RZ/V2M ISP Support Package Version.1.10

Release Note

Introduction

This release note describes the contents of the RZ/V2M ISP Support Package and how to construct its operating environments.

Contents

1. Release Items

The release items in the RZ/V2M ISP Support Package are as following.

- **Name and Version**

  RZ/V2M ISP Support Package Version.1.10

- **Target Board**

  Evaluation kit for RZ/V2M

  Note: For the settings of Evaluation kit for RZ/V2M, please refer to “3.2 Board Setting” of the RZ/V2M Linux Package Start-Up Guide. Refer to “5.2 Preparation” for necessary equipment other than the Evaluation kit for RZ/V2M.

- **Features**

  1. Firmware that controls ISP (Provided as binary)
     This firmware is for using RZ/V2M ISP functions.

     Major updates:

     Display drawing APIs and captured image adjustment APIs are added.

  2. Patch for RZ/V2M Linux Package for ISP control
     This is a patch for RZ/V2M Linux Package to control ISP from Linux.

     Major updates:

     The additional ISP APIs are supported.

- **File Contents**

Table 1-1 shows the list of contents in this package. Table 1-2 shows the list of contents in rzv2m_isp_support-pkg_v110.tar.gz.

Table 1-1 File Contents

Folder / Filename	Explanation
core1_firmware.bin	Firmware binary file on core1.
r01an5904ej011100-rzv2m-isp-control-sw-specifications.pdf	API specification for ISP control.
rzv2m_isp_support-pkg_v110.tar.gz	Recipe to add ISP support to Linux Package.
r01an5978ej0110-rzv2m_isp-support.pdf	This document.

Table 1-2 Contents of rzv2m_isp_support-pkg_v110.tar.gz

Directory		Explanation
meta-isp/		meta-layer files to add ISP Support Package to Linux Package.
	conf/	meta-isp configuration files.
	recipes-comctl/	Command control library* Recipe.
	recipes-kernel/	Kernel patches required to apply this meta-layer.
	recipes-openamp/	OpenAMP** bare metal library Recipe.
meta-openamp/		meta-layer files to add OpenAMP** support to Linux Package.

* The command control library is the library that supports ISP control API from Linux application.

