RZ/V2H Robotic Development Kit User Manual

Release 0.1

Renesas Electronics Corporation

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CHAPTER

ONE

GETTING STARTED

1.1 Overview

WS125 Robotic Development Kit is a solution with Renesas new generation RZ/V2H MPU for AI application, which has AI inference processing performance of up to 80TOPS with multi-core CPU to run multiple OS simultaneously for high performance AI image processing.

It is also equipped with many interfaces that make it suitable for development and integration into a variety of robotic applications.

1.1.1 Software Environment

Category	Description
OS Support	Yocto 5.1 (Styhead) and Ubuntu 24.04 (available in headless and LXDE versions).
ROS 2 Distribution	ROS 2 Jazzy

1.1.2 Hardware Environment

Items	Description
RZ/V2H	• **CPU** – 4 × Arm Cortex-A55 (1.8GHz) – 2 × Arm Cortex-R8 (800MHz) – 1 × Arm Cortex-M33 (200MHz) • **DRP** – Vision/Dynamically Reconfigurable Processor • **DRP-AI** – Hardware AI Accelerator (8 dense TOPS, 80 sparse TOPS) • **Package** – R9A09G057H44GBG: 1368-pin FCBGA
Memory	LPDDR4 1600MHz (8GB) × 2
SD Card	64GB SanDisk
QSPI Flash ROM	64MB
Interfaces	• DC Jack (12–24V / 2A) • JTAG (10-pin) • MIPI CSI-2 4-Lane ×2 (22-pin / 0.5mm) • HDMI • USB3.2 Type-A ×2 • USB Micro-B (SCIF) • 10/100/1000 Base-T RJ45 • Micro SD • PCIe 3.0 Root Complex (16-pin / 0.5mm) • CAN-FD ×2 • 40-pin RasPi GPIO Header

For more details about RZ/V2H RDK's specification, visit the WS125 Robotic Development Kit Hardware Manual.

RZ/V2H RDK Board Image View:

The following image shows the top/bottom view of the RZ/V2H Robotics Development Kit (RDK) board, highlighting its main connectors and interfaces.

