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Linux Interface Specification Device Driver MSIOF

User's Manual: Software

R-Car H3/M3/M3N/E3/D3/V3U/V3H 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/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/D3V3U/V3H User's Manual.

— To know the electrical specifications of the multimedia processor for R-Car H3/M3/M3N/E3/D3V3U/V3H

→ See the R-Car H3/M3/M3N/E3/D3V3U/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 ... xxxx, 0bxxxx, or xxxxB

Decimal ... xxxx

Hexadecimal ... 0xxxxx or xxxxH

Data type: Double word ... 64 bit

Word ... 32 bits

Half word ... 16 bits

Byte ... 8 bits

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1. Overview

1.1 Overview

This manual explains the driver module (this module) that controls the MSIOF Interfaces on R-Car H3/M3/M3N/E3/D3/V3U/V3H.

1.2 Function

This module transmits/receives data to/from a device connected to MSIOF on the R-Car H3/M3/M3N/E3/D3/V3U/V3H. The following table lists the function of this module.

Table 1.1 Driver Function

Function	Support status (R-Car H3/M3/M3N/E3/D3/V3H)	Support status (R-Car V3U)
Number of channels	4	6
Channel	Ch0 ~ Ch3	Ch0 ~ Ch5
Master Mode	Support	
Slave Mode	Support	
DMA function	Support	
MSIOF Chip select signal	Hardware control	
Settable word size	8, 16, 32 bits	
Settable transfer size	Set multiple of the word size by byte unit.	
Module Clock	R-Car H3/M3/M3N/E3/D3/V3U/V3H: 12.5MHz (initial value) - 133.33MHz	
Max transfer frequency	For R-Car H3/M3/M3N/E3/D3/V3U/V3H: MSIOF_SCK clock cycle time (when master TX or slave RX): "Module Clock" / 4 MSIOF_SCK clock cycle time (when master RX or slave TX): "Module Clock" / 8 Please designate the set value which considered an electrical characteristic as the transfer rate designated by application. (refer to R-Car Series, "3rd Generation Additional Document for User's Manual: Hardware")	

When you would like to use DMA transfer, please set the transfer size to the value calculated by the following Equation1. Other sizes will transfer 256m by DMA and transfer the remainder by PIO.

DMA transfer size = $16 + 4n + 256m$. . . (Equation1)

n: 0, 1, 2, ~ 60

m: 0, 1, 2, ...

Ex)

In case of 510 bytes, 256 bytes will be transferred by DMA and 254 bytes will be transferred by PIO.

In case of 568 bytes, 256 bytes and 256 bytes and 56 bytes will be transferred by 3 times DMA.

In case of 266 bytes, 256 bytes will be transferred by DMA and 10 bytes will be transferred by PIO.

1.3 Connected device

This chapter describes the connected device to MSIOF. Please refer to the following tables for each device.

Table 1.2 MSIOF Connected device (R-Car H3/M3/M3N)

MSIOF Channel	Connected device	Support Status	Note
Ch0	None	No	—
Ch1	None	No	—
Ch2	None	No	—
Ch3	None	No	—

Table 1.3 MSIOF Connected device (R-Car E3)

MSIOF Channel	Connected device	Support Status	Note
Ch0	LVDS Control Connector – CN41	No	—
Ch1	None	No	—
Ch2	None	No	—
Ch3	None	No	—

Table 1.4 MSIOF Connected device (R-Car D3)

MSIOF Channel	Connected device	Support Status	Note
Ch0	None	No	—
Ch1	None	No	—
Ch2	LVDS Control Connector – CN41	No	—
Ch3	None	No	—

Table 1.5 MSIOF Connected device (R-Car V3U)

MSIOF Channel	Connected device	Support Status	Note
Ch0	None	No	—
Ch1	None	No	—
Ch2	None	No	—
Ch3	None	No	—
Ch4	None	No	—
Ch5	None	No	—

Table 1.6 MSIOF Connected device (R-Car V3H)

