User's Manual

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Ethernet AVB Software Media Clock Recovery Handler

User's Manual: Software

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

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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 processor.

- **[Purpose]**
  This manual is intended to give users an understanding of the functions of the R-Car H3/M3/M3N/E3 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
  → See the R-Car H3/M3/M3N/E3 User's Manual.
  — To know the electrical specifications of the multimedia processor for R-Car H3/M3/M3N/E3
  → See the R-Car H3/M3/M3N/E3 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

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1. Overview

1.1 Overview

This manual explains the Media clock Recovery Handler module (MCH) that is a middleware of AVB Streaming in Ethernet AVB-IF on R-Car H3/M3/M3N/E3/D3 System Evaluation Board. The clock recovery function corrects the clock difference between devices.

1.2 Reference

1.2.1 Standard

The following table shows the document related to module.

Table 1.1 Standards

Number	Issue	Title	Edition	Date
IEEE Std 802.1BA-2011	IEEE STANDARDS ASSOCIATION	IEEE Standard for Local and metropolitan area networks - Audio Video Bridging (AVB) Systems	-	30 September 2011
IEEE Std 1722-2016	IEEE STANDARDS ASSOCIATION	IEEE Standard for a Transport Protocol Time-Sensitive Applications in Bridged Local Area Networks	-	7 December 2016

1.2.2 Related Document

The following table shows the document related to this module.

Table 1.2 Related documents

Number	Issue	Title	Edition	Date
-	Renesas Electronics	R-Car Series, 3rd Generation User's Manual: Hardware	Rev.2.30	Aug 2021
-	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-4D (E3 board 4xDRAM) Hardware Manual	Rev.1.01	Jul. 19, 2018
-	Renesas Electronics	R-CarD3 System Evaluation Board Draak Hardware Manual	Rev.1.20	July. 2017
-	Renesas Electronics	R-Car H3/M3/M3N/E3/D3 Series, Ethernet AVB Software Media Streaming Engine User's Manual: Software	Rev.2.30	Dec. 01, 2021

1.3 Restrictions

Nothing

1.4 Terminology

The following table shows the terminology related to this module.

Table 1.3 Terminology

Terms	Explanation
ADG	Audio Clock Generator
ALSA	Advanced Linux Sound Architecture
AVB	Audio Video Bridging
AVTP	Audio Video Transport Protocol (IEEE Std 1722)
CRF	Clock Reference Format (IEEE Std 1722)
DMAC	Direct Memory Access Controller
MSE	Media Streaming Engine
MAC	Media Access Control
PTP	Precision Time Protocol
SCU	Sampling rate Converter Unit
SSI	Serial Sound Interface
SRC	Sampling Rate Converter
VLAN	Virtual LAN (IEEE Std 802.1Q)

2. Operating Environment

2.1 Hardware Environment

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

Table 2.1 Hardware environment (R-Car H3/M3/M3N/E3/D3)

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-4D	-	Renesas Electronics
R-CarD3 System Evaluation Board Draak	-	Renesas Electronics

2.2 Module Configuration

The following figure shows the configuration of this module. MCH provides clock recovery function as a submodule of Media Steaming Engine (MSE).

