User's Manual

R-CarM3-SiP System Evaluation Board Salvator-X

Hardware Manual

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[Confidential]

This manual should only be disclosed under an NDA.

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1. Overview

The Salvator-X is an R-CarM3-SiP-specific evaluation board that can be used to evaluate systems using the R-CarM3-SiP and to develop operating systems, device drivers, and applications. Using the Salvator-X board allows the developers to efficiently conduct required tasks such as evaluation of the R-CarM3-SiP system performance and thus greatly to reduce the turn-around time in their product development.

The R-CarM3-SiP is directly mounted or mounted via a dedicated socket on the Salvator-X board. Furthermore, by using a dedicated socket, you can mount an R-CarH3-SiP instead of an R-CarM3-SiP, and then evaluate the R-CarH3-SiP on the Salvator-X board.

1.1. Features

1.1.1. Features of the Salvator-X Board

The following table lists the features of the Salvator-X board. For the features of the R-CarM3-SiP, see the respective hardware manual.

Table 1.1.1 Features of the Salvator-X Board

Item	Description
SiP	● R-CarM3-SiP including LPDDR4-3200 memory devices and Hyper Flash memory
Display interfaces	● HDMI output connectors for HDMI0 ● LVDS output connectors for LVDS ● Analog RGB output connector for DU
Video input interfaces	● HDMI input connector for CSI0 ● CVBS input connector for CSI1
Audio interfaces	● Audio output connector for SSI0 ● Microphone input connector for SSI1
Storage interfaces	● USB2.0 type micro AB receptacle for USB0 ● USB2.0 type A receptacles for USB1 ● USB3.0 type A receptacle for USB0 ● Two SD card slots for SDHI0 and SDHI3 ● eMMC memory for MMCIF0
Network interfaces	● PCIE × 1 connector for PCIEC0 ● BT/Wi-Fi connector for PCIEC1/SATA ● Gigabit Ethernet (GbE) connector for the EtherAVB
Peripheral interfaces	● Two debug serial connectors for SCIF2_A and SCIF1/HSCIF1_A
Debugger interfaces	● 20-pin JTAG connector
Peripheral connectors	● External memory connector for LBSC ● Four EXIO connectors for LBSC, SSI, and other modules
Power supply	● DC12.0V input
Operating temperature	● +25 degrees C at ambient temperature

1.1.2. Functions of the Salvator-X Board

Table 1.1.2 List of Salvator-X Board Functions (1)

Board Function	Module	Description	Note
SDRAM	DBSC	Dual Channel LPDDR4-3200 2GByte x2 channels, 32bit data width x2 (on R-CarM3-SiP) 16Gbit(32bit data width) x2 devices. SDRAM Backup feature: Supported.	
Flash memory Interfaces	LBSC	NOR Flash Connector: NOR Flash board 'R0P0400C0001FS' can be connected. Databus width 16bit 1MB (LBSC_A19~A0)	Functions cannot be used at the same time: DU, VIN Interrupt: IRQ2
	Hyper Flash QSPI0 QSPI1	Either [A] or [B] or [C] [A] Hyper Flash Spansion S26KS512S (512Mbit=64MB) (on R-CarM3-SiP) [B] SPI Flash and EX-SPI connector [B1] QSPI0: Spansion S25FS128SAGMFV10 (128Mbit=16MB) [B2] QSPI1: EX-SPI connector [C] EXSPI connector [C1] QSPI0: EX-SPI connector [C2] QSPI1: EX-SPI connector	Attention: QSPI1 cannot be operated without QSPI0. QSPI0 can be operated without QSPI1.
Display Interfaces	LVDS	LVDS output. 5 pairs (CLK, CH0~CH3) Connector: Signal: Hirose DF14A-20P-1.25H(55), Backlight: Jst SM14B-SRSS-TB(LF)(SN)	Feature: Backlight can be controlled by GP6_07 Brightness can be controlled by GP2_07/PWM1.
	HDMI0	HDMI output. 4 pairs (CLK, DATA0~DATA2) Connector: HDMI standard type A : Tyco 1747981-1	
	DU	Analog RGB output DU output format: RGB888. Video DAC: Analog Devices ADV7123 (DU_DOTCLKOUT0 is connected) Connector: DSUB15pin	Functions cannot be used at the same time: LBSC, IRQ2, VIN
Video Input Interfaces	CSI0	Either [A] or [B] [A] HDMI input HDMI Receiver: Analog Devices ADV7482W (transmitter-A, 4-Lane output) Connector: HDMI standard type A : Tyco 1747981-1 [B] EXIO Connector C: QSH-030-01-L-D-A	I^2C channel: I2C4 Interrupt: GP6_30, GP6_31 Feature: The audio output signanls of ADV7482W are connected to the R-CarM3-SiP's SSI4.
	CSI1	Either [A] or [B] [A] Composite Video input HDMI Receiver: Analog Devices ADV7482W (transmitter-B, 1-Lane output) Connector: RCA [B] EXIO Connector C: QSH-030-01-L-D-A	
	VIN4	EXIO Connector D: QSE-040-01-F-D-A	Functions cannot be used at the same time: LBSC, DU, INTC
	VIN5	EXIO Connector D: QSE-040-01-F-D-A	
Audio Interfaces	SSI0, SSI1	Audio Output(SSI0), Input(SSI1) Codec: AKM AK4613VQ Connector: mini jack for stereo line output Connector: mini jack for stereo MIC input	I^2C channel: I2C2[A]
	SSI3	EXIO Connector B: QSE-040-01-F-D-A	Functions cannot be used at the same time: DRIF0_A, GPIOs for USB2.0-ch0 OTG GPIO for backlight control.
	SSI4	Audio Input(SSI4) HDMI Receiver: Analog Devices ADV7482W EXIO Connector B: QSE-040-01-F-D-A	Functions cannot be used at the same time: DRIF0_A
	SSI7, SSI8	EXIO Connector A: QSH-030-01-L-D-A EXIO Connector B: QSE-040-01-F-D-A	Functions cannot be used at the same time: DRIF1_A
	Other SSI	EXIO Connector A: QSH-030-01-L-D-A EXIO Connector B: QSE-040-01-F-D-A EXIO Connector C: QSH-030-01-L-D-A	Functions cannot be used at the same time: GPLED/TactSW, GPIOs for USB2.0-ch0(OTG), USB2.0-ch2-PWEN,OVC Following signals are not connected: SSI_WS2[A], SSI_SCK1[A], SSI_WS1[A], SSI_SCK2[B], SSI_WS2[B]
USB2.0 Interfaces	USB2.0 ch0	USB2.0 Host , Function, or On-The-Go Connector: Type microAB.	Note: GPIOs for OTG functions are as follows. GP6_05/SSI_SCK34 as OTG_STAT1 GP6_06/SSI_WS34 as OTG_STAT2 GP6_16/SSI_SDATA6 as OTG_EXTLP#
	USB2.0 ch1	USB2.0 Host Connector: Double Stacked Type A. (located in the 1st floor)	
USB3.0 Interface	USB3.0 ch0	USB3.0 Host , Function Connector: Type Standard A.	

Table 1.1.3 List of Salvator-X Board Functions (2)

Board Function	Module	Description	Note
SD Host Interfaces	SDHI0	Connector: Full size SD Card Slot. DBG2 can be connected instead of SD Card. Interface voltage: Either 3.3V or 1.8V.	For voltage control: GP5_02, GP5_01
	SDHI3	Either [A] or [B] [A] Full size SD Card Slot. (SD3_DAT[3:0] are connected.) [B] EXIO Connector B. (SD3_DAT[7:4] and SD3_DS are also connected.) Interface voltage: Either 3.3V or 1.8V.	For voltage control: GP3_15, GP3_14 Functions cannot be used at the same time: R-NANDC
MMC memory Interface	MMCIF0	eMMC: Samsung KLMBG4GESD-B031 32GByte Interface voltage: 1.8V	For reset PRESET# Functions cannot be used at the same time: SDHI1, SDHI2, DBG3, R-NANDC
PCI Express Interface	PCIEC0	PCI Express Base Specification Revision 2.0, 1-lane, 2.5GT/s or 5.0GT/s Connector: 87715-9006	
BT/WLAN Interface	PCIEC1/SATA HSCIF0 SSI7,SSI8 GPIO	EXIO Connector A: QSH-030-01-L-D-A EXIO board: murata BT/WLAN board "LBEE6ZZ1FD-TEMPS-D"	Functions cannot be used at the same time: MLB, SATA
Ethernet Interface	EtherAVB	Gigabit Ethernet Transceiver Micrel KSZ9031RNXVA Connector: RJ45: Bel Fuse Inc 0826-1G1T-23-F	
		EtherAVB PHY Connector: QSH-030-01-L-D-A EXIO board: tessera EtherAVB PHY board "TSE-BRPHY004"	I^2C channel: I2C2[A]
I^2C Interfaces	I^2C2[A]	Interface voltage: 3.3V This interface is connected to the following devices through I^2C buffer LTC4313-1. EtherAVB PHY Connector, AK4613VQ, CS2000-CP, EXIO Connector B.	
	I^2C4	Interface voltage: 3.3V This interface is connected to the following devices. 5P49V5923A, PCA9654EDTR2G, 9FGV0841AKILF, ADV7482WBBCZ, two MAX9611AUB+, EXIO Connector C.	
I^2C Interface for DVFS	I2C_DVFS	Interface voltage: 3.3V This interface is connected to the following devices through TXS0102DCUT. BD9571MWV-M, BR24T01FVM-W	
Serial Interfaces	SCIF2[A]	Debug Serial-0 (TX, RX) USB to UART Bridge SILICON LABS CP2102-GM (Bridge spec: max 1Mbps) Connector: USB Type microAB	Feature: SCIF download mode
	SCIF1[A] / HSCIF1[A]	Debug Serial-1 (TX, RX, RTS, CTS) USB to UART Bridge SILICON LABS CP2102-GM (Bridge spec: max 1Mbps) Connector: USB Type microAB	Functions cannot be used at the same time: HSCIF1[A]
MSIOF Interfaces	MSIOF0	CP1~CP4	Note: MSIOF0 pins are shared with other GPIO pins for SOFTSW and shared with AUDIO_CLKOUT[A].
	MSIOF1[A]/[C]	EXIO Connector B	Functions cannot be used at the same time: DRIF0_A, DRIF1_A
GPIO Interfaces	GPIO	LED x3 devices '***GPLED***' for General Purpose. GP6_11, GP6_12, GP6_13	GPIO pins of tactile switches are shared with GPLED.
		Mechanical switch x3 elements '***TactSW***' for General Purpose GP6_11, GP6_12, GP6_13	
		Mechanical switch x4 elements '***SOFTSW***' for General Purpose. GPIOs: GP5_17, GP5_20, GP5_22, GP5_23	
Debuger Interfaces	DBG	Connector: HTST-110-01-S-DV (20pin)	
	DBG2	through Full size SD Card Slot for SDHI0	
Peripheral Connectors	various modules	EXIO Connector A: BT/WLAN samtec 60pin. QSH-030-01-L-D-A	Note: PCIE1/SATA, HSCIF0, SSI7, SSI8, JTAG and GPIOx3/MLB are connected.
		EXIO Connector B: SSI/SDHI1,2,3/Digital Radio samtec 80pin. QSE-040-01-F-D-A	Note: DRIF0[A] and DRIF1[A] are connected. Functions cannot be used at the same time: TSIF0[A],TSIF1[A],SSP1_0[A],SSP1_1[A],SIMcard[D]
		EXIO Connector C: MIPI CSI-2 samtec 60pin QSH-030-01-L-D-A	Note: CSI[1:0], I2C4 and GPIOs are connected.
		EXIO Connector D: LBSC/DU/VIN samtec 80pin. QSE-040-01-F-D-A	Note: LBSC and INTC signals are connected.
		EtherAVB PHY Connector samtec 60pin. QSH-030-01-L-D-A	Note: EtherAVB and I2C2[A] signals are connected.
Power MOSFET drivers	—	ROHM PMIC BD9571MWV-M	Interrupt: IRQ0, I^2C channel: I2C_DVFS
		maxim MAX16933	
Power Supply	—	DC12.0V input	
Operating Temperature	—	+25 degrees C at ambient temperature	
Board size	—	210mm x 160mm	

Note: The parts on Salvator-X are not only automotive grade but also industrial or commercial grade.

1.2. Usage Notes

1.2.1. Salvator-X Board Specifications

- Take particular care to ensure the correct configurations of the jumpers and switches mounted on the Salvator-X board. Incorrect configurations may damage on-board devices.
- For power supply to the Salvator-X board, be sure to use the AC adaptor that comes with it. Applying a voltage greater than 12.0 [V] may damage devices on the Salvator-X board.
- There are sequences for turning on and off the power supply to the Salvator-X board. For the Salvator-X board, be sure to obey the notes below.

  (1) When power is turned on
  Be sure to confirm that the ACC switch (SW23) is off before plugging the AC adapter into the power source. It is prohibited to plug the AC adapter into a power source while the ACC switch (SW23) is on.

  (2) When power is shut off
  Be sure to turn off the ACC switch (SW23) before unplugging the AC adapter from the power source. It is prohibited to unplug the AC adapter from the power source while the ACC switch (SW23) is on.
- The AC adapter that comes with the Salvator-X can supply current up to 9.0 A at 12.0 V. If you intend to connect IO expansion boards or external storage devices to the Salvator-X board, ensure that this does not lead to supply current exceeding 9.0 A.
  If the system configuration is such that the current supply does exceed 9.0 A, prepare a separate stabilized DC power supply that can supply 15.0 A or more at 12.0 V.
- Salvator-X board doesn't guarantee software development on the SPI flash memory (U5) side.
- If the R-CarM3-SiP in the socket of the product as shipped is exchanged for another device (an R-CarH3-SiP for the R-CarM3-SiP, etc.), the model number of the board must be changed when the Salvator-X board is exported. Since shipment with the model number as-is is not possible, obtain the product datasheet for the board that corresponds to the mounted SiP for customs clearance and go through the procedures required for export compliance in Japan. Contact your local Renesas sales representative regarding any point that may be unclear to you.
- If you intend to use the Salvator-X board with a Wi-Fi board, we have confirmed the connection with the LBEE6ZZ1FD-TEMPS-D board manufactured by Murata. Note that you must prepare the Wi-Fi driver software yourself, which will require you to have a license agreement with Broadcom. When you use other Wi-Fi board, for details, contact the manufacures.

