

RL78/G22 Multiwavelength Smoke Detector Evaluation Board

Manual: Software

RL78 Family

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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. Precaution against Electrostatic Discharge (ESD)

A strong electrical field, when exposed to a CMOS device, can cause destruction of the gate oxide and ultimately degrade the device operation. Steps must be taken to stop the generation of static electricity as much as possible, and quickly dissipate it when it occurs. Environmental control must be adequate. When it is dry, a humidifier should be used. This is recommended to avoid using insulators that can easily build up static electricity. Semiconductor devices must be stored and transported in an anti-static container, static shielding bag or conductive material. All test and measurement tools including work benches and floors must be grounded. The operator must also be grounded using a wrist strap. Semiconductor devices must not be touched with bare hands. Similar precautions must be taken for printed circuit boards with mounted semiconductor devices.

2. Processing at power-on

The state of the product is undefined at the time 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 time 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 time 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 time when power is supplied until the power reaches the level at which resetting is specified.

3. Input of signal during power-off state

Do not input signals or an I/O pull-up power supply while the device is powered off. The current injection that results from input of such a signal or I/O pull-up power supply may cause malfunction and the abnormal current that passes in the device at this time may cause degradation of internal elements. Follow the guideline for input signal during power-off state as described in your product documentation.

4. Handling of unused pins

Handle unused pins in accordance with the directions given under handling of unused pins in the manual. The input pins of CMOS products are generally in the high-impedance state. In operation with an unused pin in the open-circuit state, extra electromagnetic noise is induced in the vicinity of the 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.

5. Clock signals

After applying a reset, only release the reset line after the operating clock signal becomes stable. When switching the clock signal during program execution, wait until the target clock signal is 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. Additionally, 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.

6. Voltage application waveform at input pin

Waveform distortion due to input noise or a reflected wave may cause malfunction. If the input of the CMOS device stays in the area between V_{IL} (Max.) and V_{IH} (Min.) due to noise, for example, the device may malfunction. Take care to prevent chattering noise from entering the device when the input level is fixed, and also in the transition period when the input level passes through the area between V_{IL} (Max.) and V_{IH} (Min.).

7. Prohibition of access to reserved addresses

Access to reserved addresses is prohibited. The reserved addresses are provided for possible future expansion of functions. Do not access these addresses as the correct operation of the LSI is not guaranteed.

8. Differences between products

Before changing from one product to another, for example to a product with a different part number, confirm that the change will not lead to problems. The characteristics of a microprocessing unit or microcontroller unit products in the same group but having a different part number might differ in terms of 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.

How to Use This Manual

1. Purpose and Target Readers

This manual is designed to provide the user with an understanding of the hardware functions and electrical characteristics of the MCU. It is intended for users designing application systems incorporating the MCU. A basic knowledge of electric circuits, logical circuits, and MCUs is necessary in order to use this manual.

The manual comprises an overview of the product; descriptions of the CPU, system control functions, peripheral functions, and electrical characteristics; and usage notes.

Particular attention should be paid to the precautionary notes when using the manual. These notes occur within the body of the text, at the end of each section, and in the Usage Notes section.

The revision history summarizes the locations of revisions and additions. It does not list all revisions. Refer to the text of the manual for details.

The following documents apply to the Multiwavelength Smoke Detector solution. Make sure to refer to the latest versions of these documents. The newest versions of the documents listed may be obtained from the Renesas Electronics Web site.

| Document Type | Description | Document Title | Document No. |
|----------------------------|--|--|--------------------|
| User's manual for Software | Description of CPU instruction set | RL78/G22 Multiwavelength Smoke Detector Evaluation Board Manual (Software) | This User's manual |
| User's manual for Hardware | Hardware specifications (pin assignments, memory maps, peripheral function specifications, electrical characteristics, timing charts) and operation description Note: Refer to the application notes for details on using peripheral functions. | RL78/G22 Multiwavelength Smoke Detector Evaluation Board Manual (Hardware) | R01UH1161 |
| Application Note | Information on using peripheral functions and application examples Sample programs Information on writing programs in C language | Available from Renesas Electronics Web site. | |
| Renesas Technical Update | Product specifications, updates on documents, etc. | | |

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1. Introduction

1.1 Overview

The purpose of this User's Manual (Software) is to explain the architecture and features of the sample software for the Multiwavelength Smoke Detector. By using this sample software together with the Multiwavelength Smoke Detector POC substrate (hereinafter referred to as the POC substrate), Multiwavelength Smoke Detector can be easily developed.

The hardware and sample software in this case are for reference purposes only for development, and we do not guarantee that they will operate as products. When using hardware and sample software, please use it after thorough evaluation in an appropriate environment.

The development environment IDE used for this software project is the RL78 version of e²studio, which also includes the configurator tool.

1.2 Development environment

The sample software development environment is shown in Table 1-1 and Table 1-2.

Table 1-1. Hardware Development Environment

| Microcomputer | AFE | Evaluation Board |
|-------------------|-----------|--------------------|
| R7F102GBE2DNP#YJ1 | RAA23910X | RTK7RL22SMD00000BJ |

Table 1-2. Software Development Environment

| e ² studio Version | Smart Configurator Version | Toolchain Version |
|-------------------------------|----------------------------|-------------------|
| V2025-01 | V1.12.0 | CC-RL V1.15.00 |

For purchase and technical support, please contact our sales and special agent.

2. Memory Resources and Timing Constraints

2.1 Memory Resources

This section describes the memory resources of the RL78/G22 microcontroller (R7F102GBE2DNP#YJ1), which is the core of the overall configuration of the Multiwavelength Smoke Detector.

- 64KB code Flash memory
- 2KB data flash memory
- 4KB RAM

2.2 Timing constraints

You must consider the timing constraints of the Table 2-1.

Table 2-1. Timing Constraints

| Item | Description | Constraints |
|---------------|--|--|
| AFE Ready pin | Latency from AFE EN signal | AFE EN and AFE Ready signals require a max 50 us latency |
| LED | LED light stabilization time | It is necessary to wait for the time for the LED emission to output stably. |
| A/D converter | Analog input and standard voltage stabilization time | It is necessary to wait for analog-to-digital conversion until the analog input and reference voltage stabilize. |

3. Hardware Configuration

3.1 POC Board Overview

The POC board has the following features:

- "OR" type power supply configuration (DC24V~40V main power supply, USB power supply, E2_Lite emulator power supply, user serial power supply, main unit debug power supply)
- Compact, low-power, high-performance microcontroller
- Analog front-end ICs provide smoke detection drivers and operational amplifiers
- Alarm LED (red) and external notification signal circuit
- Photoelectric smoke detection of multi-wavelength light with three types of LEDs

3.2 System configuration

Figure 3-1 shows the Multiwavelength Smoke Detector system configuration.

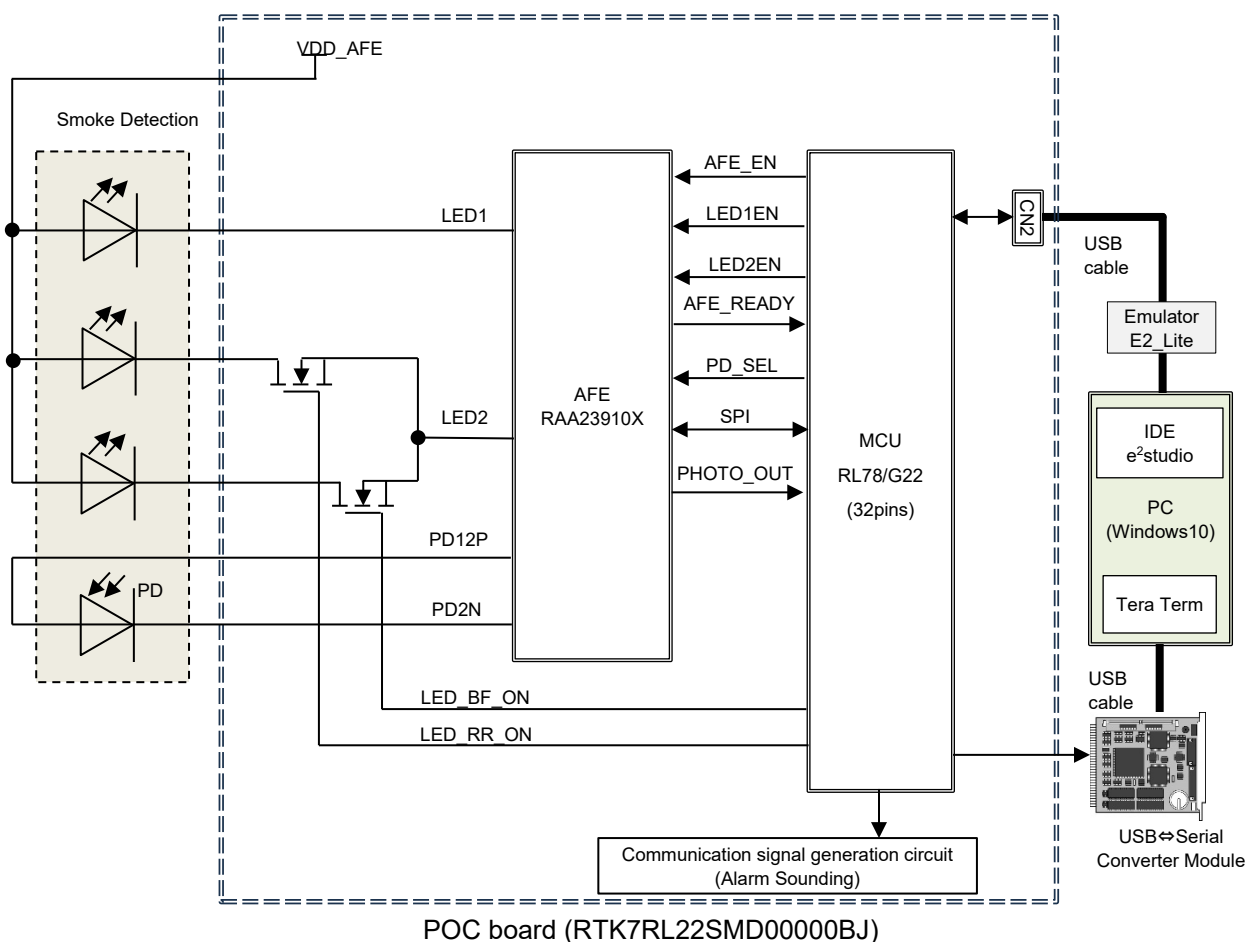


Figure 3-1. System Configuration Diagram

3.3 User Interface

Table 3-1 shows the POC board user interface.

