RL78/G23

Remote-Control Signal Transmission Using ELCL Function (NEC format)

Introduction

This application note describes how to use Timer Array Unit (TAU) and Logic and Event Link Controller (ELCL) to transmit remote-control signals.

The target remote-control format is NEC format (with header, 32-bit data, and repeat code).

Target Device

Evaluation Board	: RL78/G23-64p Fast Prototyping Board
Infrared Remote-Control Transmitter Module	: Ren He V1221

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

Contents

1. Specifications

1.1 Specifications Overview

1.1.1 System Overview

This application note realizes remote-control signal transmission using Timer Array Unit (TAU) and Logic and Event Link Controller (ELCL).

1.1.2 Signal Format

The remote-control signal is generated in NEC format. This format uses 940 nm infrared rays as the carrier wave, with a frequency of 38 kHz and a duty ratio of 1/3 as the subcarriers. The data to be transmitted is encoded by controlling the on and off periods of the subcarriers.

In the NEC format, data is transmitted by controlling the output of subcarriers with the smallest unit cycle being 562 us (one cycle). The signal has a structure called frame or repeat, which contains information. The information transmitted is a 16-bit customer code (manufacturer identification code) and 8-bit data code.

The frame is the basic unit of a remote-control signal and is a set of a series of signals that make up the data to be transmitted. The frame consists of the following elements.

1. Header: The part that indicates the start of transfer, consisting of a signal pattern with 16 cycles ON and 8 cycles OFF.
2. Customer code: 16-bit manufacturer identification code.
3. Data code: 16-bits of data, consisting of 8 bits of transmitted data and its bit inversion data.
4. Stop bit: The part that indicates the end of transfer.

The bit data contained in customer code and data code is represented by the length of the signal. A signal transmission period ratio of 1:1 indicates “0” and the ratio of 1:3 indicates “1”.

Repeat is a signal transmitted by pressing and holding a button on the remote-control, etc. Following the frame, the signal is transmitted repeatedly with a cycle of 108 ms. This causes the receiver to assume that the same signal is being sent if the button is pressed. Repeat consists of the following elements.

1. Header: The part that indicates the start of transfer, consisting of a signal pattern with 16 cycles ON and 4 cycles OFF.
2. Stop bit: The part that indicates the end of transfer.

Figure 1-1 shows the remote-control signal of NEC format and Figure 1-2 shows the signal pattern when the button is pressed long.

Figure 1-1 Remote-Control Signal of NEC Format

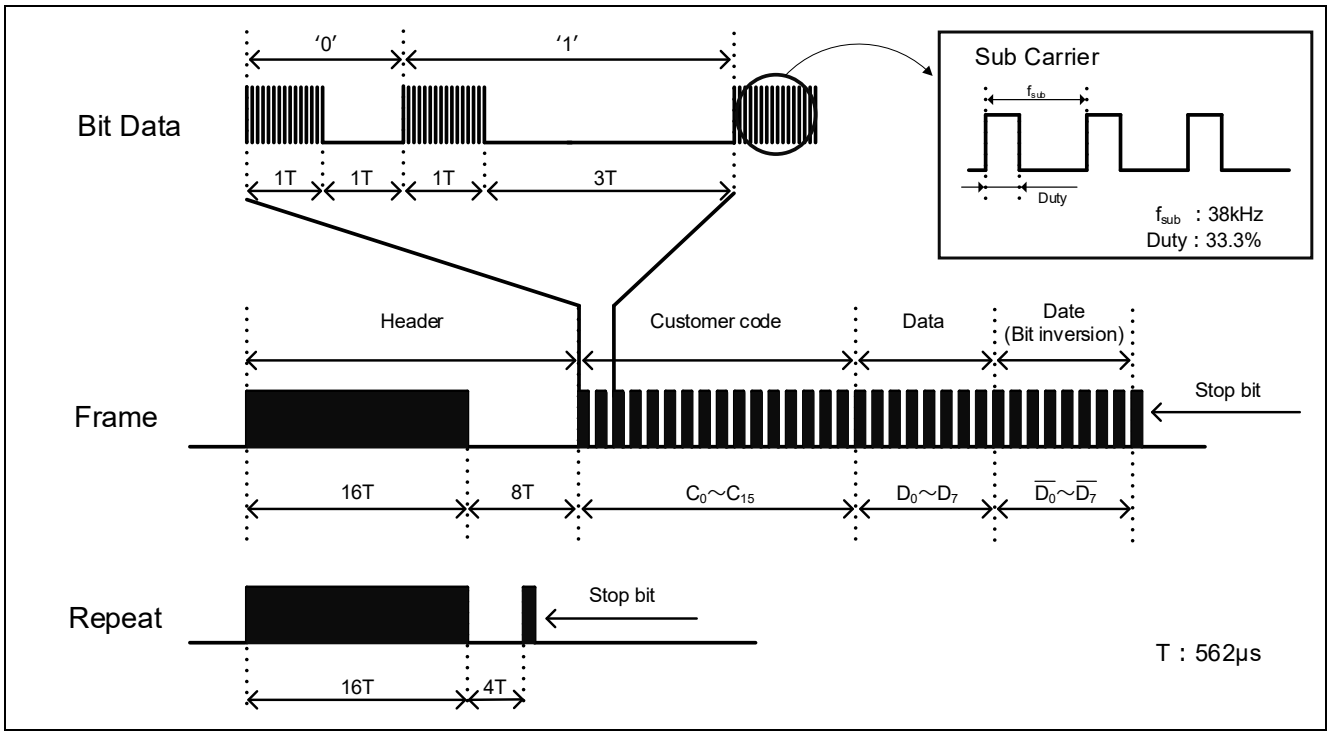
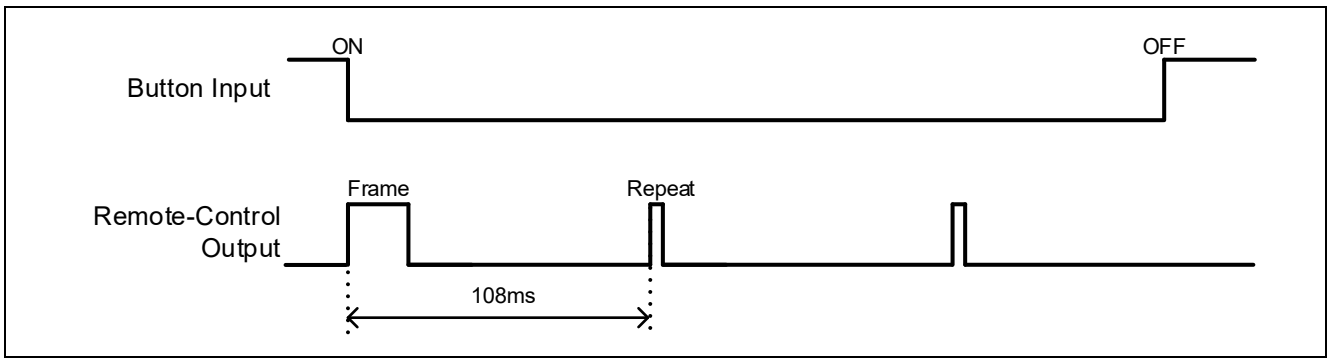


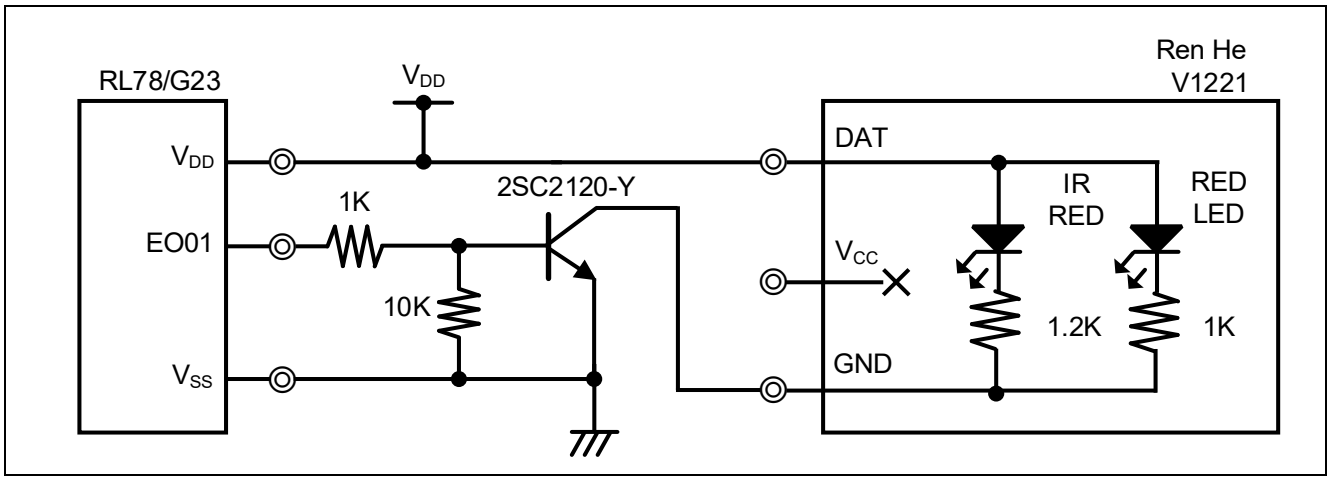
Figure 1-2 Signal Pattern When Button is Pressed Long



1.1.3 Circuit Configuration

Figure 1-3 shows the configuration for remote-control transmission.

Figure 1-3 Configuration of RL78/G23 and Remote-Control Transmission Module



1.1.4 Remote Control Signal Transmission Using ELCL

Figure 1-4 shows the configuration of the ELCL.

Timer Array Unit 0 (TAU0) is used to generate the remote-control signal. PWM outputs are provided that generates a subcarrier waveform on channel 0 (TAU0_0) and channel 1 (TAU0_1). In channel 2 (TAU0_2), interrupt processing is performed at intervals of 562 µs period in NEC format, counting the elapsed period. Based on the period counted by TAU0_2, the level of P10 is controlled and a mask waveform is generated.

ELCL receives subcarrier waveform inputs from TAU0_1 and mask waveform inputs from P51 pin, and by performing AND operations on them, outputs a remote-control signal on the P01 pin.