1.2.2. Precaution on Voltage Settings by the GPIO Pins

The Salvator-X board incorporates an SD card slot (CN13) for the DBG2 or SDHI0 as debugger interfaces. When using the DBG2 interface, ensure the supply of 1.8 V to the VDDQVA_SD0 pin of the R-CarM3-SiP. For details, see section 2.17, Debugger Interfaces (DBG and DGB2).

1.3. Board Configuration

1.3.1. Block Diagram of the Salvator-X Board

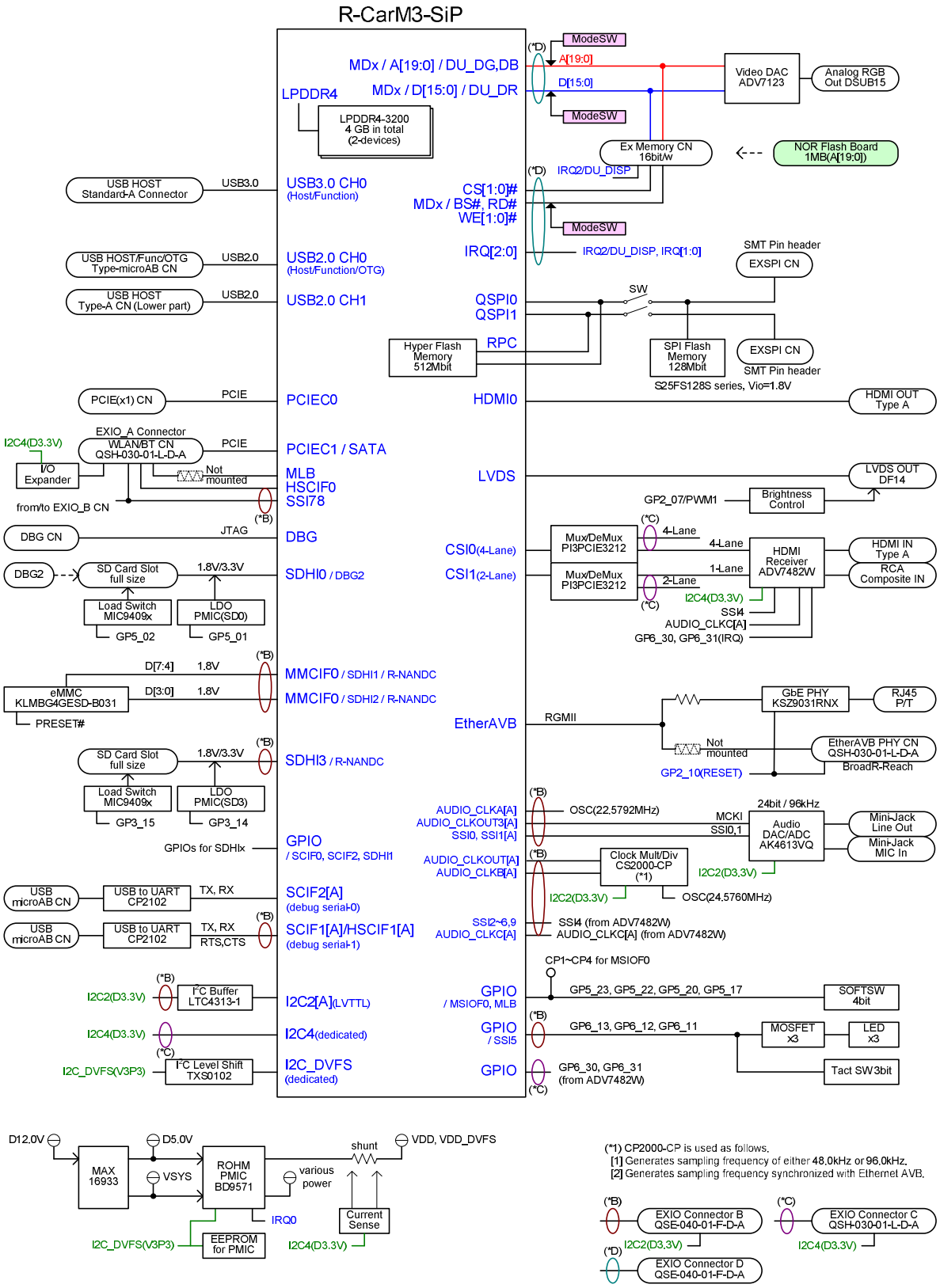

Figure 1.3.1 Block Diagram of the Salvator-X Board

2. Salvator-X Interface Module Specifications

2.1. Mode Setting

2.1.1. Specifications

The operating mode of the R-CarM3-SiP is set by a power-on reset. For details on the operating mode, see the R-CarM3-SiP hardware manual.

2.1.1.1. MD0 Pin — Selection of Free-Running Mode or Step-Up Mode

This pin selects the free-running mode or step-up mode.

MD0	Selection of Free-Running Mode or Step-Up Mode
0	Free-running mode (Initial value)
1	Step-up mode

2.1.1.2. MD[4:1] Pins — Selection of Boot Device

These pins select the boot device.

MD4	MD3	MD2	MD1	Selection of Boot Device
0	0	0	0	External ROM boot (area 0)
0	0	0	1	Reserved
0	0	1	0	Hyper Flash ROM boot at 160 MHz using DMA
0	0	1	1	Hyper Flash ROM boot at 80 MHz using DMA
0	1	0	0	Serial flash ROM boot at single read 40 MHz using DMA (Initial value)
0	1	0	1	eMMC boot at 25MHz x1 bus widths using DMA (option)
0	1	1	0	Reserved
0	1	1	1	Reserved
1	0	0	0	Reserved
1	0	0	1	Reserved
1	0	1	0	Hyper Flash ROM at 160 MHz (320 Mbps) using XIP mode
1	0	1	1	Hyper Flash ROM at 80 MHz using XIP mode
1	1	0	0	Reserved
1	1	0	1	eMMC boot at 50MHz x8 bus widths using DMA (option)
1	1	1	0	Reserved
1	1	1	1	SCIF download mode

2.1.1.3. MD5 Pin — Selection of Secure Authorization

These pins selects whether or not secure authorization is applied.

MD5	Selection of Secure Authorization Flow except for Secure LCM state
0	Secure authorization is selected. This bit is forced to 0 internally at Secure LCM state..
1	Secure authorization is not selected except for Secure LCM state. (Initial value)

2.1.1.4. MD[7:6] Pins — Selection of Master Boot Processor

These pins select the master boot processor.

MD7	MD6	Selection of Master Boot Processor
0	0	Booted through CPU0 in Cortex-A57 (Initial value)
0	1	Booted through CPU0 in Cortex-A53
1	0	Reserved
1	1	Booted through Cortex-R7

2.1.1.5. MD8 Pin — Selection of Area 0 Space Data Bus Width

This pin sets the data bus width of the area 0 space (CS0) to 8 bits or 16 bits. Select the data bus width of the boot device connected to the LBSC.

MD8	Selection of data bus width of area 0 space
0	8 bits
1	16 bits (Initial value)

2.1.1.6. MD9 Pin — Selection of Crystal Resonator or Crystal Oscillator

This pin selects either a crystal resonator or a crystal oscillator to be connected to the EXTAL/XTAL pins. A crystal oscillator (X4, 16.6666 MHz) is mounted on the Salvator-X board by default. The crystal resonator (X3) and its peripheral circuit are not mounted.

MD9	EXTAL/XTAL Pin Setting
0	An external clock signal is input to the EXTAL pin. (Initial value)
1	A crystal resonator is connected to the EXTAL and XTAL pins.

2.1.1.7. MD21, MD20, MD11, MD10, and MDT[1:0] Pins — Switching of JTAG, DBG2 (SDHI0), and DBG3 (SDHI1)

These pins select the debugging function through the JTAG connector (CN1) or the SD card slot for the SDHI0 (CN13). The debugging through the JTAG, DBG2 (SDHI0), or DBG3 (SDHI1) is possible by the combination of MD pin settings in the R-CarM3-SiP specifications. A connector for the DBG3 (SDHI1) is not mounted on the Salvator-X board.
The initial values of pins MD21, MD20, MD11, and MDT[1:0] are all 0.

MD10	MD[21:20]	MD11	MDT[1:0]	JTAG	DBG2 (/SDHI0)	DBG3 (/SDHI1)
0	00	*	*	–	Normal function	Normal function
0	01	*	*	Reserved	Reserved	Reserved
0	10	0	*	CoreSight debug port	Normal functon	Normal function
0	10	1	00	CoreSight debug port	ADSP	Normal function
0	10	1	01	CoreSight debug port	Reserved	Normal function
0	10	1	10	CoreSight debug port	Normal function	ADSP
0	10	1	11	CoreSight debug port	Normal function	Reserved
1	11	0	*	ADSP	Normal function	Normal function

*: don't care, –: No connection with the TAP controller

2.1.1.8. MD12 Pin — Reserved

Do not change the initial setting at shipment (MD12 = 0).

2.1.1.9. MD[14:13] Pins — Selection of PLL Multiplication Ratio

These pins select the frequency of the crystal oscillator or crystal resonator on the Salvator-X board. The PLL multiplication ratio in the R-CarM3-SiP is selected by these setting. Do not change the initial setting at shipment (MD14 = 0, MD13 = 0).

MD14	MD13	EXTALFrequency	EXTALDivider
0	0	16.66 MHz	x 1/1
0	1	20.00 MHz	x 1/1
1	0	25.00 MHz	x 1/1
1	1	33.33 MHz	x 1/2

2.1.1.10. MD15 Pin — Selection of AArch32 or AArch64

This pin selects AArch32 or AArch64.

MD15	Selection of the initial ARMv8 execution states of Cortex-A57 and Cortex-A53
0	AArch32
1	AArch64 (Initial value)

2.1.1.11. MD16 Pin — Reserved

Do not change the initial setting at shipment (MD16 = 1).

2.1.1.12. MD19 and MD17 Pins — Selection of the DDR Clock Frequency

These pins select the DDR clock frequency. The R-CarM3-SiP on the Salvator-X board incorporates the LPDDR4 SDRAM.

MD19	MD17	Selection of the DDR Clock Frequency
0	0	DDR3200 <TBD>
0	1	DDR2133 <TBD>
1	0	Prohibited setting
1	1	DDR1600 (Initial value)

2.1.1.13. MD18 Pin — Selection of the External Bus Clock Frequency

This pin selects the frequency of the external bus clock (CLKOUT).

MD18	Selection of the External Bus Clock Frequency
0	66.6 MHz (Initial value)
1	44.4 MHz

2.1.1.14. MD27 and MD22 Pins — Selection of DDR Phy Pin Multiplexing

These pins select the DDR Phy pin multiplexing. The R-CarM3-SiP on the Salvator-X board incorporates LPDDR4 SDRAM.
Do not change the initial setting at shipment (MD27 = 0, MD22 = 0).

MD27	MD22	Selection of DDR Phy Pin Multiplexing
0	0	LPDDR4 (Initial value)
0	1	LPDDR3
1	0	Reserved
1	1	Reserved

2.1.1.15. MD23 Pin — Selection of Field Bist Mode

This pin selects Field Bist Mode 0 or Field Bist Mode 1.

MD23	Selection of Field Bist Mode
0	Field Bist Mode 0 (Initial value)
1	Field Bist Mode 1

2.1.1.16. MD25 Pin — Selection of Field Bist Control

This pin enables or disables the field Bist function.

MD25	Selection of Field Bist Control
0	Field Bist is not activated (Initial value)
1	Field Bist is activated.

2.1.1.17. MD26 Pin — Reserved

Do not change the initial setting at shipment (MD26 = 0).

2.1.1.18. MD28 Pin — Reserved

Do not change the initial setting at shipment (MD28 = 0).

2.1.2. Initial Values of Mode Setting Pins on the Salvator-X Board

Table 2.1.1 Initial Values of R-CarM3-SiP Mode Setting Pins on the Salvator-X Board

MD Pins	Initial Value	Initial Function
MD0	0	Free-running mode
MD[4:1]	0100	Serial flash ROM boot at single read 40 MHz using DMA.
MD5	1	Secure authorization is not selected except for Secure LCM state.
MD[7:6]	00	Booted through CPU0 in Cortex-A57.
MD8	1	Data bus width of area 0 space = 16 bits
MD9	0	Inputs an external clock to the EXTAL pin.
MD12	0	Reserved. Fixed to ‘0’
MD10, MD[21:20], MD11, MDT[1:0]	0, 00, 0, 00	Selects SDHI0 and SDHI1.
MD[14:13]	00	Reserved. Fixed to ‘00’
MD15	1	AArch64
MD16	1	Reserved. Fixed to ‘1’
MD18	0	CLKOUT = 66.6 MHz
MD19, MD17	11	LPDDR4-1600 mode
MD27,MD22	00	LPDDR4
MD25, MD23	00	Field Bist is not activated, Field Bist Mode 0.
MD26	0	Reserved. Fixed to ‘0’
MD28	0	Reserved. Fixed to ‘0’

2.1.3. Multiplexing and Setting of Mode Setting Pins

The following table shows the pin functions that are multiplexed with the mode pins of the R-CarM3-SiP, and how the individual mode pins are set.
For the mode pins that are used with fixed values, resistors are used to set them to their fixed values according to the initial settings in Table 2.1.1, Initial Values of R-CarM3-SiP Mode Setting Pins on the Salvator-X Board. Such mode pins are described as "Fixed by a resistor" in the Setting column in the table below.

