

RL78/G12

R01AN1030EJ0100

Rev.1.00

Initialization

Mar. 30, 2012

Introduction

This application note describes the basic setting items that are necessary for initializing the RL78/G12.

The sample program discussed in this application note initializes the RL78/G12 and provides on/off control of three LEDs according to the combination of two switch input states.

Target Device

RL78/G12

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1. Specification

The sample program described in this application note performs basic initialization steps such as the setup of the clock frequency and input/output ports. After the initialization, the program controls, in its main processing routine, the On/Off of three LEDs according to the combination of two switch input states.

Table 1.1 lists the peripheral functions to be used and their usage and figure 1.1 shows the outline of the processing.

Table 1.1 Peripheral Functions to be Used and their Usage

| Peripheral Function | Usage |
|---------------------|-----------------------------------------------------------------|
| Port input/output | Switch input (SW1 and SW2) LED On/Off control (LED0 to LED2) |

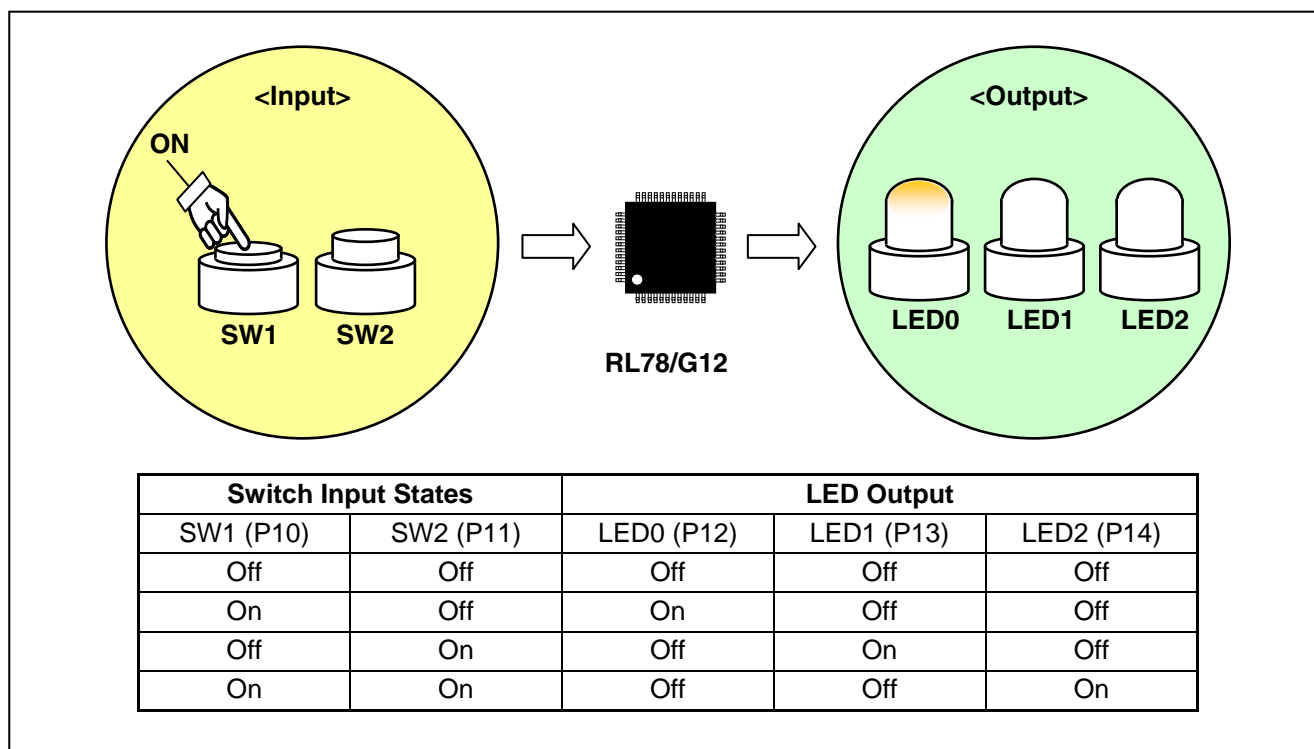


Figure 1.1 Operation Processing Outline

2. Operation Evaluate Conditions

The sample code contained in this application note has been evaluated under the conditions listed in the table below.

Table 2.1 Operation Check Conditions

| Item | Description |
|------------------------------------|----------------------------------------------------------------------------------------------------------------------------|
| Microcontroller used | RL78/G12 (R5F1026A) |
| Operating frequency | High-speed on-chip oscillator (HOCO) clock: 24 MHz CPU/peripheral hardware clock: 24 MHz |
| Operating voltage | 5.0 V (can run on a voltage range of 2.9 V to 5.5 V.) LVD operation (V_{LVI}): Reset mode 2.81 V (2.76 V to 2.87 V) |
| Integrated development environment | CubeSuite+ V1.01.01 from Renesas Electronics Corp. |
| Assembler | RA78K0R V1.50 from Renesas Electronics Corp. |
| Board used | RL78/G12 target board (QB-R5F1026A-TB) + SW and LED |

3. Description of the Hardware

3.1 Hardware Configuration Example

The example of configuration of the hardware that is used for this application note is shown below.

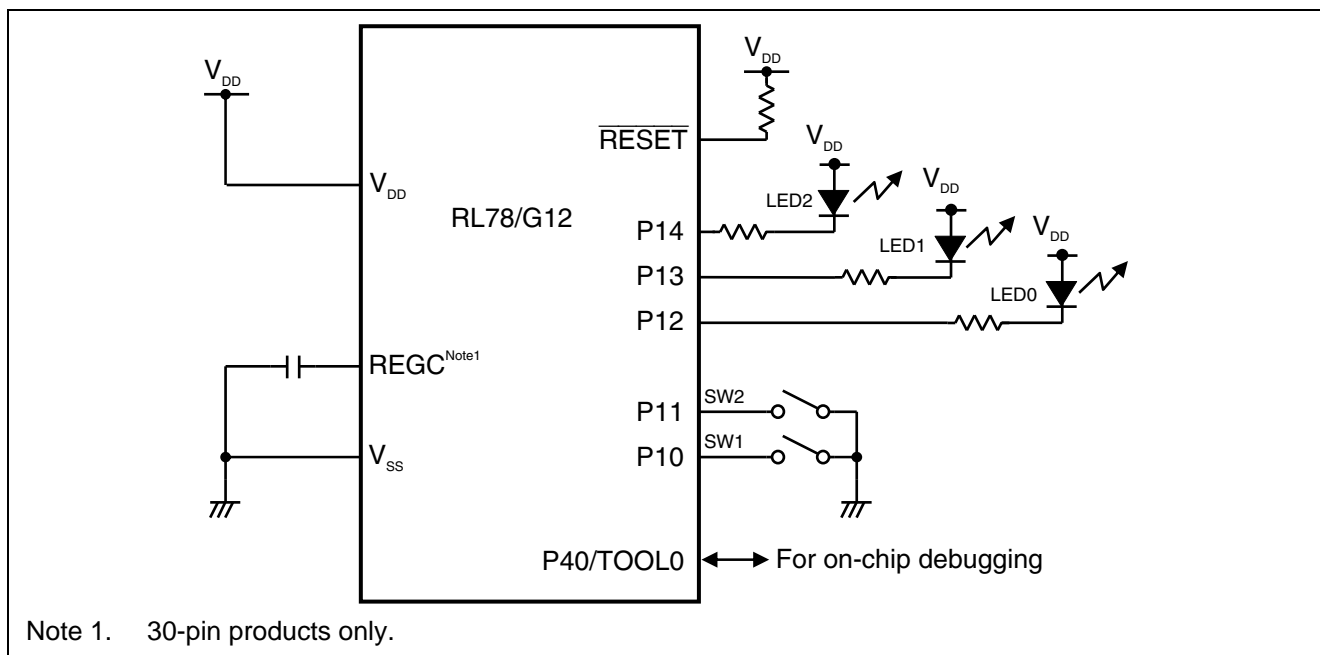


Figure 3.1 Hardware Configuration

- 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 characteristics conditions 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 LVD detection voltage (V_{LVI}) that is specified as LVD.

