL03	TOL02	TOL01	0
0	0	0	0	**1**	**0**	**1**	0

Bit 3, 1

TOL0n	Control of timer output level of channel n
0	Positive logic output (active-high)
1	**Positive logic output (active-high)**

Note: Refer to the RL78/G10 User's Manual (Hardware version) for details on how to set registers.

Configuring the output value for the timer output pin

- Timer output register 0 (TO0)

Configure the output value for the timer output pin for each channel.

Symbol: TO0

7	6	5	4	3	2	1	0
0	0	0	0	TO03	TO02	TO01	TO00
0	0	0	0	**0**	**0**	**0**	**0**

Bit 3-0

TO0n	Timer output of channel n
0	**Timer output value is "0".**
1	Timer output value is "1".

Enabling the timer output

- Timer output enable register 0 (TOE0)

Enable/disable the timer output for each channel.

Symbol: TOE0

7	6	5	4	3	2	1	0
0	0	0	0	TOE03	TOE02	TOE01	TOE00
0	0	0	0	**1**	**0**	**1**	**0**

Bit 3, 1

TOE0n	Timer output enable/disable of channel n
0	Disable output of timer. Without reflecting on TO0n bit timer operation, to fixed the output. Writing to the TO0n bit is enabled and the level set in the TO0n bit is output from the TO0n pin.
1	**Enable output of timer.** **Reflected in the TO0n bit timer operation, to generate the output waveform.** **Writing to the TO0n bit is disabled (writing is ignored).**

Note: Refer to the RL78/G10 User's Manual (Hardware version) for details on how to set registers.

5.7.6 External Interrupt Setting

Figure 5.8 shows the flowchart for setting the external interrupt.

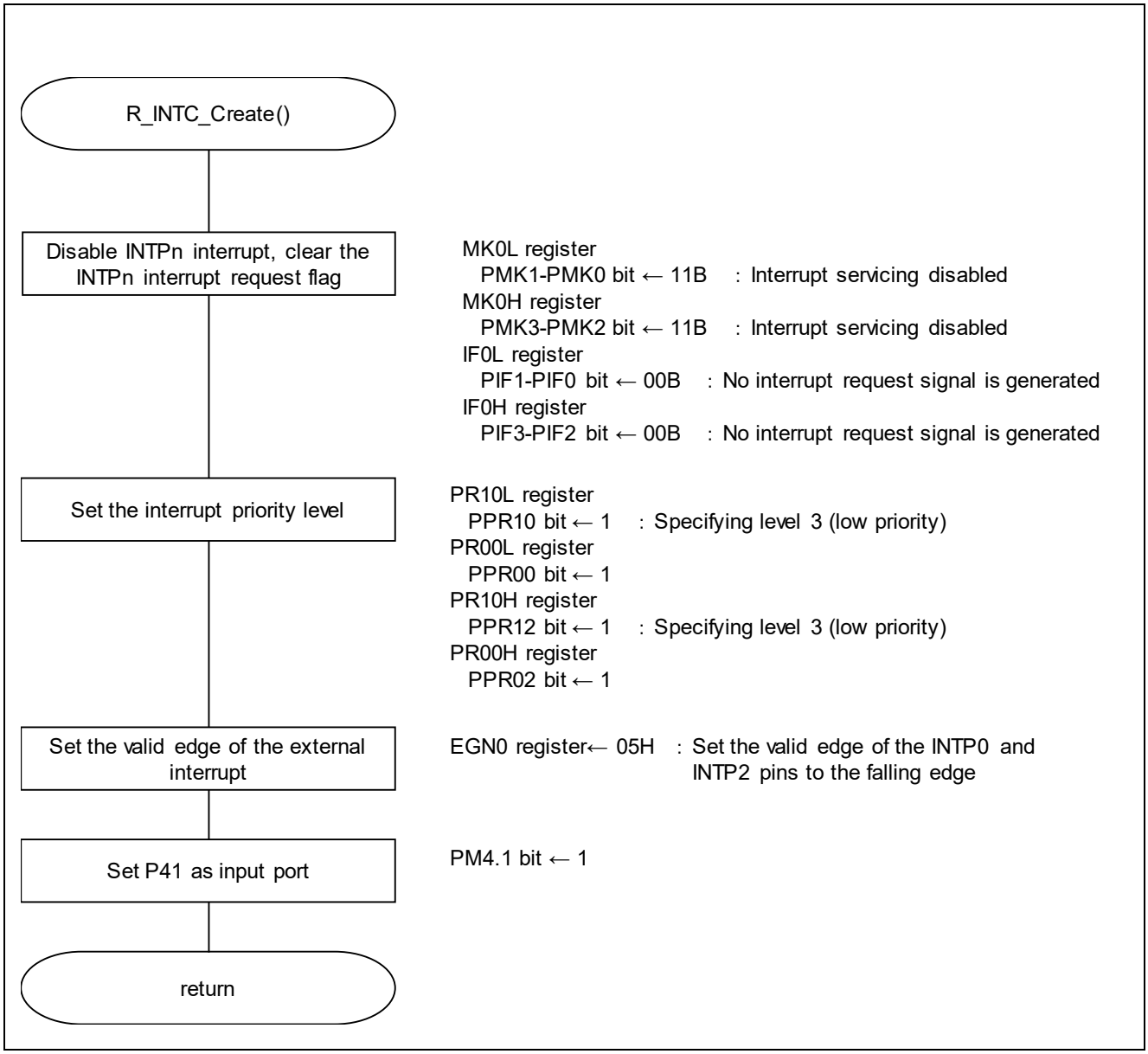

Figure 5.8 External Interrupt Setting

Set edge detection of INTP0 pin and INTP2 pin

- External interrupt rising edge enable register 0 (EGP0)
- External interrupt falling edge enable register 0 (EGN0)

Set valid edge of INTP0 pin and INTP2 pin.

Symbol: EGP0

7	6	5	4	3	2	1	0
0	0	0	0	EGP3	EGP2	EGP1	EGP0
0	0	0	0	x	**0**	x	**0**

Symbol: EGN0

7	6	5	4	3	2	1	0
0	0	0	0	EGN3	EGN2	EGN1	EGN0
0	0	0	0	x	**1**	x	**1**

EGPn	EGNn	INTPn pin valid edge selection (n = 0 to 3)
0	0	Edge detection disabled
0	**1**	**Falling edge**
1	0	Rising edge
1	1	Both rising and falling edges

Note: Refer to the RL78/G10 User's Manual (Hardware version) for details on how to set registers.

5.7.7 12-bit Interval Timer Initial Setting

Figure 5.9 shows the flowchart for the 12-bit interval timer initial setting.

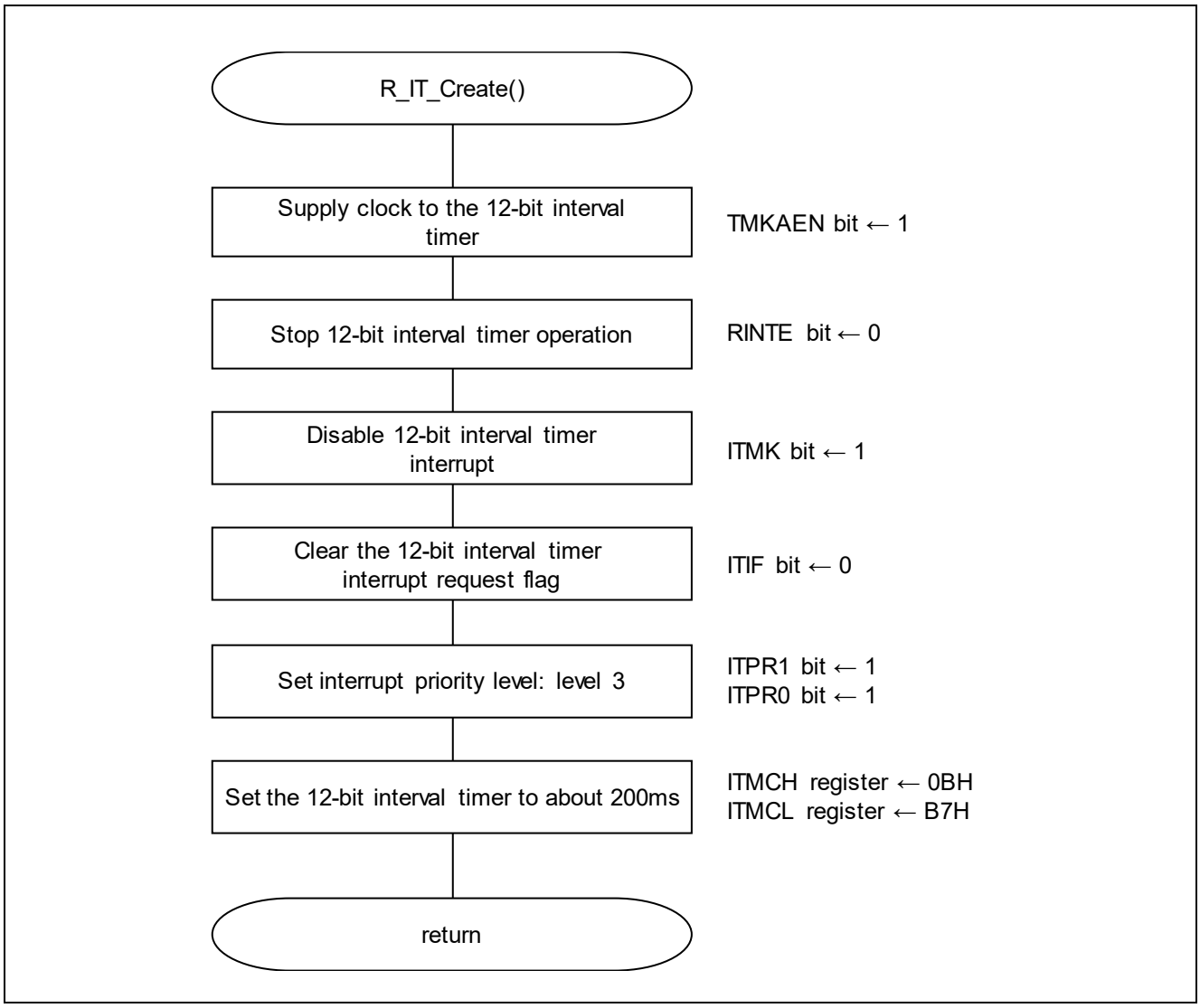

Figure 5.9 12-bit Interval Timer Initial Setting

12-bit interval timer clock supply setting

- Peripheral enable register 0 (PER0)

  Enable clock supply to the 12-bit interval timer.

Symbol: PER0

7	6	5	4	3	2	1	0
TMKAEN	CMPEN	ADCEN	IICA0EN	0	SAU0EN	0	TAU0EN
1	x	x	x	0	x	0	x

Bit 7

TMKAEN	Control of 12-bit interval timer input clock supply
0	Stops input clock supply.
1	**Enables input clock supply.**

12-bit interval timer operation and to specify the timer compare value setting

- 12-bit interval timer control register (ITMCH, ITMCL)

  Stop 12-bit interval timer count operation.

  Set the 12-bit interval timer compare value.