Figure 1-4 Configuration of ELCL

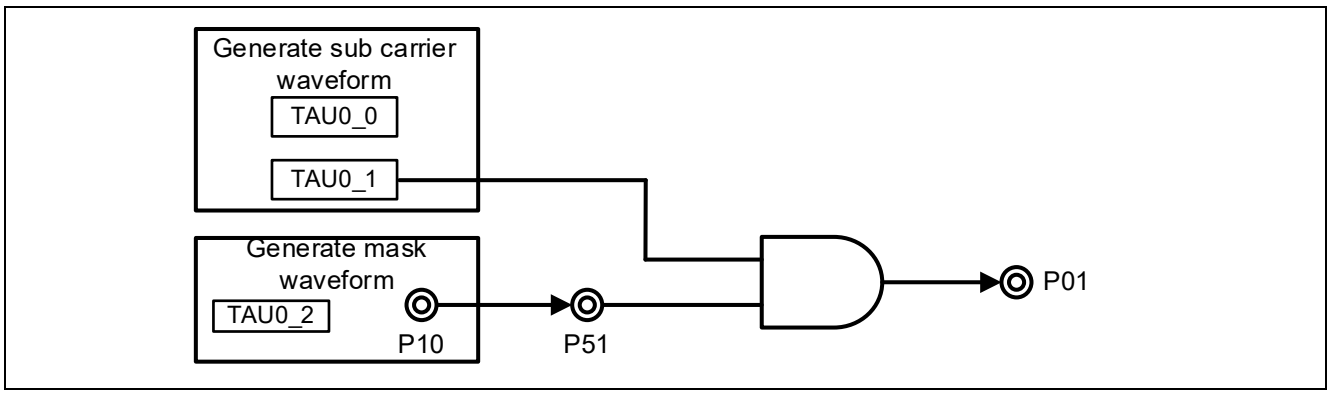
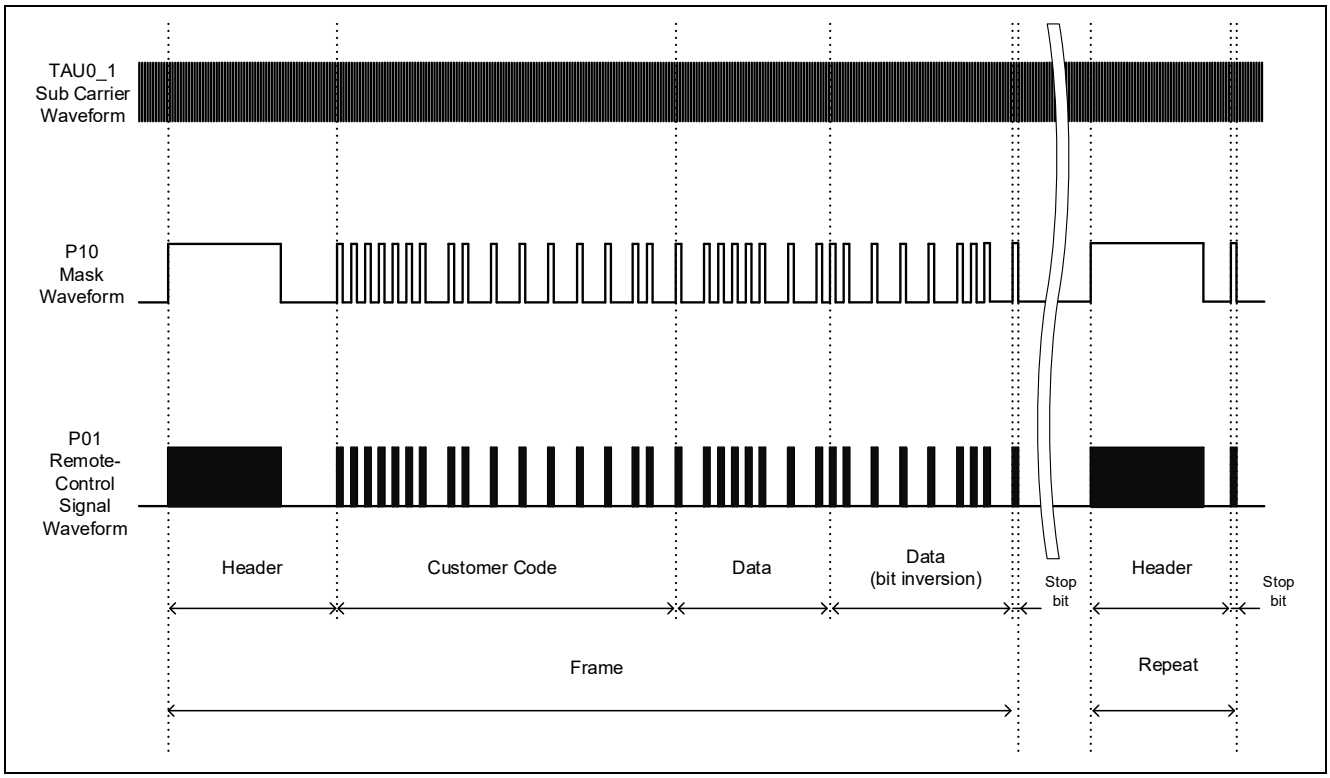


Figure 1-5 shows the remote-control signal waveforms using the ELCL.

In this application note, the remote-control signal is generated with the customer code as 0x02fd and the data code as 0x86.

Figure 1-5 Remote-Control Signal Waveforms Using ELCL



1.2 Operation Details

This application note shows an example of using remote-control signal transmission.

By pressing the switch (SW1) on the board, the remote-control signal is transmitted. If the switch is held down, the repeat code is transmitted repeatedly.

2. Operation Confirmation Conditions

The sample code described in this application note has been confirmed under the following conditions.

Table 2-1 Operation Confirmation Conditions

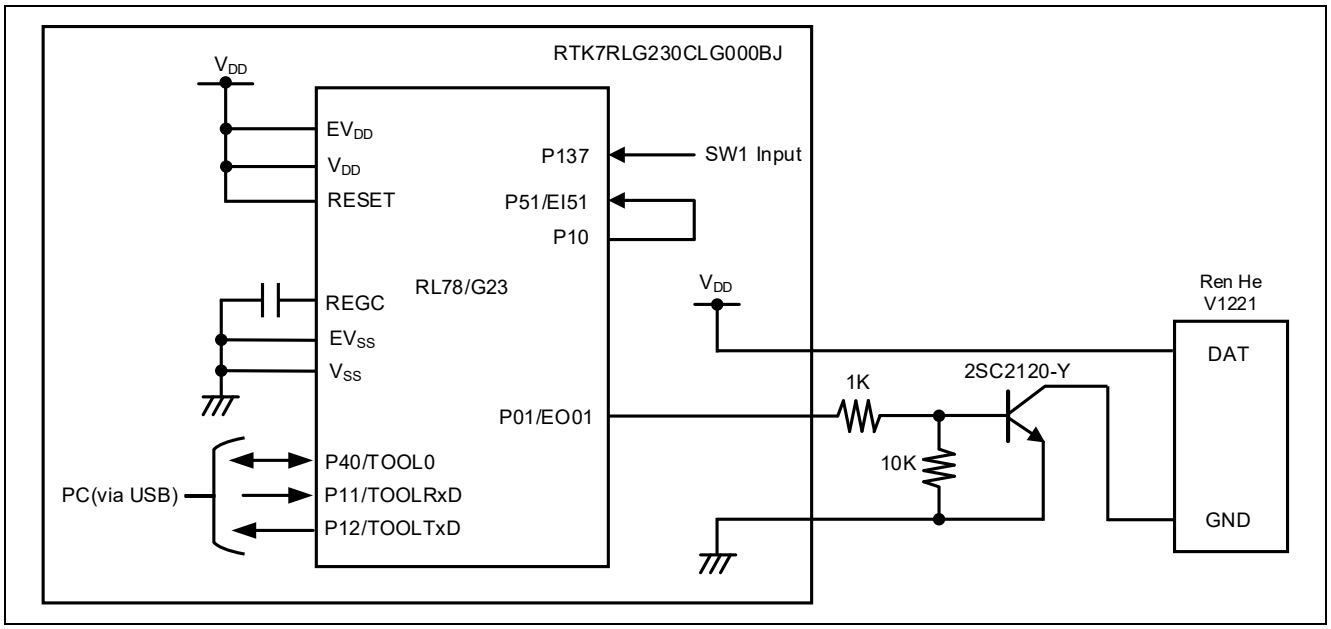
Item	Descriptions
Device used	RL78/G23 (R7F100GLG)
Board used	RL78/G23-64p Fast Prototyping Board (RTK7RLG230CLG000BJ)
Operating frequency	• High-speed On-Chip Oscillator: 32MHz • CPU/Peripheral Hardware Clock: 32MHz
Operating voltage	• 5.0V • LVD0 Operation (V_{LVD0}): Reset Mode • Reset Voltage (V_{LVD0}): 1.65 (V)
Integrated development environment (CS+)	CS+ for CC V8.13.0 Manufactured by Renesas Electronics
C compiler (CS+)	CC-RL V1.15 Manufactured by Renesas Electronics
Integrated development environment (e^2 studio)	e^2 studio 2025-04 (25.4.0) Manufactured by Renesas Electronics
C compiler (e^2 studio)	CC-RL V1.15 Manufactured by Renesas Electronics
Integrated development environment (IAR)	IAR Embedded Workbench for Renesas RL78 V 5.20.1 Manufactured by IAR Systems
C compiler (IAR)	IAR C/C++ Compiler for Renesas RL78 5.20.1.2826 (5.20.1.2826) Manufactured by IAR Systems
Smart Configurator	V.1.13.0
Board Support Package (r_bsp)	V.1.90
Infrared Remote-Control Transmitter Module	Ren He V1221

3. Hardware Description

3.1 Example of Hardware Configuration

Figure 3-1 shows an example of hardware configuration.

Figure 3-1 Example of Hardware Configuration



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

Note 2. Connect any pin whose name begins with EV_{SS} to V_{SS}, and any pin whose name begins with EV_{DD} to V_{DD}, respectively.

Note 3. V_{DD} must not be lower than the reset release voltage (V_{LVD0}) that is specified for the LVD0.

3.2 List of used Pins

Table 3-1 shows the pins used and their functions.

Table 3-1 Pins used and Their Functions

Pin Name	I/O	Function
P01/EO01	Output	Perform AND operations on the subcarrier waveform and the mask waveform and output the generated remote-control signal
TAU0_1	Output	Generate subcarrier waveform and input to ELCL
P10	Output	Output mask waveform
P51/EI51	Input	Input mask waveform from P10
P137	Input	SW1 input

4. Software Description

4.1 Peripheral Function Used

The following shows used peripheral functions in the sample code of this application note.

Table 4-1 List of Peripheral Functions

Peripheral Function	Usage
Timer Array Unit (TAU0_0)	PWM master (Cycle setting)
Timer Array Unit (TAU0_1)	PWM slave (Duty ratio control), PWM output
Timer Array Unit (TAU0_2)	Counting the cycle of NEC format (562 µs)
Port function	P10: Generate the mask waveform P137: SW1 input
Logic and Event Link Controller (ELCL)	AND operation of PWM slave output and port output to generate remote-control signals

4.2 List of Option Byte Settings

The following shows the option byte settings.

Table 4-2 Option Byte Settings

Address	Setting Value	Description
000C0H / 020C0H	1110 1111B (0xEF)	Watchdog Timer stopped operation (Count stops after reset release)
000C1H / 020C1H	1111 1100B (0xFC)	LVD0 detection voltage: Reset mode Reset generation voltage (V_{LVD0}): 1.65 (V)
000C2H / 020C2H	1110 1000B (0xE8)	HS mode, High-speed on-chip oscillator frequency: 32MHz
000C3H / 020C3H	1000 0100B (0x84)	On-chip debug operation allowed

4.3 Folder Structure

The following shows the structure of the source files/header files used in the sample code.