3.2 List of Pins to be used

Table 3.1 lists the pins to be used and their functions.

Table 3.1 Pins to be Used and Their Functions

| Pin Name | I/O | Description |
|----------|--------|-------------------------|
| P10 | Input | Switch input (SW1) port |
| P11 | Input | Switch input (SW2) port |
| P12 | Output | LED (LED0) control port |
| P13 | Output | LED (LED1) control port |
| P14 | Output | LED (LED2) control port |

4. Description of the Software

4.1 Operation Outline

The sample program described in this application note initializes the CPU (e.g., selecting the CPU clock frequency) and sets up its I/O ports.

After completing the hardware setup, the sample program controls the On/Off of three LEDs (LED0 to LED2) according to the combination of states of two switch inputs (SW1 and SW2).

1. CPU initialization^{Note1}

- Sets up the peripheral I/O redirection function.
- Sets up the I/O ports.
- Sets up the CPU clock.

Note 1. The option bytes are referenced before the CPU is initialized.

<Setup conditions>

- Sets the reset value because the CPU does not use the peripheral I/O redirection function (PIOR register).
- Makes the following configurations for the I/O ports:
 1. Configures the ports that are configured for analog input after the release of the reset state for digital I/O (ADPC register and port mode control registers).
 2. Configures P10 and P11 which are used as switch inputs (SW1 and SW2) for input and the other ports for output (port mode register).
 3. Connects on-chip pull-up resistors to P10 and P11 which are to be used as switch inputs (SW1 and SW2) (pull-up resistor option register).
 4. Sets P12 to P14 which are used for On/Off control of LEDs (LED0 to LED2) to 1 and the other unused pins to 0 (port register).
- Sets up the CPU clock.
 1. Sets the reset value because the high-speed system clock is not to be in use (clock operation mode control (CMC) register and clock operation status control (CSC) register).
 2. Selects the HOCO (f_{IH}) as the CPU/peripheral hardware clock (f_{CLK}) (system clock control (CKC) register).
- 2. Executes the main processing.
 - Performs the LED output control as summarized in table 4.1 according to the state of the switch inputs (SW1 and SW2).

Table 4.1 Main Processing

| Switch Input States | | LED Output | | |
|---------------------|-----------|------------|------------|------------|
| SW1 (P10) | SW2 (P11) | LED0 (P12) | LED1 (P13) | LED2 (P14) |
| Off | Off | Off | Off | Off |
| On | Off | On | Off | Off |
| Off | On | Off | On | Off |
| On | On | Off | Off | On |

Note: Refer to RL78/G12 User's Manual Manual for notes on device use.

4.2 List of Option Byte Settings

Table 4.2 summarizes the settings of the option bytes.

Table 4.2 Option Byte Settings

| Address | Value | Description |
|---------|-----------|-----------------------------------------------------------------------------------------------|
| 000C0H | 01101110B | Stops the watchdog timer operation. (Stops counting after the release of the reset state.) |
| 000C1H | 01111111B | LVD reset mode 2.81 V (2.76 V to 2.87 V) |
| 000C2H | 11100000B | HS mode, HOCO: 24 MHz |
| 000C3H | 10000101B | Enables the on-chip debugging function. |

4.3 List of Functions (Subroutine)

Table 4.3 lists the functions that are used by this sample program.

Table 4.3 Functions (Subroutine)

| Function (Subroutine) Name | Outline |
|----------------------------|------------------------------------------------------------|
| RESET_START | Initializes the hardware settings and calls main function. |
| SINIOPORT | Initializes the I/O ports. |
| SINICLK | Initializes the clock generator. |
| main | Main function |

4.4 Function (Subroutine) Specifications

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

[Function Name] RESET_START

| | |
|--------------|--------------------------------------------------------------------------------------------------------|
| Synopsis | Initialize CPU at reset start. |
| Declaration | — |
| Explanation | Sets the stack pointer and, after making initial hardware settings, calls the main processing routine. |
| Arguments | None |
| Return value | None |
| Remarks | None |

[Function Name] SINIPORT

| | |
|--------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Synopsis | Set I/O ports. |
| Declaration | — |
| Explanation | Sets P10 and P11 as input points (internal pull-up resistor enabled) and P12, P13, and P14 as output ports (high-level output). Sets all other I/O ports, except P40, as output ports (low-level output). |
| Arguments | None |
| Return value | None |
| Remarks | None |

[Function Name] SINICKL

| | |
|--------------|-----------------------------------------------------------|
| Synopsis | Set clock generator circuit. |
| Declaration | — |
| Explanation | Initializes the registers related to the clock generator. |
| Arguments | None |
| Return value | None |
| Remarks | None |

[Function Name] main

| | | | | | | | | | | | | | | | | | | | | | | | | | | |
|--------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|---|-----------|---|-------|---|---|---|---|-----------|---|---|---|---|-----------|---|---|---|---|-----------|---|---|---|---|-----------|
| Synopsis | Main function | | | | | | | | | | | | | | | | | | | | | | | | | |
| Declaration | — | | | | | | | | | | | | | | | | | | | | | | | | | |
| Explanation | <p>The main processing function of the sample code.</p> <p>Outputs the following values to P1 according to the values of SW1 (P10) and SW2 (P11):</p> <table><tr><td>SW2</td><td>:</td><td>SW1</td><td>:</td><td>PORT1</td></tr><tr><td>0</td><td>:</td><td>0</td><td>:</td><td>00001100B</td></tr><tr><td>0</td><td>:</td><td>1</td><td>:</td><td>00010100B</td></tr><tr><td>1</td><td>:</td><td>0</td><td>:</td><td>00011000B</td></tr><tr><td>1</td><td>:</td><td>1</td><td>:</td><td>00011100B</td></tr></table> | SW2 | : | SW1 | : | PORT1 | 0 | : | 0 | : | 00001100B | 0 | : | 1 | : | 00010100B | 1 | : | 0 | : | 00011000B | 1 | : | 1 | : | 00011100B |
| SW2 | : | SW1 | : | PORT1 | | | | | | | | | | | | | | | | | | | | | | |
| 0 | : | 0 | : | 00001100B | | | | | | | | | | | | | | | | | | | | | | |
| 0 | : | 1 | : | 00010100B | | | | | | | | | | | | | | | | | | | | | | |
| 1 | : | 0 | : | 00011000B | | | | | | | | | | | | | | | | | | | | | | |
| 1 | : | 1 | : | 00011100B | | | | | | | | | | | | | | | | | | | | | | |
| Arguments | None | | | | | | | | | | | | | | | | | | | | | | | | | |
| Return value | None | | | | | | | | | | | | | | | | | | | | | | | | | |
| Remarks | | | | | | | | | | | | | | | | | | | | | | | | | | |

4.5 Flowcharts

Figure 4.1 shows the overall flow of the sample program described in this application note.

