Quick Start Guide

VK-RA8M1 Voice Application Combo

Quick Start Guide

Renesas RA Family

RA8 Series

Renesas Electronics
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Precautions

This Evaluation Kit is only intended for use in a laboratory environment under ambient temperature and humidity conditions. A safe separation distance should be used between this and any sensitive equipment. Its use outside the laboratory, classroom, study area, or similar such area invalidates conformity with the protection requirements of the Electromagnetic Compatibility Directive and could lead to prosecution.

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 Exampleline 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.

RENESAS

VK-RA8M1

VK-RA8M1 – Quick Start Guide

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1. Introduction

This Quick Start Guide (QSE) provides:

 • An overview of the Quick Start Guide project for the VK-RA8M1 board using the Audio Processing Front (APF), accompanied with Natural Language Understanding (NLU), Voice Anti-Spoofing (VAS) and Speaker Verification (CNSV) for identification of a speakers number that are registered to the device.

 • Instructions for importing, modifying, and building the QSG used project using Flexible Software Package (FSP) and e2 studio Integrated Development Environment (IDE)

1.1 Assumptions and Advisory Notes

1. Tool experience: It is assumed that the user has prior experience working with IDEs such as e2 studio and terminal emulation programs such as Tera Term.

2. Subject knowledge: It is assumed that the user has basic knowledge about microcontrollers, embedded systems, and FSP to modify the example project described in this document.

3. 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.

For further information and inquiries, please request a demo from Reality AI | Renesas Electronics

2. Kit Contents

The following components are included in the kit:

VK-RA8M1 board

Micro USB device cable (type-A male to micro-B male)
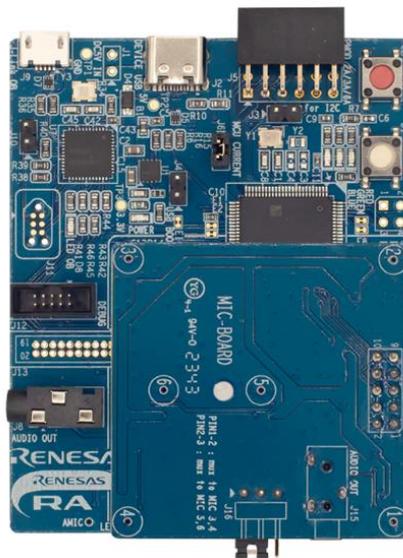
Figure 1. VK-RA8M1 Kit

3. Overview of the Quick Start Guide Project

This QSG is aimed to demonstrate a combo application of VCR-NLU, being used with APF, VAS and CNSV. It achieves a more accurate recognition of voice commands in any environment by removing interfering sounds captured by the microphone. The enhancement accompanies Renesas Voice User Interface solution with features such as

- Advanced Voice Commands Recognition with Natural Language Understanding

- Voice Activity Detection

- Multiple Languages Recognition

- Text to Speech decoding for voice prompts

- Wake-word customization feature at the end-user (via voice tagging)

- Speaker Identification

- Anti-Spoofing that identifies real human voice from machine generated voice

- An ultra-lightweight library of voice processing algorithms designed to enhance the recognition of voice commands

The application uses the mic-board microphones (check jumper positions) to perform voice command recognition.

3.1 Description of Audio Processing Front

The Audio Processing Frond (APF) is a library of voice processing algorithms designed to enhance the recognition of voice commands recognition and speech quality when noisy conditions are met.
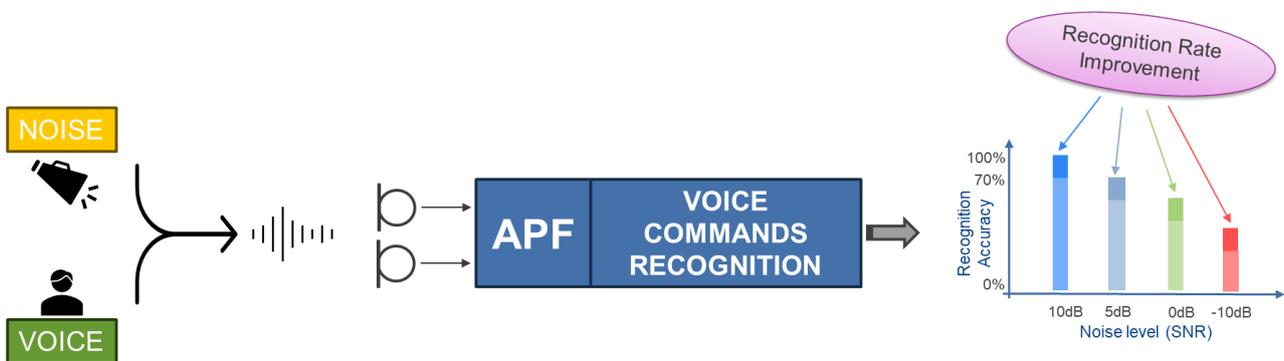

Figure 2. Recognition Rate improvement with APF

Operating Features:

Two microphones acoustic beamformer (BF) with configuration for endfire & broadside operation

Four-bands single channel noise suppression (NSUPP)

Combined with smaller size Dspotter level

API for controllable operation and tuning

Methodology to configure for other microphones' distance

Operation as USB audio enumerated device

Configuration Features:

Activate / deactivate the complete APF

Select for NSUPP (1 mic) or BF/NSUPP (2 mic) operation

Select between end-fire / broad-side BF configurations

Configure noise level activation threshold

Configure attack / decay and timeout thresholds

3.2   Description of Voice Recognition and Natural Language Understanding

VCR is high-performance embedded voice recognition solution specially optimized for mobile phones, automotives, smart home devices, consumer products, and interactive toys. Based on phoneme acoustic models, it enables developers to create applications of speaker-independent (SI) voice recognition capability without requiring costly data collection process for specific commands. With Win32-based DSpotter Model Tool, developers can easily and quickly create their own voice command models simply by text input. Other important features include always-on keyword-spotting capability, highly noise immune, adjustable sensitivity, voice quality assessment, and more than 30 commonly used language versions available.