Note that files automatically generated by the integrated development environment and files from the bsp environment are excluded.

Table 4-3 Folder Structure

Folder/File Name	Description	Generated by Smart Configurator
¥ r01an7636_elcl_remocon_send<DIR>NOTE2	Sample code folder	
¥src<DIR>	Program storage folder	
main.c	Sample code source file	
main.h	Sample code header file	
¥smc_gen<DIR>	Smart configurator generated folder	√
¥Config_ELCL<DIR>	ELCL program storage folder	√
Config_ELCL.c	ELCL source file	√
Config_ELCL.h	ELCL header file	√
Config_ELCL_user.c	ELCL interrupt source file	√NOTE1
¥Config_PORT<DIR>	PORT program storage folder	√
Config_PORT.c	PORT source file	√
Config_PORT.h	PORT header file	√
Config_PORT_user.c	PORT interrupt source file	√NOTE 1
¥Config_TAU0_0 <DIR>	TAU0_0 program storage folder	√
Config_ TAU0_0.c	TAU0_0 source file	√
Config_ TAU0_0.h	TAU0_0 header file	√
Config_ TAU0_0_user.c	TAU0_0 interrupt source file	√NOTE1
¥Config_ TAU0_2<DIR>	TAU0_2 program storage folder	√
Config_ TAU0_2.c	TAU0_2 source file	√
Config_ TAU0_2.h	TAU0_2 header file	√
Config_ TAU0_2_user.c	TAU0_2 interrupt source file	√

Note “<DIR>” indicates a directory.

Note 1. This sample code does not use it.

Note 2. The sample code for IAR contains the r01an7320_elcl.ipcf file. For details on the ipcf file, please refer to RL78 “RL78 Smart Configurator User’s Guide: IAR” (R20AN0581).

4.4 List of Variables

The following shows the list of variables used in the sample code.

Table 4-4 List of Variables

Type	Variables Name	Content	File
uint8_t	g_data_bit[4]	Array to store data to be sent	main.c
uint8_t	g_bit_index	Index of the bit currently being processed	main.c
uint8_t	g_byte_index	Index of the byte currently being processed	main.c
uint8_t	g_tm02_count	Variable to indicate the lapse of the cycle	main.c Config_TAU0_2_user.c
uint8_t	g_repeat_count	Variable to count cycle for repeat code output	main.c Config_TAU0_2_user.c
uint16_t	g_cusutomer_code	Variable to store the customer code	main.c
uint8_t	g_data_code	Variable to store the data code	main.c

4.5 List of Constants

The following shows the list of constants used in the sample code.

These constants are defined in main.h.

Table 4-5 List of Constants

Constant Name	Setting Value	Contents
SW1_PRESSED	0	Value to indicate the state SW1 is pressed down
SIGNAL_HIGH	1	Set the output of P10 to HIGH
SIGNAL_LOW	0	Set the output of P10 to LOW
HEADER_HIGH_CYCLES	16	Header HIGH cycle
HEADER_LOW_CYCLES_FRAME	8	Header LOW cycle (Frame)
HEADER_LOW_CYCLES_REPEAT	4	Header LOW cycle (Repeat)
CYCLE_HIGH_0	1	HIGH cycle of bit data (if 0)
CYCLE_LOW_0	1	LOW cycle of bit data (if 0)
CYCLE_HIGH_1	1	HIGH cycle of bit data (if 1)
CYCLE_LOW_1	3	LOW cycle of bit data (if 1)
STOP_CYCLES	1	HIGH cycle of stop bit
REPEAT_CYCLES	192	Cycle interval at which repeats are output Calculated by dividing the repeat interval (108 ms) by 1 cycle (562 µs)

4.6 Function List

The following shows the function list used in the sample code.

Table 4-6 Function List

Function Name	Overview	Source File
main	Main processing	main.c
invert_and_store	Change the data and store in the array	main.c
tx_data_bit	Output the bit data	main.c
r_Config_TAU0_2_interrupt	TAU0_2 interrupt	Config_TAU0_2_user.c

4.7 Function Specifications

The following describes the function specifications of the sample code.

[Function name] main

Overview	Main processing
Headers	r_smc_entry.h
Declaration	int main (void)
Description	This function outputs the remote-control signal when it receives a switch input.
Arguments	None
Return values	None
Remarks	None

[Function name] invert_and_store

Overview	Change the data and store in the array
Headers	main.h
Declaration	void invert_and_store(uint16_t customer, uint8_t data)
Description	This function changes customer code and data code into remote-control signal and stores in g_data_bit[4].
Arguments	customer: Customer code data: Data code
Return values	None
Remarks	None

[Function name] tx_data_bit

Overview	Output the bit data
Headers	main.h
Declaration	void tx_data_bit(void)
Description	This function outputs the value stored in g_data_bit[4] in NEC format rules.
Arguments	None
Return values	None
Remarks	None

[Function name] r_Config_TAU0_2_interrupt

Overview	Interrupt of TAU0_2
Headers	Config_TAU0_2.h
Declaration	static void __near r_Config_TAU0_2_interrupt(void)
Description	This function counts every NEC format cycle (562 µs).
Arguments	None
Return values	None
Remarks	None

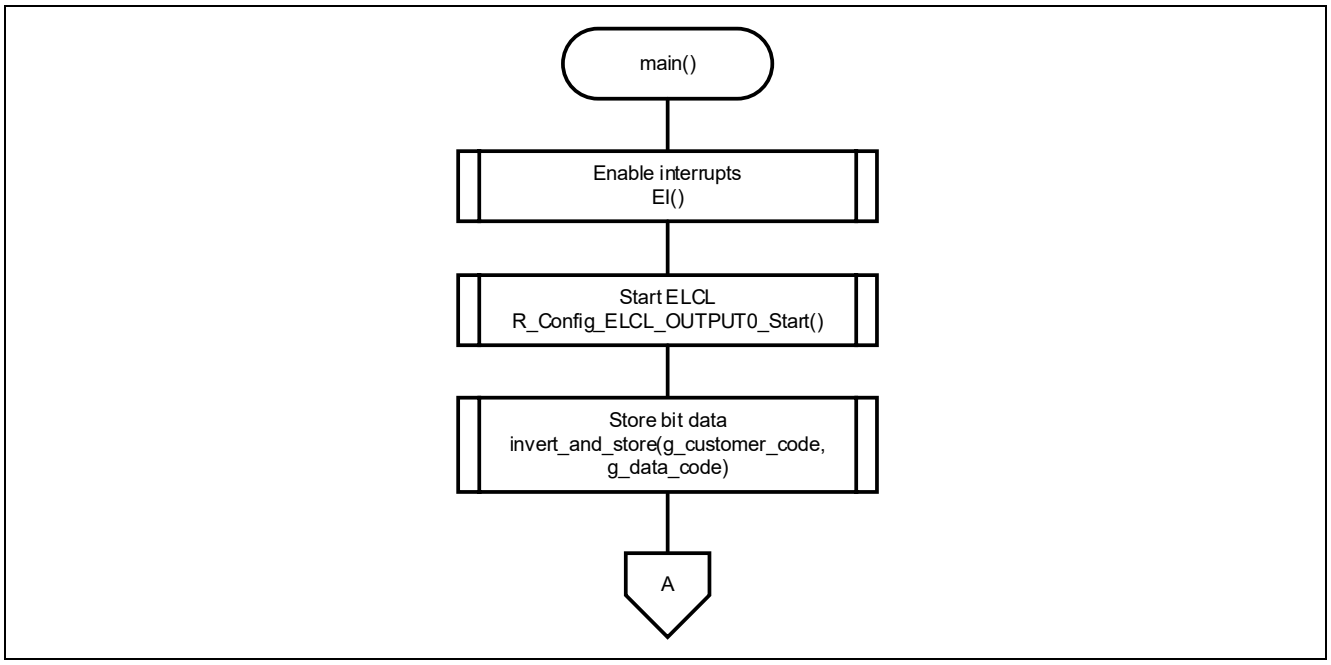
4.8 Flowchart

4.8.1 Main Process

The following shows the flowchart for the main process.

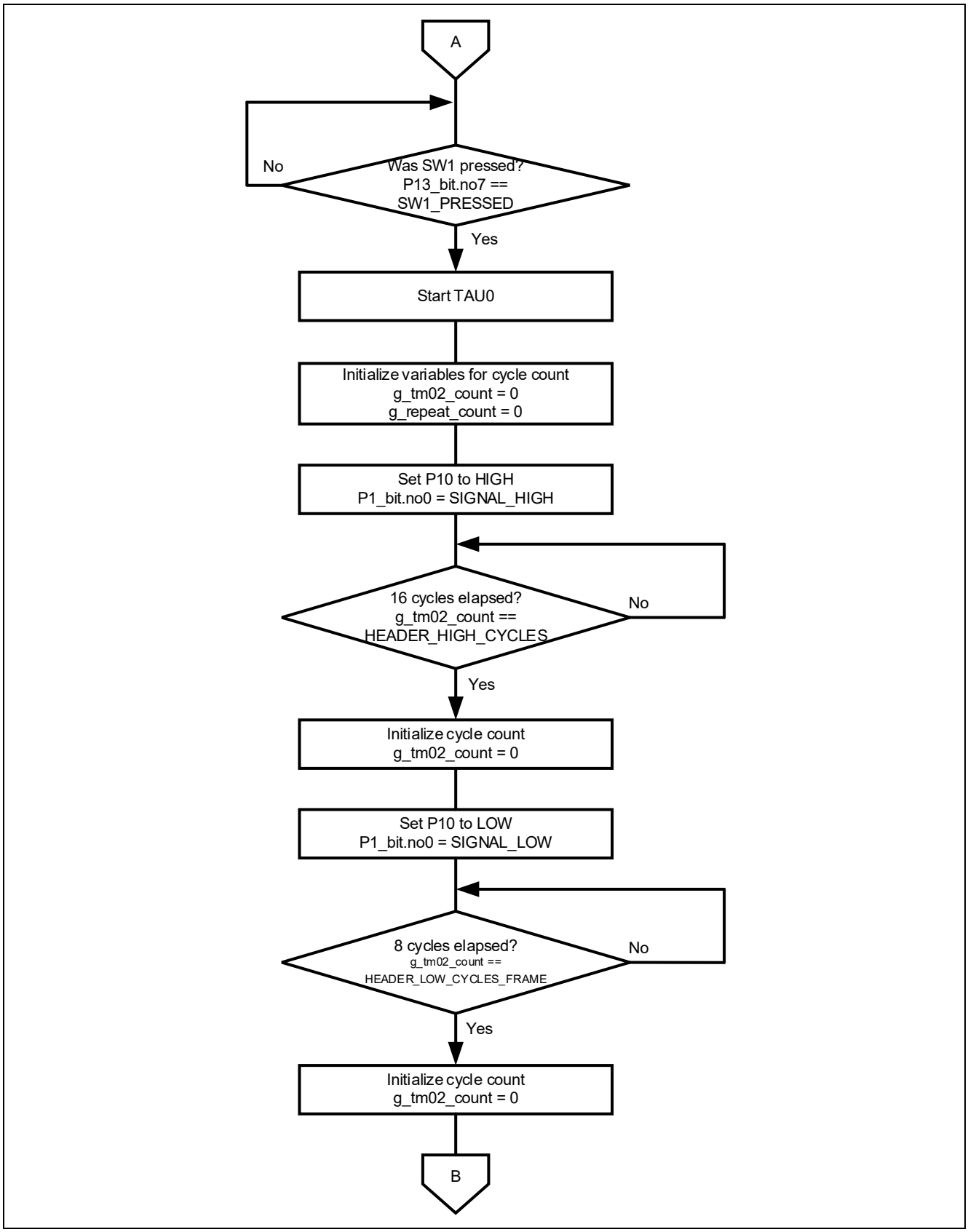
First, this function initializes the program.

