

## RL78/G23

### SMS LED Blinking Dimming Control

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#### Introduction

This application note describes how to control the LEDs using the SNOOZE mode sequencer and the 32-bit interval timer.

The SNOOZE mode sequencer is started for each 32-bit interval timer interrupt, changing the LED brightness from 100% to 0%, and controlling the LED so that it gradually darkens.

By controlling the PWM output required for LED control with the SNOOZE mode sequencer, lower power consumption can be achieved than with CPU control.

#### Target Device

RL78/G23

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.

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### 1. Specifications

During the HALT mode (CPU operating clock: stop), the SNOOZE mode sequencer (SMS) controls the PWM output and gradually reduces the LED brightness.

The PWM output function of the timer array unit (TAU) controls the LED brightness. In SMS, processing to change the duty ratio of the PWM output is set in advance. The interval that controls the PWM output is set using a 32-bit interval timer (TML32), and SMS is started by a TML32 interrupt (INTITL). By SMS starting, the duty ratio of the PWM output changes and the LED brightness is controlled.

Figure 1-1 shows the system configuration, and Figure 1-2 shows the flowchart of the entire system.

**Figure 1-1 System Configuration**

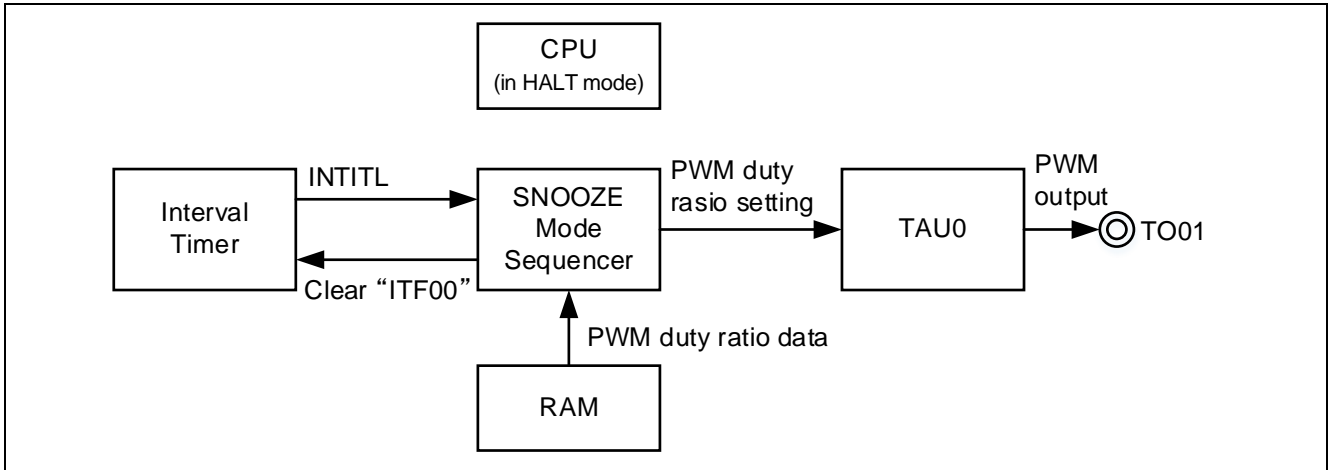
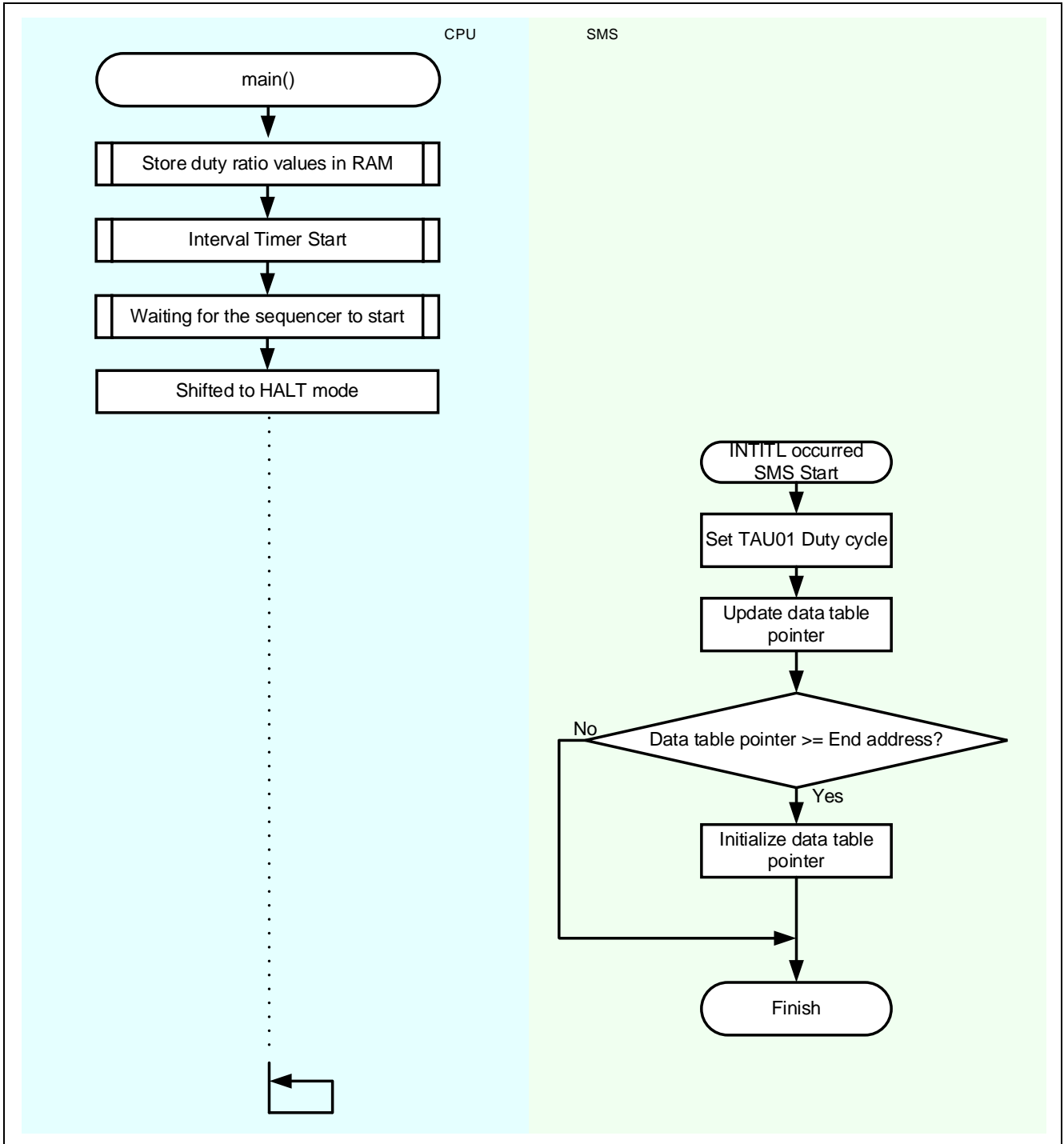


Figure 1-2 Entire Flowchart



## 2. Conditions for Operation Confirmation Test

The sample code with this application note runs properly under the condition below.