Table 3-1. User Interface

| Item | Interface Components | Function |
|-------------|----------------------|--|
| ERROR RESET | Push Switch (SW1) | User Switch |
| LED1 | Green LED | User LED |
| LED2 | Red LED | <ul style="list-style-type: none">• When an error is detected: Turning-on• During normal operation: Light-off |
| LED3 | LED | transmit light LED1 |
| LED4 | LED | transmit light LED2 |
| LED5 | LED | transmit light LED3 |
| PD | PD | PD for light detection |

3.4 RL78/G22 Block

Figure 3-2 shows the MCU block diagram. current configuration uses timer array unit, GPIOs, analog-to-digital converters (channel 2 and internal reference), 32-bit interval timers (for cyclic triggering) , SPI communication (for communication with AFE ICs), UART communication .

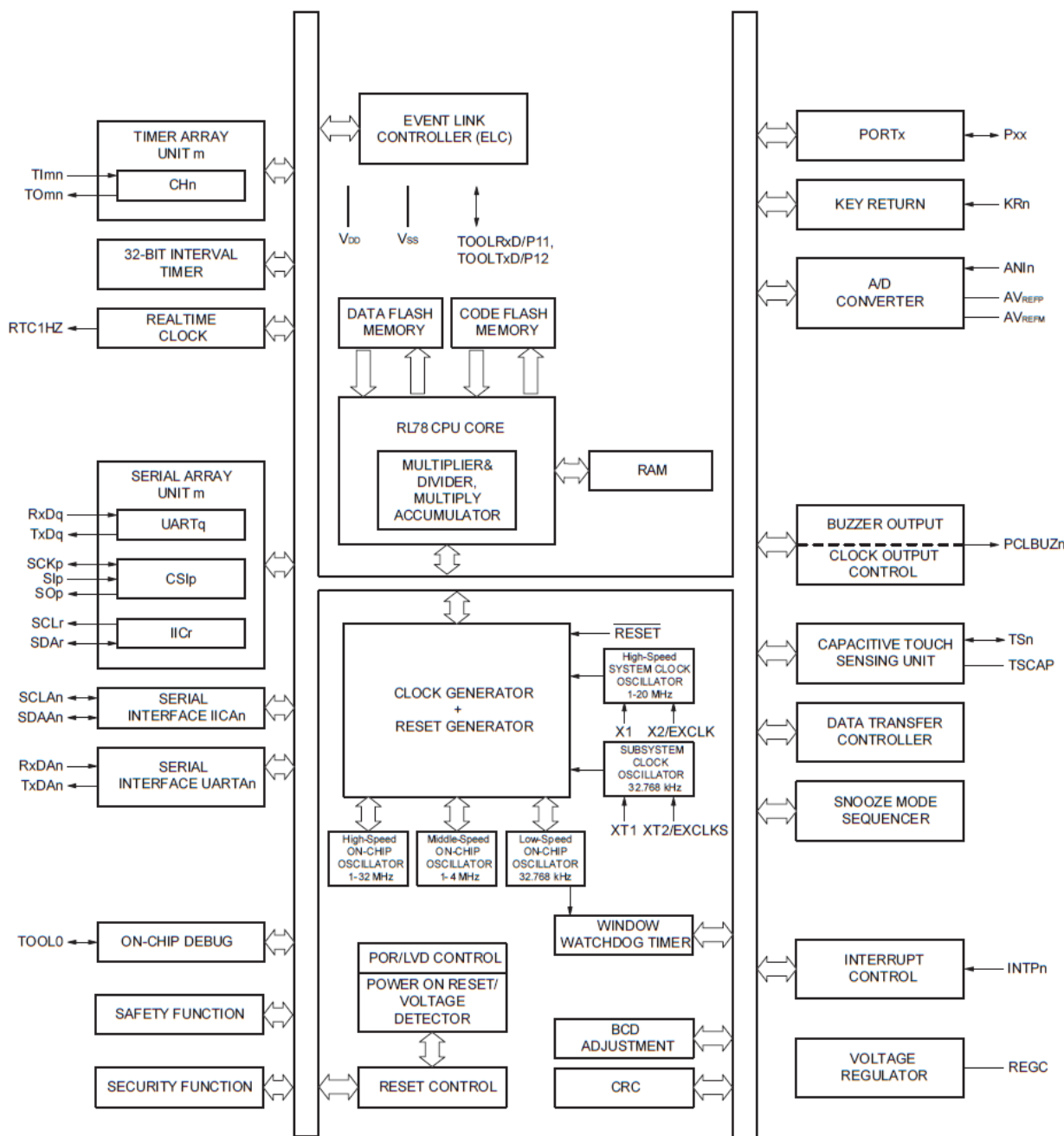


Figure 3-2. RL78/G22 Block Diagram

- Notes: 1. SERIAL INTERFACE ICA is only available for 24~48-pin products (this manual uses 32-pin products).
- 2. SERIAL INTERFACE UARTA is only available for 36~48-pin products (not applicable in this document).
- 3. KEY RETURN is only available for 40~48 pin products (not applicable in this document).

Remarks: m: Unit number, n: Channel number, p: Simple SPI (CSI) number, q: UART number, r: Simple I2C number, xx: Port number

3.5 Terminal Interface

Table 3-2 shows the terminal interfaces used in this system.

Table 3-2. List of MCU Terminals

| No. | Terminal Name | Peripheral Function Name | Connect to | Remarks |
|-----|---------------|------------------------------|------------------------|---------------|
| 1 | P40 | TOOL0 | E2Lite | |
| 2 | RESET_B | /RESET | E2Lite | |
| 3 | P137 | — | TP32 | (Unused) |
| 4 | P122 | General-purpose I/O (output) | Red Rear LED (FET) | LED_RR_ON |
| 5 | P121 | General-purpose I/O (output) | Blue Forward LED (FET) | LED_BF_ON |
| 6 | REGC | — | capacitor | |
| 7 | VSS | — | GND | |
| 8 | VDD | — | VDD_MCU | 3.3V |
| 9 | P60 | — | TP31 | (Unused) |
| 10 | P61 | — | TP29 | (Unused) |
| 11 | P62 | — | TP28 | (Unused) |
| 12 | P31 | General-purpose I/O (input) | AFE | AFE_READY |
| 13 | P70 | General-purpose I/O (output) | AFE | SEN |
| 14 | P30 | SCK11 | AFE | SCLK |
| 15 | P50 | SI11 | AFE | SDO |
| 16 | P51 | SO11 | AFE | SDI |
| 17 | P17 | General-purpose I/O (output) | AFE | LED1_EN |
| 18 | P16 | General-purpose I/O (output) | AFE | LED2_EN |
| 19 | P15 | General-purpose I/O (input) | USER button | |
| 20 | P14 | General-purpose I/O (output) | LED green | LEDs on board |
| 21 | P13 | General-purpose I/O (output) | LED red | LEDs on board |
| 22 | P12 | TxD0 | Serial⇒USB | RxD |
| 23 | P11 | — | No connection | (Unused) |
| 24 | P10 | — | TP27 | (Unused) |

| | | | | |
|----|------|------------------------------|----------------------|--|
| 25 | P147 | General-purpose I/O (output) | AFE | AFE_EN |
| 26 | P23 | General-purpose I/O (output) | AFE | PD_SEL |
| 27 | P22 | ANI2 | AFE | PHOTO_OUT |
| 28 | P21 | AVREFM | GND | |
| 29 | P20 | AVREFP | Reference voltage IC | OUT terminal (2.048V) |
| 30 | P01 | — | TP30 | (Unused) |
| 31 | P00 | General-purpose I/O (output) | Reference voltage IC | SHDN_B |
| 32 | P120 | General-purpose I/O (output) | SMOKE_DET | For communication signal generation circuits (alarm) |

Once these settings are applied, no changes are allowed. Only when a new configuration is started.

4. Software Layer

This sample software process is divided into a driver section that controls the peripheral functions of the MCU, a middleware section that controls the Multiwavelength Smoke Detector, and a user application section that operates the middleware. The overall configuration of the sample software is shown in Figure 4-1.