Figure 4-1 Main Process (1/4)



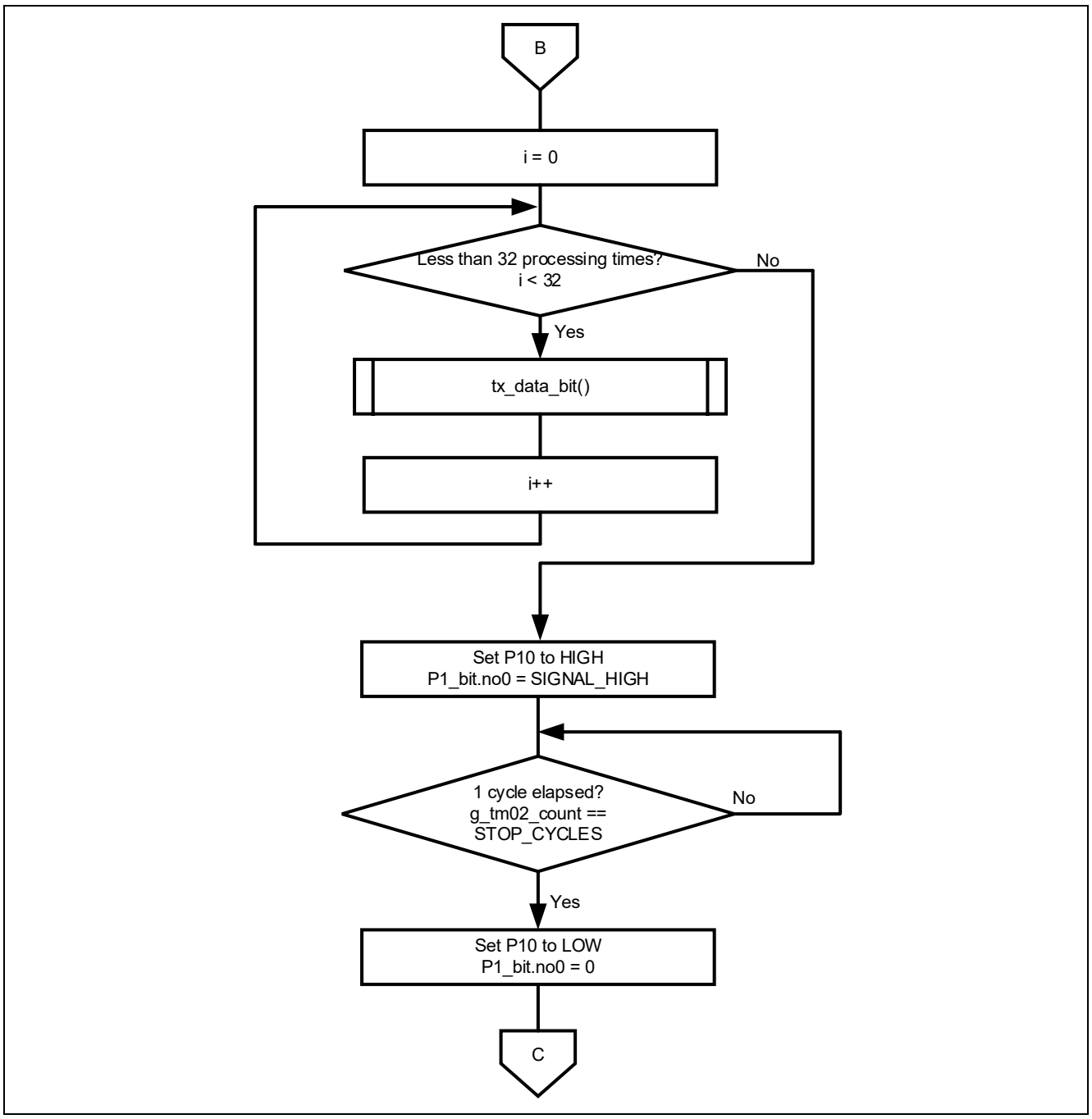
The process detects the pressing of SW1 and sends the header of the frame.

Figure 4-2 Main Process (2/4)



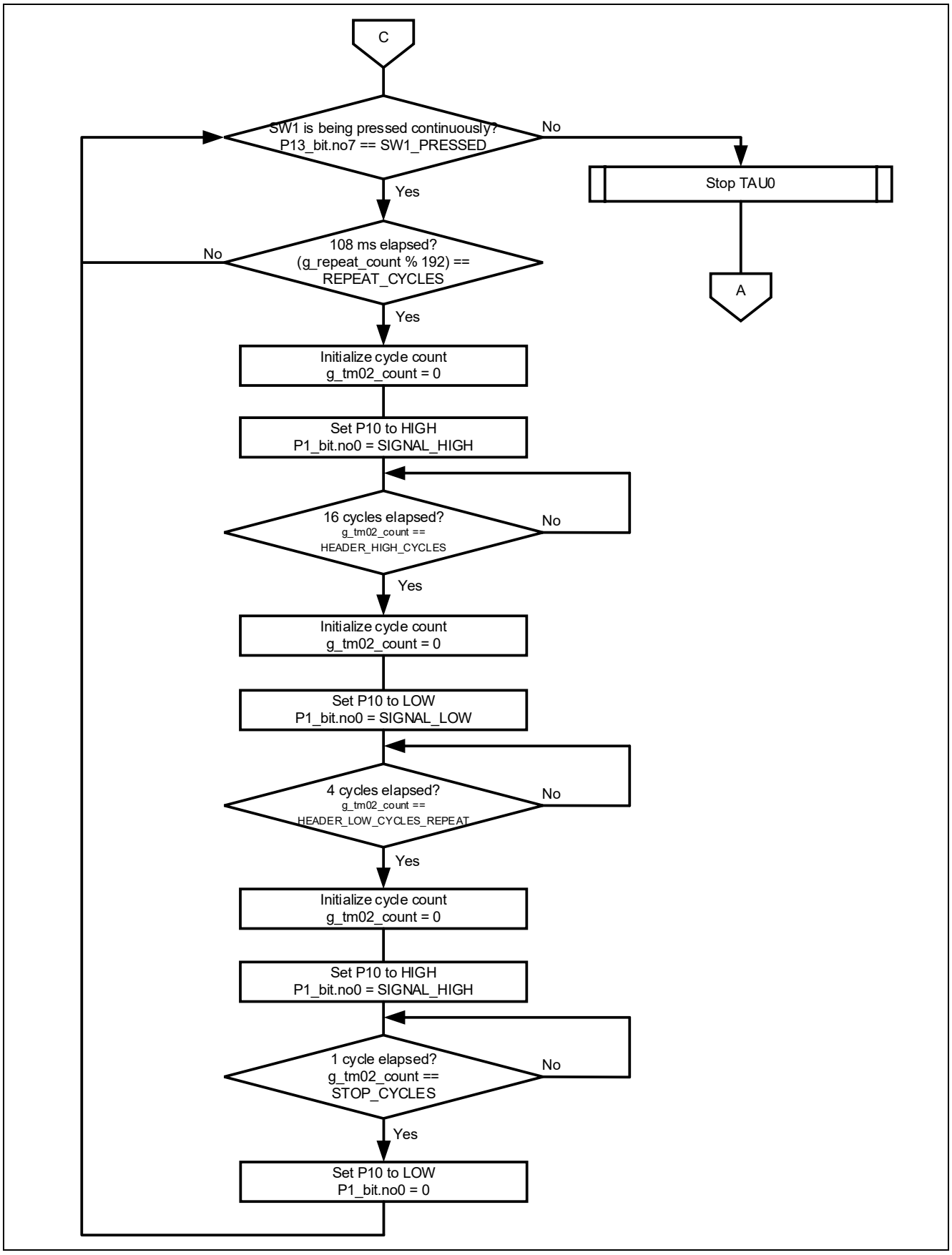
Transmission processing is performed for a total of 32 bits of customer code and data code, and the stop bit is output.

Figure 4-3 Main Process (3/4)



If SW1 is kept pressed, the repeat is sent at 108 ms intervals.

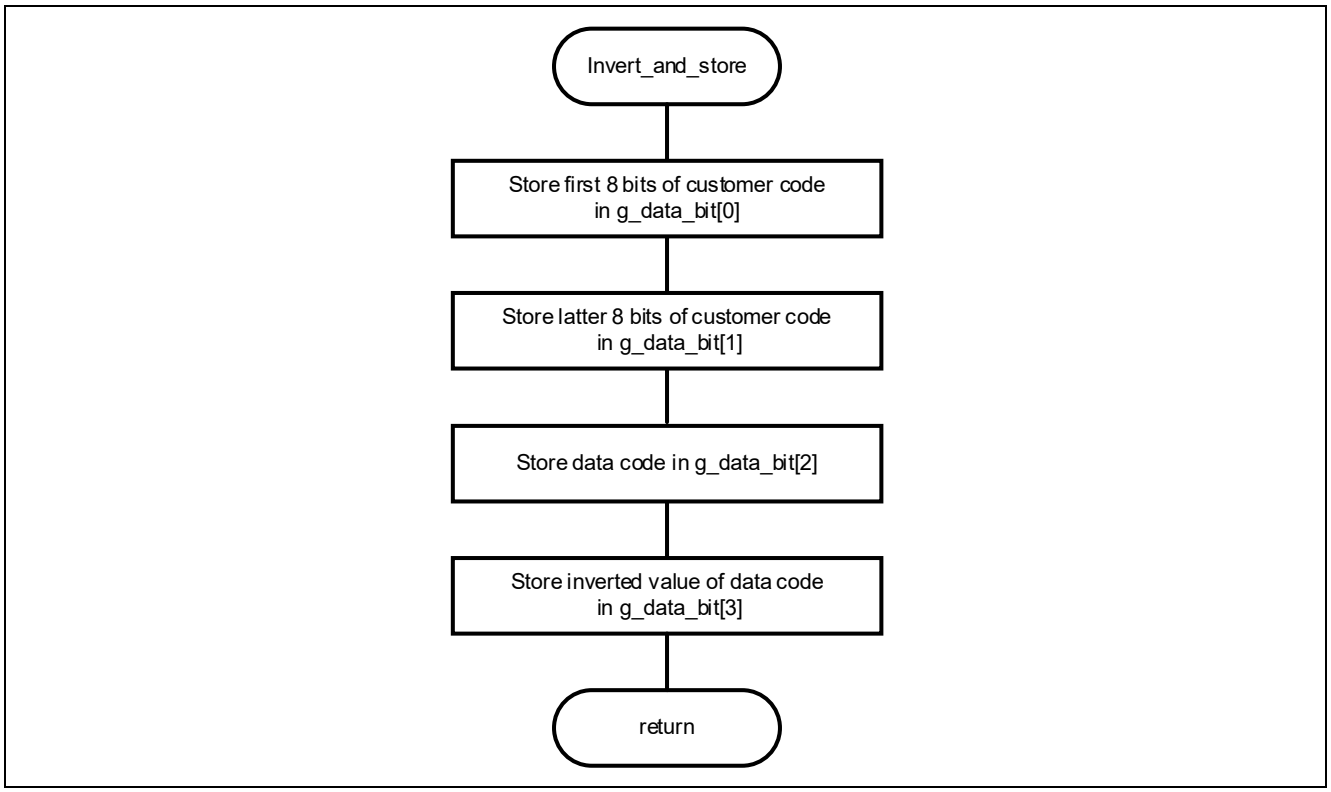
Figure 4-4 Main Process (4/4)



4.8.2 Flowchart of invert_and_store

The following shows the flowchart of invert_and_store function.