MSIOF Channel	Connected device	Support Status	Note
Ch0	CN17 - Multiplexed with JTAG2 signals	No	—
Ch1	None	No	—
Ch2	None	No	—
Ch3	None	No	—

Note : The MSIOF0, and other functions (e.g. DU_DRGB[1:0] functions) are multiplexed on the same pins as the JTAG2 functions due to the specifications of the R-CarV3H's pin function controller. Accordingly, when the JTAG2 functions are in use, the MSIOF0 and other functions are not available. Due to the specifications of the R-CarV3H's JTAG2 interface, the power-supply voltage to the VDDQ_DU pins must be 1.8 V when that interface is to be used. If you will be using the Condor-I board with an expansion board that requires a 3.3 V power supply voltage, the JTAG2 connector (CN26) will not be usable because of the difference in the power-supply voltage.

1.4 Reference

1.4.1 Standard

There are no reference documents on standards.

1.4.2 Related documents

The following table shows the document related to this module.

Table 1.7 Related documents (R-Car H3/M3/M3N/E3/D3/V3U/V3H)

Number	Issue	Title	Edition	Data
-	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-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, 2020
-	Renesas Electronics	R-CarD3 System Evaluation Board Hardware Manual RTP0RC77995SEB0010S	Rev.1.20	Jul. 25, 2017

1.5 Restriction

There is no restriction in this module.

1.6 Notice

When once of transmission exceeds 256 byte, it's possible to transfer with 2 group. (But present driver is not supported.)

When being used in 256 byte x 2group, a SS signal is asserted by the 512 byte unit.

When an asserting period of a SS signal requires more than 512 bytes, control by GPIO is needed.

The DTDL of SITMDR1/SIRMDR1 is set the fixed value (2 clock cycle delay) in case of R-Car H3 Ver.3.0 by the H/W specification.

2. Operating Environment

2.1 Hardware Environment

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

Table 2.1 Hardware specification (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

2.2 Module Configuration

The following figure shows the configuration of this module.