Symbol: ITMCH

7	6	5	4	3	2	1	0
RINTE	0	0	0	ITCMP11-ITCMP8			
0	0	0	0	1	0	1	1

Bit 7

RINTE	12-bit interval timer operation control
0	**Count operation stopped (count clear)**
1	Count operation started

Bit 3-0

ITCMP11-ITCMP8	Specification of 12-bit interval timer compare value
BH	**These bits generate an interrupt at the fixed cycle (count clock cycles * (ITCMP setting value BB7H＋1)).**
0H	Setting prohibited

Symbol: ITMCL

7	6	5	4	3	2	1	0
ITCMP7-ITCMP0							
1	**0**	**1**	**1**	**0**	**1**	**1**	**1**

Bit 7-0

ITCMP7-ITCMP0	Specification of 12-bit interval timer compare value
B7H	**These bits generate an interrupt at the fixed cycle (count clock cycles * (ITCMP setting value BB7H＋1)).**
00H	Setting prohibited

Note: Refer to the RL78/G10 User's Manual (Hardware version) for details on how to set registers.

5.7.8 Main Processing

Figure 5.10 to Figure 5.12 shows the flowchart of the main processing.

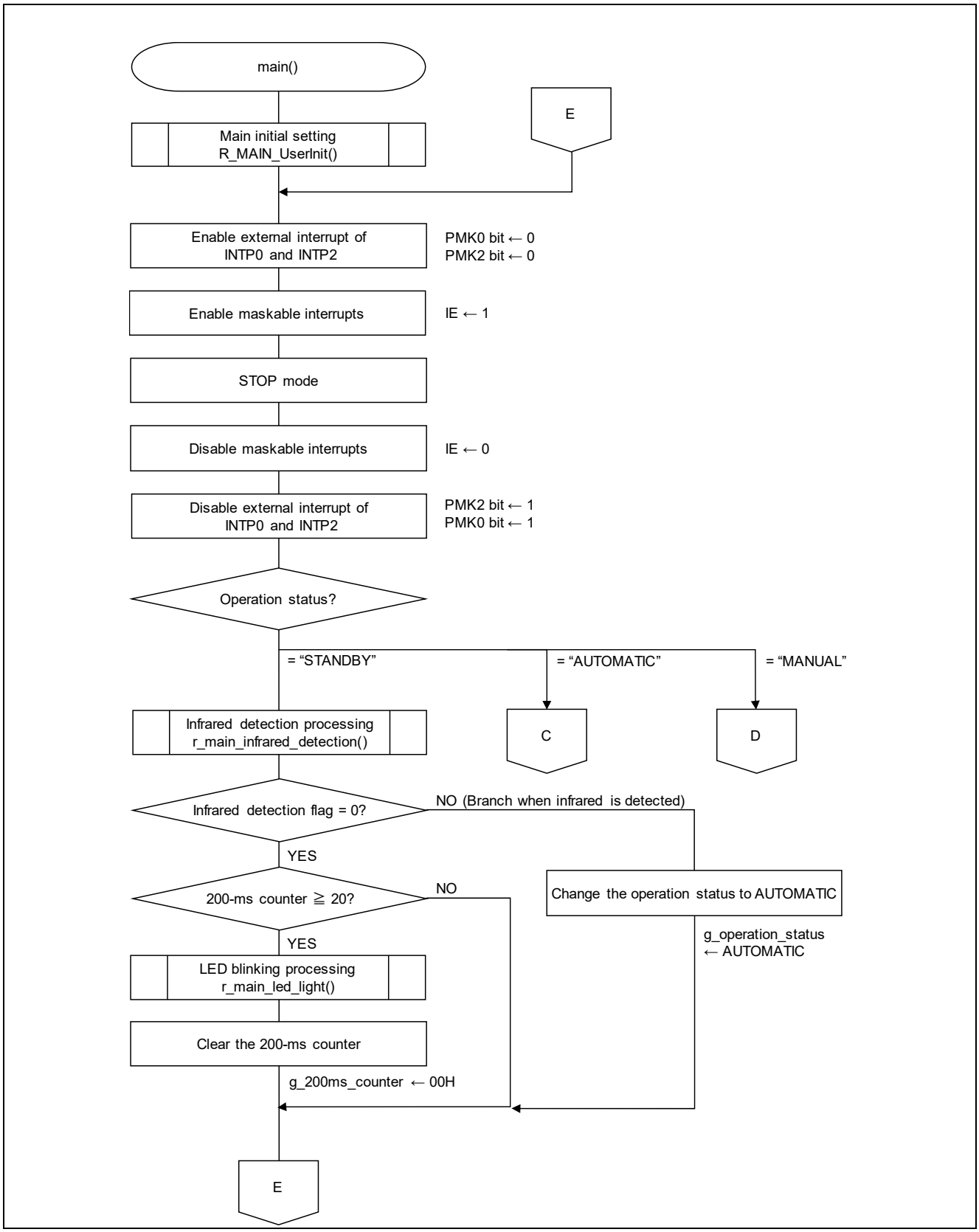

Figure 5.10 Main Processing (1/3)

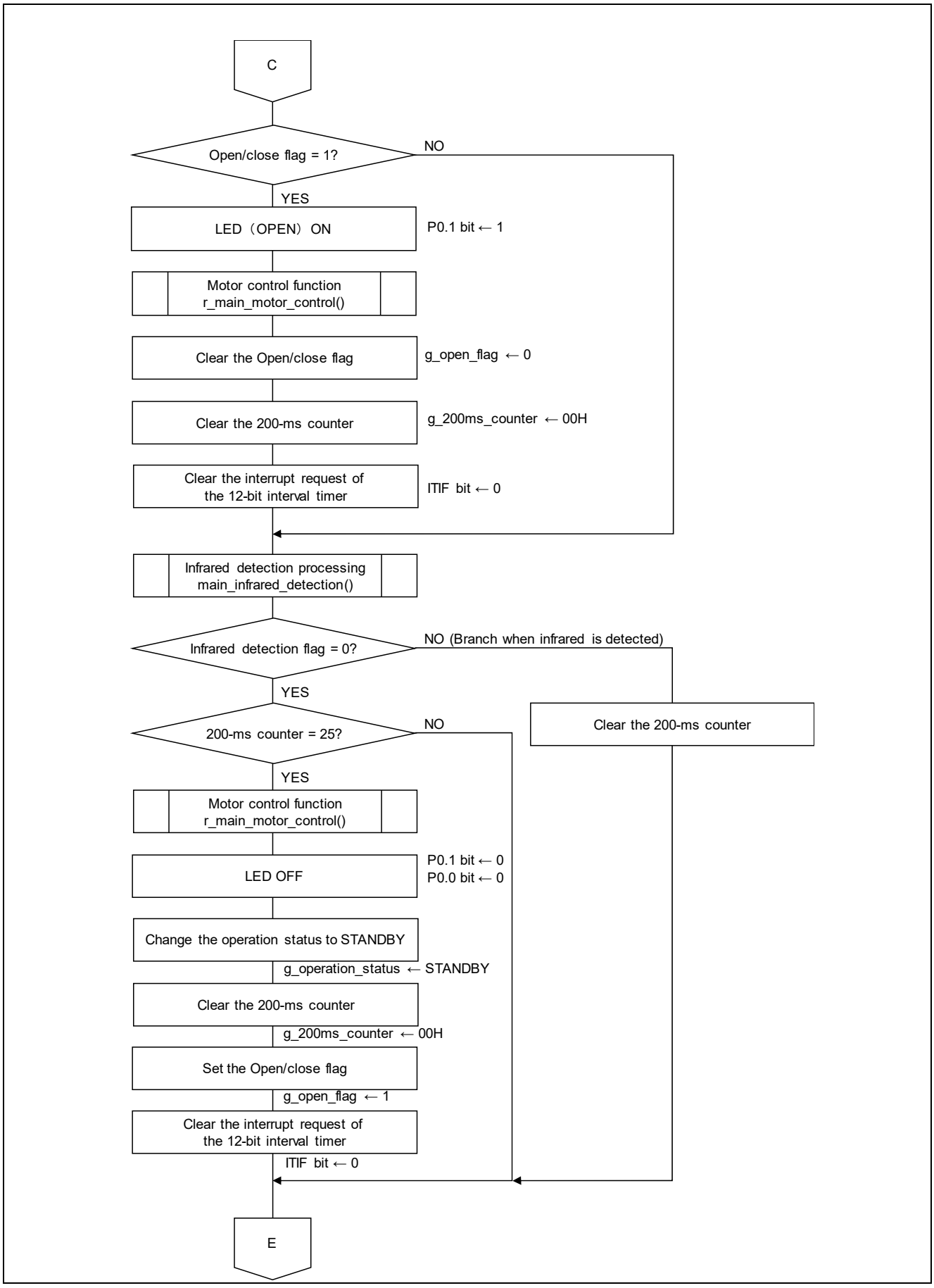

Figure 5.11 Main Processing (2/3)

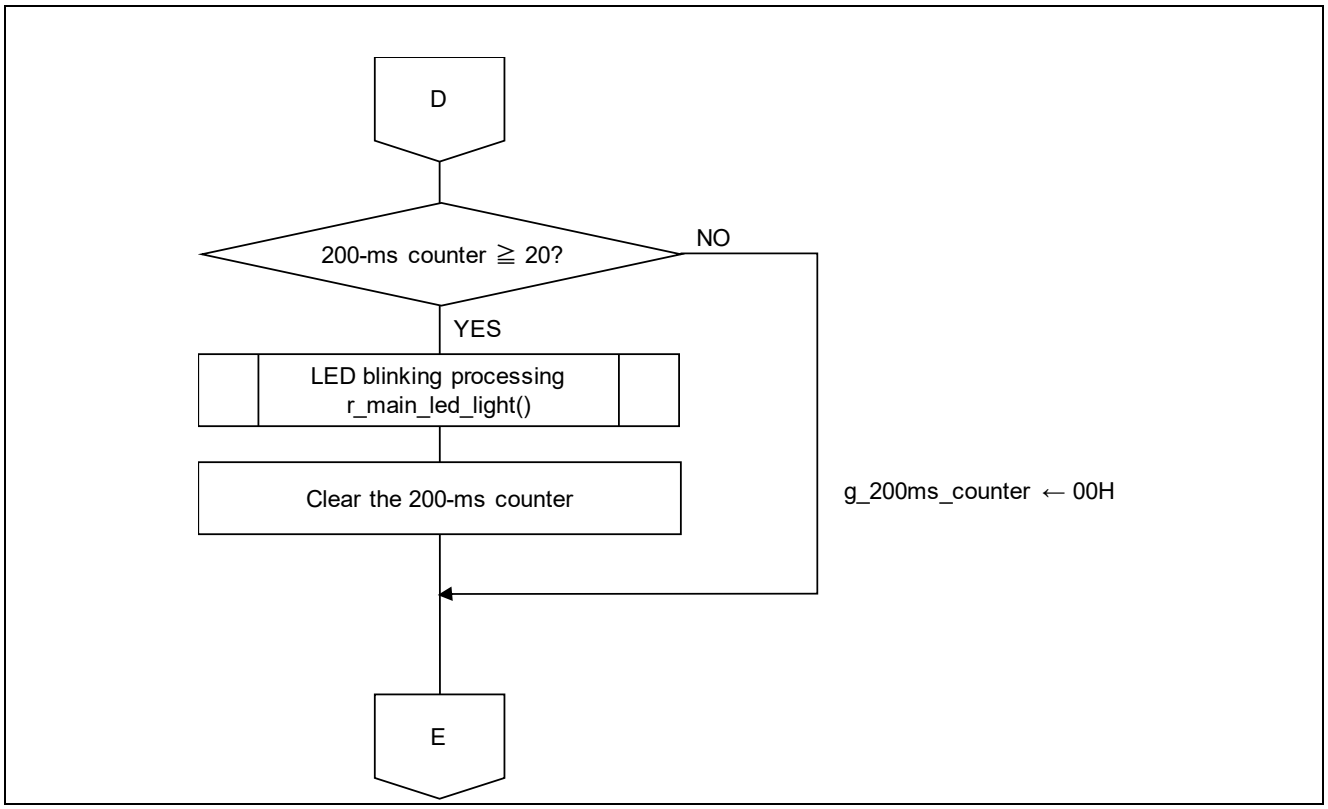

Figure 5.12 Main Processing (3/3)

5.7.9 Main Initial Setting

Figure 5.13 shows the flowchart of the main initial setting.