Table 2.1.2 Pin Multiplexing of Mode Setting Pins of R-CarM3-SiP

MD Pin	Pin Function	Strapping Options	Setting	Default
MD0	D1	Free-running (0)/step-up (1) Mode	Set by SW11	ON (0)
MD1	D2	Boot device selection[0]	Set by SW10	ON (0)
MD2	D3	Boot device selection[1]	Set by SW10	ON (0)
MD3	D5	Boot device selection[2]	Set by SW10	OFF (1)
MD4	D6	Boot device selection[3]	Set by SW10	ON (0)
MD5	D7	Secure authorization selection	Set by SW11	OFF (1)
MD6	D9	Master boot processor[0]	Set by SW10	ON (0)
MD7	D10	Master boot processor[1]	Set by SW10	ON (0)
MD8	D11	Data bus width of area 0 space	Fixed by a resistor	Pulled up (1)
MD9	D12	EXTAL or EXTAL/XTAL	Fixed by a resistor	Pulled down (0)
MD10	D13	Debugging mode[5]	Set by SW11	ON (0)
MD11	D4	Debugging mode[2]	Set by SW11	ON (0)
MD12	D8	–	Set by SW12	ON (0)
MD13	A19	EXTAL input frequency[0]	Set by SW12	ON (0)
MD14	A18	EXTAL input frequency[1]	Set by SW12	ON (0)
MD15	A17	AArch32 or AArch64	Set by SW12	OFF (1)
MD16	A16	–	Fixed by a resistor	Pulled up (1)
MD17	A15	DDR clock frequency[0]	Set by SW10	OFF (1)
MD18	A14	CLKOUT frequency setting	Set by SW12	ON (0)
MD19	A13	DDR clock frequency[1]	Set by SW10	OFF (1)
MD20	A10	Debugging mode[3]	Set by SW11	ON (0)
MD21	A12	Debugging mode[4]	Set by SW11	ON (0)
MD22	A7	DDR Phy pin multiplexing[0]	Fixed by a resistor	Pulled down (0)
MD23	A6	Field Bist mode selection	Set by SW12	ON (0)
MD25	A4	Field Bist control selection	Set by SW12	ON (0)
MD26	A3	–	Fixed by a resistor	Pulled down (0)
MD27	A1	DDR Phy pin multiplexing[1]	Fixed by a resistor	Pulled down (0)
MD28	A0	–	Fixed by a resistor	Pulled down (0)
MDT0	BS#	Debugging mode[0]	Set by SW11	ON (0)
MDT1	RD#	Debugging mode[1]	Set by SW11	ON (0)

2.1.4. Block Diagram of Peripheral Circuit for Mode Pins

On the Salvator-X board, pull-up (100 kΩ) and pull-down (10 kΩ) resistors are used to implement the settings of the mode pins that are largely used with fixed values. When changes to the settings of mode pins are likely, this can be implemented by switches which select the low level when turned on and the high level when turned off.
When the R-CarM3-SiP is released from the power-on reset state (when the level of the PRESET# signal of the R-CarM3-SiP changed from low to high), the mode settings made by the pull-up resistors, pull-down resistors, and switches are input to the R-CarM3-SiP.

The pull-up resistor (R127, 100 kΩ, size 1005) and pull-down resistor (R128, 10 kΩ, size 1608) are connected in parallel in the circuit for setting the MD9 mode pin. This circuit works as the equivalent of a 9-kΩ pull-down resistor, which causes MD9 to be set to the low level (logical 0). If you wish to set MD9 to the high level (1), remove the pull-down resistor (R128).

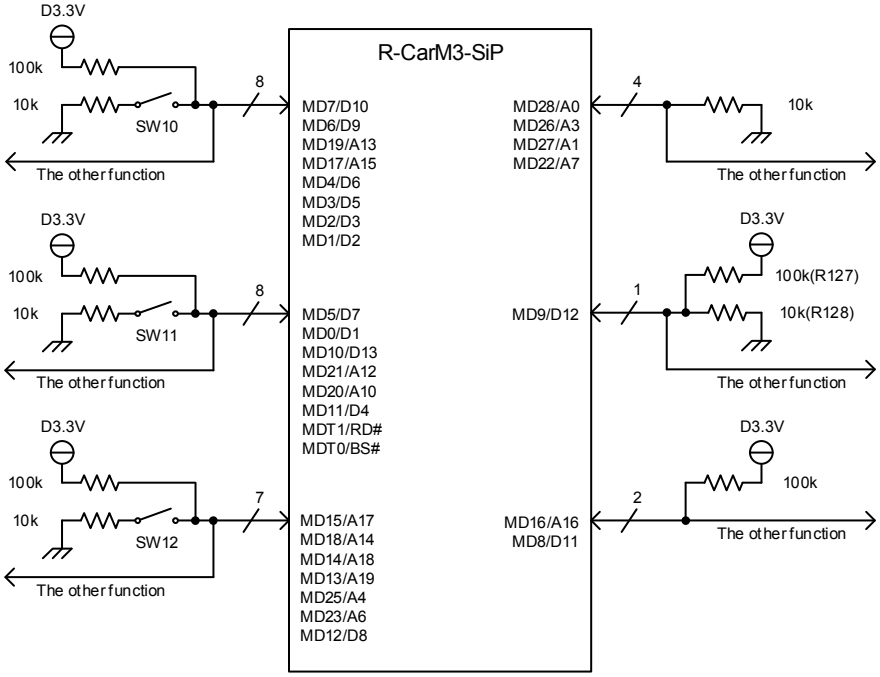

Figure 2.1.1 Peripheral Circuit for Mode Pins on the Salvator-X Board

2.2. Flash Memory Sub-Board Interface (LBSC)

2.2.1. Specifications

The Salvator-X board has a connector (CN2) to connect a flash memory sub-board. The R0P0400C0001FS can be connected as a flash memory sub-board. The specifications of the R0P0400C0001FS are summarized in the table below.
The R0P0400C0001FS board incorporates two flash memory devices S29GL512N10TFIR10 (512 Mbits × 16 bits).
The capacity can be set to 64 Mbytes or 128 Mbytes by the switch settings on the flash memory sub-board.
However, since the LBSC address space of the R-CarM3-SiP is 1 Mbyte (A0 to A19), the amount of flash memory accessible from the R-CarM3-SiP is limited to 1 Mbyte.
The flash memory sub-board is connected to the R-CarM3-SiP via a 16-bit data bus and can be mapped to area 0 (CS0) or area 1 (CS1).
For details, see the specifications of the R0P0400C0001FS. For details on the LBSC, see the R-CarM3-SiP hardware manual.

Notes: 1. The DU pins are multiplexed with the LBSC pins due to the specifications of the R-CarM3-SiP's pin function controller. Accordingly, when the DU is in use, the LBSC is not available for use.
2. When the R0P0400C0001FS is used on the Salvator-X board, settings of SW7 and SW8 are required.
3. The Salvator-X board does not support the R0P0400C0001FS with a 32-bit-wide data bus. Be sure to set the R0P0400C0001FS for a 16-bit-wide data bus.
4. Do not connect other types of flash memory board such as FMRS6401 to the Salvator-X board since it does not support access to them.

Table 2.2.1 Flash Memory Sub-Board Specifications

Flash Sub-board	R0P0400C0001FS (Renesas Electronics original board)
Flash memory	S29GL512N10TFIR10 (512 Mbits, 8-/16-bit data width configuration) from Spansion × 2 pcs
Operating voltage	3.3 V
Capacity	1 Mbyte
Mapping area	Area 0 or 1 (selectable)
Bus width	The Salvator-X board supports only 16 bits.
Connector	'CN2' on the Salvator-X board

2.2.2. Block Diagram

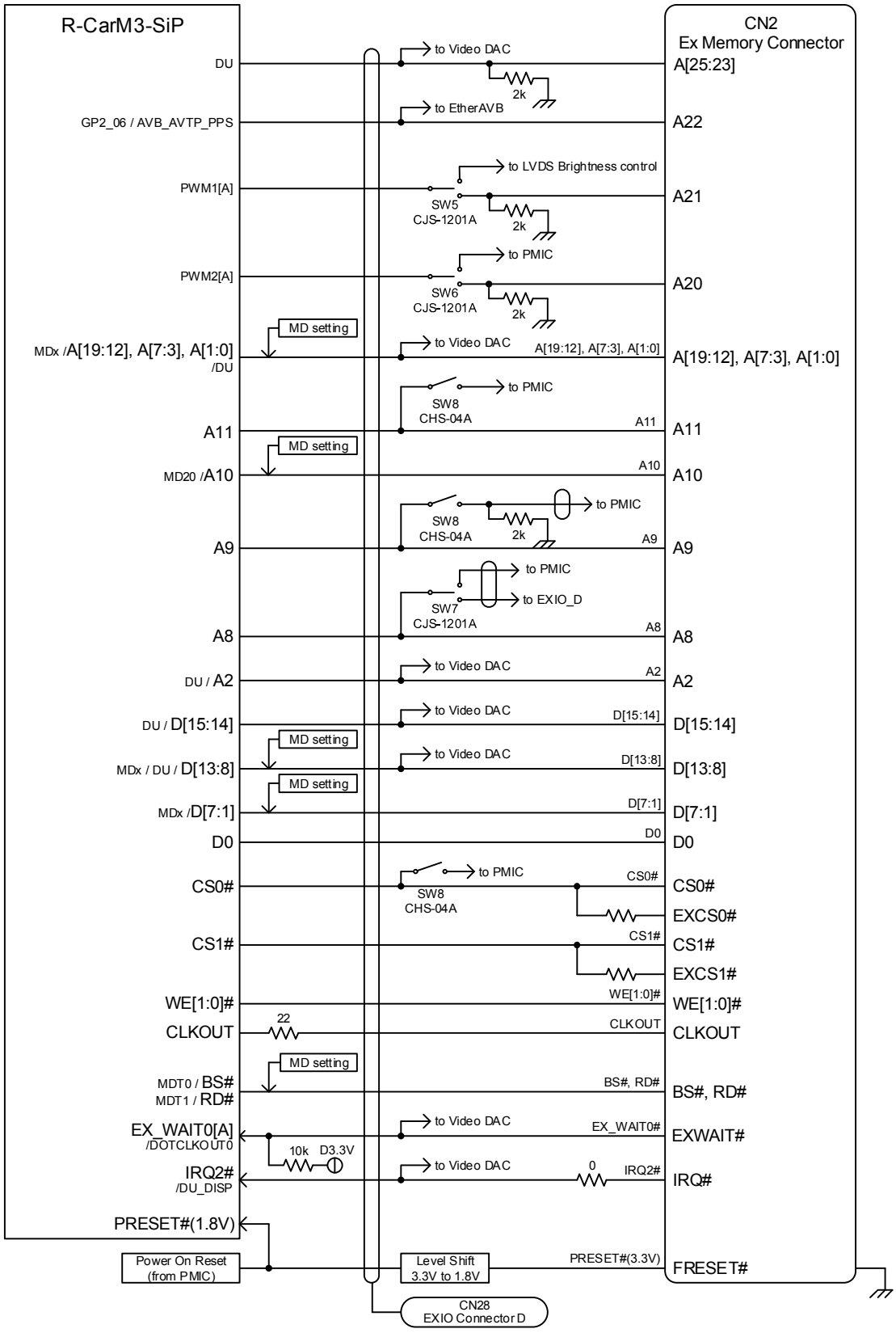

Figure 2.2.1 Block Diagram of the Flash Memory Sub-Board Interface

2.3. Hyper Flash memory / SPI Flash memory Interfaces (Hyper Flash / QSPI0 and QSPI1)

2.3.1. Specifications

As well as the in-package Hyper Flash memory of the R-CarM3-SiP, the Salvator-X board incorporates a 128-Mbit SPI flash memory device (U5) manufactured by Spansion and two expansion connectors (CN3 and CN4) for SPI flash memory devices. SPI flash memory devices and expansion connectors are connected to the Hyper Flash/QSPI Controllers of the R-CarM3-SiP via switches SW1 and SW2. The settings of SW10 can select booting from the in-package Hyper Flash memory of the R-CarM3-SiP or an SPI flash memory device on the board.
For details on the Hyper Flash memory Controller and SPI flash memory Controller, see the R-CarM3-SiP hardware manual. For details on the SPI flash memory manufactured by Spansion, see the datasheet published by Spansion.

When using the in-package Hyper Flash memory of the R-CarM3-SiP, set SW3 to on and set SW1 and SW2 to off.
When using the SPI flash memory on the Salvator-X board, set SW3 to off, set SW1 and SW2 to on, and set SW13 to the pin 1 side.
If you require access to the SPI flash memory (CN3) on the expansion connector side, set SW13 to the pin 3 side.
Since the loader and mini-monitor are stored in the lower-order address space of the SPI flash memory (U5), do not modify the contents of this area. The contents of the in-package Hyper Flash memory of the R-CarM3-SiP can be modified as required.

Table 2.3.1 Hyper Flash memory / SPI Flash memory Interfaces Specifications

Flash memory Controller	On-chip Hyper Flash/QSPI Controller in the R-CarM3-SiP
Hyper Flash memory	In the R-CarM3-SiP
SPI Flash memory	U5: S25FS128SAGMFV10 or S25FS128SAGMFI101 (128 Mbits) from Spansion
EX-SPI connector	CN3 and CN4: PSM-410336-09 from Hirosugi-Keiki
Clock rate of the on-chip Hyper Flash /QSPI	Hyper Flash memory: Max <TBD> MHz operation SPI Flash memory: Max <TBD> MHz operation

Due to the specifications of the R-CarM3-SiP, QSPI1 is not independently usable. The QSPI1 interface can only be used with the QSPI0, and with an 8-bit data width. The QSPI0 is independently usable.
The possible combinations are as follows.

Case A: Use the SPI flash memory (U5) via QSPI0.
Case B: Use the SPI flash memory (U5) and flash memory connected to the EX-SPI connector (CN4), respectively via QSPI0 and QSPI1, with 8-bit data widths.
Case C: Use flash memory connected to the EX-SPI connector (CN3) and EX-SPI connector (CN4), respectively via QSPI0 and QSPI1, with 8-bit data widths.

