Quick Start Guide

# Audio Processing Front(APF) with USB for Voice User Interface Applications

Quick Start Guide

Renesas RA Family
RA6 Series

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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.

# VOICE-RA6E1

## VOICE-RA6E1 – Quick Start Guide

### Contents



### Figures

# 1. Introduction

This Quick Start Guide (QSG) provides:

• An overview of the Quick Start Guide project for the VOICE-RA6E1 board with Audio Processing Frond (APF) and USB

• Instructions for importing, modifying, and building the QSE 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:

1. VOICE-RA6E1 board.
2. MIC-Board
3. Micro USB device cable (type-A male to micro-B male)

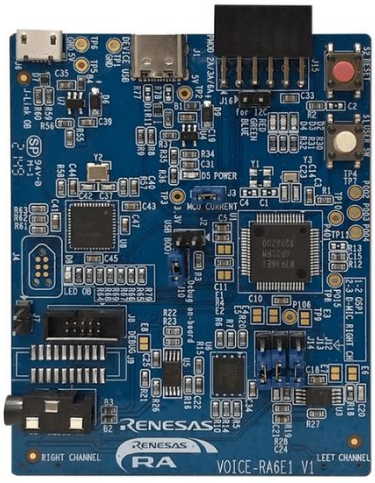


**Figure 1. VOICE-RA6E1 Kit**

# 3. Overview of the Quick Start Guide Project

This QSE is aimed to demonstrate the application of Audio Processing Front (APF) with audio output in the USB type C port(J1). 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

- An ultra-lightweight library of voice processing algorithms designed to enhance the recognition of voice commands
- Sound recordings from microphones via USB type C

The application uses the on-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.

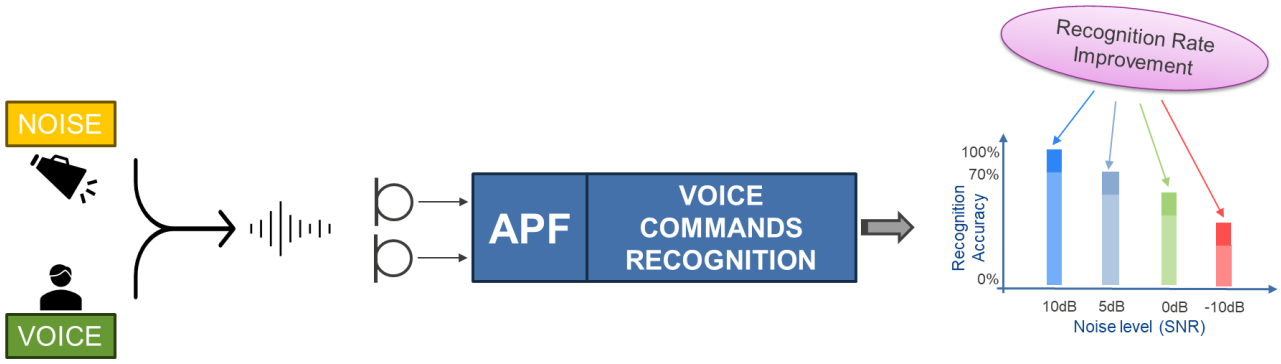


**Figure 2. Recognition Rate improvement with APF**

**Operating Features:**

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

Four-bands single channel noise suppression (NSUPP)

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

# 4. Running the Quick Start Guide Project

This section lists the requirements and instructions to power up the VOICE-RA6E1 board and run the Quick Start Guide project.

**Hardware Requirements**

- VOICE-RA6E1 board
- Micro USB device cable
- USB Type C cable
- A PC with at least 1 USB port

**Software Requirements**

- Windows® 10 operating system
- Audicity (free) or other sound editors can be used

## 4.1 Connecting and Powering Up the VOICE-RA6E1 Board

1. Prior to running the Quick Start Guide project or programming the VOICE-RA6E1 board, default jumper settings must be changed. J12, J13, J14 jumpers must be all short on pin 2-3 to switch to I2S Digital microphone right channel. This will enable both digital microphones on the device.
2. Power up the voice-kit through the micro-B USB port (J6) of the VOICE-RA6E1 board (cable is included). J6 is used for programming the application example.
3. Connect the other end of this cable to the USB port of the host PC. The power LED on the VOICE-RA6E1 board lights up blue, indicating that the VOICE-RA6E1 board is powered on.