DSpotterNLU Engine is a Cyberon engine that can understand what the speaker's intent in a single full sentence. It can process natural language and hence the speaker do not need to say the exact fixed words. The sentence said by the speaker can contains words that are not relevant to the intent but the engine can still understand.

3.3   Description of Cyberon Speaker Verification

Cyberon CNSV is an engine designed to enable developers to integrate speaker verification capabilities into their applications and devices. CNSV leverages advanced neural network algorithms optimized for edge environments, providing high accuracy and low latency while maintaining efficient resource usage.

Speaker verification focuses on identifying specific speakers by analyzing vocal characteristics, unlike traditional speech recognition, which converts speech into text. This technology makes applications more user-friendly, as it can be used in scenarios where identifying the speaker is necessary, enhancing both convenience and intuitive operation.

Key Features of CNSV SDK:
- Advanced Neural Network Technology for Edge Devices: Utilizes state-of-the-art neural network models specifically optimized for edge computing environments, providing high accuracy with minimal computational overhead.
- Optimized for Embedded Systems and ARM Platforms: Designed to operate efficiently on resource constrained devices, making it ideal for embedded systems, ARM-based platforms, and other edge devices.
- Efficient Resource Usage: Low CPU and memory consumption ensures that the SDK can be deployed on devices with limited processing power and memory.
- Robust Performance in Real-World Environments: Maintains high accuracy and reliability in various conditions, including noisy environments and diverse microphone setups.

By leveraging neural network-based speaker verification, developers can enhance the user experience of their edge device applications. CNSV SDK is particularly suited for developers focused on building efficient and user-friendly solutions for embedded systems and ARM-based platforms.

3.4   Description of Voice Anti-Spoofing

The Renesas Reality AI Voice Anti-Spoofing library is used as an extension of the VUI - Voice Command Recognition from Cyberon, to detect Human real voice vs Machine generated or recorded voice.
For demonstration purposes, limited amount of data and recording devices has been used to train the model on e2studio and Reality AI TOOLS®.

4. Running the Quick Start Guide Project

This section lists the requirements and instructions to power up the VK-RA8M1 board and run the Quick Start Guide project.

Hardware Requirements

- VK-RA8M1 board
- Micro USB device cable
- A PC with at least 1 USB port

Software Requirements

- Windows® 10 operating system

4.1 Connecting and Powering Up the VK-RA8M1 Board

1. Prior to running the Quick Start Guide project or programming the VK-RA8M1 board, Mic board need to be attached to VK-RA8M1 board. This will enable the digital microphones on the mic board.

2. Power up the voice-kit through the micro-B USB port (J9) of the VK-RA8M1 board (cable is included).

3. Connect the other end of this cable to the USB port of the host PC. The power LED on the VK-RA8M1 board lights up blue, indicating that the VK-RA8M1 board is powered on.

Figure 3. Connecting the VK-RA8M1 Board to the Host PC via USB Debug Port

4.2 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
- RA8M1_VK_voice_combo.srec

Verify that the VK-RA8M1 board is connected to the PC and run the Flash Device.bat file, the project will be automatically downloaded to the DUT.

4.3   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
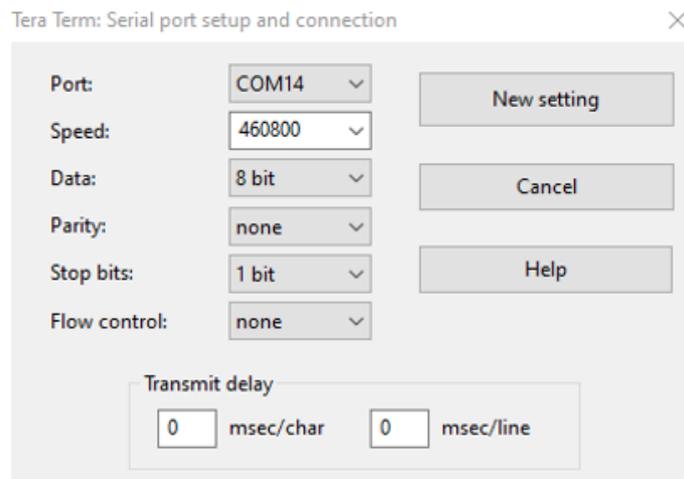
Figure 4. Serial Port Setup

4.4   Running the Quick Start Guide Project

Table 1. Mode configurations

APF Disabled	VAS Enabled	CNSV Enabled	NLU Enabled
APF Enabled (NSUPP mode)	VAS Disabled	CNSV Enabled	NLU Enabled
APF Enabled (BFNSUPP mode)	VAS Disabled	CNSV Enabled	NLU Enabled

To run the Quick Start Guide project, use the following instructions:

1. On power up or RESET.
2. The LEDs blink
3. The board starts in Bypass mode with NSUPP and BFNSUPP disabled, no LEDs are On

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

4. Open Teraterm with Speed 460800, Data 8 bit, Parity none, Stop bits 1 bit.
5. Say "Train Speaker x", with x being user from 1 to 6
6. The device will prompt user to say "Hi Renesas" 3 times for the registering to be completed

