User's Manual

RENESAS

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Linux Interface Specification Device Driver PWM

User's Manual: Software

R-Car H3/M3/M3N/E3/D3/V3U/V3H Series

Renesas Electronics
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Rev.3.1.0 Dec. 2023

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(Rev.5.0-1 October 2020)

Corporate Headquarters

TOYOSU FORESIA, 3-2-24 Toyosu,
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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/V3U/V3H processor.

- **[Purpose]**
  This manual is intended to give users an understanding of the functions of the R-Car H3/M3/M3N/E3/D3/V3U/V3H 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/V3U/V3H
  → See the R-Car H3/M3/M3N/E3/D3/V3U/V3H User's Manual.
  — To know the electrical specifications of the multimedia processor for R-Car H3/M3/M3N/E3/D3/V3U/V3H
  → See the R-Car H3/M3/M3N/E3/D3/V3U/V3H 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 bit
  Word … 32 bits
  Half word ... 16 bits
  Byte ... 8 bits

Table of Contents

1. Overview

Overview

This manual explains the driver module (this module) that controls the PWM timer on R-Car H3/M3/M3N/E3/D3/V3U/V3H (including PWM mode in TPU driver).

1.1 Function

This module controls the PWM timer and TPU with PWM mode on R-Car H3/M3/M3N/E3/D3/V3U/V3H. The following functionality is supported:

1.2

For PWM driver:

- Output continuous high-level width of signal.
- The settable range of period is from 30ns to 2.15s (0x7FFF-FFFF ns). This limitation is due to sysfs framework.
- The settable range of duty_cycle is from 15ns to the value of period.

For TPU driver:

- PWM mode allows the output of a PWM waveform with any duty cycle.
- The four outputs can be used to produce PWM output in up to four phases.

Table 1.1 Support status of PWM (R-Car H3/M3/M3N/E3/D3/V3U/V3H)

Feature	Software support status
PWM output cycle settable (10 bits)	Supported
PWM output cycle settable within the range from 2 cycles to 2^{24} × 1023 cycles of internal bus clock (i.e. from 30ns to 257.5s when internal bus clock = 66.66 MHz)	Not supported (Output cycle is fixed from 30ns to 2.15s by sysfs framework)
High-level width of the PWM output signal settable (10 bits)	Supported
Continuous pulse output or single pulse output selectable	Supported

Table 1.2 Support status of TPU (R-Car V3U/V3H)

Feature	Software support status
PWM mode allows the output of a PWM waveform with any duty cycle	Supported
The four outputs can be used to produce PWM output in up to four phases	Supported
One interrupt request from TPU	Supported

Connected Port

Supported connector of this module is as follows.

Table 1.3 Supported connector (R-Car H3/M3/M3N)

Channel	Connector	Support status	Remark
PWM 0	-	No	-
PWM 1	CN19	Yes	-
PWM 2	CN28 (EXIO)	Yes	-
PWM 3	-	No	-
PWM 4	-	No	-
PWM 5	-	No	-
PWM 6	-	No	-

Table 1.4 Supported connector (R-Car E3)

Channel	Connector	Support status	Remark
PWM 0	-	No	-
PWM 1	-	No	-
PWM 2	-	No	-
PWM 3	CN39	Yes	-
PWM 4	-	No	-
PWM 5	CN19	Yes	-
PWM 6	PMIC	Yes	-

Table 1.5 Supported connector (R-Car D3)

Channel	Connector	Support status	Remark
PWM 0	CN19	Yes	-
PWM 1	CN39	Yes	-
PWM 2	-	No	-
PWM 3	-	No	-

Table 1.6 Supported connector (R-Car V3U)

Channel	Connector	Support status	Remark
PWM 0	-	No	-
PWM 1	-	No	-
PWM 2	-	No	-
PWM 3	-	No	-
PWM 4	-	No	-
TPU	CN4 (TPU0TO1)	Yes	-

Table 1.7 Supported connector (R-Car V3H)

Channel	Connector	Support status	Remark
PWM 0	-	No	-
PWM 1	-	No	-
PWM 2	-	No	-
PWM 3	-	No	-
PWM 4	-	No	-
TPU	-	No	-

Reference

1.4.1 Standard

There is no supported standard in this module.

