

RE01 256KB Group

Ultra-Low Consumption Voice Recognition Wearable User Interface, Home Appliance Remote Control (Bluetooth® communication)

Introduction

Conventional voice recognition devices often require AC power, but the ultra-low power RE family enables voice recognition remote controls and wearable device user interfaces that can run without external power sources for long periods of time on small batteries.

This application note describes the sample code, which combines voice recognition using the RECAIUS™ Speech recognition middleware Voice Trigger, Bluetooth® communication, and RGB light sensor processing.

Target Device

RE01 256KB Group

- RECAIUS™ Speech recognition middleware Voice Trigger is a product of Toshiba Digital Solutions Corporation. Below, it is described as Voice Trigger.
- RECAIUS™ is a registered trademark or trademark of Toshiba Digital Solutions Corporation in Japan or other countries.
- Bluetooth® is a registered trademark or trademark of Bluetooth SIG, inc. USA. Below, it is described as Bluetooth.

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1. Specifications

1.1 Description of Sample Code

This application note describes the sample code that combines voice recognition using Voice Trigger, Bluetooth communication, and RGB light sensor processing. In the voice recognition mode, assuming hands-free operation like a smartwatch or smart glasses, the system recognizes the voice input to the microphone and display the relevant information on the LCD according to the word detected by the voice recognition software. The RGB light sensor mode is included as an additional feature as an example of sensor processing in IoT edge devices. The application calculates the illuminance from the value obtained by the sensor, and outputs the illuminance value via the LCD and also by BLE communication.

1.1.1 Menu Selection

Use the APP_SET (SW2) and APP_MODE (SW1) buttons to select a demo to run from the menu. The selectable menus are "Voice" and "Brightness".

APP_SET (SW2): Decide (demo with triangle on the left edge is performed)

APP_MODE (SW1): Select the next demo (the left triangle moves)

Figure 1 shows the menu screen, Figure 2 shows the location of the buttons on the board.



Figure 1 Menu screen

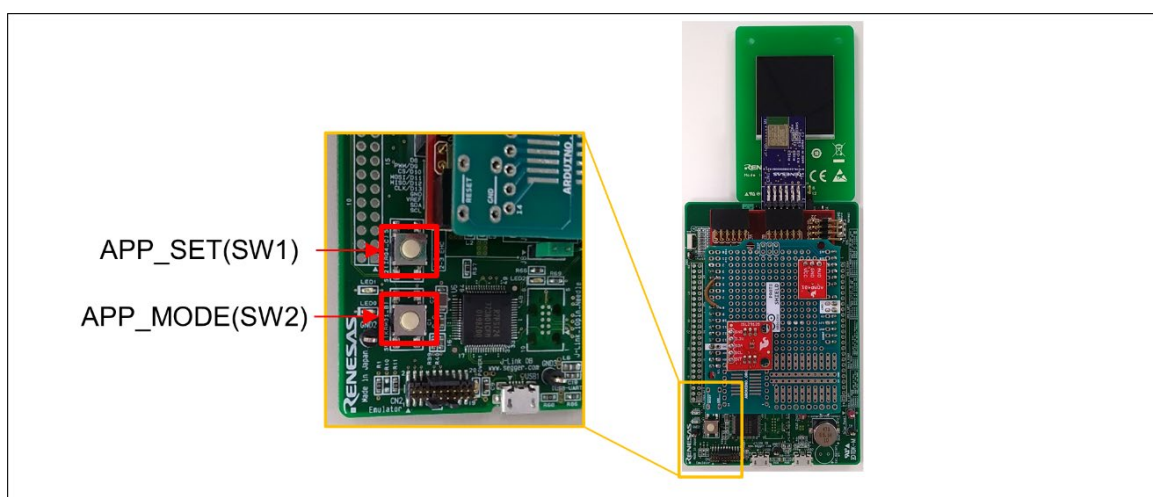


Figure 2 Button position

1.1.2 Voice: Voice Recognition Mode

When "Voice" is selected from the menu, the demo transitions to the voice recognition mode. In this mode, the Voice Trigger recognizes the voice input to the microphone and displays information on the LCD depending on the word or phrase detected. The speech recognition result is also transmitted via Bluetooth and displayed on the tablet PC running an Android app created by Renesas.

Figure 3 shows the operation in voice recognition mode, and Table 1 shows the words to be recognized and the output results.