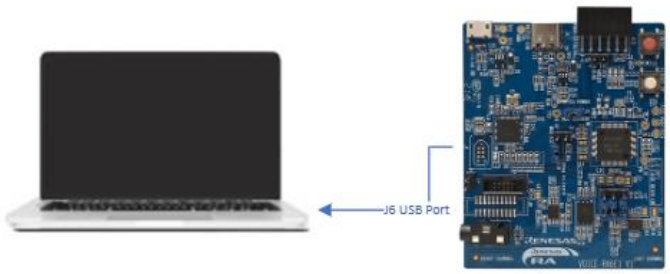


**Figure 3. Connecting the VOICE-RA6E1 Board to the Host PC via USB Debug Port**

4. When ready to start recording data disconnect the micro-B USB port (J6) and connect the voice-kit through the USB type C port (J1) of the VOICE-RA6E1 board.
5. Connect the other end of this cable to the USB port of the host PC. This will enable the option to use USB type C port to get the audio data.

## 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
- RA6E1_VOICE_apf_usb.srec

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

## 4.3 Recording device setup

- Connect Device (J1 Type C port) with the PC
- Open Audacity or similar audio editors
- In Audio Setup choose Microphone USB
- Press “Record” to start recording

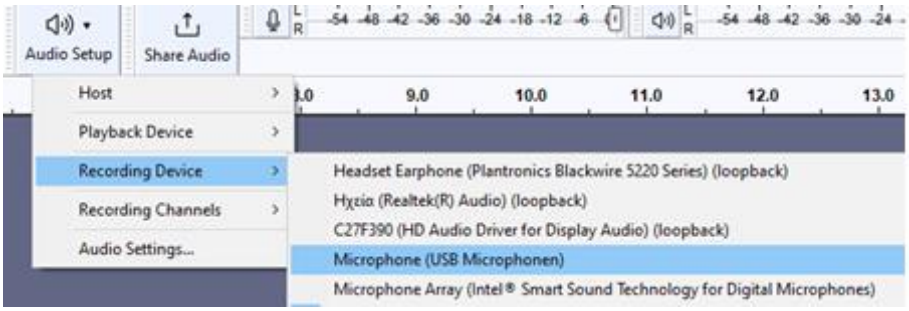


**Figure 4. Recording Device Setup**

## 4.4 Running the Quick Start Guide Project

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

1. On power up or RESET.
2. Board has Noise Suppression ON (NSUPP). Red LED is On

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

3. Start recording the sound you want using Audacity.
4. Press the S1 Button.
5. Board changed state and have broadside Beamformer and Noise Suppression ON (NSUPP). Red LED is On.
6. Start recording the sound you want using Audacity.
7. Press the S1 Button.
8. Board changed state and have endfire Beamformer and Noise Suppression ON (NSUPP). Red and Blue LEDs are On.
9. Start recording the sound you want using Audacity.
10. Press the S1 Button.
11. Board changed state to Bypass, No Beamformer and NSUPP is enabled. Blue LED is On.
12. Start recording the sound you want using Audacity.

**Note: Start Recording before changing state/Pressing S1 button**

**Table 1. Microphone State options**

| State | LEDs |
|---|---|
| Noise Suppression (1 mic) Default setting | Red LED |
| Broadside Beamformer with Noise Suppression (2 mics) | Blue LED |
| Endfire Beamformer with Noise Suppression (2 mics) | Red and Blue LEDs |
| Bypass (No Beamformer \ NSUPP) (1 mic) | LEDs Off |

## 5. Customizing the Quick Start Guide Project

This section lists the requirements and instructions for customizing the VOICE DEMO project.

**Hardware Requirements**

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

**Software Requirements**

- Windows® 10 operating system
- e2 studio IDE
- FSP
- Voice 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) USB project to a local directory on the host PC.
    a. The APF USB Demo project (source code and project files) is available on request.
    b. Download the APF USB 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.