1.4.2 Related document

1.4

The related document to this module are shown in a table

Table 1.8 Related document (R-Car H3/M3/M3N/E3/D3/V3U/V3H)

Number	Issue	Title	Edition	Date
-	Renesas Electronics	R-Car Series, 3rd Generation User's Manual: Hardware	Rev.2.20	Jun. 30, 2020
-	Renesas Electronics	R-CarH3-SiP System Evaluation Board Salvator-X Hardware Manual RTP0RC7795SIPB0011S	Rev.1.09	May. 11, 2017
-	Renesas Electronics	R-CarM3-SiP System Evaluation Board Salvator-X Hardware Manual RTP0RC7796SIPB0011S	Rev.0.04	Oct. 3, 2016
-	Renesas Electronics	R-CarH3-SiP/M3-SiP/M3N-SiP System Evaluation Board Salvator-XS Hardware Manual	Rev.2.04	Jul. 17, 2018
-	Renesas Electronics	R-CarE3 System Evaluation Board Ebisu Hardware Manual RTP0RC77990SEB0010S	Rev.0.03	Apr. 11, 2018
-	Renesas Electronics	R-CarE3 System Evaluation Board Ebisu-4D (E3 board 4xDRAM) Hardware Manual	Rev.1.01	Jul. 19, 2018
-	Renesas Electronics	R-CarE3 System Evaluation Board Ebisu-4D (E3 board 4xDRAM) Hardware Manual	Rev.1.01	Jul. 19, 2018
-	Renesas Electronics	R-Car V3U Series User's Manual	Rev.0.5	Jul. 31, 2020
-	Renesas Electronics	R-CarV3U System Evaluation Board Falcon Hardware Manual	Rev.0.01	Sep. 11, 2020
-	Renesas Electronics	R-Car V3H_2 Additional Document for User's Manual: Hardware	Rev.0.50	Jul. 31, 2020
-	Renesas Electronics	R-CarV3H System Evaluation Board Condor-I Hardware Manual	Rev.0.02	Nov. 11, 2019
-	Renesas Electronics	R-CarD3 System Evaluation Board Hardware Manual RTP0RC77995SEB0010S	Rev.1.20	Jul. 25, 2017

1.5

Restrictions

There are no restrictions.

2. Terminology

The following table shows the terminology related to this module.

Table 2.1 Terminology

Terms	Explanation
PWM	Pulse width modulation
TPU	Timer Pulse Unit
LVDS	Low voltage differential signaling

3. Operating Environment

Hardware Environment

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

Table 3.1 Hardware Environment (R-Car H3/M3/M3N/E3/D3/V3U/V3H)

Name	Version	Manufacture
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-CarV3U System Evaluation Board Falcon	-	Renesas Electronics
R-CarV3H System Evaluation Board Condor-I	-	Renesas Electronics
R-CarD3 System Evaluation Board Draak	-	Renesas Electronics

3.1

3.2 Module Configuration

The following figure shows the configuration of this module.