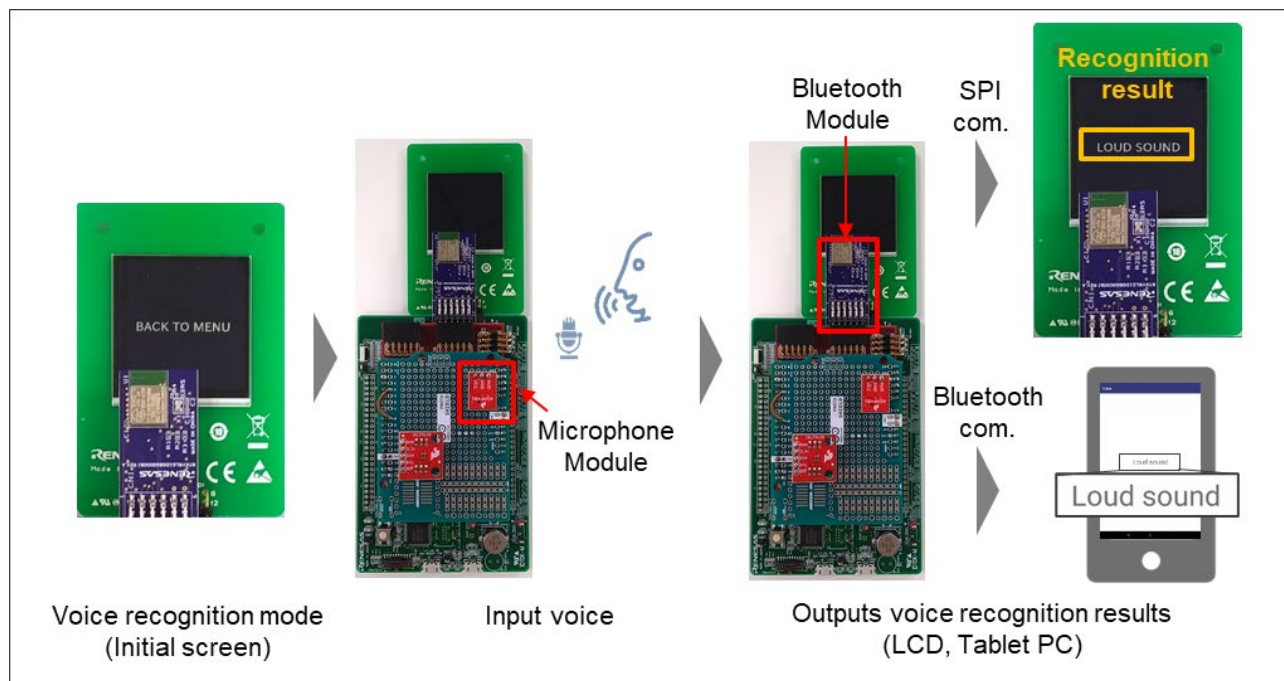


Figure 3 Recognition mode

Table 1 Correspondence between recognized words and output results*

Voice commands	Output Result	
	LCD	Tablet PC
Turn on TV	TURN ON TV	Turn on TV
Turn off TV	TURN OFF TV	Turn off TV
Loud sound	LOUD SOUND	Loud sound
Small sound	SMALL SOUND	Small sound
Channel up	CHANNEL UP	Channel up
Channel down	CHANNEL DOWN	Channel down

1.1.3 Brightness: RGB Light Sensor Mode

When "Brightness" is selected from the menu, the illuminance value is calculated from the data obtained from the RGB light sensor and displayed on the LCD. In addition, the illuminance value is transmitted via Bluetooth and displayed time series graph of it on the tablet PC running an Android app created by Renesas.

Figure 4 shows the operation in RGB light sensor mode.