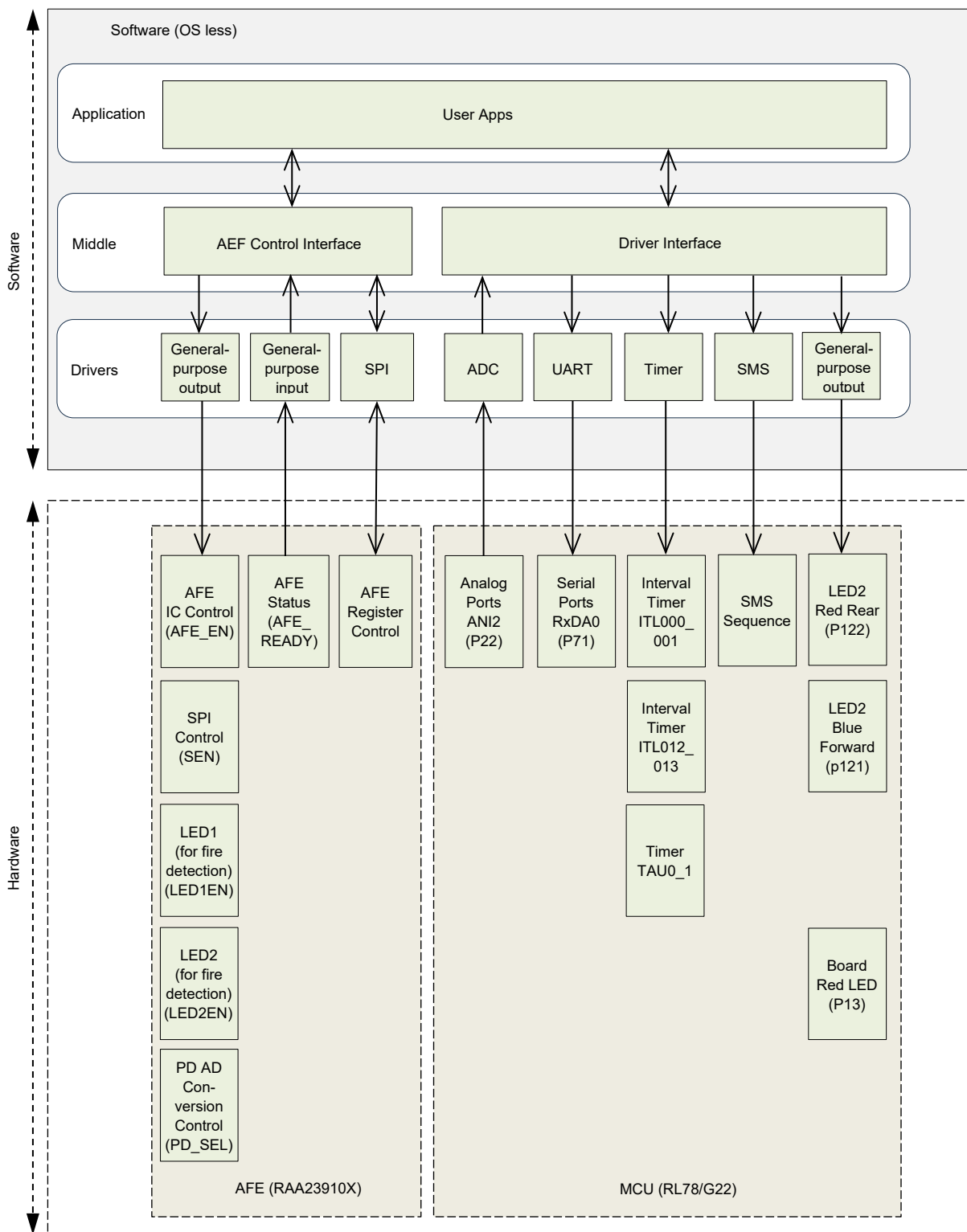


Figure 4-1. Software Configuration

5. Software Description

5.1 State Transitions

The state transitions are shown in Figure 5-1.

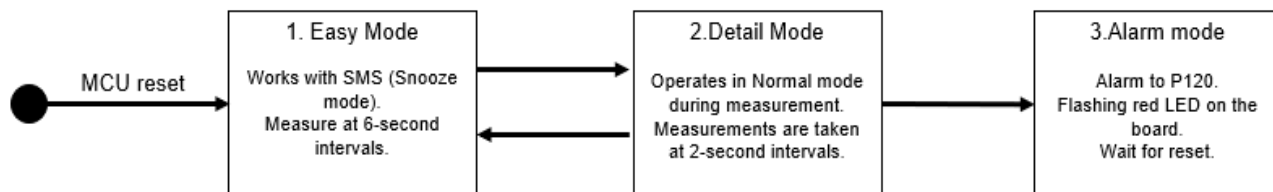


Figure 5-1. State Transition Diagram

5.2 System Initialization

Figure 5-2 shows the initialization sequence after a power-on reset.

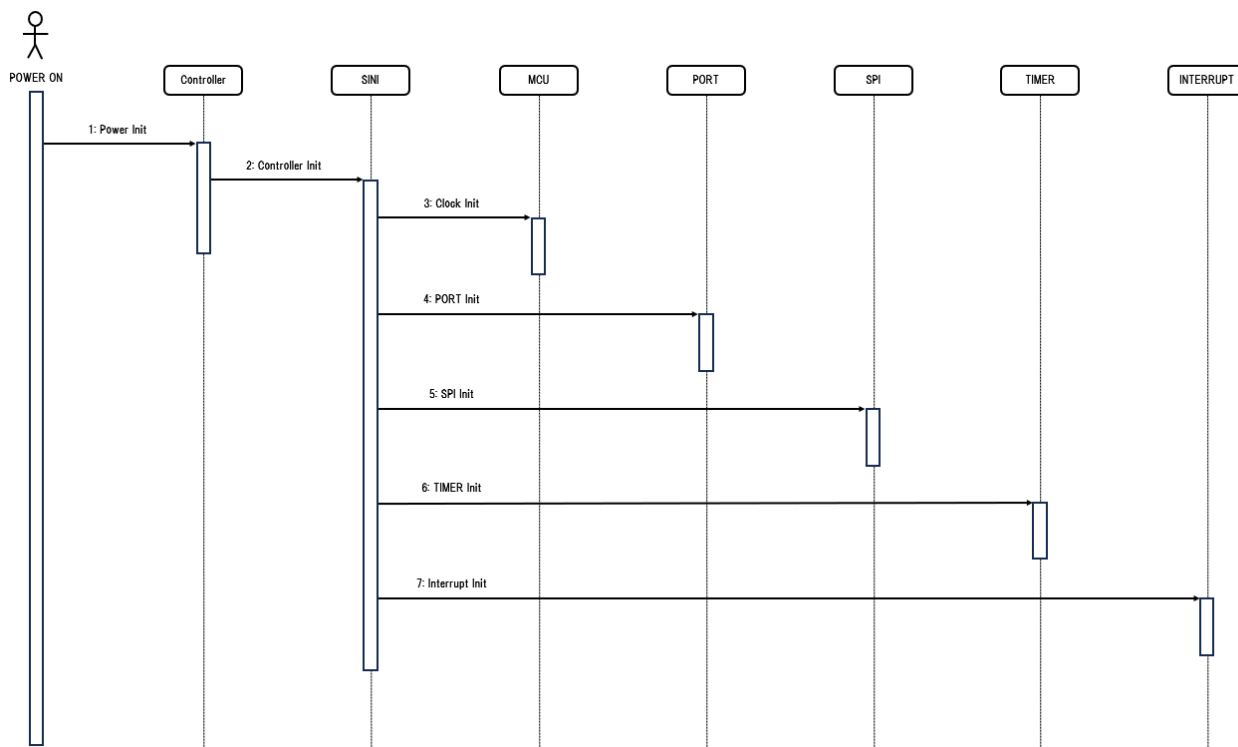


Figure 5-2. System Initialization

The first step after a power-on reset is to initialize the basic controller. The clock tree and microcontroller hardware components are then initialized. The sequence ends with the initialization of the AFE IC port.

5.3 Interrupts

Table 5-1 lists all the interrupts used in the sample software.

Table 5-1. Interrupts

| Interrupt Vector | Interrupt Handling Functions | Priority | Interrupt Factors | Processing Contents |
|------------------|--|----------|--|--|
| RESET | main | Level 0 | Power-on or microcontroller reset | Main process |
| INTSMSE | r_Config_SMS_interrupt | Level 0 | Exit SMS Mode | Exit SMS mode and return to normal process |
| INTSR0 | r_Config_UART0_interrupt_send | Level 3 | Completed transfer of UART0 transmission | Send the contents of the send buffer |
| INTCSI11 | r_Config_CSI11_interrupt | Level 3 | Completed serial transfer | SPI data transmission and reception processing |
| INTTM01 | r_Config_TAU0_2_interrupt | Level 3 | Specified counter elapsed | Waiting process for [usec] order |
| INTAD | r_Config_ADC_interrupt | Level 3 | Completed AD conversion | Set AD conversion termination flag |
| INTITL | R_Config_ITL001_ITL002_Callback_Shared_Interrupt | Level 3 | Specified counter elapsed | Waiting process for [msec] order |
| INTITL | R_Config_ITL012_ITL013_Callback_Shared_Interrupt | Level 3 | Specified counter elapsed | Waiting process for [msec] order |

6. Process Flow

6.1 Main Process Flow

Figure 6-1 shows the main process flow.

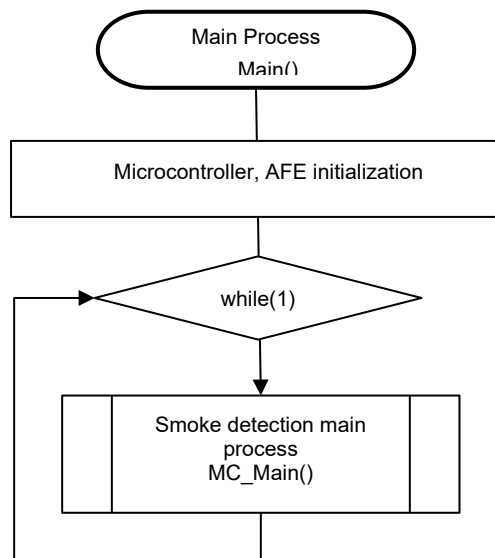


Figure 6-1. Main Process Flow

6.2 Main Process Flow for Smoke Detection

Figure 6-2 shows the main process flow for smoke detection.