Figure 4-5 Flowchart of invert_and_store Function



4.8.3 Flowchart of tx_data_bit

The following shows the flowchart of tx_data_bit function.

Figure 4-6 Flowchart of tx_data_bit Function (1/3)

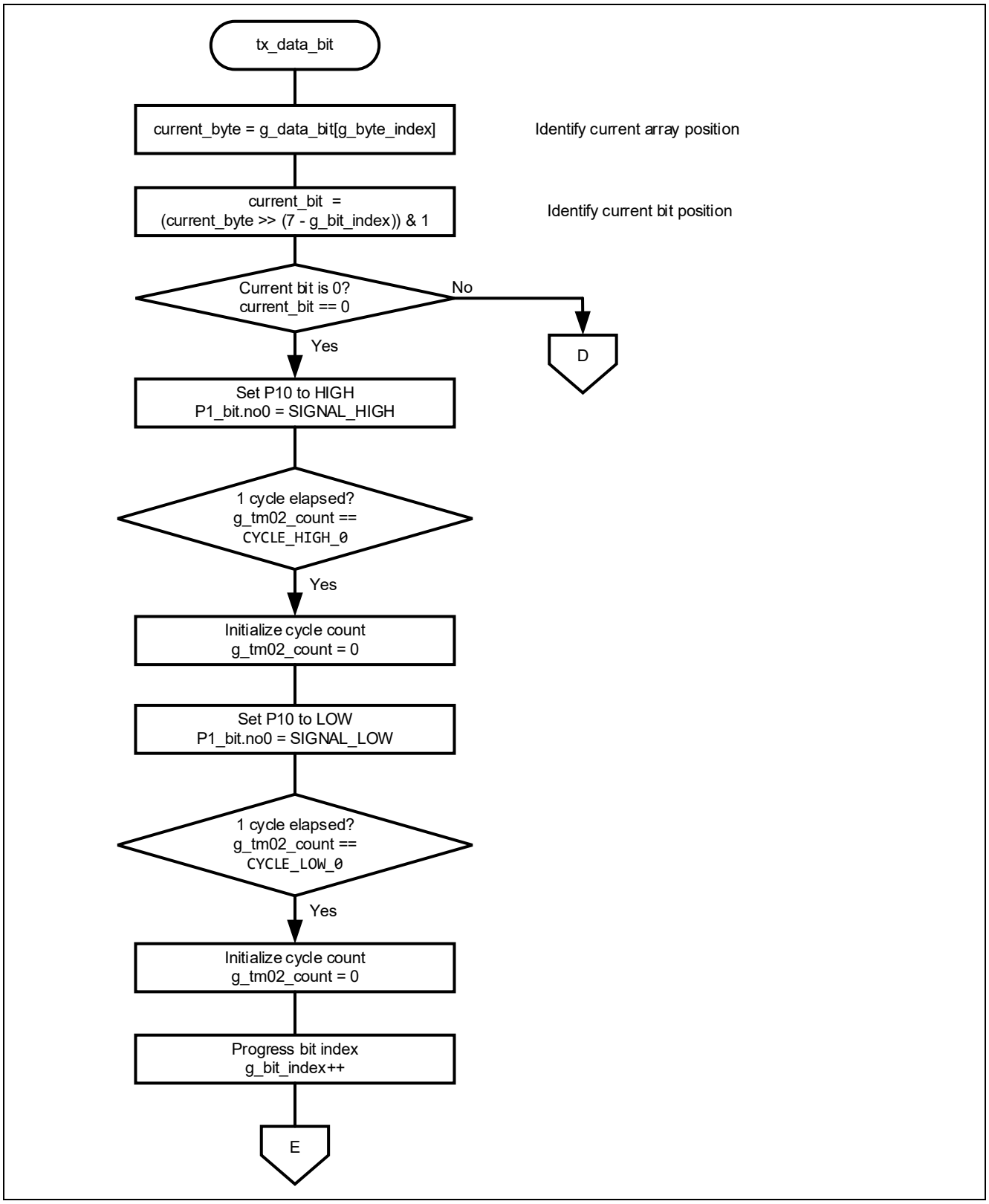


Figure 4-7 Flowchart of tx_data_bit Function (2/3)

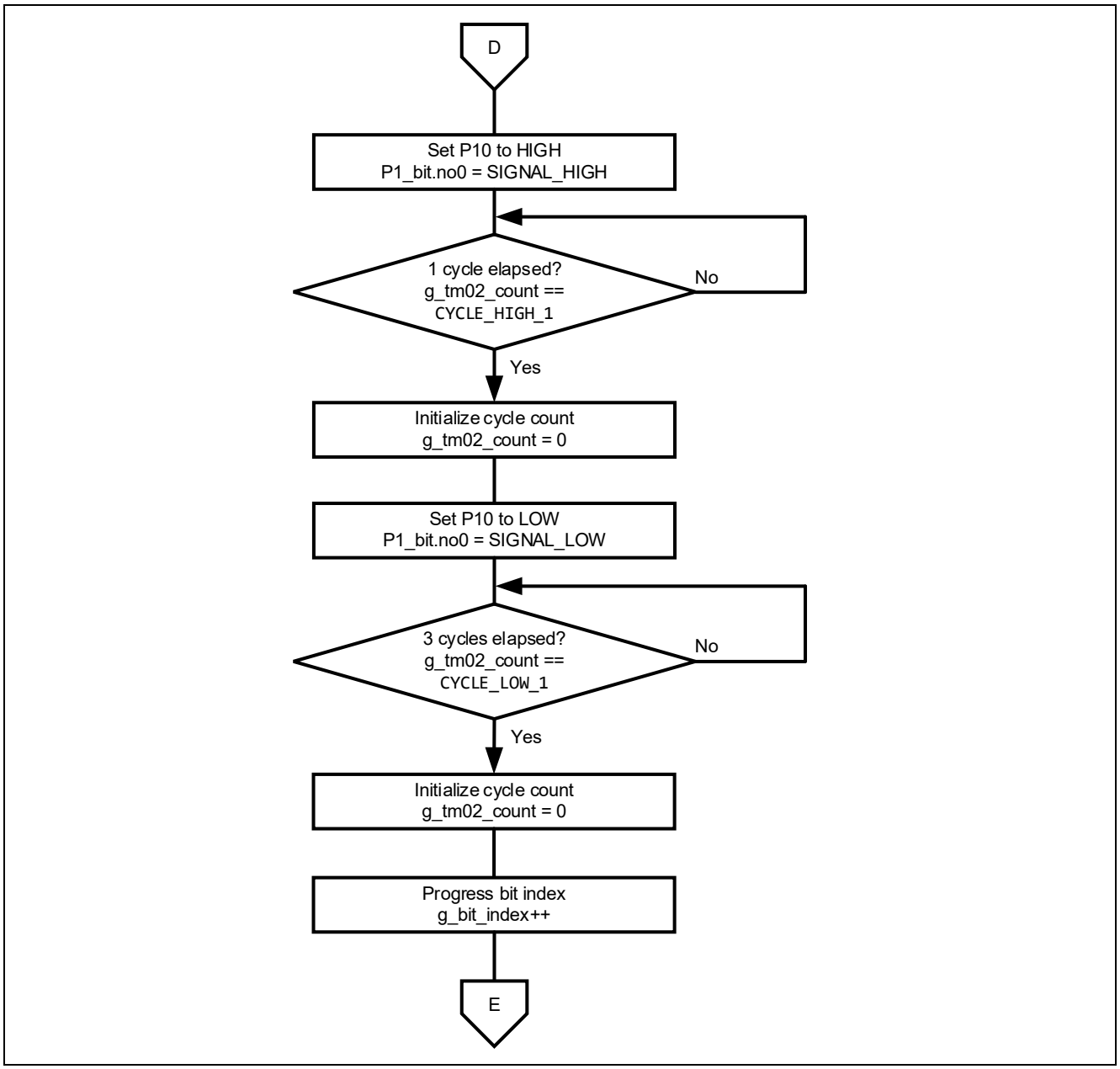
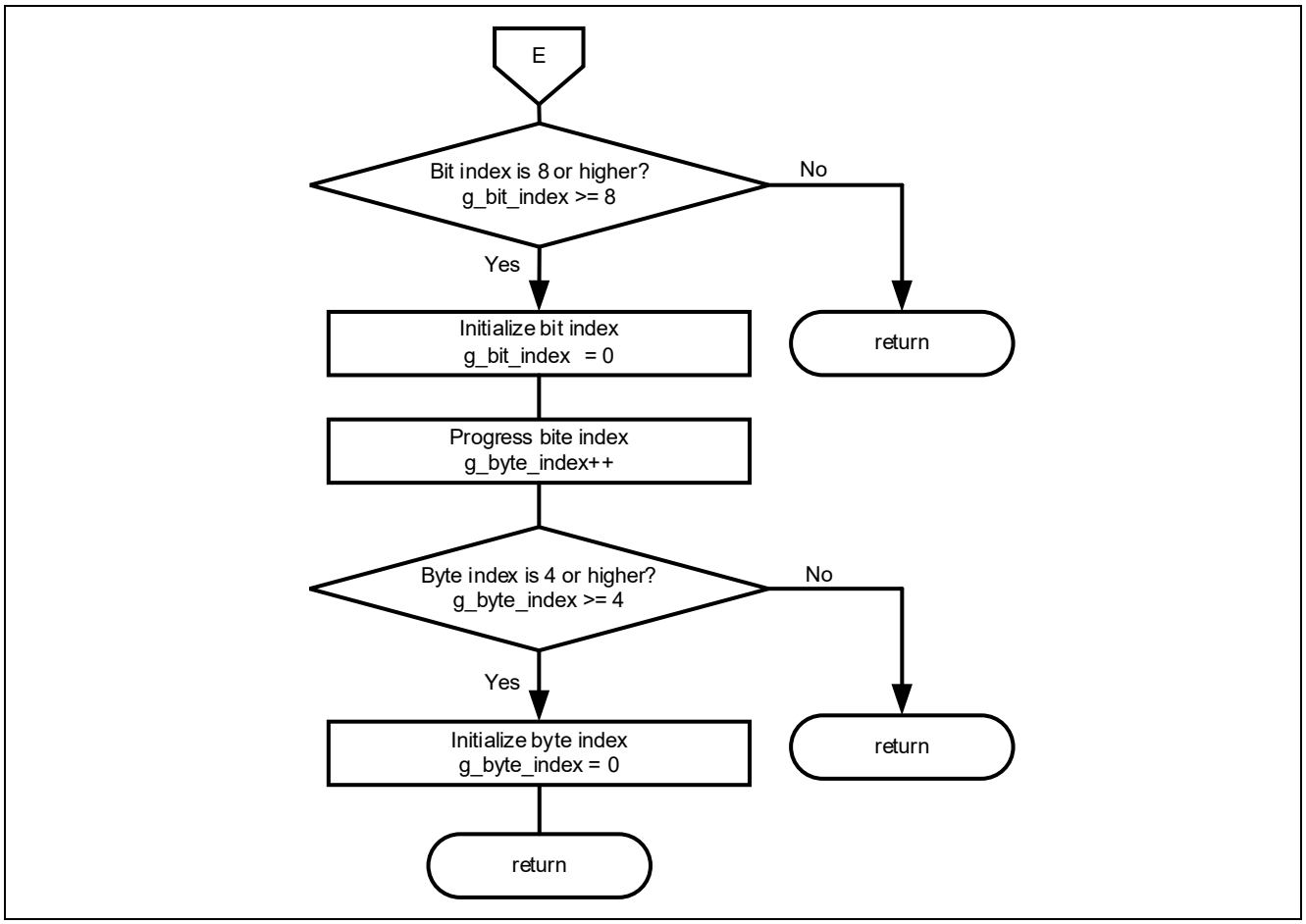


