RL78/G1D

Smart Lock

R01AN3584EC0110
Rev.1.10
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Introduction

This user's manual describes Renesas Bluetooth Low Energy (BLE) microcontroller RL78/G1D application on smart lock (for Android). Please refer to the following documents for the program structure and usage information on Bluetooth Low Energy RL78/G1D applications.

Document	Document No.
User's Manual	R01UW0095E
API Reference Manual Basic	R01UW0088E
Quick Start Guide	R01AN2767E
Embedded Configuration Sample Application	R01AN3319E
RL78/G1D applications to communicate with RenesasBLE	R01AN3017E

Target Device

RL78/G1D

Contents

1. Outline of System Function

1.1 Introduction of Smart Lock

As we know, the lock usually having a lock hole, and need a key to unlock it. However, smart lock is a kind of lock, which can liberate the user from the key, and just need an APP on your smartphone to achieve unlocking, it can be used in bicycle, motorcycle, etc. For security, the correct password must be entered to unlock smart lock. The user can view the status of smart lock on smartphone APP, such as the battery power, etc.

To demonstrate the application, the BLE protocol stack library and application program are required to be written into RL78/G1D demo board. Then, install the appropriate APP to Android smartphone, to achieve the smart lock control with smartphone APP through BLE function. The demo board is composed of main control board (RL78/G1D module (RTK0EN0002C01001BZ)) and peripheral board (power supply circuit, motor control circuit, etc.). RL78/G1D module (RTK0EN0002C01001BZ) is in the RL78/G1D evaluation board (RTK0EN0001D01001BZ).

Smart lock system is shown in Figure 1.1.

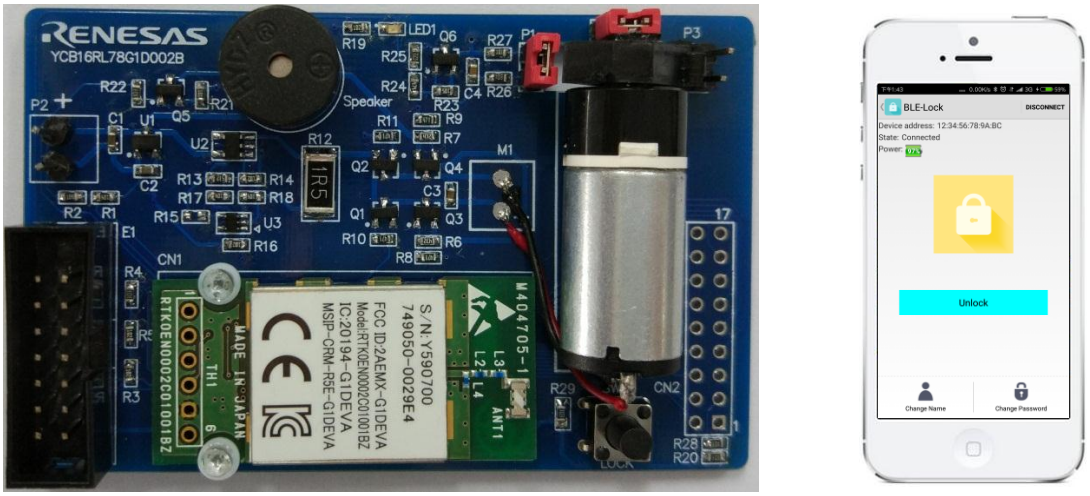

Figure 1.1 Smart Lock System

1.2 Brief Introduction of Smart Lock Demo Board

Smart lock uses 3 AAA batteries as power supply, the control principle of smart lock is that the DC motor drives the latch to move, to realize the lock on/off operation, and the detection of the latch position is realized by the motor current detection circuit (when the motor reaches the preset position, it will be locked and the current will increase). When smart lock is on locking state, if the lock core is cut off, the buzzer will alarm, connect smartphone APP and lock to disarm the alarm. The user password is stored in the RL78/G1D internal data flash. The block diagram of demo board is shown in Figure 1.2.

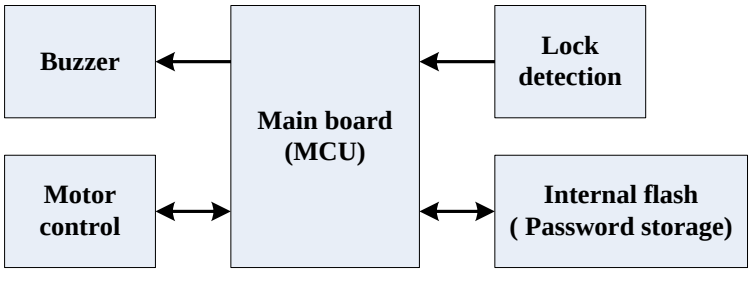

Figure 1.2 Block Diagram of Smart Lock Demo Board

1.3 Introduction of Operation

1.3.1 Device Connection

Install the smart lock APP into Android smartphone. Open it and start to scan smart lock around, and then click for connection if the device is available.

The connection interface of smart lock APP is shown in Figure 1.3.

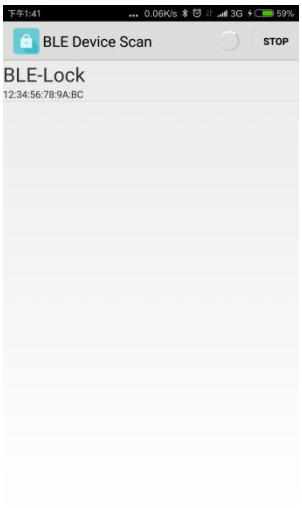

Figure 1.3 Connection Interface of Smart Lock APP

1.3.2 Enter Password

Once click for connection, the enter password box will pop up, you need to enter the correct 6-bit password. The correct password will enter the main control interface, while the wrong password will disconnect the device. After enter the correct password once, the next time can be password-less login. The default password is '123456'.

The enter password interface of smart lock APP is shown in Figure 1.4.