2.3.2. Block Diagram

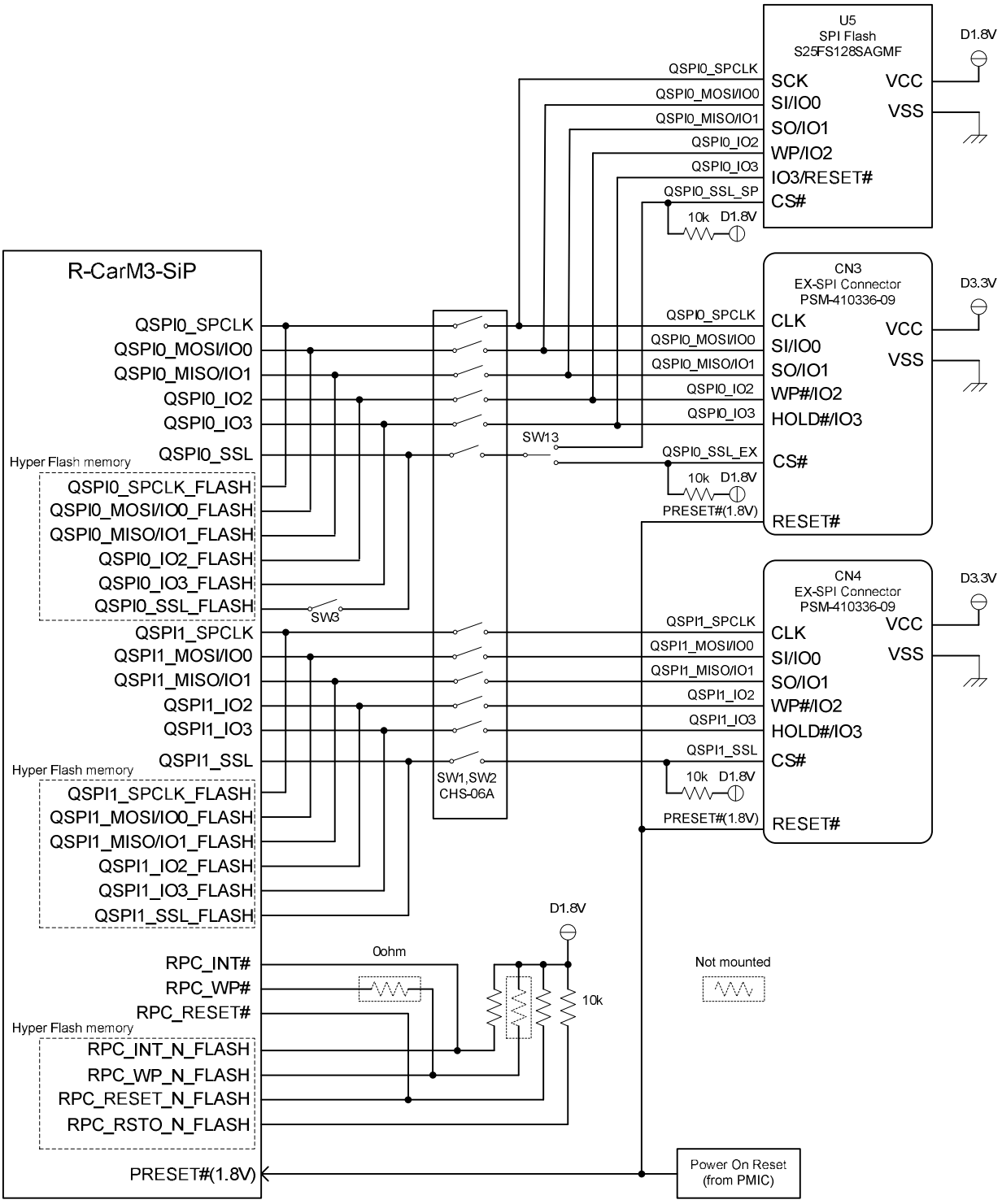

Figure 2.3.1 Block Diagram of the Hyper Flash memory and SPI Flash Memory Interfaces

2.4. Display Interfaces (HDMI0, LVDS, and DU)

2.4.1. Specifications

The R-CarM3-SiP incorporates the following display interfaces. For details on the display interfaces, see the R-CarM3-SiP Hardware Manual.

(1) A single HDMI interface
(2) A single LVDS interface
(3) A single digital RGB interface (8-bit resolution for each of the RGB colors)

The Salvator-X board supports a single interface for HDMI output (HDMI0), a single interface for LVDS output (LVDS), and a single interface for analog RGB output. The analog RGB output signals are obtained by using a D/A converter to convert the digital RGB signals (DU, RGB888).

The external dot clock input signals DU_DOTCLKIN1 is connected to crystal oscillators X21 on the Salvator-X board, which supplies a clock frequency of 33.0 MHz.
DU_DOTCLKIN0 and DU_DOTCLKIN2 are connected to a 5P49V5923B programmable clock generator manufactured by IDT.
This device can supply various dot clock signals. The internal registers of the 5P49V5923B can be accessed over an I^2C bus (interface 4).
For details on the 5P49V5923B, see the datasheet published by IDT.

Table 2.4.1 Display Interface Specifications

Display controller	On-chip display unit in the R-CarM3-SiP
HDMI0	[HDMI output] Connector CN16: 1747981-1 (HDMI type A, standard, 19 pins) from Tyco Electronics
LVDS	[LVDS output] Connector CN18: DF14A-20P-1.25H from Hirose, for LVDS signals CN19: SM14B-SRSS-TB (LF)(SN) from JST, for power supply of backlight.
Digital RGB	[Analog RGB output] The video D/A converter converts digital RGB signals to analog RGB signals. U24: ADV7123KSTZ140 from Analog Devices Connector CN15: D02-M15SAG-23L9E from JAE

Table 2.4.2 Dot Clock Input Specifications

Clock Input Pin	Device of Clock Output
DU_DOTCLKIN0	148.5 MHz OUT1 pin of 5P49V5923B (U61) I^2C bus: Interface 4 I^2C slave address: 0xD5 for read, 0xD4 for write
DU_DOTCLKIN1	33.0 MHz Oscillator (X21)
DU_DOTCLKIN2	108.0 MHz OUT2 pin of the 5P49V5923B (U61) I^2C bus: Interface 4 I^2C slave address: 0xD5 for read, 0xD4 for write

2.4.2. Block Diagram

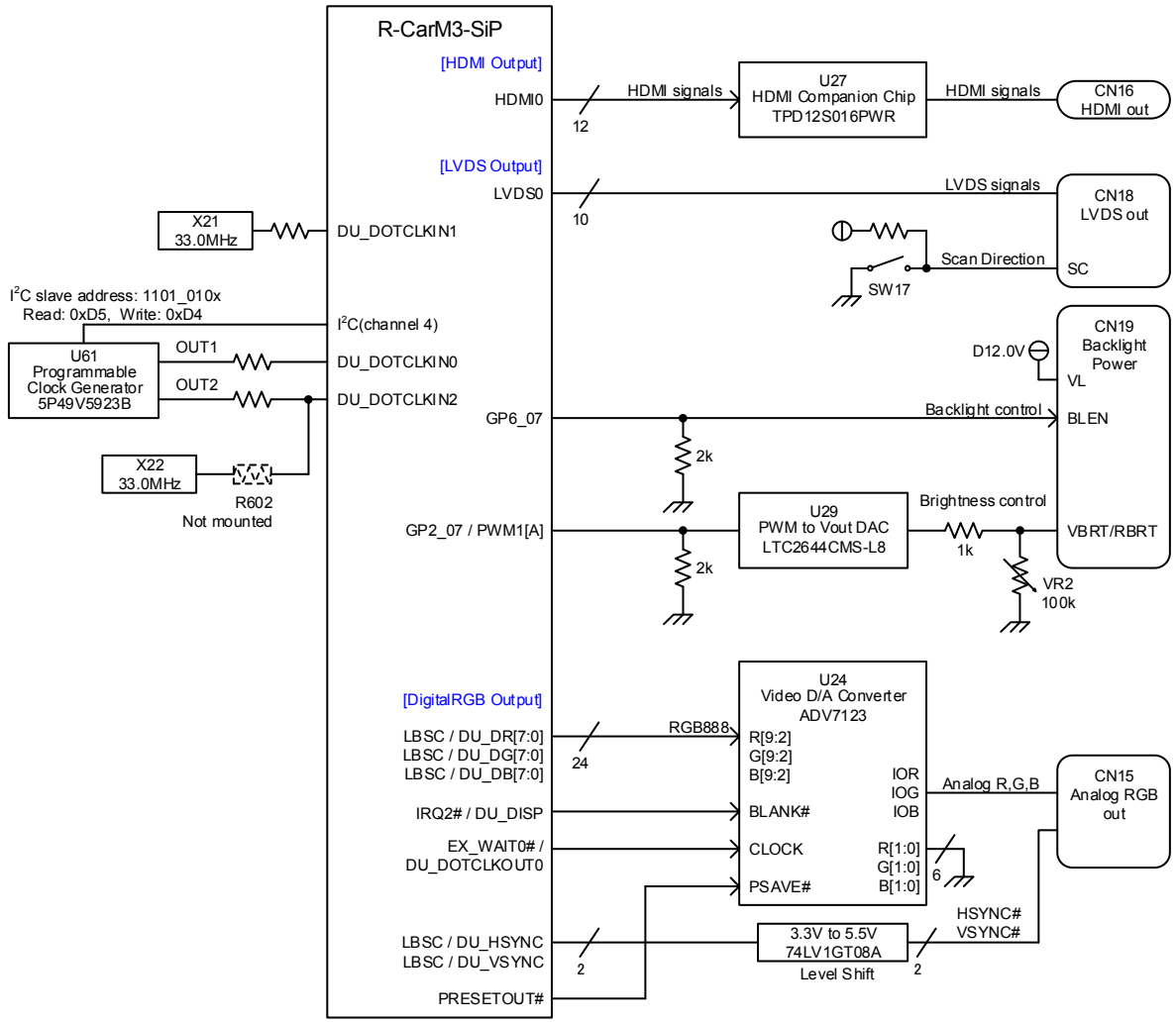

Figure 2.4.1 Block Diagram of the Display Interfaces

2.5. HDMI Output Interface (HDMI0)

2.5.1. Specifications

The R-CarM3-SiP incorporates a single HDMI output interface. For details on the HDMI, see the R-CarM3-SiP Hardware Manual. The Salvator-X board supports a single HDMI output interface (HDMI0) and its output signal is connected to the HDMI connectors (CN16) via the TPD12S016PWR HDMI companion chips (U27). The TPD12S016PWR incorporates ESD protection and an I^2C level shifter. When the source device (R-CarM3-SiP) is connected to a sink device (HDMI monitor), the hot-plug detection signal (HPD) is driven high, and LED1 is turned on if the connection is to HDMI0. For details on the TPD12S016PWR, see the datasheet published by TI.

Table 2.5.1 HDMI Output Interface Specifications

Display controller	On-chip display unit in the R-CarM3-SiP (HDMI)
HDMI0	[HDMI specification] HDMI0 supports HDMI1.4 class transfer rate. [HDMI output] HDMI companion chip TPD12S016PWR (U27) from TI Connector CN16: 1747981-1 (HDMI type A, standard, 19 pins) from Tyco Electronics

2.5.2. Block Diagram

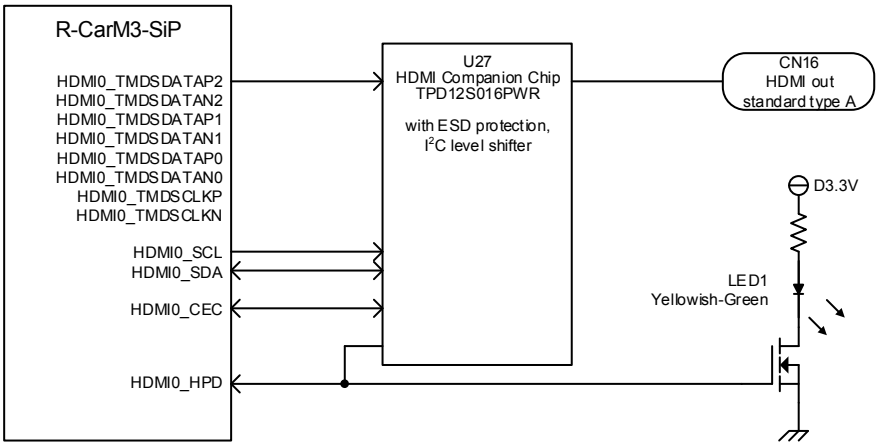

Figure 2.5.1 Block Diagram of the HDMI Output Interface

2.6. LVDS Output Interface (LVDS)

2.6.1. Specifications

The R-CarM3-SiP incorporates a single LVDS output interface. For details on the LVDS, see the R-CarM3-SiP Hardware Manual.
The Salvator-X board incorporates an LCD connector (CN18) which is connected to the LVDS output signal from the R-CarM3-SiP and also incorporates a 12-V power supply connector (CN19) for power supply to the LCD backlight.
The power supply for the LCD backlight can be controlled by the GPIO output signal (GP6_07) from the R-CarM3-SiP. Driving the GP6_07 signal high (1) or low (0) turns the power supply for the LCD backlight on or off, respectively.
The scanning direction of the LCD can be changed by using SW17.
Adjusting the brightness is also possible through either of the following procedures:

(1) Adjusting a trimming potentiometer (VR2)
To use the trimming potentiometer to adjust the brightness, select the GP2_07 output on the GP2_07/PWM1 (group A) multiplexed pin and drive the GP2_07 signal high. This maximizes the output voltage (Vout) of the LTC2644CMS-L8 (U29) to 2.5 V and enables adjustment of brightness by changing the resistance of VR2. Adjusting VR2 clockwise increases the brightness.

(2) Adjusting the on-chip PWM function in the R-CarM3-SiP (PWM1, group A)
To use PWM control to adjust the brightness, select the PWM1 function on the GP2_07/PWM1 (group A) multiplexed pin. Assuming the time at high level of the PWM1 signal is tPWH, and the period of the PWM1 signal is tPERIOD, the LTC2644CMS-L8 (U29) outputs the following voltage (Vout).
Vout = (tPWH / tPERIOD) × 2.5 [V]
The brightness is at the minimum level when Vout is 2.5 V and at the maximum level when Vout is 0 V. Be sure to decrease the brightness by adjusting VR2 counterclockwise beforehand when using the PWM to adjust the brightness.