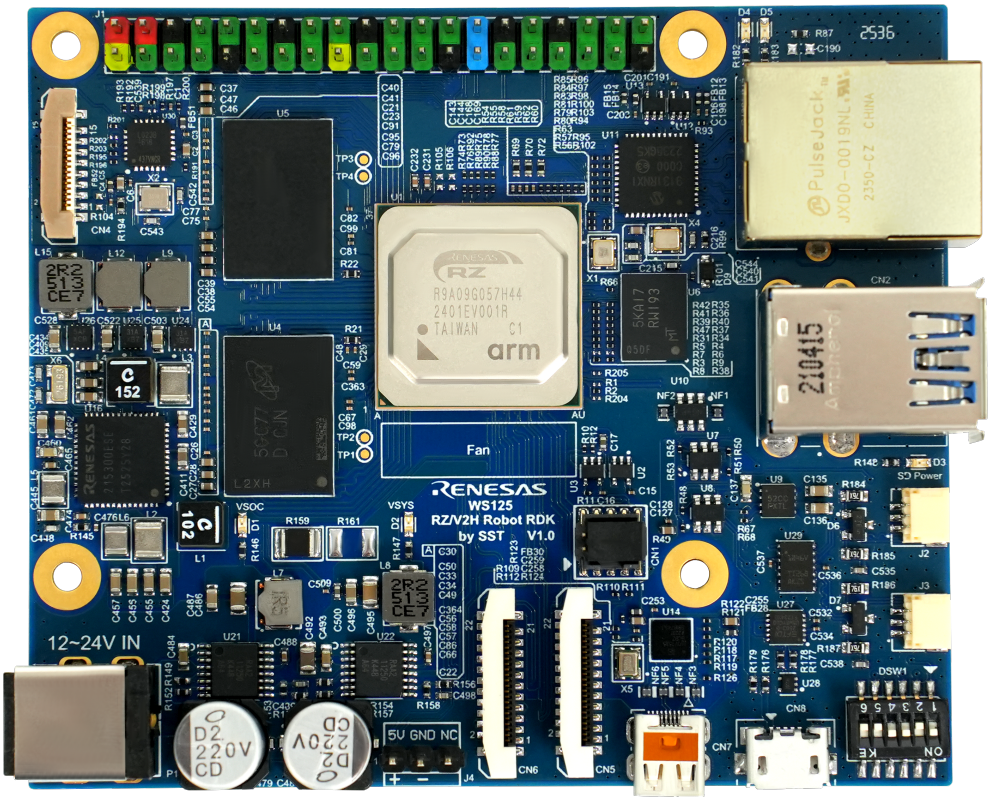

Fig. 1: RZ/V2H RDK Board Top View

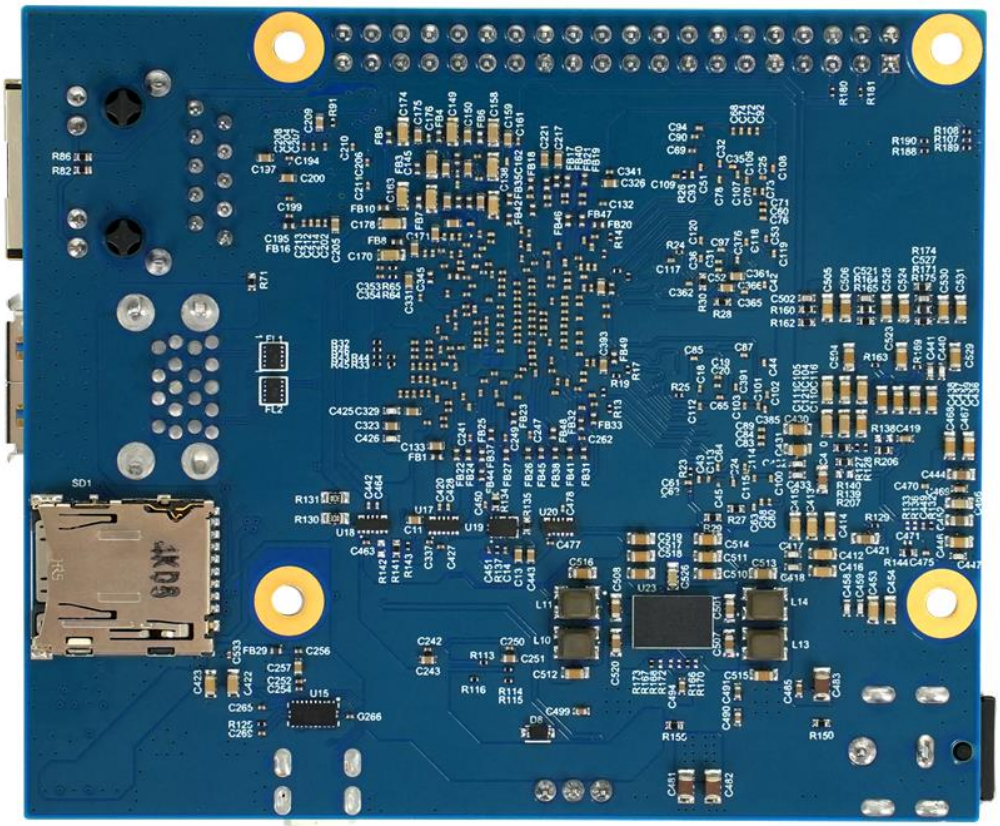

Fig. 2: RZ/V2H RDK Board Bottom View

1.2 Quick setup guide

This quick start guide focuses on booting the board using a **microSD card**, which is the most straightforward method.

Other advanced boot methods, such as **xSPI flash**, are also supported.

The **TFTP + NFS boot** method is supported as well but is not covered in detail here.

1.2.1 Preparing the SD Card

To boot the RZ/V2H RDK board using a microSD card, you must first flash a bootable Linux image onto it.

Requirements

- **Balena Etcher:** GUI-based tool to flash image
- **microSD card:** at least 16 GB recommended
- **Provided bootable Linux images:**

File name	Target OS	Host platform support
ubuntu-lxde-image.wic.gz	Ubuntu 24.04 with GUI LXDE support	Windows / macOS / Linux
ubuntu-core-image.wic.gz	Ubuntu 24.04 headless	Windows / macOS / Linux

Flash using Balena Etcher

Balena Etcher is a user-friendly GUI tool to flash OS images to SD cards and USB drives. It provides a simple and safe method.

1. **Install Balena Etcher**

   Download and install the software from the Balena Etcher Official Website.