** The OpenAMP open-source software provides asymmetric multiprocessing functions.

- **Related Packages**

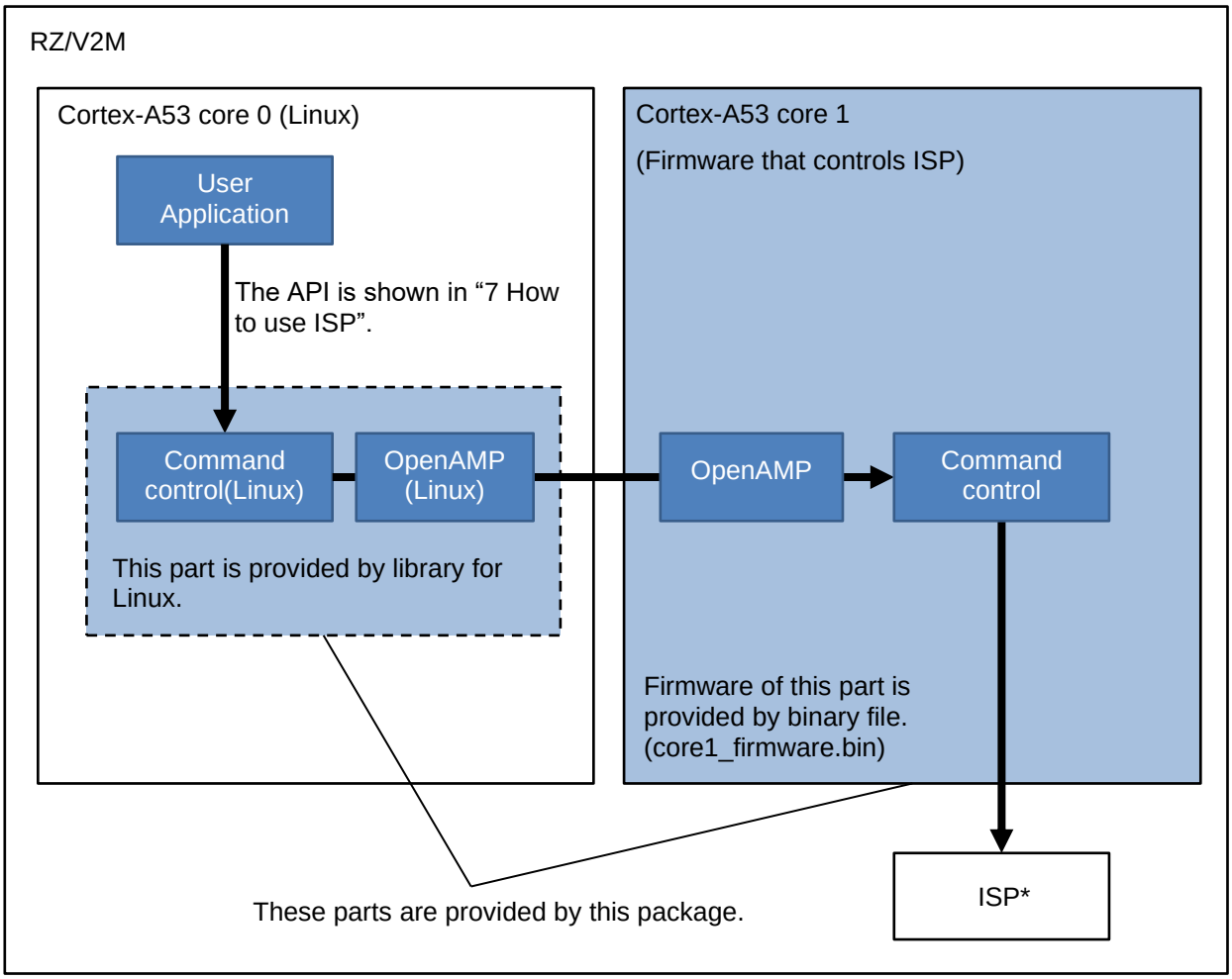
1. RZ/V2M Linux Package Version.1. 1.0
2. RZ/V2M DRP-AI Support Package Version.5.00

- **Related Documents**

1. RZ/V2M Linux Package Release Note (R01AN5971EJ0110)
2. RZ/V2M Linux Package Start-Up Guide (R01US0527EJ0110)
3. RZ/V2M DRP-AI Support Package Release Note (R11AN0530EJ0500)
4. RZ/V2M DRP-AI Sample Application Note

2. System Configuration

The following illustration represent the system configuration when this package is applied to the Linux Package.



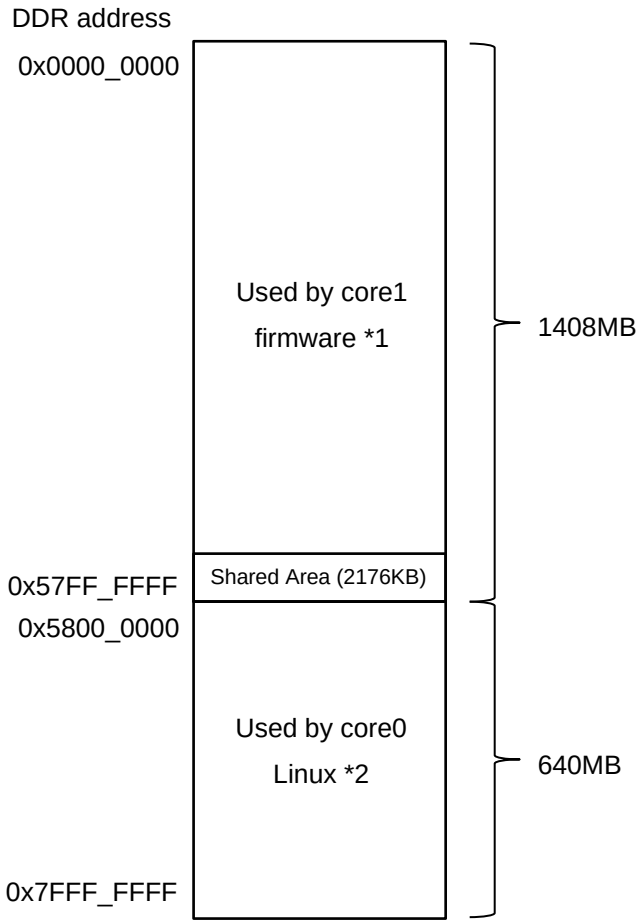
* Image Signal Processor of RZ/V2M.