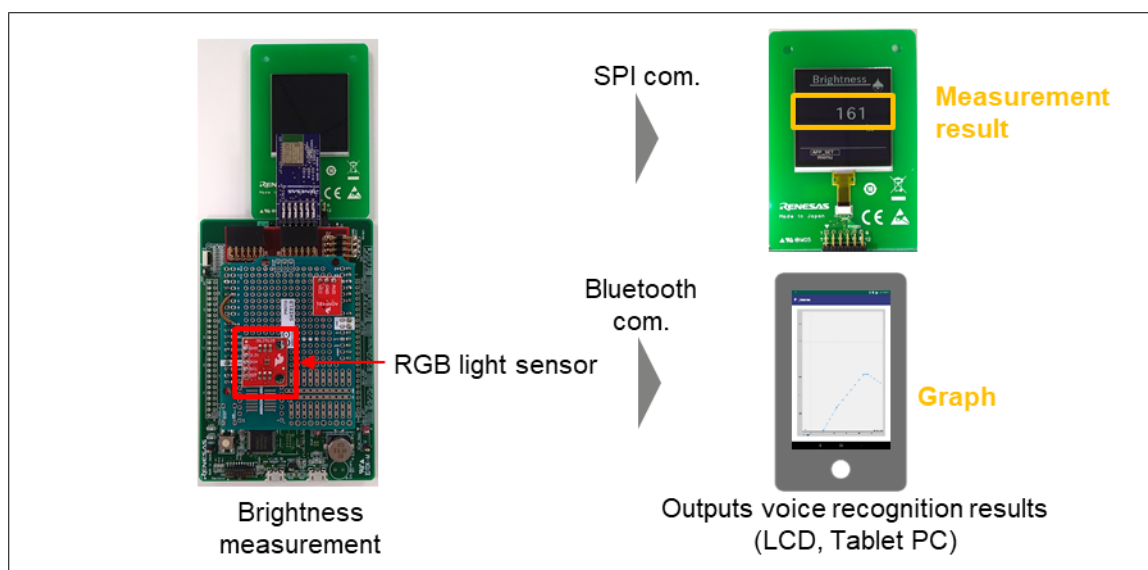


Figure 4 RGB light sensor mode

1.2 Pins Used

The pins used by this sample code are as shown in Table 2.

Table 2 Pins used

Features	Terminal name	Contents
Switch	P509	APP_ MODE push switch - KRM01_B
	P508	APP_ SET push switch - IRQ4-C
RGB Light Sensor	P808	IIC communication for illuminance sensor - INT
	P809	IIC communication for illuminance sensor - SDA
	P810	IIC communication for illuminance sensor - SCL
LCD	P814	Serial communication for LCD - VCOM
	P813	Serial communication for LCD - RST
	P011	Serial communication for LCD - SCLK
	P010	Serial communication for LCD - MOSI
	P015	Serial communication for LCD - SCS
Bluetooth module	P702	UART Communication - RXD
	P703	UART Communications - TXD
Microphone module	P003	AD analog signal

2. Operating conditions

The operation of the sample code provided with this application note has been tested under the following conditions (Table 3).

Table 3 Operating Conditions

Item	Description
Microcontroller used	R7F0E01182CFP 100pin

Operating frequency	HOCO is selected as the system clock	<ul style="list-style-type: none"> HOCO: 64MHz System Clock (ICLK): 64MHz(HOCO) Peripheral module clock A (PCLKA): 64MHz (HOCO frequency is not divided) Peripheral module clock B (PCLKB): 2MHz (HOCO frequency is divided by 32)
Operating voltage		<ul style="list-style-type: none"> 3.3V
Integrated Development Environment	e ² studio	Renesas e ² studio 2020-10 C Compiler: GCC ARM Embedded Version 6.3.1.20170620 GNU 6-2017-q2-update
Debugger		Segger J-Link OB
Demo components	Target board	Evaluation Kit RE01 256KB (Part name: RTK70E0118CXXXXBJ)
	LCD expansion board	Included with Evaluation Kit RE01 256KB (LCD part name: TN0181ANVNANN-AN00)
	Microphone module	SparkFun MEMS Microphone Breakout ADMP401
	RGB light sensor	SparkFun RGB Light Sensor - ISL29125
	Bluetooth module	RL78/G1D Module Pmod™ Interface evaluation board (Part name: RY7011A0000DZ00)
	Tablet PC	NEC LAVIE Tab S PC-508FAM(OS: Android 6.0)
CMSIS driver package version		Rev1.00
Sample code version		Rev1.00

3. Discription of Software

3.1 System configuration diagram

Figure 5 shows a system configuration diagram.