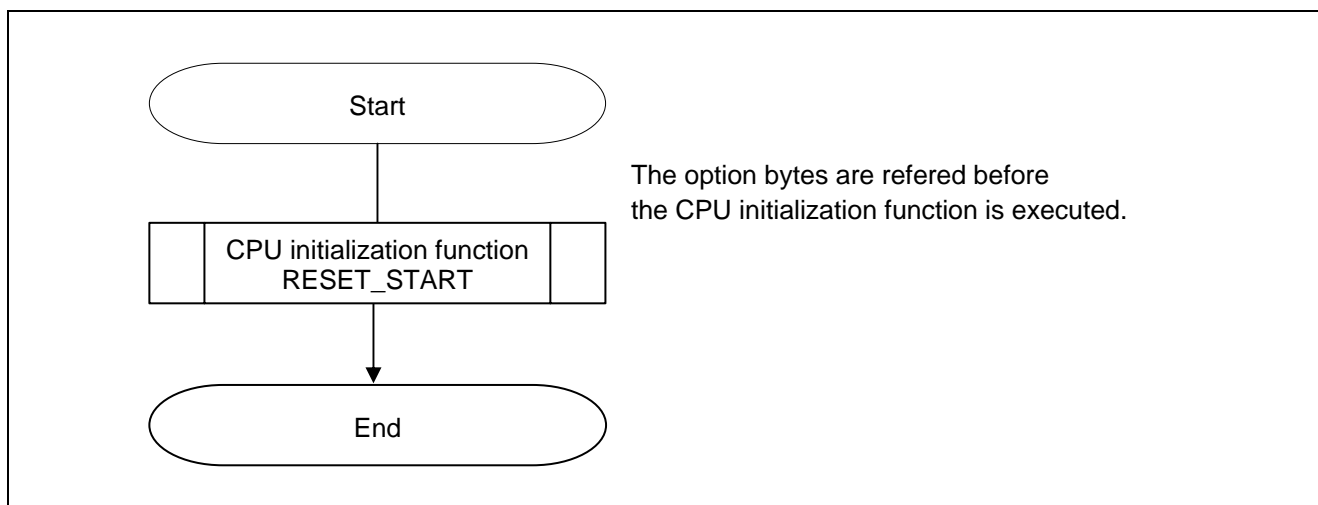


Figure 4.1 Overall Flow

Option Byte Configuration Outline

The option bytes of the RL78/G12 are made up of user option bytes (000C0H-000C2H) and on-chip debugging option bytes (000C3H).

The option bytes are automatically referred and the prespecified functions are set up when power is first supplied or after the release of the reset state. The option bytes cannot be set up by any user program.

The option bytes can exercise the controls listed below. The settings of the option bytes are contained in the file opt.asm.

- User option bytes
 - Makes settings related to the watchdog timer (000C0H).
 - Makes LVD-related and RESET pin function settings (000C1H).
 - Sets up the HOCO and flash memory operation mode (000C2H).
- On-chip debugging option bytes (000C3H)

The option byte settings can be specified through “User Option Byte Values” in the “Device” panel of the “Link Option” tag in CubeSuite+. Settings made via the “Link Option” tag take precedence over settings specified in software programs. Therefore, “Set user option bytes” should be set to “No,” as shown below.

| Device | |
|----------------------------------|----------|
| Use on-chip debug | Yes(-go) |
| Option byte values for OCD | HEX 85 |
| Debug monitor area start address | HEX 3E00 |
| Debug monitor area size[byte] | 512 |
| Set user option byte | No |

Note: For details on the procedure for setting up the CubeSuite+ link options, refer to the CubeSuite+ tutorial.

(1) 000C0H (Watchdog Timer Related Settings)

| | | | | | | | |
|--------|---------|---------|-------|-------|-------|-------|----------|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| WDTINT | WINDOW1 | WINDOW0 | WDTON | WDCS2 | WDCS1 | WDCS0 | WDSTBYON |
| 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 |

Bit 0

| WDSTBYON | Control of Watchdog Timer Counter (HALT/STOP mode) |
|----------|----------------------------------------------------|
| 0 | Disables counter operation in HALT/STOP mode. |
| 1 | Enables counter operation in HALT/STOP mode. |

Bits 3 to 1

| WDCS2 to WDCS0 | Watchdog Timer Overflow Time |
|----------------|------------------------------|
| 000 | $2^6/f_{IL}$ |
| 001 | $2^7/f_{IL}$ |
| 020 | $2^8/f_{IL}$ |
| 011 | $2^9/f_{IL}$ |
| 100 | $2^{11}/f_{IL}$ |
| 101 | $2^{13}/f_{IL}$ |
| 110 | $2^{14}/f_{IL}$ |
| 111 | $2^{16}/f_{IL}$ |

Bit 4

| WDTON | Control of Watchdog Timer Counter |
|-------|-------------------------------------------------------------------------------------|
| 0 | Disables counter operation. (Stops counter after the release of reset sequence.) |
| 1 | Enables counter operation. (Starts counter after the release of reset sequence.) |

Bits 6 and 5

| WINDOW1 and WINDOW0 | Watchdog Timer Window Open Period |
|---------------------|-----------------------------------|
| 00 | Setting prohibited |
| 01 | 50% |
| 10 | 75% |
| 11 | 100% |

Bit 7

| WDTINT | Use of Interval Interrupts of watchdog timer |
|--------|---------------------------------------------------------|
| 0 | Interval interrupt is not used. |
| 1 | An interval interrupt is generated when 75% is reached. |

(2) 000C1H (LVD-Related Settings)

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-------|-------|-------|----------|-------|-------|---------|---------|
| VPOC2 | VPOC1 | VPOC0 | PORTSELB | LVIS1 | LVIS0 | LVIMDS1 | LVIMDS0 |
| 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

When Used as Interrupt and Reset Mode

| Detection Voltage | | | Option Byte Setting Value | | | | | | | | | | | |
|-------------------|--------------|-------------------|---------------------------|---------|-------|-------|-------|-------|-------|---|---|---|---|---|
| V _{LVIH} | | V _{LVIL} | LVIMDS1 | LVIMDS0 | VPOC2 | VPOC1 | VPOC0 | LVIS1 | LVIS0 | | | | | |
| Rising edge | Falling edge | Falling edge | | | | | | | | | | | | |
| 1.98 V | 1.94 V | 1.84 V | | | | | | | | | | | | |
| 2.09 V | 2.04 V | | | | | | | | | | | | | |
| 3.13 V | 3.06 V | | | | | | | | | | | | | |
| 2.61 V | 2.55 V | 2.45 V | | | | | | | | 0 | 1 | 0 | 1 | 0 |
| 2.71 V | 2.65 V | | | | | | | | | | | | 0 | 1 |
| 3.75 V | 3.67 V | | | | | | | | | | | | 0 | 0 |
| 2.92 V | 2.86 V | 2.75 V | | | | | | | | 0 | 1 | 1 | 1 | 0 |
| 3.02 V | 2.96 V | | | | | | | | | | | | 0 | 1 |
| 4.06 V | 3.98 V | | 0 | 0 | | | | | | | | | | |
| Other than above | | | Setting prohibited | | | | | | | | | | | |

When Used as Reset Mode

| Detection Voltage | | Option Byte Setting Value | | | | | | |
|-------------------|-------------------|---------------------------|---------|-------|-------|-------|-------|-------|
| V _{LVIH} | V _{LVIL} | LVIMDS1 | LVIMDS0 | VPOC2 | VPOC1 | VPOC0 | LVIS1 | LVIS0 |
| Rising edge | Falling edge | | | | | | | |
| 1.88 V | 1.84 V | 1 | 1 | 0 | 0 | 1 | 1 | 1 |
| 1.98 V | 1.94 V | | | 0 | 0 | 1 | 1 | 0 |
| 2.09 V | 2.04 V | | | 0 | 0 | 1 | 0 | 1 |
| 2.50 V | 2.45 V | | | 0 | 1 | 0 | 1 | 1 |
| 2.61 V | 2.55 V | | | 0 | 1 | 0 | 1 | 0 |
| 2.71 V | 2.65 V | | | 0 | 1 | 0 | 0 | 1 |
| 2.81 V | 2.75 V | | | 0 | 1 | 1 | 1 | 1 |
| 2.92 V | 2.86 V | | | 0 | 1 | 1 | 1 | 0 |
| 3.02 V | 2.96 V | | | 0 | 1 | 1 | 0 | 1 |
| 3.13 V | 3.06 V | | | 0 | 0 | 1 | 0 | 0 |
| 3.75 V | 3.67 V | | | 0 | 1 | 0 | 0 | 0 |
| 4.06 V | 3.98 V | | | 0 | 1 | 1 | 0 | 0 |
| Other than above | | Setting prohibited | | | | | | |