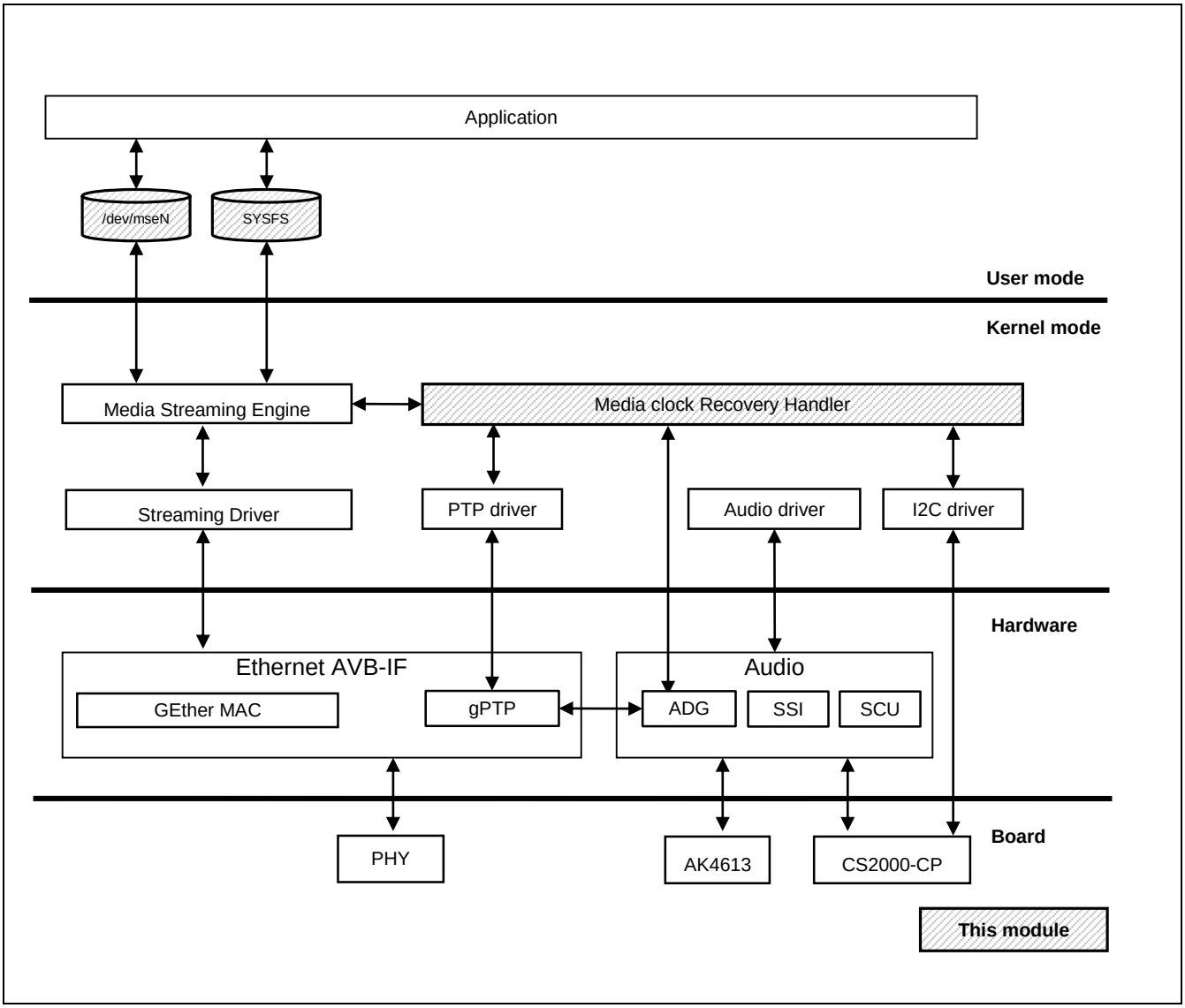

Figure 2.1 Module configuration

3. Function

This module is a sub-module of MSE, controls the Ethernet AVB-IF and clock source of Audio on the R-Car H3/M3/M3N/E3/D3.
The device that transmits the reference time information is called a "master", and the device that corrects the clock according to the time information of the "master" is called a "slave". Control of the clock source is done on the slave side.

3.1 Processing clock recovery of MCH

The function required on master side and slave side are different. This module has both functions. The functions on this module are the following list.

- Function of Master side
  - MCH is provide timestamp synchronized with audio clock to MSE. MSE generates AVTP frame or CRF frame based on this timestamp.

- Function of slave side
  - MCH is provide local gPTP time to MSE. MSE serializes received timestamp and local gPTP time.
  - MSE inputs the serialized time information to MCH. MCH is calculate the clock ratio from difference of timestamp sent by master and gPTP time of own device.
  - Control the audio clock source of its own device by clock difference ratio.