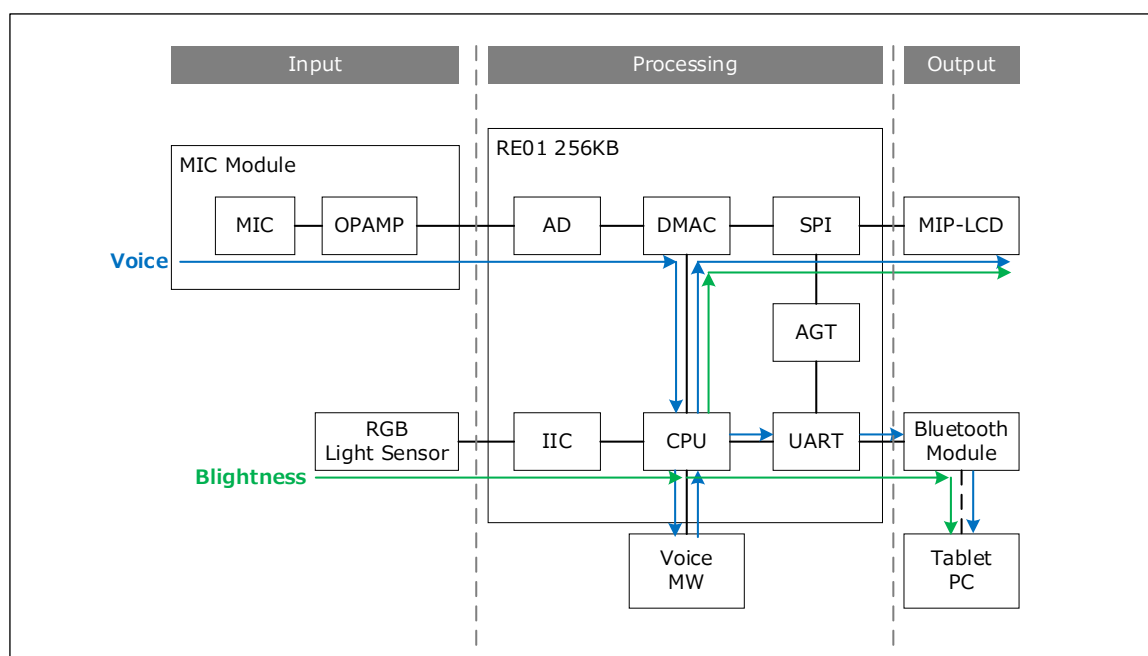


Figure 5 System Configuration Diagram

3.2 Software Structure

The sample code for this application has the structure shown in Figure 6

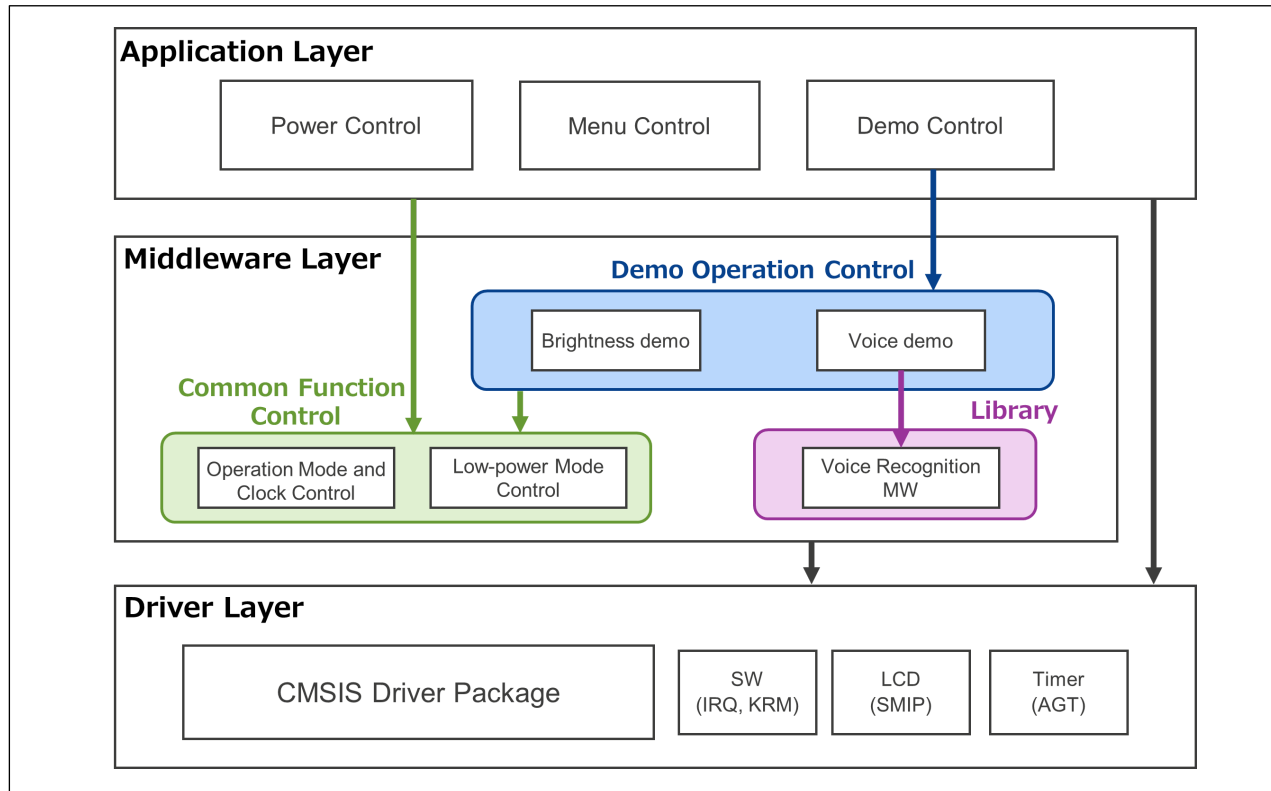


Figure 6 Software Structure

3.3 Flowchart

The flowchart of this application is shown in Figure 7.