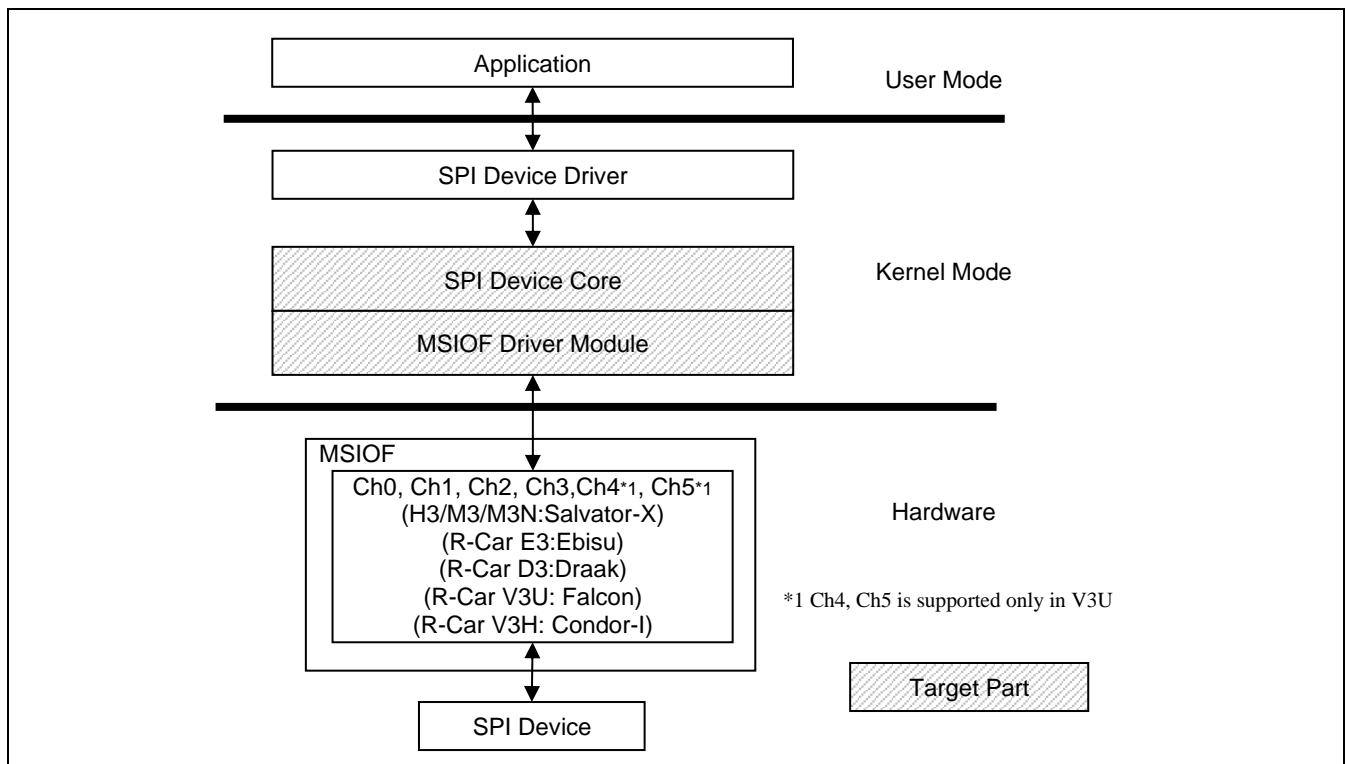


Figure 2.1 Module configuration (R-Car H3/M3/M3N/E3/D3/V3U/V3H)

2.3 State Transition Diagram

There is no state transition diagram for this module.

3. External Interface

Detailed explanation is skipped because the external interface of this module is based on Linux.

4. Integration

4.1 Directory Configuration

The directory configuration is shown below.

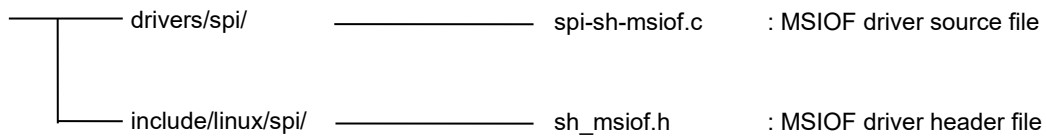


Figure 4-1 Directory Configuration (R-Car H3/M3/M3N/E3/D3/V3U/V3H)

4.2 Integration Procedure

Add the setting of the channel to be used.

Add "Pin Function", "Clock setting", "Channel Node setting", "sub node setting" to the device tree and add the compatible value of the sub node to spidev.c.

4.2.1 Device tree setting

Typical editing examples are shown below. The device tree file name varies depending on the board to be used. Please refer to the user's manual of Kernel Core for the device tree file name.

- Example for R-Car H3 Ver.3.0 or later(In case of Salvator-XS board)
File path: arch/arm64/boot/dts/renesas/r8a77951-salvator-xs-4x2g.dts
- Example for R-Car E3(In case of Ebisu board)
File path: arch/arm64/boot/dts/renesas/r8a77990-ebisu.dts
- Example for R-Car D3 (In case of Draak board)
File path: arch/arm64/boot/dts/renesas/r8a77995-draak.dts
- Example for R-Car V3U (In case of Falcon board)
File path: arch/arm64/boot/dts/renesas/r8a779a0-falcon.dts
- Example for R-Car V3H (In case of Condor-I board)
File path: arch/arm64/boot/dts/renesas/r8a77980-condor.dts

Edit the device tree as follows.

- 4.2.1.1 Pin Function setting
- 4.2.1.2 Clock setting
- 4.2.1.3 Channel Node setting
- 4.2.1.4 sub node setting

4.2.1.1 Pin Function setting

The editing contents are shown in Figure 4-2 (Example for r8a77951-salvator-xs-4x2g.dts).

```
&pfc {
    msiof0_pins: spi0 {
        groups = "msiof0_clk", "msiof0_sync",
                "msiof0_rxd", "msiof0_txd";
        function = "msiof0";
    };

    msiof1_pins: spi1 {
        groups = "msiof1_clk_c", "msiof1_sync_c",
                "msiof1_rxd_c", "msiof1_txd_c";
        function = "msiof1";
    };

    msiof2_pins: spi2 {
        groups = "msiof2_clk_b", "msiof2_sync_b",
                "msiof2_rxd_b", "msiof2_txd_b";
        function = "msiof2";
    };

    msiof3_pins: spi3 {
        groups = "msiof3_clk_d", "msiof3_sync_d",
                "msiof3_rxd_d", "msiof3_txd_d";
        function = "msiof3";
    };
};
```