2. **Flashing the Image**

   - Once Etcher is open:

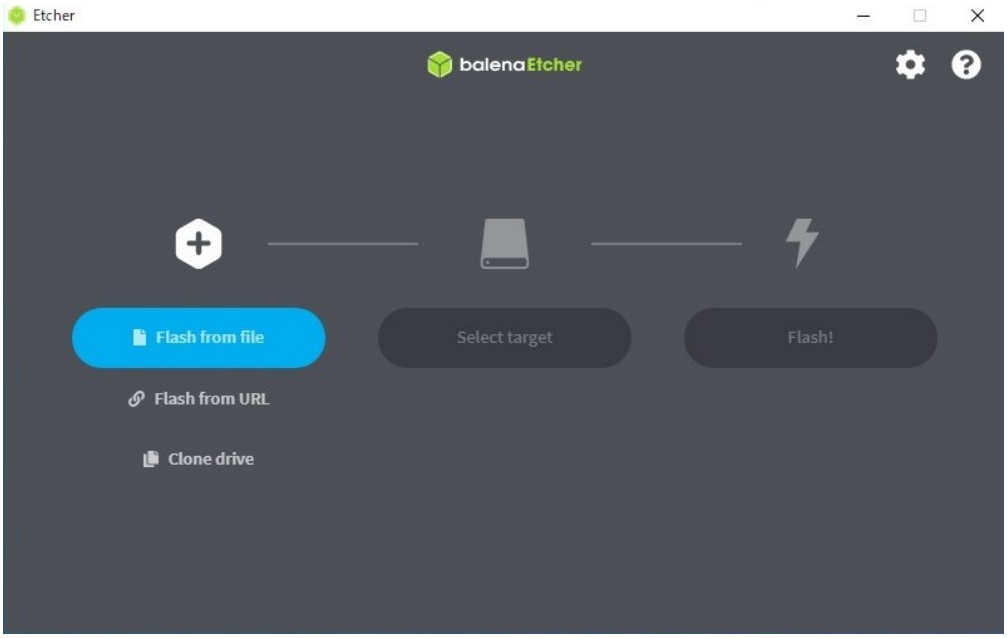

Fig. 3: Balena Etcher Application

   - **Select Image:** Click "Flash from file" and choose your image file (e.g., ubuntu-lxde-image.wic.gz)
   - **Select Target:** Insert your SD card into the host machine and choose the correct device.

> **Note**
>
> Please confirm the SD card device name carefully. Double-check to avoid overwriting your main disk.

   - **Flashing:** Click "Flash" to begin. Etcher will:
     - Write the image
     - Validate the image
     - Automatically unmount the SD card
   - **Finish:** Remove the SD card safely after Etcher reports successful completion.

1.2.2 Boot Mode Configuration (DIP Switch)

Before powering up the RZ/V2H RDK, make sure the board's boot mode is configured correctly using the DIP switches.

DSW1	RZ/V2H Pin	Default Setting	Operation
1	BTSEL (BOOSTSELCPU)	ON = High: 1	Select the coldboot CPU: • High: **CA55** (*default*) • Low: **CM33**
2, 3	BOOTPLLCA_1 BOOTPLLCA_0	OFF = High: 1 ON = High: 1	Input the CA55 frequency at CA55 coldboot. **BOOT_PLLCA[1:0]:** • Low:Low → 1.1 GHz • Low:High → 1.5 GHz (0.9 V) • High:Low → 1.6 GHz (0.9 V) • High:High → 1.7 GHz (0.9 V) (*default*)
4 5	MD_BOOT1 MD_BOOT0	ON = Low: 0 OFF = Low: 0	Input boot mode select signal. **MD_BOOT[1:0]:** • Low:Low → SD (*default*) • Low:High → eMMC • High:Low → xSPI • High:High → SCIF download
6	MD_BOOT3	OFF = Low: 0	Select JTAG debug mode: • Low: normal mode (*default*) • High: JTAG

Attention

Always power off the board before changing boot switches.

1.2.3 Boot Mode Support

The board supports multiple boot options, including:

Boot Source	Description	DSW1 Setting
microSD	Boot from SD card	SD mode
xSPI	Boot from xSPI flash	xSPI mode

Tip

The serial port is powered by the **board's power supply**, not by the **USB port** from the PC. Early boot messages might not appear automatically in the terminal (including U-Boot console and SCIF terminal). To view them, manually reset the board by connecting **JTAG QRESN (PIN10)** to **GND**, as shown below.