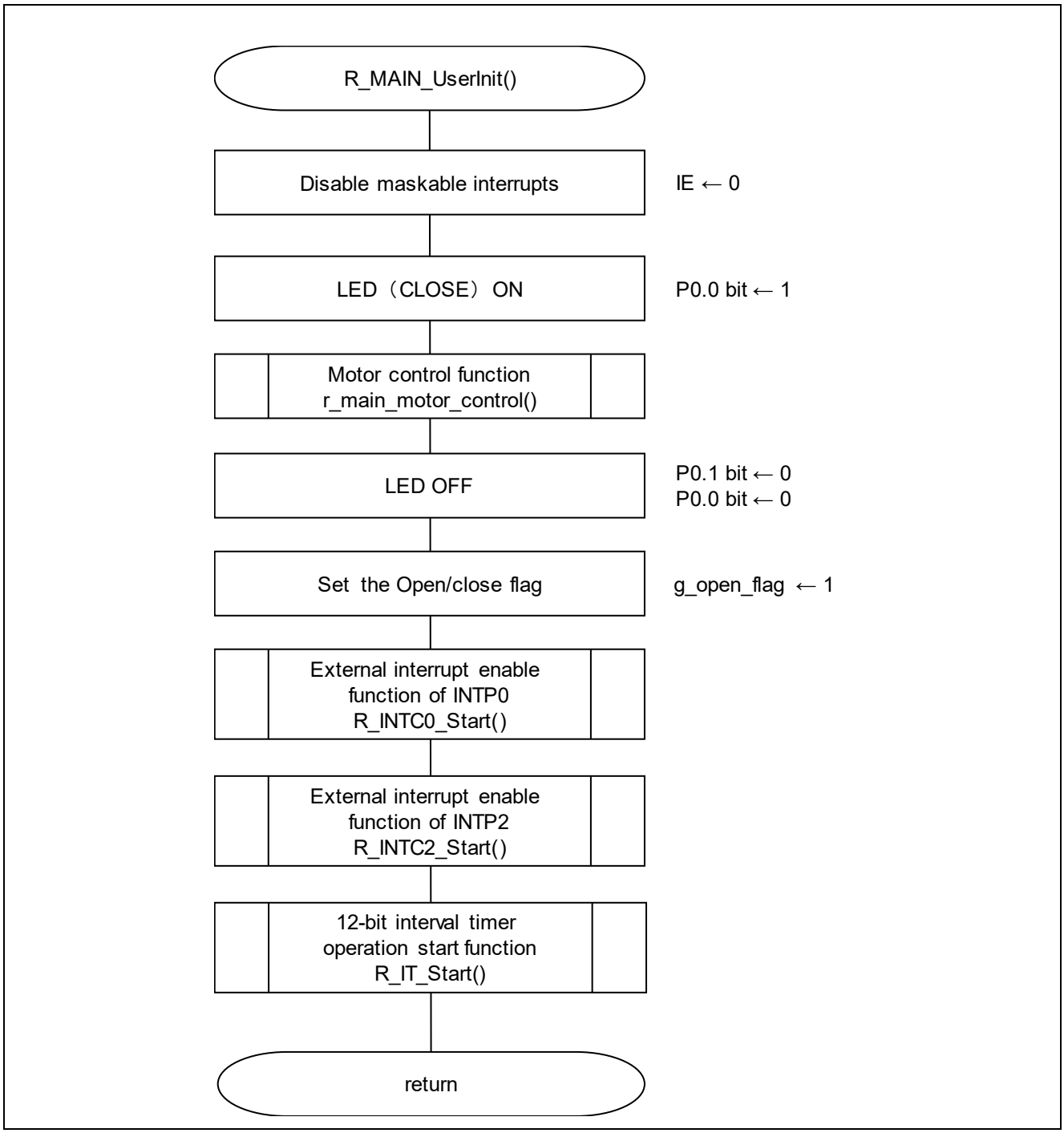

Figure 5.13 Main Initial Setting

5.7.10 Motor Control Function

Figure 5.14 and Figure 5.15 shows the flowchart of the main initial setting.

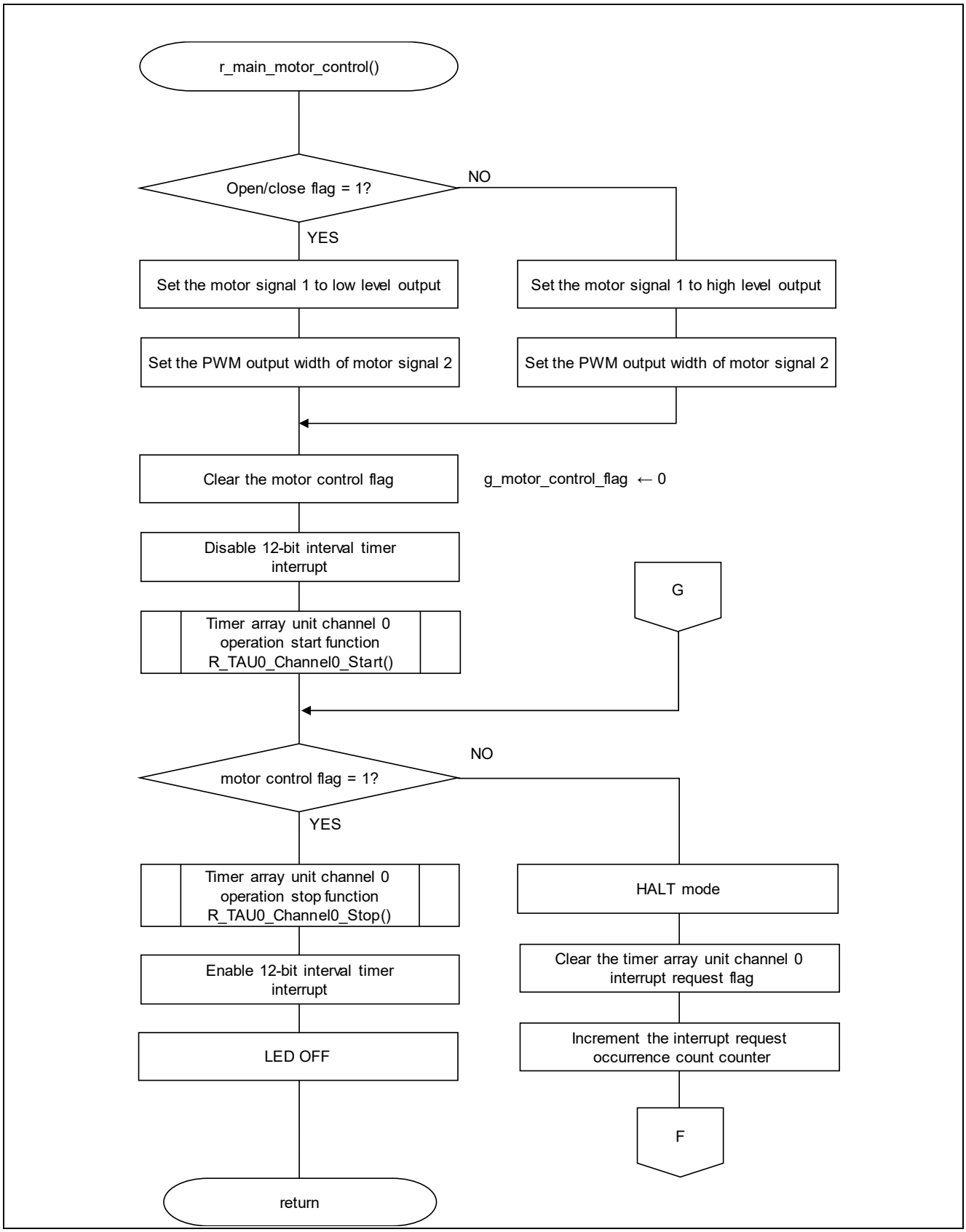

Figure 5.14 Motor Control Function (1/2)

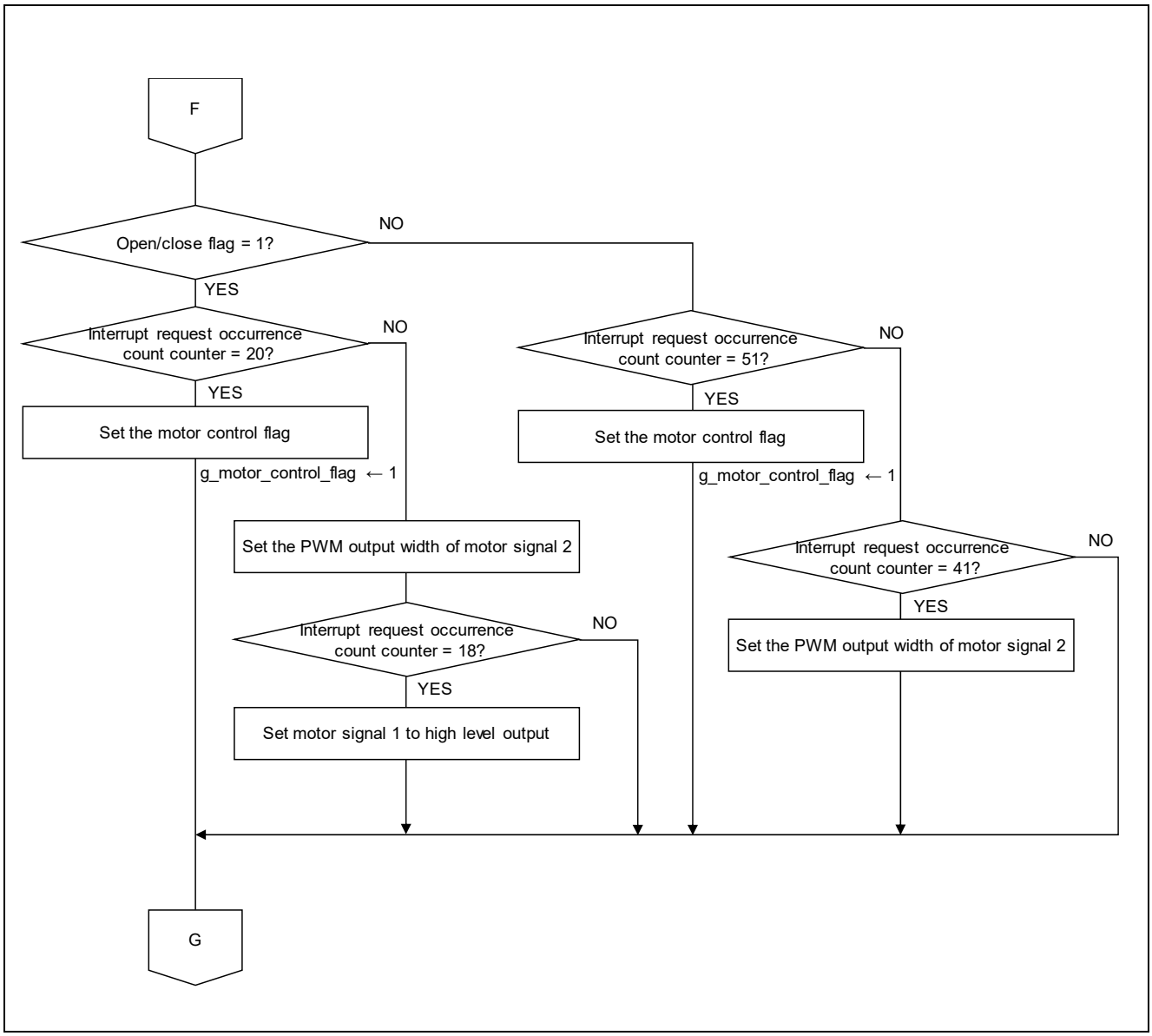

Figure 5.15 Motor Control Function (2/2)

5.7.11 Infrared Detection Processing

Figure 5.16 and Figure 5.17 shows the flowchart of the infrared detection processing.

