

Voice Anti-Spoofing (VAS) for Voice User Interface Applications with Speaker ID (SID)

Quick Start Guide

Renesas RA Family
RA6 Series

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The product generates, uses, and can radiate radio frequency energy and may cause harmful interference to radio communications. There is no guarantee that interference will not occur in a particular installation. If this equipment causes harmful interference to radio or television reception, which can be determined by turning the equipment off or on, you are encouraged to try to correct the interference by one or more of the following measures:

- Ensure attached cables do not lie across the equipment.
- Reorient the receiving antenna.
- Increase the distance between the equipment and the receiver.
- Connect the equipment into an outlet on a circuit different from that which the receiver is connected.
- Power down the equipment when not in use.
- Consult the dealer or an experienced radio/TV technician for help.

Note: It is recommended that wherever possible shielded interface cables are used.

The product is potentially susceptible to certain EMC phenomena. To mitigate against them it is recommended that the following measures be undertaken:

- The user is advised that mobile phones should not be used within 10 m of the product when in use.
- The user is advised to take ESD precautions when handling the equipment.

The Evaluation Kit does not represent an ideal reference design for an end product and does not fulfill the regulatory standards for an end product.

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.

Voice Kit-RA6E1 – Quick Start Guide

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1. Introduction

This Quick Start Guide (QSG) provides:

- Instructions for running the “Voice Anti-Spoofing (VAS) for Voice User Interface Applications with Speaker ID (SID)” application example.

For further information and inquiries please contact: rai-cs@dm.renesas.com

1.1 Assumptions and Advisory Notes

1. Prior to running the Quick Start example project or programming the Voice Kit-RA6E1 board, default jumper settings must be used. Refer to the Voice Kit-RA6E1 user's manual for the default jumper settings.
2. The screen shots provided throughout this document are for reference. The actual screen content may differ depending on the version of software and development tools used.

2. Overview of the “Voice Anti-Spoofing (VAS) for Voice User Interface Applications with Speaker ID (SID)” application example

The Renesas Reality AI Voice Anti-Spoofing application example is used as an extension of the VUI - Voice Command Recognition from Cyberon, to detect Human real voice vs Machine generated or recorded voice.

Hereby the key wake word “Hi-Renesas” is used and only if real human voice is identified by the Voice Anti-Spoofing feature, the Voice Command Recognition will accept next coming commands accordingly.

For demonstration purposes, limited amount of data and recording devices has been used to train the model on e2studio and Reality AI TOOLS®.

With the Speaker ID (SID) it enables the registration of up to 3 users that the system will capture their voices and use them for identification.

It is strongly recommended that the provided recordings will be used to examine fake word detection.