Refer to r01an5904ej0110-rzv2m-isp-control-sw-specifications.pdf for explanation of ISP.

Figure 2-1 System configuration

3. Memory Map

The following illustration represent DDR memory map when this package is applied to the Linux Package.



*1 The area used by the core1 firmware that controls ISP for MIPI camera images, etc.

*2 Please refer to the “5.1 Memory Map” of “RZ/V2M Linux Package Release Note” for a detailed breakdown.

Figure 3-1 Memory Map

4. Build

This chapter will explain how to build the RZ/V2M ISP Support Package. The following packages are required to build this package.

1. RZ/V2M Linux Package
2. RZ/V2M DRP-AI Support Package

Note: Before executing bitbake commands, apply all above recipes.

4.1 Preparation

Refer to the “RZ/V2M DRP-AI Support Package Release Note” and follow the steps described in the “3. Build” chapter.

4.2 Add the Environmental Variable

As in the “RZ/V2M DRP-AI Support Package Release Note”, set the working directory as the environmental variable.

```
$ export WORK=/home/user/user_work
```

Note: Specify the working directory in red above according to your machine. The example above uses “user/user_work”.

4.3 Extract the ISP Support Package recipe

Go to the working directory and extract the ISP Support Package contained in this package.

```
$ cd $WORK
$ tar xzvf rzv2m_isp_support-pkg_v110.tar.gz
```

After the command executed, meta-isp and meta-openamp directories and rzv2m-isp-conf.patch file will be shown in the working directory.

```
$WORK/
  build/
  meta-drpai/
  meta-gplv2/
  meta-isp/
  meta-linaro/
  meta-openamp/
  meta-openembedded/
  meta-rzv2m/
  poky/
  rzv2m-drpai-conf.patch
  rzv2m-isp-conf.patch
```

Note: The directories in red are added when the recipe of ISP Support Package is extracted.

4.4 Set the build environment variables

Run the following command to set the environment variable for the build.

Note: The environmental variable will be reset if the terminal is closed. Please run the command for each time you open the terminal.

```
$ cd $WORK
$ source poky/oe-init-build-env
```

4.5 Confirm the configuration

Confirm the bblayers.conf and local.conf files look like below.

```
$ tail conf/bblayers.conf
  ${TOPDIR}/../meta-rzv2m \
  ${TOPDIR}/../meta-linaro/meta-linaro-toolchain \
  ${TOPDIR}/../meta-linaro/meta-optee \
  ${TOPDIR}/../meta-openembedded/meta-oe \
  ${@'${TOPDIR}/../meta-openembedded/meta-filesystems' if '${VIRTUALIZATION_CHECK}' == 'True' else ''} \
  ${@'${TOPDIR}/../meta-openembedded/meta-networking' if '${VIRTUALIZATION_CHECK}' == 'True' else ''} \
  ${@'${TOPDIR}/../meta-openembedded/meta-python' if '${VIRTUALIZATION_CHECK}' == 'True' else ''} \
  ${@'${TOPDIR}/../meta-virtualization' if '${VIRTUALIZATION_CHECK}' == 'True' else ''} \
  ${TOPDIR}/../meta-drpai \
  "
$ tail conf/local.conf
#MACHINE_FEATURES_append = " docker"

DL_DIR = "${TOPDIR}/oss_packages"
BB_NO_NETWORK = "0"

TOOLCHAIN_TARGET_TASK_append = " kernel-devsrc"

TOOLCHAIN_TARGET_TASK_append = " drpai"

IMAGE_INSTALL_append =" ai-eva-sw "
```

Note: The parts written in red are the parts changed in RZ/V2M DRP-AI Support Package.