**Table 2-1 Operation Confirmation Conditions**

| Items  | Contents  |
|--|---|
| MCU  | RL78/G23 (R7F100GLG)  |
| Operating frequencies                                      | <ul style="list-style-type: none"> <li>High-speed on-chip oscillator clock: 32 MHz</li> <li>CPU/peripheral hardware clock: 32 MHz</li> </ul>                                |
| Operating voltage  | <ul style="list-style-type: none"> <li>3.3V</li> <li>LVD0 operations (<math>V_{LVD0}</math>) : Reset mode<br/>Rising edge TYP.1.875V<br/>Falling edge TYP.1.835V</li> </ul> |
| Integrated development environment (CS+)                   | CS+ for CC V8.05.00 from Renesas Electronics Corp.  |
| C compiler (CS+)   | CC-RL V1.10 from Renesas Electronics Corp.  |
| Integrated development environment (e <sup>2</sup> studio) | e <sup>2</sup> studio 2021-04 (21.4.0) from Renesas Electronics Corp.   |
| C compiler (e <sup>2</sup> studio)                         | CC-RL V1.10 from Renesas Electronics Corp.  |
| Integrated development environment (IAR)                   | IAR Embedded Workbench for Renesas RL78 v4.21.1 from IAR Systems  |
| C compiler (IAR)   |   |
| Smart Configurator   | V.1.0.1   |
| Board support package (r_bsp)                              | V.1.10  |
| Emulator   | CS+, e <sup>2</sup> studio: COM port<br>IAR: E2 Emulator Lite   |
| Board  | RL78/G23 Fast Prototyping Board (RTK7RLG230CLG000BJ)  |

### 3. Related application note

The following application note is related to this application note.

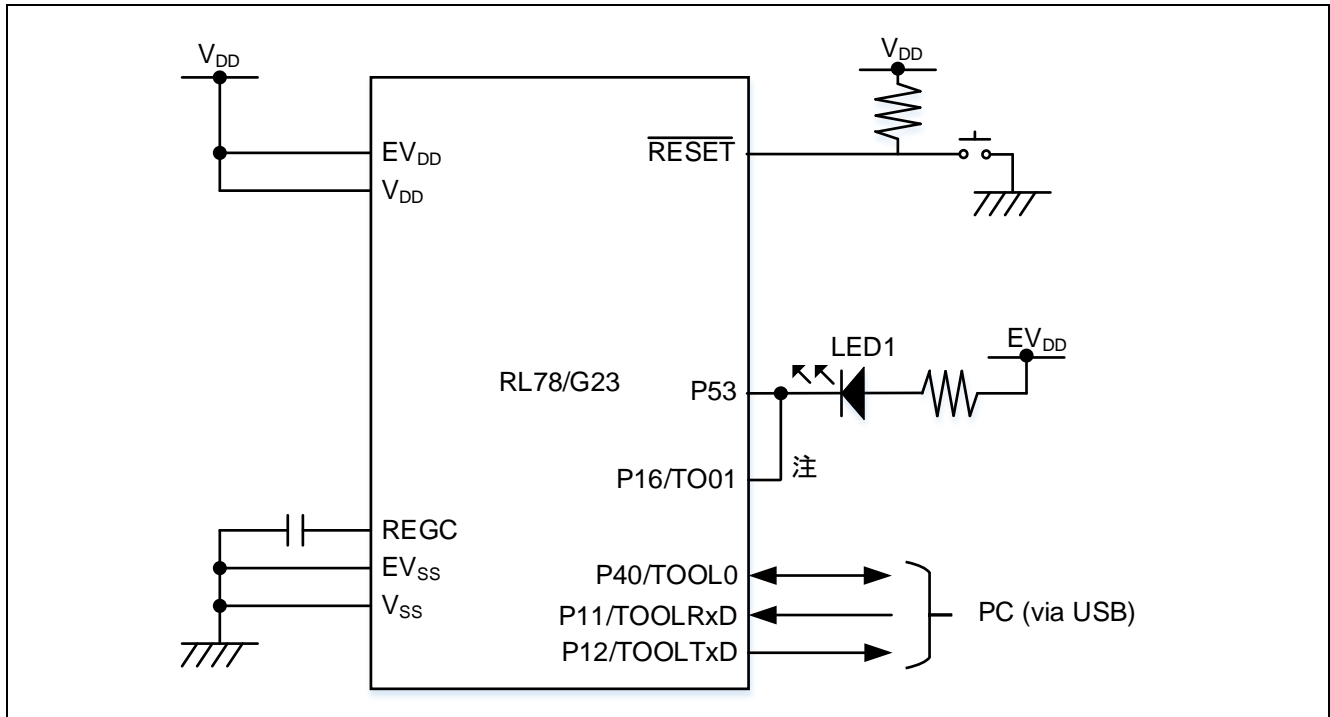
Please refer to them as well.

## 4. Hardware

### 4.1 Example of Hardware Configuration

Figure 4-1 shows an example of the hardware configuration in this application.

Figure 4-1 Hardware Configuration



Note In this application note, P16 and P53 are connected externally because the LED on the board (RTK7RLG230CLG000BJ) is used. Change the circuit if necessary.

Caution 1. This simplified circuit diagram was created to show an overview of connections only. When actually designing your circuit, make sure the design includes sufficient pin processing and meets electrical characteristic requirements. (Connect each input-only port to  $V_{DD}$  or  $V_{SS}$  through a resistor.)

Caution 2. Connect the  $EV_{SS}$  pin to  $V_{SS}$  and the  $EV_{DD}$  pin to  $V_{DD}$ .

Caution 3.  $V_{DD}$  must be held at not lower than the reset release voltage ( $V_{LVD0}$ ) that is specified as LVD.

### 4.2 Used Pins

Table 6-1 Table 4-1 shows list of used pins and assigned functions.

Table 4-1 List of Pins and Functions

| Pin name | Input/Output | Function                  |
|----------|--------------|---------------------------|
| P16      | Output       | PWM Output (LED1 control) |
| P53      | Input        | Prohibit P53 output       |

Caution. In this application note, only the used pins are processed. When actually designing your circuit, make sure the design includes sufficient pin processing and meets electrical characteristic requirements.



## 5. Software

### 5.1 Overview of the sample program

In this sample code, The 32-bit interval timer (TML32) interrupt request (INTITL) starts the SNOOZE mode sequencer (SMS), and SMS changes the duty ratio of the PWM output of the timer array unit (TAU).

The LED brightness is changed by changing the duty ratio of the PWM output. By fixing the PWM output period to 1ms and increasing the duty ratio from 0% to 100% in 32 steps, the LED brightness is gradually reduced. The duty ratio value is stored in RAM in advance. SMS reads the value stored in RAM and writes it to the timer data register (TDR).

In addition, after the initial setting, it shifts to HALT mode to reduce power consumption.

The following is an overview of the features of this sample code.

- (1) Creates a data table for setting the duty ratio of PWM output
- (2) Starts counting TAU
- (3) Starts counting TML32
- (4) Shifts HALT mode
- (5) Starts SMS with TML32 compare match
- (6) Writes the data table value indicated by the pointer to the timer data register
- (7) Branches to (8) if the pointer advances to the end of the data table, else branches (9)
- (8) Sets the pointer to the start address of the data table
- (9) SMS shifts to standby state and go to (5)

(6) to (9) are processed by SMS.