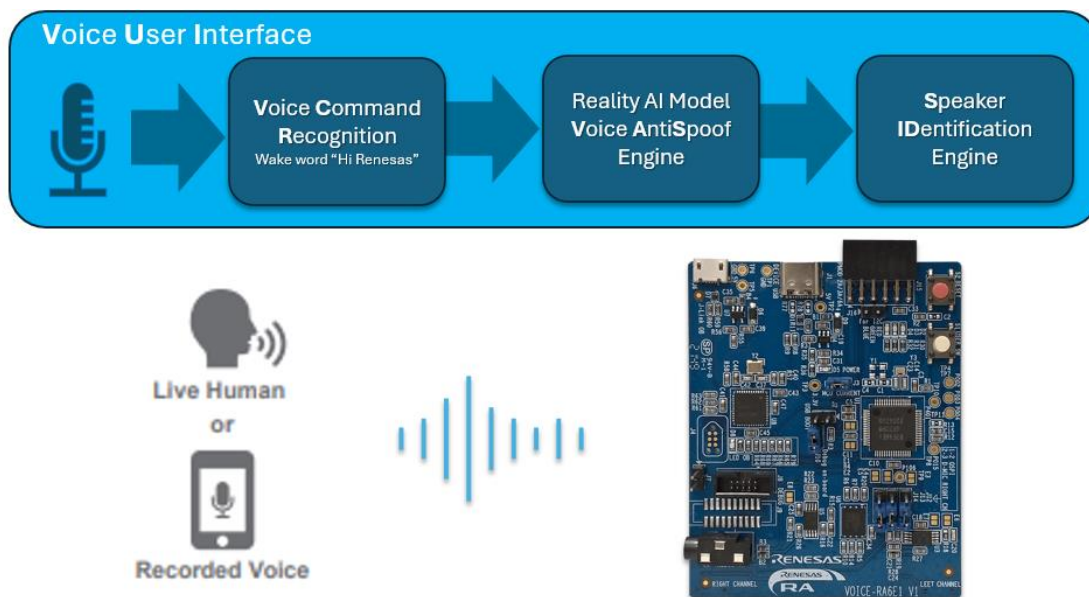


Figure 1. Overview of VAS with SID

2.1 Quick Start Guide Project Flow

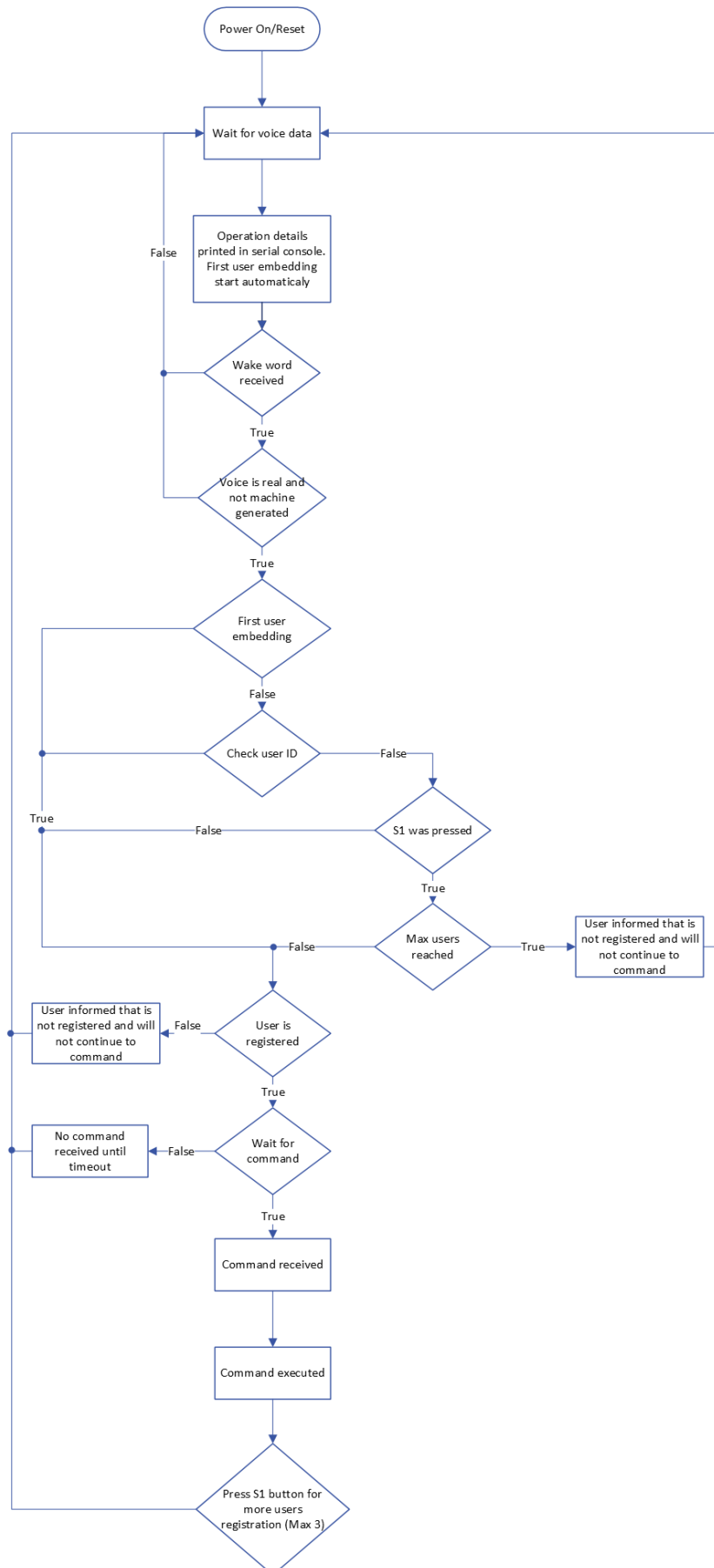


Figure 2. Quick Start Guide Project Flow

3. Running the “Voice Anti-Spoofing (VAS) for Voice User Interface Applications with Speaker ID (SID)” application example

This section lists the requirements and instructions to power up the Voice Kit -RA6E1 board and run application example.

Hardware Requirements

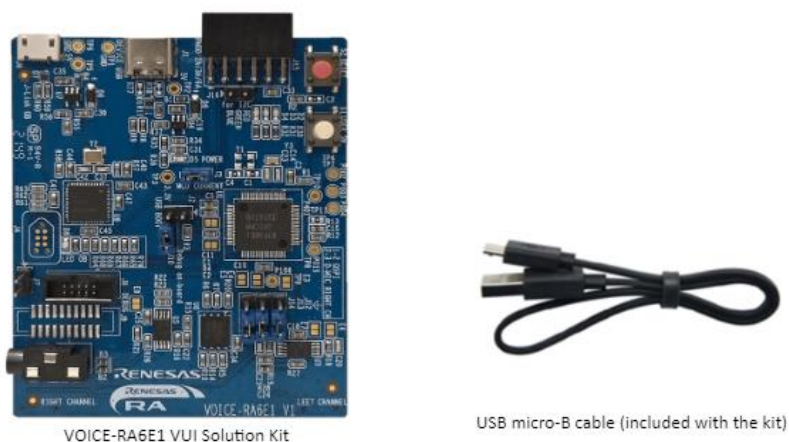
- Voice Kit-RA6E1 board
- Micro USB device cable
- A PC with at least 1 USB port

Software Requirements

- Windows® 10 operating system
- Serial terminal (e.g. Tera Term, Putty)
- J-Link tools

3.1 Connecting and Powering Up the Voice Kit-RA6E1 Board

1. Connect the micro-USB end of the micro-USB device cable to micro-AB USB port (J6) of the Voice Kit -RA6E1 board.
2. Connect the other end of this cable to the USB port of the host PC. Power LED (LED5) on the Voice Kit -RA6E1 board lights up blue, indicating that the Voice Kit-RA6E1 board is powered on.

**Figure 3. Voice Kit-RA6E1 Board & USB Debug cable**

3.2 Programming the application example

Flash the device with the binary that has been provided with this document.

In the folder Flasher you will find the following files:

- Flash Device.bat
- Flash Device.jlink
- JLink.exe
- JLink_x64.dll

- vk_ra6e1_vas_sid_01_07_2024.srec

Verify that the Voice Kit -RA6E1 board is connected to the PC and run the Flash Device.bat file, the project will be automatically downloaded to the DUT.

3.3 UART Terminal Output

On power on, the UART output is enabled.