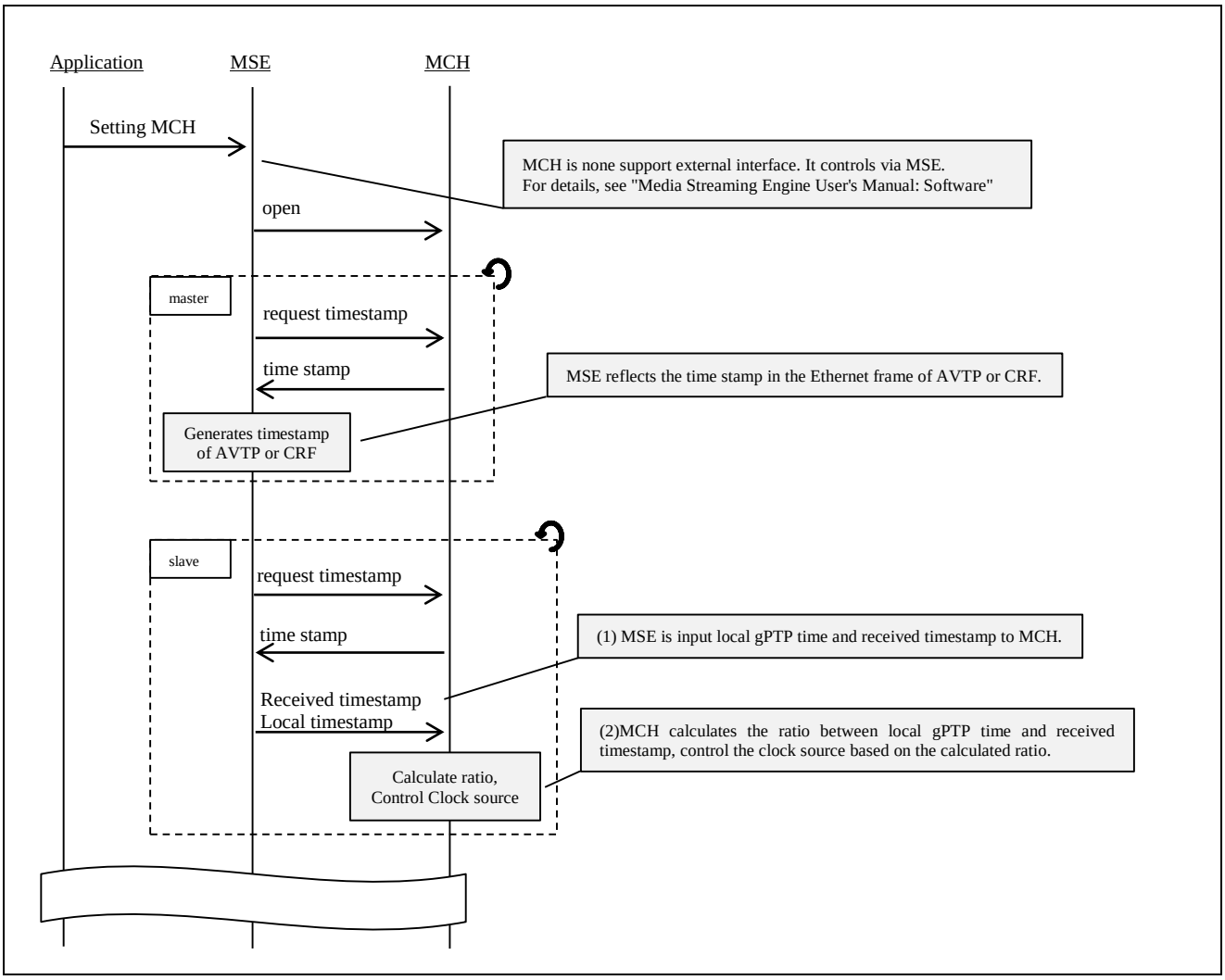

Figure 3.1 Processing clock recovery

3.2 Block Diagram of MCH (when streaming talker is master device)

Case where the talker device is master and listener device is slave is shown in Figure 3.2. Talker device send AVTP stream containing captured time stamp. Listener device corrects clock source from the comparison result between received time stamp and local time stamp. With this operation, the audio clock of slave is aligned with the audio clock of master.