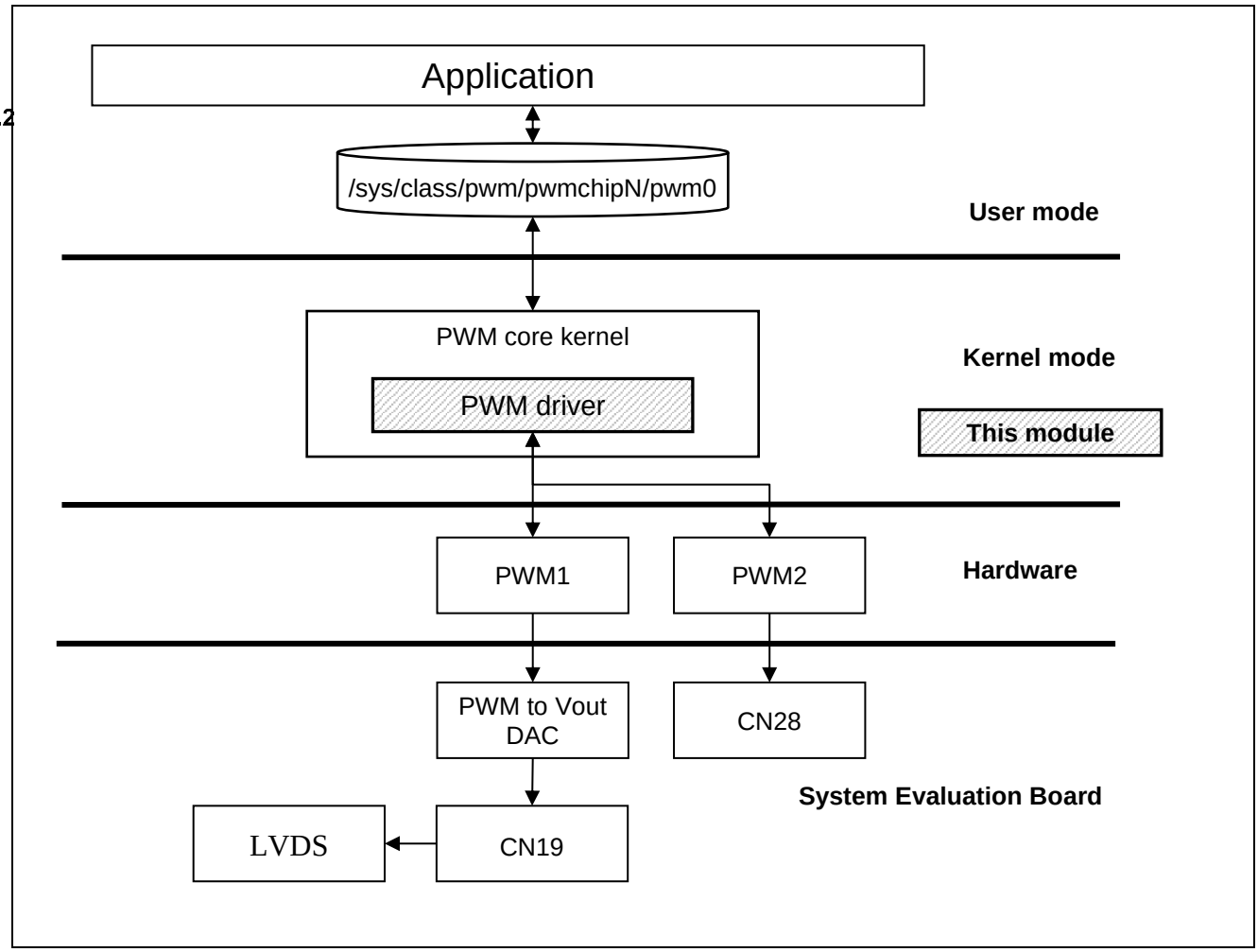

Figure 3.1 Module configuration (R-Car H3/M3/M3N)

