User's Manual

Linux Interface Specification Device Driver GPIO

User's Manual: Software

RZ/G2 Group

Renesas Electronics
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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.

How to Use This Manual

1. Purpose and Target Readers

This document is designed to provide the user with an understanding of the software development environment for RZ/G2 Group processors. It is intended for users developing software incorporating the processors. A basic knowledge of software development and Linux systems is necessary in order to use this document.

> Particular attention should be paid to the precautionary notes when using the manual. These notes occur within the body of the text, at the end of each section, and in the Usage Notes section.

> The revision history summarizes the locations of revisions and additions. It does not list all revisions. Refer to the text of the manual for details.

The following documents apply to the RZ/G2 Group. Make sure to refer to the latest versions of these documents. The newest versions of the documents listed may be obtained from the Renesas Electronics Web site.

Document Type	Description	Document Title	Document No.
Verified Linux Package user's manual	Describes all basic steps to use Yocto build environment with Verified Linux Package	RZ/G Verified Linux Package for 64bit kernel Version 1.0.x Release Note	R01TU0277EJxxxx
Application note	Describes the procedure to develop application software with GStreamer and Qt	RZ/G2 Group Application Note	R01US0429EJxxxx
	Describes build steps using Yocto build environment without Verified Linux Package	Linux Interface Specification Yocto recipe Start-Up Guide	R01US0398EJxxxx
Hardware user's manual	Describes common specifications.	RZ/G Series, 2nd Generation User's Manual: Hardware	R01UH0808EJxxxx

2. List of Abbreviations and Acronyms

Abbreviation	Description
AHCl	Advanced Host Controller Interface
ALSA	Advanced Linux Sound Architecture
ATA	Advanced Technology Attachment
BSP	Board Support Package
CPRM	Content Protection for Recordable Media
DMA	Direct Memory Access
DMAC	DMA Controller
DRM	Direct Rendering Manager
DU	Display Unit on RZ/G
EHCI	Enhanced Host Controller Interface
eMMC	Embedded Multi Media Card
FB	Framebuffer
GLSL	OpenGL Shading Language
GPIO	General Purpose Input/Output interface
GPL	GNU General Public License
gPTP	Generalized Precision Time Protocol
GUI	Graphical User Interface
HSCIF	High Speed Serial Communications Interface with FIFO
I2C	Inter-Integrated Circuit
LGPL	GNU Lesser General Public License
MMC	Multi Media Card
MMCIF	Multi Media Card Interface H/W module
MMP	Multi Media Package
MSIOF	Clock-Synchronized Serial Interface with FIFO
MTD	Memory Technology Device
NCQ	Native Command Queuing
OHCI	Open Host Controller Interface
OSS	Open Source Software

PCI	Peripheral Component Interconnect
PCIe	PCI Express
PCIEC	PCIe host controller
PCM	Pulse Code Modulation
PTP	Precision Time Protocol
QSPI	Quad Serial Peripheral Interface
SATA	Serial Advanced Technology Attachment
SCIF	Serial Communications Interface with FIFO
SD	Secure Digital
SDIO	Secure Digital Input/Output
SPI	Serial Peripheral Interface
SRC	Sampling Rate Converter
SSI	Serial Sound Interface
USB	Universal Serial Bus
V4L2	Video for Linux2
VLP	Verified Linux Package
VSPD	VSP for DU
xHCI	Extensible Host Controller Interface

3. Conventions

Command line run on Linux host PC will be shown as below:

```
$ echo "This is command line run on x86-64 Linux PC"
```

Command line run on target board will be shown as below:

```
# echo "This is command line run on ARM board"
```

File content will be shown as below:

```
<$WORK/a script>
#!/bin/bash
echo "This is content in a file"
```

Table of Contents

1. Overview

1.1 Overview

This manual explains the driver module (this module) that controls the GPIO on RZ/G Series, 2nd Generation.