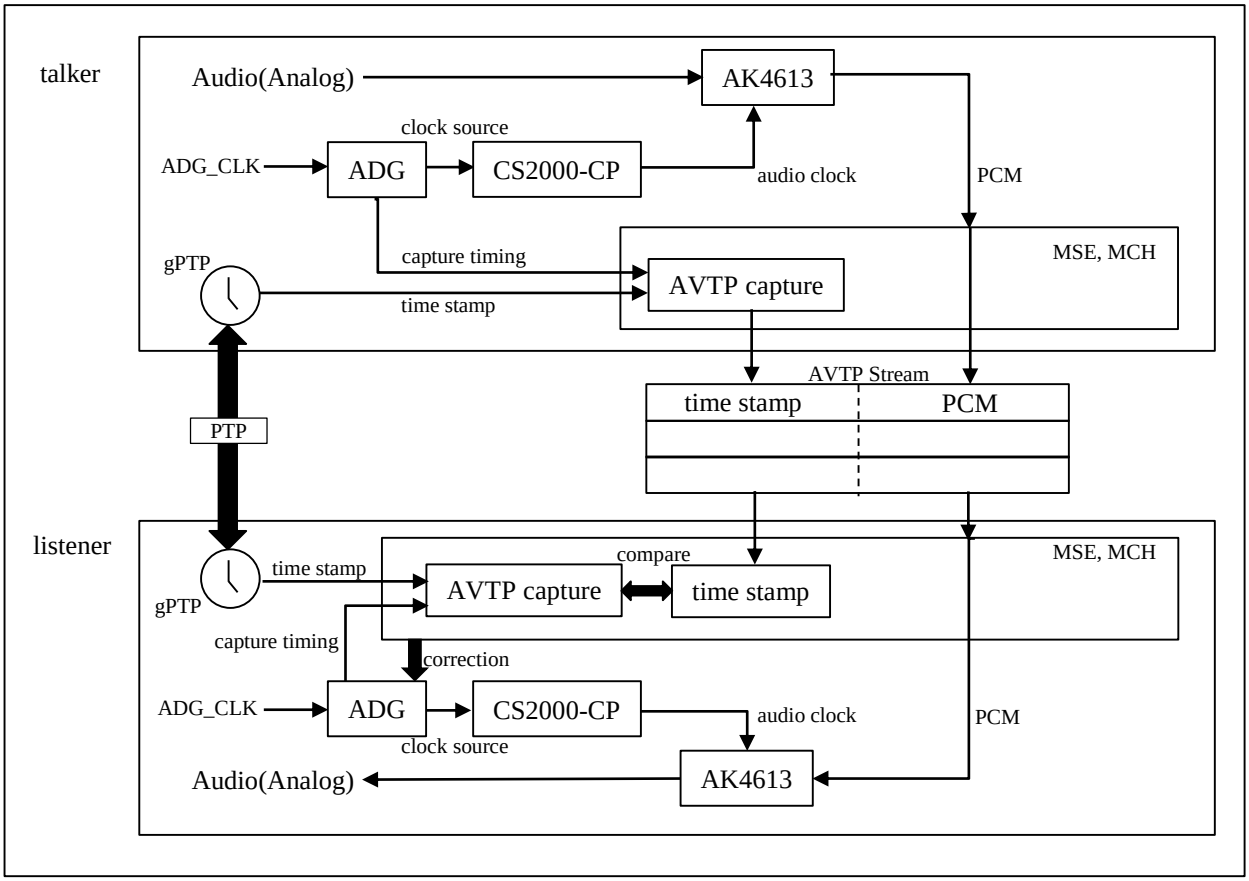

Figure 3.2 Streaming talker is master device of MCH

3.3 Block Diagram of MCH (when streaming listener is master device)

Case where the listener device is master and talker device is slave is shown in Figure 3.3. Talker device send AVTP stream. Listener device send CRF containing captured time stamp. Talker device corrects clock source from the comparison result between received time stamp and local time stamp. With this operation, the audio clock of slave is aligned with the audio clock of master.