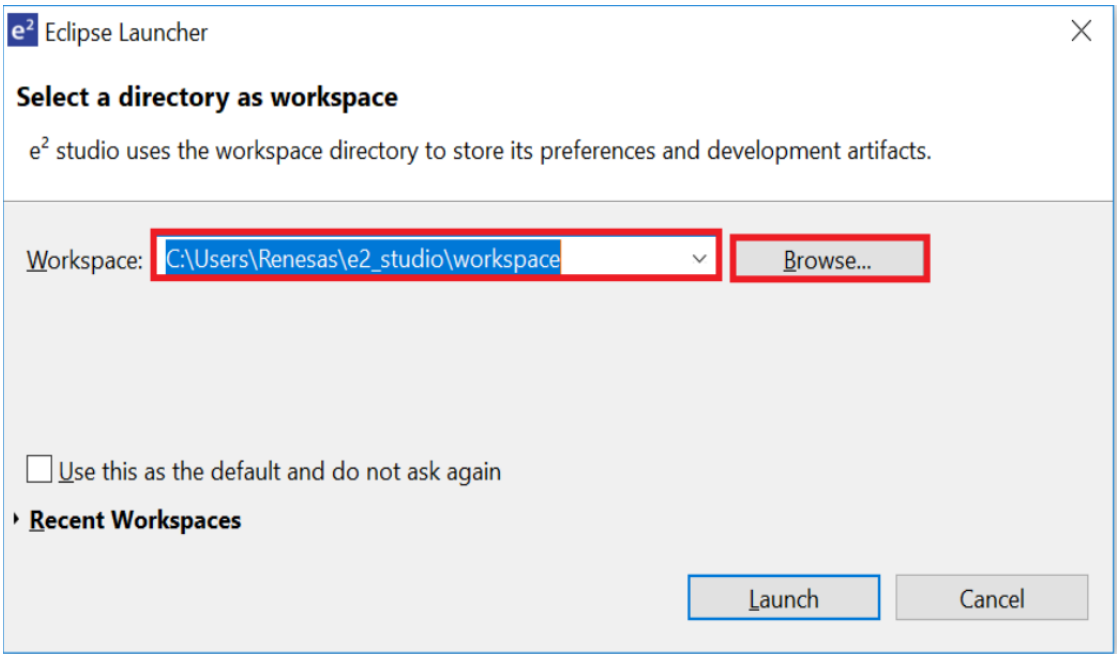


**Figure 5. Creating a New Workspace**

5. Click **Launch.**

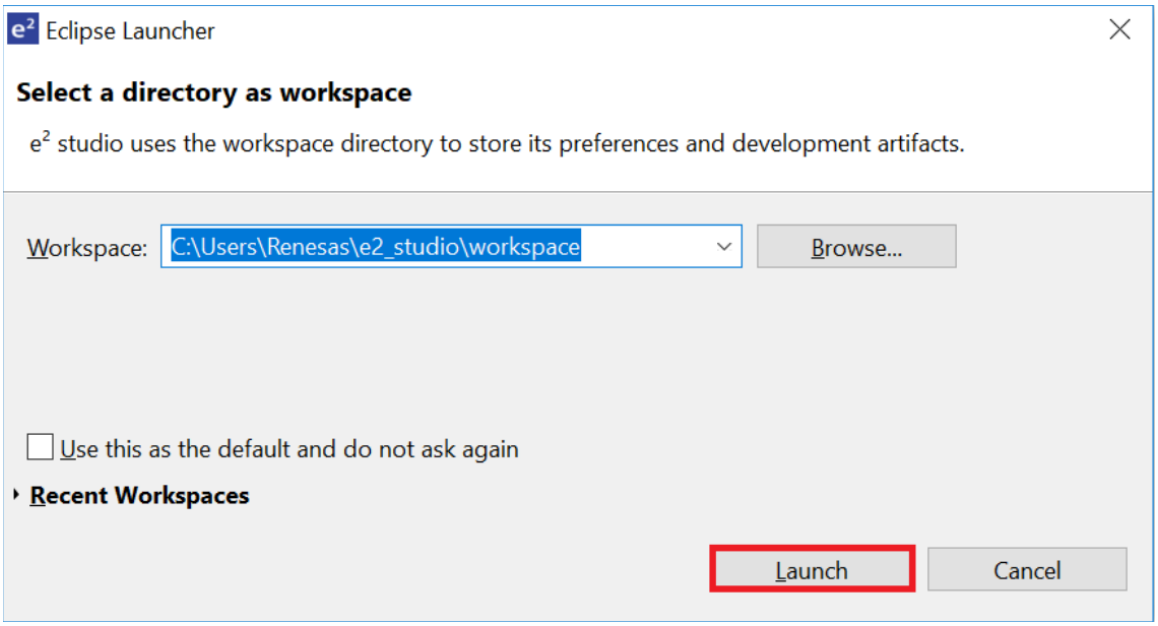


**Figure 6. Launching the Workspace**

6. Click Import from the File drop-down menu.

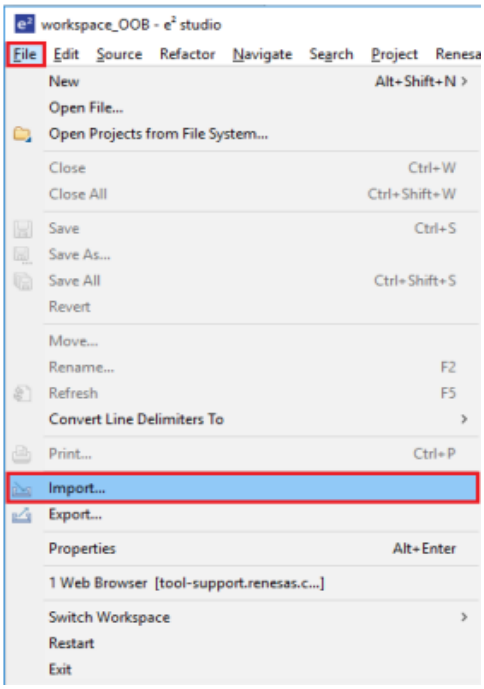


**Figure 7. Importing the Project**

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