Note: Currently, RZ/G2E, RZ/G2M v1.3, RZ/G2M v3.0, RZ/G2N, RZ/G2H with reference boards EK874 (Revision C and E), HiHope-RZG2M, HiHope-RZG2N, HiHope-RZG2H are supported.

1.2 Function

This module controls GPIO on RZ/G2 Group, support following function.

- Support selection of input/output in GPIO pin.
- Support reading state of high/low in Input pin.
- Support setting high/low value in Output pin.
- Support detection of interrupt (high level, low level, rising edge, falling edge and both edge).

1.2.1 Supported pin

GPIO supported pin on RZ/G2E, RZ/G2M v1.3, RZ/G2M v3.0, RZ/G2N and RZ/G2H device are shown in table 1-1.

Table 1-1 GPIO supported pin (RZ/G2E, RZ/G2M v1.3, RZ/G2M v3.0, RZ/G2N and RZ/G2H)

	RZ/G2E [Total: 132 pins]		**RZ/G2M v1.3, RZ/G2M v3.0, RZ/G2N and RZ/G2H [Total: 156 pins]**	
GPIO bank	**Number of bank**	**Pin range**	**Number of bank**	**Pin range**
GPIO-0	18	GP-0-0 … GP-0-17	16	GP-0-0 … GP-0-15
GPIO-1	23	GP-1-0 … GP-1-22	29	GP-1-0 … GP-1-28
GPIO-2	26	GP-2-0 … GP-2-25	15	GP-2-0 … GP-2-14
GPIO-3	16	GP-3-0 … GP-3-15	16	GP-3-0 … GP-3-15
GPIO-4	11	GP-4-0 … GP-4-10	18	GP-4-0 … GP-4-17
GPIO-5	20	GP-5-0 … GP-5-19	26	GP-5-0 … GP-5-25
GPIO-6	18	GP-6-0 … GP-6-17	32	GP-6-0 … GP-6-31
GPIO-7	-	-	4	GP-7-0 … GP-7-3

1.2.2 Connected device

GPIO connected device on RZ/G2E, RZ/G2M v1.3, RZ/G2M v3.0, RZ/G2N and RZ/G2H are shown in below tables.

Table 1-2 GPIO connected device for RZ/G2E, board EK874

GPIO pin		device/method
Revision C	**Revision E**	
GP-5-19	GP-5-19	LEDs
GP-3-14	GP-3-14	
GP-4-10	GP-5-16	
GP-6-04	GP-6-04	

Table 1-3 GPIO connected device for RZ/G2M v1.3, RZ/G2M v3.0, RZ/G2N and RZ/G2H board HiHope-RZG2M, HiHope-RZG2N and HiHope-RZG2H.

GPIO pin	device/method
GP-6-13	Tact Switches or LEDs
GP-6-12	(Tactile Switches is shared with LEDs)
GP-6-11	
GP-0-0	

1.3 Reference

1.3.1 Standard

There is no supported standard in this module.

1.3.2 Related document

There is no related document in this module.

1.4 Restrictions

There is no restriction in this module

2. Terminology

The following table shows the terminology related to this module.

Table 2-1 Terminology

Terms	Explanation
GPIO	General Purpose Input/Output interface

3. Operating Environment

3.1 Hardware Environment

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

Table 3-1 Hardware specification (RZ/G2E, RZ/G2M v1.3, RZ/G2M v3.0, RZ/G2N and RZ/G2H)

Name	Version	Manufacture
RZ/G2E System Evaluation Board EK874	C, E	Silicon Linux
RZ/G2M v1.3 System Evaluation Board HiHope-RZG2M	-	Hoperun Technology
RZ/G2M v3.0 System Evaluation Board HiHope-RZG2M	-	Hoperun Technology
RZ/G2N System Evaluation Board HiHope-RZG2N	-	Hoperun Technology
RZ/G2H System Evaluation Board HiHope-RZG2H	-	Hoperun Technology

3.2 Module Configuration

The following figure shows the configuration of this module.