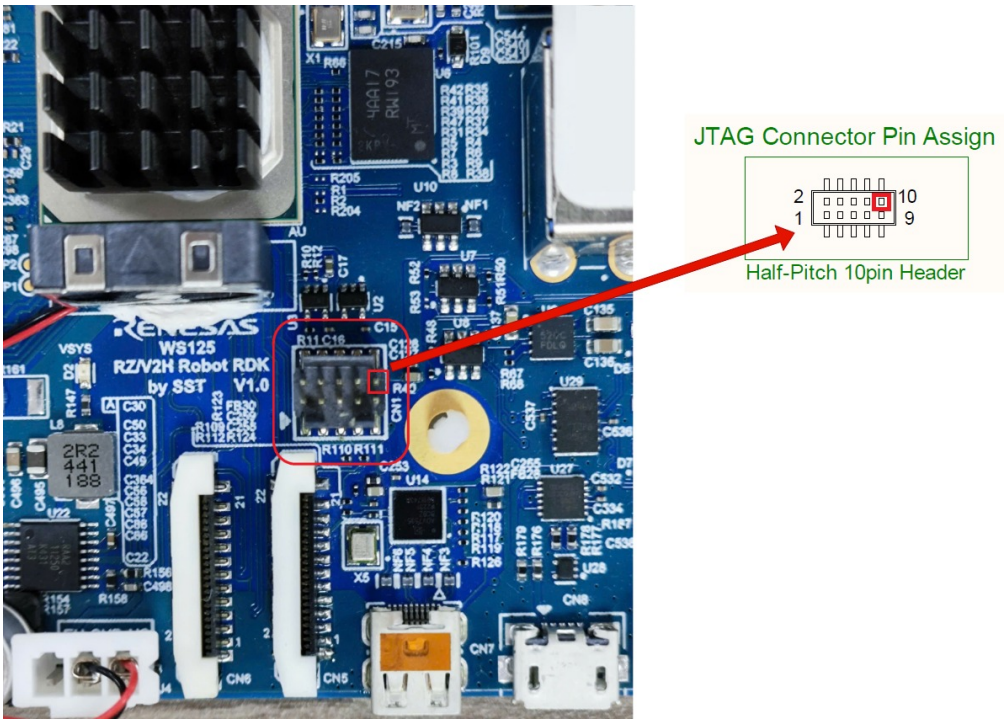

Fig. 4: JTAG Reset Pin Example

Option 1: SD Card Boot Mode

For **SD card boot mode**, the IPLs are already written to the SD card when flashing the image using Balena Etcher.

On the RZ/V2H RDK board, configure the **DSW1** switches as shown below:

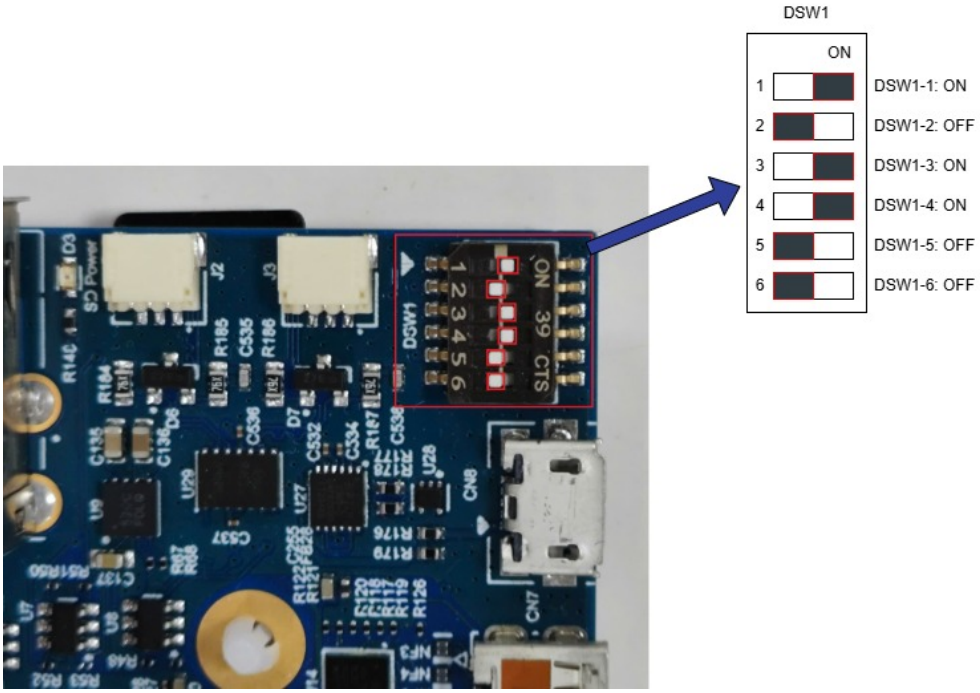

Fig. 5: DSW1 SD Card Boot Mode

After that, insert the SD card and connect the power supply (**Max 24V/5A**) to the board.