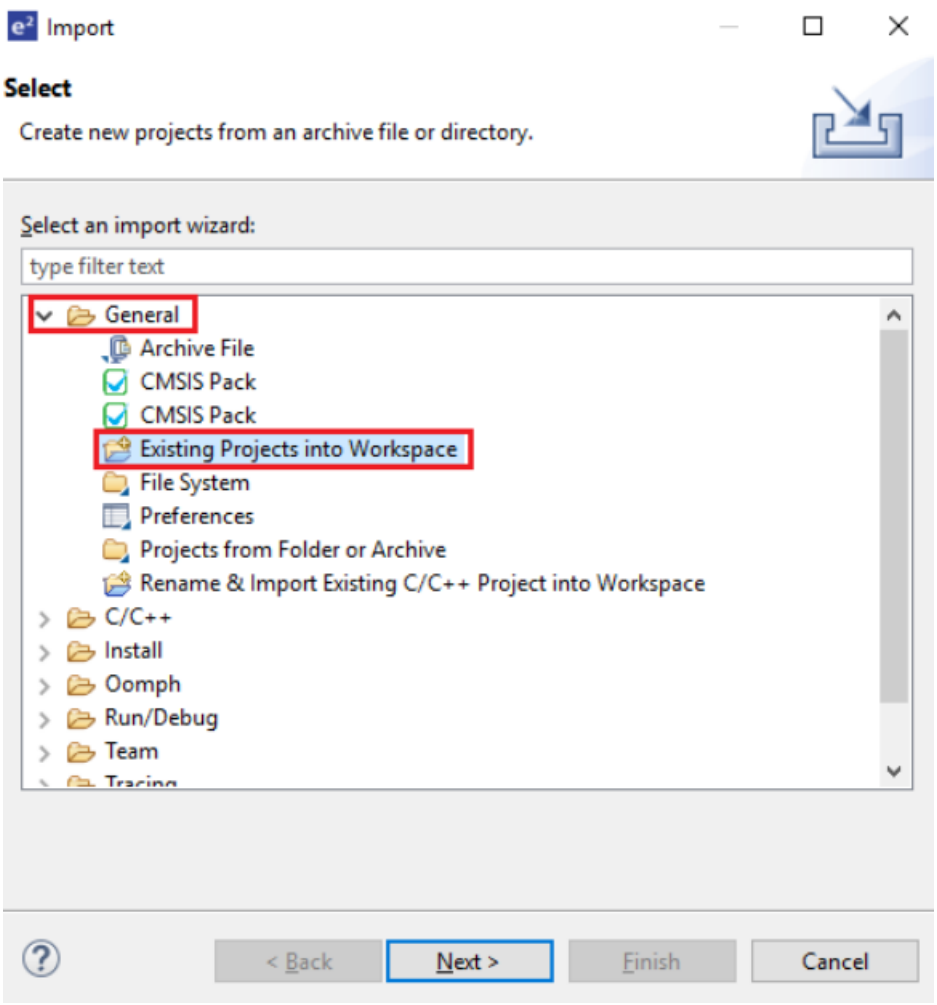


**Figure 8. Importing Existing Projects into the Workspace**

8. Click **Next.**

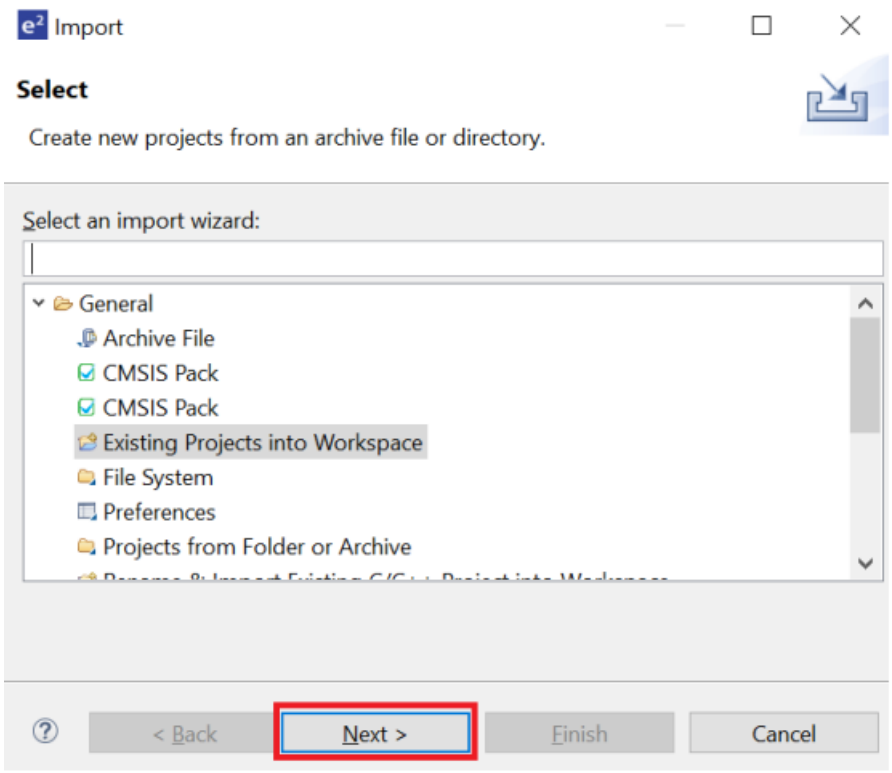


**Figure 9. Clicking Next to Import Existing Projects into the Workspace**

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

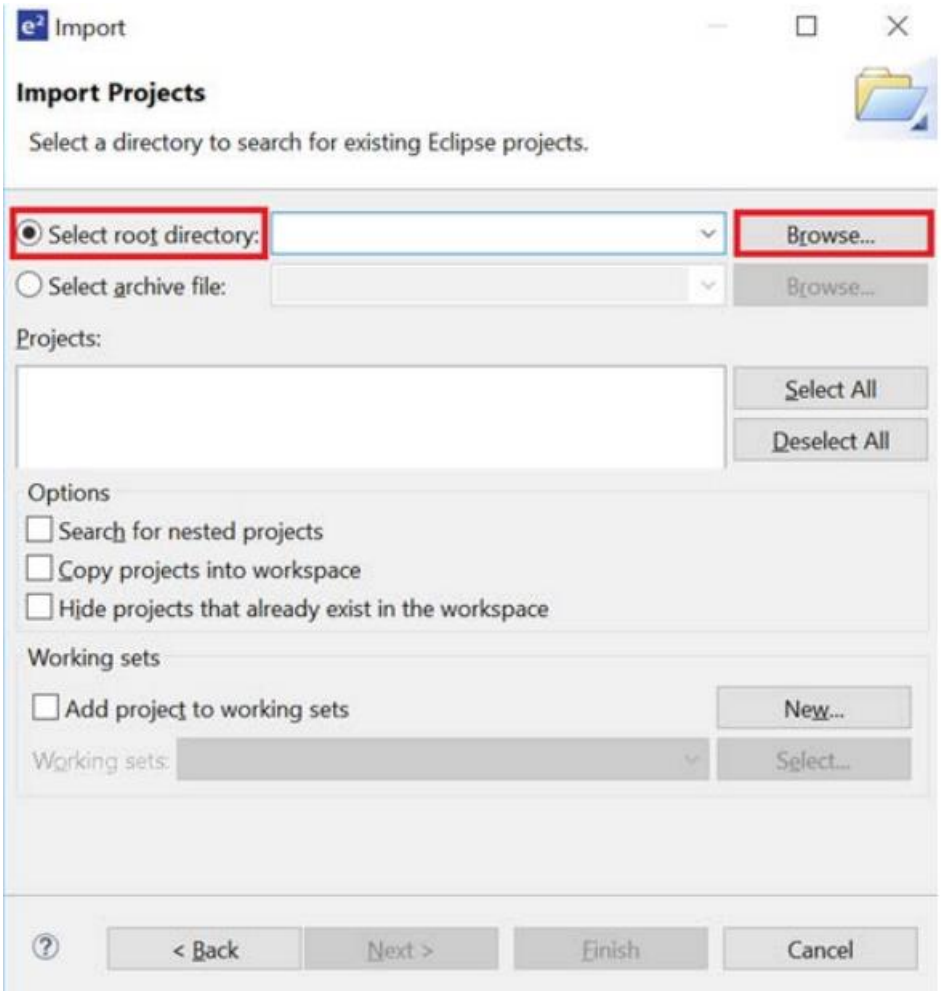