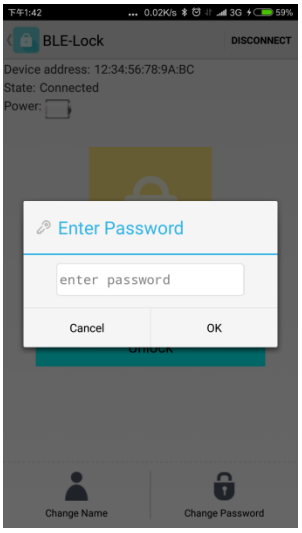

Figure 1.4 Enter Password Interface of Smart Lock APP

1.3.3 Unlocking

After entering the correct password, the current state of smart lock will be displayed on the main control interface, as shown in the following lock state and battery level in picture. In the locked state, click the 'Unlock' button to unlock the lock. The icons of lock state and battery level are real-time refreshed as the state of smart lock.

The demo board and APP of smart lock (unlocked) are shown in Figure 1.5.

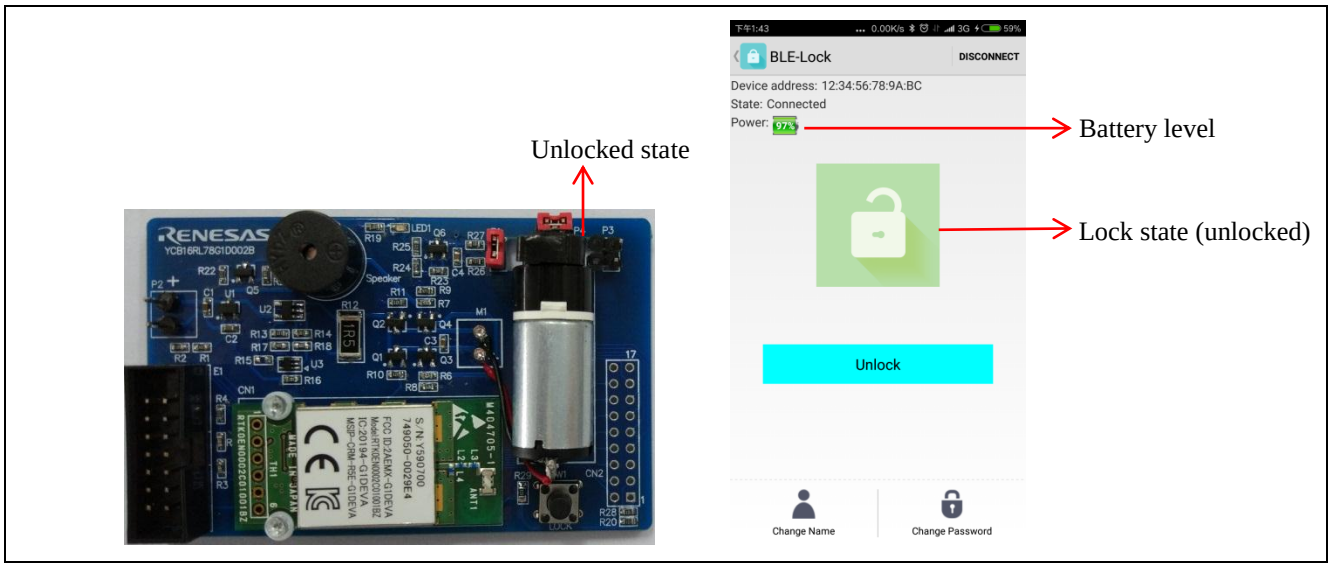

Figure 1.5 Demo Board and APP of Smart Lock (Unlocked)

1.3.4 Locking

In the unlocked state, press the 'LOCK' key for locking, and then the icon of lock state will be refreshed. The locking operation can also be carried out when the smartphone is disconnected.

The demo board and APP of smart lock (locked) are shown in Figure 1.6.

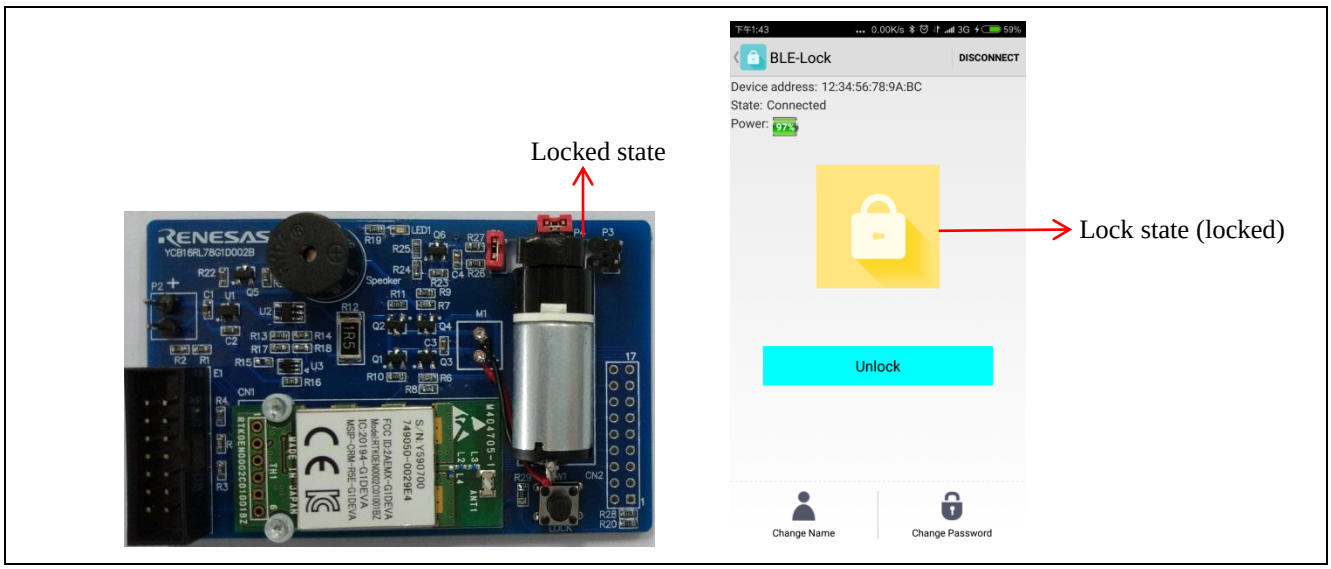

Figure 1.6 Demo Board and APP of Smart Lock (Locked)

1.3.5 Change Device Name

In the main control interface, if click the 'Change Name' icon, the change device name box will pop up, enter new name in box to change the device name of smart lock, and the new device name will be stored in the RL78/G1D internal data flash. The new device name will be found at next time device scan.