7. After registration is completed say "Hi Renesas" as wake word.

8. VAS will run and give a result if the voice is human or machine generated only in Bypass mode.

9. Give one of the following commands using natural language:

    a. Open Light

    b. Close Light

    c. Play Music

    d. Stop Music

    e. Pause Music

    f. Resume Music

    g. Next Music

    h. Previous Music

    i. Volume Up

    j. Volume Down

    k. Volume too Low

    l. Volume too Loud

10. Verify command received in Serial Terminal.

11. Press the S1 Button.

12. Board changed state and have Noise Suppression ON (NSUPP). Red LED is On.

13. Say "Hi Renesas" as wake word.

14. Give one of the commands in step 9.

15. Verify command received in Serial Terminal.

16. Press the S1 Button.

17. Board changed state to BFNSUP. Green LED is On.

18. Say "Hi Renesas" as wake word.

19. Give one of the commands in step 9.

20. Verify command received in Serial Terminal.

Table 2. Microphone State options

| State	LEDs
Bypass (No Beamformer \ NSUPP) (1 mic) Default setting	No LEDs
Noise Suppression (1 mic) (NSUPP)	Red LED
Broadside Beamformer with Noise Suppression (2 mics) (BFNSUPP)	Green LED
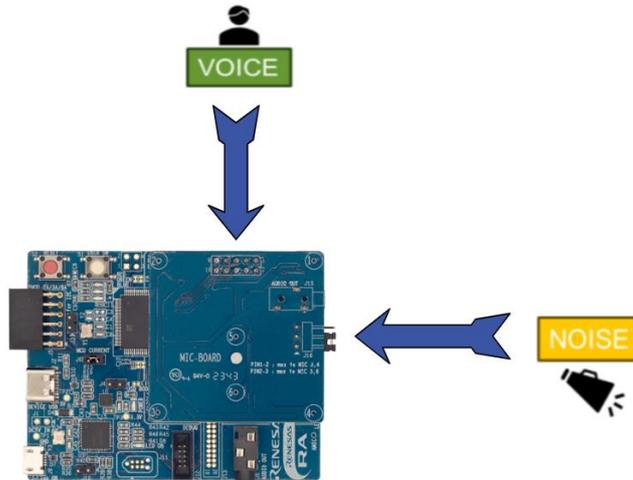
Figure 5. BFNSUPP Broadside configuration

For optimal results in BFNSUPP mode the Broadside configuration is suggested, for more details please review the r01an7593ee0100 application note (available on request).

5. Customizing the Quick Start Guide Project

This section lists the requirements and instructions for customizing the Voice Combo Demo project.

Hardware Requirements

- VK-RA8M1 board
- Micro USB device cable
- A PC with at least 1 USB port

Software Requirements

- Windows® 10 operating system
- e2 studio IDE
- FSP
- Voice Combo Demo project

5.1 Downloading and Installing Software and Development Tools

Before the Quick Start Guide used project can be modified, it is necessary to download and install software and development tools on the host PC.

The FSP, J-Link USB drivers, and e2 studio are bundled in a downloadable platform installer available on the FSP webpage at renesas.com/ra/fsp. New users are recommended to use the **Quick Install** option provided in the installation wizard, to minimize the amount of manual configuration needed.

There is no need to download and install software, development tools, and drivers separately.

5.2 Downloading and Importing the Quick Start Guide Project

1. For further information and inquiries, please request a demo from Reality AI | Renesas Electronics.
2. Download and extract the Voice Command Recognition Demo (APF) project to a local directory on the host PC.
   a. The Voice Combo Demo project (source code and project files) is available on request.

   b. Download the Voice Combo Demo project to a local directory on the host PC.

3. Launch e2 studio.

4. Browse to the Workspace where the project file is to be imported. Enter the name in the Workspace dialog box to create a new workspace.
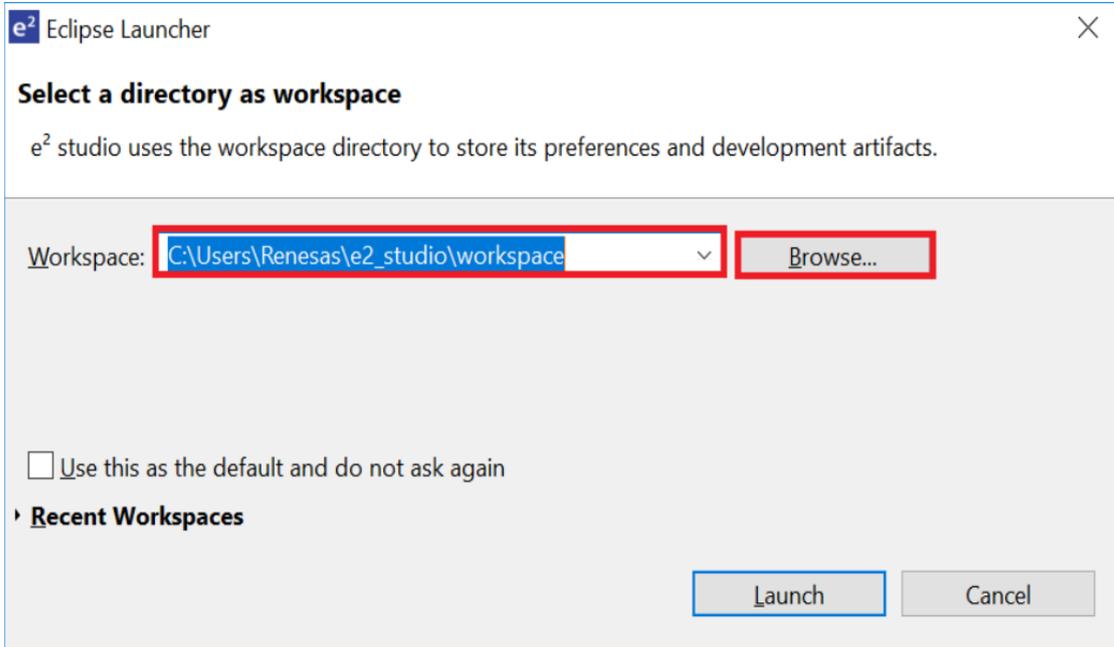