**Figure 10. Selecting the Root Directory**

10. Select the Quick Start Guide project and click **Finish**.

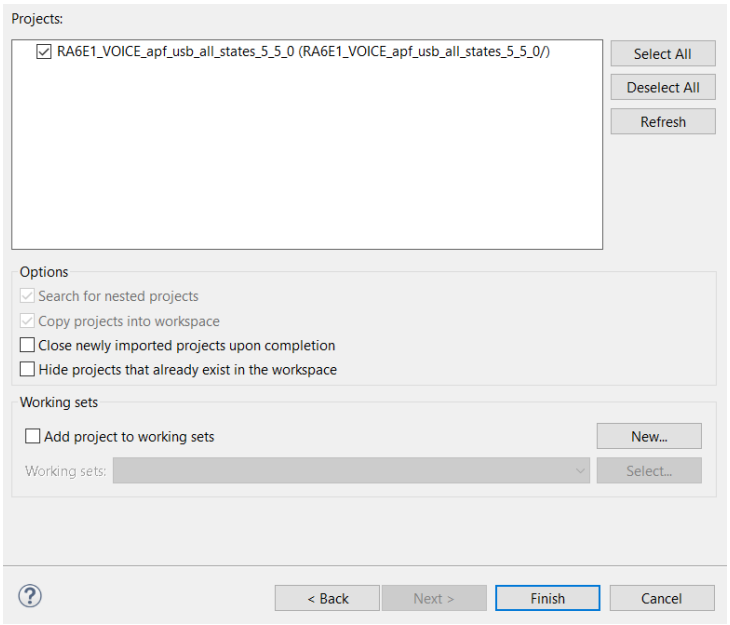


**Figure 11. Finishing Importing the Quick Start Guide Project**

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

This section provides instructions to modify the APF USB DEMO project. The APF USB 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 