Renesas ASSP EASY Voice HMI Kit

Based on RISC-V

Introduction

The Renesas ASSP EASY Voice HMI Kit is based on the R9A06G150 RISC-V ASSP.

It is an edge voice recognition development kit designed to be used by Ecosystem Partners, Application Engineers, Field Application Engineers, and for Business Development opportunities.

The primary purpose is to evaluate the functionality of projects developed by Ecosystem Partners, and to facilitate the development of additional partner projects.

The heart of the kit is the QFN 48 pin ASSP device, complemented by a QSPI flash with large data storage capabilities, operational amplifier, audio codec and power devices chosen from the Renesas product portfolio.

The kit enables engineers to easily test and evaluate the performance of the ASSP in a laboratory environment to implement voice driven human machine interfaces, capable of spotting activation keywords and perform audio driven command execution.

It kit can be powered directly from the USB port of a Host PC for demo purpose and includes both analog and digital microphones on-board.

Target Device: R9A06G150

Contents

Figures

Tables

1. Kit Contents

The following components are included in the kit:

1. ASSP EASY voice HMI kit
2. USB device cable (type-A male to type-C male)
3. WIFI dongle (for running Cyberon DSpotter Modeling Tool)

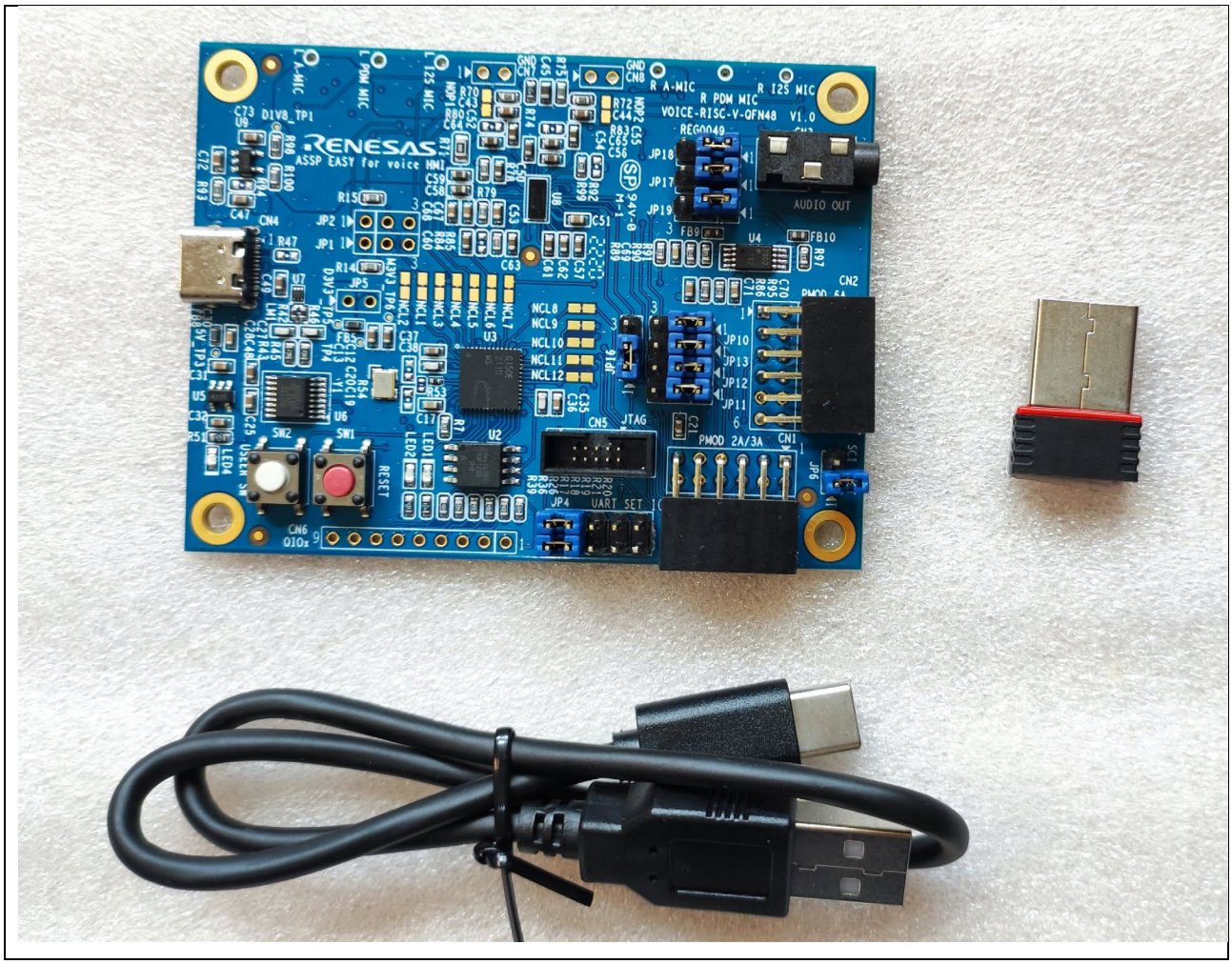

Figure 1. Kit Contents

ASSP EASY voice HMI kit SKU number: **TW001-VUI-RISCVPOCZ**

2. Kit Features

The following interfaces and featured components are included:

Microphones (audio inputs):

- PDM MEMS digital microphones
- 2 MEMS analog microphones
- 2 I2S MEMS digital microphones (optional, not populated on the board)

The distance between each pair of microphones is more than 40mm which is suitable for beamforming applications.

Audio outputs:

- One stereo audio headphone jack supporting mono output on both channels.

External memory:

- **o**ne QSPI flash memory device, Renesas AT25QF128A-SHB-T, 128M-bit (16MB), with support for XIP (eXecute In Place) mode, to be used for storing customer specific audio files and extensions.

Connectors:

- PMOD: two Digilent PMOD connectors: CN1 connector supports UART, SPI configurations. CN2 connector supports I3C configuration.
- Debug: 4-wire standard JTAG and supports Segger J-Link as debug probe.