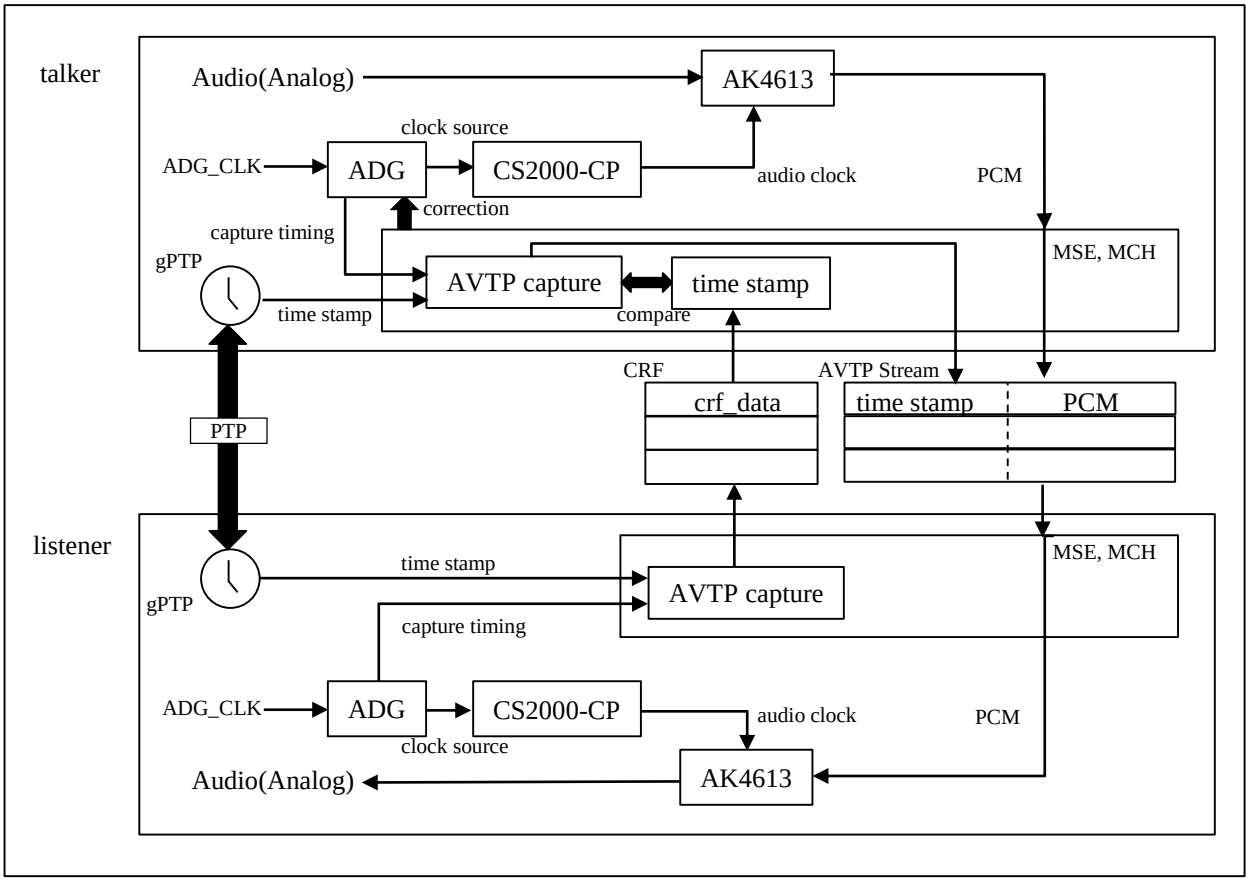

Figure 3.3 Streaming listener is master device of MCH

4. External Interface

None support the external interface of this module.