The change device name interface of smart lock APP is shown in Figure 1.7.

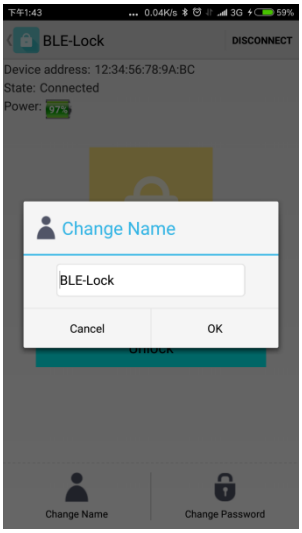

Figure 1.7 Change Device Name Interface of Smart Lock APP

1.3.6 Change Device Password

In the main control interface, if click the 'Change Password' icon, the change device password box will pop up, enter new 6-bit password in box to change the device password of smart lock, and the new device password will be stored in the RL78/G1D internal data flash.

The change device password interface of smart lock APP is shown in Figure 1.8.

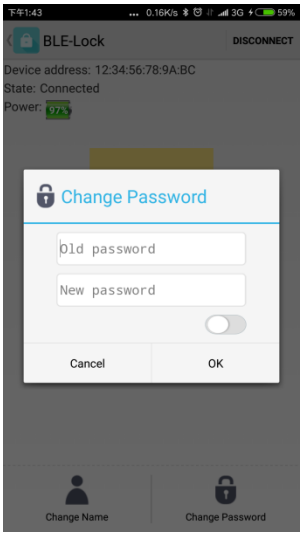

Figure 1.8 Change Device Password Interface of Smart Lock APP

2. Introduction of Hardware

2.1 Introduction of PCB

The top view of smart lock is shown in Figure 2.1.

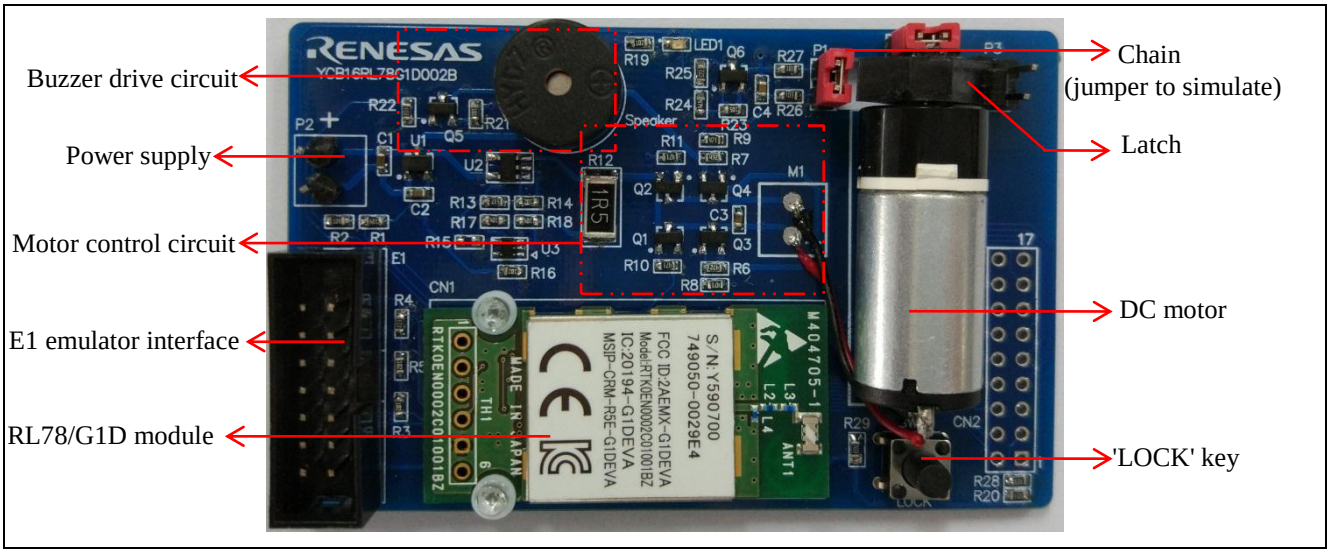

Figure 2.1 Top View of Smart Lock

The bottom view of smart lock is shown in Figure 2.2.

Figure 2.2 Bottom View of Smart Lock

2.2 Hardware Block Diagram

The hardware block diagram of smart lock is shown in Figure 2.3.