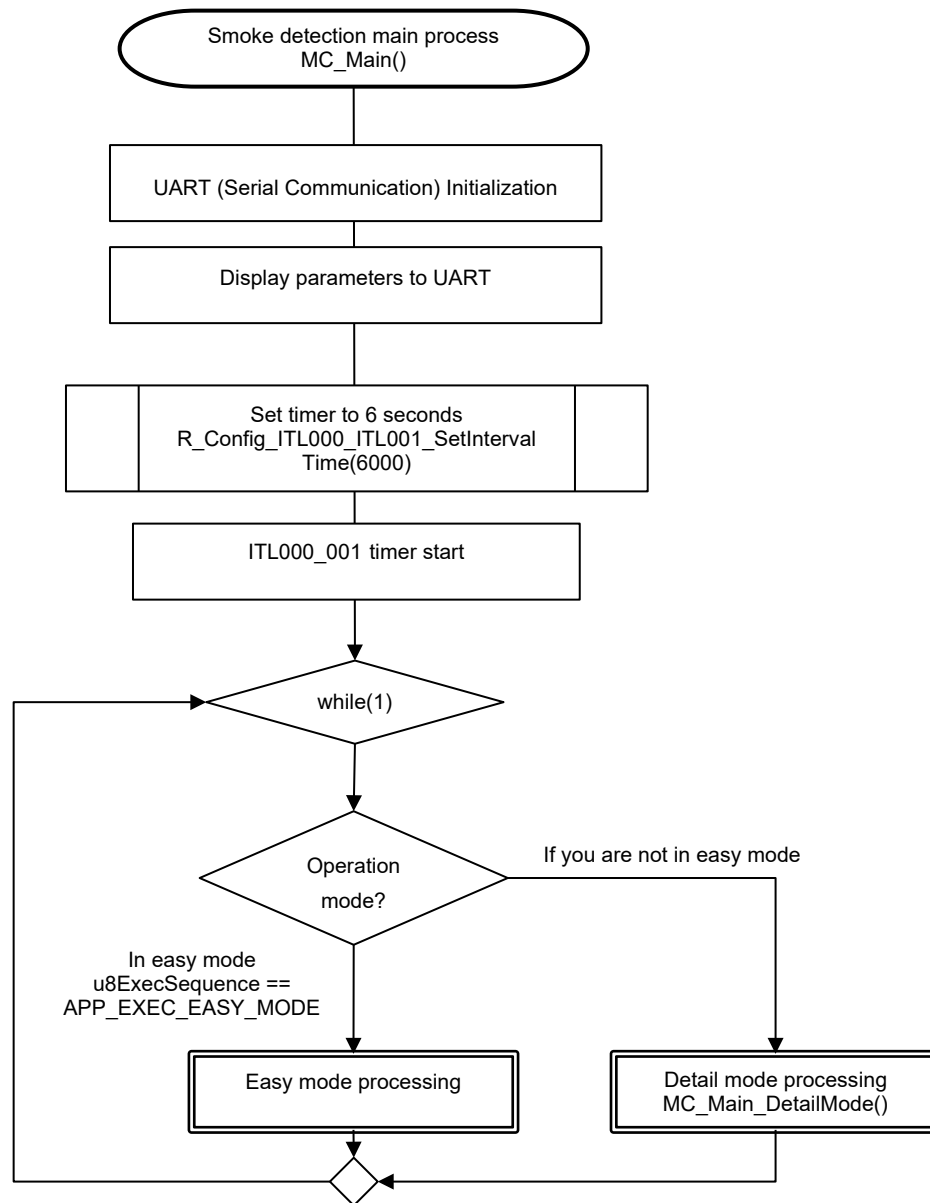


Figure 6-2. Smoke Detection Main Process Flow

6.3 Easy Mode Processing

Figure 6-3 shows the easy mode process flow.

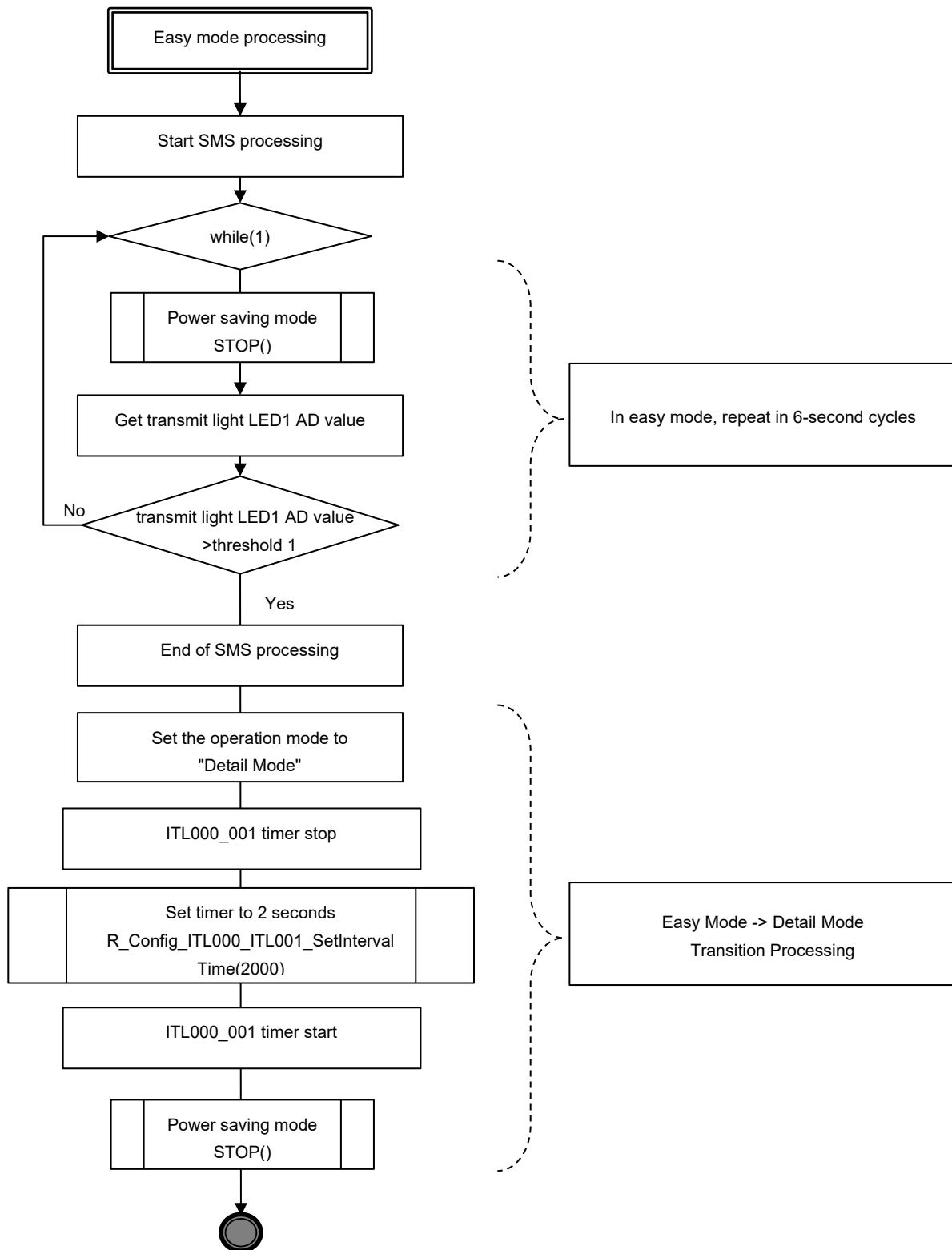


Figure 6-3. Easy Mode Process Flow

6.4 Detail Mode Process Flow

Figure 6-4, Figure 6-5, and Figure 6-6 show the detail mode process flow.

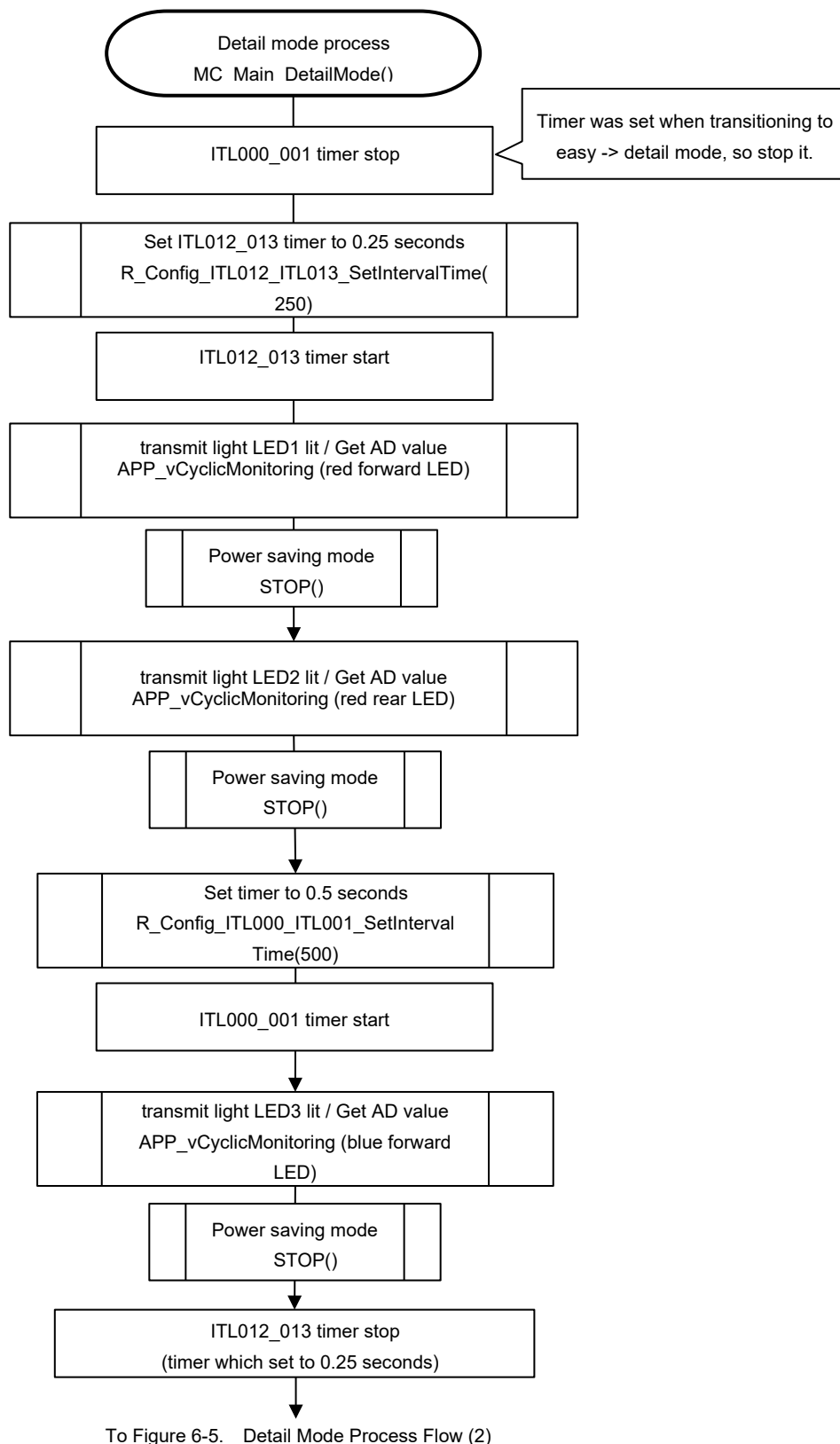


Figure 6-4. Detail Mode Process Flow (1)