Figure 6. Creating a New Workspace

5. Click **Launch.**
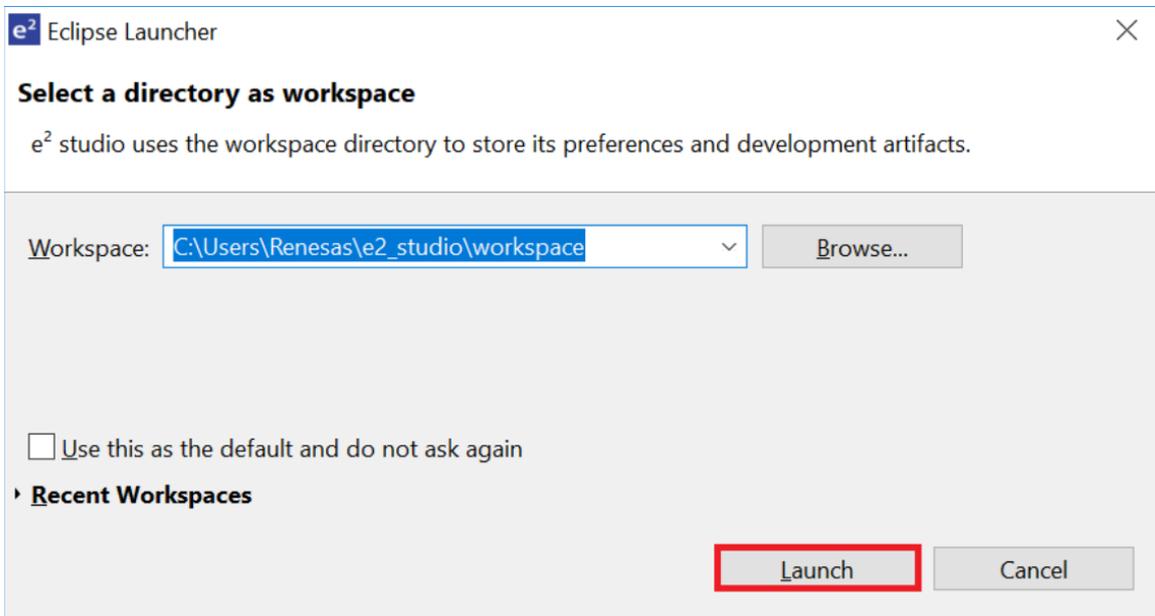
**Figure 7. Launching the Workspace**

6. Click Import from the File drop-down menu.
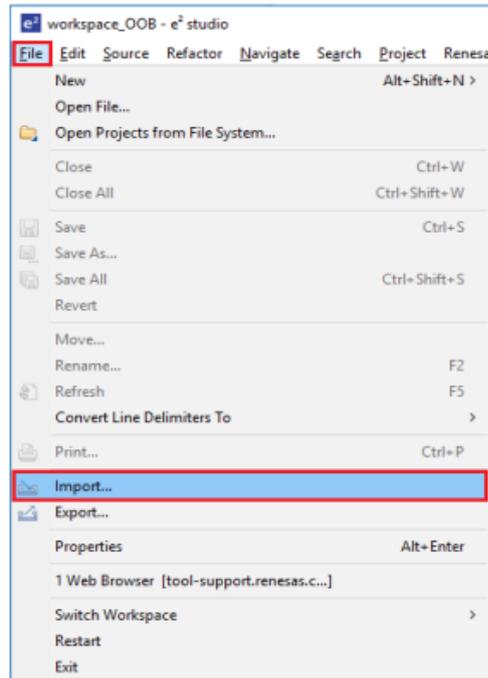
Figure 8. Importing the Project

7. In the **Import** dialog box, select **General**, and then select **Existing Projects into Workspace.**
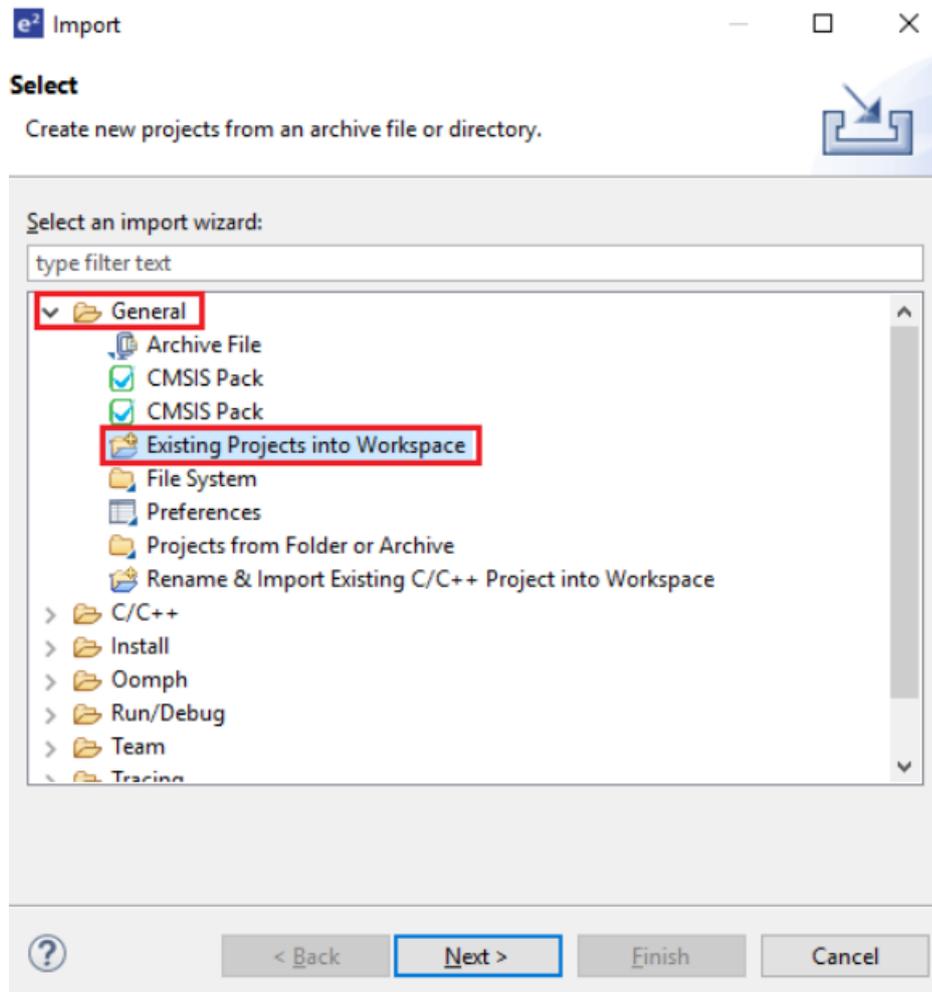
Figure 9. Importing Existing Projects into the Workspace