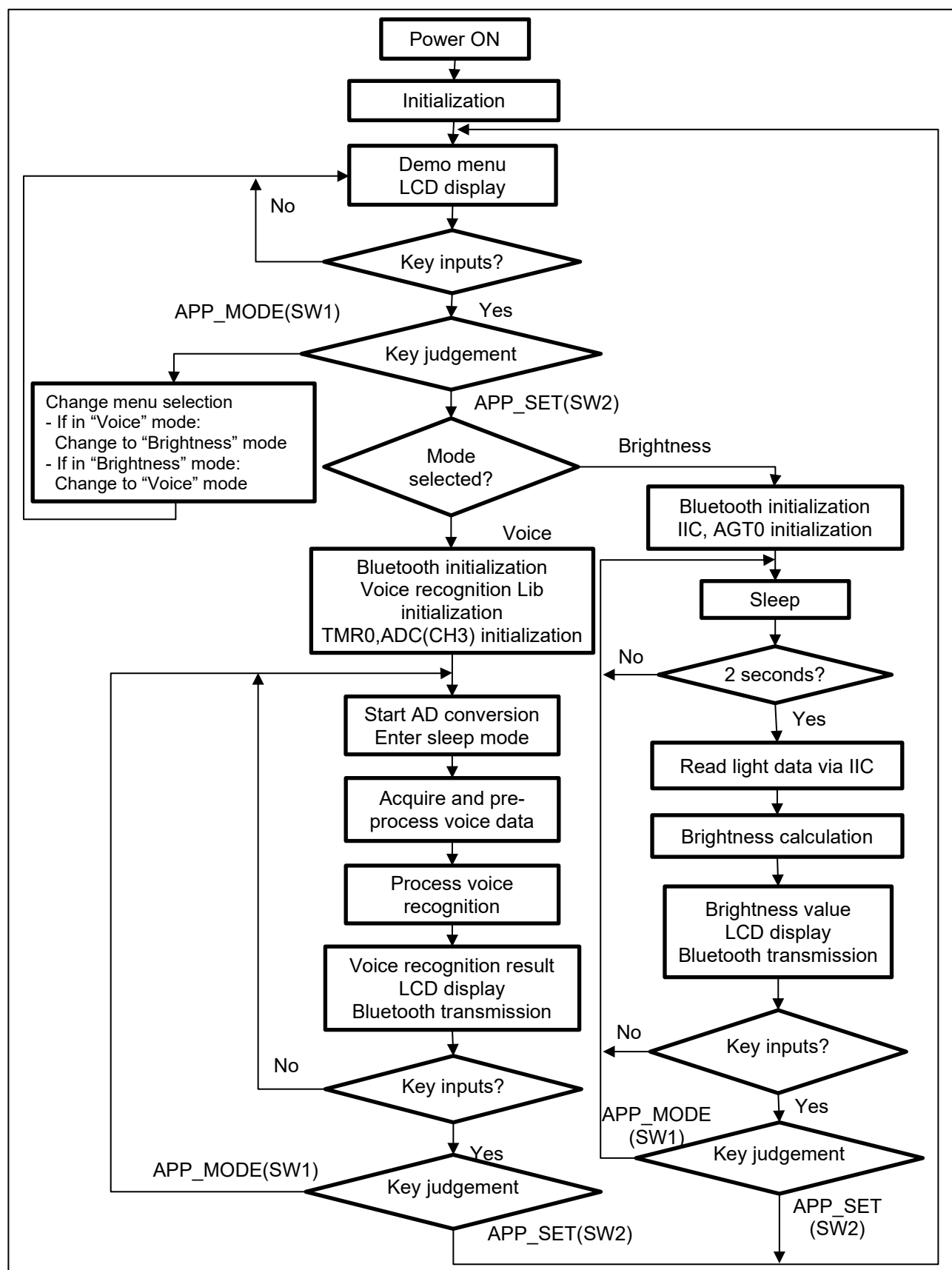


Figure 7 Flowchart

3.4 Clock Settings for each Mode

The application layer manages the clock and operating mode during each demo mode operation to reduce the current consumption.

- Clock and operation mode during operation: Managed by the application layer
- Clock and operation mode during the standby period in menu control: Managed by the application layer
- Clock and operation mode during the standby period in the demo control: Managed by the middleware layer

Table 4 shows the clock and operation mode during operation in each state. In the application layer, the state during "menu control" is the basic state, and after each state, the clock and operation mode transitions to the same as during menu control.

Table 4 List of clocks and operation modes in operation

State		LOCO 32KHz	SOSC 32KHz	MOCO 2MHz	MOSC 32MHz	HOCO 64MHz	Power control mode	Power supply mode
After reset released		Operate	Stop	Stop	Stop	Operating	Boost	ALLPWON
After startup executed		Operate	Stop	Stop	Stop	Operating	Boost	ALLPWON
Demo menu		Operate	Stop	Stop	Stop	Operating	Boost	ALLPWON
Mode	Voice recognition demo	Operate	Stop	Stop	Stop	Operating	Boost	ALLPWON
	Brightness sensor demo	Operate	Stop	Stop	Stop	Operating	Boost	ALLPWON

During the waiting period of AD conversion of acquiring audio data, or the waiting period for user action, the software is transitioned to the low-power mode (Sleep) by application layer to reduce current consumption. Table 5 shows an example of the clock and operation mode during the waiting period.

Table 5 List of clocks and operation modes in waiting period

State		LOCO 32KHz	SOSC 32KHz	MOCO 2MHz	MOSC 32MHz	HOCO 64MHz	Power control mode	Power supply mode
Demo menu		Operate	Stop	Stop	Stop	Operating	Boost	ALLPWON