## 5.2 Folder Configuration

Table 5-1 shows folder configuration of source file and header files using by sample code except the files generated by integrated development environment and the files in the bsp environment.

**Table 5-1 Folder configuration**

| Folder/File configuration       | Outline                                 | Created by Smart configurator |
|---------------------------------|---|-------------------------------|
| ¥r01an5611_sms_led_dimming<DIR> | Root folder of this sample code         |                               |
| ¥src<DIR>                       | Folder for program source               |                               |
| main.c                          | Sample code source file                 |                               |
| ¥smc_gen<DIR> <sup>Note 2</sup> | Folder created by Smart Configurator    | √                             |
| ¥Config_ITL000_ITL001<DIR>      | Folder for TML32 program                | √                             |
| Config_ITL000_ITL001.c          | Source file for TML32                   | √                             |
| Config_ITL000_ITL001.h          | Header file for TML32                   | √                             |
| Config_ITL000_ITL001_user.c     | Interrupt source file for TML32         | √ <sup>Note 1</sup>           |
| ¥Config_PORT<DIR>               | Folder for PORT program                 | √                             |
| Config_PORT.c                   | Source file for PORT                    | √                             |
| Config_PORT.h                   | Header file for PORT                    | √                             |
| Config_PORT_user.c              | Interrupt source file for PORT          | √ <sup>Note 1</sup>           |
| ¥Config_SMS<DIR>                | Folder for SMS program                  | √                             |
| Config_SMS.c                    | Source file for SMS                     | √                             |
| Config_SMS.h                    | Header file for SMS                     | √                             |
| Config_SMS_ASM.smsasm           | ASM source file for SMS                 | √                             |
| Config_SMS_user.c               | Interrupt source file for SMS           | √ <sup>Note 1</sup>           |
| ¥Config_TAU0_0<DIR>             | Folder for TAU program                  | √                             |
| Config_TAU0_0.c                 | Source file for TAU                     | √                             |
| Config_TAU0_0.h                 | Header file for TAU                     | √                             |
| Config_TAU0_0_user.c            | Interrupt source file for TAU           | √ <sup>Note 1</sup>           |
| ¥general<DIR>                   | Folder for initialize or common program | √                             |
| ¥r_bsp<DIR>                     | Folder for BSP program                  | √                             |
| ¥r_config<DIR>                  | Folder for BSP_CFG program              | √                             |

Note. <DIR> means directory.

Note 1. Not used in this sample code.

Note 2. The sample code of the IAR version has a different configuration. Check the sample code of the IAR version for details. In addition, stores r01an5611\_sms\_led\_dimming.ipcf. For details, refer to "RL78 Smart Configurator User's Guide: IAREW (R20AN0581)".

### 5.3 Option Byte Settings

Table 5-2 shows the option byte settings.

**Table 5-2 Option Byte Settings**

| Address       | Setting Value    | Contents  |
|---------------|------------------|---|
| 000C0H/040C0H | 1110 1111B (EFH) | Operation of Watchdog timer is stopped (counting is stopped after reset)                        |
| 000C1H/040C1H | 1111 1110B (FEH) | LVD0 operating mode: reset mode<br>Detection voltage: Rising edge 1.875V<br>Falling edge 1.835V |
| 000C2H/040C2H | 1110 1000B (E8H) | Flash operating mode: HS mode<br>High-speed on-chip oscillator clock: 32MHz                     |
| 000C3H/040C3H | 1000 0101B (85H) | On-chip debugging is enabled  |

### 5.4 Constants

Table 5-3 shows the constants that are used in this sample code.

**Table 5-3 Constants used in the sample code**

| Constant Name   | Setting Value | Contents                                 | File   |
|-----------------|---------------|--|--------|
| BRIGHTNESS_RANK | 32            | Number of steps to change the duty ratio | main.c |

### 5.5 Variables

Global variables are not used in this sample code.

### 5.6 Functions

Table 5-4 shows the functions used in the sample code. However, the unchanged functions generated by the Smart Configurator are excluded.

**Table 5-4 Functions**

| Function name | Outline      | Source file |
|---------------|--------------|-------------|
| main          | Main process | main.c      |

### 5.7 Function Specifications

This part describes function specifications of the sample code.

[Function name] main

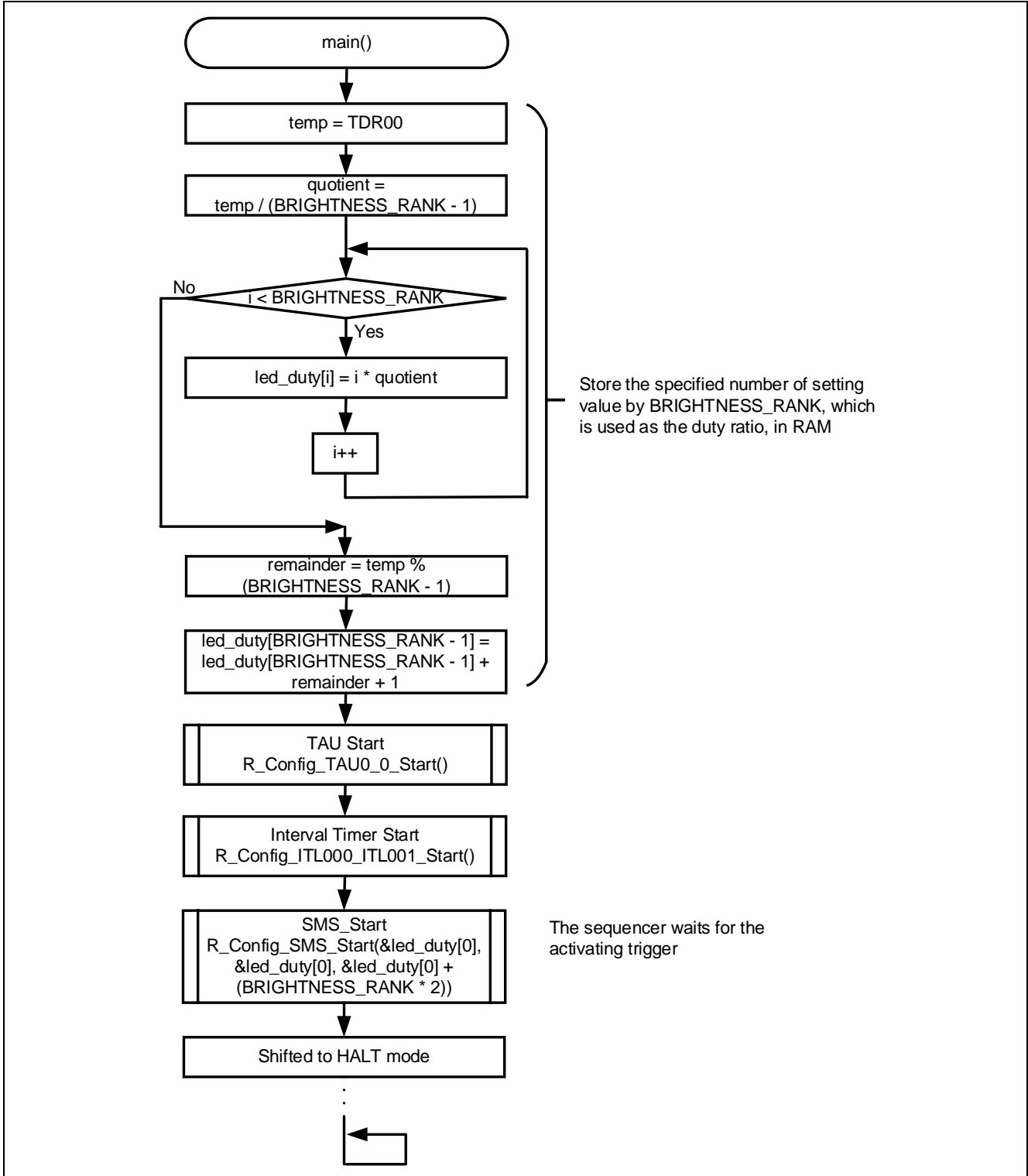
|                     |  |
|---------------------|--|
| <b>Outline</b>      | Main process   |
| <b>Header</b>       | r_smc_entry.h  |
| <b>Declaration</b>  | void main (void);  |
| <b>Description</b>  | This function defines the duty ratio value as a data table, then starts TML32 and TAU operation and shifts to HALT mode. |
| <b>Arguments</b>    | None   |
| <b>Return value</b> | None   |
| <b>Remarks</b>      | None   |