4.6 Apply the patch

Apply the patch that describes the changes for this package.

```
$ cd $WORK/build
$ patch -p2 < ../rzv2m-isp-conf.patch
```

After applying the patch, confirm the bblayers.conf and local.conf files look like below.

```
$ tail conf/bblayers.conf
  ${TOPDIR}/../meta-linaro/meta-optee \
  ${TOPDIR}/../meta-openembedded/meta-oe \
  ${@'${TOPDIR}/../meta-openembedded/meta-filesystems' if '${VIRTUALIZATION_CHECK}'
== 'True' else ''} \
  ${@'${TOPDIR}/../meta-openembedded/meta-networking' if '${VIRTUALIZATION_CHECK}' ==
'True' else ''} \
  ${@'${TOPDIR}/../meta-openembedded/meta-python' if '${VIRTUALIZATION_CHECK}' ==
'True' else ''} \
  ${@'${TOPDIR}/../meta-virtualization' if '${VIRTUALIZATION_CHECK}' == 'True' else
''} \
  ${TOPDIR}/../meta-drpai \
  ${TOPDIR}/../meta-openamp \
  ${TOPDIR}/../meta-isp \
  "
$ tail -n 15 conf/local.conf


TOOLCHAIN_TARGET_TASK_append = " drpai"


IMAGE_INSTALL_append =" ai-eva-sw "


PREFERRED_VERSION_libmetal="2018.10%"
PREFERRED_VERSION_open-amp="2018.10%"
# OpenAMP settings
IMAGE_INSTALL_append = " \
    kernel-modules \
    libmetal \
    open-amp \
"
IMAGE_INSTALL_append =" comctl "
```

Note: The parts written in red are the parts changed in this package.

4.7 Build

Run the bitbake command to build the Linux Package.

```
$ cd $WORK/build
$ bitbake core-image-bsp
```

After the Build, the following files will be generated under `$WORK/build/tmp/deploy/image/rzv2m`.

Table 4-1 Generated Files after Build

Filename	Name
Image	Linux Kernel Image
r9a09g011gbg-evaluation-board.dtb	Linux Device Tree File
core-image-bsp-rzv2m.tar.bz2	A set of root filesystem

5. Boot

This chapter will explain how to boot the system applied by RZ/V2M ISP Support Package.

There are two ways to boot.

(1) the network boot

(2) boot from the SD Card.

5.2 Preparation

Refer to “4.2 Preparation” or “5.2 Preparation” of “RZ/V2M DRP-AI Support Package Release Note” to prepare for booting.

- “4.2 Preparation” : the preparation for Network booting
- “5.2 Preparation”: the preparation for SD Card booting.

In addition, prepare the sensor board Sensor-415 Board attached to the Evaluation kit for RZ/V2M. with CS mount lens and video monitor connecting by HDMI cable.

Table 5-1 lists necessary equipment for network booting and

Table 5-3 lists necessary equipment for SD Card booting.

The RZ/V2M Evaluation Board connected sensor board and video monitor looks like below.