5. Integration

5.1 Directory Configuration

The directory configuration is shown below.

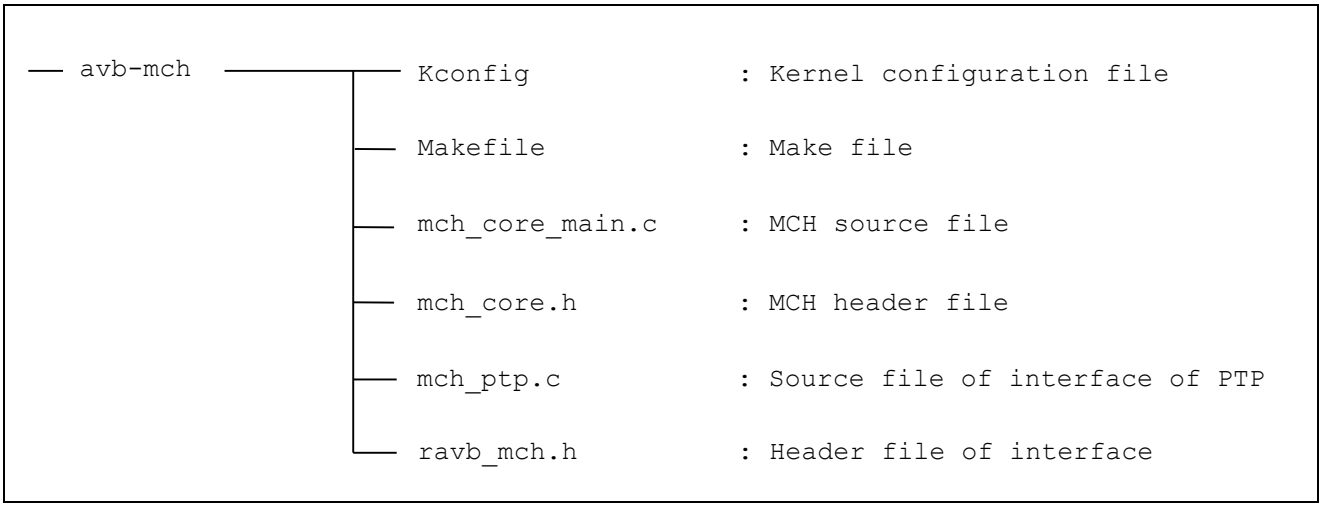

Figure 5.1 Directory configuration

5.2 Integration Procedure

5.2.1 Build kernel module only

Following operation is to build loadable modules.

step1. Build MCH as Linux loadable module.

```
# cd avb-mch
# make KERNEL_SRC=/path/to/linux
```

step2. Copy kernel modules. Next step integration, show 5.2.3

```
# cp mch_core.ko ${ROOTFS_PATH}
```

${ROOTFS_PATH} rootfs of target

5.2.2 Build MCH with the Linux kernel

Following operation is to build MCH with Linux Kernel.

step1. Copy source file to the Linux kernel source.

```
# cp -r ${MODULE_SOURCE}/ ${KERNEL_SOURCE}/drivers/staging/
```

${MODULE_SOURCE} MCH source directory
${KERNEL_SOURCE} Linux kernel source directory

step2. Edit ${KERNEL_SOURCE}/drivers/staging/Kconfig

```
menuconfig STAGING
        bool "Staging drivers"
        default n
        ---help---
  ...

source "drivers/staging/vc04_services/Kconfig"
source "drivers/staging/avb-mch/Kconfig"

endif # STAGING
```

add this line

step3. Edit ${KERNEL_SOURCE}/drivers/staging/Makefile

```
# Makefile for staging directory

  obj-y                                 += media/
  obj-$(CONFIG_SLICOSS)                 += slicoss/
...
  obj-$(CONFIG_BCM2708_VCHIQ)           += vc04_services/
  obj-$(CONFIG_AVB_MCH)                 += avb-mch/
```

add this line

step4. To enable the function of this module, make the following setting with Kernel Configuration. Then, rebuild kernel.

```
Device Drivers    --->
        [*] Staging drivers --->
                [*] AVB MCH --->
                        <*> MCH Core module        (#1)
```