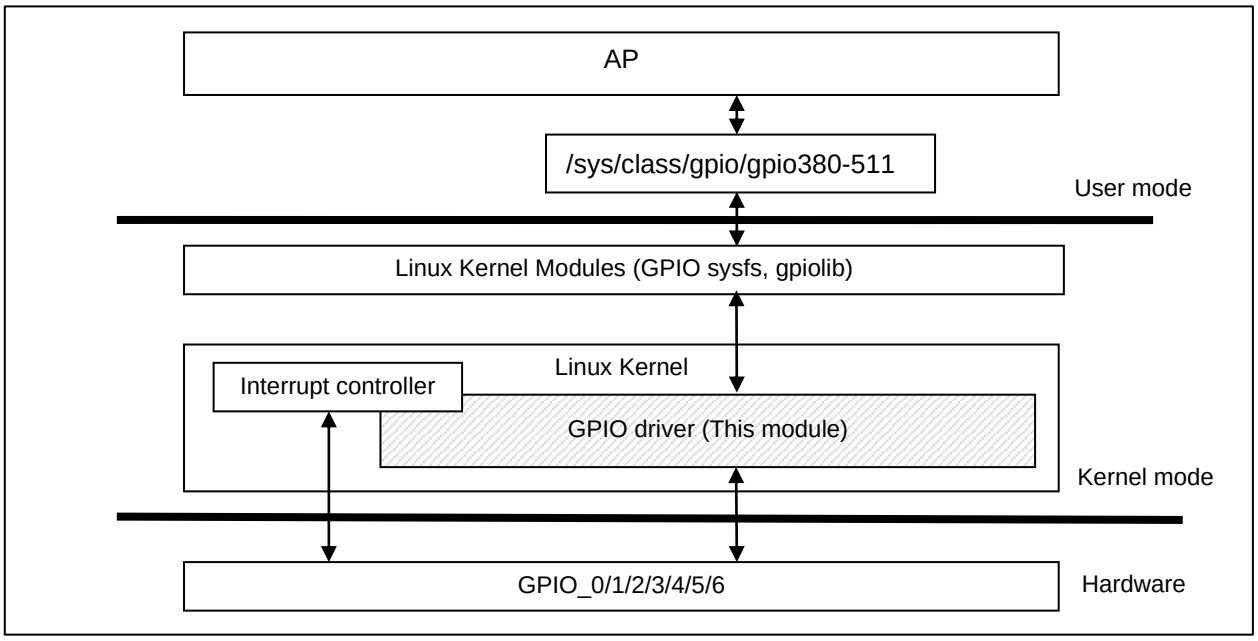


Figure 3-1 Module configuration (RZ/G2E)