8. Click **Next.**
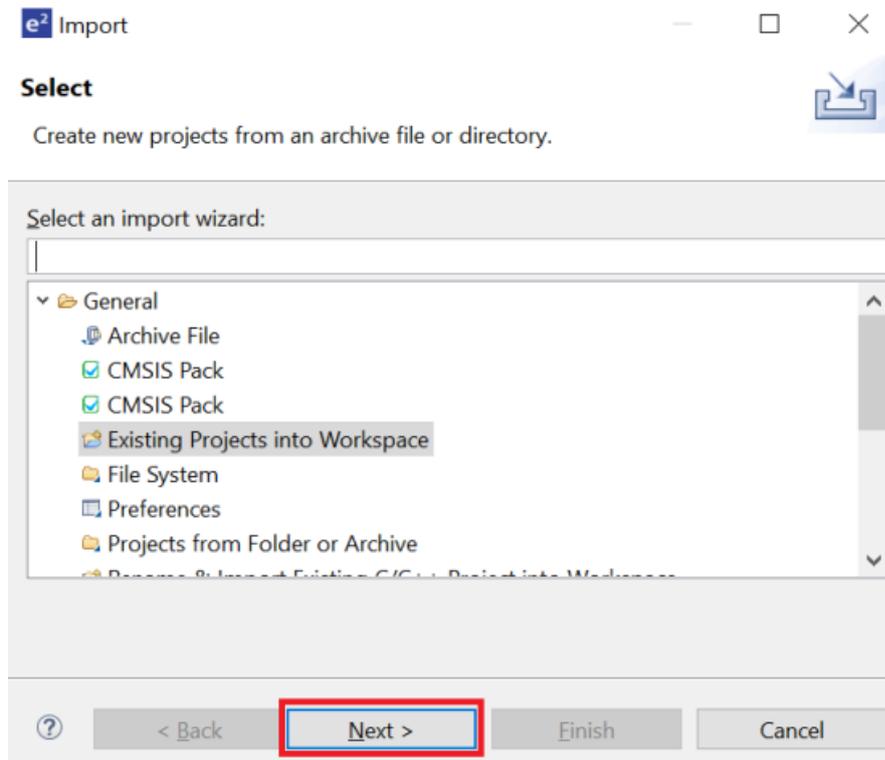
Figure 10. Clicking Next to Import Existing Projects into the Workspace

9. Click **Select root directory** and click **Browse** to go to the location of the Quick Start Guide project folder.
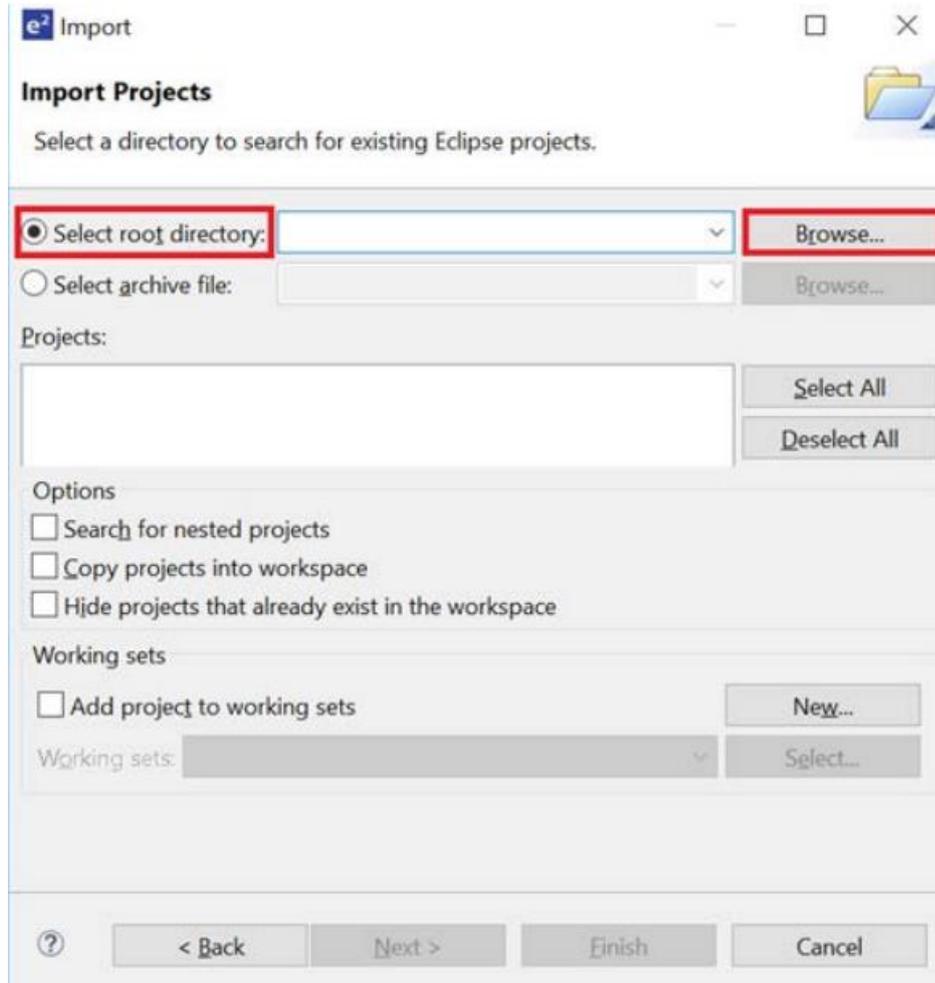
Figure 11. Selecting the Root Directory