Mode	Voice recognition demo	Operate	Stop	Stop	Stop	Operating	Boost	SLEEP ALLPWON
	Brightness sensor demo	Operate	Stop	Stop	Stop	Operating	Boost	SLEEP ALLPWON

3.5 Current Consumption

Table 6 shows the power consumption of each operation modes.

Table 6 power consumption of each operation modes

State		Power consumption of current(mA)
Demo menu		1.1
Mode	Voice recognition demo	1.2
	Brightness sensor demo	1.2

4. Get Sample Code

We provide the sample code for RE01 256KB along with the Android app for tablet PC.

Please contact your local Renesas Electronics sales office or distributor.

www.renesas.com/contact/

For more information about Voice Trigger, please contact Toshiba Digital Solutions Corporation.

<https://www.toshiba-sol.co.jp/en/contact/index.html>

5. Reference Documents

User's Manual: Hardware

RE01 1500KB Group User's Manual Hardware R01UH0796

RE01 256K Group User's Manual Hardware R01UH0894

(The latest version can be downloaded from the Renesas Electronics website.)

RE01 1500KB, 256KB CMSIS Package Startup Guide

RE01 1500KB, 256KB Group Startup Guide to Development Using CMSIS Package R01AN4660

(The latest version can be downloaded from the Renesas Electronics website.)

Technical Update/Technical News

(The latest version can be downloaded from the Renesas Electronics website.)

User's Manual: Development Tools

(The latest version can be downloaded from the Renesas Electronics website.)

Revision History

Rev.	Date	Description	
		Page	Summary
1.00	Jan.25.21		First released
1.01	Feb.19.21	- 5	Voice recognition demo supported English commands. The contact information of RECAIUS™ Speech recognition middleware Voice Trigger was added.

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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.

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