- USB: USB-C connector(CN4) for power input and 1 virtual COM port for log output.

User inputs and outputs:

- LEDs: three LEDs, LED1 (Red) and LED2 (Green) configurable by the user. LED4 (Blue) is the 3.3V power indicator.
- Buttons: one RESET button (SW1), and one USER button (SW2).

Form Factor: 8 x 6 cm

3. ASSP Feature Support

The RISC-V MCU supports a full array of peripheral functions, especially suited for voice recognition application. The published features of the MCU are listed below. Features highlighted in **BOLD** text are directly supported by the kit hardware for voice recognition applications.

- **RISC-V Andes D25F CPU Core**
  - RISC-V instruction-set architecture (RV32I), support ‘P’ extension (packed SIMD, DSP-like)
  - Maximum operating frequency: 100 MHz
  - Debug port: JTAG
  - Andes Physical Memory Protection unit (Andes PMP) with 16 regions
- **Memory**
  - 256KB code flash memory
  - 16KB data flash memory (100,000 program/erase cycles minimum)
  - 128KB SRAM
  - Standby RAM: 1KB
  - Flash Cache (FCACHE)
  - 128-bit unique ID
- Connectivity

- **Serial Communications Interface (SCI) × 2**
- Serial Peripheral Interface (SPI)
- **Quad Serial Peripheral Interface (QSPI)**
- **I3C bus interface**
- **Serial Sound Interface Enhanced (SSIE) × 2**
- **PDM Interface × 2**
- IrDA interface

■ Analog

- **6 channel 12-bit A/D Converter (ADC12) with 2 sample-and-hold circuits**
- **12-bit D/A Converter (DAC12) × 2**

■ **Timers**

- **General PWM Timer 16-bit (GPT16) × 4**
- Low Power Asynchronous General-Purpose Timer (AGT) × 4

- **System and Power Management**
  - Low power modes
  - Event Link Controller (ELC)
  - Data Transfer Controller (DTC)
  - DMA controller (DMAC) x 8
  - Power-on reset
  - Low Voltage Detection (LVD) with voltage settings
  - Watchdog Timer (WDT)
  - Independent Watchdog Timer (IWDT)
- **Multiple Clock Sources**
  - **Main clock oscillator (MOSC) (8 to 24 MHz)**
  - High-speed on-chip oscillator (HOCO) (16/18/20 MHz)
  - Middle-speed on-chip oscillator (MOCO) (8 MHz)
  - Low-speed on-chip oscillator (LOCO) (32.768 kHz)
  - IWDT-dedicated on-chip oscillator (15 kHz)
  - Clock trim function for HOCO/MOCO/LOCO
  - PLL
  - Clock out support
- **General-Purpose I/O Ports**
  - 5V tolerance, open drain, input pull-up, switchable driving ability
- Operating Voltage
  - VCC: 2.7 to 3.3 V