When Used as Interrupt Mode

| Detection Voltage | | Option Byte Setting Value | | | | | | |
|-------------------|-------------------|---------------------------|---------|-------|-------|-------|-------|-------|
| V _{LVIH} | V _{LVIL} | LVIMDS1 | LVIMDS0 | VPOC2 | VPOC1 | VPOC0 | LVIS1 | LVIS0 |
| Rising edge | Falling edge | | | | | | | |
| 1.88 V | 1.84 V | 0 | 1 | 0 | 0 | 1 | 1 | 1 |
| 1.98 V | 1.94 V | | | 0 | 0 | 1 | 1 | 0 |
| 2.09 V | 2.04 V | | | 0 | 0 | 1 | 0 | 1 |
| 2.50 V | 2.45 V | | | 0 | 1 | 0 | 1 | 1 |
| 2.61V | 2.55 V | | | 0 | 1 | 0 | 1 | 0 |
| 2.71 V | 2.65 V | | | 0 | 1 | 0 | 0 | 1 |
| 2.81 V | 2.75 V | | | 0 | 1 | 1 | 1 | 1 |
| 2.92 V | 2.86 V | | | 0 | 1 | 1 | 1 | 0 |
| 3.02 V | 2.96 V | | | 0 | 1 | 1 | 0 | 1 |
| 3.13 V | 3.06 V | | | 0 | 0 | 1 | 0 | 0 |
| 3.75 V | 3.67 V | | | 0 | 1 | 0 | 0 | 0 |
| 4.06 V | 3.98 V | | | 0 | 1 | 1 | 0 | 0 |
| Other than above | | Setting prohibited | | | | | | |

When LVD Is Off

| Detection Voltage | | Option Byte Setting Value | | | | | | |
|-------------------|-------------------|---------------------------|---------|-------|-------|-------|-------|-------|
| V _{LVIH} | V _{LVIL} | LVIMDS1 | LVIMDS0 | VPOC2 | VPOC1 | VPOC0 | LVIS1 | LVIS0 |
| Rising edge | Falling edge | | | | | | | |
| — | — | 0/1 | 1 | 1 | × | × | × | × |
| Other than above | | Setting prohibited | | | | | | |

Remarks: × = don't care

| PORTSELB | |
|----------|------------------------------------------------------------|
| 0 | Port function (P125/KR1/SI01) |
| 1 | RESET input (PU125 = 1, internal pull-up resistor enabled) |

(3) 000C2H (HOCO and Flash Memory Operation Settings)

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|--------|--------|---|---|---------|---------|---------|---------|
| CMODE1 | CMODE0 | 1 | 0 | FRQSEL3 | FRQSEL2 | FRQSEL1 | FRQSEL0 |
| 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |

Bits 7 and 6

| CMODE1 | CMODE0 | Setting of Flash Memory Operating Mode | | |
|------------------|--------|----------------------------------------|---------------------------|-------------------------|
| | | | Operating Frequency Range | Operating Voltage Range |
| 1 | 0 | LV (low voltage main) mode | 1 MHz to 8 MHz | 1.8 V to 5.5 V |
| 1 | 1 | HS (high speed main) mode | 1 MHz to 16 MHz | 2.4 V to 5.5 V |
| | | | 1 MHz to 24 MHz | 2.7 V to 5.5 V |
| Other than above | | Setting prohibited | | |

Bits 3 to 0

| FRQSEL3 | FRQSEL2 | FRQSEL1 | FRQSEL0 | HOCO Frequency |
|------------------|---------|---------|---------|--------------------|
| 0 | 0 | 0 | 0 | 24 MHz |
| 1 | 0 | 0 | 1 | 16 MHz |
| 0 | 0 | 0 | 1 | 12 MHz |
| 1 | 0 | 1 | 0 | 8 MHz |
| 1 | 0 | 1 | 1 | 4 MHz |
| 1 | 1 | 0 | 1 | 1 MHz |
| Other than above | | | | Setting prohibited |

(4) 000C3H (On-Chip Debugging Option Bytes)

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|----------|---|---|---|---|---|---|---------|
| OCDENSET | 0 | 0 | 0 | 0 | 1 | 0 | OCDERSD |
| 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |

Bits 7 and 0

| OCDENSET | OCDERSD | Control of On-chip Debugging Operation |
|----------|---------|--------------------------------------------------------------------------------------------------|
| 0 | 0 | Disables on-chip debugging. |
| 0 | 1 | Setting prohibited |
| 1 | 0 | Enables operation and erases flash memory data when authentication of security ID fails. |
| 1 | 1 | Enables operation but does not erase flash memory data when authentication of security ID fails. |

4.5.1 CPU Initialization Function

Figure 4.2 shows a flowchart of the CPU initialization function.

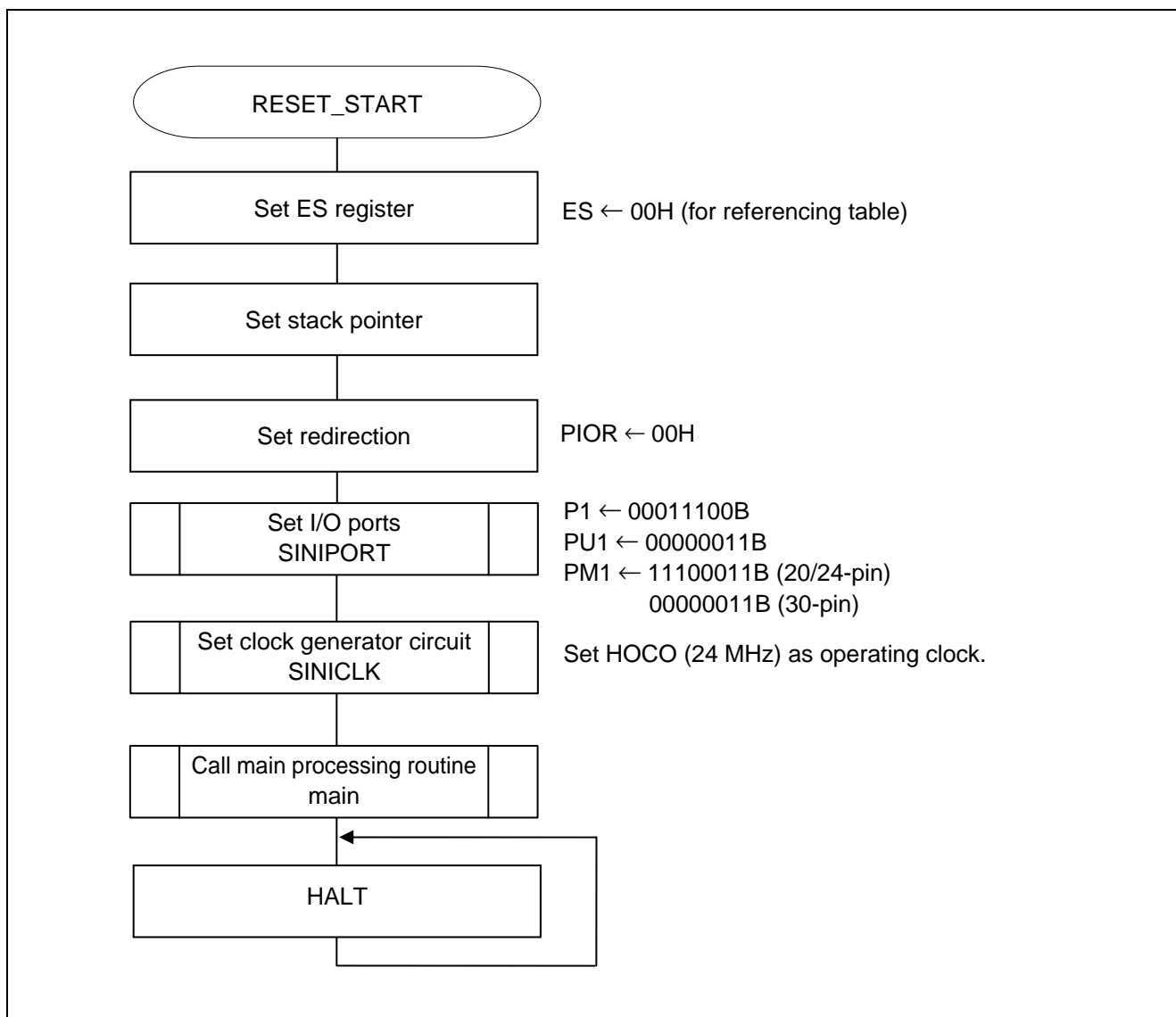


Figure 4.2 CPU Initialization Function

4.5.2 Setting up the I/O Ports

Figure 4.3 shows the flowchart for setting up the I/O ports.