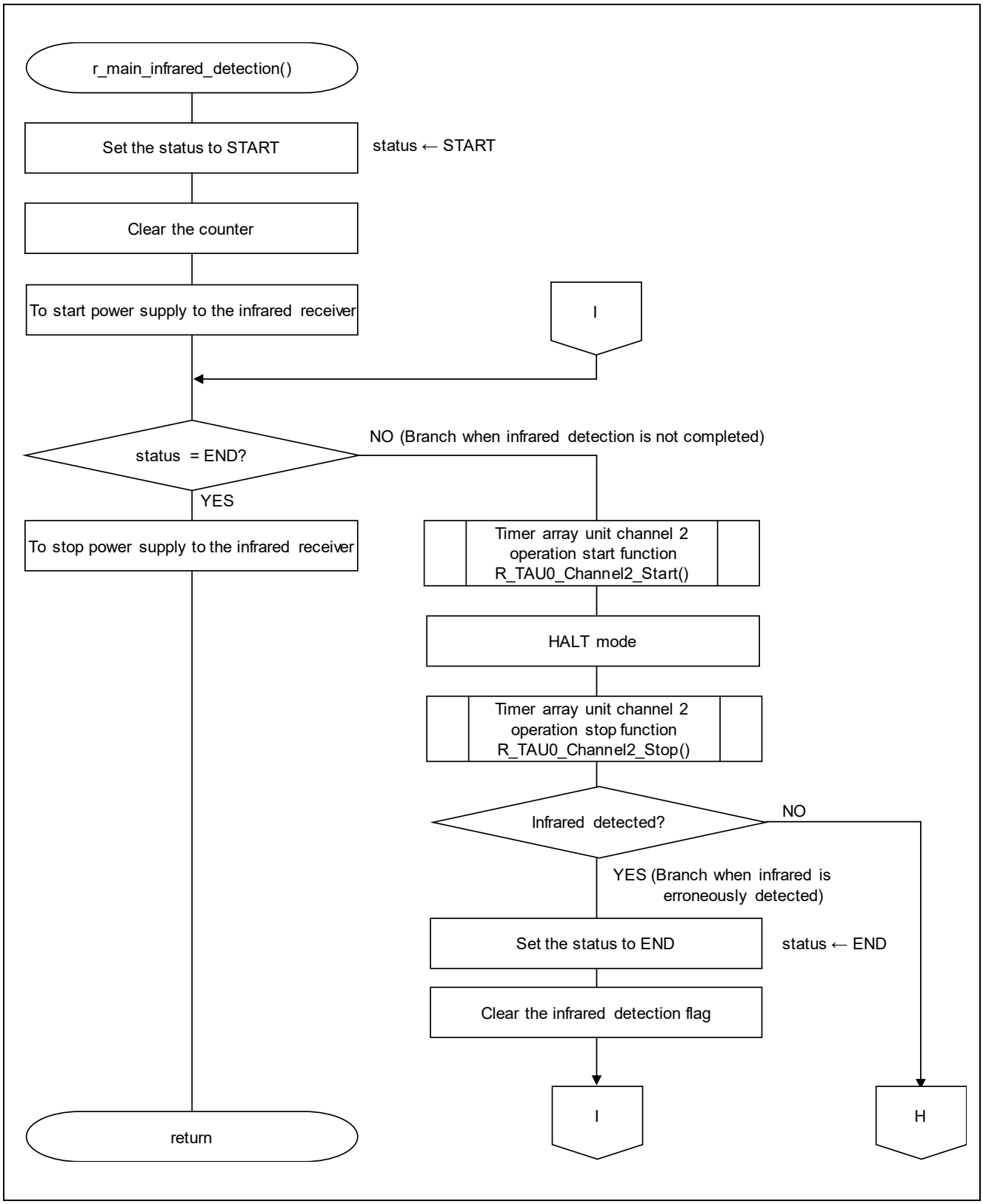

Figure 5.16 Infrared Detection Processing (1/2)

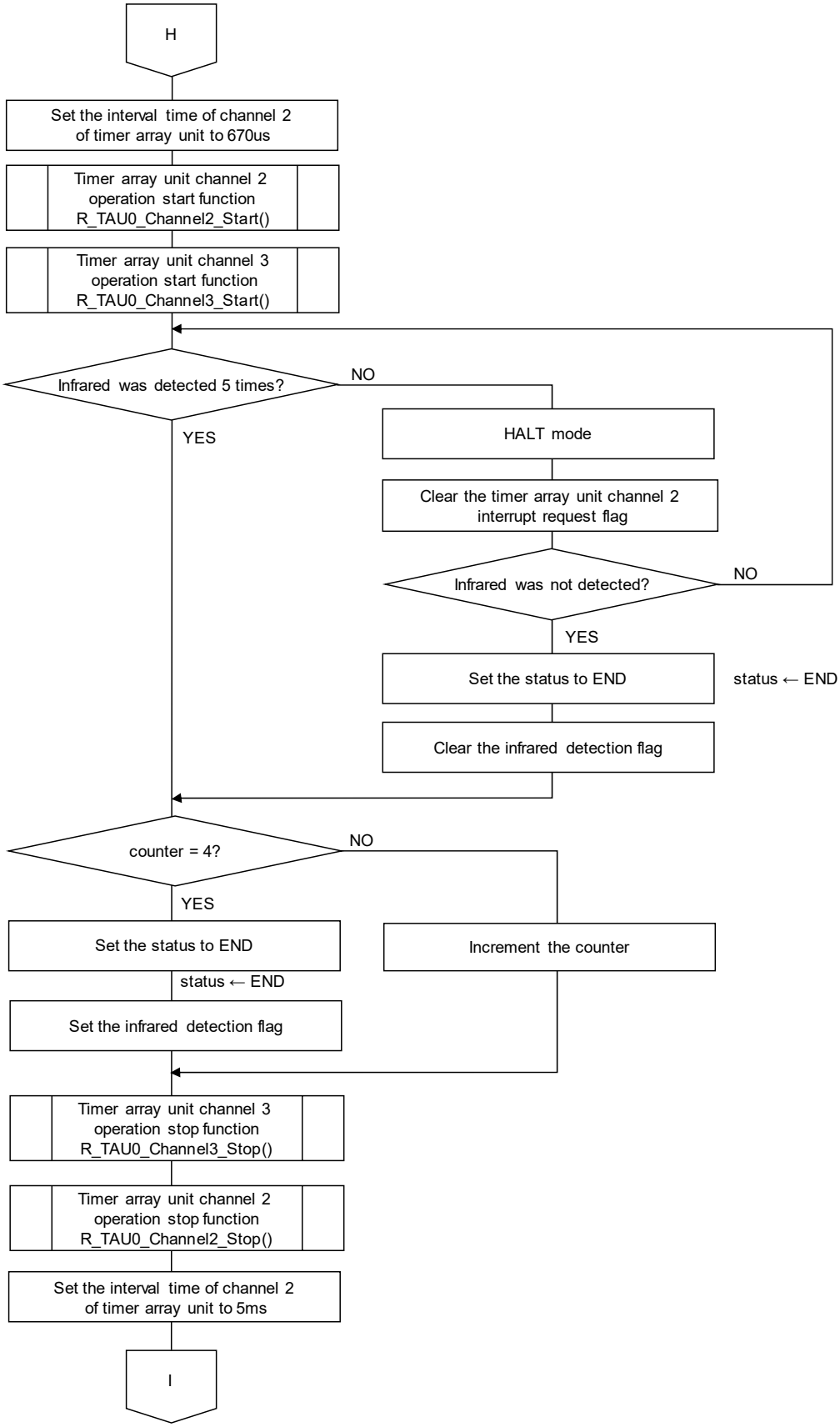

Figure 5.17 Infrared Detection Processing (2/2)

5.7.12 LED Blinking Processing

Figure 5.18 shows the flowchart of the infrared detection processing.

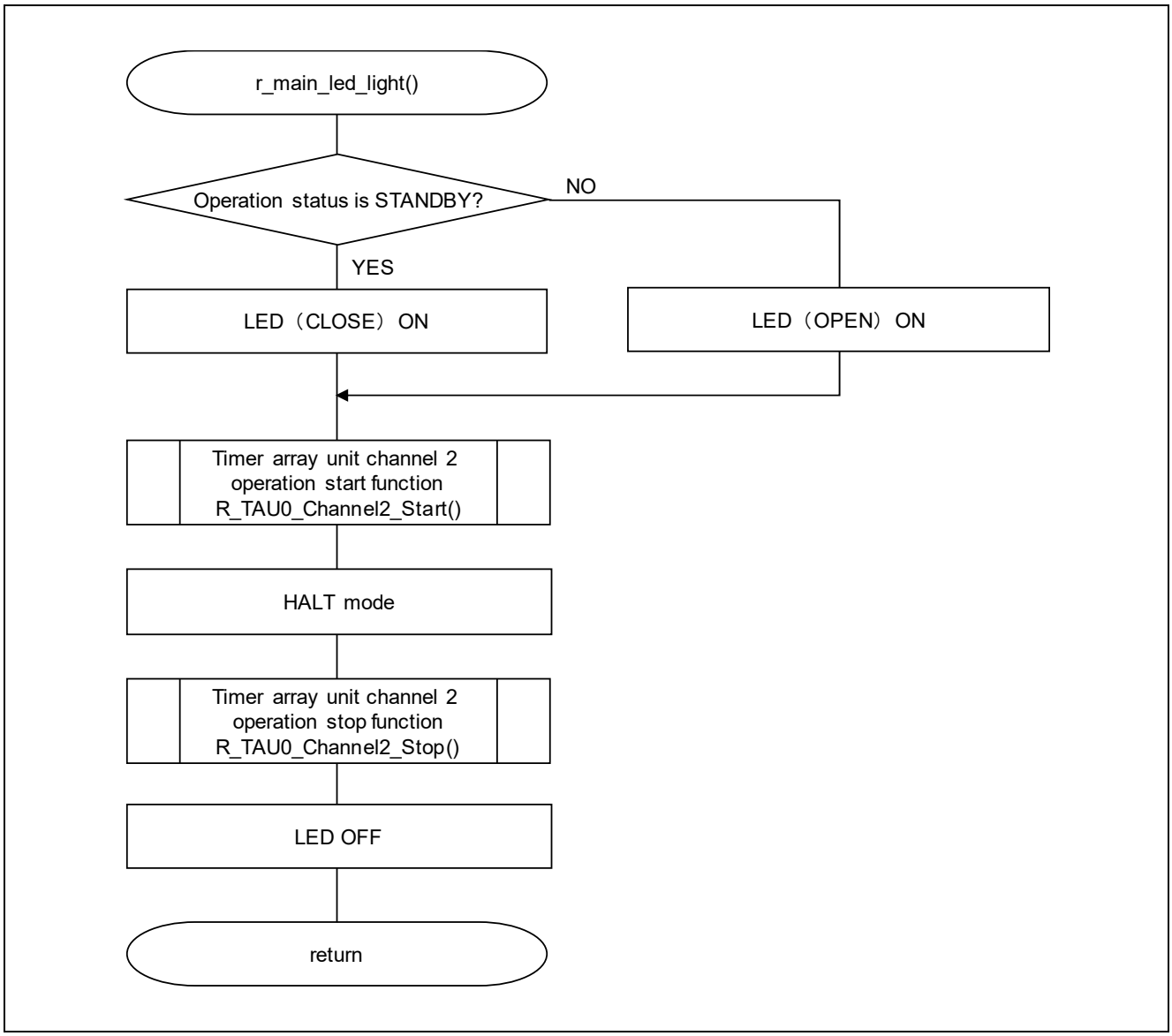

Figure 5.18 LED Blinking Processing

5.7.13 External Interrupt Processing of INTP0

Figure 5.19 shows the flowchart of the external interrupt processing of intp0.