4. Kit System Block Diagram

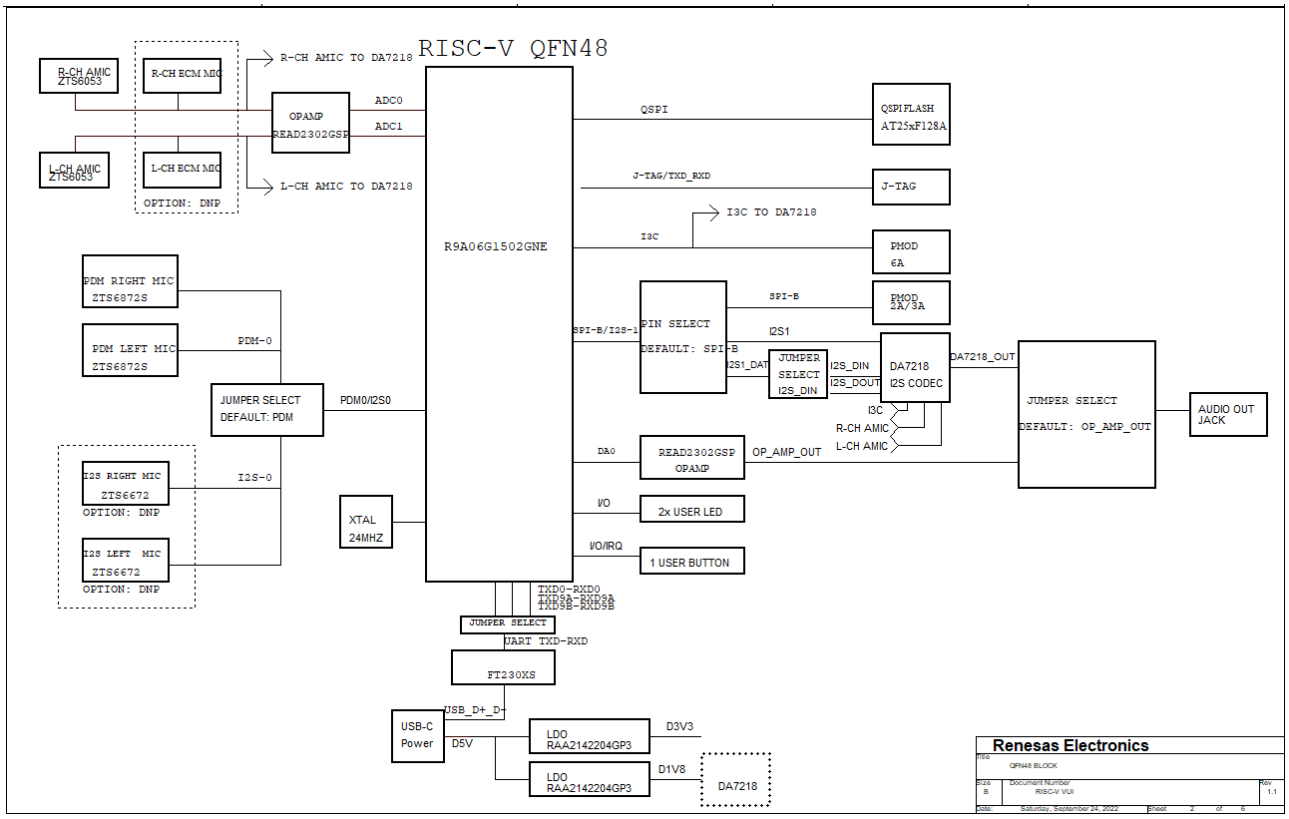

Figure 2. System Block Diagram

5. Jumper Settings

Two types of jumpers are provided on the VOICE-RISC-V board.