5.8 Flow Charts

5.8.1 Main Process

Figure 5-1 shows flowchart of main process.

Figure 5-1 Main process



## 5.9 SNOOZE Mode Sequencer settings

When the event set in the start trigger occurs, SMS executes the processing commands stored in the sequencer instruction register (SMSI0-31) in order. When executing a processing command, the Sequencer general-purpose register (SMSG0-15) is used to store the source address, destination address, calculated data, and so on.

SMSI0-31 and SMSG0-15 are set by writing the SMS program (.SMSASM file) in assembly language. The SMS program can also be created by combining processing blocks using the SNOOZE mode sequencer component of the Smart Configurator. The created SMS program is converted to a C language file by the SMS assembler and incorporated into the program.

The specifications of SMS processing executed by the sample code are shown below.

|                                   |  |
|-----------------------------------|--|
| <b>Outline</b>                    | SMS process  |
| <b>Description</b>                | SMS is started by TML32 interrupt, gets data from the data table that defines the duty ratio of the PWM output, and writes it to the timer data register of the TAU. |
| <b>Arguments</b> <sup>Note1</sup> | val_ram_d, val_ram_s, val_ram_e  |
| <b>Return value</b>               | None   |
| <b>Remarks</b>                    | None   |

Note1. Argument to be specified in the R\_Config\_SMS\_Start function setting. For details, refer to 6.2.1 and 6.2.7.

Table 5-2 shows flowchart of SMS process.

Table 5-5 to Table 5-6 show the register settings that control the SNOOZE mode sequencer.

Figure 5-2 SMS process

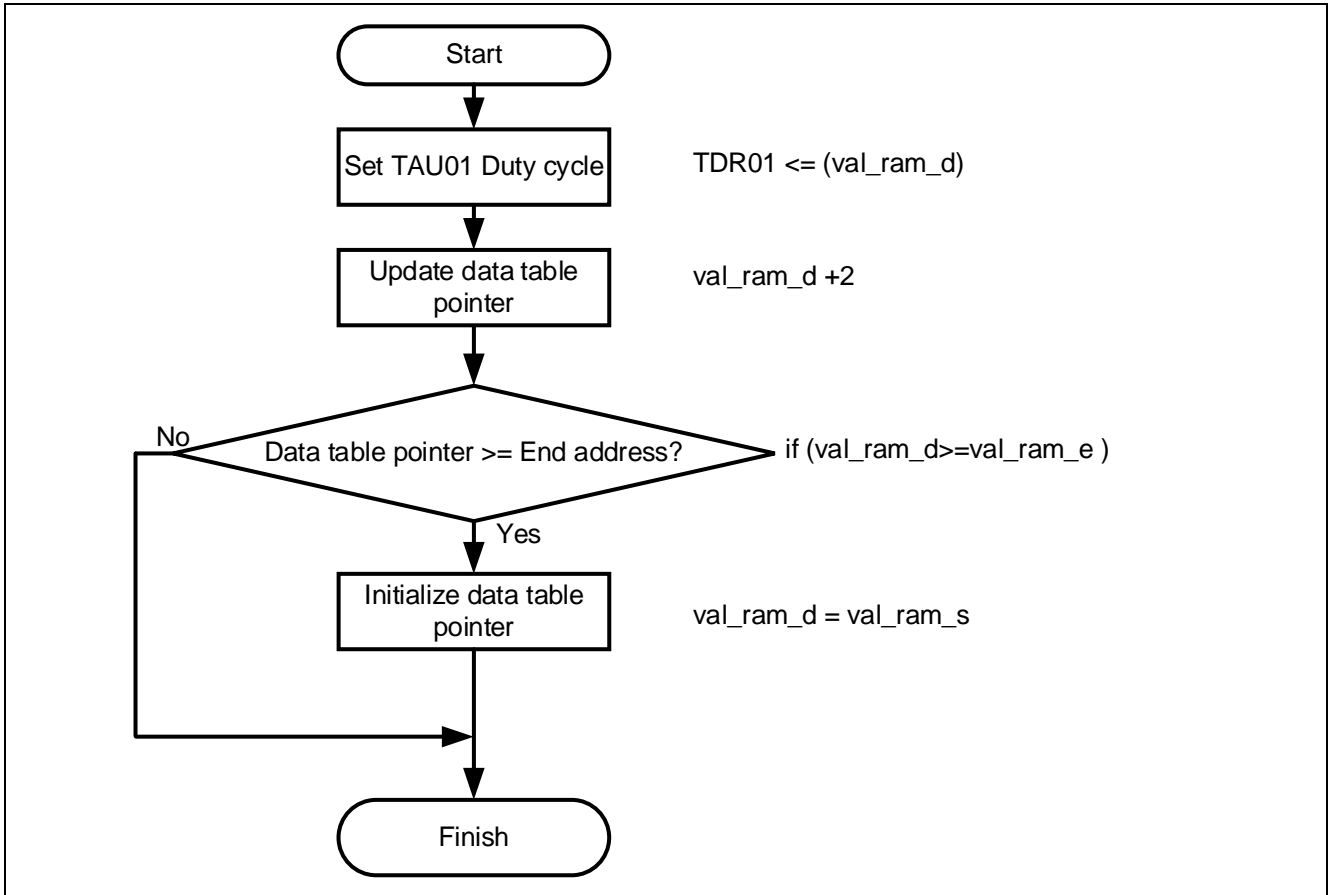


Table 5-5 Sequencer general-purpose registers 0-15

| Register Symbol | Setting | Remark                              |
|-----------------|---------|-------------------------------------|
| SMSG0           | 0000H   | fixed value: 0000H                  |
| SMSG1           | 0000H   | Data table pointer: val_ram_d       |
| SMSG2           | 0000H   | Data table end address: val_ram_e   |
| SMSG3           | 0000H   | Data table start address: val_ram_s |
| SMSG4           | &ITLS0  | ITLS0 address                       |
| SMSG5           | &SMSG1  | SMSG1 address                       |
| SMSG6           | &TDR01  | TDR01 address                       |
| SMSG7           | 2       | fixed value: 2                      |
| SMSG8           | 0000H   | SMS internal variable               |
| SMSG9           | 0000H   | unused                              |
| SMSG10          | 0000H   | unused                              |
| SMSG11          | 0000H   | unused                              |
| SMSG12          | 0000H   | unused                              |
| SMSG13          | 0000H   | unused                              |
| SMSG14          | 0000H   | unused                              |
| SMSG15          | FFFFH   | fixed value: FFFFH                  |