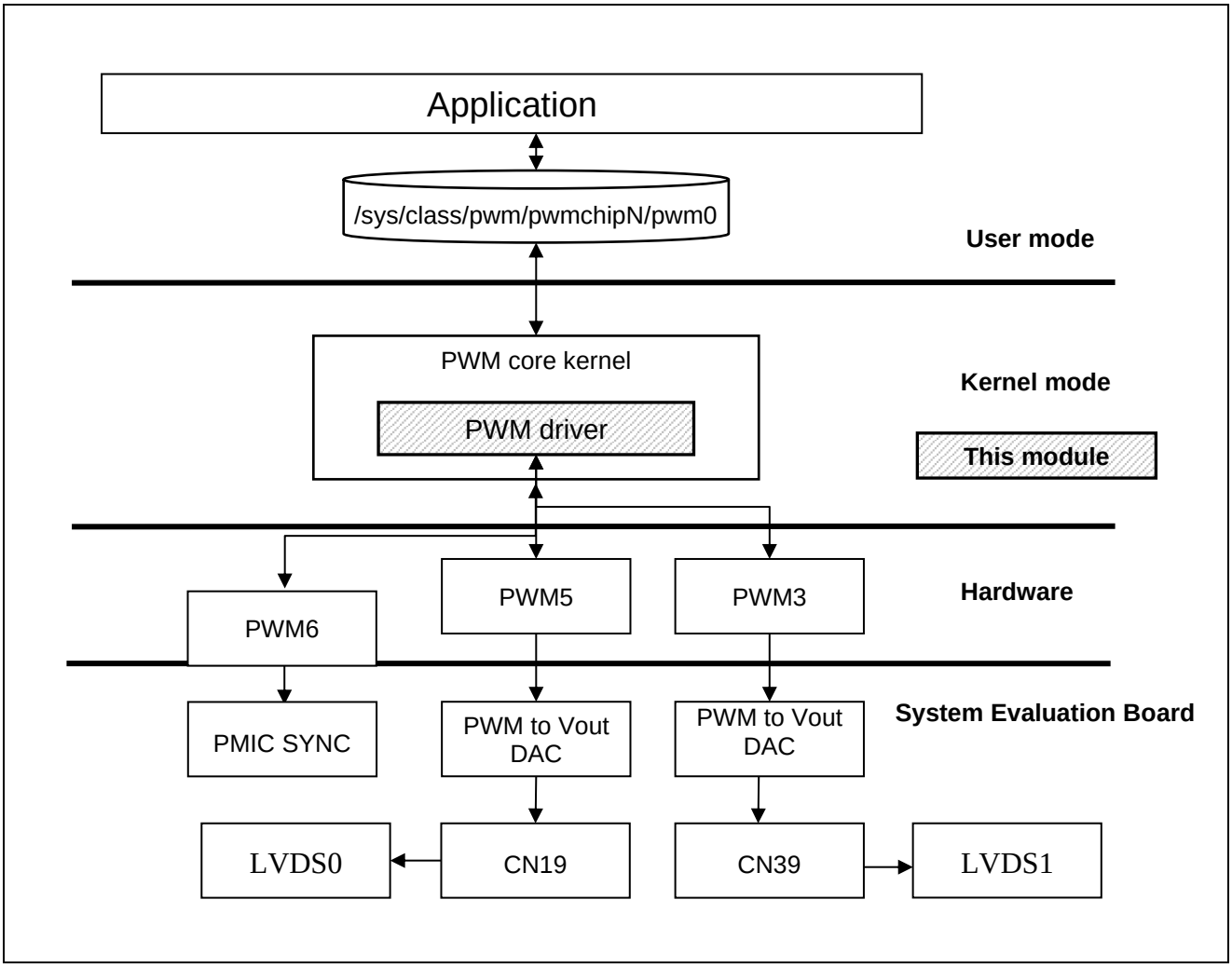

Figure 3.2 Module configuration (R-Car E3)