Table 2.6.1 LVDS Output Interface Specifications

Display controller	On-chip display unit in the R-CarM3-SiP (LVDS)
LVDS	[LVDS Output] Scanning direction control: SW17 Backlight control: GP6_07: '1' turns backlight on, '0' turns backlight off. Brightness control: (1) Trimmer 'VR2' on the Salvator-X board. Set GP2_07 to '1' beforehand. (2) R-CarM3-SiP's PWM1 (group A). Adjust VR2 counterclockwise beforehand. Connector: CN18: DF14A-20P-1.25H from Hirose, for the LVDS signals. CN19: SM14B-SRSS-TB (LF)(SN) from JST, for power supply of backlight.

2.6.2. Block Diagram

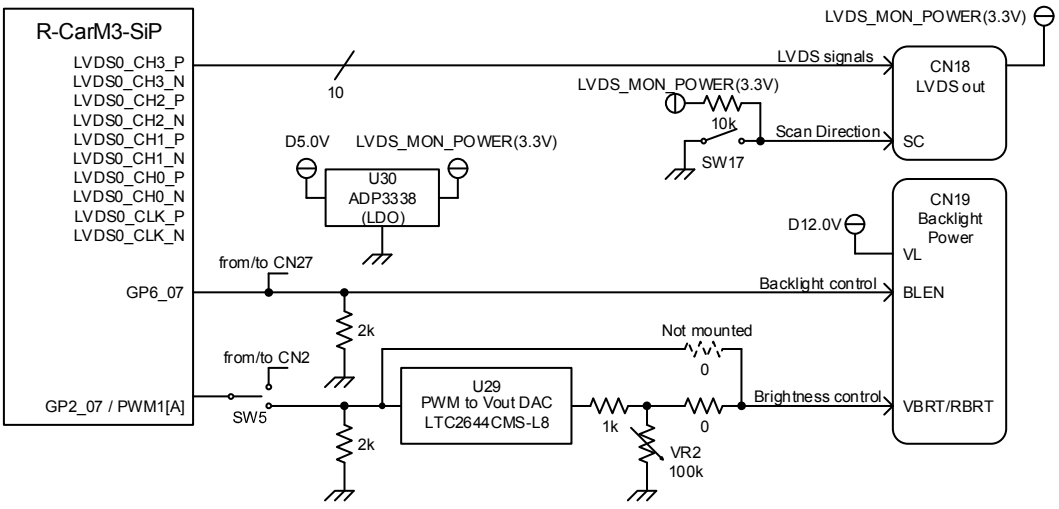

Figure 2.6.1 Block Diagram of the LVDS Output Interface

2.7. Analog RGB Output Interface (DU)

2.7.1. Specifications

The Salvator-X board incorporates a video D/A converter (ADV7123KSTZ140, U24) manufactured by Analog Devices to convert the digital RGB signals from the R-CarM3-SiP to analog RGB signals. The analog signals are connected to the DSUB 15-pin connector (CN15).
The digital RGB signals are also connected to an expansion connector on the Salvator-X board. For details on the display unit (DU), see the R-CarM3-SiP hardware manual. For details on the ADV7123KSTZ140, see the datasheet published by Analog Devices.
The digital RGB and LBSC functions are multiplexed on the same pins due to the specifications of the R-CarM3-SiP's pin function controller. Accordingly, when the analog RGB output signals on the Salvator-X board are in use, the LBSC function is not available.

Table 2.7.1 Analog RGB Output Interface Specifications

Display controller	On-chip display unit in the R-CarM3-SiP (Digital RGB)
Analog RGB	[Analog RGB output] Video D/A Converter: U24: ADV7123KSTZ140 from Analog Devices Connector: CN15: D02-M15SAG-23L9E from JAE

2.7.2. Block Diagram

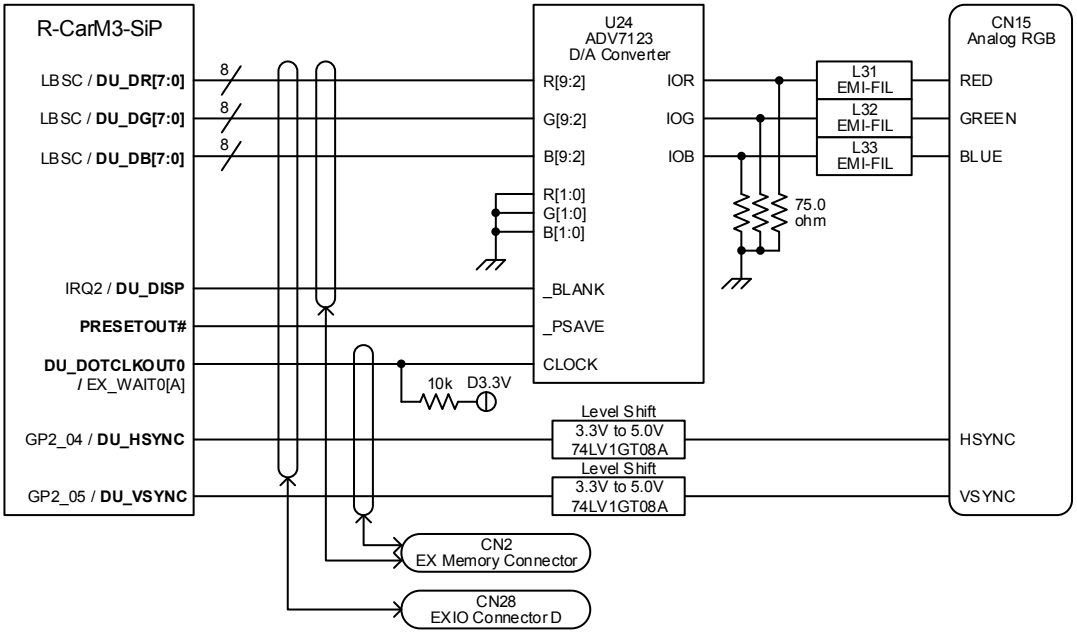

Figure 2.7.1 Block Diagram of the Analog RGB Output Interface

2.8. Video Input Interfaces (MIPI-CSI2)

2.8.1. Specifications

The R-CarM3-SiP incorporates two MIPI-CSI2 interfaces (CSI0 to CSI1). For details on the MIPI-CSI2 interfaces, see the R-CarM3-SiP Hardware Manual.
The Salvator-X board incorporates an ADV7482W MIPI-CSI2 decoder (U31) which is connected to the CSI0 (4 lanes) and CSI1 (2 lanes) of the R-CarM3-SiP. The route A output (4 lanes) is connected to the CSI0 (4 lanes) and the route B output (1 lane) is to the CSI1 (2 lanes). Set the valid number of lanes to 1 in the case of CSI1.
Setting of the ADV7482W registers can be handled through an I^2C bus (interface 4).
The interrupt output pins INTRQ1 and INTRQ2 of ADV7482W are respectively connected to the GP6_30 and GP6_31 pins of the R-CarM3-SiP. ADV7482W has an audio output function supporting the 8-channel TDM output mode. This function is connected to AUDIO_CLKC (group A), SCK4, WS4, and SDATA4 on the Salvator-X board.

CSI0 and CSI1 can be connected not only to ADV7482W but also to EXIO connector C (CN29). This is controlled by SW29.

On the Salvator-X board, the SSI4 functions (SCK4, WS4, and SDATA4) or functions multiplexed on the same pins can be used via EXIO connector B (CN27). Be sure to remove the 0-Ω resistors R638, R639, and R640 on the Salvator-X board when using the SSI functions or functions multiplexed on the same pins via CN27.

For details on ADV7482W, see the datasheet published by Analog Devices.

Table 2.8.1 Video Input Interface Specifications

Video input module	On-chip MIPI-CSI2 interfaces 0 and 1 in the R-CarM3-SiP
MIPI-CSI2 video decoder	U31: ADV7482WBBCZ from Analog Devices Transmitter A is connected to the R-CarM3-SiP's CSI0. Transmitter B is connected to the R-CarM3-SiP's CSI1.
I^2C bus	Interface 4 Slave address = 0xE0 for write, 0xE1 for read (ALSB = 0)
Interrupt pin	GP6_30: INTRQ1 GP6_31: INTRQ2
Video input connector	CN20: Type A HDMI connector for the CSI0 CN21: RCA connector for the CSI1
EXIO connector	CSI0 and CSI1 are connected to EXIO connector C (CN29) through the bus switch 'PI3PCIE3212ZBE'.

2.8.2. Block Diagram

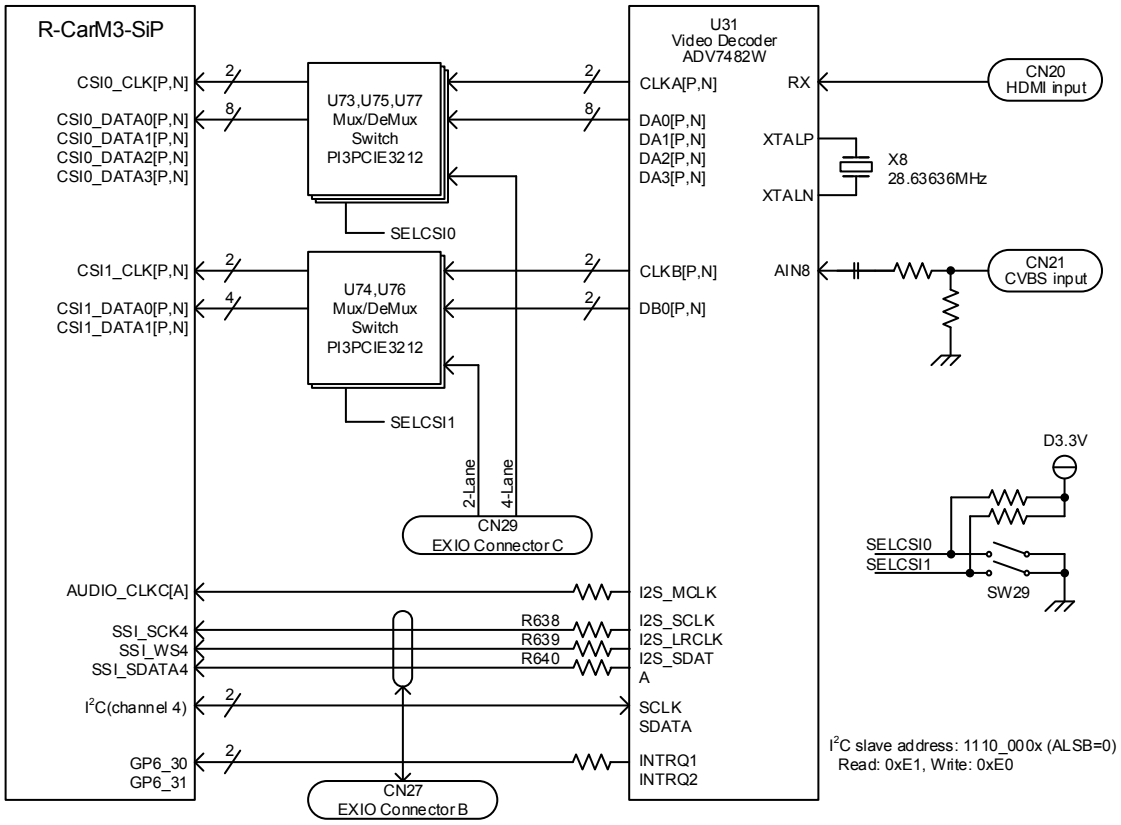

Figure 2.8.1 Block Diagram of the Video Input Interfaces

2.9. Audio Codec Interfaces (SSI0 and SSI1)

2.9.1. Specifications

The Salvator-X board incorporates an audio codec (AK4613VQ, U38) which is connected to SSI0 and SSI1 of the R-CarM3-SiP. For details on the SSI, see the R-CarM3-SiP Hardware Manual. For details on the AK4613VQ, see the datasheet published by Asahi Kasei Microdevices.

The master clock input of the AK4613 is connected to the AUDIO_CLKOUT3 pin (group A) of the R-CarM3-SiP. AUDIO_CLKA (group A) or AUDIO_CLKB (group A) can be selected as the clock signal to be output from AUDIO_CLKOUT3. AUDIO_CLKA is connected to the 22.5792-MHz (X11) clock signal from which a sampling frequency of 44.1 or 88.2 kHz is derived while AUDIO_CLKB is connected to a CS2000-CP (U41) manufactured by Cirrus Logic.
By setting the CS2000-CP registers over an I^2C bus (interface 2, group A), a sampling frequency of 48.0 or 96.0 kHz can be generated from the reference 24.5760-MHz (X12) clock source. For details on the CS2000-CP, see the datasheet published by Cirrus Logic.

Whether the AK4613 is to operate in the master or slave mode can be selected by the M/S pin (pin 17) of the AK4613. Since the M/S pin is set to the low level by a 0-Ω resistor (R680) on the Salvator-X board, the AK4613 operates in the slave mode with the initial setting as shipped. Removing R680 causes the AK4613 to operate in the master mode.

On the Salvator-X board, the SSI_SDATA0 and SSI_SDATA1 (group A) pins of the R-CarM3-SiP are connected to the SDTI1 and SDTO1 pins of the AK4613. Accordingly, set the SSI_SDATA0 pin for transmission and set the SSI_SDATA1 pin (group A) for reception.
The registers of the AK4613 are accessible over an I^2C bus (interface 2, group A).
The power-down pin (PDN) of the AK4613 is connected to the PRESETOUT# output from the R-CarM3-SiP.

On the Salvator-X board, the signals of the audio interfaces are also connected to EXIO connector B (CN27). When using the GP6_03/SSI_SDATA1 (group A) pin or a function multiplexed on that pin as an input to the R-CarM3-SiP via CN27, be sure to remove R683 (a 0-Ω resistor) to avoid conflict with the SDTO1 signal (pin 24) of the AK4613.