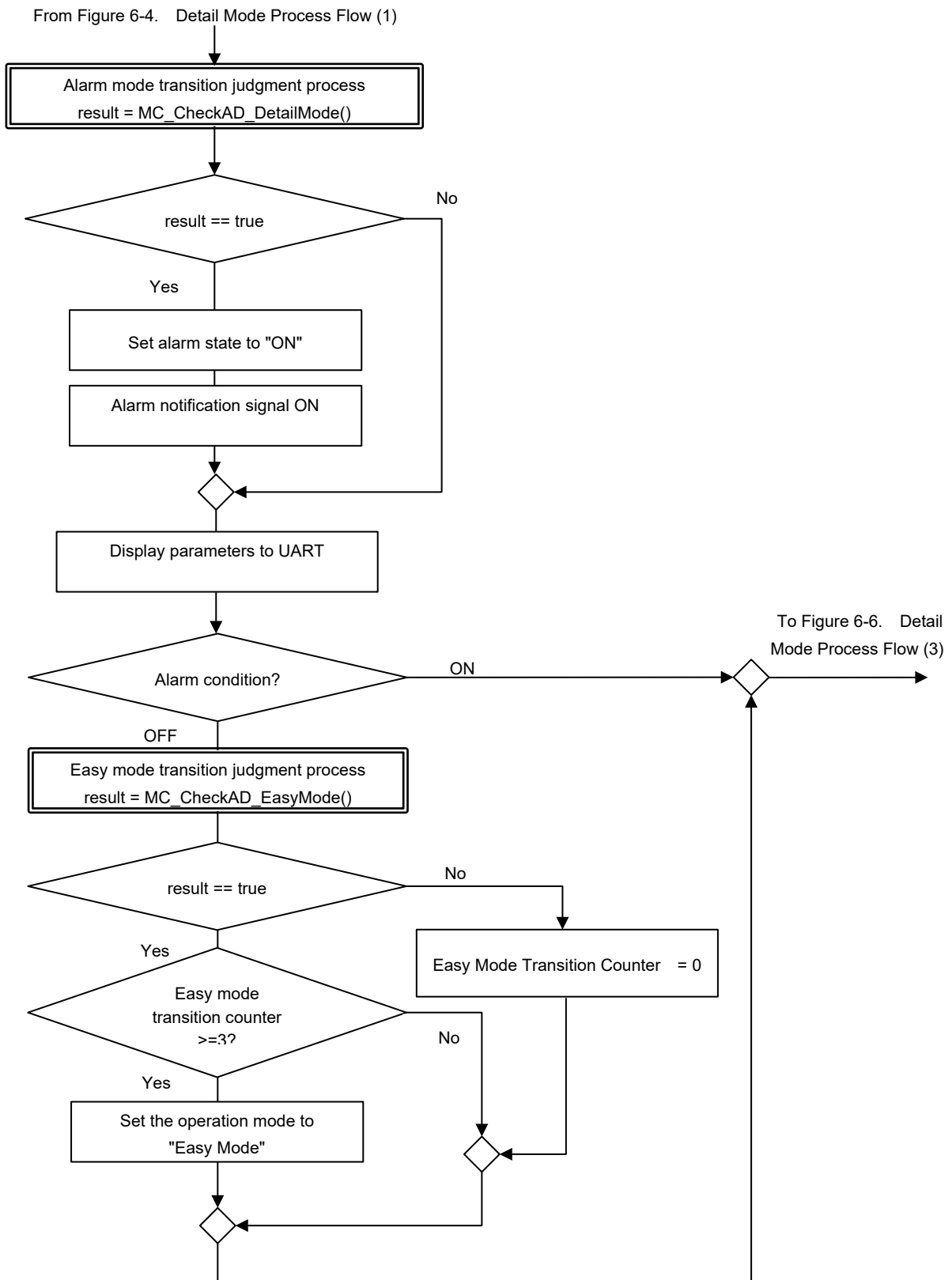


Figure 6-5. Detail Mode Process Flow (2)

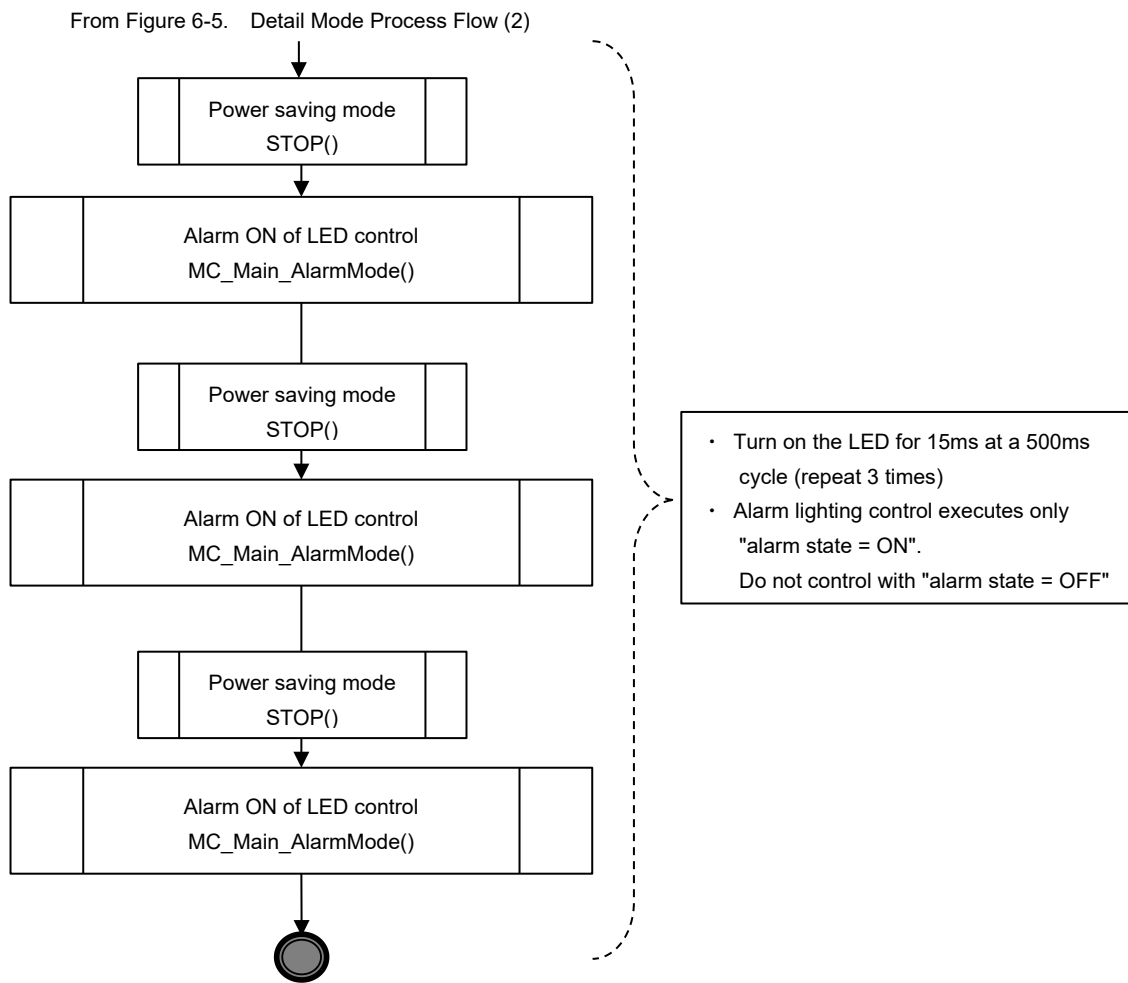


Figure 6-6. Detail Mode Process Flow (3)

6.5.1 Easy Mode Transition Judgment Process

Figure 6-8 shows the judgment process flow for easy mode transition.

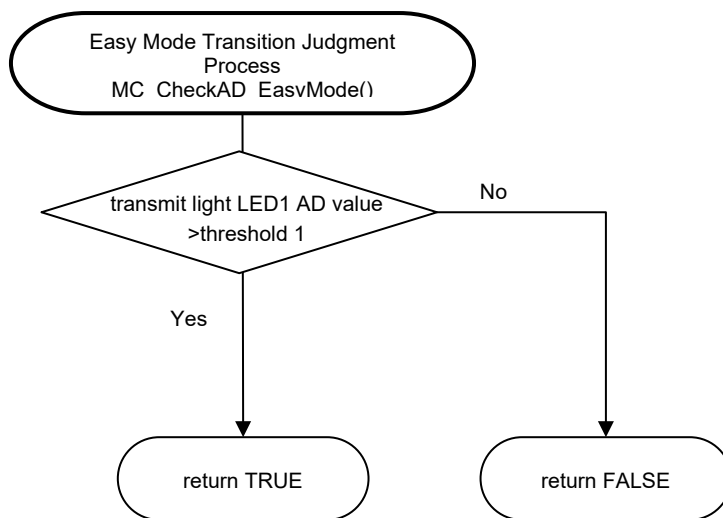


Figure 6-8. Easy Mode Transition Judgment Process Flow

7. Peripherals Configuration

7.1 Configuring Clock

Figure 7-1 shows the clock settings. The RL78/G22 clock tree contains a high-speed on-chip oscillator with an operating frequency of 32MHz. This frequency value reduces power consumption, but the main system clock can also be set to 1 MHz (medium main mode).