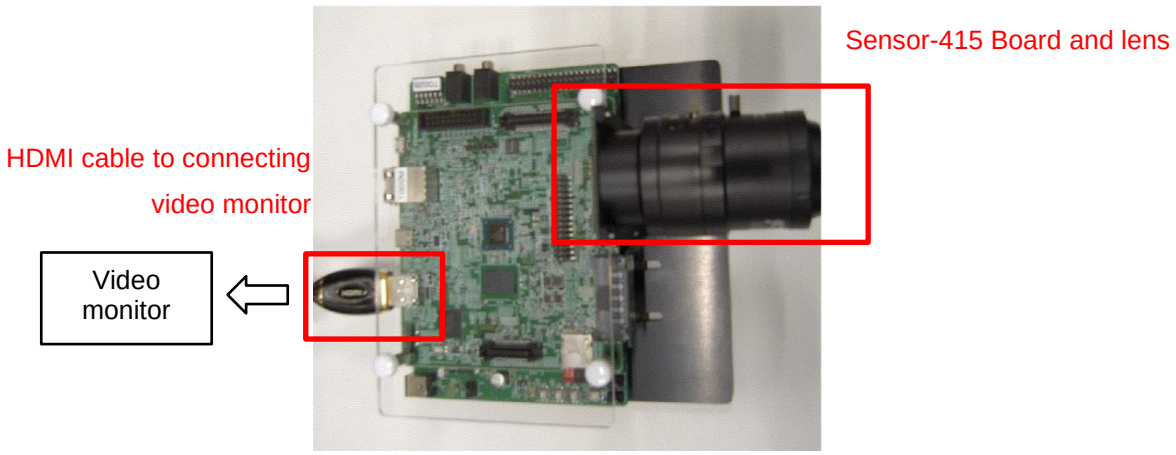


Table 5-1 Necessary Equipment for Booting

Equipment	Details
RZ/V2M Evaluation Kit	Evaluation kit for RZ/V2M.
- RZ/V2M Board (Main)	Target board. Main functional components for RZ/V2M are mounted on this board. Note that the boot loader and U-Boot images are pre-written to the eMMC (THGBMJG7C1LBAIL).
- RZ/V2M Base Board (Base)	Connected to CN12 and CN 13 on the RZ/V2M Board. Board for the generation and supply of power.
- Sensor-415 Board	Attached to the Evaluation kit for RZ/V2M
Serial to Micro USB Cable	Used for serial communication between PC and board.
Ethernet crossover cable	Used for ethernet communication between Linux PC and board.
CS mount lens	Used for sensor board lens.
HDMI cable	(Optional) Used for connecting video monitor.
Video monitor	(Optional) Used for monitoring sensor images. Requires support for HDMI input and Full HD display.

Note: The parts written in red are necessary equipment to add to RZ/V2M DRP-AI Support Package.

Table 5-2 Necessary Equipment for Network Booting

Equipment	**Details**
Linux PC	Used as build/debug environment for RZ/V2M Linux software. Max 100GB free space on HDD is necessary.
- OS	Ubuntu 16.04 LTS 64-bit OS must be used.
- TFTP server	Used for downloading the Linux kernel to board.
- NFS server	Used for mounting rootfs via NFS.

Table 5-3 Necessary Equipment for SD Card Booting

Equipment	Details
Linux PC	Used as build/debug environment for RZ/V2M Linux software. Used for creating microSD card. Max 100GB free space on HDD is necessary.
- OS	Ubuntu 16.04 LTS 64-bit OS must be used.
- SD card reader	Used for creating microSD card.
Windows PC	Used for Serial communication display.
- OS	Windows 10
- Terminal software	Used for controlling serial console of the target board. Operation Environment: Tera Term
- Serial port driver	Virtual COM Port driver which enables to communicate Windows PC and the target board via USB which is virtually used as serial port.
microSD card	Used for SD Card Booting. Only SDHC is supported. Operation Environment: Transcend Ultimate 600x 8GB

.

5.3 Network Booting

Refer to the “RZ/V2M DRP-AI Support Package Release Note” and follow the steps described in the “4. Network Booting” chapter with the following two additions:

1. Copy the binary file of firmware on core1 to TFTP directory in the “4.3.2 Setup the Files for TFTP Server” chapter of “RZ/V2M DRP-AI Support Package Release Note”.

```
$ sudo cp <PATH_TO_FILE>/core1_firmware.bin /tftpboot
```

2. Use the following U-boot environment variables and boot command in the “4.4 Boot” chapter of “RZ/V2M DRP-AI Support Package Release Note”.

```
=> env default -a
=> setenv ipaddr 192.168.1.11
=> setenv serverip 192.168.1.10
=> setenv core1_vector 0x01000000
=> setenv core1addr 0x01000000
=> setenv core1_firmware core1_firmware.bin
=> setenv fdt_addr 0x58000000
=> setenv fdt_file r9a09g011gbg-evaluation-board.dtb
=> setenv loadaddr 0x58080000
=> setenv kernel Image
=> setenv bootargs_nfs 'setenv bootargs root=/dev/nfs rw
nfsroot=${serverip}:/nfs/rzv2m,nfsvers=3
ip=${ipaddr}:${serverip}::${netmask}:rzv2m:eth0'
=> setenv bootnfs 'run bootargs_nfs;tftp ${core1addr} ${core1_firmware};tftp
${loadaddr} ${kernel};tftp ${fdt_addr} ${fdt_file};wakeup_a53core1
${core1_vector};booti ${loadaddr} - ${fdt_addr}'
=> setenv bootcmd 'run bootnfs'
=> saveenv
=> boot
```

Note:

The above U-boot environment variable settings are required only when using this package for the first time or when the boot method is switched from SD Card booting.

ipaddr: IP address of Evaluation kit for RZ/V2M.

serverip: IP address of Ubuntu PC.