Figure 4-2 Pin Function setting (Example for r8a77951-salvator-xs-4x2g.dts)

The editing contents are shown in Figure 4-3 (Example for r8a77990-ebisu.dts).

```
&pfc {
    msiof0_pins: spi0 {
        groups = "msiof0_clk", "msiof0_sync",
                "msiof0_rxd", "msiof0_txd";
        function = "msiof0";
    };
};
```

Figure 4-3 Pin Function setting (Example for r8a77990-ebisu.dts)

The editing contents are shown in Figure 4-4 (Example for r8a77995-draak.dts).

```
&pfc {  
    msiof0_pins: spi0 {  
        groups = "msiof0_clk", "msiof0_sync",  
                "msiof0_rxd", "msiof0_txd";  
        function = "msiof0";  
    };  
  
    msiof2_pins: spi2 {  
        groups = "msiof2_clk", "msiof2_sync_b",  
                "msiof2_rxd", "msiof2_txd";  
        function = "msiof2";  
    };  
};
```

Figure 4-4 Pin Function setting (Example for r8a77995-draak.dts)

The editing contents are shown in Figure 4-5 (Example for r8a779a0-falcon.dts).

```
&pfc {  
    msiof0_pins: spi0 {  
        groups = "msiof0_clk", "msiof0_sync",  
                "msiof0_rxd", "msiof0_txd";  
        function = "msiof0";  
        power-source = <1800>;  
    };  
  
    msiof1_pins: spi1 {  
        groups = "msiof1_clk", "msiof1_sync",  
                "msiof1_rxd", "msiof1_txd";  
        function = "msiof1";  
        power-source = <1800>;  
    };  
  
    msiof2_pins: spi2 {  
        groups = "msiof2_clk", "msiof2_sync",  
                "msiof2_rxd", "msiof2_txd";  
        function = "msiof2";  
        power-source = <1800>;  
    };  
};
```

Figure 4-5 Pin Function setting (Example for r8a779a0-falcon.dts)

The editing contents shown in Figure 4-6 (Example for r8a77980-condor.dts)

```
&pfc {  
    msiof0_pins: spi0 {  
        groups = "msiof0_clk", "msiof0_sync",  
                "msiof0_rxd", "msiof0_txd";  
        function = "msiof0";  
    };  
    msiof1_pins: spi1 {  
        groups = "msiof1_clk", "msiof1_sync",  
                "msiof1_rxd", "msiof1_txd";  
        function = "msiof1";  
    };  
    msiof2_pins: spi2 {  
        groups = "msiof2_clk", "msiof2_sync",  
                "msiof2_rxd", "msiof2_txd";  
        function = "msiof2";  
    };  
    msiof3_pins: spi3 {  
        groups = "msiof3_clk", "msiof3_sync",  
                "msiof3_rxd", "msiof3_txd";  
        function = "msiof3";  
    };  
};
```

Figure 4-6 Pin Function setting (Example for r8a77980-condor.dts)

4.2.1.2 Clock setting

Define the original clock for generating the bus speed.

```
/* module clock */
&msiof_ref_clk {
    clock-frequency = <133333333>; *1
};

*1 Please set a value based on electrical characteristics.
```