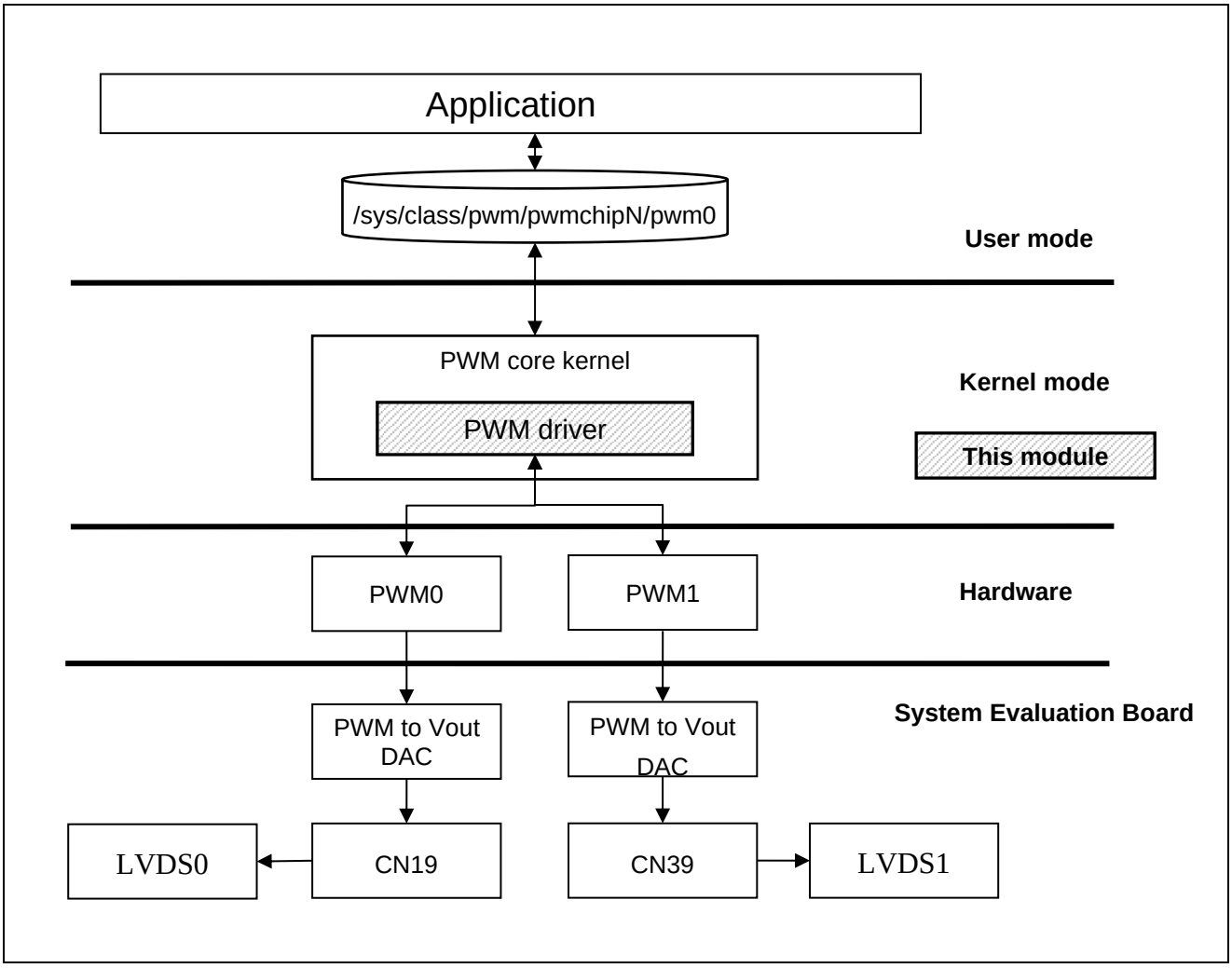

Figure 3.3 Module configuration (R-Car D3)

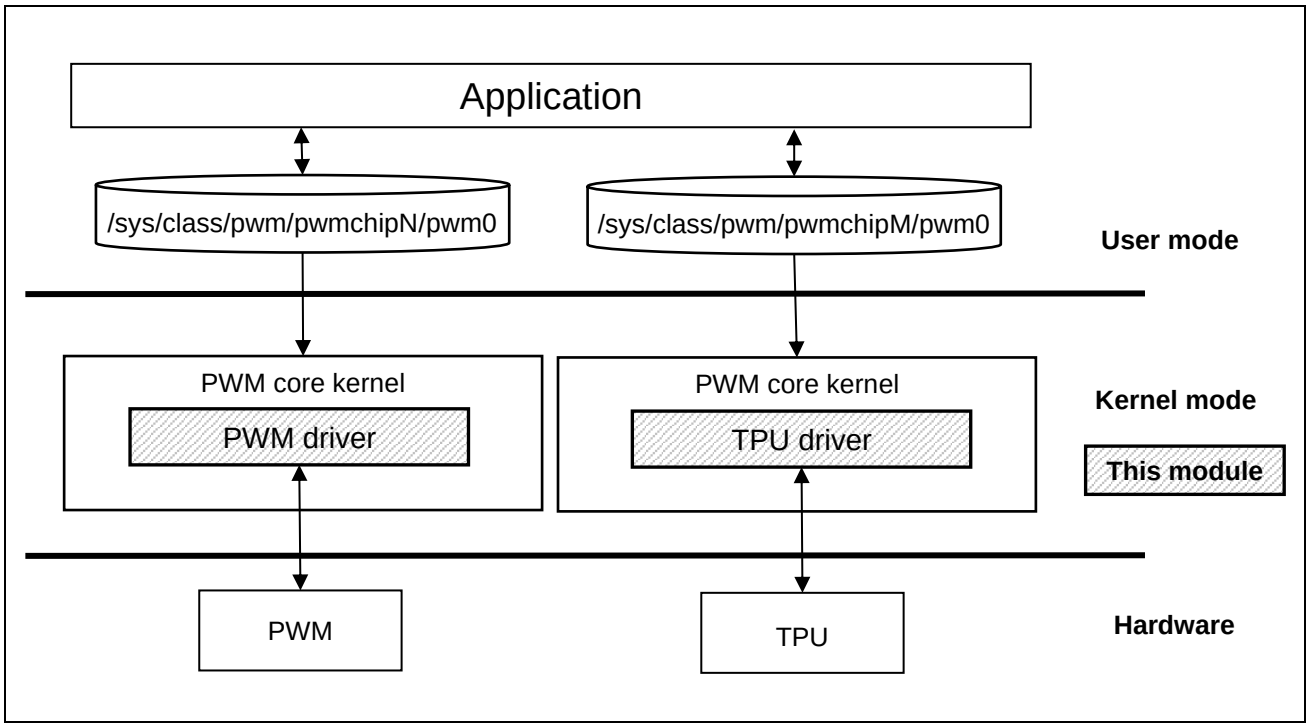

Figure 3.4 Module configuration (R-Car V3U/V3H)

State Transition Diagram

The duty ratio of a PWM output pulse can be obtained by setting a high-level period and a cycle. The timer channel counts the PWM clock signal pulses using a 10-bit counter to generate the PWM output pulse having the specified period and cycle. When the channel function is enabled (EN0 = 1), the timer outputs a high level until the counter value reaches the value set in the PH0 bits of the PWM count register (PWMCNT). The output goes low when the PH0 value is reached, and is held low until the counter value reaches the value set in the CYC0 bits of PWMCNT. When the CYC0 value is reached, the output goes high and the counter is reset.