Table 5-6 Sequencer instruction registers 0-31

| Register Symbol | Setting | Remark                |
|-----------------|---------|-----------------------|
| SMSI0           | 0400H   | MOV [SMSG4+0], SMSG0  |
| SMSI1           | 3180H   | MOVW SMSG8, [SMSG1+0] |
| SMSI2           | 2680H   | MOVW [SMSG6+0], SMSG8 |
| SMSI3           | 7170H   | ADDW SMSG1, SMSG7     |
| SMSI4           | 7122H   | CMPW SMSG1, SMSG2     |
| SMSI5           | 8020H   | BC \$2                |
| SMSI6           | 2530H   | MOVW [SMSG5+0], SMSG3 |
| SMSI7           | F000H   | FINISH                |
| SMSI8-31        | 0000H   | unused                |

## 6. Application example

In addition to the sample code, this application note stores the following Smart Configurator configuration files.

r01an5611\_sms\_led\_dimming.scfg

r01an5611\_sms\_led\_dimming.sms

The following is a description of the file and setting examples and precautions for use.

### 6.1 r01an5611\_sms\_led\_dimming.scfg

This is the Smart Configurator configuration file used in the sample code. It contains all the features configured in the Smart Configurator. The sample code settings are as follows.

**Table 6-1 Parameters of Smart Configurator**

| Tag name   | Components  | Contents  |
|------------|-------------|---|
| Clocks     | -           | Operation mod: High-speed main mode 2.4 (V) ~ 5.5 (V)<br>EV <sub>DD</sub> setting: $1.8V \leq EV_{DD0} < 5.5V$<br>High-speed on-chip oscillator: 32MHz<br>f <sub>IHP</sub> : 32MHz<br>f <sub>CLK</sub> : 32000kHz (High-speed on-chip oscillator)<br>f <sub>SXP</sub> : 32.768kHz (Low-speed on-chip oscillator)  |
| System     | -           | On-chip debug operation setting: COM port <sup>Note 1</sup><br>Pseudo-RRM/DMM function setting: Used<br>Start/Stop function setting: Unused<br>Trace function setting: Used<br>Security ID setting: Use security ID<br>Security ID : 0x00000000000000000000<br>Security ID authentication failure setting: Do not erase flash memory data   |
| Components | r_bsp       | Start up select : Enable (use BSP startup)<br>Control of invalid memory access detection : Disable<br>RAM guard space (GRAM0-1) : Disabled<br>Guard of control registers of port function (GPORT) : Disabled<br>Guard of registers of interrupt function (GINT) : Disabled<br>Guard of control registers of clock control function, voltage detector, and RAM parity error detection function (GCSC) : Disabled<br>Data flash access control (DFLEN) : Disables<br>Initialization of peripheral functions by Code Generator/Smart Configurator : Enable<br>API functions disable : Enable<br>Parameter check enable : Enable<br>Setting for starting the high-speed on-chip oscillator at the times of release from STOP mode and of transitions to SNOOZE mode : High-speed<br>Enable user warm start callback (PRE) : Unused<br>Enable user warm start callback (POST) : Unused<br>Watchdog Timer refresh enable : Unused |
|            | Config_LVD0 | Operation mode setting: Reset mode<br>Voltage detection setting: Reset generation level (V <sub>LVD0</sub> ): 1.835 (V)   |



Table 6-2 Parameters of Smart Configurator

| Tag name   | Components           | Contents  |
|------------|----------------------|---|
| Components | Config_ITL000_ITL001 | Components: Interval timer<br>Operation mode: 16 bit count mode<br>Resource: ITL000_ITL001<br>Operation clock: $f_{SXP}$<br>Clock source: $f_{ITL0}/128$<br>Interval value: 125 ms<br>Interrupt setting: unused   |
|            | Config_TAU0_0        | Components: PWM Output<br>Resource: TAU0_0<br>Operation clock: CK00<br>Clock source: $f_{CLK}/2^8$<br>Cycle value: 1 ms<br>Interrupt setting: unused (INTTM00)<br>PWM Slave select setting: Channel 1 slave<br>Duty value: 0%<br>Output level: Active-high<br>Interrupt setting: unused (INTTM01) |
|            | Config_SMS           | Components: SNOOZE Mode Sequencer<br>Start trigger: Interval detection interrupt (INTITL)   |
|            | Config_PORT          | Components: Port<br>Port selection: PORT5<br>P53: In  |

Note 1. When using IAR, use the following settings.

On-chip debug operation setting: Use emulator

Emulator setting: E2 Emulator Lite

### 6.1.1 Clocks

Set the clock used in the sample code.

### 6.1.2 System

Set the on-chip debug of the sample code.

"Control of on-chip debug operation" and "Security ID authentication failure setting" affect "On-chip debugging is enabled" in "Table 5-2 Option Byte Settings". Note that changing the settings.

### 6.1.3 r\_bsp

Set the startup of the sample code.

### 6.1.4 Config\_LVD0

Set the power management of the sample code.

Affects "Setting of LVD0" in "Table 5-2 Option Byte Settings". Note that changing the settings

### 6.1.5 Config\_IT000\_ITL001

Initialize the interval timer for the sample code.

The interval timer interrupt (INTITL) is used to start the SMS in the sample code. Therefore, "Interrupt setting" is set to "Not used". "Interrupt Settings" can also be changed to "Use".

Since INTITL is masked by the R\_Config\_SMS\_Start function, the CPU will not start even if INTITL is generated during STOP or SNOOZE mode. After returning from STOP mode and SNOOZE mode, INTITL is in a masked state, so unmask INTITL if necessary.

### 6.1.6 Config\_TAU0\_0

Set TAU00 of the sample code.

### 6.1.7 Config\_SMS

Set the sample code SMS.

For details, refer to "6.2 r01an5611\_sms\_led\_dimming.sms".

### 6.1.8 Config\_PORT

Set the port of the sample code.

In the sample code, P53 is used to control LED1.