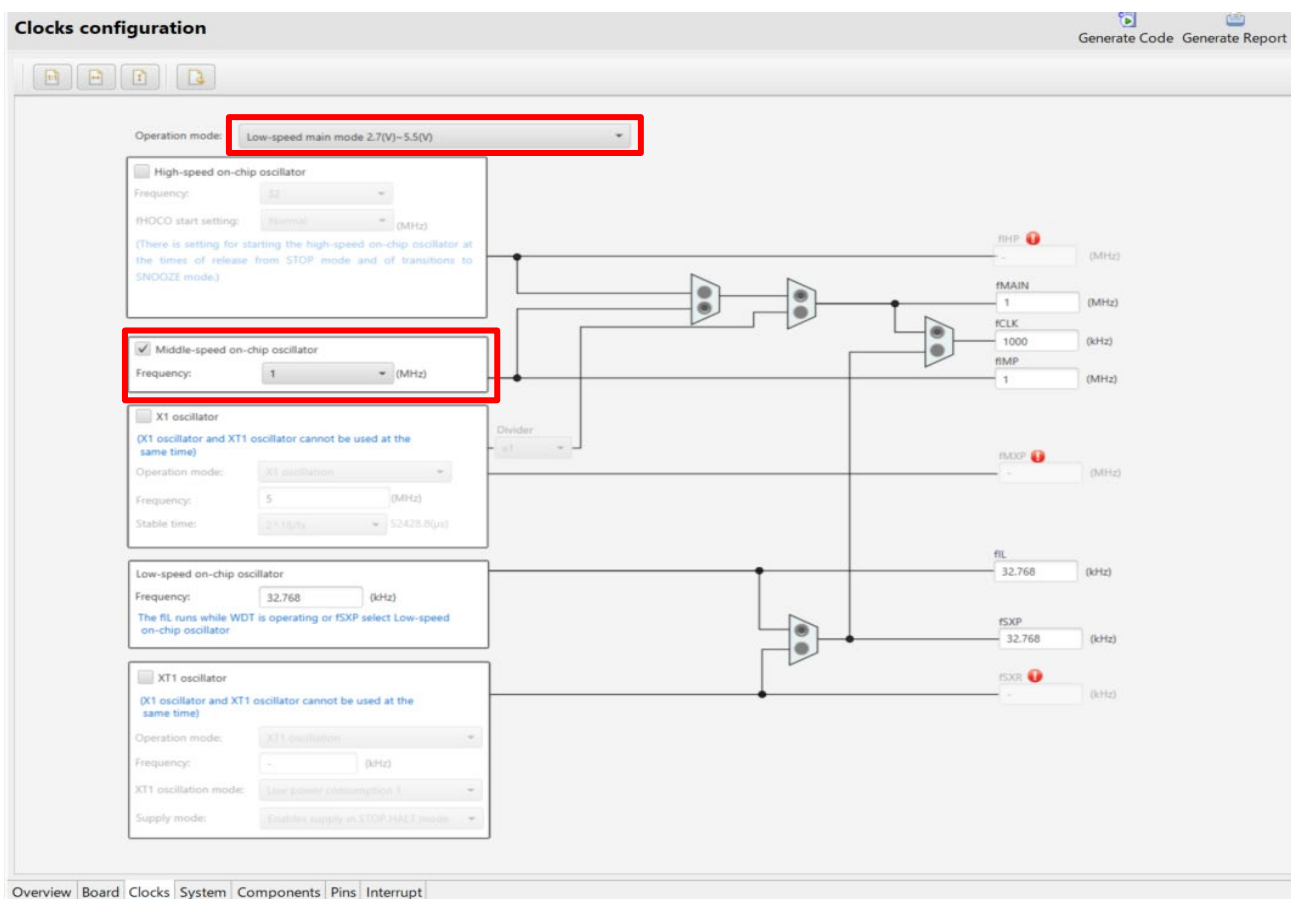


Figure 7-1. Configuring Clock

7.2 Configuring Ports

Figure 7-2 - Figure 7-9 shows the configuration for each port. The RL78/G22 R7F102GBE2DNP#YJ1 has 28 digital I/O pins that can control a variety of operations. In addition, these pins have some alternative features.

7.2.1 Configuring Port 0

| Port selection | PORT0 | PORT1 | PORT2 | PORT3 | PORT6 | PORT7 | PORT12 | PORT14 |
|---|------------------------------|--------------------------|--------------------------------------|----------------------------------|-------------------------------------|---|-------------------------------|--|
| <p>"Input buffer OFF" is effective when the pin is used for a port function or an alternative function, or the pin is not used. Please make sure that other peripherals are not using the alternative input function before selecting "Input buffer OFF".</p> <p><input type="checkbox"/> Apply to all</p> <p> <input checked="" type="radio"/> Unused <input type="radio"/> In <input type="radio"/> Out <input type="checkbox"/> Pull-up <input type="checkbox"/> TTL buffer <input type="checkbox"/> Input buffer OFF <input type="checkbox"/> N-ch <input type="checkbox"/> Output 1 </p> | | | | | | | | |
| P00 | <input type="radio"/> Unused | <input type="radio"/> In | <input checked="" type="radio"/> Out | <input type="checkbox"/> Pull-up | | <input type="checkbox"/> Input buffer OFF | <input type="checkbox"/> N-ch | <input checked="" type="checkbox"/> Output 1 |
| P01 | <input type="radio"/> Unused | <input type="radio"/> In | <input checked="" type="radio"/> Out | <input type="checkbox"/> Pull-up | <input type="checkbox"/> TTL buffer | | | <input type="checkbox"/> Output 1 |

Figure 7-2. Configuring Port 0Configuring Port 1

7.2.2 Configuring Port 1

| Port selection | PORT0 | PORT1 | PORT2 | PORT3 | PORT6 | PORT7 | PORT12 | PORT14 |
|---|---|-------------------------------------|--------------------------------------|----------------------------------|-------------------------------------|---|-------------------------------|--|
| <p>"Input buffer OFF" is effective when the pin is used for a port function or an alternative function, or the pin is not used. Please make sure that other peripherals are not using the alternative input function before selecting "Input buffer OFF".</p> <p><input type="checkbox"/> Apply to all</p> <p> <input checked="" type="radio"/> Unused <input type="radio"/> In <input type="radio"/> Out <input type="checkbox"/> Pull-up <input type="checkbox"/> TTL buffer <input type="checkbox"/> Input buffer OFF <input type="checkbox"/> N-ch <input type="checkbox"/> Output 1 </p> | | | | | | | | |
| P10 | <input type="radio"/> Unused | <input type="radio"/> In | <input checked="" type="radio"/> Out | <input type="checkbox"/> Pull-up | <input type="checkbox"/> TTL buffer | <input type="checkbox"/> Input buffer OFF | <input type="checkbox"/> N-ch | <input type="checkbox"/> Output 1 |
| P11 | <input checked="" type="radio"/> Unused | <input type="radio"/> In | <input type="radio"/> Out | <input type="checkbox"/> Pull-up | <input type="checkbox"/> TTL buffer | <input type="checkbox"/> Input buffer OFF | <input type="checkbox"/> N-ch | <input type="checkbox"/> Output 1 |
| P12 | <input checked="" type="radio"/> Unused | <input type="radio"/> In | <input type="radio"/> Out | <input type="checkbox"/> Pull-up | | <input type="checkbox"/> Input buffer OFF | <input type="checkbox"/> N-ch | <input type="checkbox"/> Output 1 |
| P13 | <input type="radio"/> Unused | <input type="radio"/> In | <input checked="" type="radio"/> Out | <input type="checkbox"/> Pull-up | <input type="checkbox"/> TTL buffer | <input type="checkbox"/> Input buffer OFF | <input type="checkbox"/> N-ch | <input checked="" type="checkbox"/> Output 1 |
| P14 | <input type="radio"/> Unused | <input type="radio"/> In | <input checked="" type="radio"/> Out | <input type="checkbox"/> Pull-up | <input type="checkbox"/> TTL buffer | <input type="checkbox"/> Input buffer OFF | <input type="checkbox"/> N-ch | <input checked="" type="checkbox"/> Output 1 |
| P15 | <input type="radio"/> Unused | <input checked="" type="radio"/> In | <input type="radio"/> Out | <input type="checkbox"/> Pull-up | <input type="checkbox"/> TTL buffer | <input type="checkbox"/> Input buffer OFF | <input type="checkbox"/> N-ch | <input type="checkbox"/> Output 1 |
| P16 | <input type="radio"/> Unused | <input type="radio"/> In | <input checked="" type="radio"/> Out | <input type="checkbox"/> Pull-up | <input type="checkbox"/> TTL buffer | | | <input type="checkbox"/> Output 1 |
| P17 | <input type="radio"/> Unused | <input type="radio"/> In | <input checked="" type="radio"/> Out | <input type="checkbox"/> Pull-up | <input type="checkbox"/> TTL buffer | <input type="checkbox"/> Input buffer OFF | <input type="checkbox"/> N-ch | <input type="checkbox"/> Output 1 |

Figure 7-3. Configuring Port 1

7.2.3 Configuring Port 2

| Port selection | PORT0 | PORT1 | PORT2 | PORT3 | PORT6 | PORT7 | PORT12 | PORT14 |
|--|-------|-------|-------|-------|-------|-------|--------|--------|
| <input type="checkbox"/> Apply to all | | | | | | | | |
| <input checked="" type="radio"/> Unused <input type="radio"/> In <input type="radio"/> Out <input type="checkbox"/> Output 1 | | | | | | | | |
| P20 | | | | | | | | |
| <input checked="" type="radio"/> Unused <input type="radio"/> In <input type="radio"/> Out <input type="checkbox"/> Output 1 | | | | | | | | |
| P21 | | | | | | | | |
| <input checked="" type="radio"/> Unused <input type="radio"/> In <input type="radio"/> Out <input type="checkbox"/> Output 1 | | | | | | | | |
| P22 | | | | | | | | |
| <input checked="" type="radio"/> Unused <input type="radio"/> In <input type="radio"/> Out <input type="checkbox"/> Output 1 | | | | | | | | |
| P23 | | | | | | | | |
| <input type="radio"/> Unused <input type="radio"/> In <input checked="" type="radio"/> Out <input type="checkbox"/> Output 1 | | | | | | | | |

Figure 7-4. Configuring Port 2

7.2.4 Configuring Port 3

| Port selection | PORT0 | PORT1 | PORT2 | PORT3 | PORT6 | PORT7 | PORT12 | PORT14 |
|---|-------|-------|-------|-------|-------|-------|--------|--------|
| <input type="checkbox"/> Apply to all | | | | | | | | |
| <input checked="" type="radio"/> Unused <input type="radio"/> In <input type="radio"/> Out <input type="checkbox"/> Pull-up <input type="checkbox"/> Output 1 | | | | | | | | |
| P30 | | | | | | | | |
| <input checked="" type="radio"/> Unused <input type="radio"/> In <input type="radio"/> Out <input type="checkbox"/> Pull-up <input type="checkbox"/> Output 1 | | | | | | | | |
| P31 | | | | | | | | |
| <input type="radio"/> Unused <input checked="" type="radio"/> In <input type="radio"/> Out <input type="checkbox"/> Pull-up <input type="checkbox"/> Output 1 | | | | | | | | |