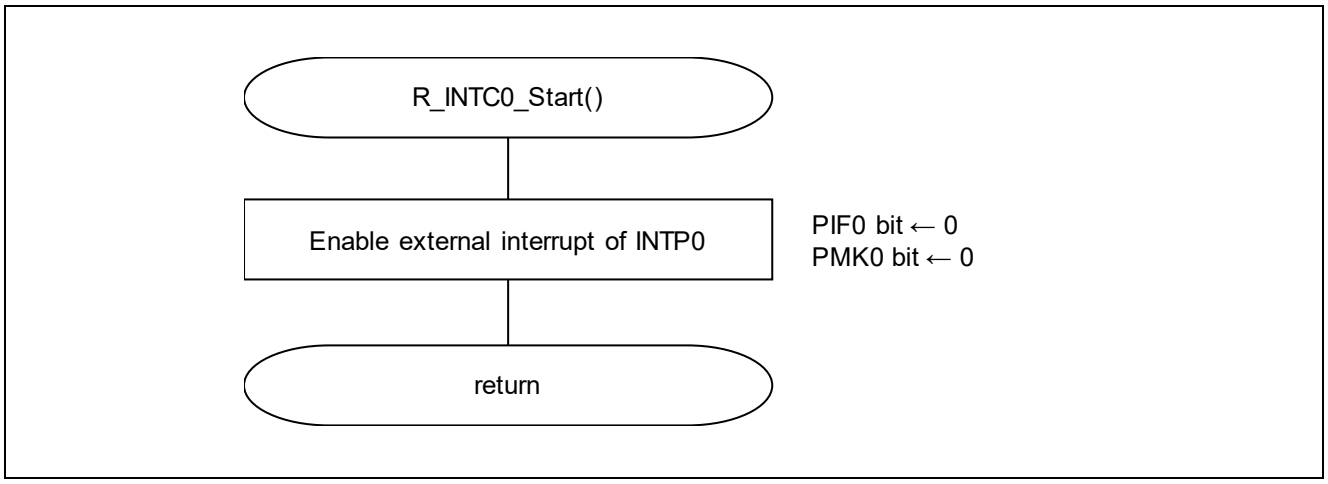

Figure 5.19 External Interrupt Processing of INTP0

5.7.14 External Interrupt processing of INTP2

Figure 5.20 shows the flowchart of the external interrupt processing of intp2.

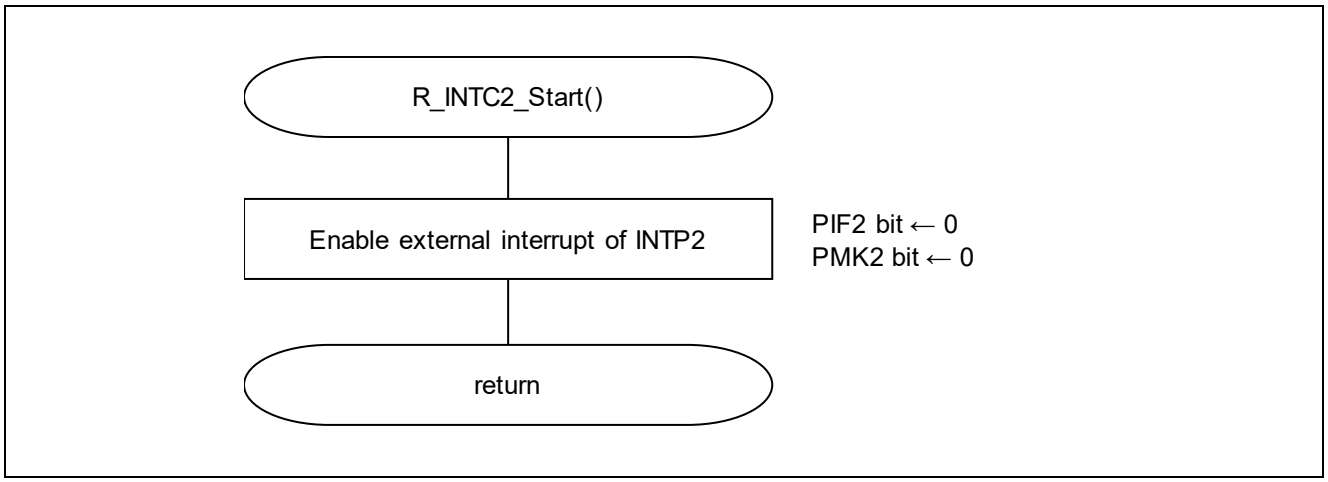

Figure 5.20 External Interrupt Processing of INTP2

5.7.15 12-bit Interval Timer Operation Start

Figure 5.21 shows the flowchart of the 12-bit interval timer operation start.

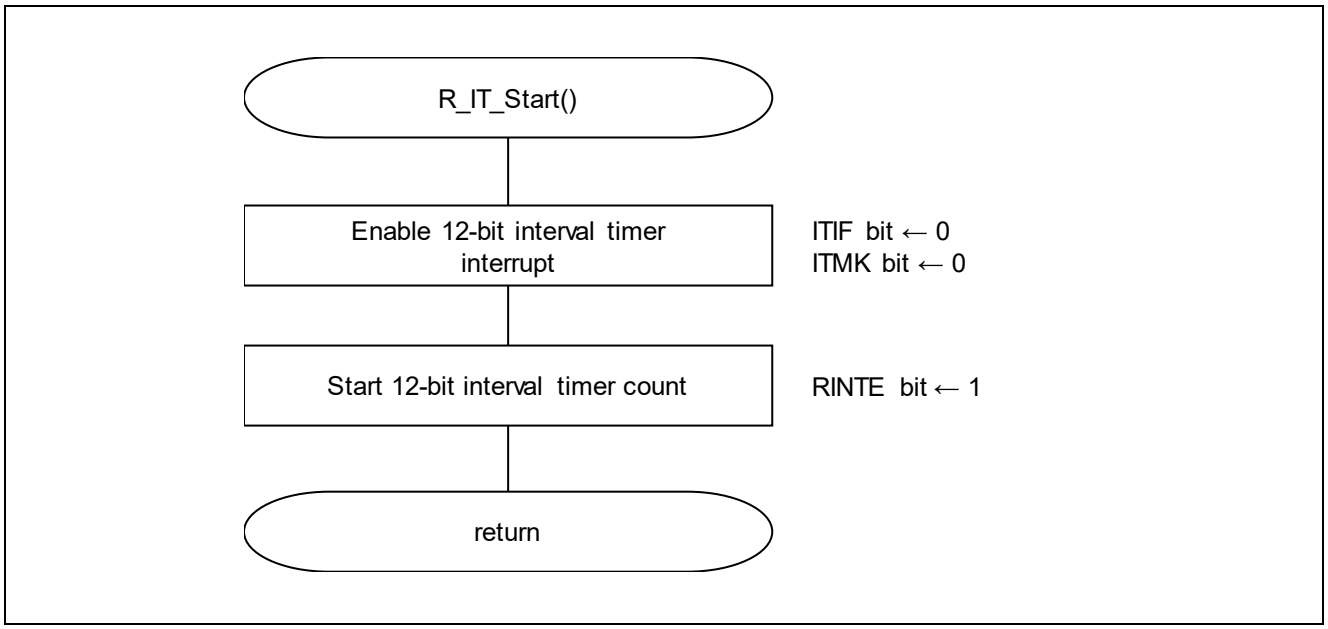

Figure 5.21 12-bit Interval Timer Operation Start

5.7.16 Timer Array Unit Channel0 Operation Start Function

Figure 5.22 shows the flowchart of the timer array unit channel0 operation start function.

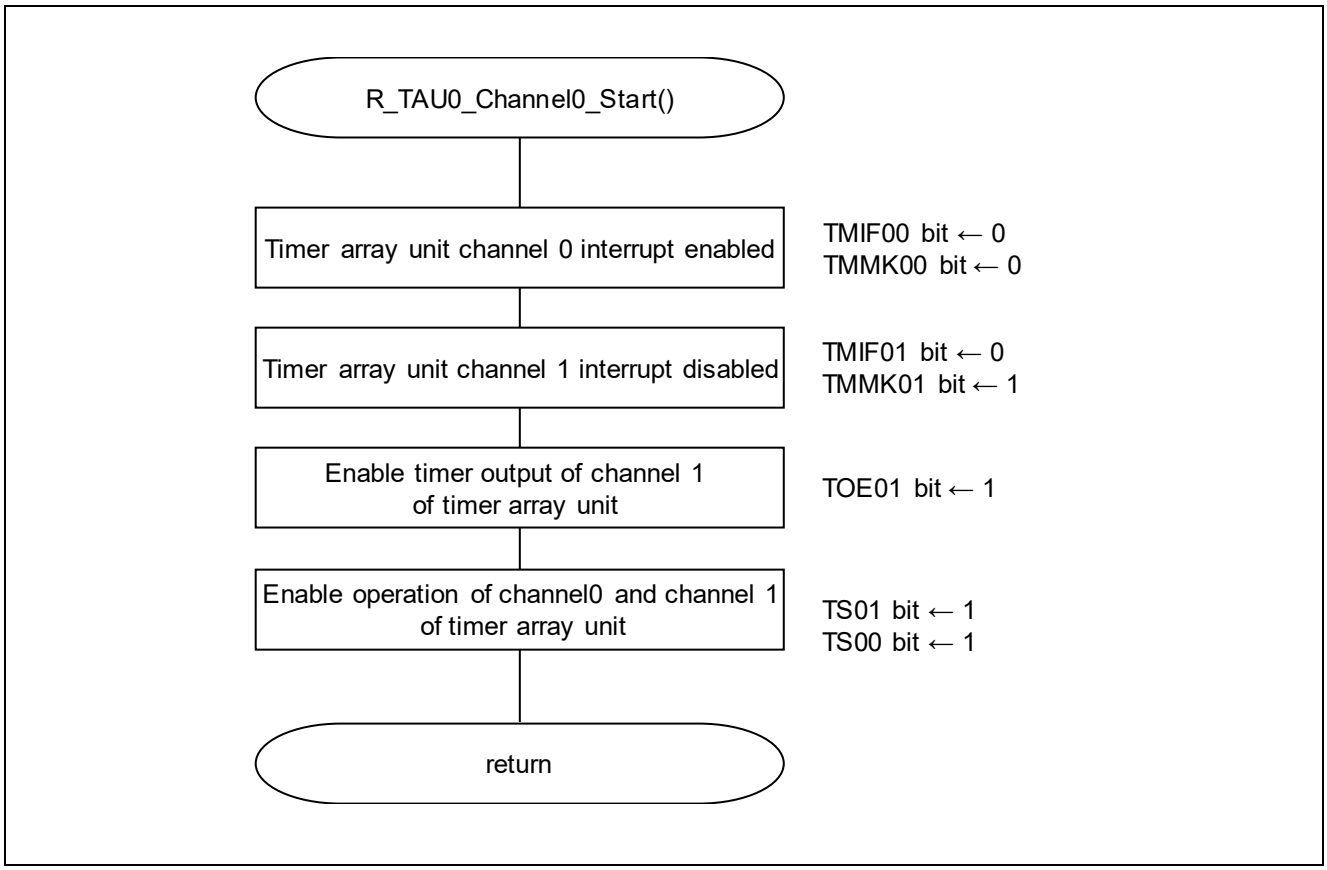

Figure 5.22 Timer Array Unit Channel0 Operation Start Function

5.7.17 Timer Array Unit Channel0 Operation Stop Function

Figure 5.23 shows the flowchart of the timer array unit channel0 operation stop function.