1. Traditional pin header jumpers

2. Copper jumpers (trace-cut type and solder bridge type)

5.1 Traditional Pin Header Jumpers

These jumpers are traditional small pitch jumpers that require an external shunt to open/close them. The traditional pin jumpers on the kit are 2.54mm pitch headers and require compatible 2.54mm shunt jumpers.

5.1.1 Default Jumper Configuration

Table 1 lists and describes the traditional pin header jumper setting (JPx designation). Functional details for many of the listed jumpers may be found in sections associated with each functional area of the kits.

Table 1. Default Jumper Settings

Location	Default setting	Function
JP1 JP2	Default not populated	Multiplex for PDM MIC and I2S MIC. JP1 & JP2 default not populated: 1. Short on pin 1-2 switch to PDM MIC.

		2. Short on pin 2-3 switch to I2S MIC. (default not populated) 3. There are R14 & R15 to short between pin 1-2, so it is default switch to PDM MIC, if you want to use I2S MIC, please remove R14 & R15, mount M5 & M6(ZillTek ZTS6672), mount JP1 & JP2, and short on pin 2-3 to switch to I2S MIC.
JP4	Short on pin 1-3 Short on pin 2-4	Selecting for UART port for log output: 1. Short on pin 1-3 & short on pin 2-4 to select RXD0 & TXD0 as log output. 2. Short on pin 3-5 & short on pin 4-6 to select RXD9_B & TXD9_B as log output. 3. Short on pin 7-9 & short on pin 8-10 for SCI boot mode. (Please also short JP6 & then press SW1 reset button to let MCU enter SCI boot mode).
JP5	Default not populated	Labeled with “measure current”, it is for measure RISC-V MCU current, if you want to measure MCU current, please mount JP5 with pin header and remove FB5, then you can serial with a current meter on JP5 to measure RISC-V MCU current.
JP6	Open	SCI boot mode: Please short JP6 & then press SW1 reset button to let MCU enter SCI boot mode.
JP10 JP11 JP12 JP13	All short on pin 1-2	Multiplex for PMOD 2A/3A(CN1) and DA7218 Audio CODEC: 1. Short on pin 1-2 switch to PMOD 2A/3A(CN1) function. 2. Short on pin 2-3 switch to DA7218 Audio CODEC.
JP16	Short on pin 1-2	Select RISC-V Serial Sound Interface (SSI) data transmission direction: Short on pin 1-2, the I2S data is RISC-V to DA7218. Short on pin 2-3, the I2S data is DA7218 to RISC-V.
JP17 JP18 JP19	All short on pin 1-2	Multiplex for Audio out from READ2302GSP OPAMP or DA7218 Audio CODEC: 1. Short on pin 1-2, Audio out come from READ2302GSP OPAMP. 2. Short on pin 2-3, Audio out come from DA7218 Audio CODEC.

5.2 Copper Jumpers

Copper jumpers have two types, designated NCLx(Normal Closed) and NOPx(Normal Opened).

The trace-cut jumper is Normal Closed, which provided with a narrow copper trace connecting between its pads. The silk screen overlay printing around a trace-cut jumper is a solid box. To isolate the pads, cut the trace between pads adjacent to each pad, then remove the connecting copper foil either mechanically or with the assistance of heat. Once the etched copper trace is removed, the trace-cut jumper is turned into a solder-bridge jumper for any later changes.

A solder-bridge jumper is Normal Opened, which provided with two isolated pads that may be joined together by one of three methods:

- Solder may be applied to both pads to develop a bulge on each and the bulges joined by touching a soldering iron across the two pads.
- A small wire may be placed across the two pads and soldered in place.
- A SMT resistor, size 0603, or 0402, may be placed across the two pads and soldered in place. A zero-ohm resistor shorts the pads together.

For any copper jumper, the connection is considered closed if there is an electrical connection between the pads (default for trace-cut jumpers.) The connection is considered open if there is no electrical connection between the pads (default for the solder-bridge jumpers.)