10. Select the Quick Start Guide project and click **Finish**.
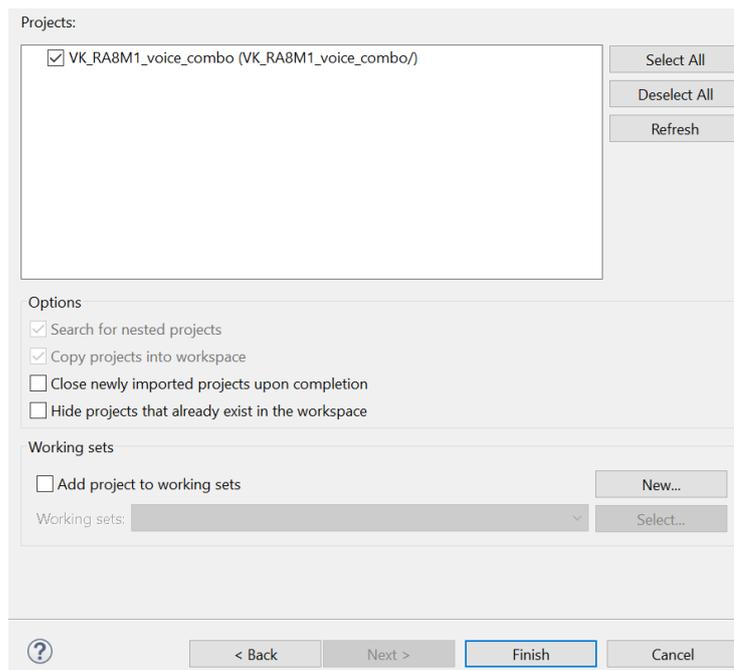
Figure 12. Finishing Importing the Quick Start Guide Project

5.3 Modifying, Generating, and Building the Quick Start Guide Project

This section provides instructions to modify the Voice Combo Demo project. The Voice Combo Demo project can be modified by editing the source code and reconfiguring the properties of the MCU peripherals, pins, clocks, interrupts, and so forth.

Note: The specific modifications that can be made to the Voice Combo Demo project are not prescribed in this QSE. User discretion is advised while modifying the Voice Combo Demo project.

Once Voice Combo Demo project is imported, click the configuration.xml file to open the configurator. The configurator provides an easy-to-use interface to configure the properties of MCU peripherals, pins, clocks, and so forth.
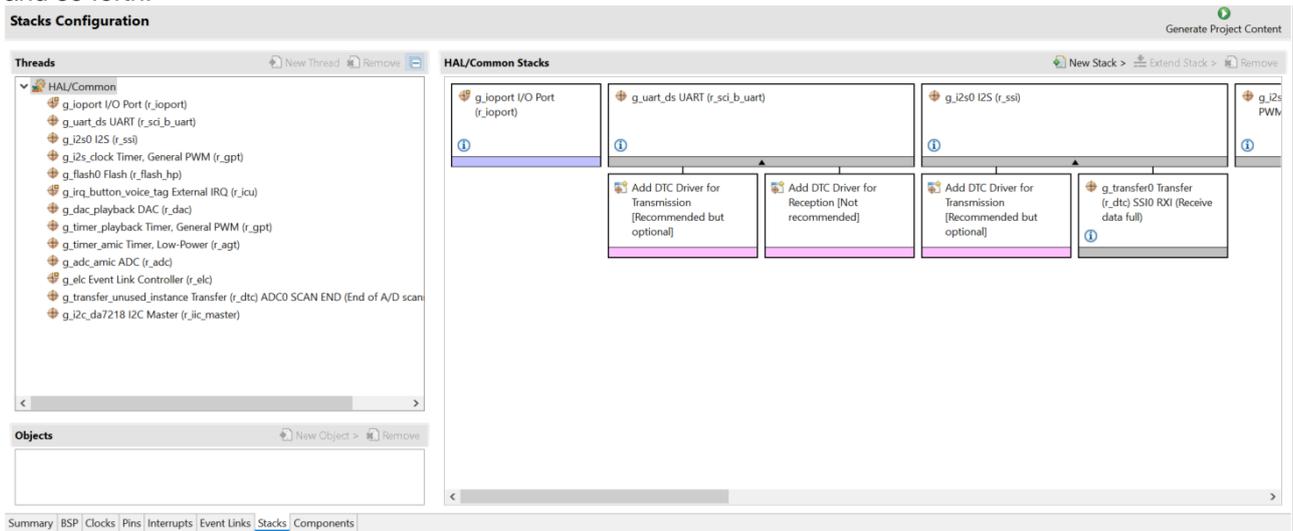