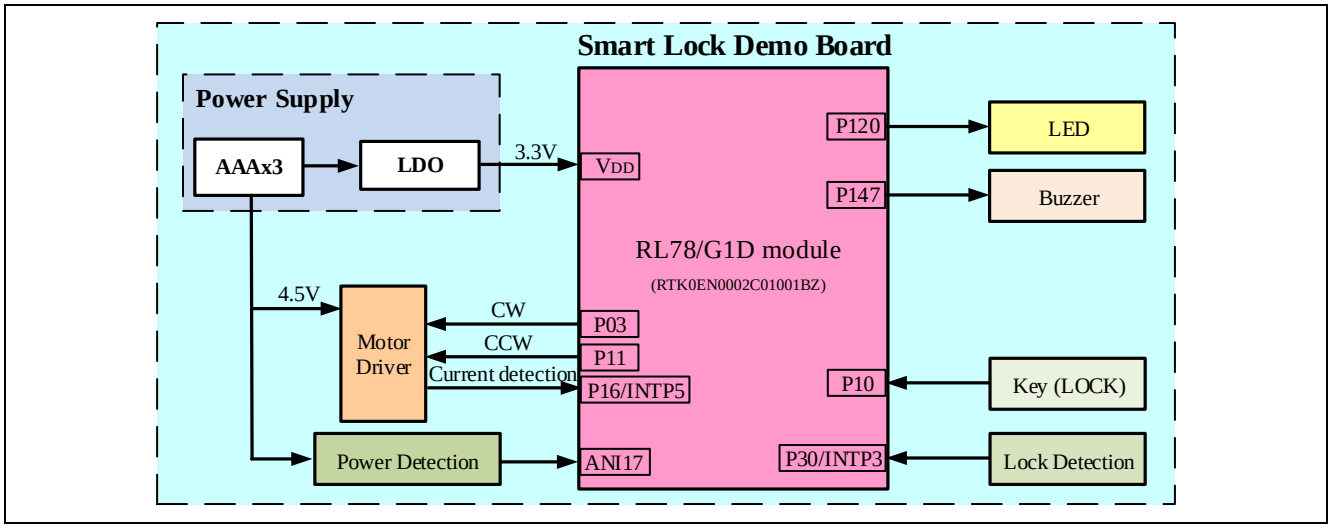

Figure 2.3 Hardware Block Diagram of Smart Lock

2.3 Main MCU

The demo board of smart lock uses RL78/G1D (R5F11AGJ) as main MCU. The Flash ROM size of RL78/G1D is 256 KB and the RAM size is 20 KB. The peripheral functions of RL78/G1D and their applications are shown in Table 2.1.

Table 2.1 Peripheral Functions and Their Applications

Peripheral functions	Usage
Channel 0 of TAU0	10ms timer
P03	Motor driver: CW (unlock)
P11	Motor driver: CCW (lock)
P147	Buzzer driver
P120	BLE status indicator LED
P10	'LOCK' key
P16/INTP5	External interrupt: the detection of motor current
P30/INTP3	External interrupt: the detection of chain state
P02/ANI17	A/D sampling: the detection of battery voltage
Bluetooth Low Energy (BLE) function	Refer to User's Manual (R01UW0095E)

The circuit board of RL78/G1D module (RTK0EN0002C01001BZ in the RTK0EN0001D01001BZ) is shown in Figure 2.4.

Figure 2.4 Circuit Board of RL78/G1D Module

The interface control circuit of RL78/G1D module (RTK0EN0002C01001BZ in the RTK0EN0001D01001BZ) is shown in Figure 2.5.

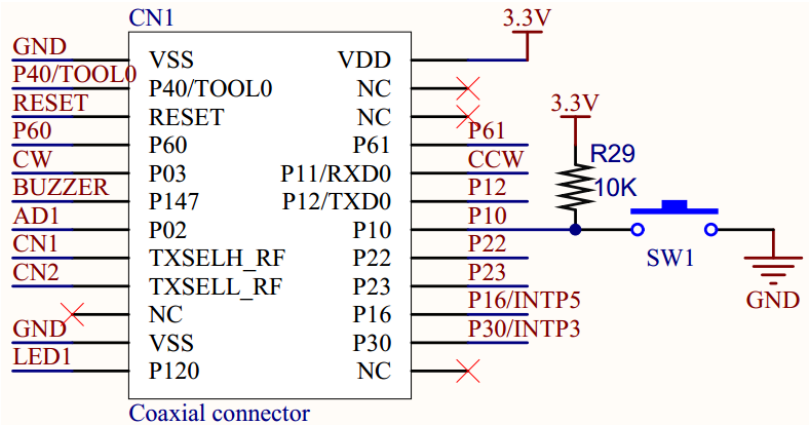

Figure 2.5 Interface Control Circuit of RL78/G1D Module

2.4 Power Supply Circuit

Smart lock uses 3 AAA batteries as power supply, and gets stable 3.3V for system power supply through chip XC6206, the battery voltage is sampled through A/D port.

The power supply circuit is shown in Figure 2.6.

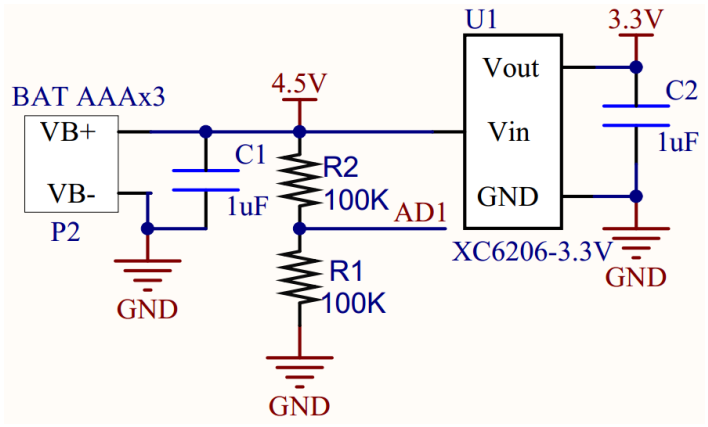

Figure 2.6 Power Supply Circuit

2.5 DC Motor Driver Circuit

Smart lock works by DC motor drives the latch to move, to realize the lock on/off operation. The detection of the latch position is realized by the motor current detection circuit. When the motor reaches the preset position, it will be locked and the current will increase, then the increased current passes through the amplifier and comparator circuit that will output a jump edge signal, which will be detected by an external interrupt INTP5, then the position of latch can be determined for stopping motor.

The DC motor driver circuit is shown in Figure 2.7.