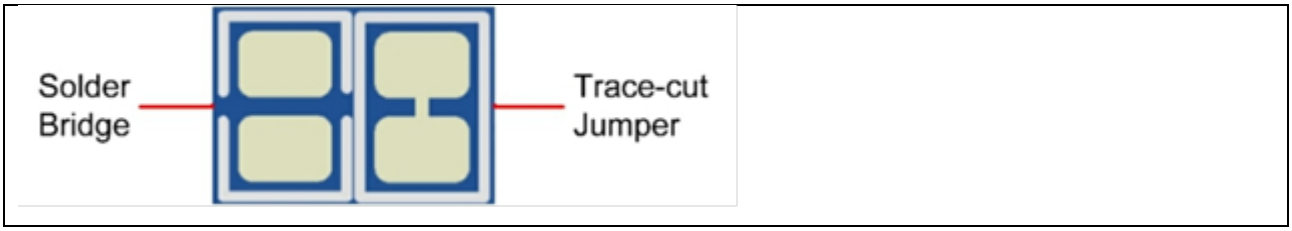

Figure 3. Copper Jumpers

Table 2. Default Copper Jumper Settings

Location	Default Open/Closed	Function
NCL1	Closed	SSILRCK0/SSIFS0/PDM_DATA0
NCL2	Closed	SSIBCK0/PDM_CLK0
NCL3	Closed	CN2-10, PMOD 6A, GPIO4
NCL4	Closed	I2S microphone data input
NCL5	Closed	ADC2, Analog microphone left channel
NCL6	Closed	ADC3, Analog microphone right channel
NCL7	Closed	DAC out to READ2302GSP OPAMP, audio output
NCL8	Closed	CN5, J-LINK TCK signal
NCL9	Closed	RTS_CTS9_B/SSLA0_B/SSILRCK1/SSIFS1
NCL10	Closed	SCK9_B/RSPCK_B/SSIDATA1
NCL11	Closed	RXD9_B/MISO_B/SSIBCK1
NCL12	Closed	TXD9_B/MOSI_B/AUDIO_CLK1
NCL13	Closed	Right channel analog microphone signal
NCL14	Closed	Left channel analog microphone signal
NOP1	Opened	For external ECM analog microphone left channel
NOP2	Opened	For external ECM analog microphone right channel

6. MCU Port Mapping

Here are the port and pin assignments for the kit.

Table 3. MCU Port Assignments

Port	Assigned Function(s)
P000	CN2, PMOD 6A, GPIO4
P001	I2S microphone data input
P002	ADC2, Analog microphone left channel
P003	ADC3, Analog microphone right channel
P100	For PMOD or DA7218, select by JP10
P101	For PMOD or DA7218, select by JP13
P102	For PMOD or DA7218, select by JP12
P103	For PMOD or DA7218, select by JP11
P104	To CN1, PMOD 2A/3A, pin 7, IRQ9
P105	To CN2, PMOD 6A, pin7, IRQ8
P106	QSPI CLK for QSPI flash
P107	QSPI_CS for QSPI flash
P108	QSPI DQ0 for QSPI flash
P109	QSPI DQ1 for QSPI flash
P110	QSPI DQ2 for QSPI flash
P200	NMI, pull-high with 10K
P201/MD	Boot Mode, The RISC-V enter SCI boot mode if the MD pin is held low when release the reset signal, it can be downloaded code to RISC-V MCU by Renesas Flash Programmer.
P202	LED1, user LED, red color
P203	LED2, user LED, green color
P204	CN2, PMOD 6A, pin 1
P205	SW2, user switch, IRQ12
P206	RXD0 for UART log and also connect to CN2 PMOD 6A, pin 9 as GPIO
P207	TXD0 for UART log and also connect to CN2 PMOD 6A, pin 8 as GPIO
P208	CN2, PMOD 6A, pin4, I3C SDA signal, also connect to DA7218
P209	CN2, PMOD 6A, pin3, I3C SCL signal, also connect to DA7218
P212/EXTAL	Connect to 24MHz crystal, for Main clock oscillator
P213/XTAL	Connect to 24MHz crystal, for Main clock oscillator
P400	PDM DATA input or I2S LR clock, select by JP2
P401	PDM CLOCK output or I2S BCLK, select by JP1
P402	Connect to CN1, PMOD 2A/3A, pin 9, as GPIO2
P403	Connect to CN1, PMOD 2A/3A, pin 10, as GPIO3

7. Implementation Details

Here are the implementation details for the supported features.

7.1 PMOD

A total of 2 PMOD connectors are included. These two PMOD connections should be available simultaneously and be configured independently. CN1 is PMOD type 2A/3A connectors (2x6 pin, dual row, right angle socket).

