User's Manual

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Linux Interface Specification Device Driver UIO

User's Manual: Software

R-Car H3/M3/M3N/E3/D3 Series

Renesas Electronics
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How to Use This Manual

- **[Readers]**
  This manual is intended for engineers who develop products which use the R-Car H3/M3/M3N/E3/D3 processor.

- **[Purpose]**
  This manual is intended to give users an understanding of the functions of the R-Car H3/M3/M3N/E3/D3 processor device driver and to serve as a reference for developing hardware and software for systems that use this driver.

- **[How to Read This Manual]**
  It is assumed that the readers of this manual have general knowledge in the fields of electrical
  — Engineering, logic circuits, microcontrollers, and Linux.
  → Read this manual in the order of the CONTENTS.
  — To understand the functions of a multimedia processor for R-Car H3/M3/M3N/E3/D3
  → See the R-Car H3/M3/M3N/E3/D3 User's Manual.
  — To know the electrical specifications of the multimedia processor for R-Car H3/M3/M3N/E3/D3
  → See the R-Car H3/M3/M3N/E3/D3 Data Sheet.

- **[Conventions]**
  The following symbols are used in this manual.
  Data significance: Higher digits on the left and lower digits on the right
  Note: Footnote for item marked with Note in the text
  Caution: Information requiring particular attention
  Remark: Supplementary information
  Numeric representation: Binary ... ××××, 0b××××, or ××××B
  Decimal ... ××××
  Hexadecimal ... 0x×××× or ××××H
  Data type: Double word ... 64 bits
  Word … 32 bits
  Half word ... 16 bits
  Byte ... 8 bits

Table of Contents

1. Overview

1.1 Overview

This manual explains UIO driver for R-Car H3/M3/M3N/E3/D3 System Evaluation Board.

UIO driver is Linux driver to provide interrupt control handler and device resource mapping of hardware module(s) to user-space application. This driver also provides the PMA interface to control power, clock and software reset of the hardware modules.

The driver supports some hardware modules..

1.2 Function

This driver provides the following functions:

- Generic interrupt control handler and generic interface to enable/disable interrupts from user-space application
- Device resource mapping
- PMA interface

Below shows the list of IMR-LX4 module.

Table 1-1 Number of channels in IMR-LX4 modules

No.	Name	Number of channels (R-Car H3)	Number of channels (R-Car M3)	Number of channels (R-Car M3N)	Number of channels (R-Car E3)	Number of channels (R-Car D3)
1	IMR	04	02	02	01	01

1.3 Reference

1.3.1 Standard

There is no reference document on standards.

1.3.2 Related documents

The following table shows the documents related to this module.

Table 1-2 Related document

Number	Issue	Title	Edition	Date
-	Renesas Electronics	R-Car Series, 3rd Generation User's Manual: Hardware	Rev.2.30	Aug. 31, 2020

1.4 Restrictions

None

1.5 Notice

- The UIO initialization driver does not perform any initialization processing to hardware modules.
  Prior to accessing hardware registers, the user-space software shall perform hardware initialization according to hardware manual.

2. Terminology

The following table shows the terminology related to this module.

Table 2-1 Terminology

Terms	Explanation
UIO	Userspace Input Output framework
PMA	Power Management Agent
CPG	Clock Pulse Generator
SYSC	System Controller
IMR	Image Renderer (with Rotator and Scaler functionality)

3. System Configuration

3.1 Hardware Environment

The following table shows the hardware needed to use this module.

Table 3-1 Hardware environment

Name	Version	Manufacturer
• R-CarH3-SiP System Evaluation Board Salvator-X	-	Renesas Electronics
• R-CarM3-SiP System Evaluation Board Salvator-X	-	Renesas Electronics
• R-CarH3-SiP/M3-SiP/M3N-SiP System Evaluation Board Salvator-XS	-	Renesas Electronics
• R-CarE3 System Evaluation Board Ebisu	-	Renesas Electronics
• R-CarE3 System Evaluation Board Ebisu-4D	-	Renesas Electronics
• R-CarD3 System Evaluation Board Draak	-	Renesas Electronics

3.2 Module Configuration

The following figure shows the configuration of this module.