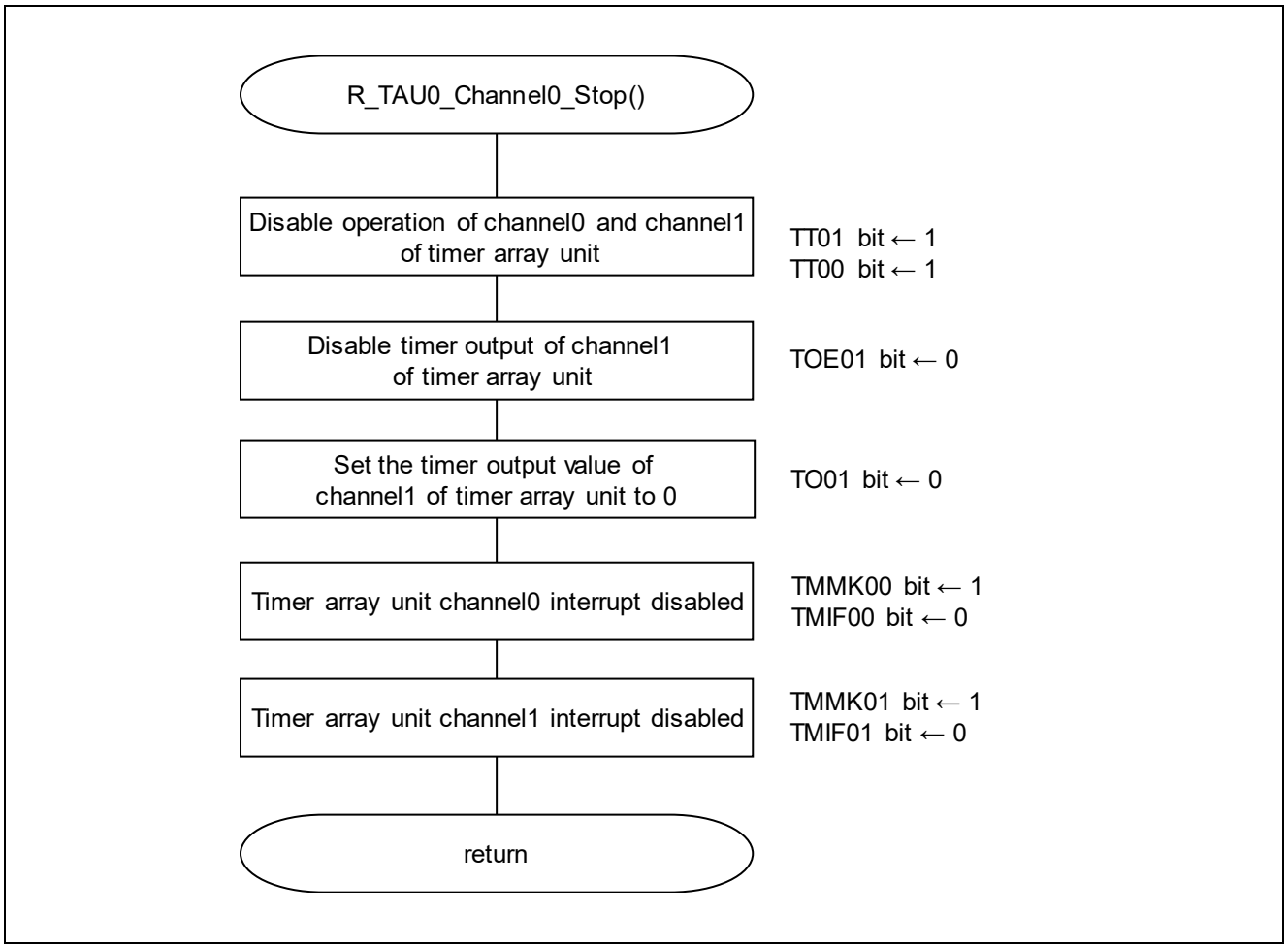

Figure 5.23 Timer Array Unit Channel0 Operation Stop Function

5.7.18 Timer Array Unit Channel2 Operation Start Function

Figure 5.24 shows the flowchart of the timer array unit channel2 operation start function.

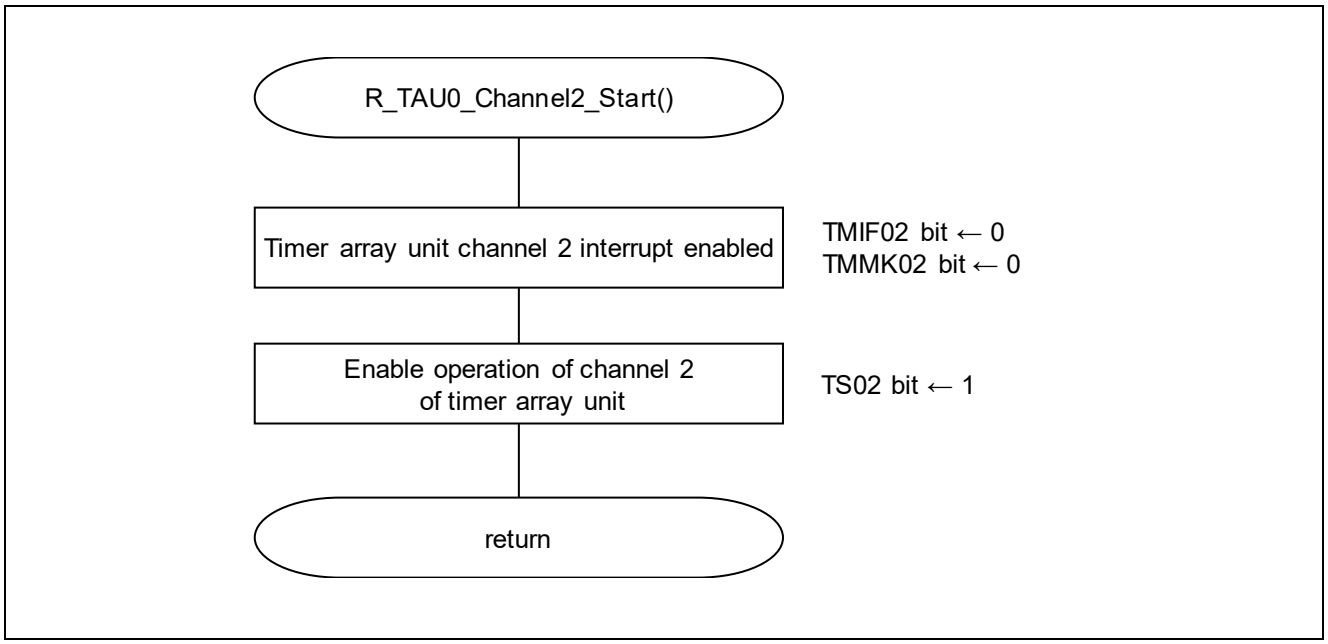

Figure 5.24 Timer Array Unit Channel2 Operation Start Function

5.7.19 Timer Array Unit Channel2 Operation Stop Function

Figure 5.25 shows the flowchart of the timer array unit channel2 operation stop function.

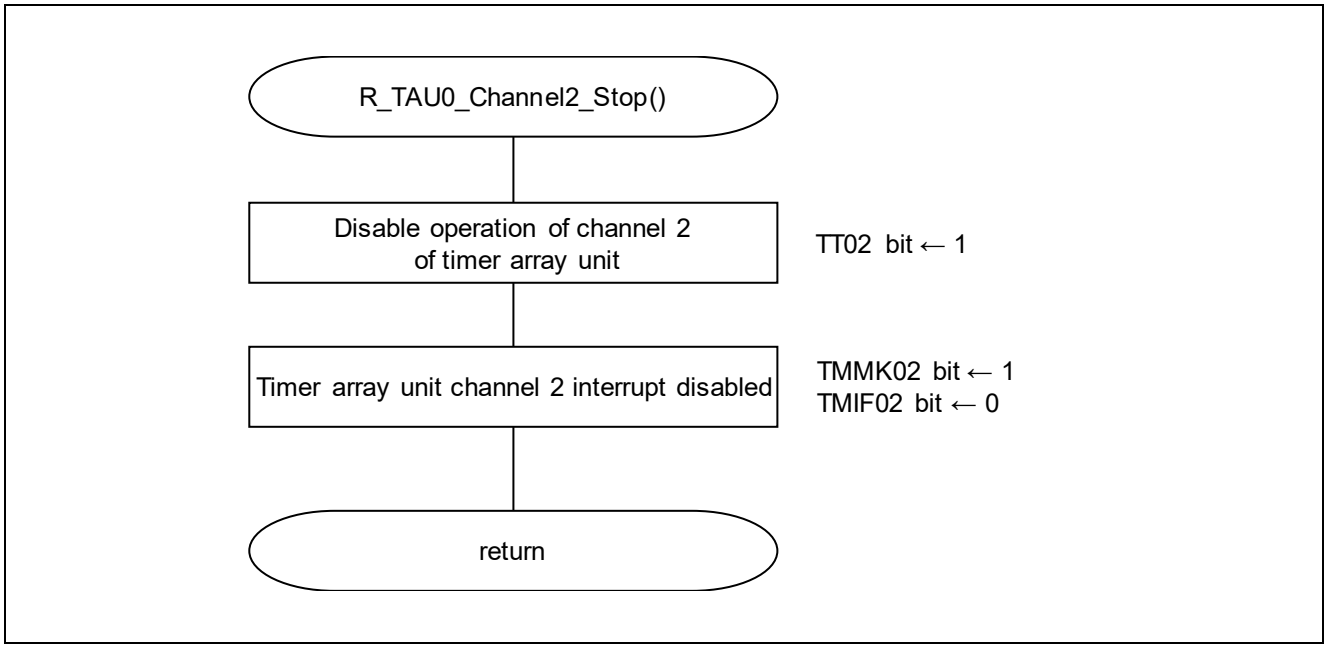

Figure 5.25 Timer Array Unit Channel2 Operation Stop Function

5.7.20 Timer Array Unit Channel3 Operation Start Function

Figure 5.26 shows the flowchart of the timer array unit channel3 operation start function.