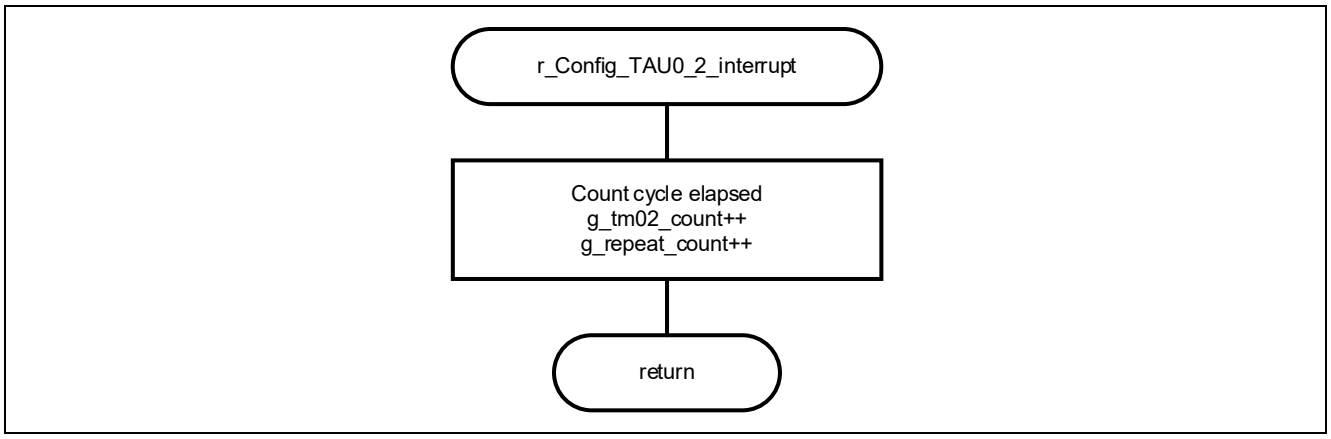
Figure 4-8 Flowchart of tx_data_bit Function (3/3)



4.8.4 Flowchart of r_Config_TAU0_2_interrupt

The following shows the flowchart of r_Config_TAU0_2_interrupt function.

Figure 4-9 Flowchart of r_Config_TAU0_2_interrupt Function



4.9 Example of Applications

4.9.1 Setting Up the Smart Configurator

This application note contains the following Smart Configurator configuration file in addition to the sample code.

r01an7636_elcl_remocon_send.scfg

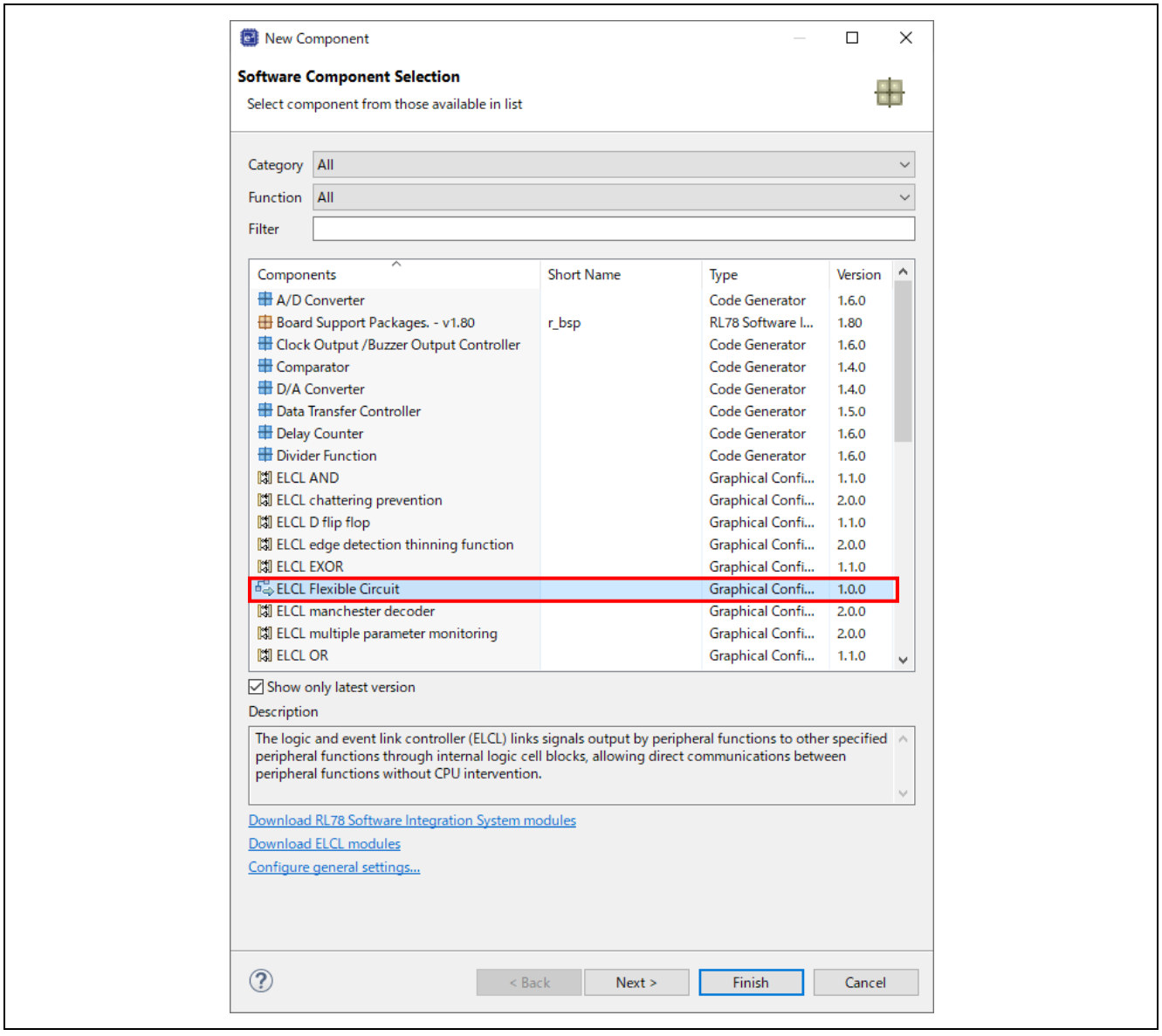
The following describes the file and provides examples and precautions for use.

4.9.1.1 Setting the ELCL Component

The following describes how to set the ELCL component.

1. Start the Smart Configurator.
2. Click on the “Components” tag and click on “Add Component”.
3. Select “ELCL Flexible Circuit”.

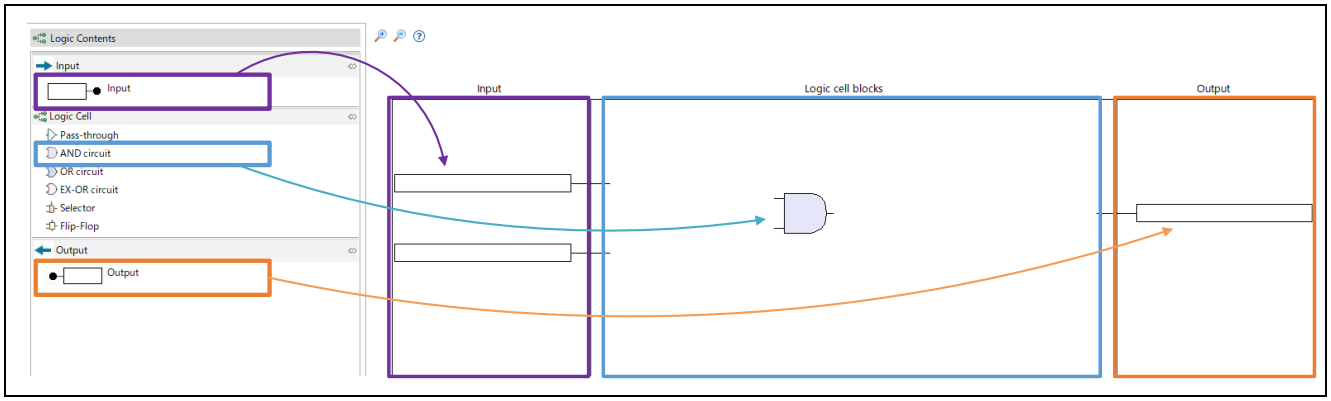
Figure 4-10 Selecting the Component



4.9.1.2 How to Use the ELCL Flexible Circuit

1. Select the block used in the ELCL.
   Drag and drop the Input, Logic cell and Output blocks in the “Logic Contents” column to the corresponding aeras.

Figure 4-11 Select the Block



2. Set the property.
   Clicking on the installed block, you can configure the I/O pins, resources, and other settings from the “Properties” column in the lower left corner of the screen.