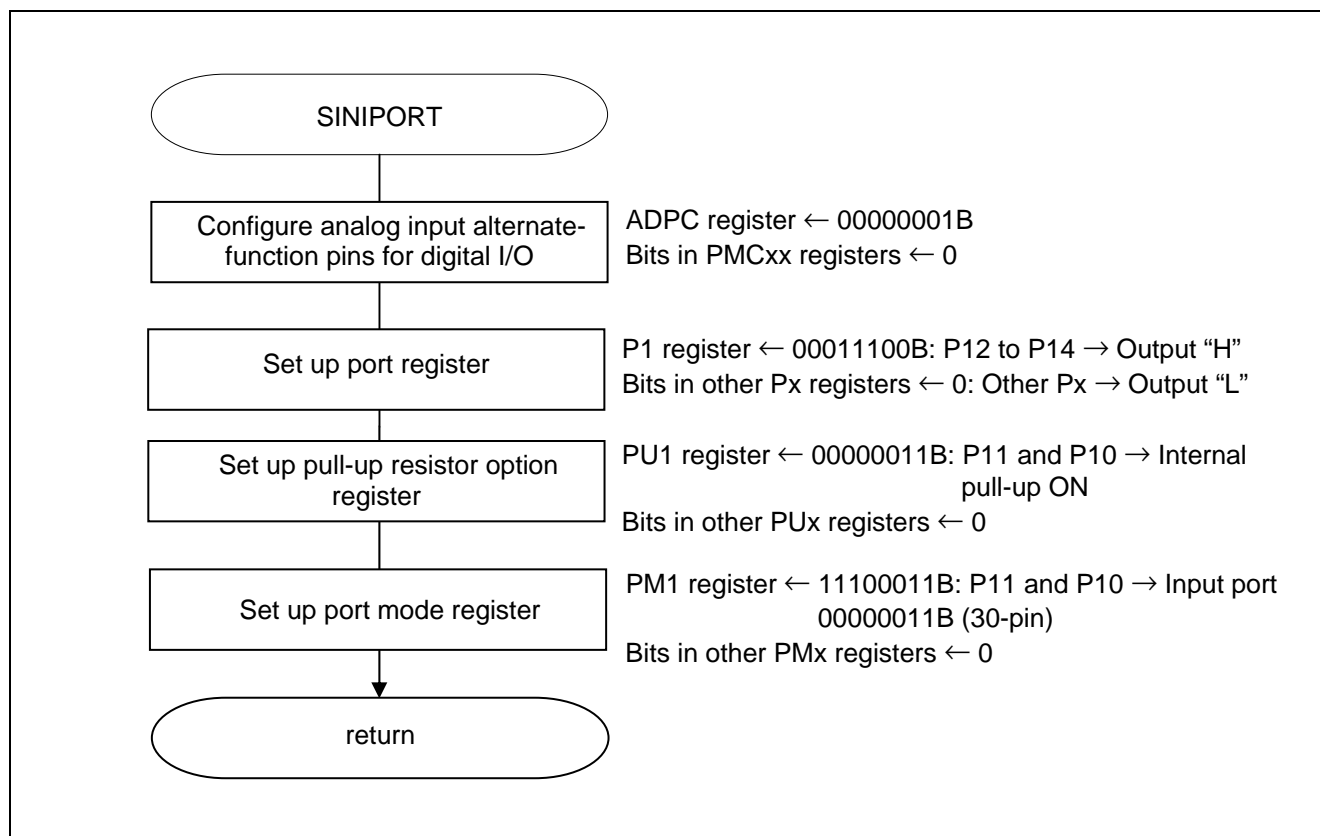


Figure 4.3 I/O Port Setup

Outline of I/O Port Setup

The RL78/G12 is equipped with digital I/O ports so that it can provide a variety of controls.

The I/O ports serve multiple pin functions in addition to serving as digital I/O ports.

The I/O ports are controlled by the registers listed below. They must be set up during the system initialization routine that is executed when power is first supplied or after the release of the reset state.

Registers that are used to manipulate ports:

- Port mode register (PMxx)
- Port register (Pxx)
- Pull-up resistor option register (PUxx)
- Port input mode register (PIMx)
- Port output mode register (POMx)
- Port mode control register (PMCxx)^{Note1}
- A/D port configuration register (ADPC)^{Note1}

Note 1. A register used to place port pins in digital I/O or analog input mode. Since the port pins are configured for analog input when a reset signal occurs, the pins that are to be used for digital I/O must always be set up with this register after the release of the reset state. For the sample program described in this application note, all port pins are configured for digital I/O.

- Notes 1. Refer to RL78/G12 User's Manual Manual: Hardware for the procedure to set up registers to configure ports as alternate-function pins for peripheral functions.
2. Provide proper treatment for unused pins so that their electrical specifications are observed. Connect each of any unused input-only ports to V_{DD} or V_{SS} via a resistor, independently.

Given below is an example of manipulating ports that are used in this sample code.

Setting Up Ports for LEDs

- Port mode register 1 (PM1)
P12: LED0
P13: LED1
P14: LED2

Setting Up Ports for Switches

- Port mode register 1 (PM1)
- Pull-up resistor option register 1 (PU1)
P10: SW1
P11: SW2

Symbol: PM1

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|----------------------|----------------------|----------------------|------|------|------|------|------|
| PM17 | PM16 | PM15 | PM14 | PM13 | PM12 | PM11 | PM10 |
| 0/1 ^{Note1} | 0/1 ^{Note1} | 0/1 ^{Note1} | 0 | 0 | 0 | 1 | 1 |

| PM1n | PM1n Pin I/O Mode Selection (n = 1 to 7) |
|------|------------------------------------------|
| 0 | Output mode (output buffer on) |
| 1 | Input mode (output buffer off) |

Note 1. The setting differs depending on the product. These pins are not present on 20/24-pin products, so the setting is 1. On 30-pin products the setting is 0.

- Notes 1. This sample code configures any unused ports for output to minimize the adverse influence of through current.
2. For details on the procedure for setting up the registers, refer to RL78/G12 User's Manual: Hardware.

Symbol: PU1

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|------|------|------|------|------|------|------|------|
| PU17 | PU16 | PU15 | PU14 | PU13 | PU12 | PU11 | PU10 |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |

| PU1n | Selection of On-Chip Pull-Up Resistor for P1n Pin |
|------|---------------------------------------------------|
| 0 | On-chip pull-up resistor not connected. |
| 1 | On-chip pull-up resistor connected. |

4.5.3 Clock Generator Circuit Settings

Figure 4.4 shows a flowchart of the clock generator circuit settings.