3.3

Unless the channel function is enabled, the output is held high, and the counter is held in the reset state.

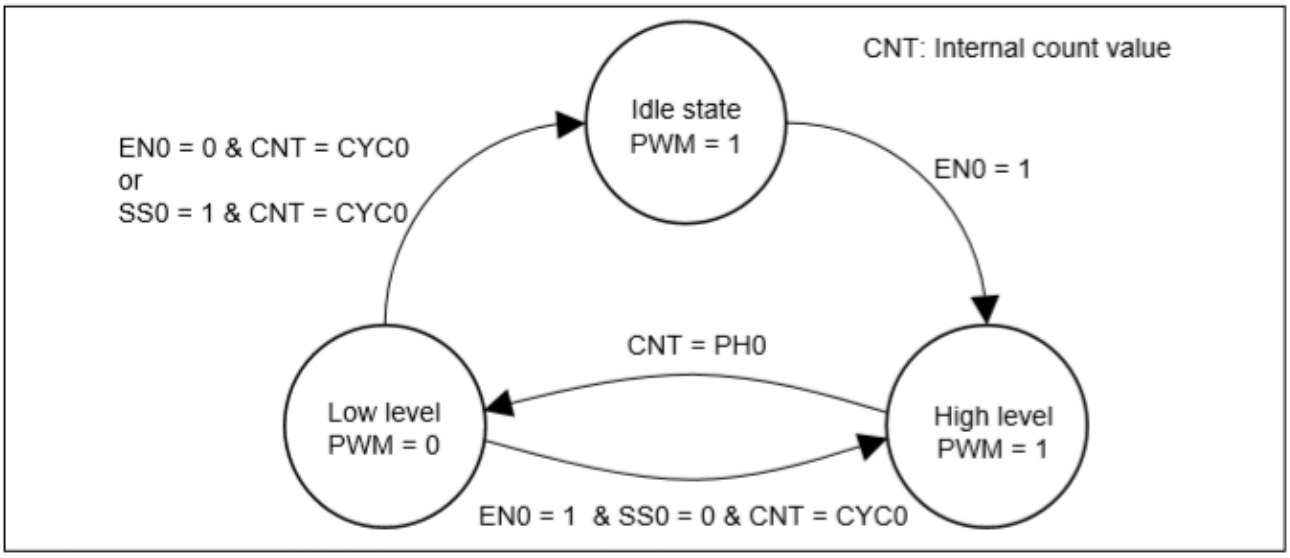

Figure 3.5 PWM Timer State Transition

4. External Interface

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

sysfs interface

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

Table 4.1 PWM device file (R-Car H3/M3/M3N)

4.1

PWM	Device Node
PWM1	/sys/class/pwm/pwmchip0/pwm0
PWM2	/sys/class/pwm/pwmchip1/pwm0

Table 4.2 PWM device file (R-Car E3)

PWM	Device Node
PWM3	/sys/class/pwm/pwmchip0/pwm0
PWM5	/sys/class/pwm/pwmchip1/pwm0
PWM6	/sys/class/pwm/pwmchip2/pwm0

Table 4.3 PWM device file (R-Car D3)

PWM	Device Node
PWM0	/sys/class/pwm/pwmchip0/pwm0
PWM1	/sys/class/pwm/pwmchip1/pwm0

Table 4.4 PWM device file (R-Car V3U/V3H)

PWM	Device Node
PWM0	/sys/class/pwm/pwmchip0/pwm0
PWM1	/sys/class/pwm/pwmchip1/pwm0
PWM2	/sys/class/pwm/pwmchip2/pwm0
PWM3	/sys/class/pwm/pwmchip3/pwm0
PWM4	/sys/class/pwm/pwmchip4/pwm0
TPU	/sys/class/pwm/pwmchip5/pwm0 /sys/class/pwm/pwmchip5/pwm1 /sys/class/pwm/pwmchip5/pwm2 /sys/class/pwm/pwmchip5/pwm3

The PWM sub-system provides a number of controls that can be accessed via /sys/class/pwm. **Table 4.5** shows specification in R-Car H3/M3/M3N/E3/D3/V3U/V3H. If you want to confirm the other interface, please see https://www.kernel.org/doc/Documentation/ABI/testing/sysfs-class-pwm.