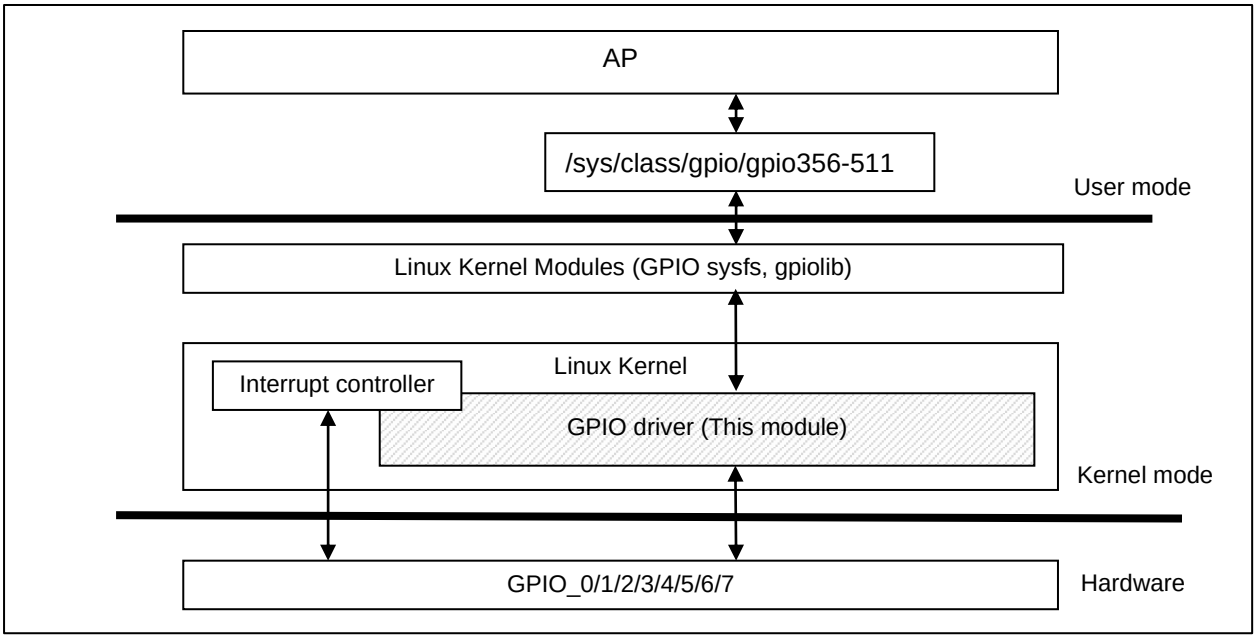


Figure 3-3 Module configuration (RZ/G2M v1.3, RZ/G2M v3.0, RZ/G2N, RZ/G2H)

3.3 State Transition Diagram

There is no state transition diagram for this module

4. External Interface

4.1 sysfs interface

The external interface of this module is based on Linux. The interface for operating GPIO pin from a user land is GPIO sysfs. Device node of this module is shown below.

Table 4-1 GPIO device node (RZ/G2E)

GPIO bank	Name of pin	device node
GPIO-0	GP-0-0 : GP-0-17	/sys/class/gpio/gpio494 : /sys/class/gpio/gpio511
GPIO-1	GP-1-0 : GP-1-22	/sys/class/gpio/gpio471 : /sys/class/gpio/gpio493
GPIO-2	GP-2-0 : GP-2-25	/sys/class/gpio/gpio445 : /sys/class/gpio/gpio470
GPIO-3	GP-3-0 : GP-3-15	/sys/class/gpio/gpio429 : /sys/class/gpio/gpio444
GPIO-4	GP-4-0 : GP-4-10	/sys/class/gpio/gpio418 : /sys/class/gpio/gpio428
GPIO-5	GP-5-0 : GP-5-19	/sys/class/gpio/gpio398 : /sys/class/gpio/gpio417
GPIO-6	GP-6-0 : GP-6-17	/sys/class/gpio/gpio380 : /sys/class/gpio/gpio397

Table 4-2 GPIO device node (RZ/G2M v1.3, RZ/G2M v3.0, RZ/G2N and RZ/G2H)

GPIO bank	Name of pin	device node
GPIO-0	GP-0-0 : GP-0-15	/sys/class/gpio/gpio496 : /sys/class/gpio/gpio511
GPIO-1	GP-1-0 : GP-1-28	/sys/class/gpio/gpio467 : /sys/class/gpio/gpio495
GPIO-2	GP-2-0 : GP-2-14	/sys/class/gpio/gpio452 : /sys/class/gpio/gpio466
GPIO-3	GP-3-0 : GP-3-15	/sys/class/gpio/gpio436 : /sys/class/gpio/gpio451
GPIO-4	GP-4-0 : GP-4-17	/sys/class/gpio/gpio418 : /sys/class/gpio/gpio435
GPIO-5	GP-5-0 : GP-5-25	/sys/class/gpio/gpio392 : /sys/class/gpio/gpio417
GPIO-6	GP-6-0 : GP-6-31	/sys/class/gpio/gpio360 : /sys/class/gpio/gpio391
GPIO-7	GP-7-0 : GP-7-3	/sys/class/gpio/gpio356 : /sys/class/gpio/gpio359

4.2 Interface specification

This section explains in the following format about the functions this module supplies.