Table 2.9.1 Audio Codec Specifications

Controller	On-chip SSI0 and SSI1 in the R-CarM3-SiP
Codec	AK4613VQ (U38) from Asahi Kasei Microdevices I^2C (interface 2, group A) I^2C slave address: 0x21 for read, 0x20 for write. (CAD[1:0] = 00)
Clock divider & multiplier	CS2000-CP (U41) from Cirrus Logic I^2C (interface 2, group A) I^2C slave address: 0x9F for read, 0x9E for write. (AD0 = 1)
Audio interface	R-CarM3-SiP (SSI): Master mode AK4613VQ: Slave mode (initial setting at shipment)
Microphone amplifiers	MAX9813LEKA+T (U82 and U83) from Maxim Integrated 20-dB fixed gain
Audio connector	LINE-OUT (CN24, lower-side, 3.5-mm stereo mini-jack) MIC-IN (CN24, upper-side, 3.5-mm stereo mini-jack)

On the Salvator-X board, the analog input pins (RIN1 and LIN1) of the AK4613 are connected to microphone amplifiers (MAX9813L, U82 and U83) from Maxim. The gain of these amplifiers is fixed to 20 dB. When using the microphone input connector (CN24, upper-side) as a line input connector, be sure to use a cable that includes a resistor.

2.9.2. Block Diagram

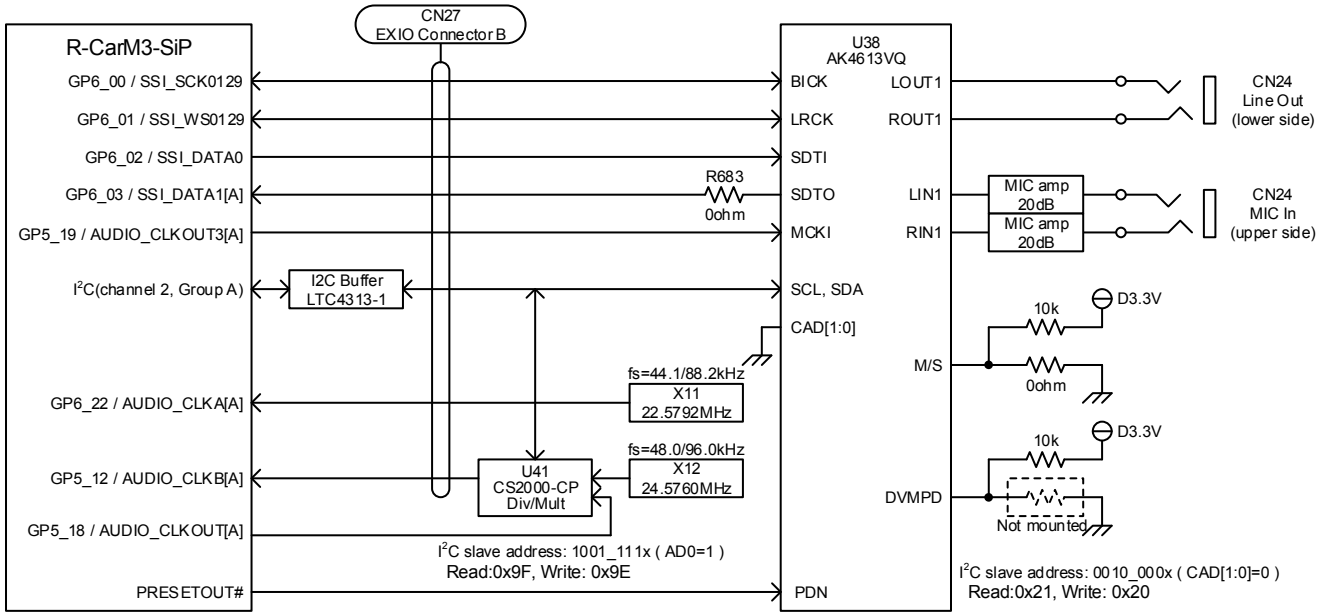

Figure 2.9.1 Block Diagram of the Audio Codec

2.10. SD Host Interface (SDHI0)

2.10.1. Specifications

The Salvator-X board incorporates an SD card slot (CN13) for the on-chip SD card host interface 0 (SDHI0) in the R-CarM3-SiP.
For details on the SDHI0, see the R-CarM3-SiP Hardware Manual.
On the Salvator-X board, the power (3.3 V) to be supplied to the VDD pin (pin 6 of CN13) of the SD card slot can be controlled by GP5_02. When GP5_02 is set to 1, power is supplied. When GP5_02 is set to 0, power is shut off.
On the Salvator-X board, the interface voltage (VDDQVA_SD0) of the SD card slot can be selected by GP5_01 when SW28 is set to off. When GP5_01 is set to 1, 3.3 V is supplied as VDDQVA_SD0. When GP5_01 is set to 0, 1.8 V is supplied as VDDQVA_SD0.
When using the SD card slot (CN13) for the SDHI0 function, make the following jumper pin and switch settings on the Salvator-X board.

1. Insert the jumper for JP2 in the pin 1 side.
2. Set SW16 to the pin 1 side.
3. Set SW28 to OFF.
4. Set GP5_01 to output.

With the above settings, the level on GP5_01 selects the voltage on VDDQVA_SD0.

When using the SD card slot (CN13) for the DBG2 function, see section 2.17, Debugger Interfaces (DBG and DGB2).

Table 2.10.1 SD Host Interface 0 (SDHI0) Specifications

SD host interface	On-chip SD host interface 0 in the R-CarM3-SiP (SDHI0)
Voltage control for VDD (pin 6 of CN13)	When JP2 is set to the pin 1 side, VDD (pin 6 of CN13) = 3.3 V (GP5_02 = '1') VDD (pin 6 of CN13) = 0.0 V (GP5_02 = '0')
Interface voltage control	VDDQVA_SD0 = 3.3 V (GP5_01 = '1', SW28 = 'OFF') VDDQVA_SD0 = 1.8 V (GP5_01 = '0', SW28 = 'OFF')
SD card slot	SCDABA0801 (CN13) from ALPS

2.10.2. Block Diagram

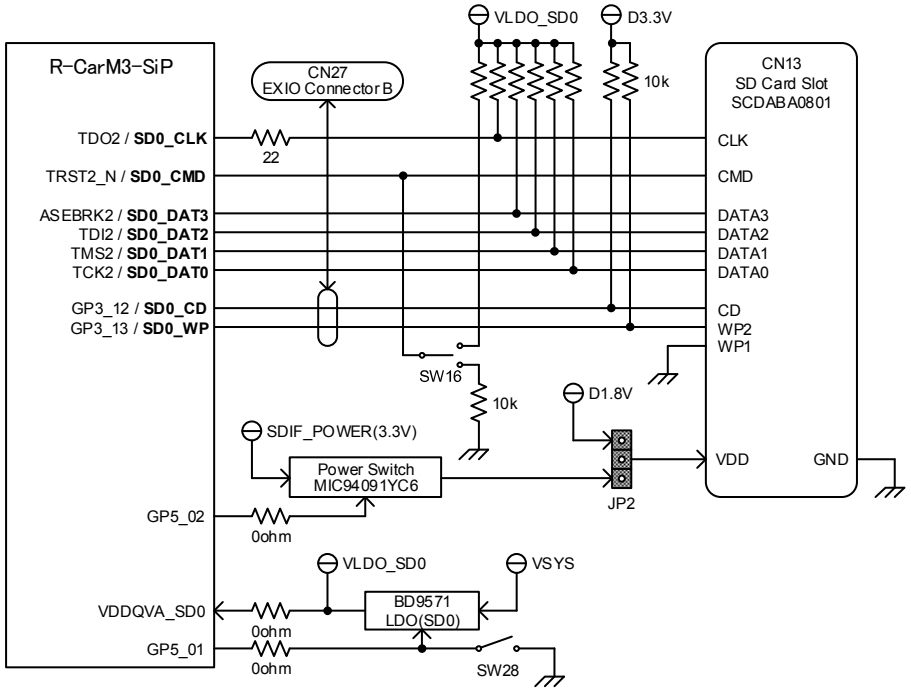

Figure 2.10.1 Block Diagram of the SD Host Interface 0 (SDHI0)

2.11. SD Host Interface (SDHI3)

2.11.1. Specifications

The Salvator-X board incorporates an SD card slot (CN14) for the on-chip SD card host interface 3 (SDHI3) in the R-CarM3-SiP. For details on the SDHI3, see the R-CarM3-SiP Hardware Manual.
On the Salvator-X board, the power (3.3 V) to be supplied to the VDD pin (pin 6 of CN14) of the SD card slot can be controlled by GP3_15. When GP3_15 is set to 1, power is supplied. When GP3_15 is set to 0, power is shut off.
On the Salvator-X board, the interface voltage (VDDQVA_SD3) of the SD card slot can be selected by GP3_14. When GP3_14 is set to 1, 3.3 V is supplied as VDDQVA_SD3. When GP3_14 is set to 0, 1.8 V is supplied as VDDQVA_SD3.

Table 2.11.1 SD Card Host Interface 3 (SDHI3) Specifications

SD host interface	On-chip SD host interface 3 in the R-CarM3-SiP (SDHI3)
Voltage control for VDD (pin 6 of CN14)	VDD (pin 6 of CN14) = 3.3 V (GP3_15 = '1') VDD (pin 6 of CN14) = 0.0 V (GP3_15 = '0')
Interface voltage control	VDDQVA_SD3 = 3.3 V (GP3_14 = '1') VDDQVA_SD3 = 1.8 V (GP3_14 = '0')
SD card slot	SCDABA0801 (CN14) from ALPS

2.11.2. Block Diagram

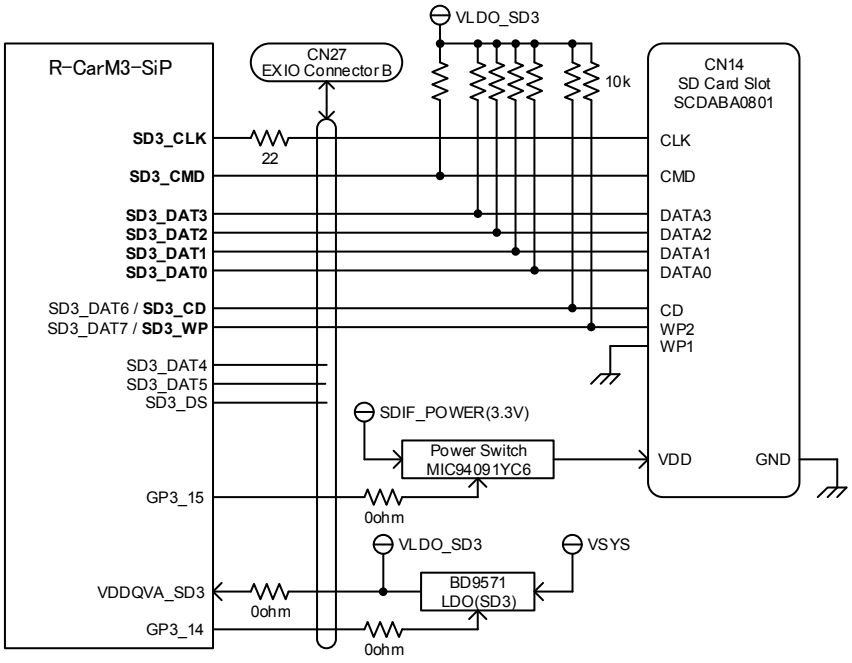

Figure 2.11.1 Block Diagram of the SD Host Interface 3 (SDHI3)

2.12. eMMC Memory Interface (MMCIF0)

2.12.1. Specifications

The R-CarM3-SiP incorporates two MMC interfaces (MMCIF0 and MMCIF1). For details on the MMC interfaces, see the R-CarM3-SiP Hardware Manual.
The Salvator-X board incorporates an eMMC memory KLMBG4GESD-B031 (32 Gbytes, U22) manufactured by Samsung which is connected to the on-chip MMCIF0 in the R-CarM3-SiP. For details on the KLMBG4GESD-B031, see the datasheet published by Samsung.
Due to the specifications of the Salvator-X board, the interface voltage between the R-CarM3-SiP and eMMC memory is fixed to 1.8 V.

Table 2.12.1 MMC Memory Interface 0 (MMCIF0) Specifications

MMC controller	On-chip MMC interface in the R-CarM3-SiP (MMCIF0)
Interface voltage	1.8 V (GP5_03 = '0', GP5_09 = '0')
eMMC memory	KLMBG4GESD-B031 (U22) from Samsung Capacities: 32 Gbytes

On the Salvator-X board, the MMCIF0 or functions multiplexed on the same pins (SDHI1/DBG3 and SDHI2) can be used via EXIO connector B (CN27). If you will be using the SDHI1/DBG3 or SDHI2 function, be sure to remove 0-Ω resistors R225 to R235 and to mount 0-Ω resistors as R617 to R623 and R626 to R629. Also mount R624 (47 kΩ) to ensure a defined level on the input pin of the eMMC memory (U22).
For connection of the 0-Ω resistors, see the circuit diagram for the Salvator-X board.

When using the SDHI1 function via CN27, be sure to remove 0-Ω resistors R75 and to mount 0-Ω resistors as R790.
The interface voltage (VDDQVA_SD1) of the SDHI1 can be selected by GP5_03. When GP5_03 is set to 1, 3.3 V is supplied as VDDQVA_SD1. When GP5_03 is set to 0, 1.8 V is supplied as VDDQVA_SD1.
Similarly, when using the SDHI2 function via CN27, be sure to remove 0-Ω resistors R76 and to mount 0-Ω resistors as R791.
The interface voltage (VDDQVA_SD2) of the SDHI2 can be selected by GP5_09. When GP5_09 is set to 1, 3.3 V is supplied as VDDQVA_SD2. When GP5_09 is set to 0, 1.8 V is supplied as VDDQVA_SD2.