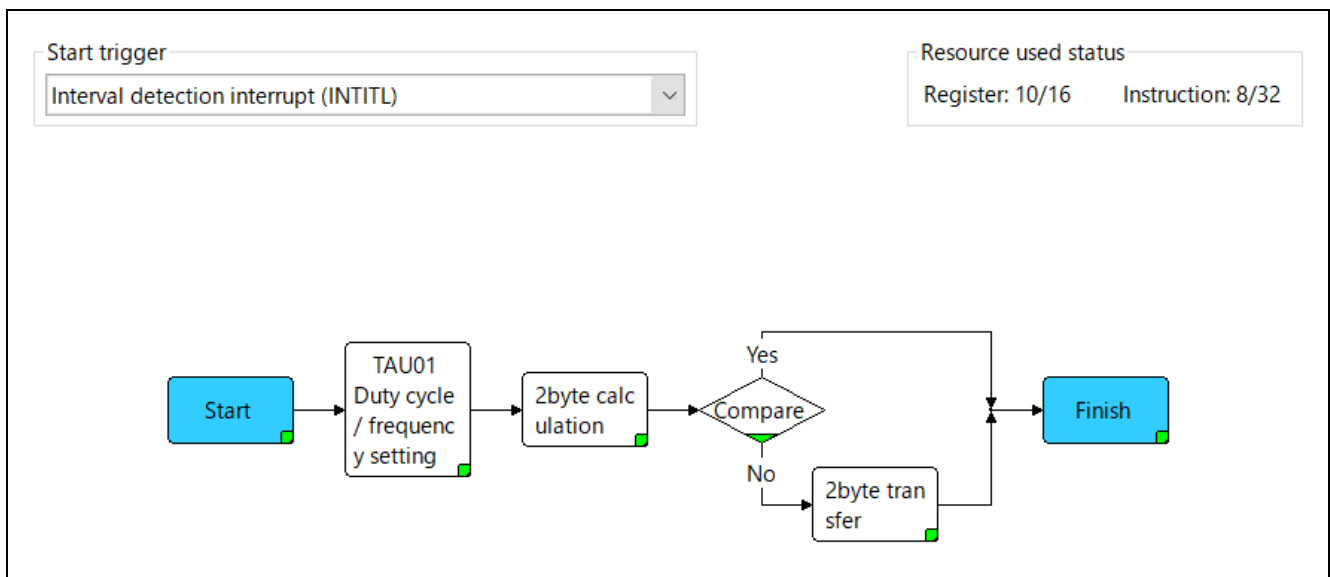
## 6.2 r01an5611\_sms\_led\_dimming.sms

This is the data for Config\_SMS alone. In the sample code, the interrupt of the interval timer is used to start SMS, and TAU is used in the operation of SMS. Note that it is necessary to set the interval timer and TAU separately.

The r01an5611\_sms\_led\_dimming.sms can also be imported into the Smart Configurator of another project. After setting up the SMS component in another project, go to [Import SMS Sequence] -> [Browse] and select "r01an5611\_sms\_led\_dimming.sms" to import it.

When imported into the smart configurator, the flow chart will be as shown in Figure 6-1. This flow chart is the same as "Figure 5-2 SMS process".

Figure 6-1 Config\_SMS flow chart

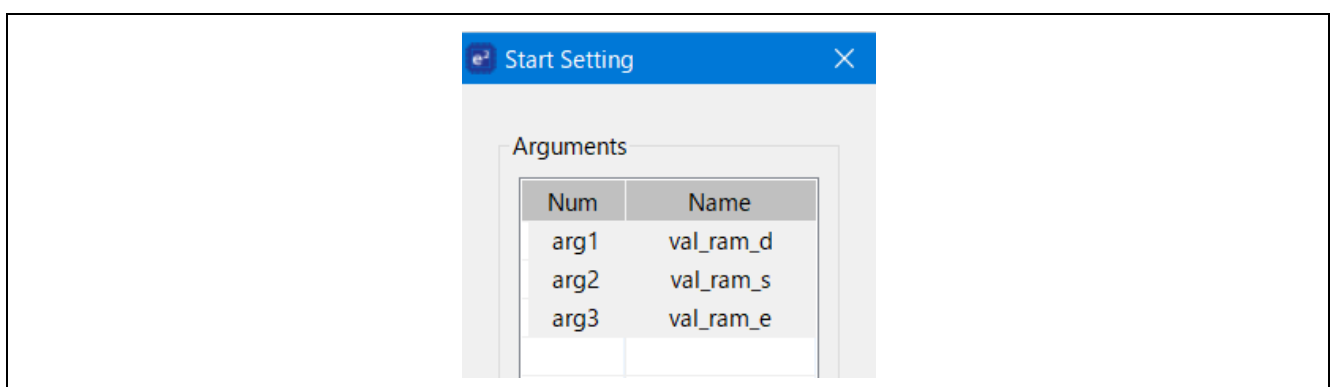


A description of each block is shown below.

### 6.2.1 Start

When the SMS starts, the values passed as arguments in the SMS start function (R\_Config\_SMS\_Start function) are set to val\_ram\_d (data table pointer), val\_ram\_s (data table start address), and val\_ram\_e (data table end address).

Figure 6-2 Start Setting



### 6.2.2 TAU Duty cycle / frequency setting

Changes the duty ratio of the TAU. Stores the value of val\_ram\_d (data table pointer) in the TDR register of the channel-specified TAU01.

In the sample code, TAU01 is set as the channel designation because PWM output is performed using TAU00 and TAU01, but the channel designation can be set from among TAU00 to TAU07.

Figure 6-3 TAU01 Duty cycle frequency Setting

The screenshot shows a dialog box titled "TAU01 Duty cycle / frequency setting Setting". It contains the following settings:

- Specify target:** (empty)
- Specify channel:** TAU01
- TDR value:**
  - Fixed value: 0
  - Variable: (empty dropdown)
  - Address: val\_ram\_d

### 6.2.3 2byte calculation

Add "2" to val\_ram\_d where the duty ratio is stored, and store the result in val\_ram\_d. This will change the pointer to the data table that contains the next duty ratio.

Figure 6-4 2byte calculation Setting

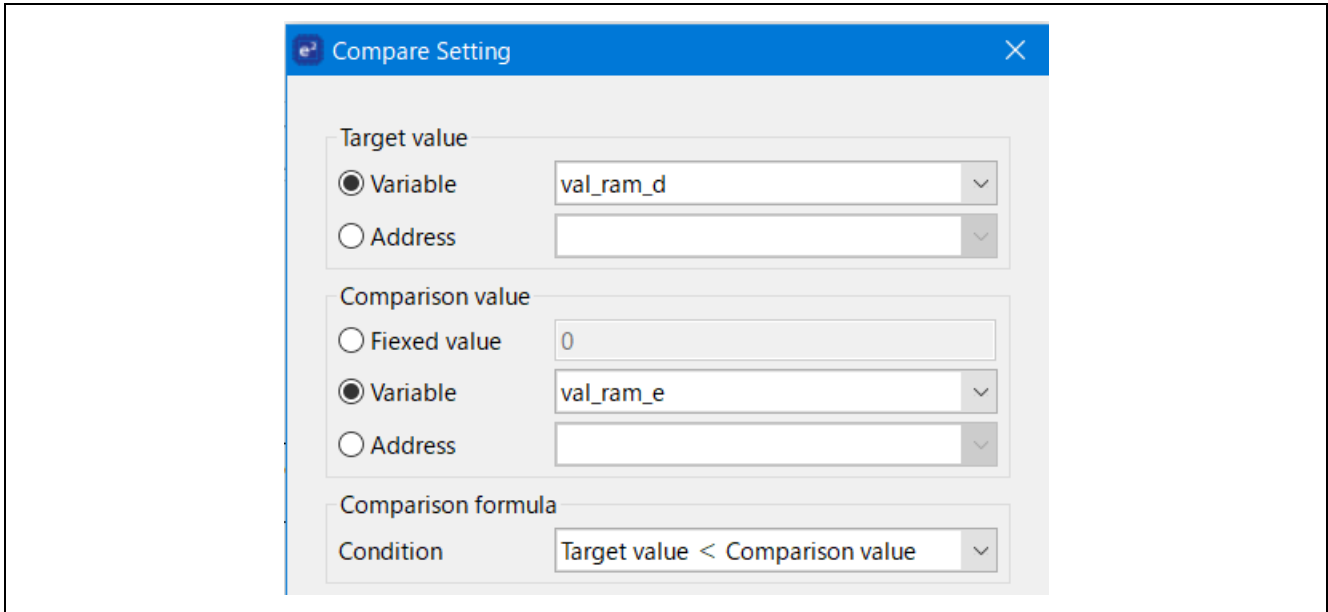
The screenshot shows a dialog box titled "2byte calculation Setting". It contains the following settings:

- Target value:**
  - Variable: val\_ram\_d
  - Address: (empty dropdown)
- Calculation value:**
  - Fixed value: 2
  - Variable: (empty dropdown)
  - Address: (empty dropdown)
- Calculation formula:**
  - +(plus)
  - (minus)

### 6.2.4 Compare

Compare whether the data table pointer stored in val\_ram\_d is smaller than the threshold value stored in val\_ram\_e (the last address of the data table). If val\_ram\_d is smaller than the threshold value, it will shift to HALT mode. If val\_ram\_d is larger than the threshold value, it performs the next 2-byte transfer and updates val\_ram\_d.

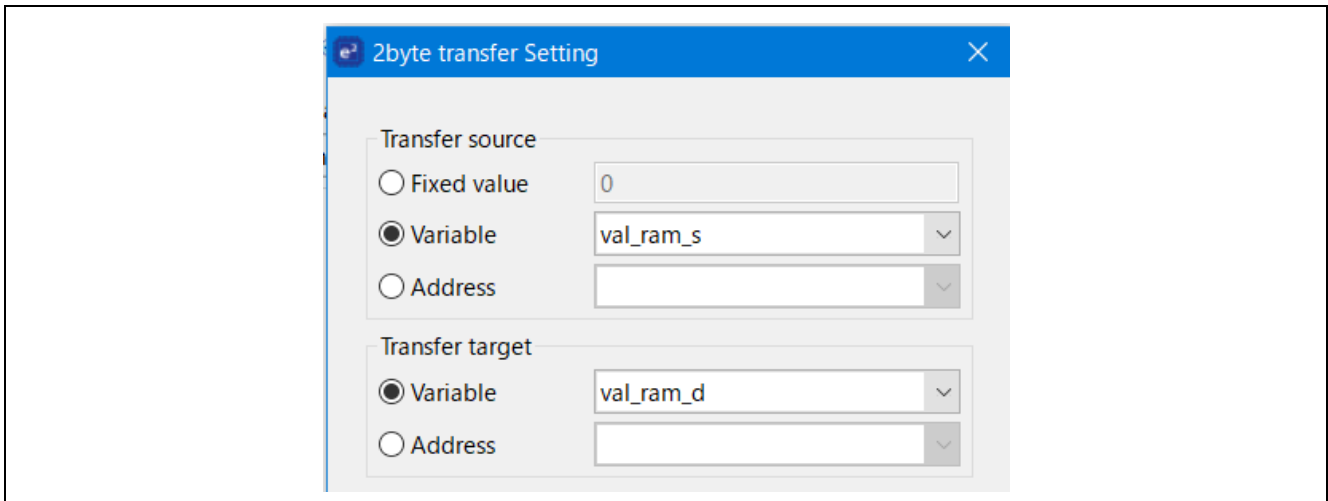
Figure 6-5 Compare Setting



### 6.2.5 2byte transfer Setting

Store the value of val\_ram\_s (data table start address) in the transfer target val\_ram\_d.

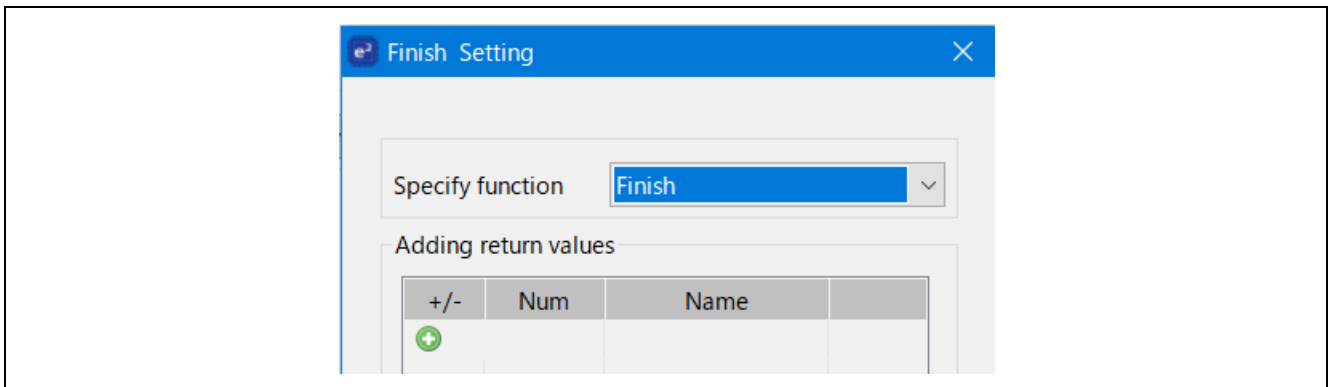
Figure 6-6 2byte transfer Setting



### 6.2.6 Finish

It shifts to HALT mode. In the sample code, the return value is not used.

Figure 6-7 Finish Setting



### 6.2.7 Variable Setting

The settings of the variables used in SMS are shown below.

Table 6-3 Variables used in SMS

| Data name | Initialization mode                  | Initial value | Description  |
|-----------|--------------------------------------|---------------|--|
| val_ram_d | Pass argument via SMS start function | -             | Stores the pointer to the data table that stores the duty ratio.<br>The pointer to led_duty[0] is set as an argument in the R_Config_SMS_Start function.                                 |
| val_ram_s | Pass argument via SMS start function | -             | Stores the start address of the data table to store the duty ratio.<br>The address of led_duty[0] is set as an argument in the R_Config_SMS_Start function.                              |
| val_ram_e | Pass argument via SMS start function | -             | Stores the last address of the data table that stores the duty ratio.<br>The address of "&led_duty[0] + (BRIGHTNESS_RANK * 2)" is set as an argument in the R_Config_SMS_Start function. |