Figure 4-7 Clock setting

4.2.1.3 Channel Node setting

Enable status property.

```
&msiof0 {
    pinctrl-0 = <&msiof0_pins>;
    pinctrl-names = "default";
    /* Please use exclusively to the rcar_sound node */
    /* status = "okay"; */

    /* Add a subnode. */
};

&msiof1 {
    pinctrl-0 = <&msiof1_pins>;
    pinctrl-names = "default";
    /* In case of using this node, please enable this property */
    /* status = "okay"; */

    /* Add a subnode. */
};

&msiof2 {
    pinctrl-0 = <&msiof2_pins>;
    pinctrl-names = "default";
    /* In case of using this node, please enable this property */
    /* status = "okay"; */

    /* Add a subnode. */
};

&msiof3 {
    pinctrl-0 = <&msiof3_pins>;
    pinctrl-names = "default";
    /* In case of using this node, please enable this property */
    /* status = "okay"; */

    /* Add a subnode. */
};
```

Figure 4-8 Channel Node setting

4.2.1.4 sub node setting

Add a subnode to the channel node in Figure 4-8. Subnode is partially defined in master mode and slave mode.

Use the slave device name of the connection destination as the compatible value. The following form is ideal.

Maker name, slave device name

The editing contents sample for master mode are shown in Figure 4-9.

```
/* Add a subnode. */
slavedev {
    compatible = "maker,slavedev";
    reg = <0>;
    spi-max-frequency = <16666666>;
    spi-cpha;
    spi-cpol;
};
```

Figure 4-9 Subnode definition for master mode

The subnode name in slave mode is "slave".

The editing contents sample for slave mode are shown in Figure 4-10.

```
spi-slave;

/* Add a subnode. */
slave {
    compatible = "maker,slavedev";
    spi-cpha;
    spi-cpol;
};
```

Figure 4-10 Subnode definition for slave mode

4.2.2 Add userspace interface

Add the compatible value of the subnode to the next file.

file : drivers/spi/spidev.c

```
static const struct of_device_id spidev_dt_ids[] = {
    ...
    { .compatible = "maker,slavedev" },    <-- Add this line.
    {} ,
};
```

Figure 4-11 User space interface

4.2.3 Kernel configuration

To enable the function of this module, make the following setting with Kernel Configuration. The changes affect after re-building the kernel.

```
Device Drivers  --->
  [*] SPI support  -->
    --- SPI support
      <*> SuperH MSIOF SPI Controller
          ...
          *** SPI Protocol Masters ***
      <*> User mode SPI device driver support
          ...
      [ ] SPI slave protocol handlers *1
```

Figure 4-12 Kernel configuration (R-Car H3/M3/M3N/E3/D3/V3U/V3H)

Notes: *1: Please set if you want to enable SPI Slave mode.

4.3 Option Setting

4.3.1 Module Parameters

There are no module parameters.

4.3.2 Kernel Parameters

There are no module parameters.

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REVISION HISTORY	Linux Interface Specification Device Driver MSIOF User's Manual: Software
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Rev.	Date	Description	
		Page	Summary
0.1	Sep. 25, 2015	—	New creation.
0.2	Nov. 20, 2015	2	1.5 Restrictions DMA was supported.
		7	Figure 4.3 Kernel configuration (R-Car H3) Remove the DMA item.
		7	Notes: Remove.
0.3	Mar. 18, 2016	1	1.2 Function Usage of DMA.
		1	Table 1.1 Driver Function Add transfer size.
0.4	Apr. 15, 2016	All	Add R-Car M3 support.
		2	Table 1.5 Related document (R-Car H3/M3) Update related documents.
		6	4.2 Integration Procedure Add R-Car M3 Device tree file(r8a7796.dtsi).
0.5	Aug. 5, 2016	1	Table 1.1 Add "Module Clock", "The biggest transfer clock"
		2	Table 1.3-2 Related Documents - H3 Document Update. - Add M3 Document.
		5, 6	Add "3.1 IPMMU Setting"
0.6	Dec. 16, 2016	5, 7	3.1 IPMMU Setting 4.2 Integration Procedure Change R-Car H3 Device tree file name (r8a7795.dtsi, r8a7795-salvator-x.dts)
0.7	Mar. 15, 2017	1	1.3 Connected device Fix "R-Car H3/M3 System" to "R-Car H3-Sip/M3-Sip System"
		2	Table 1.5 Related document (R-Car H3/M3) - Add User's Manual: Hardware Rev.0.53. - Add Salvator-XS Hardware Manual Rev.2.00.
		3	Table 2.1 Hardware specification Add Evaluation Board Salvator-XS.
		5, 6	3.1 IPMMU Setting - Add R-Car H3 WS2.0 Device tree file(r8a7795.dtsi). - Add hardware revision to the description of device tree file name (r8a7795-es1.dtsi, r8a7795-es1.dtsi). - Change the Figure and description for Figure 3.1 and Figure 3.2
		8	4.2 Integration Procedure - Add R-Car H3 WS2.0 Device tree file(r8a7795-salvator-x.dts). - Add Salvatore-XS Device tree file(r8a7795-salvator-xs.dts). - Add hardware revision to the description of device tree file name (r8a7795-salvator-x.dts, r8a7795-salvator-xs.dts , r8a7795-es1-salvator-x.dts). - Change the Figure 4.2
0.8	Apr. 14, 2017	1	Table 1.1 Driver Function Add the biggest transfer clock for R-Car H3 WS2.0.
		6	3.1 IPMMU Setting Add DMA channel to use for each channel.
0.9	Jun. 14, 217	1, 5, 8	1.2 Function 3.1 IPMMU Setting 4.2 Integration Procedure Change of version notation.
		2	Update User's Manual: Hardware Rev0.53 to Rev0.54.
1.00	Aug. 8, 2017	All	Update document format.