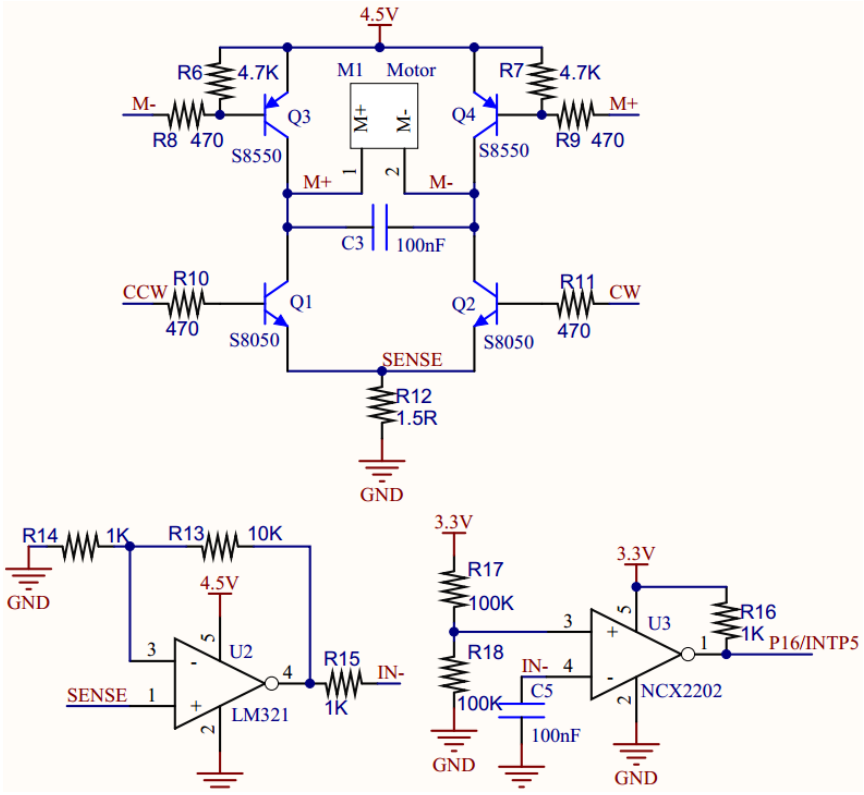

Figure 2.7 DC Motor Driver Circuit

2.6 Chain Detection Circuit

The chain of smart lock is simulated by a jumper, and a transistor driver circuit is used to detect the connection state of chain. In the locked state, if the jumper is cut off, INTP3 will trigger to activate the buzzer alarm.

The chain detection circuit is shown in Figure 2.8.

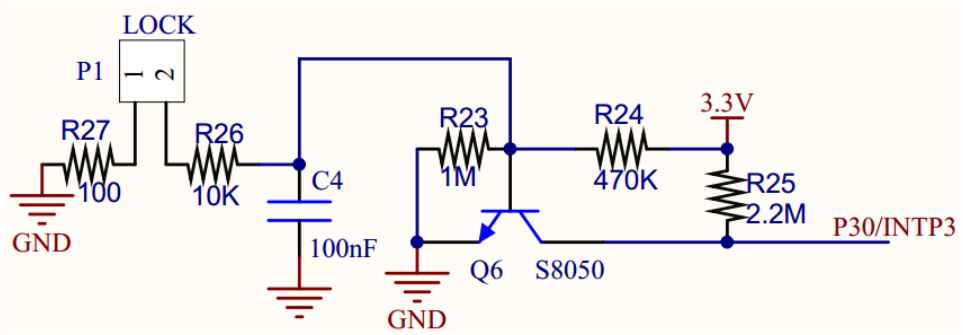

Figure 2.8 Chain Detection Circuit

2.7 Buzzer Control Circuit

Buzzer is used to the anti-theft function, which is driven by a transistor. When the alarm is triggered, connect smartphone APP and smart lock to disarm the alarm.

The buzzer control circuit is shown in Figure 2.9.

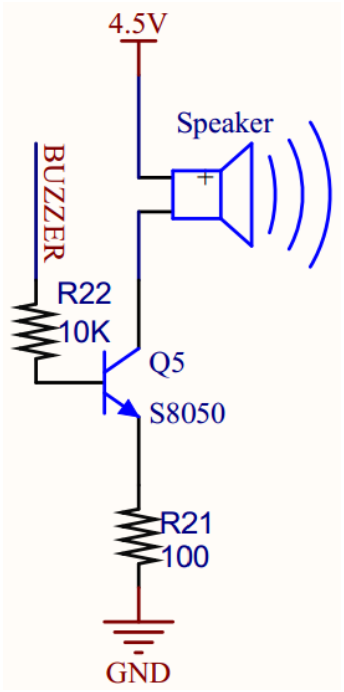

Figure 2.9 Buzzer Control Circuit

3. Schematic, PCB and Bill of Materials

3.1 Schematic

The schematic of smart lock is shown in Figure 3.1.