Notes: #1 This example, generate a kernel built-in object. If select the <M>, build as loadable module.

step5. If select <M> with kernel configuration, to copy kernel modules. Next step integration, show 5.2.3

```
# cd ${KERNEL_SOURCE}/drivers/staging/avb-mch/
# cp mch_core.ko ${ROOTFS_PATH}
```

${ROOTFS_PATH} rootfs of target

5.2.3 Integration device

Following operation is to integrate MCH on target boards, and to check the integrated devices.

Integrate builded modules on target boards (both talker and listener boards).

```
# insmod mch_core.ko
```

To check devices of MCH, executes following commands.

```
# lsmod
Modules                 Size  Used by
mch_core                9307  0
```

5.3 Option Setting

5.3.1 Module Parameters

The module parameter that is defined in this module is shown below.

Table 5.1 Module parameters

Module	Module parameters	Default value	Range	Explanation
mch_core.ko	interface	"eth0"	-	Ethernet interface for MCH.
	avtp_cap_cycle	300	1 - avtp_clk_frq	AVTP capture cycle [per second] This value is the interrupt cycle, and if it is set to a large value, the system will be affected.
	avtp_clk_frq	0	-	AVTP clock frequency [Hz] This value is stored the calculation result of MCH.
	avtp_clk_name	"avb_counter0"	-	Clock source name
	sample_rate	48000	-	Sampling rate of PCM [Hz] MCH supports only 48000Hz
	avb_clk	0	[0 – 3]	AVB Clock select for avb_counter8[0]. 0: AVBCKR AUDIO_CLK 1: AVBCKR AUDIO_CLK1 2: AVBCKR AUDIO_CLK2 3: AVBCKR AUDIO_CLK3 It depends on design of board for Audio and CS2000-CP to select AVB clock. For example, D3/Draak board uses with avb_clk=1 (AUDIO_CLK1), other boards use with avb_clk=0 (AUDIO_CLK).

5.3.2 Kernel Parameters

There are no kernel parameters.

6. Example how to use the MCH

MCH operation depends on the following configuration parameter of MSE.

- "mch_config"
- "ptp_config"
- "media_audio_config"

For details of configuration parameter, see below.

Case 1: MCH is disable

In this case, when "mch_config/enable" is 0. Other configuration parameter and execution procedure for this case, see MSE User's manual, chapter 7.1.1 "How to send speaker test tone using MSE".

Case 2: MCH is enable, and talker device is master.

In this case, when "mch_config/enable" is 1, and "media_audio_config/crf_type" is "not use". Other configuration parameter and execution procedure for this case, see MSE User's manual, chapter 7.1.2 "How to send PCM audio data using MSE with MCH".

Case 3: MCH is enable, and listener device is master.

In this case, when "mch_config/enable" is 1, and "media_audio_config/crf_type" is "tx" or "rx". Other configuration parameter and execution procedure for this case, see MSE User's manual, chapter 7.1.3 "How to send PCM audio and Media clock from other device"

Note

- MCH controls the media clock on the premise that each device is time synchronized by PTP.
- "ptp_config/capture_ch" should be the same value as "avtp_cap_ch" which is the module parameter of MCH.
- "ptp_config/capture_freq" should be the same value as "avtp_cap_cycle" which is the module parameter of MCH.