[Overview] Presents an overview of a function.

[Function Name] Explains the name of the function.

[Calling format] Explains the format for calling the function.

[Argument] Explains the argument(s) of the function.

[Return value] Explains the return value(s) of the function.

[Feature] Explains the features of the function.

[Remark] Explains points to be noted when using the function.

Table 4-2 List of interface specification

Chapter	Function Name	Description
4.2.1	gpio_request	Setting GPIO pin.
4.2.2	gpio_direction_input	GPIO pin is set as input pin
4.2.3	gpio_direction_output	GPIO pin is set as output pin
4.2.4	gpio_get_value	The state of GPIO pin get high or low.
4.2.5	gpio_set_value	The state of GPIO pin is set as high or low.
4.2.6	gpio_to_irq	Get number of irq in GPIO pin

Please include the following headers, when you use these functions.

```
#include <linux/gpio.h>
```

4.2.1 Setting GPIO pin

[Overview] Setting GPIO pin

[Function Name] gpio_request

[Calling format] int gpio_request(unsigned gpio, const char *label);

[Argument] gpio: Set GPIO pin number (refer to 4.3 Definitions)
label: Set NULL

[Return value] 0 : success
-EPROBE_DEFER : Driver requests probe retry.
-EINVAL : Invalid argument.

[Feature] GPIO pin specified by gpio of the first argument is set up.

[Remark]

4.2.2 GPIO pin is set as input pin

[Overview] GPIO pin is set as input pin.

[Function Name] gpio_direction_input

[Calling format] int gpio_direction_input(unsigned gpio)

[Argument] gpio: Set GPIO pin number(refer to 4.3 Definitions)

[Return value] 0 : success

[Feature] Specified GPIO pin is set as the input pin.

[Remark]

4.2.3 GPIO pin is set as output pin

[Overview] GPIO pin is set as output pin.

[Function Name] gpio_direction_output

[Calling format] int gpio_direction_output(unsigned gpio, int value);

[Argument] gpio: Set GPIO pin number(refer to 4.3 Definitions)
value: Output value of specified GPIO pin(0 or 1)

[Return value] 0 : success

[Feature] Specified GPIO pin is set as the output pin, and output setting of value.

[Remark]

4.2.4 The state of GPIO pin get high or low

[Overview] The state of GPIO pin get high or low.

[Function Name] gpio_get_value

[Calling format] int gpio_get_value(unsigned gpio)

[Argument] gpio: Set GPIO pin number(refer to 4.3 Definitions)

[Return value] 0 : state of GPIO pin is low
non-zero : state of GPIO pin is high

[Feature] The state of GPIO pin get high or low.

[Remark]

4.2.5 The state of GPIO pin is set as high or low

[Overview] The state of GPIO pin is set as high or low

[Function Name] gpio_set_value

[Calling format] void gpio_set_value(unsigned gpio, int value)

[Argument] gpio: Set GPIO pin number(refer to 4.3 Definitions)
value: Output value of specified GPIO pin(0 or 1)

[Return value] None.

[Feature] The state of GPIO pin is set as high or low

[Remark]

4.2.6 Get number of irq in GPIO pin

[Overview] Get number of irq in GPIO pin

[Function Name] gpio_to_irq

[Calling format] int gpio_to_irq(unsigned gpio)

[Argument] gpio: Set GPIO pin number(refer to 4.3 Definitions)

[Return value] integer value : number of irq
-ENXIO : No such device or address

[Feature] Get number of irq in GPIO pin

[Remark]

4.3 Definitions

A definitions of the GPIO Pins is described on device tree. The example of device tree is as follows.