For that the user needs to setup the serial terminal as follows:

- Speed / Baud Rate 460800
- Data 8 bit
- Parity none
- Stop bits 1 bit
- Flow Control none

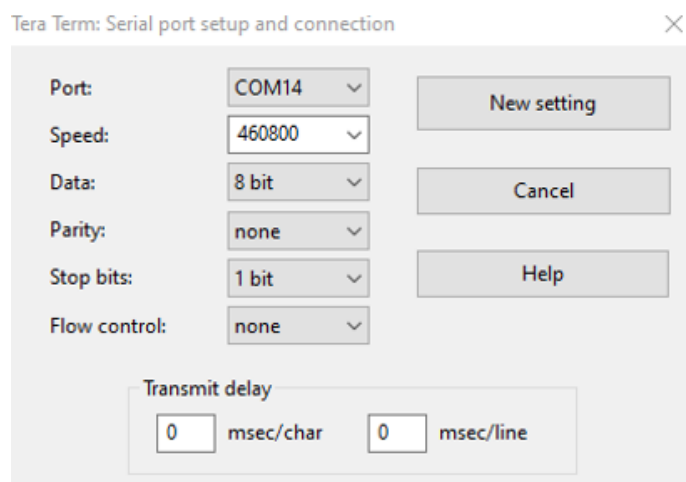


Figure 4. Serial Port Setup

3.4 Operating the Application Example

To run application example, use the following instructions:

1. On power up or RESET.

Note: The debug LED (LED OB) will blink or light up green; this can be ignored for now.

2. Connect to UART terminal as described above in UART Terminal Output section.
3. Give the wake-word "Hi Renesas".
4. If the VAS detected voice is real the UART in terminal will print "Detected Class: Accepted"
5. The voice will be registered as user 0, the max users that can be registered are 3. Terminal will print "User 0 registered!"
6. If the VAS detects recorded voice, the result is Dropped, and User can NOT continue to command.
7. If the VAS result is accepted & an SID registered user is identified, then user can continue to command the Terminal will show "Command group active."
8. Give the Command Light On or Light Off.
9. Command recognition indicators:

- Light On the Red user LED will flash
- Light Off the LED will stop flashing

New user can be added by pressing the S1 User button and then say “Hi Renesas”.

If button S1 is pressed the serial terminal will print” Button pressed registration for new user x started”

```
Successfully initialize DC/DS
Little Endian
MCU board: VOICE-RA6E1
FSP version: 5.2
Dspotter version: DspotterSDK Release v2.2.18.3 <compiled at Nov 27 2023, 10:54:13>
Copyright (C) 2018-2023 Cyberon Corp.
Sample code build: 210312
Unique ID: 0x41068A1A-35373536-63614453-4E4B2A98
This Speaker ID model declares memory buffer size = 33073
This Dspotter model declares memory buffer size = 50000
The Dspotter model, group 0 needs working memory size = 23464
Command list for group index 0:
  Hi Renesas, Map ID = 0

The Dspotter model, group 1 needs working memory size = 23176
Command list for group index 1:
  Light On, Map ID = 1
  Light Off, Map ID = 2

Speaker ID initiated. For first use the user needs to register!
To register please say <Hi Renesas>!

Wake-up group active.
  Hi Renesas, Map ID = 0
```

Figure 5. Initial information on the model and commands

If the “Hi Renesas” wake word is accepted as “real” in VAS engine the UART terminal will print the “Detected Class: Accepted” message, as seen bellow, or “Detected Class: Dropped” if the result is recognized as recorded.

For the first time registration if the VAS Detected Class is Accepted then the user 0 will be registered and the SID recognizes the user, and can continue to the command as seen bellow.

```
Successfully initialize DC/DS
Little Endian
MCU board: VOICE-RA6E1
FSP version: 5.2
Dspotter version: DspotterSDK Release v2.2.18.3 <compiled at Nov 27 2023, 10:54:13>
Copyright (C) 2018-2023 Cyberon Corp.
Sample code build: 210312
Unique ID: 0x41068A1A-35373536-63614453-4E4B2A98
This Speaker ID model declares memory buffer size = 33073
This Dspotter model declares memory buffer size = 50000
The Dspotter model, group 0 needs working memory size = 23464
Command list for group index 0:
  Hi Renesas, Map ID = 0

The Dspotter model, group 1 needs working memory size = 23176
Command list for group index 1:
  Light On, Map ID = 1
  Light Off, Map ID = 2

Speaker ID initiated. For first use the user needs to register!
To register please say <Hi Renesas>!

Wake-up group active.
  Hi Renesas, Map ID = 0

Get command(1) : Hi Renesas , Score=16, SG_Diff=39, Energy=4317, MapID=0
Detected Class: Accepted
User [0] registered!
Command group active.
  Light On, Map ID = 1
  Light Off, Map ID = 2

Get command(1) : Light On , Score=44, SG_Diff=34, Energy=5400, MapID=1

Press the <User Button S1> to register more users, max users 2
Wake-up group active.
  Hi Renesas, Map ID = 0
```