Figure 4-12 Property Settings (Input)

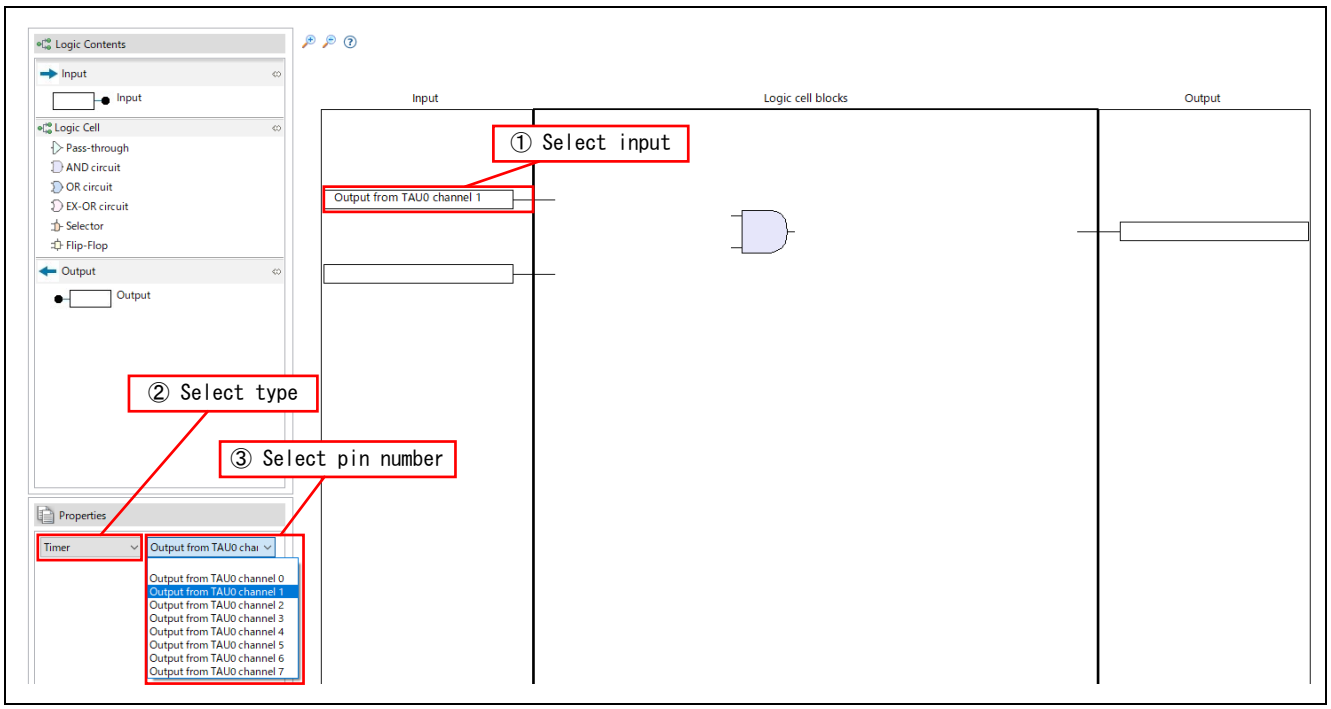


Figure 4-13 Property Settings (Logic cell)

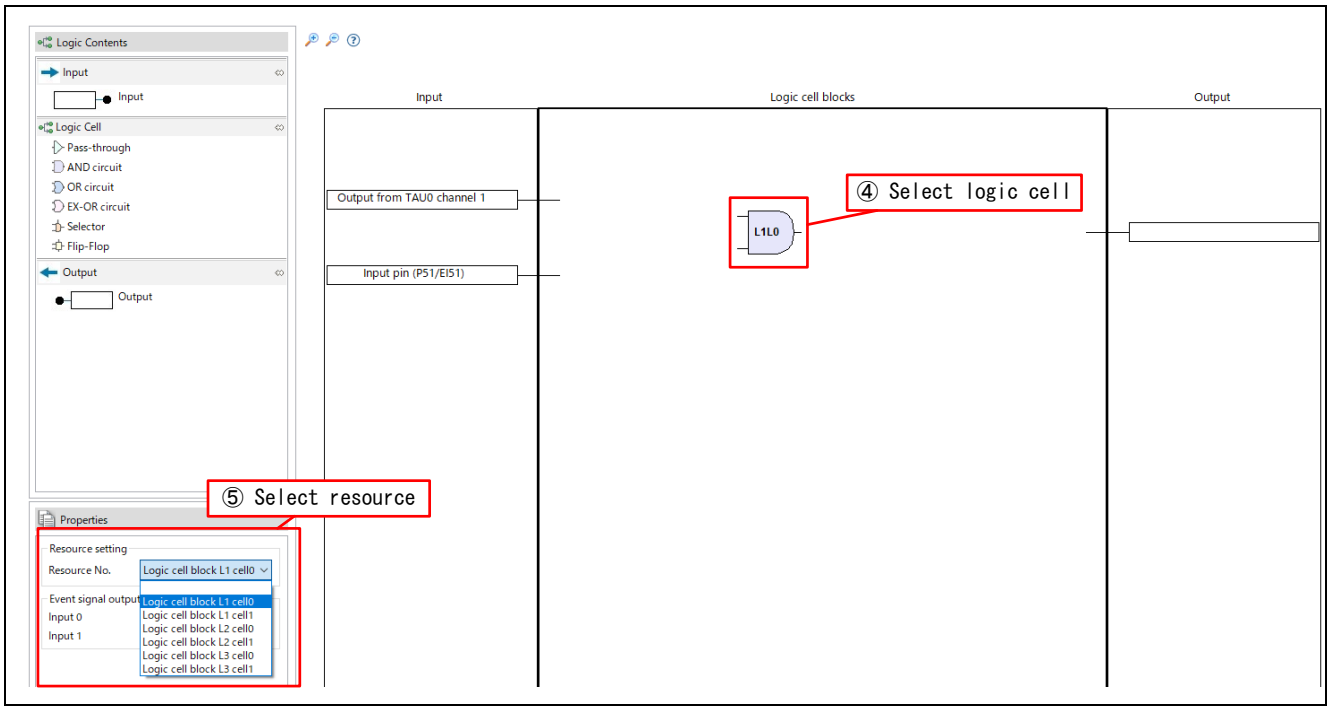
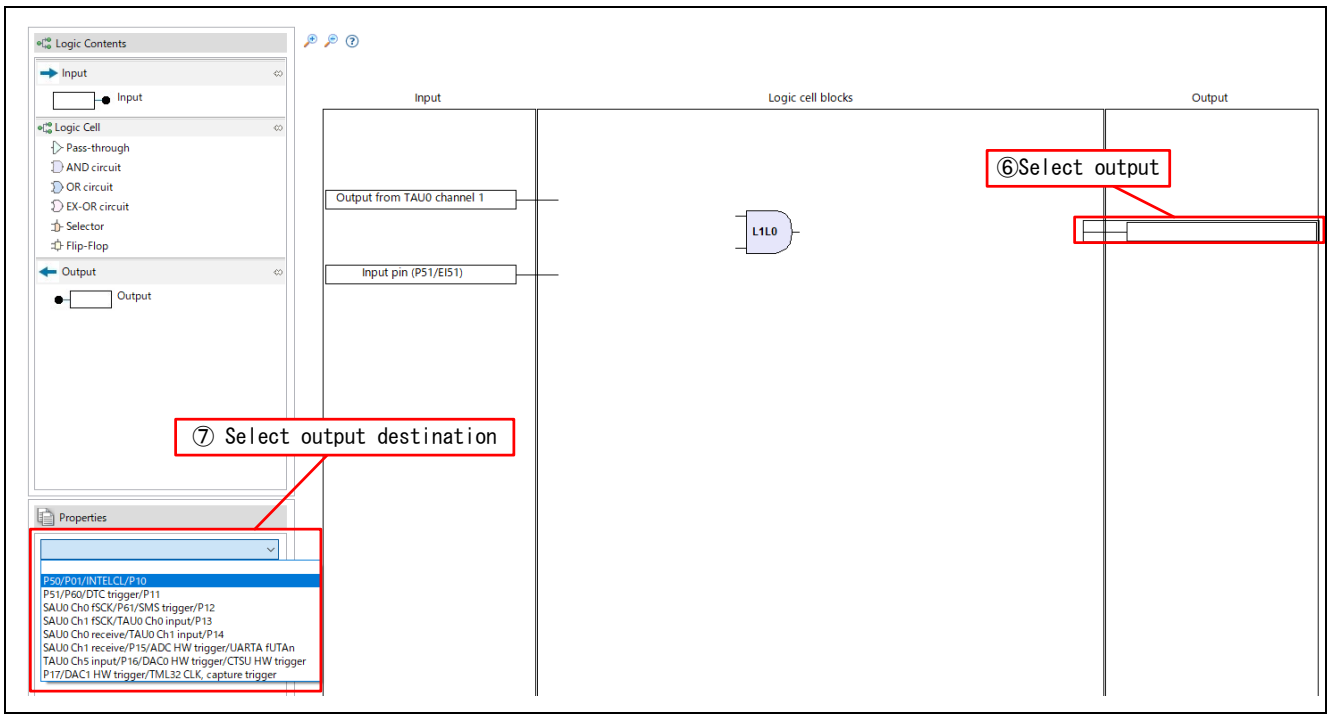
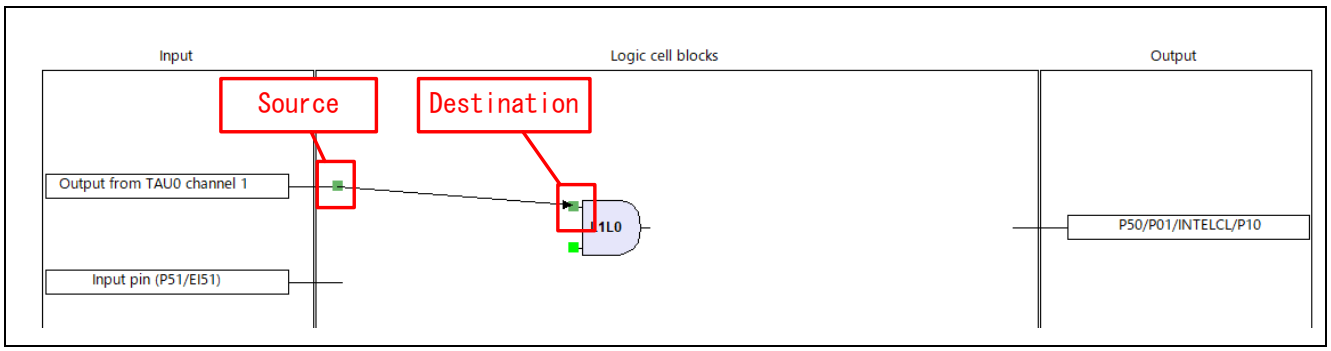


Figure 4-14 Property Settings (output)



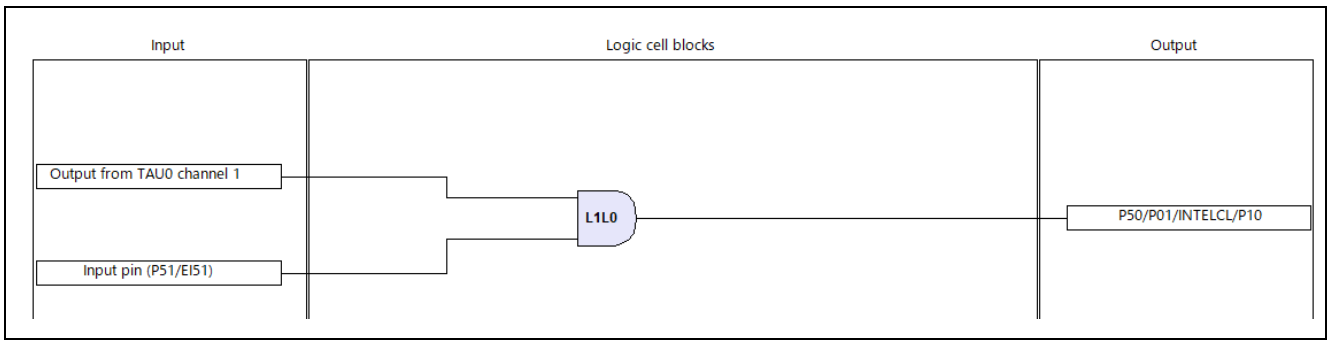
3. Connect the blocks.
   Move the cursor to the source of the connection and a green dot will appear. Click on the green dot and pull the cursor to the connection destination and release.