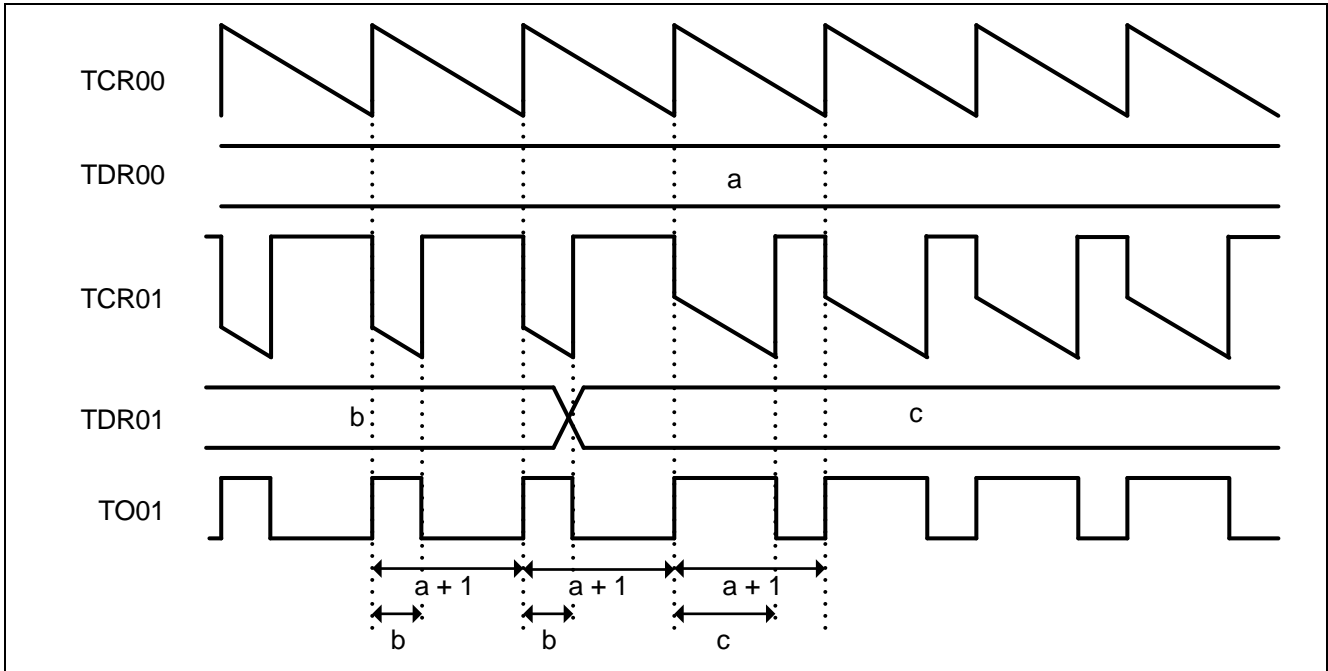
### 6.3 Example of changing the LED blinking time

Figure 6-8 shows an example of PWM operation timing of the sample code. When SMS starts, Duty cycle of TO01 is changed by changing the value of TDR01. After the initial setting value is determined by Config\_TAU0\_0, TDR00 is not changed. The value set for TDR01 is determined by how many divisions (BRIGHTNESS\_RANK) of the cycle (TDR00) are made in main.c.

In the sample code, 32 is set as shown below, so a value divided into 32 is set. When this value is changed, the LED blinking time is changed.

```
#define BRIGHTNESS_RANK (32U)
```

Figure 6-8 Timing example of PWM operation



## 7. Sample Code

Sample code can be downloaded from the Renesas Electronics website.

Furthermore, if you regenerate the code with Smart Configurator, please modify the R\_Config\_SMS\_Start function as indicated in the red frame below.

```
void R_Config_SMS_Start(uint16_t val_ram_d, uint16_t val_ram_s, uint16_t val_ram_e)
{
    /* Set the sms data from arguments */
    SMSG1 = val_ram_d;
    SMSG3 = val_ram_s;
    SMSG2 = val_ram_e;
    /* Disable related interrupts */
    ITLMK = 1U;
    TMMK01 = 1U;
    /* Start sms */
    //SMSEIF = 0U; /* clear INTSMSE interrupt flag */
    //SMSEMK = 0U; /* enable INTSMSE interrupt */
    SMSEMK = 1U; /* disable INTSMSE interrupt */
    SMSEIF = 1U; /* set INTSMSE interrupt flag */
    g_sms_wakeup_flag = 0U;
    ITLS0 = _00_INTITL_CLEAR;
    SMSSTART = 1U;
}
```

## 8. Reference

RL78/G23 User's Manual: Hardware (R01UH0896E)

RL78 Family User's Manual: Software (R01US0015E)

SMS assembler User's Manual (R20UT4792J)

RL78 Smart Configurator User's Guide: CS+ (R20AN0580E)

RL78 Smart Configurator User's Guide: e<sup>2</sup> studio (R20AN0579E)

RL78 Smart Configurator User's Guide: IAREW (R20AN0581E)

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## Revision History

| Rev. | Date      | Description    |  |
|------|-----------|----------------|--|
|      |           | Page           | Summary  |
| 1.00 | Apr.13.21 | -              | First edition  |
| 1.10 | Jun.1.21  | 6              | Updated tool version<br>Table 2-1 Operation Confirmation Conditions<br>Integrated development environment (CS+) : E8.05.00f -> V8.05.00<br>C compiler (CS+) : V1.09.00 -> V1.10<br>Integrated development environment (e <sup>2</sup> studio) : 2021-01 (21.01.0) -> 2021-04 (21.4.0)<br>C compiler (e <sup>2</sup> studio) : V1.09.00 -> V1.10<br>Integrated development environment (IAR) : V4.20.1 -> V4.21.1<br>Smart Configurator : V.1.0.0 -> V.1.0.1<br>Board support package (r_bsp) : V.1.0.0 -> V.1.10 |
|      |           | 6, 8<br>16, 17 | Changed due to COM port support<br>Table 2-1 Operation Confirmation Conditions<br>Emulator: E2 Emulator Lite -><br>CS+, e <sup>2</sup> studio: COM port<br>IAR: E2 Emulator Lite<br><br>Figure 4-1 Hardware Configuration<br>Added P11/TOOLRxD and P12/TOOLTxD<br>Table 6-1 Smart Configurator Settings<br>Note 1 added  |
|      |           | 10, 11         | Changed due to IAR version sample code update<br>Table 5-1 Folder configuration<br>Added the note about reference documents in folder configuration<br>5.7 Function Specifications [Function name] main, Header<br>e <sup>2</sup> studio, CS+ : r_smc_entry.h<br>IAR : ior7f100g.h, ior7f100g_ext.h, r_cg_macrodriver.h, Config_SMS.h, Config_ITL000_ITL001.h, Config_TAU0_0.h<br>-> r_smc_entry.h   |
|      |           | 16, 17         | Changed clock abbreviation<br>Table 6-1 Parameters of Smart Configurator<br>Clocks : f <sub>SXL</sub> -> f <sub>SXP</sub><br>Table 6-2 Parameters of Smart Configurator<br>Operation clock : f <sub>SXL</sub> -> f <sub>SXP</sub>  |
|      |           | 24             | Added of RL78 Smart Configurator User's Guide<br>8. Reference<br>RL78 Smart Configurator User's Guide: CS+ (R20AN0580E)<br>RL78 Smart Configurator User's Guide: e <sup>2</sup> studio (R20AN0579E)<br>RL78 Smart Configurator User's Guide: IAREW (R20AN0581E)  |
| 1.20 | Jan.9.24  | -              | Changed the flowchart for SMS processing   |

# 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.

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