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Rev.	Date	Description	
		Page	Summary
1.0.1	Oct. 24, 2-17	All	Add R-Car M3N support.
		8	4.2 Integration Procedure Add Salvatore-XS Device tree file(r8a7796-salvator-xs.dts).
1.50	Jan. 29, 2018	2	Table 1.5 Related documents (R-Car H3/M3/M3N) - Delete User's Manual: Hardware Rev.0.51. - Delete User's Manual: Hardware Rev.0.55. - Add User's Manual: Hardware Rev.0.80.
		6	Delete 3.1 IPMMU Setting
		7	Add 4.2.1 Device tree setting
		10	Add 4.2.2 Add userspace interface
		11	Update 4.2.3 Kernel configuration
1.51	Mar. 28, 2018	All	Add R-Car E3 support.
		1,2	Table 1.1 Driver Function - Update "Module Clock ", "Max transfer frequency" 1.4 Related documents - Add "R-Car Series, 3rd Generation Additional Document for User's Manual: Hardware "
		8	4.2.1 Device tree setting - Update "aliases "
		9	Figure 4 4 Clock setting - Update "clock-frequency"
1.52	Jun. 27, 2018	8	1.6 Notice - Add notice for R-Car H3 Ver.3.0.
		8	4.2.1 Device tree setting - Update the target file.
1.53	Oct. 22, 2018	2	1.4 Related documents - Delete User's Manual: Hardware Rev.0.80. - Delete "R-Car Series, 3rd Generation Additional Document for User's Manual: Hardware " - Add User's Manual: Hardware Rev.1.00.
2.00	Dec. 25, 2018	2	Table 1.5 Related documents (R-Car H3/M3/M3N/E3) - Updated board manual.
		4	Table 2.1 Hardware specification (R-Car H3/M3/M3N/E3) - Updated board name.
		-	Update AddressList.
2.01	Mar. 11, 2019	8, 11,12	Fix typo.
2.50	Apr. 24, 2020	All	Add R-Car V3U support
		All	Update for based on kernel v5.4
2.51	Dec. 1, 2020	2	Table 1.4 Update connected device
		3	Table 1.5 Related documents (R-Car H3/M3/M3N/E3/V3U) Fix Edition and Data of H/W manual for V3U/Falcon
		10	Figure 4-4 Pin Add pin setting for V3U falcon
2.52	Jan. 29, 2021	-	Add R-Car V3H v2.0 support.
2.53	Apr. 21, 2021	-	- Add R-Car D3 support. - Add Kernel v5.10 support
2.54	Aug. 16, 2021	10	Figure 4-4 Update Pin function setting for D3 Draak
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

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