5.4 SD Card Booting

Refer to the “RZ/V2M DRP-AI Support Package Release Note” and follow the steps described in the “5. SD Card Booting” chapter with the following two additions:

1. Copy binary file of firmware on core1 to partition 1 of SD Card in the “2. Setup the partition 1” of “5.3.1 Setup the SD Card” chapter of “RZ/V2M DRP-AI Support Package Release Note”.

```
$ sudo cp <PATH_TO_FILE>/core1_firmware.bin /mnt/sd
```

2. Use following U-boot environment variables and boot command in the “5.4 Boot” chapter of “RZ/V2M DRP-AI Support Package Release Note”.

```
=> env default -a
=> setenv core1_vector 0x01000000
=> setenv core1addr 0x01000000
=> setenv core1_firmware core1_firmware.bin
=> setenv fdt_addr 0x58000000
=> setenv fdt_file r9a09g011gbg-evaluation-board.dtb
=> setenv loadaddr 0x58080000
=> setenv kernel Image
=> setenv bootargs_sd 'setenv bootargs root=/dev/mmcblk0p2 rootwait rootfstype=ext3
rw'
=> setenv bootsd 'run bootargs_sd;fatload mmc 0:1 ${core1addr}
${core1_firmware};fatload mmc 0:1 ${loadaddr} ${kernel};fatload mmc 0:1 ${fdt_addr}
${fdt_file};wakeup_a53core1 ${core1_vector};booti ${loadaddr} - ${fdt_addr}'
=> setenv bootcmd 'run bootsd'
=> saveenv
=> boot
```

Note:

The above U-boot environment variable settings are required only when using this package for the first time or when the boot method is switched from network booting.

6. Sample Application

6.1 SDK

Before building the SDK, refer “4 Build” and apply DRP-AI Support Package and this package in advance. Refer to “6. SDK” chapter of the “RZ/V2M DRP-AI Support Package Release Note” for explanation on how to construct the Compile Environment, SDK, which is necessary to compile a RZ/V2M Linux application.

6.2 Sample Application

“DRP-AI Sample Application for Darknet Tiny YOLOv2 MIPI-HDMI version”, “DRP-AI Sample Application for Darknet Tiny YOLOv2 MIPI-VCD version” and “DRP-AI Sample Application for HRNet MIPI-HDMI version” are examples of how to use ISP control API. Refer to the “RZ/V2M DRP-AI Sample Application Note” for explanations on how to compile it, how it works, and how to use it.

7. How to use ISP

This chapter describes how to use ISP. The ISP operated by ISP control API. Refer to r01an5904ej0100-isp-control-sw-specifications.pdf for ISP control API specifications.

ISP control API can be used by linking libcomctl.so.

7.1 How to link libcomctl.so

Link libcomctl.so to use “-lcomctl” option of compiler when building the application that uses ISP control API. See Makefile of “DRP-AI Sample Application for Darknet Tiny YOLOv2 MIPI-HDMI version” or “DRP-AI Sample Application for Darknet Tiny YOLOv2 MIPI-VCD version” for linking libcomctl.so. See “RZ/V2M DRP-AI Sample Application Note” for detail of the sample applications.