Figure 7-5. Configuring Port 3

7.2.5 Configuring Port 6

| Port selection | PORT0 | PORT1 | PORT2 | PORT3 | PORT6 | PORT7 | PORT12 | PORT14 |
|---|-------|-------|-------|-------|-------|-------|--------|--------|
| <input type="checkbox"/> Apply to all <input checked="" type="radio"/> Unused <input type="radio"/> In <input type="radio"/> Out <input type="checkbox"/> Output 1 | | | | | | | | |
| P60 <input type="radio"/> Unused <input type="radio"/> In <input checked="" type="radio"/> Out <input type="checkbox"/> Output 1 | | | | | | | | |
| P61 <input type="radio"/> Unused <input type="radio"/> In <input checked="" type="radio"/> Out <input type="checkbox"/> Output 1 | | | | | | | | |
| P62 <input type="radio"/> Unused <input type="radio"/> In <input checked="" type="radio"/> Out <input type="checkbox"/> Output 1 | | | | | | | | |

Figure 7-6. Configuring Port 6

7.2.6 Configuring Port 7

| Port selection | PORT0 | PORT1 | PORT2 | PORT3 | PORT6 | PORT7 | PORT12 | PORT14 |
|--|-------|-------|-------|-------|-------|-------|--------|--------|
| <input type="checkbox"/> Apply to all <input checked="" type="radio"/> Unused <input type="radio"/> In <input type="radio"/> Out <input type="checkbox"/> Pull-up <input type="checkbox"/> Output 1 | | | | | | | | |
| P70 <input type="radio"/> Unused <input type="radio"/> In <input checked="" type="radio"/> Out <input type="checkbox"/> Pull-up <input type="checkbox"/> Output 1 | | | | | | | | |

Figure 7-7. Configuring Port 7

7.2.7 Configuring Port 12

| Port selection | PORT0 | PORT1 | PORT2 | PORT3 | PORT6 | PORT7 | PORT12 | PORT14 |
|--|-------|-------|-------|-------|-------|-------|--------|--------|
| <p>"Input buffer OFF" is effective when the pin is used for a port function or an alternative function, or the pin is not used. Please make sure that other peripherals are not using the alternative input function before selecting "Input buffer OFF".</p> <input type="checkbox"/> Apply to all <input checked="" type="radio"/> Unused <input type="radio"/> In <input type="radio"/> Out <input type="checkbox"/> Pull-up <input type="checkbox"/> Input buffer OFF <input type="checkbox"/> N-ch <input type="checkbox"/> Output 1 | | | | | | | | |
| P120 <input type="radio"/> Unused <input type="radio"/> In <input checked="" type="radio"/> Out <input type="checkbox"/> Pull-up <input type="checkbox"/> Input buffer OFF <input type="checkbox"/> N-ch <input type="checkbox"/> Output 1 | | | | | | | | |
| P121 <input type="radio"/> Unused <input type="radio"/> In <input checked="" type="radio"/> Out <input type="checkbox"/> Pull-up <input type="checkbox"/> Output 1 | | | | | | | | |
| P122 <input type="radio"/> Unused <input type="radio"/> In <input checked="" type="radio"/> Out <input type="checkbox"/> Pull-up <input type="checkbox"/> Output 1 | | | | | | | | |

Figure 7-8. Configuring Port 12

7.2.8 Configuring Port 14

| Port selection | PORT0 | PORT1 | PORT2 | PORT3 | PORT6 | PORT7 | PORT12 | PORT14 |
|---|-------|-------|-------|-------|-------|-------|--------|--------|
| <input type="checkbox"/> Apply to all | | | | | | | | |
| <input checked="" type="radio"/> Unused <input type="radio"/> In <input type="radio"/> Out <input type="checkbox"/> Pull-up <input type="checkbox"/> Output 1 | | | | | | | | |
| P147 | | | | | | | | |
| <input type="radio"/> Unused <input type="radio"/> In <input checked="" type="radio"/> Out <input type="checkbox"/> Pull-up <input type="checkbox"/> Output 1 | | | | | | | | |

Figure 7-9. Configuring Port 14

7.3 Configuring Serial Array

7.3.1 Configuring SPI

Figure 7-10 shows the SPI (CSI11) configuration.

Configure

Transfer clock setting

Transfer clock mode: Internal clock (master) ▼

Operation clock: CK00 ▼

Clock source: fCLK ▼ (Clock frequency: 1000 kHz)

Transfer mode setting

Single transfer mode Continuous transfer mode

Data length setting

8 bits 7 bits

Transfer direction setting

LSB MSB

Specification of data timing

(The below figures are for MSB data transfer direction.)

Type 1 Type 2

Type 3 Type 4

Transfer rate setting

Baudrate: 153600 ▼ (bps) (Actual value: 166666.667)

Interrupt setting

Transfer interrupt priority (INTCSI11): Level 3 (low) ▼

Callback function setting

Transmission end Reception end Overrun error

Figure 7-10. Configuring SPI(CSI11)

7.3.2 Configuring UART0

Figure 7-11 shows the UART0 configuration.

Configure

Transmission

UART0 clock setting

Operation clock CK00 ▼

Clock source fCLK ▼ (Clock frequency: 1000 kHz)

Transfer mode setting

Single transfer mode Continuous transfer mode

Data length setting

7 bits 8 bits 9 bits

Transfer direction setting

LSB MSB

Parity setting

None 0 parity Odd parity Even parity

Stop bit length setting

1 bit 2 bits

Transfer data level setting

Non-reverse Reverse

Transfer rate setting

Transfer rate setting 38400 ▼ (bps) (Current error: 0.16%)

Interrupt setting

Transmit end interrupt priority (INTST0) Level 3 (low) ▼

Callback function setting

Transmission end

Figure 7-11. Configuring UART0

7.4 Configuring A/D Converter

Figure 7-12 shows A/D converter configuration.

Configure

Comparator operation setting
 Stop Operation

Resolution setting
 10 bits 8 bits

VREF(+) setting
 VDD AVREFP Internal reference voltage

VREF(-) setting
 VSS AVREFM

Trigger mode setting
 Software trigger mode
 Hardware trigger no wait mode
 Hardware trigger wait mode
 INTTM01

Operation mode setting
 Continuous select mode Continuous scan mode
 One-shot select mode One-shot scan mode
 A/D channel selection: ANI2

Conversion time setting
 Conversion time mode: Low voltage 1
 Conversion time: 38/fCLK (38 μs)

Conversion result upper/lower bound value setting
 Generates an interrupt request (INTAD) when $ADLL \leq ADCR \leq ADUL$
 Generates an interrupt request (INTAD) when $ADUL < ADCR$ or $ADLL > ADCR$
 Upper bound (ADUL) value: 255
 Lower bound (ADLL) value: 0

Interrupt setting
 Use A/D interrupt (INTAD)
 Priority: Level 3 (low)

Figure 7-12. Configuring A/D Converter

7.5 Configuring Timer Array Unit

Figure 7-13 shows the TAU configuration. This setting generates the waiting time until the reference voltage is determined in detail mode. The default is 130ms.

The screenshot displays the configuration interface for the Timer Array Unit (TAU). It is organized into three main sections: Clock setting, Interval timer setting, and Interrupt setting.

- Clock setting:**
 - Operation clock: CK00
 - Clock source: fCLK/2^5 (Clock frequency: 31.25 kHz)
- Interval timer setting:**
 - Interval value (16 bits): 130 (Unit: μ s, Actual value: 128)
 - Generates INTTM01 when counting is started
- Interrupt setting:**
 - End of timer channel 1 count, generate an interrupt (INTTM01)
 - Priority: Level 3 (low)

Figure 7-13. Configuring Timer Array Unit TAU0_1

7.6 Configuring 32-Bit Interval Timer

The 32-bit interval timer is used as a 16-bit, two channels, as shown in Figure 7-14, Figure 7-15.

7.6.1 Configuring ITL000 and ITL001

Figure 7-14 shows the ITL000 and ITL001 settings. This setting generates a measurement interval (SMS activation interval) for the easy mode. The default is 6000ms. In addition, the detail mode is changed to 2000 ms to generate the measurement interval. In alarm mode, it is changed to 500ms to generate a blinking interval for the red LED.

Figure 7-14. Configuring Interval Timer ITL000 and ITL001

7.6.2 Configuring ITL012 and ITL013

Figure 7-15 shows the ITL012 and ITL013 settings. This setting generates the measurement interval for the three LEDs in detail mode. The default is 250ms. It is also changed to 25ms in alarm mode to generate a red LED illumination time. It is not used in easy mode.

Figure 7-15. Configuring Interval Timer ITL012 and ITL013

8. Software Processing

8.1 List of Functions

This chapter describes the function of each function.

8.1.1 Initialization and Monitoring Related Functions

Table 8-1 shows the list of functions related to initialization and monitoring processing. It is responsible for communicating with the data flash (reading and writing data), reading the supply voltage, and implementing smoke circulation monitoring.

Table 8-1. List of Functions Related to Initialization and Monitoring Processing

| File Name | Function Name | Function |
|-----------|----------------------------------|---|
| APP.c | APP_vInit() | RL78 register, initializing variable |
| | APP_vCyclicMonitoring() | Getting AD value process |
| | APP_vInitMeasurement() | Initialization before starting PD value measurement |
| | APP_vDinitMeasurement() | Stopping PD value measurement |
| | APP_delay() | Wait for AFE to stabilize |
| | APP_vInitRegisterForSMS() | Setting AFE register for LED light emission |
| | APP_vGetMcuADValue() | Getting AD value |
| | APP_vReferenceIC_SHDN_B_Toggle() | Charging process |

8.1.2 AFE Driver Related Functions

Table 8-2 shows the list of the functions of the AFE module. It has the function of direct access to AFE pins and hardware modules.