Open a terminal emulator (e.g., **Tera Term**) and connect to the **COM** port.

The COM port settings are the same as described in **Step 3** of *Write bootloaders to board*.

The board will start the boot process.

Tip

If there is no output from the terminal, do *the JTAG reset tip* first, then reset the U-Boot environment variables:

```
env default -a
saveenv
boot
```

If you intend to use **SD card boot mode only**, proceed to *First Time Boot Setup* to complete the setup.

Option 2: xSPI Boot Mode

Board Setup Procedure

Follow the instructions below to set up the board.

1. **Install Terminal Emulator**

Note

If already installed, skip this step.

- **Terminal Emulator:** Tera Term
- **Operating Environment:** Windows

2. **Install the Serial Port Driver**

> **Note**
>
> If already installed, skip this step.

- The serial communication between the Windows PC and **RZ/V2H RDK** requires: FTDI Virtual COM Port (VCP) driver

  Download and install the Windows version (*.exe*).

3. **Write Bootloaders to the Board**

Copy the bootloaders file to your Windows PC.

File Name	Description
Flash_Writer_SCIF_RZV2H_DEV_INTERNAL_MEMC	Flash writer for RZ/V2H (used in SCIF download mode)
bl2_bp_spi-rzv2h-rdk.srec	Boot loader stage 2 binary
fip-rzv2h-rdk.srec	Firmware Image Package for RZ/V2H

- Connect the **Windows PC** and **Board** using a **Serial-to-MicroUSB** cable.
- Change the **DSW1** setting to **Boot Mode 3 (SCIF download)**.

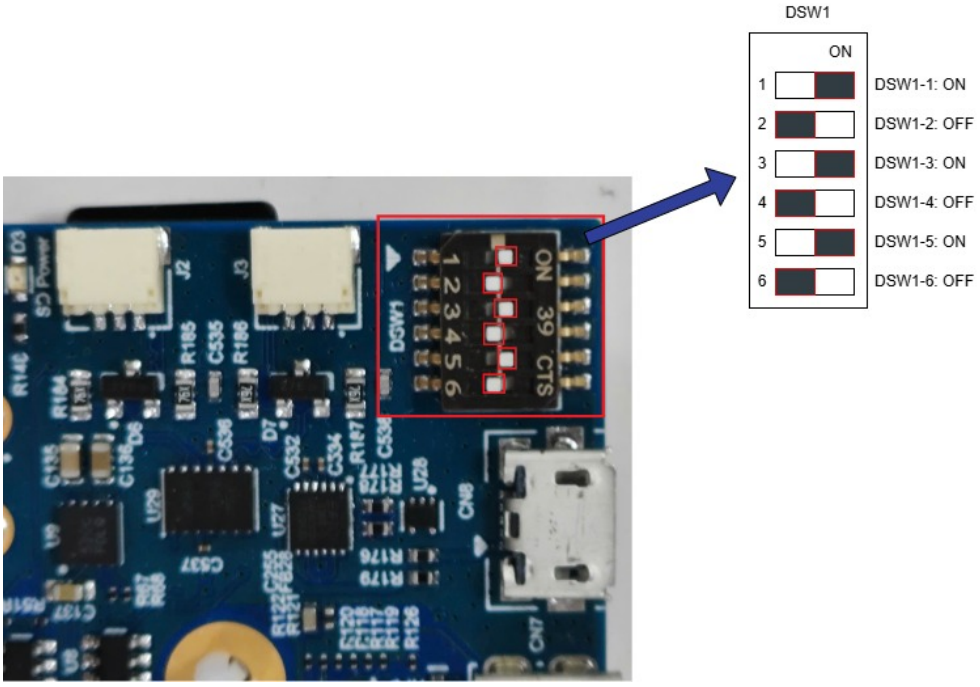

Fig. 6: DSW1 SCIF Download Mode

- Connect the power cable (**Max 24V/5A**).

- Open **Tera Term** and configure:

  Setup → Terminal:

Item	Value
New-line	Receive: Auto / Transmit: CR

  Setup → Serial Port:

Item	Value
Baud rate	115200
Data	8-bit
Parity	None
Stop	1-bit
Flow control	None
Transmit delay	0 msec/char

- Send files using "File → Send file..." and follow on-screen messages.