Table 4.5 PWM sysfs device file (R-Car H3/M3/M3N/E3/D3/V3U/V3H)

PWM Sysfs Interface	Description	Support status	Notes
period	Sets the PWM signal period in nanoseconds	Yes	Need to set over 30. (*1)
duty_cycle	Sets the PWM signal duty cycle in nanoseconds.	Yes	Need to set period, before it is set. Need to set over 15. (*1)
enable	Enable/ disable the PWM signal.	Yes	Set period and duty_cycle, before it is set 1.
polarity	Invert output signal	No	PWM H/W does not support Invert function. So, this module cannot support. If it would be set, but value isn't applied.

Note:

*1) The minimum value of period and duty_cycle are depend on "div" value that calculated by the following step.
[Step1] satisfied div: period <= 2^div * 1023 * 10^9 / 66666664 (66.66MHz) (*2)
[Step2] minimum value: 2^div * 15.

ex) If period is set 100us (100,000ns), div equals 3 and minimum value is 120ns.

*2) If you use Salvator-XS board, the S3D4 clock is 66560000(66.56MHz).

*3) If you use Ebisu board, the S3D4Cϕ clock is 66.66 MHz.

*4) If you use Draak board, the S3D4ϕ clock is 66.66 MHz.

*5) If you use Falcon board, the S1D8ϕ clock is 66.66 MHz.

*6) If you use Condor board, the S0D12ϕ clock is 66.66 MHz.

4.1.1 Set up pwm device node

```
# cd /sys/class/pwm/pwmchip0
# echo 0 > export

# cd pwm0
# echo 10000 > period
# echo 5000 > duty_cycle
# echo 1 > enable
```

Figure 4.1 Set up PWM chip sys control (R-Car H3/M3/M3N/E3/D3/V3U/V3H)

5. Integration

Directory Configuration

The directory configuration is shown below.

5.1

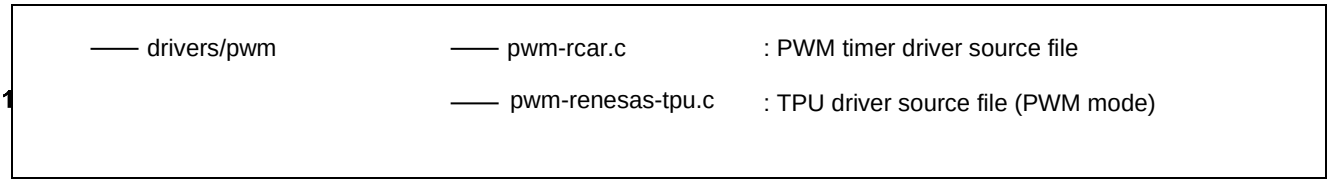

Figure 5.1 Directory configuration

Integration Procedure

5.2.1 Kernel Configuration

5.2

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

```
Device Drivesrs  --->
      [*] Pulse-Width Modulation (PWM) Support  ----
         <*> Renesas R-Car PWM support
         <*> Renesas TPU PWM support
```

Figure 5.2 Kernel configuration

5.3

Option Setting

5.3.1 Module Parameters

There are no module parameters

5.3.2 Kernel Parameters

There are no parameters.

REVISION HISTORY		Linux Interface Specification Device Driver PWM User's Manual: Software	
Rev.	**Date**	**Description**	
		Page	**Summary**
0.1	Nov. 20, 2015	—	New version
0.2	Apr. 15, 2016	All	Add R-Car M3 support.
		3	Table 2.1 Terminology Fix the explanation of PWM.
0.3	Aug. 5, 2016	2	Table 1.2 Add R-CarM3-SiP System Evaluation Board Salvator-X Hardware Manual
		4	Table 3.1 Add R-CarM3-SiP System Evaluation Board Salvator-X
0.4	Mar. 15, 2017	2	Table 1.3 Related documents. - Add R-Car Series, 3rd Generation User's Manual: Hardware - Add R-CarH3-SiP/M3-SiP System Evaluation Board Salvator-XS Hardware Manual
		4	Table 3.1 Hardware Environment - Add R-CarH3-SiP/M3-SiP System Evaluation Board Salvator-XS
		5	Table 4.2 PWM sysfs device file - Add Note description if you use Salvator-XS board.
0.5	Jun 14 2017	2	Table 1.3 Related documents. - Update R-Car Series, 3rd Generation User's Manual: Hardware
1.00	Aug. 8, 2017	All	Update document format.
1.01	Oct. 24, 2017	All	Add R-Car M3N support
1.50	Jan. 29, 2018	2	Update Related documents
1.51	Mar. 28, 2018	All	Add R-Car E3 support
		1	1.3 Connected Port (R-Car E3) - Add table 1.2 for R-Car E3 supported connectors
		2	1.4.2 Related documents. - Update Table 1.3 Related document (R-Car H3/M3/M3N/E3) - Add R-Car Series, 3rd Generation User's Manual: Hardware
		4	Table 3.1 Hardware Environment (R-Car R3/H3/M3N/E3) - Add R-Car-E3 System Evaluation Board Ebisu
		5	3.2 Module Configuration - Add Figure 3.2 Module configuration (R-Car E3)
		6	4.1 sysfs interface - Add Table 4.2 PWM device file (R-Car E3)
		6	Add Note description on clock for PWM in R-Car E3.
		7	Add PWM6 sysfs on R-Car E3
1.52	Oct. 29, 2018	2	Update Related documents
2.00	Dec. 25, 2018	2	Update Related documents
		4	Update Ebisu-4D in Hardware Environment
		-	Update Address List
2.01	Apr. 17, 2019	2	Update Related documents
		-	Update Address List
2.50	Sep. 25, 2020	All	Add R-Car V3U support
2.51	Dec. 1, 2020	2, 8	Add supported connector and device nodes for TPU
2.52	Jan. 29, 2021	-	Add R-Car V3H support
2.53	Apr. 21, 2021	-	- Add R-Car D3 support. - Add Kernel v5.10 support
3.00	Dec. 10,2021	-	Add Kernel v5.10.41 support
3.1.0	Dec. 25, 2023	-	Add Kernel v5.19.194 support for H3, M3, M3N, E3