2.12.2. Block Diagram

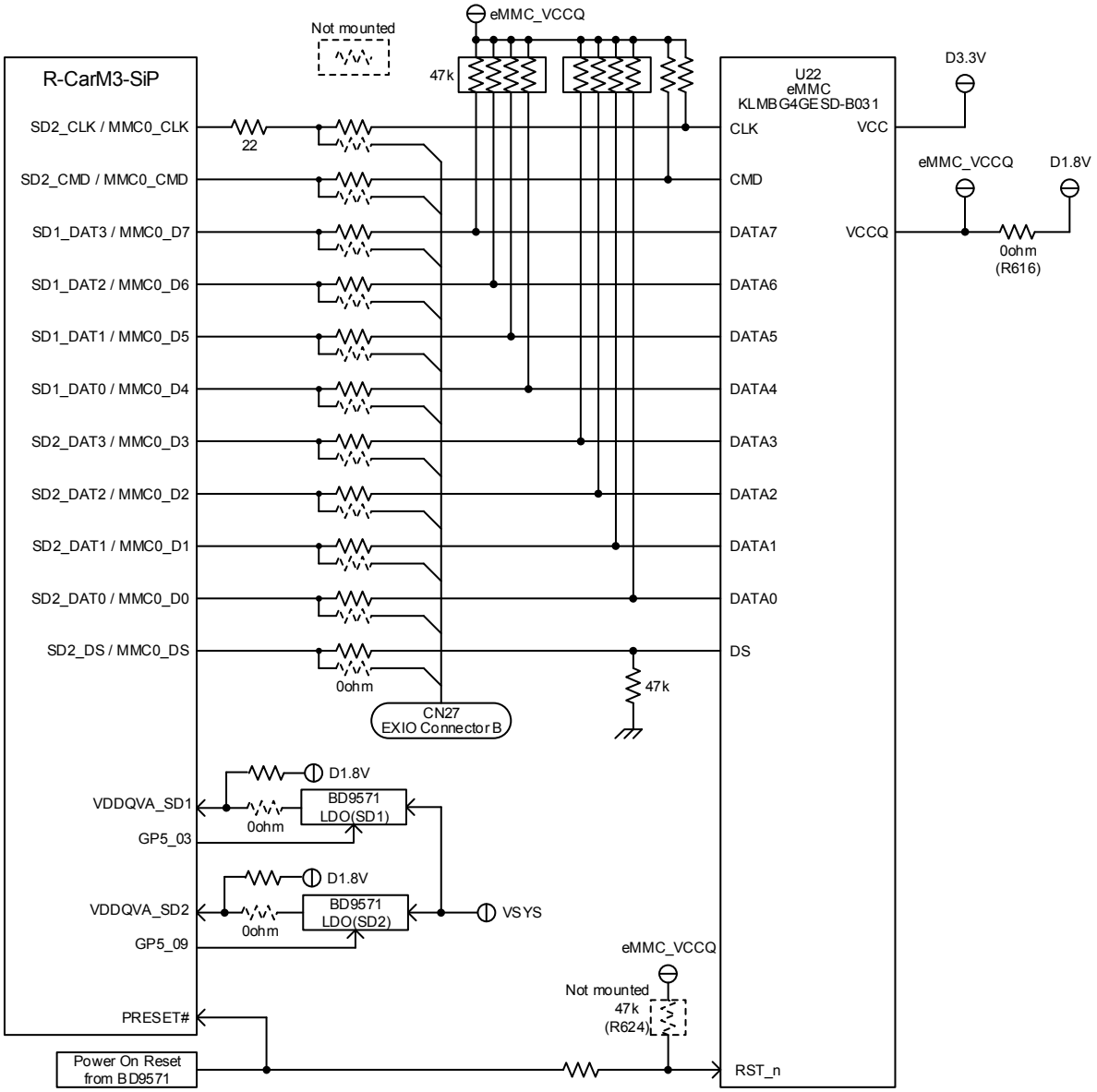

Figure 2.12.1 Block Diagram of the eMMC Memory Interface

2.13. USB3.0 Interface

2.13.1. Specifications

The Salvator-X board has a single USB 3.0 port that can be used as a single USB 3.0 host interface port or a single USB 3.0 function interface port.
The Salvator-X board incorporates a standard A connector as CN11.
When using interface 0 as a function port, use a cable with USB 3.0 standard-A plug to USB 3.0 Standard-A plug.
For details, see the R-CarM3-SiP Hardware Manual.

Table 2.13.1 USB3.0 Interface Specifications

USB controller	On-chip USB3.0 host/function controller in the R-CarM3-SiP
USB power switch	BD82065FVJ (U17) from ROHM Current limit 2.4[A]
USB host/function connector	On-chip USB3.0 interface 0 in the R-CarM3-SiP Standard A connector E8199-001-01 (CN11) from Pulse Electronics Corporation
Common mode filter with ESD protection diode	TCE0806G-900-2P from TDK for low speed, full speed, and high speed (D+/D-)
	TCE1608G-900-4P from TDK for SuperSpeed (SSRX+/SSRX-, SSTX+/SSTX-)
Chip beads	BLM18PG330SH1D from MURATA

2.13.2. Block Diagram

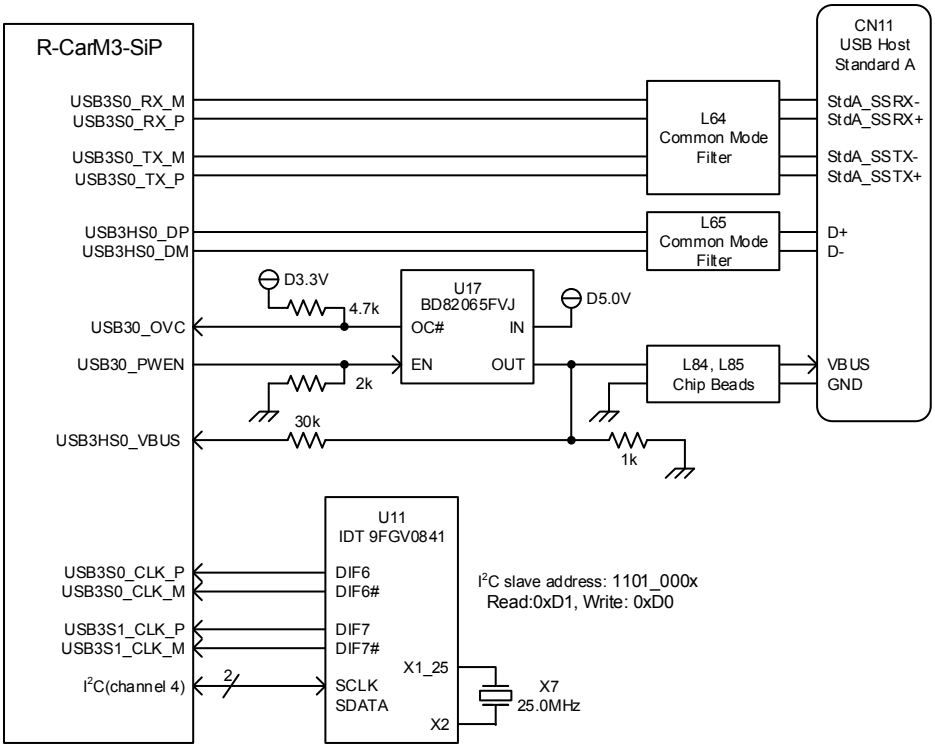

Figure 2.13.1 Block Diagram of the USB3.0 Interface

2.14. USB2.0 Interfaces

2.14.1. Specifications

The Salvator-X board has two USB2.0 ports that can be used as two USB2.0 host interface ports or a single USB2.0 host interface port and a single USB2.0 function interface port. The function interface is supported in interface 0. The MAX3355EEUD is mounted to enable use of interface 0 for evaluation of USB On-the-Go. The Salvator-X board incorporates a micro-AB connector as CN9 and dual type A connectors as CN10. For details on the USB2.0, see the R-CarM3-SiP Hardware Manual.

Table 2.14.1 USB2.0 Interfaces Specifications

USB controller	On-chip USB2.0 host/function controller in the R-CarM3-SiP
USB OTG charge pump and comparators	MAX3355EEUD from Maxim Integrated Current limit min. 0.2[A]
USB power switch	BD82065FVJ from ROHM Current limit 2.4[A]
USB host connector	On-chip USB2.0 interface 1 in the R-CarM3-SiP Type A, lower part of XM7A-0442-A (CN10) from OMRON
USB host/function connector	On-chip USB2.0 interface 0 in the R-CarM3-SiP Type microAB, ZX62D-AB-5P8 (CN9) from Hirose
Common mode filter with ESD protection diode	TCE0806G-900-2P from TDK
Chip beads	BLM18PG330SH1D from MURATA

Note: The connector for interface 0 of the USB in the R-CarM3-SiP is a micro connector shared by the USB host and function.

2.14.2. Block Diagram

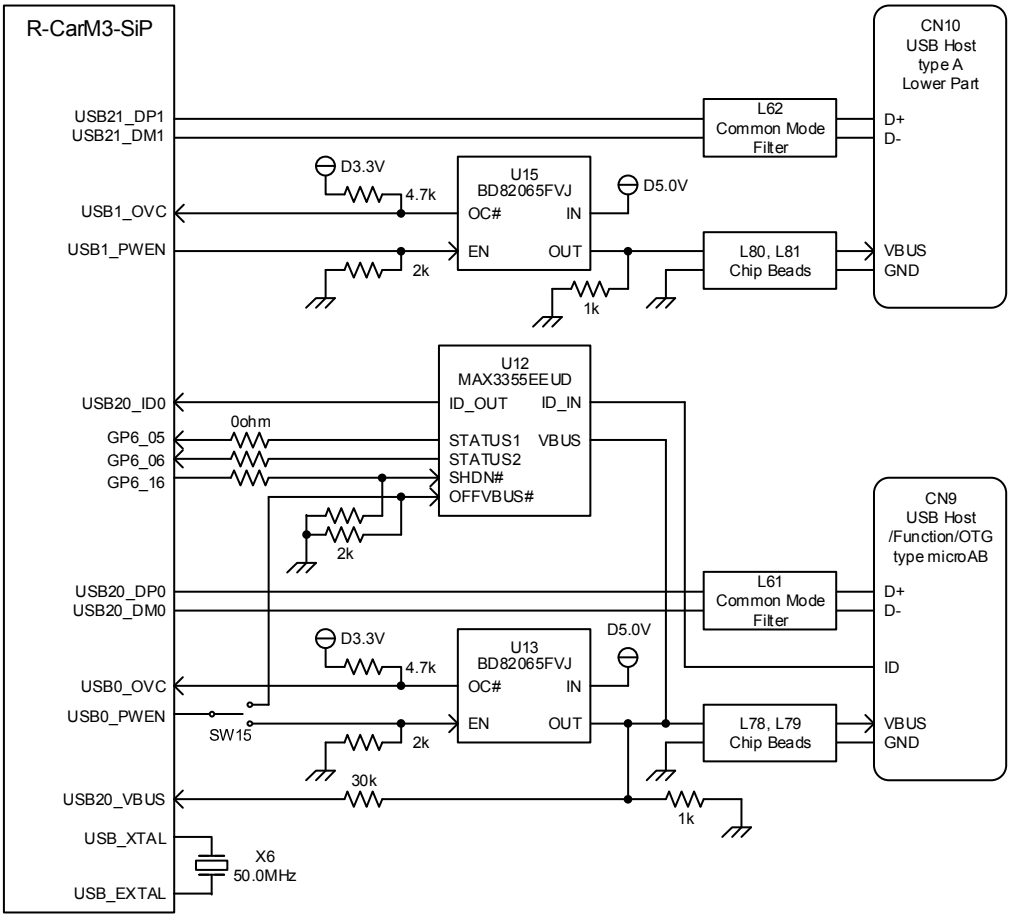

Figure 2.14.1 Block Diagram of the USB2.0 Interfaces

2.15. PCI Express Interfaces (PCIEC0 and PCIEC1/SATA)

2.15.1. Specifications

The R-CarM3-SiP incorporates two single-lane PCI Express interfaces (PCIEC0 and PCIEC1) compliant with Revision 2.0 of the PCIe Specification.
The on-chip PCIE module in the R-CarM3-SiP works in either of two modes, Root Port or Endpoint, which are defined in the PCI Express specifications. For details on the PCIEC, see the R-CarM3-SiP Hardware Manual.
On the Salvator-X board, PCIEC0 of the R-CarM3-SiP is connected to the PCI Express slot (CN5) and PCIEC1/SATA is connected to EXIO connector A (CN6).
EXIO connector A can be connected to the LBEE6ZZ1FD-TEMPS-D board manufactured by Murata. This is a combo module using the BCM89359 manufactured by Broadcom. If you intend to use the Salvator-X board with a Wi-Fi board, we have confirmed the connection with the LBEE6ZZ1FD-TEMPS-D board manufactured by Murata. Note that you must prepare the Wi-Fi driver software yourself, which will require you to have a license agreement with Broadcom.