4.3.1 Definitions of the GPIO Pins (RZ/G2E)

```
leds {
        compatible = "gpio-leds";
        led0 {
                gpios = <&gpio5 19 GPIO_ACTIVE_HIGH>;
                label = "LED0";
        };
        led1 {
                gpios = <&gpio3 14 GPIO_ACTIVE_HIGH>;
                label = "LED1";
        };
        led2 {
                gpios = <&gpio4 10 GPIO_ACTIVE_HIGH>;
                label = "LED2";
        };
        led3 {
                gpios = <&gpio6 4 GPIO_ACTIVE_HIGH>;
                label = "LED3";
        };
};
```

4.3.2 Definitions of the GPIO Pins (RZ/G2M v1.3, RZ/G2M v3.0, RZ/G2N, RZ/G2H)

```
leds {
        compatible = "gpio-leds";

        led0 {
                gpios = <&gpio6 11 GPIO_ACTIVE_HIGH>;
        };
        led1 {
                gpios = <&gpio6 12 GPIO_ACTIVE_HIGH>;
        };
        led2 {
                gpios = <&gpio6 13 GPIO_ACTIVE_HIGH>;
        };
        led3 {
                gpios = <&gpio0 0 GPIO_ACTIVE_HIGH>;
        };
};
```

The format of a "gpios" property is as follows.

The 1st cell is a node or label of GPIO device to be used.
The 2nd cell contains the identifying number for the GPIO Pin in the node.
The 3rd cell is the flags, encoded as follows:
GPIO_ACTIVE_HIGH = active high level-sensitive
GPIO_ACTIVE_LOW = active low level-sensitive

4.3.3 Get definitions of the GPIO Pins

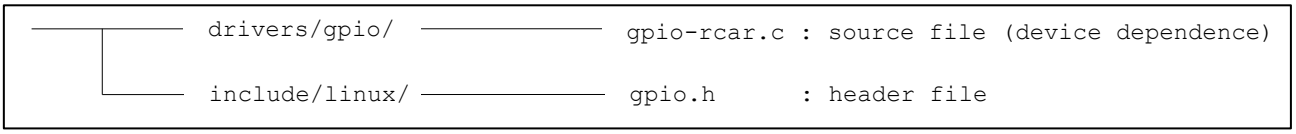
```
struct device_node *np;
int port,

np = of_find_node_by_path("/leds");
port = of_get_gpio(np, 2);
```

5. Integration

5.1 Directory Configuration

The directory configuration is shown below.



5.2 Integration Procedure

5.2.1 Kernel configuration

To enable the function of this module, make the following setting with Kernel Configuration.

```
-*- GPIO Support  --->
    Memory mapped GPIO drivers  --->
        <*> Renesas R-Car GPIO
```

When using GPIO sysfs, make the following setting with Kernel Configuration.

```
-*- GPIO Support  --->
    [*]   /sys/class/gpio/... (sysfs interface)
```

For G2N, make the following setting with leds Configuration.

```
-*- GPIO Support  --->
    [*]   /sys/class/leds/...
```

5.3 Option Setting

5.3.1 Module parameters

There are no module parameters.

5.3.2 Kernel parameters

There are no kernel parameters.

REVISION HISTORY		Linux Interface Specification Device Driver GPIO User's Manual: Software	
Rev.	**Date**	**Description**	
		Page	**Summary**
1.00	Apr. 10, 2019	—	First Edition issued
1.01	Jun. 27, 2019	—	Add G2M v1.3 support
1.02	Oct. 15, 2019	—	Add G2N support
1.03	Jan. 10, 2020	—	No modification, change version to keep consistent with other documents
1.04	Jun. 15, 2020	—	Add G2H support
1.05	Aug. 17, 2020	—	Add G2M v3.0 support
1.06	Nov. 16, 2020	—	No modification, change version to keep consistent with other documents
1.07	Feb. 26, 2021	—	Add information about EK874 Revision E board (RZ/G2E)
1.08	May. 31, 2021	1	Support EK874 Revision E board (RZ/G2E) officially
1.09	Aug. 31, 2021	—	No modification, change version to keep consistent with other documents
1.10	Nov. 15, 2021	—	No modification, change version to keep consistent with other documents
1.11	Feb. 28, 2022	—	No modification, change version to keep consistent with other documents

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User's Manual: Software

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