performed to the APF USB DEMO project are not prescribed in this QSE. User discretion is advised while modifying the APF USB DEMO project.

1. Once APF USB 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.

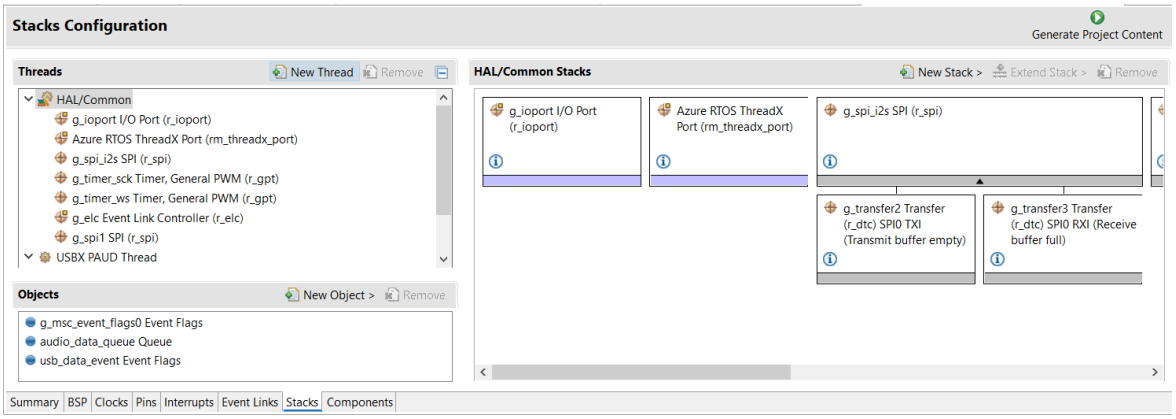


**Figure 12. Opening the Configurator**

2. 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 g_timer configuration.