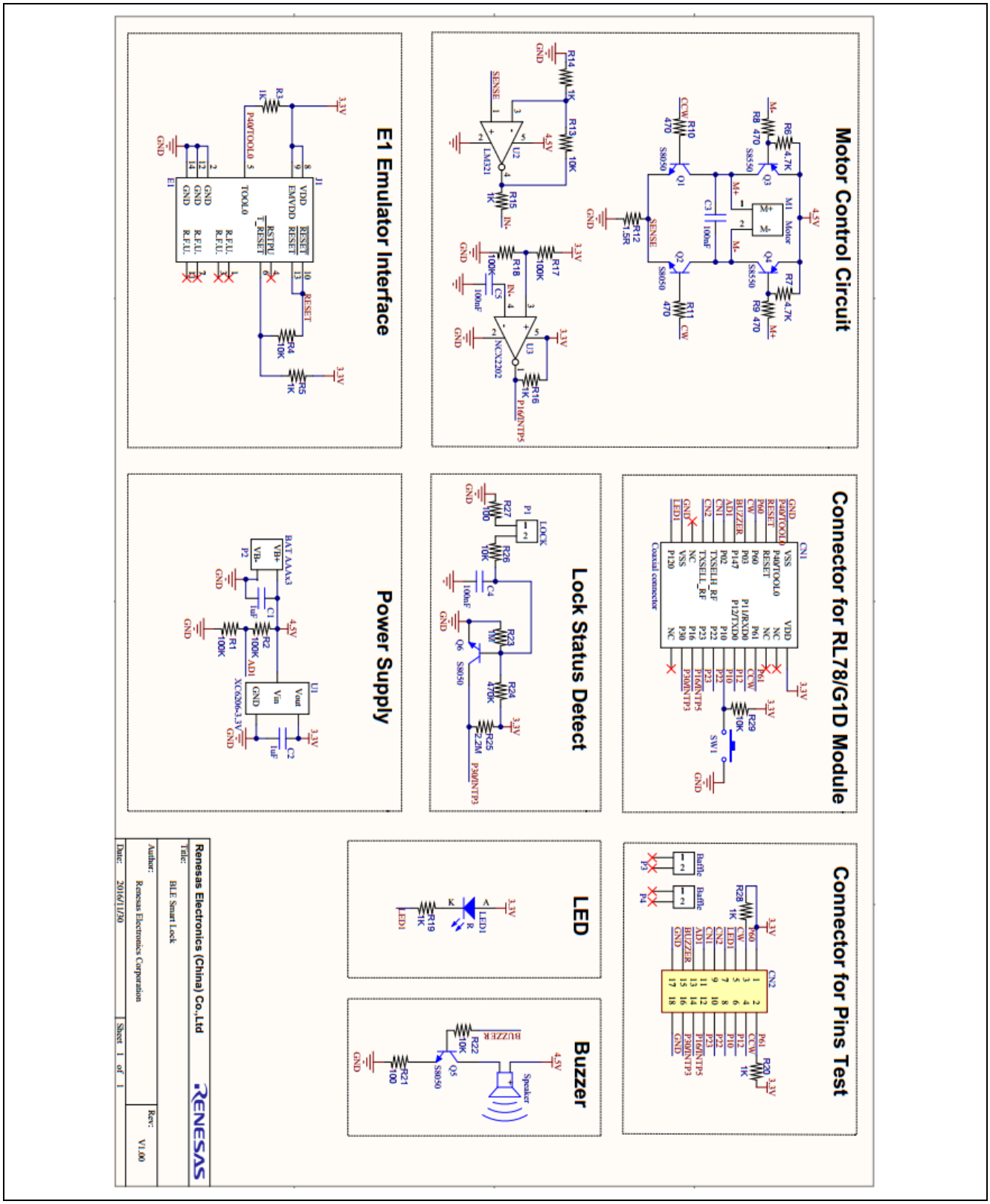

Figure 3.1 Schematic

3.2 PCB

The PCB of smart lock is shown in Figure 3.2.

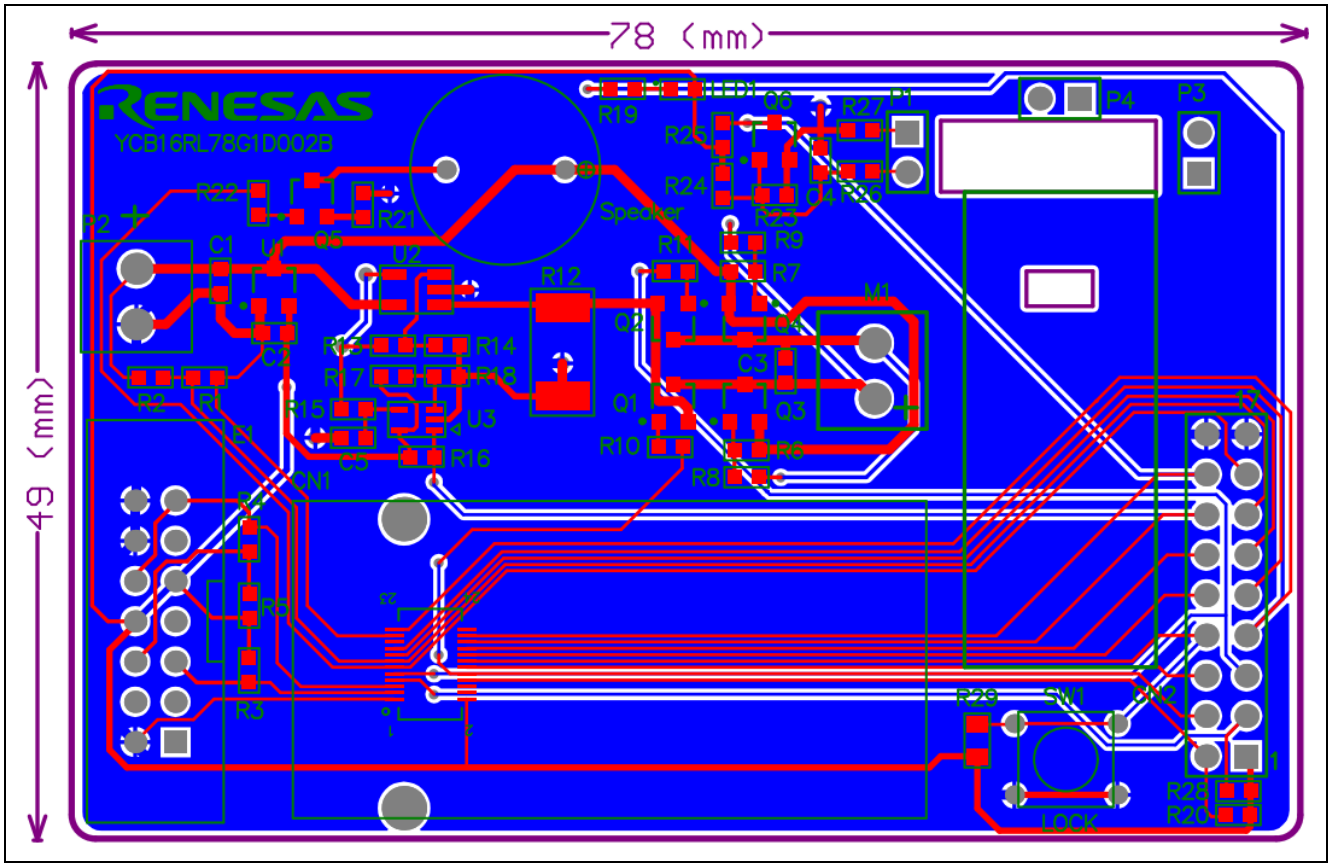

Figure 3.2 PCB

3.3 Bill of Materials

The bill of materials of smart lock is shown in Table 3.1.