Version History

Ver.	Date	Description	
		Page	Summary
0.50	12 Feb, 2021	-	Issued.
0.60	17 May, 2021	-	Updated contents included this package from Version.0.50 to Version.0.60.
		3	Updated related packages. - Updated RZ/V2M Linux Package from Version.0.8.5 to Version.0.9.0. - Updated RZ/V2M DRP-AI Support Package from Version.2.10 to Version.3.00.
		5	Added memory map.
		12	Changed usage of command control from API to daemon.
1.00	30 Jun, 2021	-	Updated contents included this package from Version.0.60 to Version 1.00.
		2	Added the tool that image-quality-tuning to “Features”.
		3	Added the tool that image-quality-tuning to “File Contents”.
		3	Updated related packages. - Updated RZ/V2M Linux Package from Version.0.9.0 to Version.1.0.0. - Updated RZ/V2M DRP-AI Support Package from Version.3.00 to Version.4.10.
		17	Since it is no longer necessary to use daemon, deleted “7.2 How to run the command controller daemon”.
1.10	8 Oct,2021	-	Updated contents included this package from Version.0.60 to Version 1.10.
		2	Name and Version; Update release packages from Version1.0 to 1.10.
		3	File Contents; Update file version from V100 to V110. Related Packages; Update version. Related Documents; Update Documents version.
		4	Figure 2-1 System configuration modified.
		7	4.3 Extract the ISP Support Package recipe; Update version of file name.
		8	4.5 Confirm the configuration is modified.
		11	5.Boot; summary contents is modified. 5.2 Preparation is modified.
		12	Table 5-1 Necessary Equipment for booting is modified. Table 5-2 Necessary Equipment for network Booting is added.
		13	Table 5-3 Necessary Equipment for SD Card Booting is modified.

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.

Notice

1. Descriptions of circuits, software and other related information in this document are provided only to illustrate the operation of semiconductor products and application examples. You are fully responsible for the incorporation or any other use of the circuits, software, and information in the design of your product or system. Renesas Electronics disclaims any and all liability for any losses and damages incurred by you or third parties arising from the use of these circuits, software, or information.
2. Renesas Electronics hereby expressly disclaims any warranties against and liability for infringement or any other claims involving patents, copyrights, or other intellectual property rights of third parties, by or arising from the use of Renesas Electronics products or technical information described in this document, including but not limited to, the product data, drawings, charts, programs, algorithms, and application examples.
3. No license, express, implied or otherwise, is granted hereby under any patents, copyrights or other intellectual property rights of Renesas Electronics or others.
4. You shall be responsible for determining what licenses are required from any third parties, and obtaining such licenses for the lawful import, export, manufacture, sales, utilization, distribution or other disposal of any products incorporating Renesas Electronics products, if required.
5. You shall not alter, modify, copy, or reverse engineer any Renesas Electronics product, whether in whole or in part. Renesas Electronics disclaims any and all liability for any losses or damages incurred by you or third parties arising from such alteration, modification, copying or reverse engineering.
6. Renesas Electronics products are classified according to the following two quality grades: “Standard” and “High Quality”. The intended applications for each Renesas Electronics product depends on the product’s quality grade, as indicated below.
   "Standard": Computers; office equipment; communications equipment; test and measurement equipment; audio and visual equipment; home electronic appliances; machine tools; personal electronic equipment; industrial robots; etc.
   "High Quality": Transportation equipment (automobiles, trains, ships, etc.); traffic control (traffic lights); large-scale communication equipment; key financial terminal systems; safety control equipment; etc.