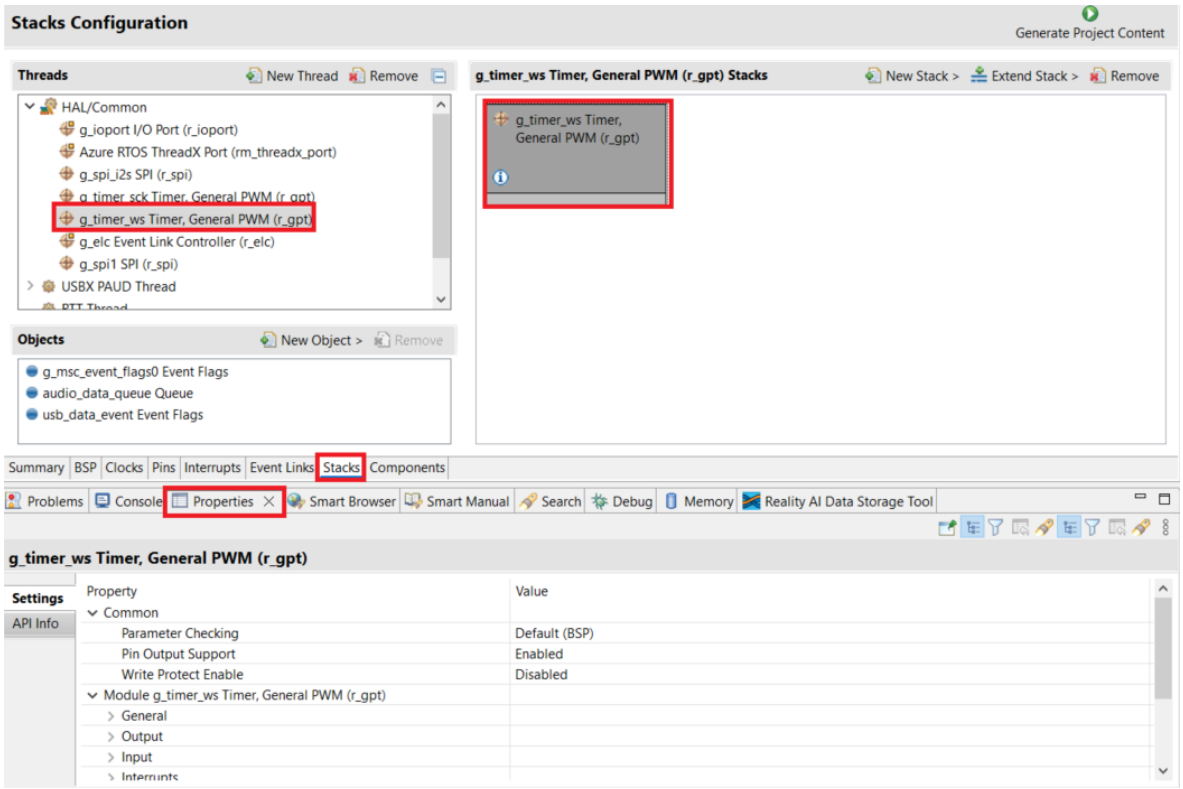


**Figure 13. Modifying the Configuration Settings**

3. After the desired modifications are made, click **Generate Project**. A dialog box may appear with an option of saving the configuration changes. Click **Proceed**.
4. Modify the source files in the **/src** folder as needed and save the changes.
5. Build the project by clicking the build icon.

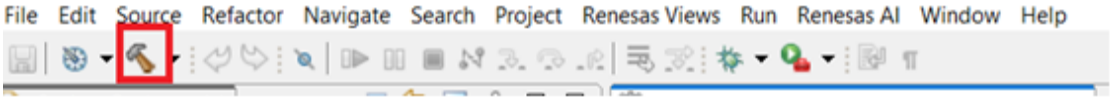


**Figure 14. Building the Project**

6. A successful build produces an output as follows.

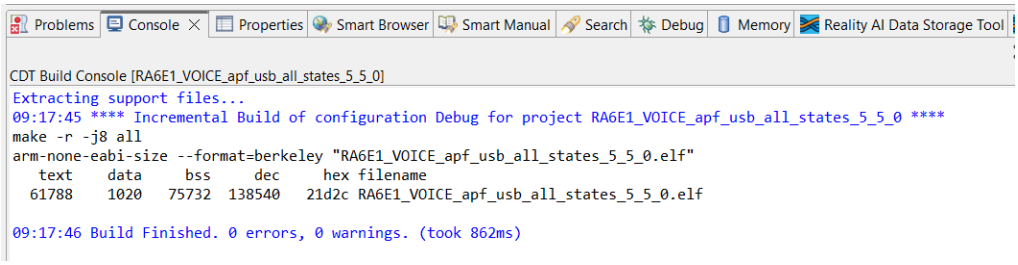


**Figure 15. Successful Build Output**

## 5.4 Setting Up Debug Connection between the VOICE-RA6E1 board and Host PC

To program the modified APF USB DEMO project on to the VOICE-RA6E1 board, a debug connection is necessary between the VOICE-RA6E1 board and host PC.

1. Connect the USB cable in the micro-B USB debug port (J6) of the VOICE-RA6E1 board.
2. Verify that the debug LED (OB) stops blinking and lights up orange indicating that the J-Link drivers are detected by the VOICE-RA6E1 board.