Figure 4-15 Connection of Block



4. The following shows the image of setting completion in this application note.

Figure 4-16 Image of Setting Completion



4.9.1.3 r01an7636_elcl_remocon_send.scfg

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

Table 4-7 Smart Configurator Settings (1/2)

Tag Name	Component	Content
Clock	-	Operation mode: High-speed main mode 4.0 (V) to 5.5 (V) EV_{DD} setting: 4.0V ≤ EV_{DD0} < 5.5V High-speed on-chip oscillator: 32MHz f_{IHP} : 32MHz f_{CLK} : 32000kHz (High-speed on-chip oscillator) f_{SXP} : 32.768kHz (Low-speed on-chip oscillator) (XT1 oscillation circuit) Operation mode: XT1 oscillation Frequency: 32.768kHz XT1 oscillation mode: Low consumption oscillation 1 Power supply mode: Power supply enabled in STOP.HALT mode
System	-	On-chip debug operation setting: COM port[Note] Pseudo-RRM/DMM function setting: Used Start/Stop function setting: Unused Trace function setting: Used Security ID setting: Set Security ID: 0x00000000000000000000 Security ID authentication failure setting: Erase flash memory data
Component	r_bsp	Start up select: Enable (use BSP startup) Control of illicit memory access detection (IAWEN): Disable Protected area in the RAM (GRAM0-1): Disabled Protection of the port control registers (GPORT): Disabled Protection of the interrupt control registers (GINT): Disabled Protection of the clock, voltage detector, and RAM parity error detection control registers (GCSC): Disabled Data flash memory area/extra area access control (DFLEN): Disables Initialization of peripheral functions by Code Generator/Smart Configurator: Enable API functions disable (R_BSP_StartClock, R_BSP_StopClock): Disable API functions disable (R_BSP_GetFclkFreqHz): Enable API functions disable (R_BSP_SetClockSource): Disable API functions disable (R_BSP_ChangeClockSetting): Disable API functions disable (R_BSP_SoftwareDelay): Disable Parameter check enable: Enable Enable user warm start callback (PRE): Unused Enable user warm start callback (POST): Unused Watchdog Timer refresh enable: Unused
	Config_LVD0	Component: Voltage Detector Operation mode setting: Reset mode Voltage detection setting: Reset generation level (V_{LVD0}): 1.65 (V)

Note. Specify the settings as follows when using IAR.
On-chip debug operation setting: Use emulator
Emulator setting: E2 emulator Lite

Table 4-8 Smart Configurator Settings (2/2)

Tag name	Component	Content
Component	Config_TAU0_0	Component: PWM output Resource: TAU0_0 Operation clock: CK00 Clock source: f_{CLK} Cycle setting: 26.32 µs Interrupt setting: Used Priority: Level 3 PWM slave selection setting: Channel 1 slave (Slave 1) Duty: 33.3% Initial output value: 0 Output level: Active high Timer output is used only as input to ELCL Interrupt setting: Unused
	Config_TAU0_2	Component: Interval timer Operation mode: 16-bit counter mode Resource: TAU0_2 Operation clock: CK00 Clock source: f_{CLK} Interval value: 562 µs Interrupt setting: Used Priority: Level 3
	Config_ELCL	Component: ELCL Flexible Circuit Common setting: L1L0 Detail setting: L1L0 Input signal selector: TO01, P51 Application: AND Output signal selector: P01
	Config_PORT	Component: Port Port selection: PORT0, PORT1, PORT13 P01: Output (Output the ELCL output signal) P10: Output P137: Input (Input 0 to SW1)

(1) Clocks

Set the clocks used in the sample code.

(2) System

Specify the on-chip debug setting of the sample code.

The settings of “On-chip debug operation setting” and “Security ID authentication failure setting” affect “On-chip debugging enabled” in Table 4-2 Option Byte Settings. If you change the settings, confirm that no problems will occur.

(3) r_bsp

Set the startup of the sample code.

(4) Config_LVD0

Set the power management of the sample code.

This affect “LVD0 settings” in “4.2 List of Option Byte Settings”. If you change the settings, confirm that no problems will occur.

(5) Config_TAU0_0

Set TAU0_0 of the sample code.

In this sample code, set the period to 26.32 µs (= 1 / 38000 Hz) and the duty cycle to 33.3% as a PWM output for use in generating a subcarrier waveform with a frequency of 38 kHz.

(6) Config_TAU0_2

Set TAU0_2 of the sample code.

In this sample code, set as an interval timer of 562 µs, which is the period of the NEC format. The elapse of the cycle is counted by an interrupt process.

(7) Config_ELCL

Set ELCL of the sample code.

This sample code uses the L1L0 AND operation circuit to select the sub carrier waveform and the mask waveform as input signal.

4.9.2 How to Change the Transmission Data

In the NEC format, 16-bit customer code and 8-bit data code are transmitted.

In this sample code, the following transmission data are set.

If you set the transmission data, please change the value of the following variables.

Table 4-9 Transmission Data

Kind of Data (Data length)	Variable Name	Value
Customer code (16-bit)	g_customer_code	0x02fd
Data code (8-bit)	g_data_code	0x86

5. How to Import the Project

The sample code is provided in e² studio project format. This chapter shows how to import the project into e² studio and CS+. After the import is complete, check the build and debugger settings.

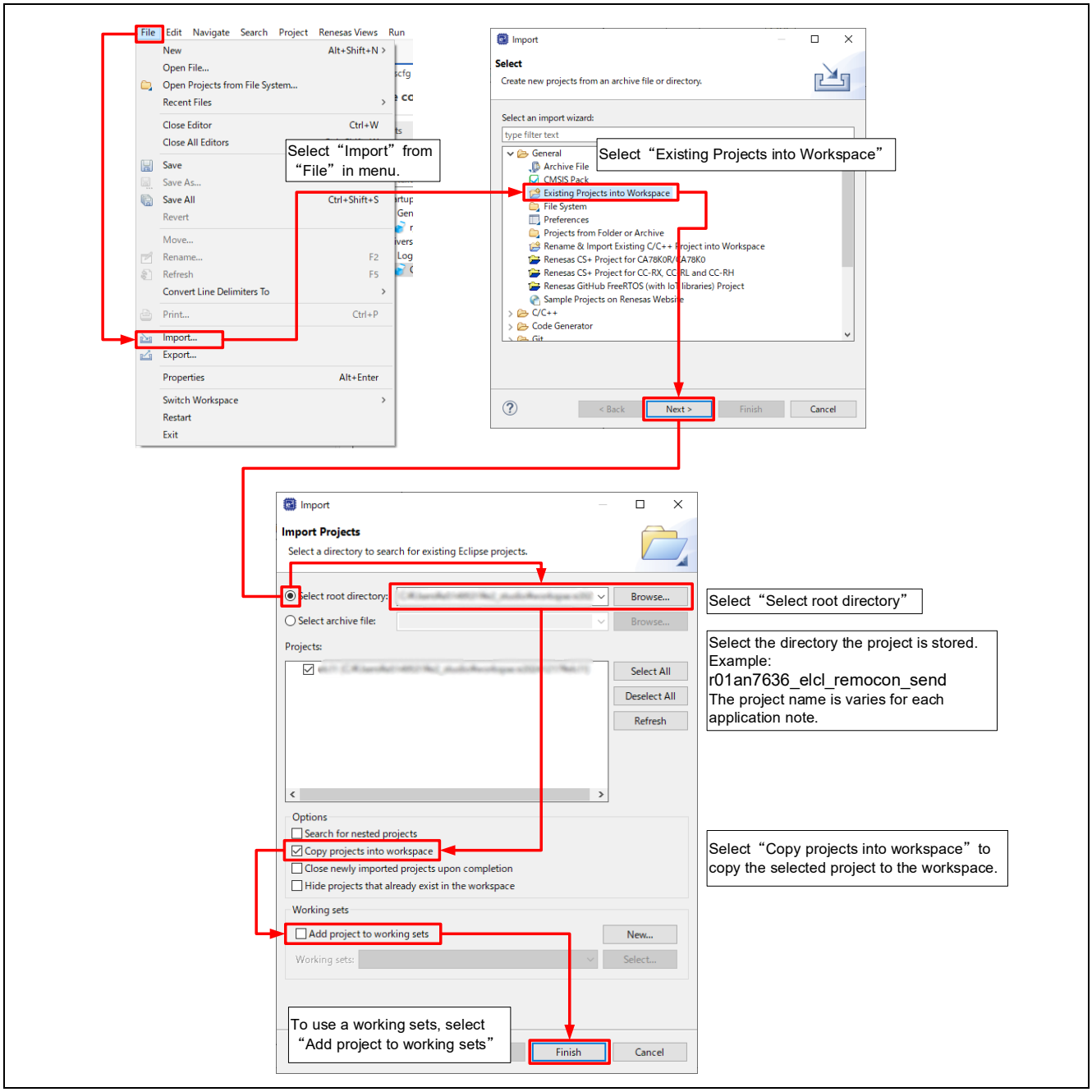
5.1 Procedure in e² studio

To use the software in e² studio, please follow the procedure below to import the software into e² studio.

In addition to space, the folder name of the project managed by e² studio and the file path to that folder must not contain any single-byte kana characters, double-byte characters, or single-byte symbols (especially '$', '#' and '%').

(The screen may differ depending on the version of e² studio used.)

Figure 5-1 How to Import the Project to e² studio



6. Sample code

Sample code can be downloaded from the Renesas Electronics website.

7. Documents for Reference

RL78/G23 User's Manual: Hardware (R01UH0896)

RL78 family user's manual software (R01US0015)

RL78 Smart Configurator User's Guide: CS+ (R20AN0580)

RL78 Smart Configurator User's Guide: e2 studio (R20AN0579)

RL78 Smart Configurator User's Guide: IAR (R20AN0581)

Application Note RL78/G23
Remote Control Signal Reception (NEC Format, STOP Mode) (R01AN6001)
(The latest versions can be downloaded from the Renesas Electronics website.)

Technical update

The latest versions can be downloaded from the Renesas Electronics website.

Revision History

Rev.	Data	Description	
		Page	Summary
1.00	Jul.14.2025	—	First Edition

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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