# 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).

## 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:

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 224 × 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

### Standard

There is no supported standard in this module.

### Related document

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 |

## Restrictions

There are no restrictions.

# 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 |

# 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 |

## Module Configuration

The following figure shows the configuration of this module.

Application

**User mode**

PWM to Vout DAC

PWM1

**This module**

**Kernel mode**

**Hardware**

**System Evaluation Board**

PWM core kernel

PWM driver

/sys/class/pwm/pwmchipN/pwm0

CN19

LVDS

CN28

PWM2

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

PWM6

Application

**User mode**

PWM to Vout DAC

PWM5

**This module**

**Kernel mode**

**Hardware**

**System Evaluation Board**

PWM core kernel

PWM driver

/sys/class/pwm/pwmchipN/pwm0

CN19

LVDS0

PWM to Vout DAC

PWM3

CN39

LVDS1

PMIC SYNC

**Figure 3.2 Module configuration (R-Car E3)**

Application

**User mode**

PWM to Vout DAC

PWM0

**This module**

**Kernel mode**

**Hardware**

**System Evaluation Board**

PWM core kernel

PWM driver

/sys/class/pwm/pwmchipN/pwm0

CN19

LVDS0

PWM1

CN39

LVDS1

PWM to Vout DAC

**Figure 3.3 Module configuration (R-Car D3)**

|  |
| --- |
| Application  **User mode**  PWM  **This module**  **Kernel mode**  **Hardware**  PWM core kernel  PWM driver  /sys/class/pwm/pwmchipN/pwm0  /sys/class/pwm/pwmchipM/pwm0  PWM core kernel  TPU  TPU driver |

**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.

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

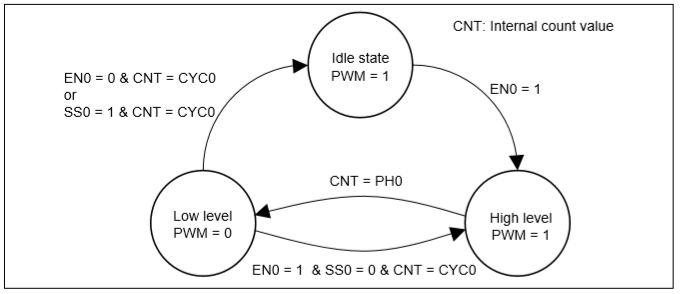


Figure .5 PWM Timer State Transition

# 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)**

|  |  |
| --- | --- |
| **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.

### 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)**

# Integration

## Directory Configuration

The directory configuration is shown below.

drivers/pwm

pwm-rcar.c

: PWM timer driver source file

pwm-renesas-tpu.c

: TPU driver source file (PWM mode)

Figure 5.1 Directory configuration

## Integration Procedure

### Kernel Configuration

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

## Option Setting

### Module Parameters

There are no module parameters

### Kernel Parameters

There are no parameters.