Table 4. PMOD 2A/3A Port Assignments (CN1)

MCU Port	PMOD Type 2A Signal (SPI)	PMOD Type 3A Signal (UART)	CN1 PMOD connector Pin
P100	SPI_SS		1
P103	MOSI	TXD	2
P102	MISO	RXD	3
P101	SPI_SCK		4
	GND	GND	5
	+3.3V	+3.3V	6
P104	INT	INT	7
P201	GPIO	GPIO	8
P402	GPIO	GPIO	9
P403	GPIO	GPIO	10
	GND	GND	11
	+3.3V	+3.3V	12

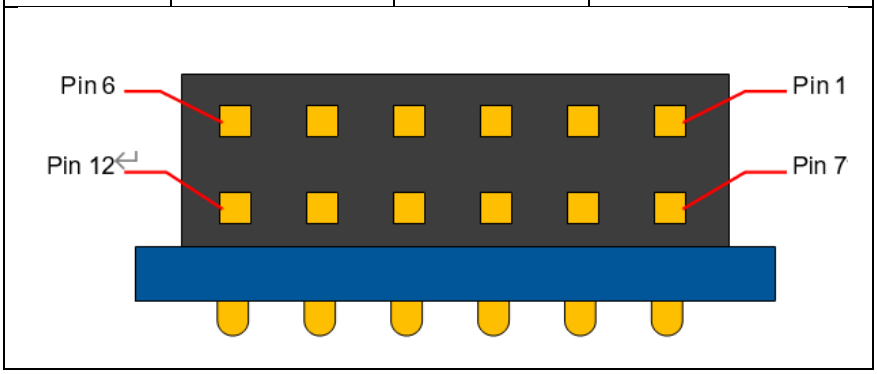

Figure 4. PMOD connector

CN2 is PMOD type 6A connectors (2x6 pin, dual row, right angle socket).

Table 5. PMOD 6A Port Assignments (CN2)

MCU Port	PMOD Type 6A Signal (I3C)	CN2 PMOD connector Pin
P204		1
P103		2
P209	SCL	3
P208	SDA	4
	GND	5
	+3.3V	6
P105	INT	7
P207	GPIO	8
P206	GPIO	9
P000	Input only	10
	GND	11
	+3.3V	12

7.2 Microphones

This board includes a pair of analog MEMS microphones (M1 & M2, ZillTek ZTS6053), these 2 analog microphone signals are amplified by the Renesas READ2302GSP OPAMP, then fed to the ASSP ADC channels 2 & 3.

The pair of digital PDM MEMS microphone (M3 & M4, ZillTek ZTS6872S), are connected to the ASSP PDM interface channel 0. The physical distance between each pair microphones is large than 40mm for support beamforming applications.

This board also can connect 2 external ECM analog microphone on CN7 & CN8. To switch to using analog microphones, please refer to the schematic: mount CN7 & CN8, cut NCL13 & NCL14, short NOP1 & NOP2.

This board can also optionally support 2 I2S MEMS digital microphones (M5 & M6, ZillTek ZTS6672). To switch using I2S MIC remove R14 & R15, mount M5 & M6(ZillTek ZTS6672), mount JP1 & JP2, short on pin 2-3.

Table 6. Analog MEMS Microphone left channel (M1) and right channel (M2) Port Assignments

Left channel (M1)		Right channel (M2)	
MCU Port	**MEMS microphone Pin**	**MCU Port**	**MEMS microphone Pin**
P002	1 – OUT	P003	1 – OUT
	2 – GND		2 – GND
	3 – GND		3 – GND
	4 – GND		4 – GND
	5 – VDD		5 – VDD

Table 7. Digital I2S MEMS Microphone (M5 & M6) Port Assignments

MCU Port	SSIE Signal	MEMS microphone Pin (M5 & M6)
P400	SSILRCK0	1 – LRC (Word Select)
		2 – SELECT M5 connect to GND for left channel M6 connect to 3.3V for right channel
	GND	3 – GND
P401	SSIBCK0	4 – BCLK
	3.3V	5 – VDD
P001	SSIDATA0	6 – DATA
		7 – CONFIG

7.3 Audio out

A stereo headphone jack is connected to the MCU DAC. The DAC signals are connected through an OPAMP. The device is Renesas READ2302GSP, in TSSOP8 packages.