Figure. Opening the Configurator

For example, in the **Stacks** tab of the configurator, the user can click to select modules to modify the configuration settings, as required. The following screen shot illustrates modifying the UART configuration.
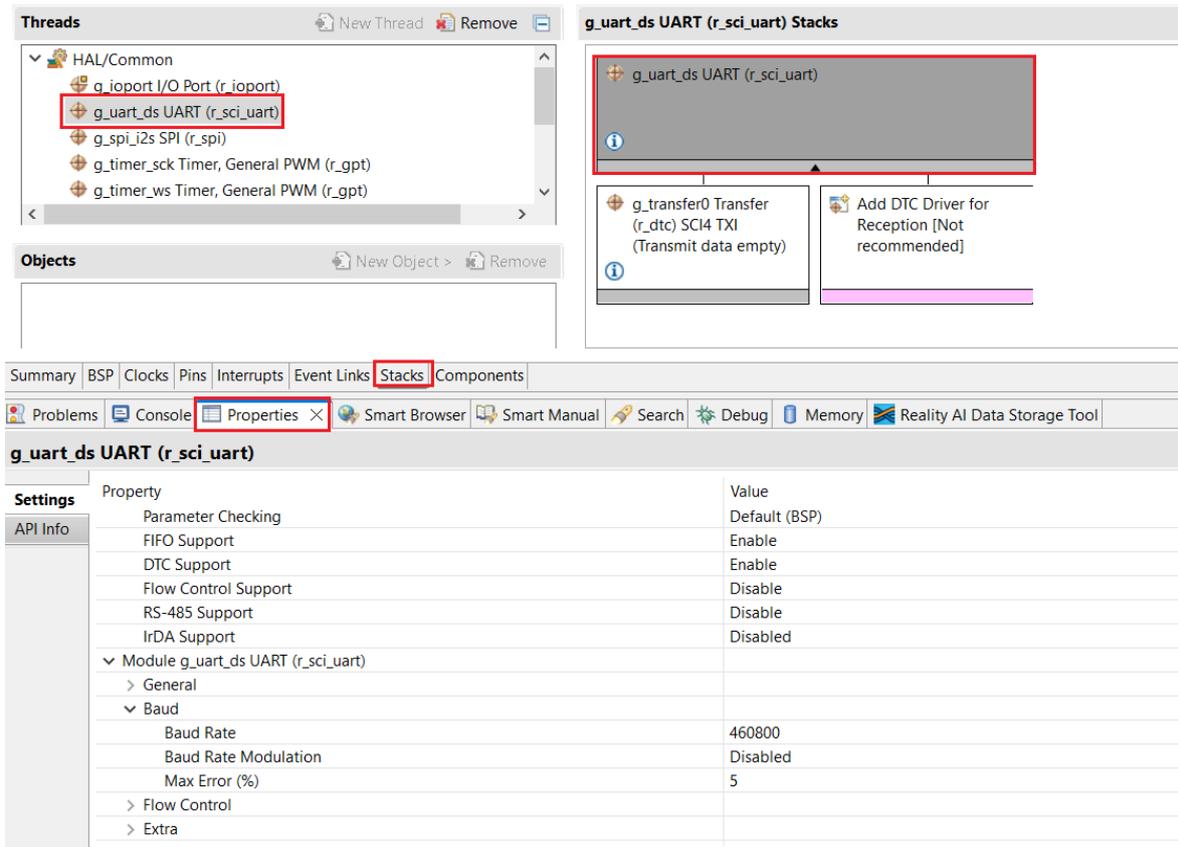
Figure 13. Modifying the Configuration Settings

1. After the desired modifications are made, click **Generate Project**. A dialog box may appear with an option of saving the configuration changes. Click **Proceed**.
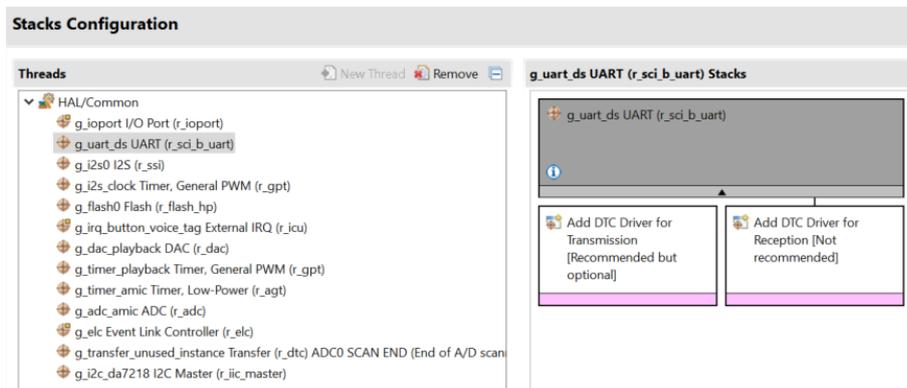

Figure 14. Saving the Configuration Changes

2. Modify the source files in the **/src** folder as needed and save the changes.

3. Build the project by clicking the build icon.
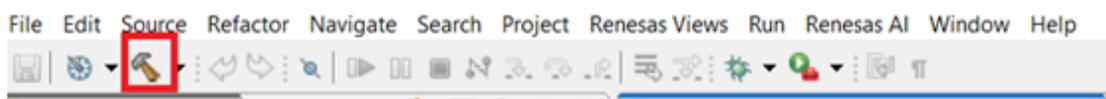
Figure 15. Building the Project

4. A successful build produces an output as follows.

```
CDT Build Console [VK_RA8M1_voice_combo]
Extracting support files...
12:10:18 **** Incremental Build of configuration Debug_DMic for project VK_RA8M1_voice_combo ****
make -r -j12 all
arm-none-eabi-size --format=berkeley "VK_RA8M1_voice_combo.elf"
   text    data     bss     dec     hex filename
2015856    1176  602768 2619800   27f998 VK_RA8M1_voice_combo.elf

12:10:18 Build Finished. 0 errors, 0 warnings. (took 544ms)
```

Figure 16. Successful Build Output

5.4 Setting Up Debug Connection between the VK-RA8M1 board and Host PC

To program the modified Voice Combo Demo project on to the VK-RA8M1 board, a debug connection is necessary between the VK-RA8M1 board and host PC.

1. Connect the USB cable in the micro-B USB debug port (J9) of the VK-RA8M1 board.

2. Verify that the debug LED (OB) stops blinking and lights up orange indicating that the J-Link drivers are detected by the VK-RA8M1 board.