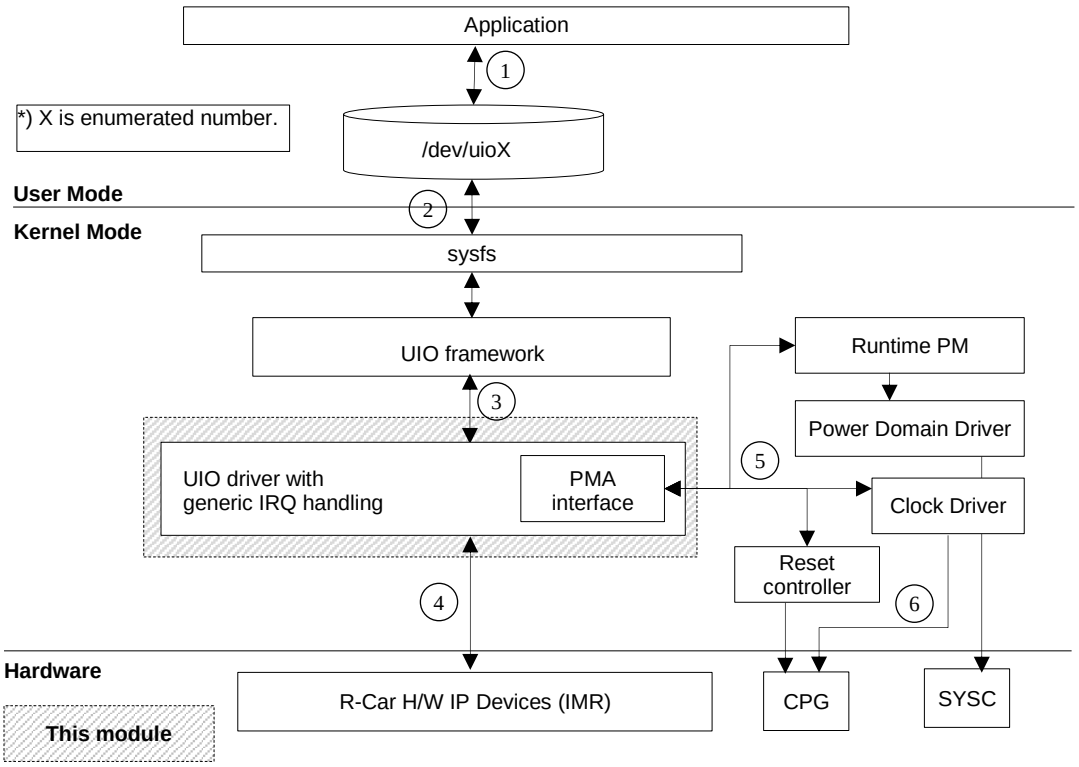

Figure 3-1 Module Configuration (R-Car H3/M3/M3N/E3/D3)

(1) After UIO driver probing, the applications can open the UIO devices by opening /dev/uioX in /dev folder in Linux filesystem. Moreover, there are alias name of UIO devices (e.g. /dev/ims_00).

(2) The UIO sysfs will expose the information of each UIO device, such as device name, device resources (start address and size of register range). The user application can perform the memory mapping in order to control hardware modules via read/write access and interrupt handling.

(3) The UIO driver will handle user applications via the UIO driver's callbacks.

(4) The access to hardware modules is done via the read/write requests from user applications.

(5) The user applications can control hardware modules power status by sending ioctl commands to PMA interface.

(6) The hardware module power status control (power domain, clock and reset) is performed by OS power management modules and the access to CPG/SYSC will be done.

3.3 State Transition Diagram

There is no state transition diagram for this module.

4. Target Performance

There are no target performance for UIO driver.