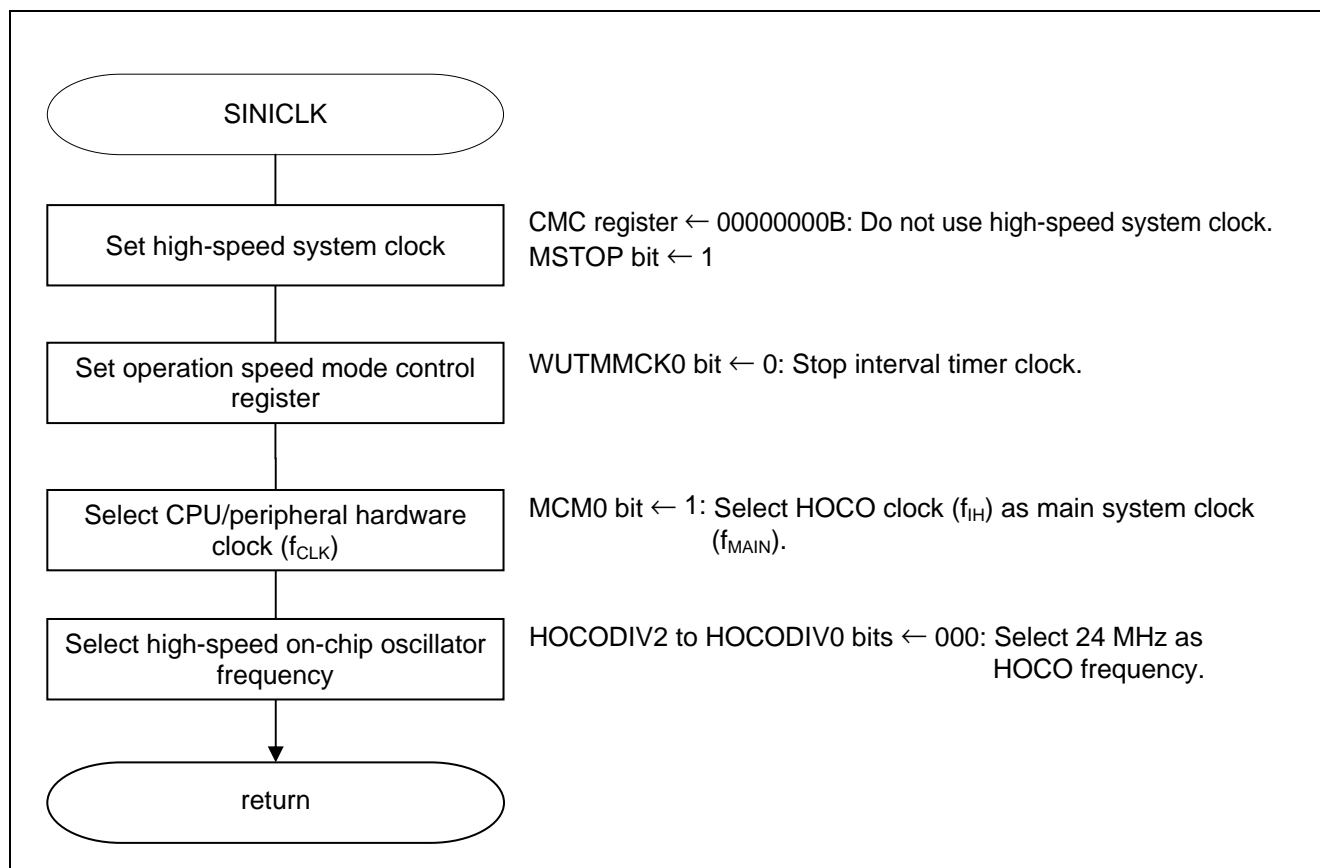


Figure 4.4 Clock Generator Circuit Settings

Outline of CPU Clock Setup

The RL78/G12 allows the user to select the system clock source from the high-speed on-chip oscillator (HOCO) and main system clock oscillator/external clock input.

The system clock is controlled by the registers listed below.

The CPU clock must be initialized during the system initialization routine that is executed when power is first supplied or after the release of the reset state.

Registers that are used to initialize the clock generator:

- Clock operation mode control register (CMC)
- Clock operation status control register (CSC)
- Operation speed mode control register (OSMC)
- System clock control register (CKC)
- High-speed on-chip oscillator frequency selection register (HOCODIV)
- Peripheral enable register 0 (PER0)

Given below is an example of setting up the clock generator for this sample code.

Setting Up the Clock Operating Mode

- Clock operation mode control register (CMC)
 High-speed system clock pin's operating mode: Input port mode
 X1 clock oscillation frequency control: $1\text{ MHz} \leq f_{MX} \leq 10\text{ MHz}$

Symbol: CMC

| | | | | | | | |
|-------|--------|---|---|---|---|---|------|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| EXCLK | OSCSEL | 0 | 0 | 0 | 0 | 0 | AMPH |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Bit 0

| PMPH | Control of X1 Clock Oscillation Frequency |
|------|-----------------------------------------------|
| 0 | $1\text{ MHz} \leq f_{MX} \leq 10\text{ MHz}$ |
| 1 | $10\text{ MHz} < f_{MX} \leq 20\text{ MHz}$ |

Bit 7 and 6

| EXCLK | OSCSEL | High-speed System Clock Pin Operating Mode | X1/P121 Pin | X2/EXCLK/P122 Pin |
|-------|--------|--------------------------------------------|-----------------------------------------|----------------------|
| 0 | 0 | Input port mode | Input port | |
| 0 | 1 | X1 oscillation mode | Connected to crystal/ceramic oscillator | |
| 1 | 0 | Input port mode | Input port | |
| 1 | 1 | External clock input mode | Input port | External clock input |

Note: For details on the procedure for setting up the registers, refer to RL78/G12 User's Manual: Hardware.

Controlling Clock Operations

- Clock operation status control register (CSC)
 High-speed system clock operation control: Stop X1 oscillator.
 HOCO clock operation control: HOCO operation

Symbol: CSC

| | | | | | | | |
|-------|---|---|---|---|---|---|---------|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| MSTOP | 1 | 0 | 0 | 0 | 0 | 0 | HIOSTOP |
| 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |

Bit 0

| HIOSTOP | Control of HOCO Clock Operation |
|---------|---------------------------------|
| 0 | Runs HOCO. |
| 1 | Stops HOCO. |

Bit 7

| MSTOP | Control of High-speed System Clock Operation | | |
|-------|----------------------------------------------|---------------------------------------------|-----------------|
| | X1 Oscillation Mode | External Clock Input Mode | Input Port Mode |
| 0 | Runs X1 oscillator. | Enables external clock from the EXCLKS pin. | Input port |
| 1 | Stops X1 oscillator. | Disables external clock from the EXCLK pin. | |

Note: For details on the procedure for setting up the registers, refer to RL78/G12 User's Manual: Hardware.

Setting Up the CPU/Peripheral Hardware Clock (f_{CLK})

- System clock control register (CKC)
 - f_{CLK} status: Main system clock
 - f_{CLK} selection: HOCO clock (f_{IH})

Symbol: CKC

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|-----|------|---|---|---|---|
| 0 | 0 | MCS | MCM0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Bit 4

| MCM0 | Control of Main System Clock (f_{MAIN}) Operation |
|------|---------------------------------------------------------------------------------------|
| 0 | Selects HOCO clock (f_{IH}) as the main system clock (f_{MAIN}). |
| 1 | Selects high-speed system clock (f_{MX}) as the main system clock (f_{MAIN}). |

Bit 5

| MCS | Main system clock (f_{MAIN}) state |
|-----|----------------------------------------|
| 0 | HOCO clock (f_{IH}) |
| 1 | High-speed system clock (f_{MX}) |

Note: For details on the procedure for setting up the registers, refer to RL78/G12 User's Manual: Hardware.

Setting Use/Disuse of Peripheral Hardware Macros

- Peripheral enable register 0 (PER0)
 - Hardware input clock control: Stop input clocks.

Symbol: PER0

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|--------|---|-------|---------|-------------------------|--------|---|--------|
| TMKAEN | 0 | ADCEN | IICA0EN | SAU1EN ^{Note1} | SAU0EN | 0 | TAU0EN |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Bit 0

| TAU0EN | Control of Timer Array Unit 0 Input Clock Supply |
|--------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0 | Stops input clock supply. <ul style="list-style-type: none"> SFR used by timer array unit 0 cannot be written. Timer array unit 0 is in the reset status. |
| 1 | Enables input clock supply. <ul style="list-style-type: none"> SFR used by timer array unit 0 can be read and written. |

Bit 3 and 2

| SAUmEN | Control of Serial Array Unit m Input Clock Supply |
|--------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0 | Stops input clock supply. <ul style="list-style-type: none"> SFR used by serial array unit m cannot be written. Serial array unit m is in the reset status. |
| 1 | Enables input clock supply. <ul style="list-style-type: none"> SFR used by serial array unit m can be read and written. |

Bit 4

| IICA0EN | Control of Serial Interface IICA0 Input Clock Supply |
|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0 | Stops input clock supply. <ul style="list-style-type: none"> SFR used by the serial interface IICA0 cannot be written. Serial interface IICA0 is in the reset state. |
| 1 | Enables input clock supply. <ul style="list-style-type: none"> SFR used by the serial interface IICA0 can be read and written. |

Bit 5

| ADCEN | Control of A/D Converter Input Clock Supply |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0 | Stops input clock supply. <ul style="list-style-type: none"> SFR used by the A/D converter cannot be written. A/D converter is in the reset status. |
| 1 | Enables input clock supply. <ul style="list-style-type: none"> SFR used by the A/D converter can be read and written. |

Bit 7

| TMKAEN | Control of 12-Bit Interval Timer Input Clock Supply |
|--------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0 | Stops input clock supply. <ul style="list-style-type: none"> SFR used by the 12-bit interval timer cannot be written. The 12-bit interval timer is in the reset status. |
| 1 | Enables input clock supply. <ul style="list-style-type: none"> SFR used by the 12-bit interval timer can be read and written. |

Note 1. For 30-pin products only.