Note: The debug LED (OB) continues to blink when J-Link drivers are not detected by the VOICE-RA6E1 board. In that case, make sure that the VOICE-RA6E1 board is connected to the host PC through the micro-B USB debug port (J6) 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**)

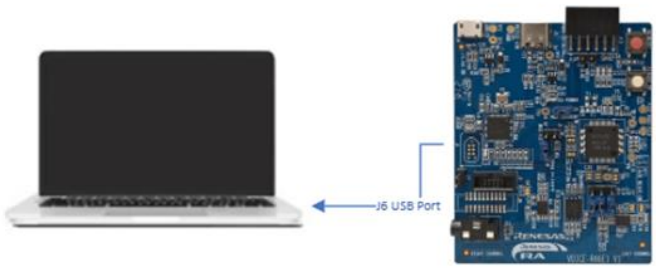


**Figure 16. Connecting the VOICE-RA6E1 Board to the Host PC via USB Debug Port**

## 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.

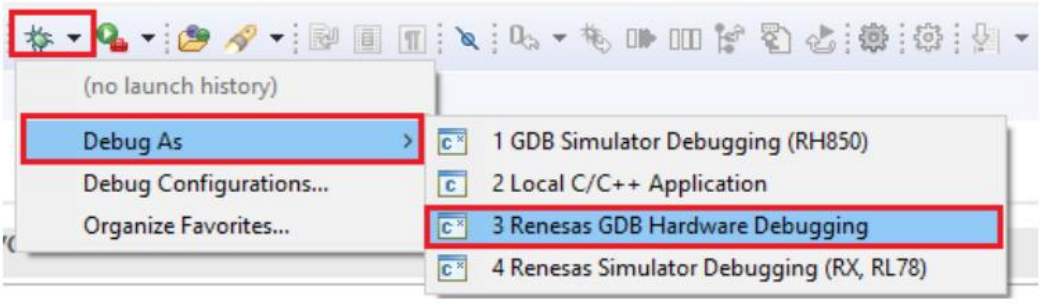


**Figure 17. Selecting the Debug Option**

2. A dialog box may appear. Click **Yes**.

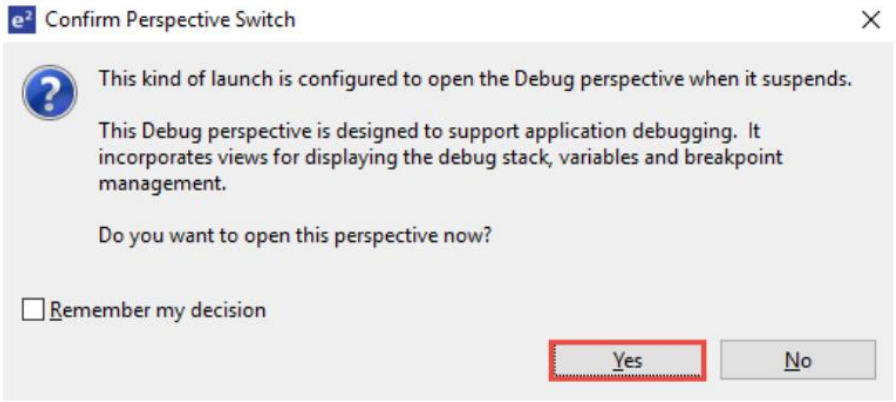


**Figure 18. Opening the Debug Perspective**

3. Press **F8** or click the **Resume** icon to begin executing the project.

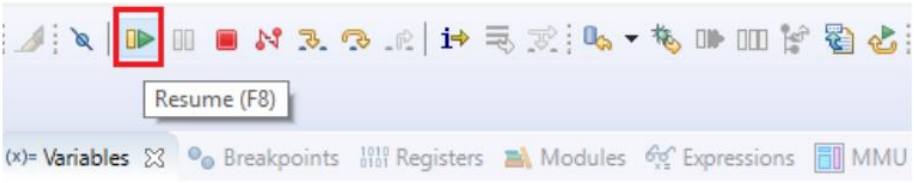


**Figure 19. Executing the Project**

4. The modified project is programmed into the VOICE-RA6E1 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 VOICE-RA6E1 kit, refer to the VOICE-RA6E1 user's manual and design package available in the Documents and Download tabs respectively of the VOICE-RA6E1 webpage at renesas.com/ VOICE-RA6E1.

2. Renesas provides several example projects that Voice 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 VOICE-RA6E1. 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.

| | |
|---|---|
| VOICE-RA6E1 Resources | renesas.com/VOICE-RA6E1 |
| 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

## Revision History

| Rev. | Date | Description | |
|---|---|---|---|
| | | Page | Summary |
| 1.00 | Dec.04.2024 | — | Initial release |

Audio Processing Front (APF) with USB for Voice User Interface Applications

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# Audio Processing Front (APF) with USB for Voice User Interface Applications

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