Table 8. Headphone Jack Pin Assignments

MCU Port	Audio out Signal	Headphone Jack Pin(CN3)
DA0_A	VOUT1	1 (Sleeve)
	VOUT2	2 (Mono signal)
	VOUT2	3 (Mono signal)

7.4 LEDs

2 user LED are included on the board and are connected to the MCU I/O. These are Red, Green and can be used for any user defined functions.

Table 9. User LED Port Assignments

MCU Port	Connected User LED
P202	Red (LED1)
P203	Green (LED2)

LED4 (blue) is power indicate LED.

7.5 Buttons

There are two mechanical push-button switches on the board. One button is for system/MCU reset (SW1). The second button is a user programmable button (SW2).

Table 10. User Button Port Assignment (SW2)

MCU Port	User Button Interrupt
P205	IRQ12

7.6 Debug

The VOICE-RISC-V board supports 10 pin J-LINK debug port with JTAG interface. Here under are pin definition.

Table 11. 10-pin JTAG Connector (CN5)

Pin	JTAG Pin Name	Signal/Bus
CN5-1	Vtref	+3V3
CN5-2	TMS	P301
CN5-3	GND	GND
CN5-4	TCK	P300
CN5-5	GND	GND
CN5-6	TDO	P302
CN5-7	Key	N.C.
CN5-8	TDI	P303
CN5-9	GND Detect	GND
CN5-10	nSRST	RESET#

7.7 Power

5V is supplied from USB TYPE-C connector (CN4).

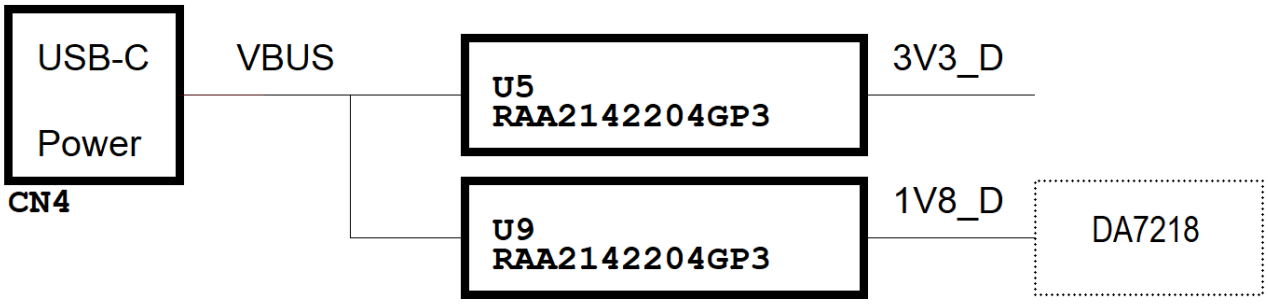

Figure 5. VOICE-RISC-V Power Block Diagram

7.8 USB

This board includes one USB TYPE-C connector (CN4) for supply 5V and virtual COM port.

Table 12. USB Type-C Signal Assignments (CN4)

USB FS Signal	USB-C Signal Name	USB-C Connection
GND	GND	A1
N.C.	TXp1	A2
N.C.	TXn1	A3
VBUS1	VBUS	A4
N.C.	CC1	A5
USB1_P	DP1	A6
USB1_N	DN1	A7
N.C.	SBU1	A8
VBUS1	VBUS	A9
N.C.	RXN2	A10
N.C.	RXP2	A11
GND	GND	A12
GND	GND	B1
N.C.	TXP2	B2
N.C.	TXN2	B3
VBUS1	VBUS	B4
N.C.	CC2	B5
USB1_P	DP2	B6
USB1_N	DN2	B7
N.C.	SBU2	B8
VBUS1	VBUS	B9
N.C.	RXN1	B10
N.C.	RXP1	B11
GND	GND	B12

7.9 Certifications

To support international distribution, the following certification requirements are met, both by design and test.

Americas: FCC Class B

Europe: CE Class B

Revision History

Rev.	Date	Description	
		Page	Summary
1.0	October, 2022		Initial release

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(Rev.5.0-1 October 2020)

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