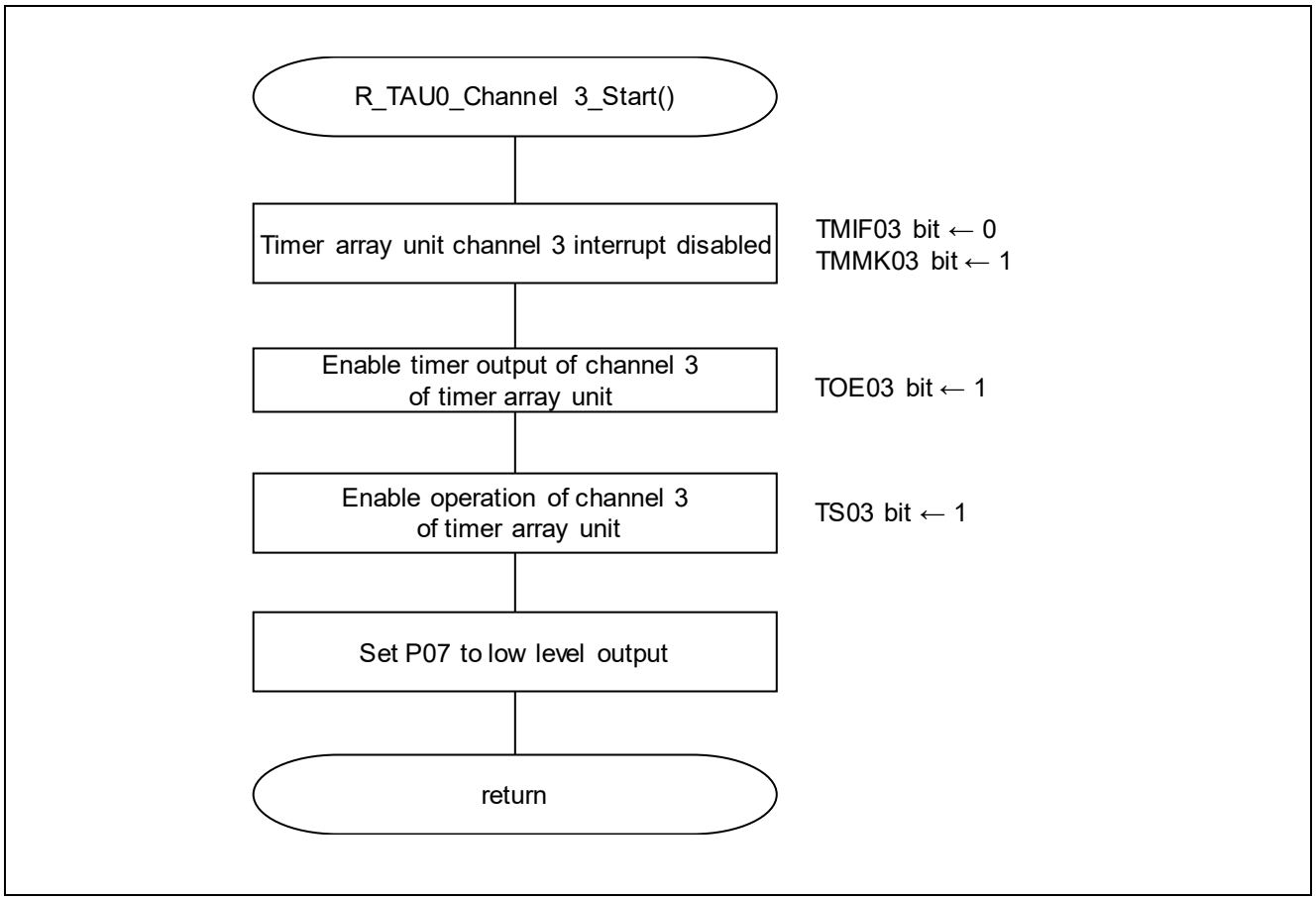

Figure 5.26 Timer Array Unit Channel3 Operation Start Function

5.7.21 Timer Array Unit Channel3 Operation Stop Function

Figure 5.27 shows the flowchart of the timer array unit channel3 operation stop function.

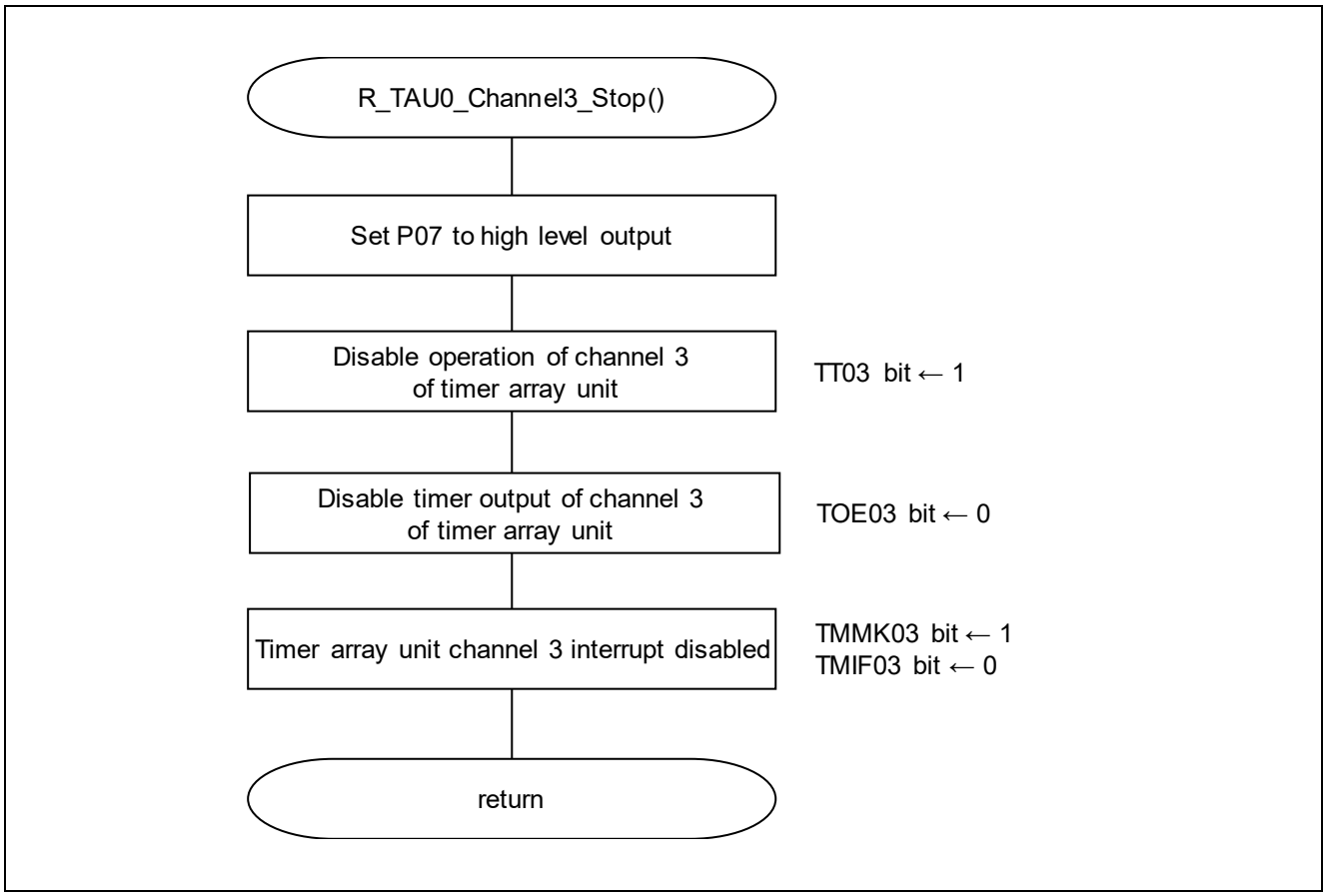

Figure 5.27 Timer Array Unit Channel3 Operation Stop Function

5.7.22 Interval Timer Signal Detection Interrupt Function

Figure 5.28 shows the flowchart of the interval timer signal detection interrupt function.

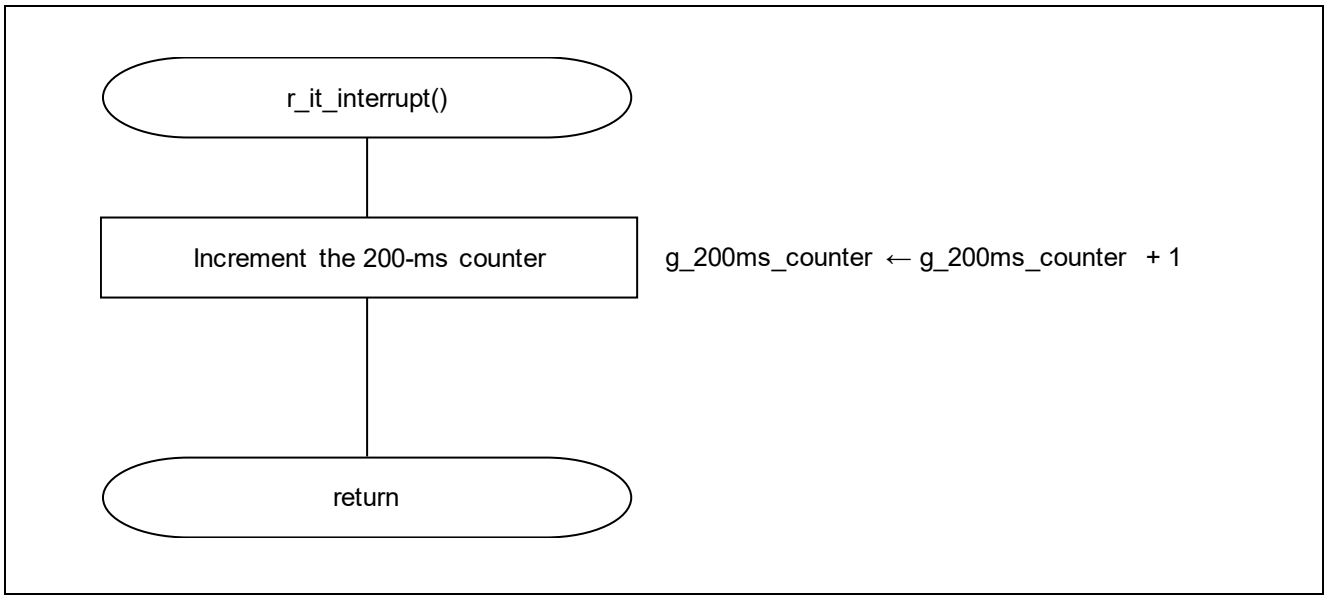

Figure 5.28 Interval Timer Signal Detection Interrupt Function

5.7.23 External Interrupt Processing of INTP0

Figure 5.29 and Figure 5.30 shows the flowchart of the external interrupt processing of INTP0.