Note: Power saving and noise reduction are achieved by stopping the supply of clocks to any unused hardware macros.

Controlling the Operation Speed Mode

- Operation speed mode control register (OSMC)
Selection of interval timer operation clock: Clock supply stopped

Symbol: OSMC

| | | | | | | | |
|---|---|---|----------|---|---|---|---|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 0 | 0 | 0 | WUTMMCK0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Bit 4

| WUTMMCK0 | Selection of Operation Clock for Realtime Clock and Interval Timer |
|----------|--------------------------------------------------------------------|
| 0 | Clock supply stopped. |
| 1 | Enables LOCO Clock (f_{IL}) supply. |

Note: The OSMC register is designed to reduce the operating current in STOP mode and thereby lower power consumption. For details on the procedure for setting up the registers, refer to RL78/G12 User's Manual: Hardware.

4.5.4 Main Processing

Figure 4.5 shows the flowchart for the main processing routine.

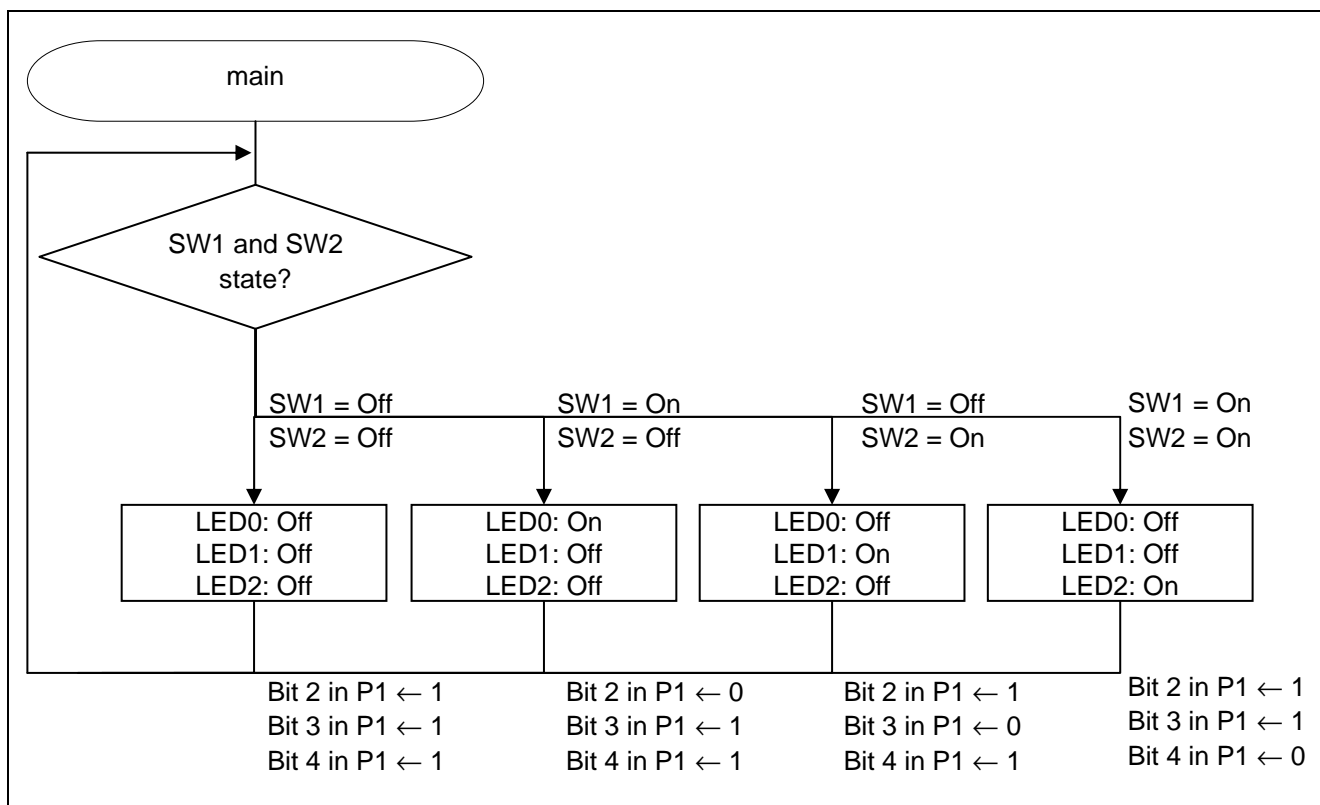


Figure 4.5 Main Processing

5. Selecting/Changing the Target Device

5.1 Selecting the Target Device

Depending on the pin count, the number of available pins differs. To accommodate this difference, the CPU initialization function of the sample program includes a file (r_init.asm) that uses the assembler control instructions \$IF ... \$ENDIF to allow selection of the instructions appropriate to each product. The name of the product to be used is defined as shown below. For example, when using the 20-pin product without data flash memory, only R5F1026 should be preceded by \$SET and the other product names preceded by \$RESET.

```
$SET( R5F1026 )      ; 20 pins with data flash memory ← This is the product to be used.
$RESET( R5F1036 )    ; 20 pins without data flash memory
$RESET( R5F1027 )    ; 24 pins with data flash memory
$RESET( R5F1037 )    ; 24 pins without data flash memory
$RESET( R5F102A )    ; 30 pins with data flash memory
$RESET( R5F103A )    ; 30 pins without data flash memory
```

Figure 5.1 Specifying the Product to Be Used

When the product version is defined in this way, among the P1-related settings (which differ depending on the product) only those for which the \$IF control instruction contains R5F1026 are true, and the subsequent lines up to \$ENDIF or \$ELSEIF are processed by the assembler.

```
$NOLIST
$IF( R5F1026 : R5F1036 : R5F1027 : R5F1037 )
$LIST
;-----
;      for 20 and 24 pins
;-----
      MOV  PM1,  #11100011B  ; P12-P14 to output port
                           ; P10 and P11 to input port

$NOLIST
$ELSEIF( R5F102A : R5F103A )
$LIST
;-----
;      for 30 pins
;-----
      MOV  PM1,  #00000011B  ; P12-P17 to output port
                           ; P10 and P11 to input port

$NOLIST
$ENDIF
```

R5F1026 is included, so this portion only is processed by the assembler.

This portion is ignored by the assembler.

Figure 5.2 Program Example

Note: **LIST/NOLIST** control instructions have been added so that device settings for other than the specified product version are not output to the assemble list file. This means that unnecessary information, including the \$IF control instructions, etc., are not visible. However, \$LIST/\$NOLIST is output.

5.2 Changing the Target Device

To change the target device used with the sample program it is necessary to create a new project. The sample project should be used as the basis when doing this.