Table 3.1 Bill of Materials

Identifier	Comment	Package	Quantity
C1, C2	1uF	0603	2
C3, C4, C5	100nF	0603	3
CN1	Coaxial connector	CRS5001 - 24	1
CN2	Header 9X2	HDR2X9	1
E1	J1	E8 Connect	1
LED1	R	LED 0603	1
M1	Motor	CON-2 D	1
P1	LOCK	HDR1X2	1
P2	BAT AAAx3	CON-2 D	1
P3, P4	Baffle	HDR1X2	2
Q1, Q2, Q5, Q6	S8050	SOT23A	4
Q3, Q4	S8050	SOT23A	2
R1, R2, R17, R18	100K	0603	4
R3, R5, R14, R15, R16, R19, R20, R28	1K	0603	8
R4, R13, R22, R26	10K	0603	4
R6, R7	4.7K	0603	2
R8, R9, R10, R11	470	0603	4
R12	1.5R	2512	1
R21, R27	100	0603	2
R23	1M	0603	1
R24	470K	0603	1
R25	2.2M	0603	1
R29	10K	0805	1
Speaker	Buzzer	BUZZER A	1
SW1	SW-PB	KEY B (6 X 6)	1
U1	XC6206-3.3V	SOT23A	1
U2	LM321	SOT-23-5	1
U3	NCX2202	SC-70 5	1

4. Introduction of Software

4.1 Integrated Development Environment

The integrated development environment of smart lock is shown in Table 4.1 and Table 4.2.

Table 4.1 Integrated Development Environments for CS+ CC

Item	Contents
Integrated development environment	CS+ for CC V4.00.00 (Renesas Electronics Corporation)
C complier	CC-RL V1.03.00 (Renesas Electronics Corporation)
Debugger	E1 (Renesas Electronics Corporation)

Table 4.2 Integrated Development Environments for E2 Studio

Item	Contents
Integrated development environment	E2 studio V5.0.0.043 (Renesas Electronics Corporation)
C complier	CC-RL V1.03.00 (Renesas Electronics Corporation)
Debugger	E1 (Renesas Electronics Corporation)

4.2 List of Option Byte Setting

The option byte setting of smart lock is shown in Table 4.3.

Table 4.3 Option Byte Setting

Address	Setting	Description
000C0H/010C0H	11101110B	Watchdog timer operation is stopped (count is stopped after reset)
000C1H/010C1H	11111111B	LVD: closed
000C2H/010C2H	10101010B	HOCO: 8 MHz, operation voltage range: 1.8 V~3.6 V
000C3H/010C3H	10000101B	On-chip debugging is enabled.

4.3 Installation Procedure

Followings are necessary to build the sample application.

Download the BLE protocol stack and EEPROM Emulation Library corresponding to your development environment from Renesas website and copy to the following folder.

(1) BLE protocol stack (ver.1.20)

https://www.renesas.com/en-us/software/D6000617.html

(Destination folder)\renesas\lib

(2) EEPROM emulation library for CC-RL/e2 studio(CC-RL)

https://www.renesas.com/en-us/software/D3017960.html

(Destination folder)\renesas\src\driver\dataflash\cc_rl

- eel.h
- eel.lib
- eel_types.h
- fdl.h
- fdl.lib
- fdl_types.h

4.4 Flow Chart

4.4.1 Flow Chart of Firmware Main Program

The flow chart of firmware main program is shown in Figure 4.1.

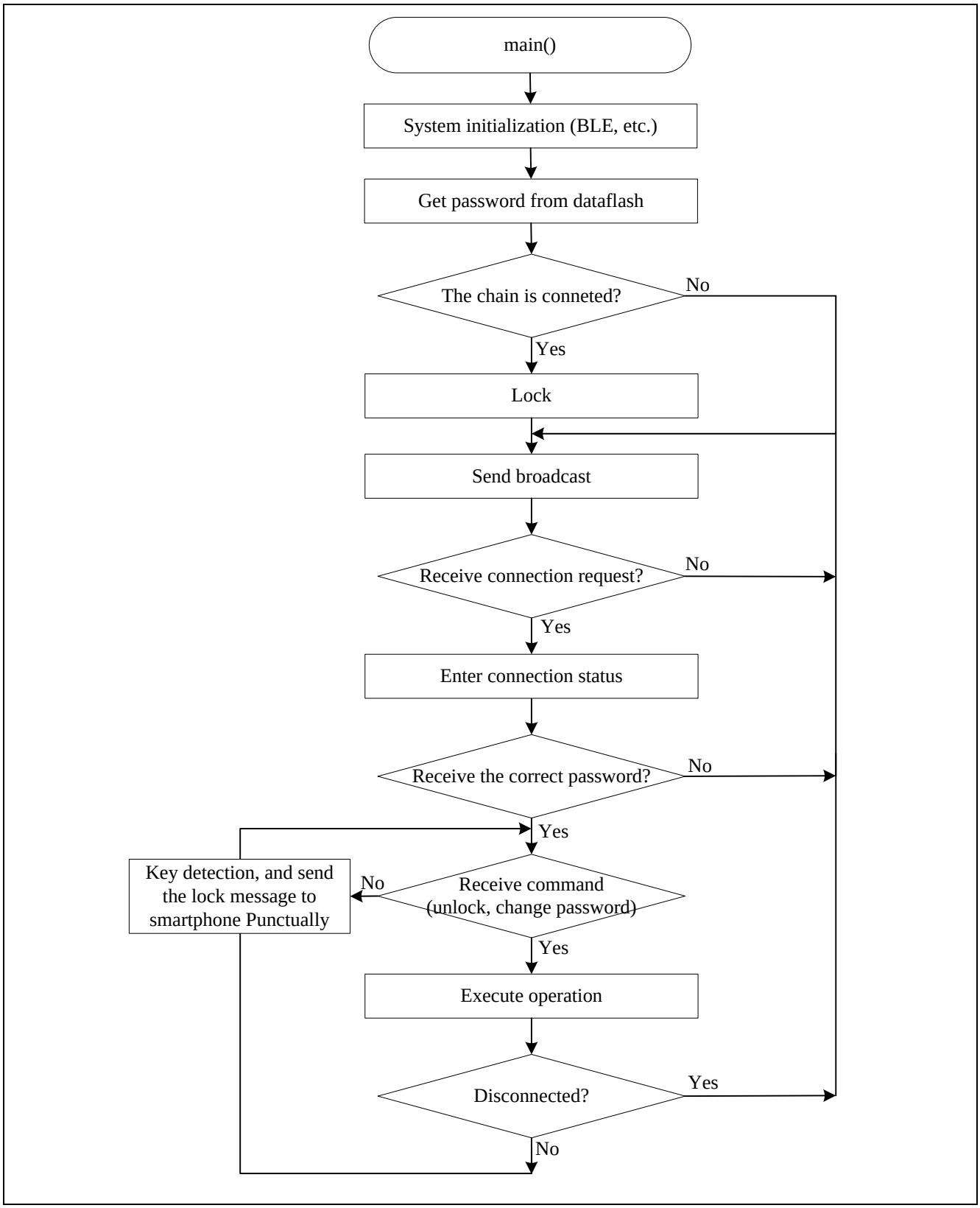

Figure 4.1 Flow Chart of Firmware Main Program

4.4.2 Flow Chart of Smartphone APP

The flow chart of smartphone APP is shown in Figure 4.2.