Figure 6. Detected Class: Accepted

The commands will be executed only if the VAS Detected Class of the wake word is Accepted and the SID user is registered.

If the User is not registered and the VAS Detected Class of the wake word is Accepted the command will not be executed and the serial will print “Detected Class: Accepted”, “User is not registered”, “Command group not active” as seen bellow

```
Get command<2> : Hi Renesas , Score=28, SG_Diff=50, Energy=2700, MapID=0
Detected Class: Accepted
User is not registered.
Command group not active.
Press the <User Button S1> to register more users, max users 2
```

Figure 7. Detected class Accepted, User not registered

If the VAS Detected class is dropped and the user is recognized with SID engine again the command will not be executed as seen below.

```
Detected Class: Dropped
IDENTIFY RETURN [0]
  Light On, Map ID = 1
  Light Off, Map ID = 2
  Sequence, Map ID = 3
```

Figure 8. Detected class is dropped, user is recognized

```
Detected Class: Dropped
User is not registered.
Command group not active.
```

Figure 9. Detected Class: Dropped

After the first user is registered the SID options to add more users will be shown (Max users is configurable in sw with max =3) as seen below.

```
Press the <User Button S1> to register more users, max users 2
Wake-up group active.
  Hi Renesas, Map ID = 0
```

Figure 10. SID user registration procedure information

```
Wake-up group active.
  Hi Renesas, Map ID = 0
Button pressed registration for new user 1 started.
```

Figure 11. S1 Button pressed for registration of SID new user

If max users (3) are reached and the S1 Button is pressed the serial will print “**Button pressed maximum registered users reached x, registration canceled.**” As seen bellow.

```
Press the <User Button S1> to register more users, max users 1
Wake-up group active.
  Hi Renesas, Map ID = 0
Button pressed maximum registered users reached 1, registration canceled.
□
```

Figure 12. Max users reached

4. Guidelines for Demo Operation

The ML model must reliably distinguish between real and spoof in the following context:

- User either says or plays back a recording of the English phrase “Hi Renesas”.

User may speak with any common spoken English accent and any natural vocal tonal quality (male or female).

- The playback device is a phone speaker (iPhone or Android) *
- Environmental noise is within such a range that the Cyberon voice stack can recognize the wake-word.
- Both real and spoofed utterances are identifiable at a variety of loudness levels.

Reliably in practice means that spoofs are correctly identified at least 95% of the time that a wake-word is recognized, and real utterances are correctly identified at least 95% of the time that a wake-word is recognized.

The following items are explicitly out-of-scope and non-deliverable:

- Specific information about the methodology used to collect data or train the model. That is, a single model is provided as-is, and there is no expectation that the model can be replicated by the end-user.
- Model generalizability to situations other than those described above. Model is not expected to generalize to arbitrary playback devices*, arbitrary utterances, or other languages.

It is strongly recommended that the provided recordings will be used to examine fake word detection.

In case of questions or further information contact rai-cs@dm.renesas.com

Revision History

Rev.	Date	Description	
		Page	Summary
1.00	August.27.2024	—	Initial release

Voice Anti-Spoofing (VAS) for Voice User Interface Applications with Speaker ID (SID)