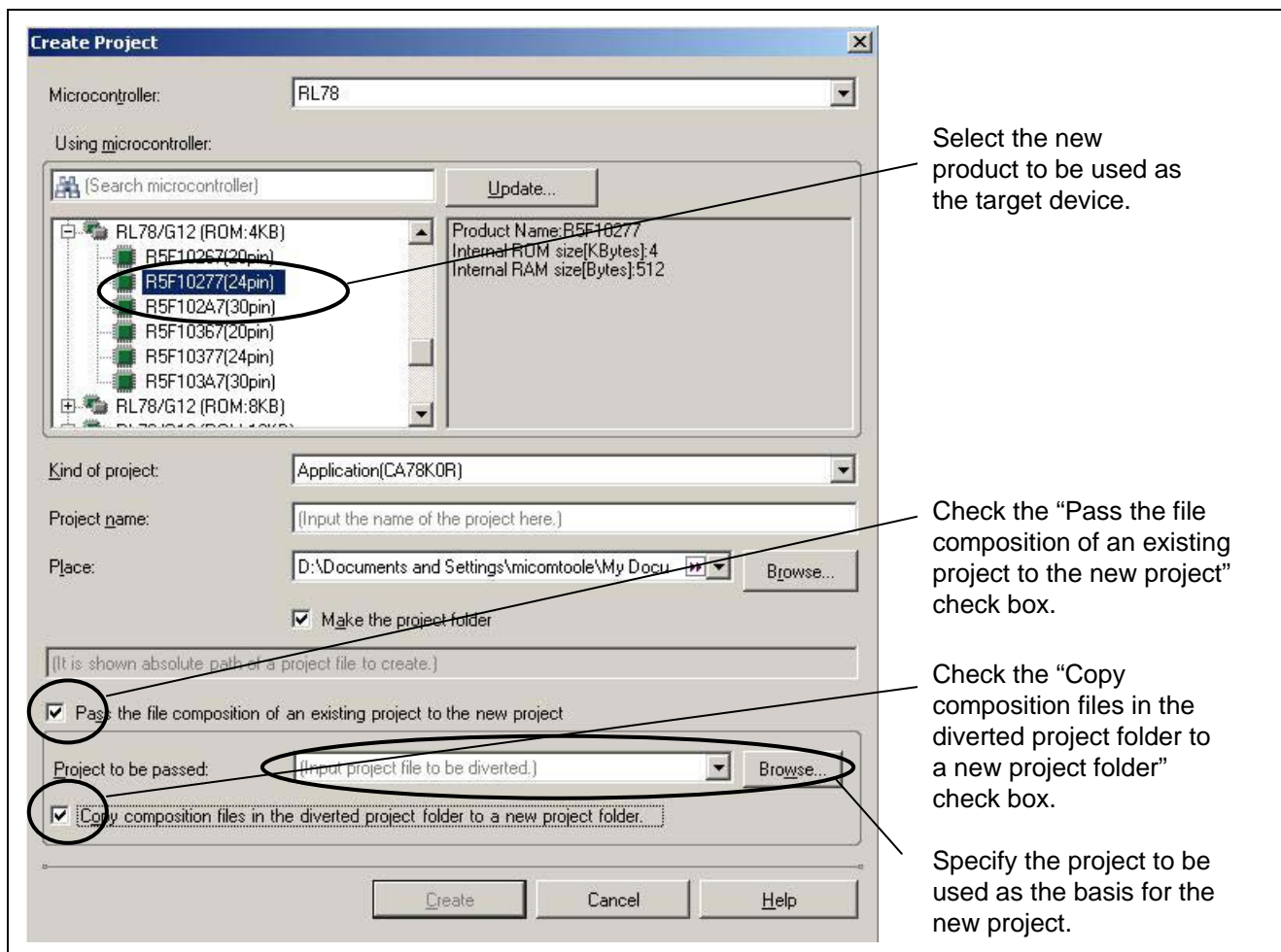


Figure 5.3 Example of Creating a New Project in Order to Change the Target Device

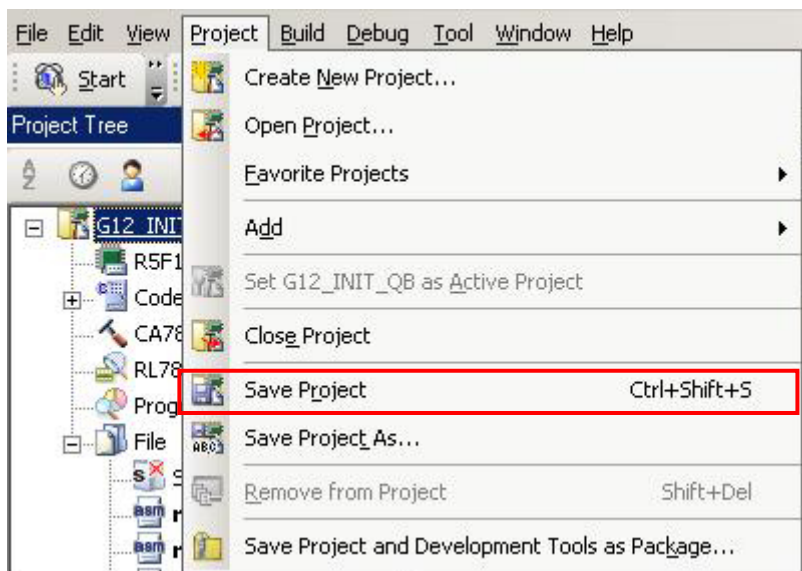
5.3 How to Change the Target Device

A warning (W0202005) may appear when the original project is opened.

At this point, simply copying the current project to create a new project may fail.

This can happen if the version of CubeSuite+ used to create the new project is newer than the version of CubeSuite+ used to create the sample code.

When such a warning is generated, first save the project in the version of CubeSuite+ you are currently using, as shown below. Then follow the instructions in 5.2, Changing the Target Device, to create a new project.



6. Notes on Using the Sample Code

The sample code is written entirely in assembly language. This means that the code generation function of CubeSuite+ cannot be used. As a consequence, care must be exercised with regard to certain settings.

6.1 CubeSuite+ Settings

Since the sample code is written entirely in assembly language, some functions of CubeSuite+ must be disabled.

- Set the link options in the CA78K0R properties as shown below. If this setting is not made, the watchdog timer may reset the device at regular intervals.

| Device | |
|----------------------------------|----------|
| Use on-chip debug | Yes(-go) |
| Option byte values for OCD | HEX 85 |
| Debug monitor area start address | HEX 3E00 |
| Debug monitor area size[byte] | 512 |
| Set user option byte | No |

This will cause the following warning (W0403029 and W0403023) to appear in the output messages during code generation, but the warning can be ignored.

- Assemble Option Settings
The setting shown below is recommended but not required. It enables output lists that addresses are determined after linking.
Open the “Assemble List” settings and change the setting of the second item, “Execute list converter,” to “Yes.”

| Assemble List | |
|---------------------------------------|---------|
| Output assemble list file | Yes(-p) |
| Execute list converter | Yes |
| Output list converter error list file | No |
| Output with assemble list info | Yes |
| Output with symbol list | No |
| Output with cross reference list | No |
| Output with form feed control code | No |
| Number of characters in 1 line | 132 |
| Number of lines on 1 page | 0 |
| Tab width | 8 |
| Header title | |

6.2 Debug Tool Settings

The sample code can be used to check the operation of the device simply by adding two switches and one LED to the RL78/G12 target board (QB-R5F1026A-TB). Power can be supplied to the target board from the emulator. This makes it possible to use a simple circuit to perform debugging.

The necessary settings are as follows:

- (1) Open the RL78 E1 (Serial) (Debug Tool) properties.
- (2) Under “Connection to target board,” set “Supply power from emulator” to “Yes” and set the voltage to “5.0 V.”

7. Sample Code

The sample code is available on the Renesas Electronics Website.

8. Documents for Reference

RL78/G12 User's Manual Manual: Hardware (R01UH0200E)

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 Record | RL78/G12 Initialization |
|-----------------|-------------------------|

| Rev. | Date | Description | |
|------|---------------|-------------|----------------------|
| | | Page | Summary |
| 1.00 | Mar. 30, 2012 | — | First edition issued |
| | | | |

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General Precautions in the Handling of MPU/MCU Products

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

1. Handling of Unused Pins

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

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

2. Processing at Power-on

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

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

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

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

3. Prohibition of Access to Reserved Addresses

Access to reserved addresses is prohibited.

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

4. Clock Signals

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

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

5. Differences between Products

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

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

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