Table 8-2. List of AFE Module Functions

| File Name | Function Name | Function |
|--------------|-------------------------------------|--|
| AFE_Driver.c | AFE_vInit() | Initializing AFE |
| | AFE_vEnableUnit() | Enable AFE Unit |
| | AFE_vDisableUnit() | Disable AFE unit |
| | AFE_vStartADC() | Requesting AD conversion start |
| | AFE_vSetLEDCurrent() | Setting the LED Current Value |
| | AFE_vSetTIA() | Setting the Amplification Degree |
| | AFE_vSetTIA_Icomp() | Setting the Offset Voltage |
| | AFE_vSetADCEnable() | Setting AD Conversion |
| | AFE_u16ReadADC() | Confirmation of completion of AD conversion |
| | AFE_WaitForTransferConfirmation() | Waiting for SPI transmission and reception completion |
| | AFE_enRead() | Reading AFE register values via SPI |
| | AFE_enwrite() | Writing AFE register value via SPI |
| | AFE_Driver_SPI_Error_Notification() | SPI Communication Error Notification |
| | AFE_Driver_SPI_RX_Confirmation() | SPI Communication Reception Completion Notification |
| | AFE_Driver_SPI_TX_Confirmation() | SPI Communication Transmission Completion Notification |
| | AFE_vSetADCEnableAndConfig() | Initial settings for AFE unit AD conversion |

Functions Related to Generation of Measurement Timing

Table 8-3 shows the list of the functions for measurement timing generation.

Table 8-3. List of Measurement Timing Generation Functions

| File Name | Interface | Contents |
|---------------|-------------------------|--|
| MeasureCtrl.c | MC_Init() | Initializing variables |
| | MC_Main() | Generating measurement timing |
| | MC_Main_EasyMode() | Easy mode processing |
| | MC_Main_DetailMode() | Detail mode processing |
| | MC_Main_AlarmMode() | Alarm Mode Processing |
| | MC_CheckAD_EasyMode() | Transition judgment process from easy mode |
| | MC_CheckAD_DetailMode() | Transition judgment process from detail mode |

8.1.3 Functions Related to Serial Communication Transmission Processing

Table 8-4 shows the list of the serial communication transmit processing functions.

Table 8-4. List of Serial Communication Transmission Processing Functions

| File Name | Interface | Contents |
|--------------|--------------------------------|--|
| SerialComm.c | SC_TransmitParamInfo() | Full parameter setting output processing |
| | SC_TransmitMeasurementResult() | AD conversion value output processing |
| | SC_TransmitParam() | Parameter name and setting value output processing |
| | SC_TransmitParamName() | Parameter name output processing |
| | SC_TransmitParamValue() | Parameter value output processing |
| | SC_SetMeasureCounter() | Measurement counter value output processing |
| | SC_AddMeasureTime() | Time Calculation Process |
| | SC_SetMeasureValue() | Measured value ASCII conversion process |

8.1.4 Parameter Management Related Functions

Table 8-5 shows the list of the parameter management functions.

Table 8-5. List of Parameter Management Functions

| File Name | Interface | Contents |
|-------------|-----------------------------|---|
| UserParam.c | APP_InitMeasureParameter() | Measurement parameter initialization processing |
| | APP_CheckMeasureParameter() | Measurement parameter matching processing |

9. POC Software Update

The application software can be updated using Renesas E2_Lite debugger and Renesas Flash programmer tools. This feature can be used for both data flash and code flash rewriting. The update requires a *.hex file that contains the data flash parameter values or the new version of the firmware. Also, you just have to follow the following steps:

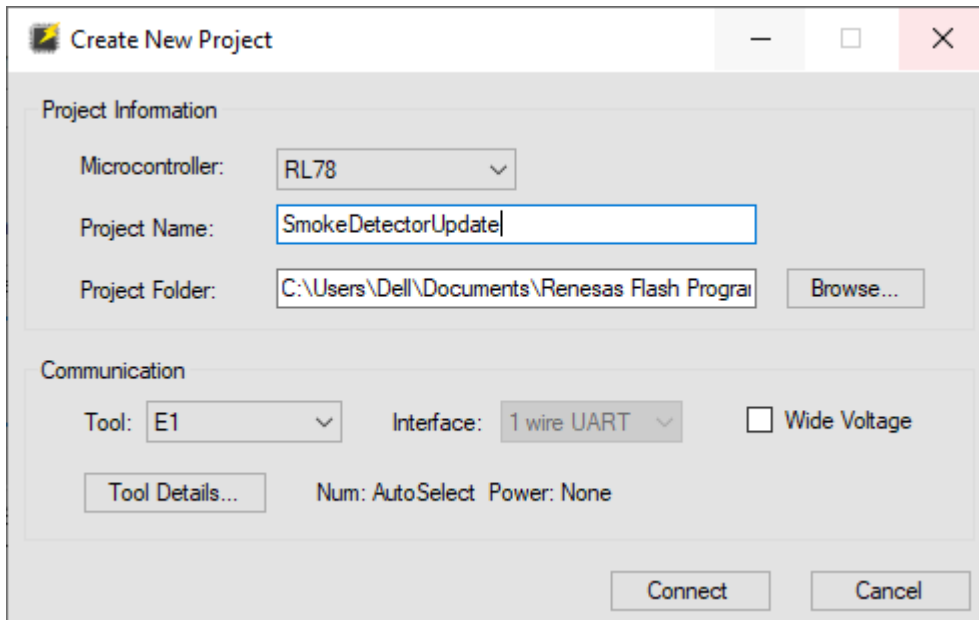


Figure 9-1. Create a New Project with the Renesas Flash Programmer Tool

Connect each tool to your development board. Load the .hex file using the Browse button shown in Figure 9-2 and start the update by pressing the Start button at the end.

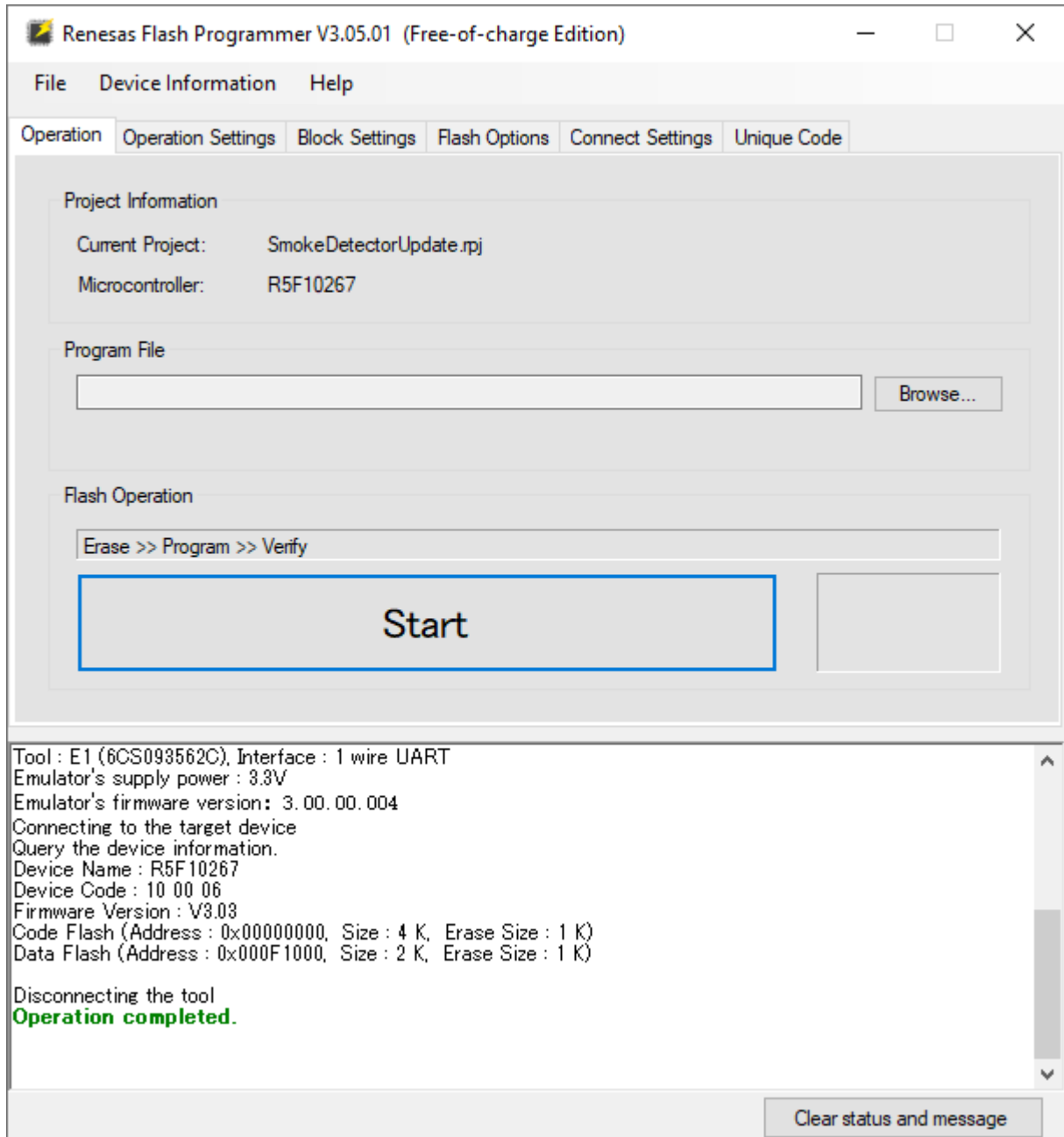


Figure 9-2. Use the Renesas Flash Programmer Tool to Connect to Boards and Flash .hex Files

10. Nomenclature

- IC Integrated Circuit
- POC Proof Of Concept
- SW SoftWare
- HW HardWare
- MCU Micro Controller Unit
- CPU Central Processing Unit
- AFE Analog Front End
- LED Light-Emitting Diode
- PD PhotoDiode
- IR Infrared Radiation
- TIA Transimpedance Input Amplifier
- PGA Programmable Gain Amplifiers
- DAC D/A converter or digital-to-analog Converter
- ADC A/D converter or analog-to-digital Converter
- SPI Serial Peripheral Interface
- UART Universal Acsynchronous Receiver Transmitter
- ROM Read-Only Memory
- RAM Random Access Memory
- DC Direct Current
- AC Alternating Current
- LDO Low-DropOut voltage regulator
- GPIO General-Purpose Input and Output
- TX Transmission
- RX Reception
- USB Universal Serial Bus
- PCB PolyChlorinated Biphenyl
- PC Personal Computer
- SINI System INitialization
- APP APPLication
- IDE Integrated Development Environment
- UL Underwriters Laboratories

11. References

- [1] RL78/G22 User's Manual: Hardware (R01UH0978)
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| | |
|------------------|---|
| Revision History | RL78/G22 Multiwavelength Smoke Detector Evaluation Board Manual (Software) |
|------------------|---|

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|------|-----------|-------------|--|
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