Linux Interface Specification Device Driver PWM
User's Manual: Software

Publication Date: Rev.0.1 Nov. 20, 2015
Rev.3.1.0 Dec. 25, 2023

Published by: Renesas Electronics Corporation

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Renesas Electronics America Inc. Milpitas Campus
1001 Murphy Ranch Road, Milpitas, CA 95035, U.S.A.
Tel: +1-408-432-8888, Fax: +1-408-434-5351

Renesas Electronics America Inc. San Jose Campus
6024 Silver Creek Valley Road, San Jose, CA 95138, USA
Tel: +1-408-284-8200, Fax: +1-408-284-2775

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9251 Yonge Street, Suite 8309 Richmond Hill, Ontario Canada L4C 9T3
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Renesas Electronics Europe GmbH
Arcadiastrasse 10, 40472 Düsseldorf, Germany
Tel: +49-211-6503-0, Fax: +49-211-6503-1327

Renesas Electronics (China) Co., Ltd.
Room 101-T01, Floor 1, Building 7, Yard No. 7, 8th Street, Shangdi, Haidian District, Beijing 100085, China
Tel: +86-10-8235-1155, Fax: +86-10-8235-7679

Renesas Electronics (Shanghai) Co., Ltd.
Unit 301, Tower A, Central Towers, 555 Langao Road, Putuo District, Shanghai 200333, China
Tel: +86-21-2226-0888, Fax: +86-21-2226-0999

Renesas Electronics Hong Kong Limited
Unit 1601-1611, 16/F., Tower 2, Grand Century Place, 193 Prince Edward Road West, Mongkok, Kowloon, Hong Kong
Tel: +852-2265-6688, Fax: +852 2886-9022

Renesas Electronics Taiwan Co., Ltd.
13F, No. 363, Fu Shing North Road, Taipei 10543, Taiwan
Tel: +886-2-8175-9600, Fax: +886 2-8175-9670

Renesas Electronics Singapore Pte. Ltd.
80 Bendemeer Road, #06-02 Singapore 339949
Tel: +65-6213-0200, Fax: +65-6213-0300

Renesas Electronics Malaysia Sdn.Bhd.
Unit No 3A-1 Level 3A Tower 8 UOA Business Park, No 1 Jalan Pengaturcara U1/51A, Seksyen U1, 40150 Shah Alam, Selangor, Malaysia
Tel: +60-3-5022-1288, Fax: +60-3-5022-1290

Renesas Electronics India Pvt. Ltd.
No.777C, 100 Feet Road, HAL 2nd Stage, Indiranagar, Bangalore 560 038, India
Tel: +91-80-67208700

Renesas Electronics Korea Co., Ltd.
17F, KAMCO Yangjae Tower, 262, Gangnam-daero, Gangnam-gu, Seoul, 06265 Korea
Tel: +82-2-558-3737, Fax: +82-2-558-5338

Colophon 7.0

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http://www.renesas.com

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ルネサス エレクトロニクス株式会社 〒135-0061 東京都江東区豊洲3-2-24（豊洲フォレシア）

■技術的なお問合せおよび資料のご請求は下記へどうぞ。
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Linux Interface Specification
Device Driver PWM

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