REVISION HISTORY	Ethernet AVB Software Media Clock Recovery Handler User's Manual: Software

Rev.	Date	Description	
		Page	Summary
0.10	Jan. 13, 2017	-	First edition issued
0.20	Mar. 15. 2017	1	1.2.1 Standard Update of Table 1.1 - Update the version of IEEE Std 1722.
		1	1.2.2 Related Document Update of Table 1.2 - Update the version of related document.
		2	1.3 Restriction Remove restriction - Clock recovery operation is not performed.
		5	2.2 Module Configuration Update of Figure 2.1 - MCH do not use audio driver to accessing ADG. - MCH use I2C driver for accessing CS2000-CP.
		7	3.2 Block Diagram of MCH (when streaming talker is master device) Add new chapter - Add block diagram and outline.
		8	3.3 Block Diagram of MCH (when streaming listener is master device) Add new chapter - Add block diagram and outline.
		10	5.1 Directory Configuration Update of Figure 5.1 - Add new file: mch_core.h
		11	5.2.2 Build MCH with the Linux kernel Fixes copy and paste problem of example of the command below "cp -r ${MODULE_SOURCE}/ ${KERNEL_SOURCE}/drivers/staging"
		13	5.3.1 Module Parameters Add Table 5.1 - List and description of module parameters.
		14	6. Example how to use the MCH Add new chapter - Usage of MCH
1.00	Jul. 12. 2017	1	1.2.2 Related Document Update of Table 1.2 - Update the version of related document.
		8	3.3 Block Diagram of MCH (when streaming listener is master device) Update of Figure 3.3 - Add "time stamp" to AVTP Stream in the figure.
		13	5.3.1 Module Parameters Update of Table 5.1 - Delete parameter of avtp_cap_ch. - Change default value of avtp_clk_frq from 800000 to 796800. - Add support sampling rate.
1.10	Nov. 14, 2017	All	Add R-Car M3N support.
		1	1.2.2 Related Document Update of Table 1.2 - Update the version of related document.
1.20	Jan. 29, 2018	-	Update Arm trademark
		1	1.2.2 Related Document Update of Table 1.2 - Update the version of related document.
1.30	Feb. 22, 2018	All	Add R-Car E3 support.
		1	1.2.2 Related Document Update of Table 1.2 - Update the version of related document.

		7	3.2 Block Diagram of MCH(when streaming talker is master device) Update of Figure 3.2 - Change the ADG clock name from S0D1 to ADG_CLK.
		8	3.3 Block Diagram of MCH(when streaming listener is master device) Update of Figure 3.3 - Change the ADG clock name from S0D1 to ADG_CLK.
		13	5.3.1 Module Parameters Update of Table 5.1 - Update module parameters of avtp_clk_frq.
1.40	Sep. 26, 2018	1	1.2.2 Related Document Update of Table 1.2 - Update the version of related document.
2.00	Dec. 25, 2018	1	1.2.2 Related Document Update of Table 1.2 - Update the version of related document.
		4	2.1 Hardware Environment Update of Table 2.1 - Add Salvator-XS Board support. - Update name of R-CarE3 evaluation board from Ebisu Board to Ebisu-4D Board.
2.10	Apr.06, 2021	-	Update AddressList
2.20	Aug. 16, 2021	1,6	Add R-Car D3 support Table 1.2 Related documents - Add R-Car D3 Hardware Manual - Update title and revision of Ethernet AVB Software Media Streaming Engine User's Manual
		4	Table 2.1 Hardware environment (R-Car H3/M3/M3N/E3) - Add R-Car D3 System Evaluation Board Draak
2.30	Dec. 01, 2021	-	- Update Notice page
		1	- Table 1.2 Related documents: update version of "R-Car Series, 3rd Generation User's Manual: Hardware" from v1.00 to v2.30
		13	- Table 5.1 Module parameters: Add description for avb_clk Modify "avtp_clk_name": only support "avb_counter0"
2.31	Dec. 25, 2023	All	Update version of the document.

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http://www.renesas.com

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Colophon 3.1

Ethernet AVB Software
Media Clock Recovery Handler

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