5. External Interface

5.1 UIO devices

Detailed explanation is skipped because the external interface of this module is based on Linux.
This module is associated with the enumerated device in runtime and based on the top-down order of the device nodes's description in R-Car H3/M3/M3N/E3/D3 device tree files.

Table 5.1 UIO devices (R-Car H3)

Name	Alias name	Description
/dev/uioX (X: 0 ~ 3)	/dev/imr_0y (y:0~3)	IMR devices with the order as IMR channel 0 to channel 3

Table 5.2 UIO devices (R-Car M3)

Name	Alias name	Description
/dev/uioX (X: 0 ~ 1)	/dev/imr_0y (y:0~1)	IMR devices with the order as IMR channel 0 to channel 1

Table 5.3 UIO devices (R-Car M3N)

Name	Alias name	Description
/dev/uioX (X: 0 ~ 1)	/dev/imr_0y (y:0~1)	IMR devices with the order as IMR channel 0 to channel 1

Table 5.4 UIO devices (R-Car E3)

Name	Alias name	Description
/dev/uioX (X: 0)	/dev/imr_00	IMR devices with the order as IMR channel 0

Table 5.5 UIO devices (R-Car D3)

Name	Alias name	Description
/dev/uioX (X: 0)	/dev/imr_00	IMR devices with the order as IMR channel 0

5.2 UIO sysfs interface

Below explains the UIO sysfs interface of each UIO device.
The upper application layers shall read information to distinguish the UIO devices and map the device resources correctly.

Table 5.6 UIO interface (R-Car H3)

Name	X value	Description
/sys/class/uio/uioX/name	0 ~ 3	Name of UIO device
/sys/class/uio/uioX/maps/map0/addr	0 ~ 3	Start address of register region of UIO device
/sys/class/uio/uioX/maps/map0/size	0 ~ 3	Size of register region of UIO device

Table 5.7 UIO interface (R-Car M3)

Name	X value	Description
/sys/class/uio/uioX/name	0 ~ 1	Name of UIO device
/sys/class/uio/uioX/maps/map0/addr	0 ~ 1	Start address of register region of UIO device
/sys/class/uio/uioX/maps/map0/size	0 ~ 1	Size of register region of UIO device

Table 5.8 UIO interface (R-Car M3N)

Name	X value	Description
/sys/class/uio/uioX/name	0 ~ 1	Name of UIO device
/sys/class/uio/uioX/maps/map0/addr	0 ~ 1	Start address of register region of UIO device
/sys/class/uio/uioX/maps/map0/size	0 ~ 1	Size of register region of UIO device

Table 5.9 UIO interface (R-Car E3)

Name	X value	Description
/sys/class/uio/uioX/name	0	Name of UIO device
/sys/class/uio/uioX/maps/map0/addr	0	Start address of register region of UIO device
/sys/class/uio/uioX/maps/map0/size	0	Size of register region of UIO device

Table 5.10 UIO interface (R-Car D3)

Name	X value	Description
/sys/class/uio/uioX/name	0	Name of UIO device
/sys/class/uio/uioX/maps/map0/addr	0	Start address of register region of UIO device
/sys/class/uio/uioX/maps/map0/size	0	Size of register region of UIO device

5.3 PMA interface

The PMA request can be done by ioctl requests to UIO devices. The list of PMA features and corresponding ioctl commands are shown as below:

Table 5.11 PMA interface

Features	ioctl commands	Value of ioctl argument (*5)
Get power status of the driver	UIO_PDRV_GET_PWR	0: Power domain is OFF 1: Power domain is ON
Change power status of the driver	UIO_PDRV_SET_PWR	0: Request to turn OFF power domain 1: Request to turn ON power domain
Get clock status of the driver	UIO_PDRV_GET_CLK	0: Device clock is OFF 1: Device clock is ON
Change clock status of the driver	UIO_PDRV_SET_CLK	0: Request to turn OFF device clock 1: Request to turn ON device clock
Get reset state of the driver	UIO_PDRV_GET_RESET	0: Device is NOT in reset state 1: Device is in reset state
Change reset state of the driver	UIO_PDRV_SET_RESET	0: Request to release software reset state 1: Request to apply software reset state
Get the device clock divider	UIO_PDRV_CLK_GET_DIV	Current value of device clock divider
Set the device clock divider	UIO_PDRV_CLK_SET_DIV	Requested value of device clock divider