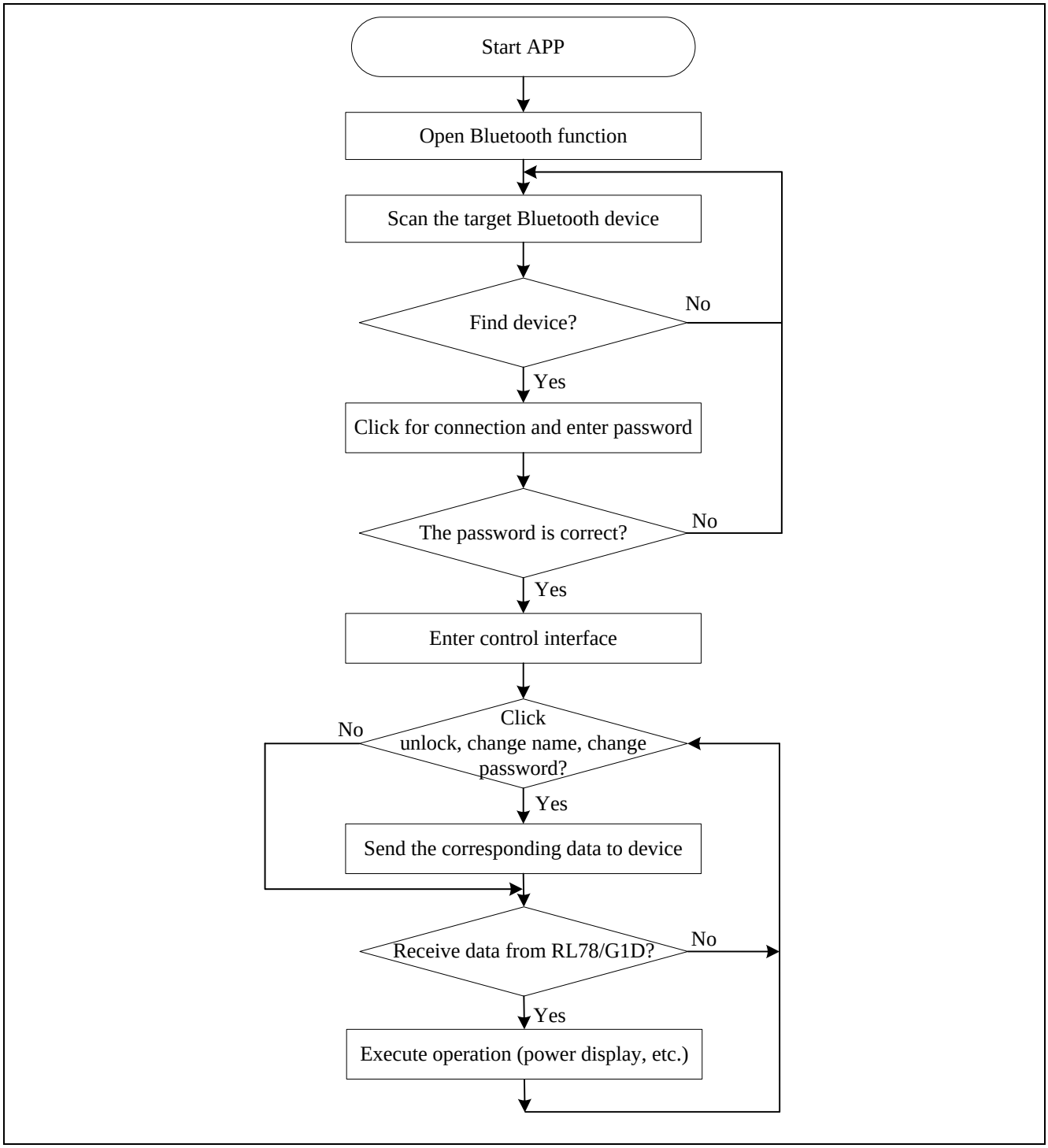

Figure 4.2 Flow Chart of Smartphone APP

5. Sample Code

The sample code is available on the Renesas Electronics Website.

6. Reference Documents

User's Manual

RL78/G1D User's Manual: Hardware (R01UH0515E)

RL78 Family User's Manual: Software (R01US0015E)

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

Technical Updates/Technical News

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

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Revision History

		Description	
Rev.	**Date**	**Page**	**Summary**
1.00	Mar.17.2017	-	First edition issued
1.10	Aug.23.2017	15-16	Change integrated development environments to CS+ CC and E2 studio.

General Precautions in the Handling of Microprocessing Unit and Microcontroller Unit Products

The following usage notes are applicable to all Microprocessing unit and Microcontroller unit products from Renesas. For detailed usage notes on the products covered by this document, refer to the relevant sections of the document as well as any technical updates that have been issued for the products.

1. Handling of Unused Pins

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

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

2. Processing at Power-on

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

   — The states of internal circuits in the LSI are indeterminate and the states of register settings and pins are undefined at the moment when power is supplied.
   In a finished product where the reset signal is applied to the external reset pin, the states of pins are not guaranteed from the moment when power is supplied until the reset process is completed. In a similar way, the states of pins in a product that is reset by an on-chip power-on reset function are not guaranteed from the moment when power is supplied until the power reaches the level at which resetting has been specified.

3. Prohibition of Access to Reserved Addresses

   Access to reserved addresses is prohibited.

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

4. Clock Signals

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

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

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

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(Note 2) "Renesas Electronics product(s)" means any product developed or manufactured by or for Renesas Electronics.

(Rev.3.0-1 November 2016)

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