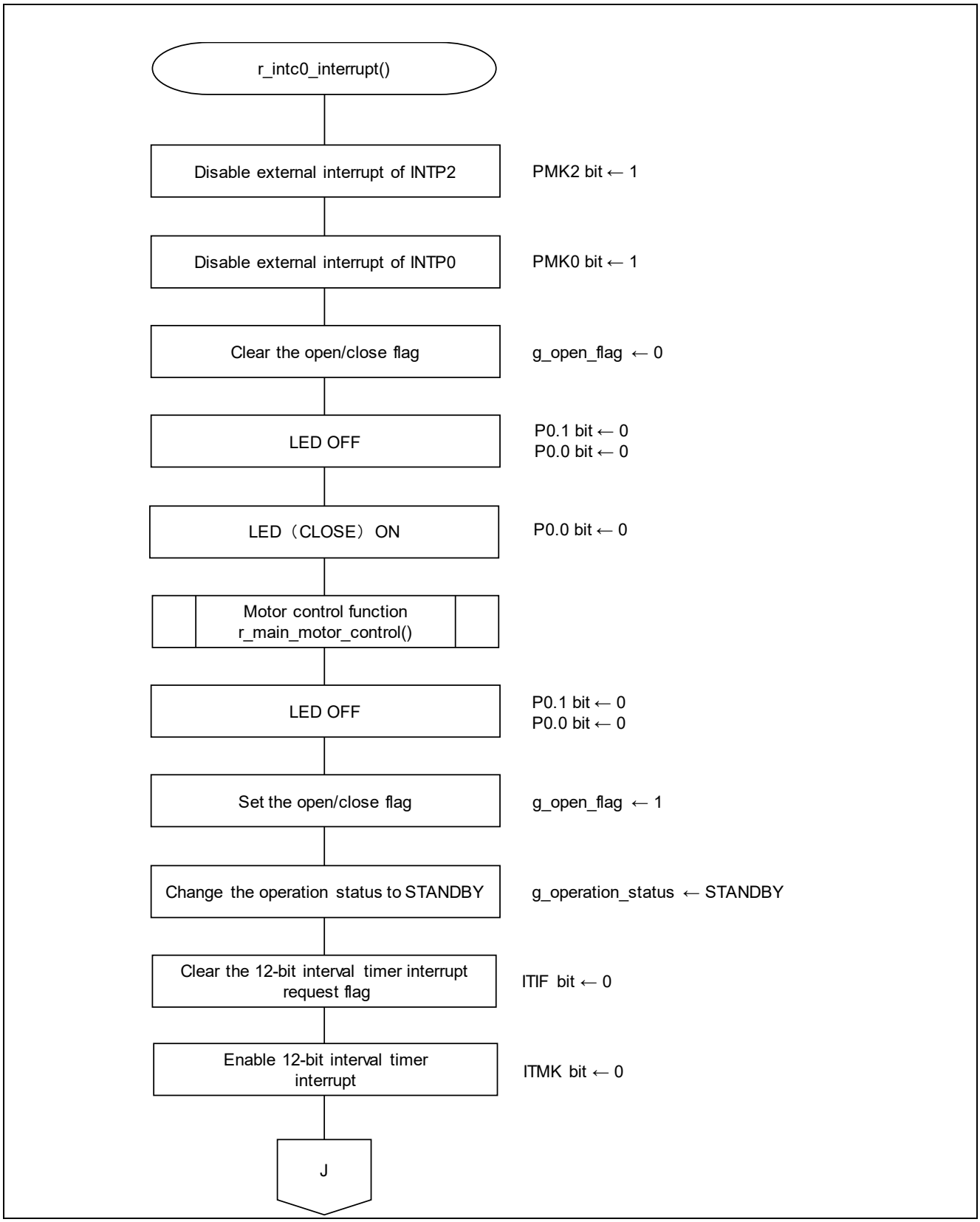

Figure 5.29 External Interrupt Processing of INTP0 (1/2)

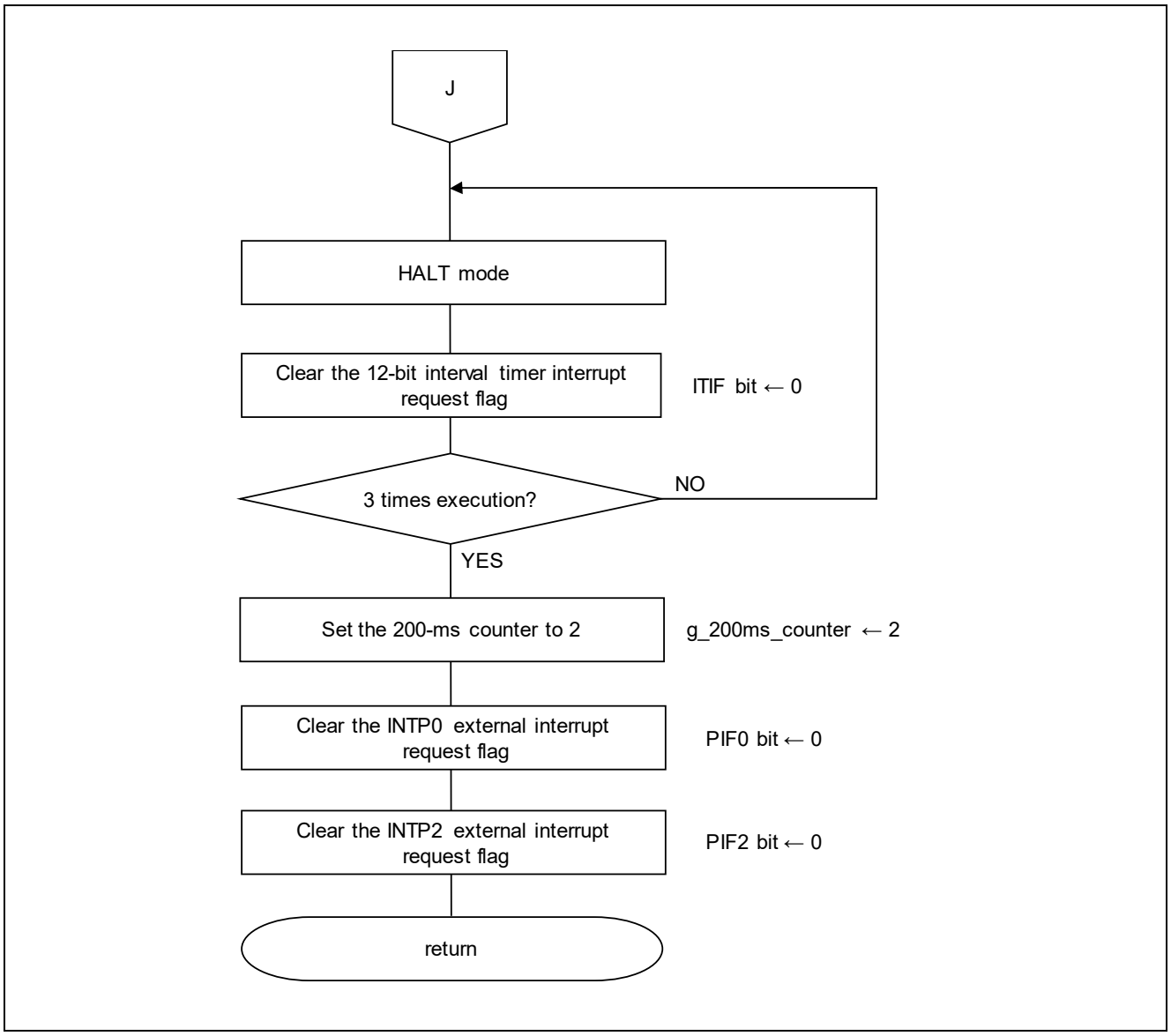

Figure 5.30 External Interrupt Processing of INTP0 (2/2)

5.7.24 External Interrupt Processing of INTP2

Figure 5.31 shows the flowchart of the external interrupt processing of INTP0.

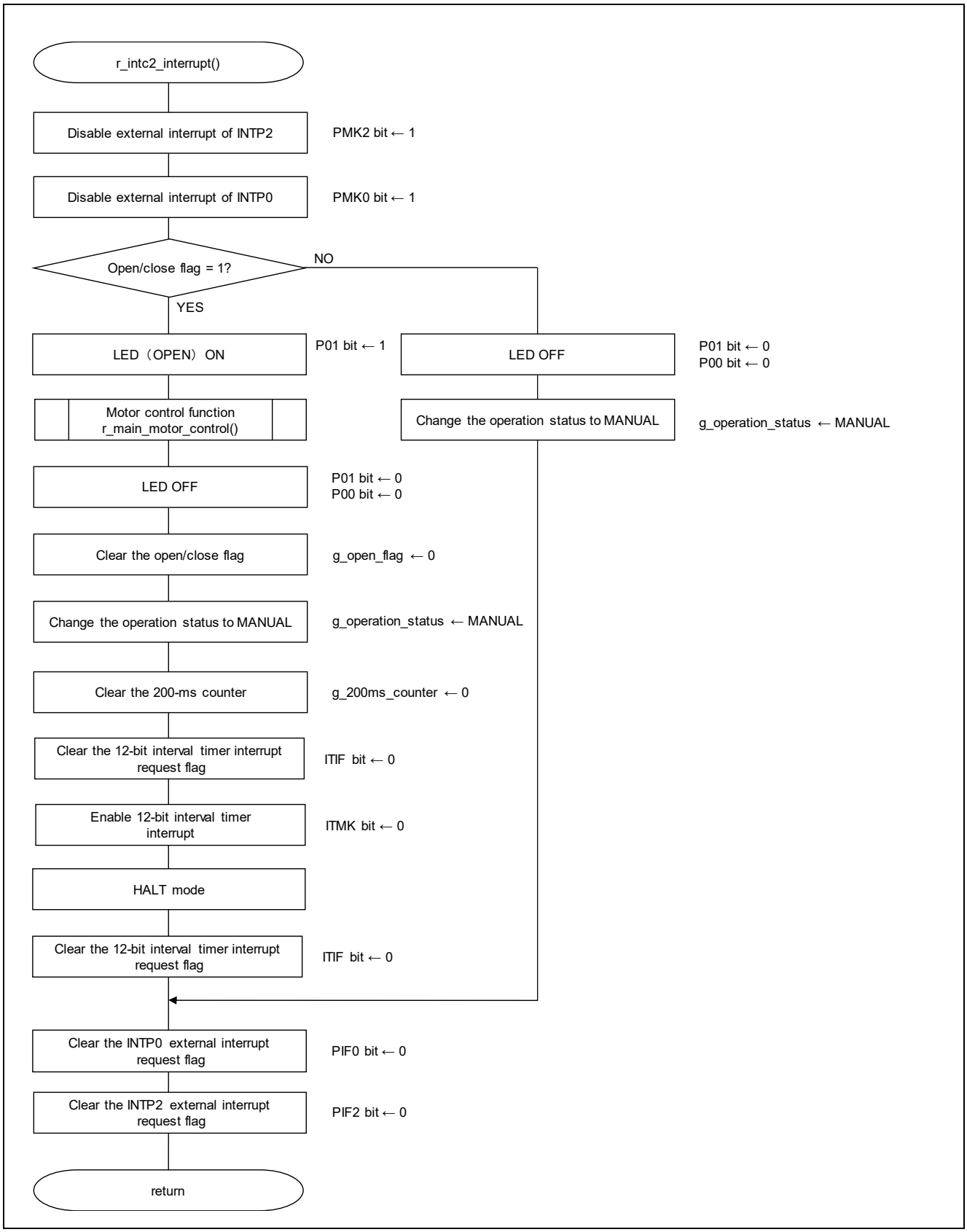

Figure 5.31 External Interrupt Processing of INTP2

6. Sample Code

The sample code is available on the Renesas Electronics Website.

7. Documents for Reference

RL78/G10 User's Manual: Hardware (R01UH0384E)

RL78 Family User's Manual: Software (R01US0015E)

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

Technical Updates/Technical Brochures

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Revision History

		Description	
Rev.	**Date**	**Page**	**Summary**
1.00	Mar. 9, 2018	—	First edition issued

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. Handling of Unused Pins

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

   ¾ 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.

   ¾ 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.

   ¾ 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.

   ¾ 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.

   ¾ The characteristics of Microprocessing unit or Microcontroller unit products in the same group but having a different part number may differ in terms of the 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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