(*5) The value of ioctl argument is passed as pointer to ioctl command.

e.g.

```
int value = 0;
dev->fd = open("/dev/uio0", O_RDWR);
int status = ioctl(dev->fd, UIO_PDRV_GET_PWR, &value);
```

6. Integration

6.1 Directory Configuration

The directory configuration is shows below (Figure 6-1).

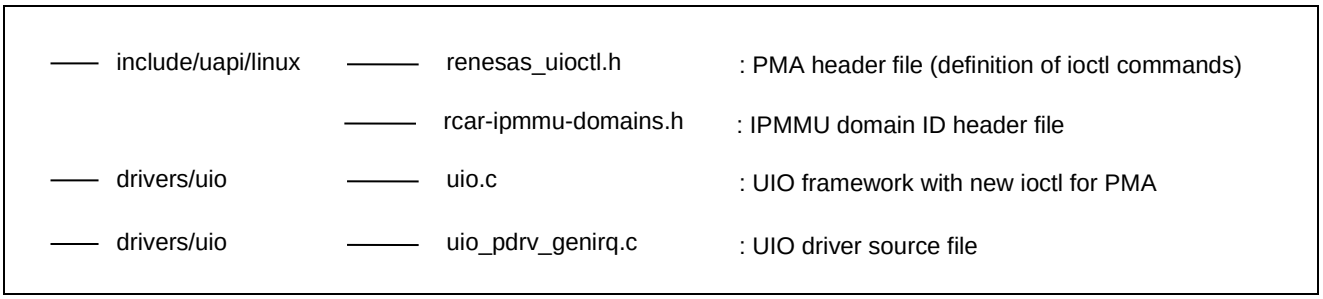

Figure 6-1 Directory Configuration

6.2 Integration Procedure

To enable the function of this module, make the following setting with kernel configuration.

```
Device Drivers --->
   <*> Userspace I/O drivers   --->
       <M> Userspace I/O platform driver with generic IRQ handling
```

By default, this module is built as loadable module (uio_pdrv_genirq.ko).

The built kernel module must be copied into the root filesystem of the development board and installed by “insmod” command.

To use PMA features of this UIO driver, the application must include the PMA header file (renesas_uioctl.h).

In case user-space applications want to control IPMMU ID of UIO devices, the user-space API (uapi) header file rcar-ipmmu-domains.h is required.

6.3 Option Setting

6.3.1 Module parameters

To load the UIO driver as the loadable module, the module parameter of_id=“generic-uio” is required.

e.g. `$ insmod uio_pdrv_genirq.ko of_id="generic-uio"`

6.3.2 Kernel parameters

There are no kernel parameters.

6.3.3 Switch to UIO driver

Some devices (such as DU and VIN) will use their legacy drivers by default. To switch to use UIO driver, the device bind/unbind operation is performed.

To use UIO driver, bind the device to UIO driver.

e.g `$ echo feb00000.du_00 > /sys/bus/platform/drivers/uio_pdrv_genirq/bind`

NOTE:

It's recommended to unbind the in-use driver (legacy driver) prior to binding to UIO driver.

REVISION HISTORY	Linux Interface Specification Device Driver UIO User's Manual: Software

Rev.	Date	Description	
		Page	Summary
2.55	Aug. 26, 2021	-	First edition for Gen3e devices Support kernel v5.10.41
3.00	Dec. 10, 2021	-	Add Kernel v5.10.41 support
		1, 2, 4, 6, 7	Add support for IMR-LX4 module

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