  (Keep the original command sequences as-is for flashing.)

4. **Setup U-Boot Configuration**
   1. Insert the microSD card to the board.
   2. Change DSW1 to **Boot mode 2 (xSPI boot)**:

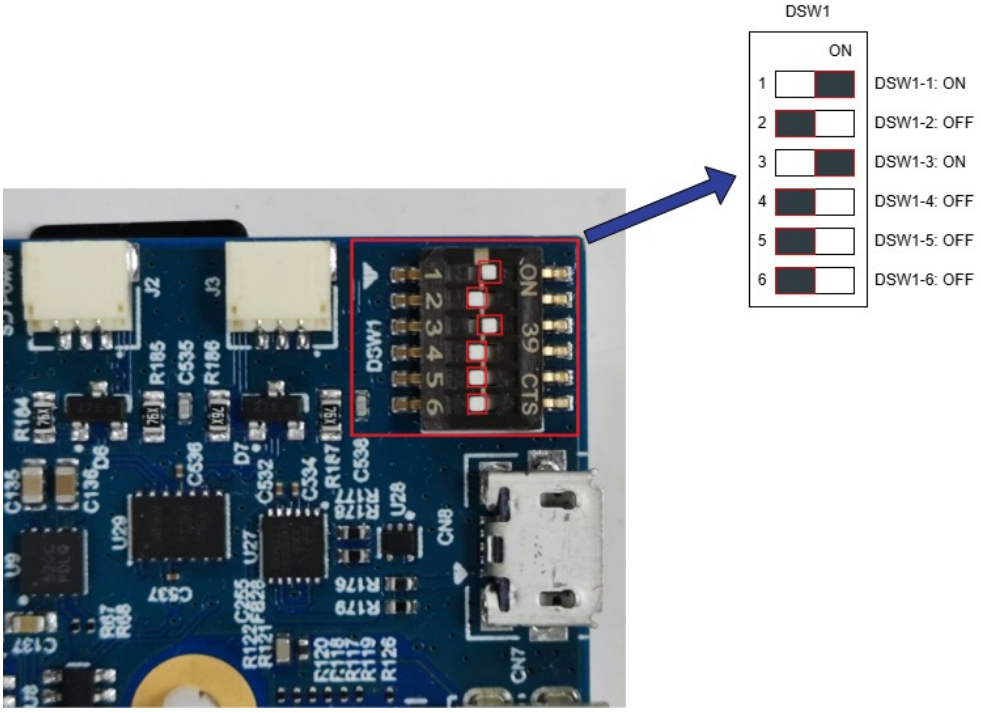

Fig. 7: DSW1 xSPI Boot Mode

3. Connect via **USB Serial to MicroUSB** cable.
4. Power on the board.
5. Open the terminal emulator and connect to the **COM** port (same configuration as before).
6. The board will boot.

> **Tip**
>
> If there is no output from the terminal, do *the JTAG reset tip* first, then reset the U-Boot environment variables:
>
> ```
> env default -a
> saveenv
> boot
> ```

1.2.4 First Time Boot Setup

After powering on the board **for the first time**, connect to the serial console and check the boot log to verify that Ubuntu boots successfully.

> **Note**
>
> This operation is required **only once**, immediately after flashing the root filesystem and booting the board for the first time.

Connect an Ethernet cable to the board and run:

```
# Check network
ping 8.8.8.8 -c 3
ping google.com -c 3
```

1. Perform apt update and resize the SD card:

   ```
   sudo apt update
   sudo apt install parted
   sudo parted /dev/mmcblk0
   ```

   Inside parted terminal:

   ```
   > print
   > resizepart 2 100%
   > print
   > quit
   ```

   Resize root filesystem:

   ```
   sudo resize2fs /dev/mmcblk0p2
   ```

2. Setup **rosdep** for ROS2 package dependency management:

   ```
   sudo rosdep init
   rosdep update
   ```

This completes the **Quick Setup Guide** for the RZ/V2H RDK board.

1.2.5 Reference

- Advanced Boot Options (xSPI): Renesas RZ/V AI SDK Developer Guide
- Balena Etcher Official Website: https://www.balena.io/etcher

1.3 RZ/V ROS2 Demos

ROS2 packages designed for computer vision applications on Renesas RZ/V MPU platforms, specifically targeting the RZ/V2H.

The packages provide AI-accelerated vision capabilities including object detection, pose estimation, and visualization tools.

TODO: Add links to individual demo documentation pages when available.