Note: The debug LED (OB) continues to blink when J-Link drivers are not detected by the VK-RA8M1 board. In that case, make sure that the VK-RA8M1 board is connected to the host PC through the micro-B USB debug port (J9) and that J-Link drivers are installed on the host PC by checking in the Windows Device Manager (expand **Universal Serial Bus controller**, and locate **J-Link driver**)
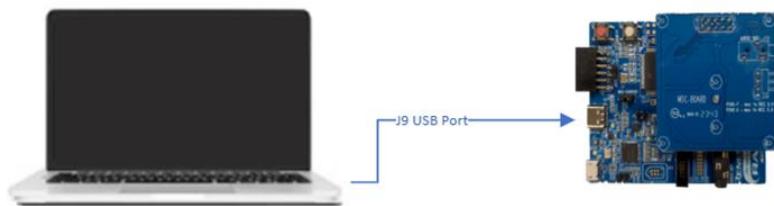
Figure 17. Connecting the VK-RA8M1 Board to the Host PC via USB Debug Port

5.5 Downloading and Running the Modified Quick Start Guide used project

1. In e2 studio, click the drop-down menu for the debug icon, select Debug As option, and choose Renesas GDB Hardware Debugging.
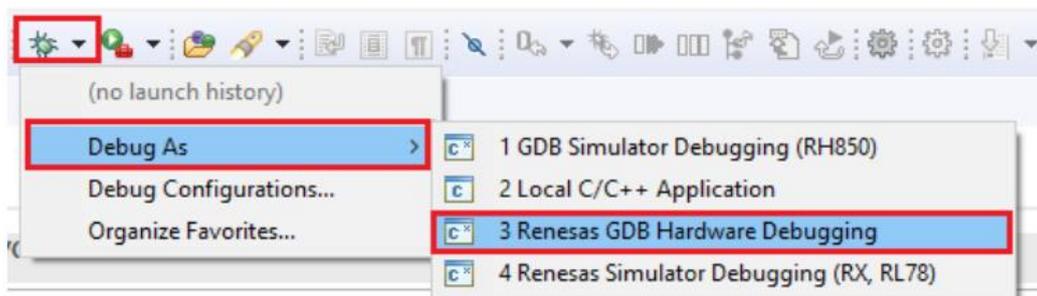

Figure 18. Selecting the Debug Option

2. A dialog box may appear. Click **Yes**.
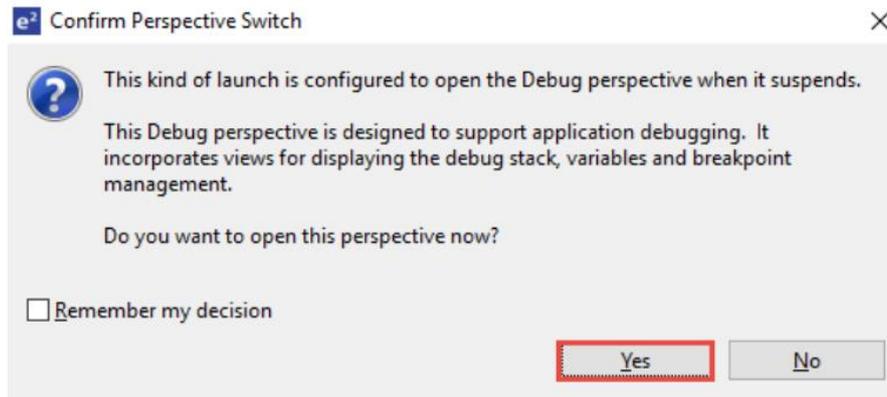
Figure 19. Opening the Debug Perspective

3. Press **F8** or click the **Resume** icon to begin executing the project.
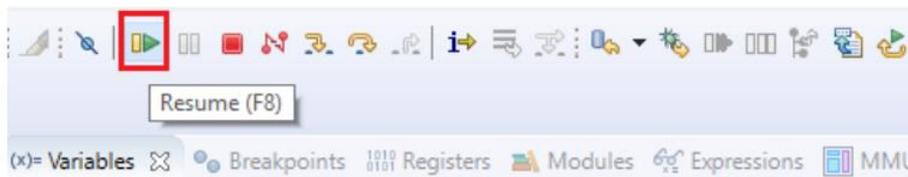
Figure 20. Executing the Project

4. The modified project is programmed into the VK-RA8M1 board and is running. The project can be paused, stopped, or resumed using the debug controls.

6. Next Steps

1. To learn more about the VK-RA8M1 kit, refer to the VK-RA8M1 user's manual and design package available in the Documents and Download tabs respectively of the VK-RA8M1 webpage at renesas.com/VK-RA8M1.

2. Renesas provides several example projects that demonstrate different capabilities of the RA MCUs. These example projects can serve as a good starting point for users to develop custom applications. Example projects (source code and project files) for other kits with RA6E1 are available in the Example Project Bundle and can be reused with VK-RA8M1. The example projects bundle is available in the Downloads tab of MCU Evaluation Kit webpage.

3. To learn how to create a new e2 studio project from scratch, refer to Chapter 2 Starting Development in the FSP User Manual (renesas.com/ra/fsp). To learn how to use e2 studio, refer to the User Manual provided on the e2 studio webpage (renesas.com/software-tool/e-studio)

7. Website and Support

Visit the following URLs to learn about the kit and the RA family of microcontrollers, download tools and documentation, and get support.

VK-RA8M1 Resources	renesas.com/VK-RA8M1
Renesas Artificial Intelligence (AI)	renesas.com/ai
RA Product Information	renesas.com/ra
MCU Evaluation Kit	renesas.com/ra-kits

| RA Product Support Forum | renesas.com/ra/forum |
| Renesas Support | renesas.com/support |

Provide Feedback/ Request a Feature

 Renesas aims to provide the best microcontroller kit experience to help jumpstart customer innovation with RA family of microcontrollers and take products to market faster. The Renesas RA microcontroller kits have been designed with a lot of attention-to-detail and customer-centric thinking at every aspect of design. Renesas aims to exceed customer expectations.

Renesas looks forward to hearing your feedback and knowing how we can enhance your experience. Please share your feedback at renesas.com/ra/kitfeedback

For further information and inquiries, please request a demo from Reality AI | Renesas Electronics

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Revision History

Rev.	Date	Description	
		Page	Summary
1.00	May.04.2025	—	Initial release

VK-RA8M1 Voice Application Combo