   Unless expressly designated as a high reliability product or a product for harsh environments in a Renesas Electronics data sheet or other Renesas Electronics document, Renesas Electronics products are not intended or authorized for use in products or systems that may pose a direct threat to human life or bodily injury (artificial life support devices or systems; surgical implantations; etc.), or may cause serious property damage (space system; undersea repeaters; nuclear power control systems; aircraft control systems; key plant systems; military equipment; etc.). Renesas Electronics disclaims any and all liability for any damages or losses incurred by you or any third parties arising from the use of any Renesas Electronics product that is inconsistent with any Renesas Electronics data sheet, user’s manual or other Renesas Electronics document.
7. No semiconductor product is absolutely secure. Notwithstanding any security measures or features that may be implemented in Renesas Electronics hardware or software products, Renesas Electronics shall have absolutely no liability arising out of any vulnerability or security breach, including but not limited to any unauthorized access to or use of a Renesas Electronics product or a system that uses a Renesas Electronics product. RENESAS ELECTRONICS DOES NOT WARRANT OR GUARANTEE THAT RENESAS ELECTRONICS PRODUCTS, OR ANY SYSTEMS CREATED USING RENESAS ELECTRONICS PRODUCTS WILL BE INVULNERABLE OR FREE FROM CORRUPTION, ATTACK, VIRUSES, INTERFERENCE, HACKING, DATA LOSS OR THEFT, OR OTHER SECURITY INTRUSION (“Vulnerability Issues”). RENESAS ELECTRONICS DISCLAIMS ANY AND ALL RESPONSIBILITY OR LIABILITY ARISING FROM OR RELATED TO ANY VULNERABILITY ISSUES. FURTHERMORE, TO THE EXTENT PERMITTED BY APPLICABLE LAW, RENESAS ELECTRONICS DISCLAIMS ANY AND ALL WARRANTIES, EXPRESS OR IMPLIED, WITH RESPECT TO THIS DOCUMENT AND ANY RELATED OR ACCOMPANYING SOFTWARE OR HARDWARE, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY, OR FITNESS FOR A PARTICULAR PURPOSE.
8. When using Renesas Electronics products, refer to the latest product information (data sheets, user’s manuals, application notes, “General Notes for Handling and Using Semiconductor Devices” in the reliability handbook, etc.), and ensure that usage conditions are within the ranges specified by Renesas Electronics with respect to maximum ratings, operating power supply voltage range, heat dissipation characteristics, installation, etc. Renesas Electronics disclaims any and all liability for any malfunctions, failure or accident arising out of the use of Renesas Electronics products outside of such specified ranges.
9. Although Renesas Electronics endeavors to improve the quality and reliability of Renesas Electronics products, semiconductor products have specific characteristics, such as the occurrence of failure at a certain rate and malfunctions under certain use conditions. Unless designated as a high reliability product or a product for harsh environments in a Renesas Electronics data sheet or other Renesas Electronics document, Renesas Electronics products are not subject to radiation resistance design. You are responsible for implementing safety measures to guard against the possibility of bodily injury, injury or damage caused by fire, and/or danger to the public in the event of a failure or malfunction of Renesas Electronics products, such as safety design for hardware and software, including but not limited to redundancy, fire control and malfunction prevention, appropriate treatment for aging degradation or any other appropriate measures. Because the evaluation of microcomputer software alone is very difficult and impractical, you are responsible for evaluating the safety of the final products or systems manufactured by you.
10. Please contact a Renesas Electronics sales office for details as to environmental matters such as the environmental compatibility of each Renesas Electronics product. You are responsible for carefully and sufficiently investigating applicable laws and regulations that regulate the inclusion or use of controlled substances, including without limitation, the EU RoHS Directive, and using Renesas Electronics products in compliance with all these applicable laws and regulations. Renesas Electronics disclaims any and all liability for damages or losses occurring as a result of your noncompliance with applicable laws and regulations.
11. Renesas Electronics products and technologies shall not be used for or incorporated into any products or systems whose manufacture, use, or sale is prohibited under any applicable domestic or foreign laws or regulations. You shall comply with any applicable export control laws and regulations promulgated and administered by the governments of any countries asserting jurisdiction over the parties or transactions.
12. It is the responsibility of the buyer or distributor of Renesas Electronics products, or any other party who distributes, disposes of, or otherwise sells or transfers the product to a third party, to notify such third party in advance of the contents and conditions set forth in this document.
13. This document shall not be reprinted, reproduced or duplicated in any form, in whole or in part, without prior written consent of Renesas Electronics.
14. Please contact a Renesas Electronics sales office if you have any questions regarding the information contained in this document or Renesas Electronics products.

(Note1) “Renesas Electronics” as used in this document means Renesas Electronics Corporation and also includes its directly or indirectly controlled subsidiaries.

(Note2) “Renesas Electronics product(s)” means any product developed or manufactured by or for Renesas Electronics.

(Rev.5.0-1 October 2020)

Corporate Headquarters

TOYOSU FORESIA, 3-2-24 Toyosu,
Koto-ku, Tokyo 135-0061, Japan
www.renesas.com

Trademarks

Renesas and the Renesas logo are trademarks of Renesas Electronics Corporation. All trademarks and registered trademarks are the property of their respective owners.

Contact information

For further information on a product, technology, the most up-to-date version of a document, or your nearest sales office, please visit:
www.renesas.com/contact/.