Table 2.15.1 PCI Express Interface Specifications

PCI Express controller	On-chip PCI Express controllers in the R-CarM3-SiP
PCIEC interface 0	PCI Express slot 1-lane, 87715-9006 (CN5) from Molex
PCIEC interface 1 / SATA	EXIO connector A 1-lane, QSH-030-01-L-D-A (CN6) from Samtec
PCI Express clock source	9FGV0841AKILF (U11) from IDT

2.15.2. Block Diagram

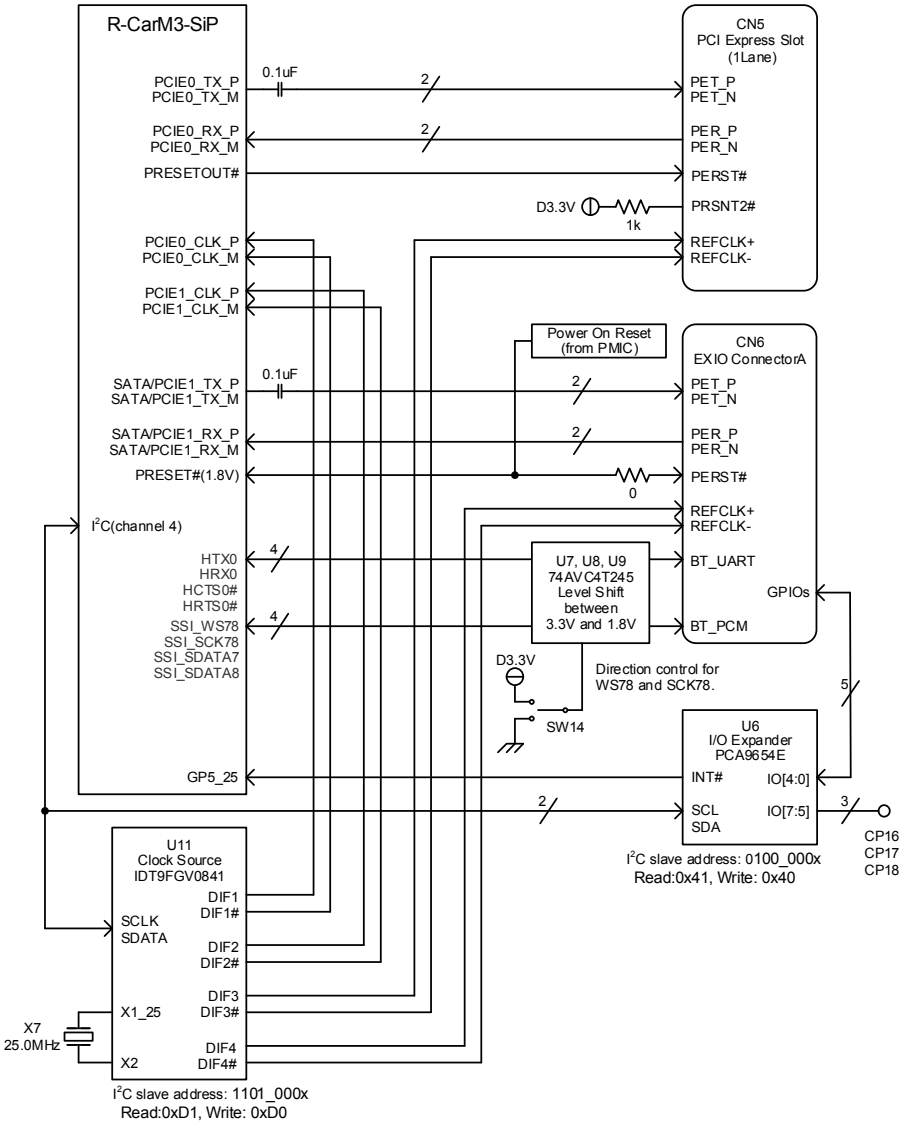

Figure 2.15.1 Block Diagram of the PCI Express Interfaces

2.15.3. Clock Source Unit of the PCI Express and USB3.0

The details of the clock source unit of the PCI Express and USB3.0 are shown below.
The IDT9FGV0841AKILF (U11) manufactured by IDT is used for the clock driver. This clock driver multiplies the input frequency (25 MHz) to supply a 100-MHz differential clock signal to the R-CarM3-SiP, PCI Express slot (CN5), and EXIO connector A (CN6). For details on the 9FGV0841AKILF, see the datasheet published by IDT.

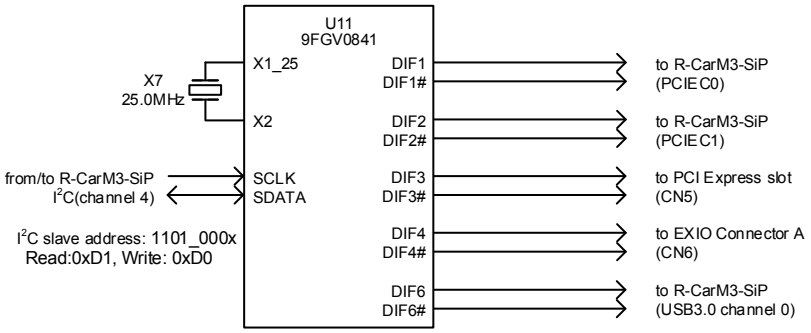

Figure 2.15.2 Block Diagram of the Clock Source Unit of the PCI Express and USB3.0

2.16. Ethernet Interface (EtherAVB)

2.16.1. Specifications

The R-CarM3-SiP incorporates a single EtherAVB interface (without the physical layer). For details on the EtherAVB, see the R-CarM3-SiP Hardware Manual.
The Salvator-X board incorporates a Gigabit Ethernet transceiver KSZ9031RNXVA (U78) manufactured by Micrel which is connected to the EtherAVB of the R-CarM3-SiP. For details on the KSZ9031RNXVA, see the datasheet published by Micrel.
The EtherAVB can also be connected to the EtherAVB PHY connector (CN23) by moving the locations of 0-Ω resistors on the board.
The EtherAVB PHY connector (CN23) can also be connected to the TSE-BRPHY004 board manufactured by TESSERA TECHNOLOGY INC., which incorporates the BCM89810 manufactured by Broadcom.

Table 2.16.1 Ethernet Interface Specifications

MAC layer	On-chip EtherAVB in the R-CarM3-SiP Supports transfer at 1000 Mbps and 100 Mbps Supports interface conforming to IEEE802.3 PHY-RGMII
Physical layer -1	Transceiver: KSZ9031RNXVA (U78) from Micrel Gigabit Ethernet transceiver with RGMII support. Supports 10/100/1000 Mbps IEEE802.3-compliant Ethernet transceiver. Connector: 0826-1G1T-23-F (CN22) from Bel Fuse RJ-45 with pulse transformer Initial setting at shipment: The following zero-Ω resistors are mounted. R641, R647, R653, R659, R664, R668, R642, R648, R654, R660, R665, and R669
Physical layer -2	Connector: QSH-030-01-L-D-A (CN23) from Samtech TSE-BRPHY004 board from Tessera can be connected. Initial setting at shipment: The following zero-Ω resistors are not mounted. R643, R651, R656, R662, R666, R670, R644, R652, R657, R663, R667, and R671

The KSZ9031 can be reset by the PRESETOUT# signal from the R-CarM3-SiP. It can also be reset under software control through GP2_10 (which is multiplexed with AVB_MAGIC). The PHY address bits PHYAD[4:2] of the KSZ9031 are fixed to 000 and PHYAD[1:0] can be specified by SW30. Other strapping options for KSZ9031 are as follows.

Table 2.16.2 Strapping Options for KSZ9031

Pin Name	Setting	Pin Function	Board Configuration
PHYAD2	Fixed to '0'	PHY address bit 2	Pulled down (R757)
MODE[3:0]	Fixed to '1111'	RGMII mode – advertise all capabilities	Pulled up (R753 to R756)
CLK125_EN	Fixed to '1'	Enable 125-MHz clock output	Pulled up (R752)
LED_MODE	Fixed to '1'	Single LED mode	Pulled up (R325)

Two LEDs (LED1 and LED2) are mounted in the RJ45 connector (CN22) and are respectively connected to LED1 (pin 17) and LED2 (pin 15) of the KSZ9031 on the Salvator-X board. LED1 indicates transmission or reception activity and LED2 indicates the presence of an Ethernet link with any speed. LED1 blinks during transmission and reception, and LED2 is turned on when an Ethernet link is established.
The GP2_12/AVB_LINK pin of the R-CarM3-SiP can also be used to read the Ethernet link state. The value 1 for the bit corresponding to the GP2_12/AVB_LINK pin indicates the presence of an Ethernet link at any speed, and 0 indicates that an Ethernet link is not present.

When connecting the EtherAVB of the R-CarM3-SiP to the EtherAVB PHY connector (CN23), move the 0-Ω resistors (A) to the locations (B).
(A) R641, R647, R653, R659, R664, R668, R642, R648, R654, R660, R665, and R669
(B) R643, R651, R656, R662, R666, R670, R644, R652, R657, R663, R667, and R671

Also be sure to remove R658 to avoid conflict between the KSZ9031 output and CN23 output on the AVB_PHY_INT signal.
Setting of SW30 is also required so that PHY addresses will not collide between the KSZ9031 and PHY via CN23.
For connection of the 0-Ω resistors, see the circuit diagram for the Salvator-X board.

2.16.2. Block Diagram

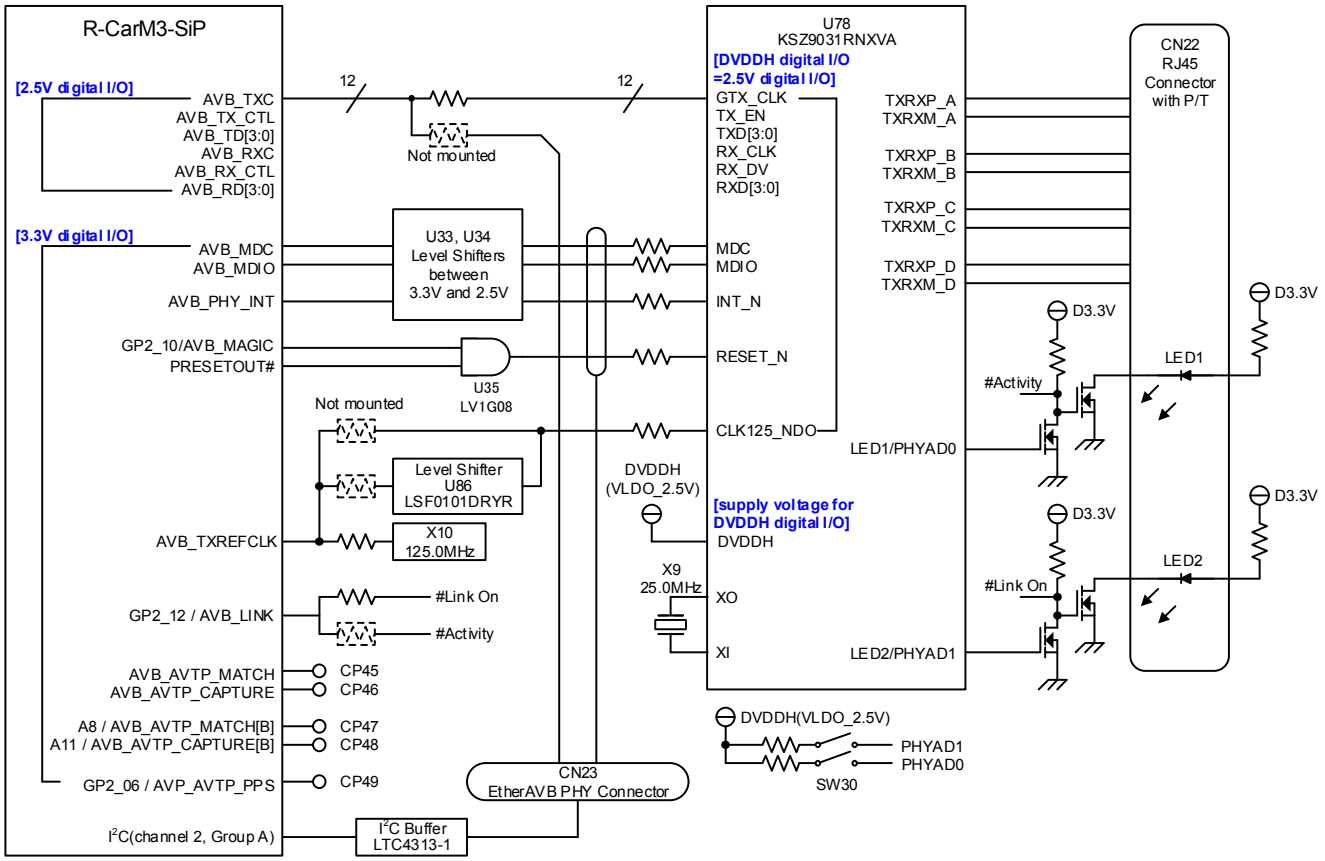

Figure 2.16.1 Block Diagram of the Ethernet Interface

2.17. Debugger Interfaces (DBG and DGB2)

2.17.1. Specifications

The Salvator-X board incorporates the following connector and SD card slot as debugger interfaces:
(1) 20-pin connector (DBG) for connection to the JTAG emulator
(2) SD card slot (CN13) for the DBG2 and SDHI0 that can be connected to the debugging board

For details on the debugger interface, see the R-CarM3-SiP Hardware Manual.

Make the following settings when using the SD card slot (CN13) as the DBG2 function.
1. Insert the jumper for JP2 in the pin 3 side.
2. Set SW16 to the pin 3 side.
3. Set SW28 to ON.
4. Set GP5_01 to input.

The above settings ensure that the voltage on VDDQVA_SD0 will be 1.8 V.

When using the SD card slot (CN13) as the SDHI0 function, see section 2.10, SD Host Interface (SDHI0).

The debugger interface of the R-CarM3-SiP supports the DBG3, however, the Salvator-X board does not incorporate the function.
The DBG3 (SDHI1)-related signals are connected to the EXIO connector B (CN27).
On the Salvator-X board, selection of debugging through the JTAG connector (CN1) or SD card slot (CN13) is possible by setting the levels on mode pins. For setting of the mode pins, see 2.1.1.7, MD21, MD20, MD11, MD10, and MDT[1:0] Pins — Switching of JTAG, DBG2 (SDHI0), and DBG3 (SDHI1).

Table 2.17.1 DBG and DBG2 Interfaces Specifications

DBG interface (20 pins)	CN1: HTST-110-01-S-V from Samtec
DBG2 interface (SD card slot)	CN13: SCDABA0801 (full SD card slot) from ALPS

2.17.2. Block Diagram

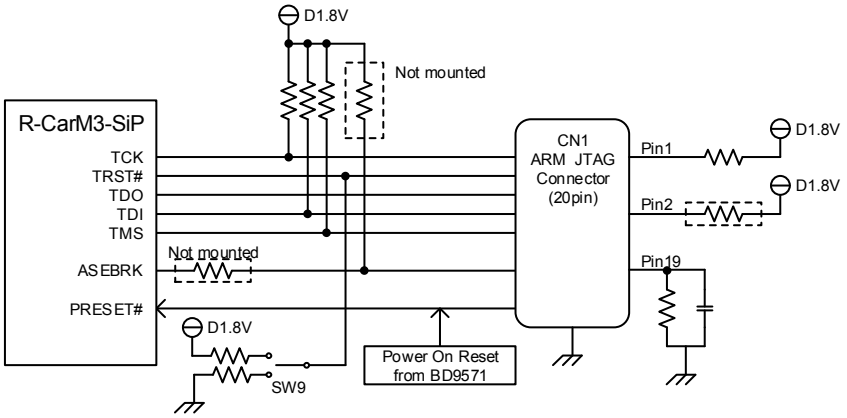

Figure 2.17.1 Block Diagram of the JTAG (DBG) Debugger Interface

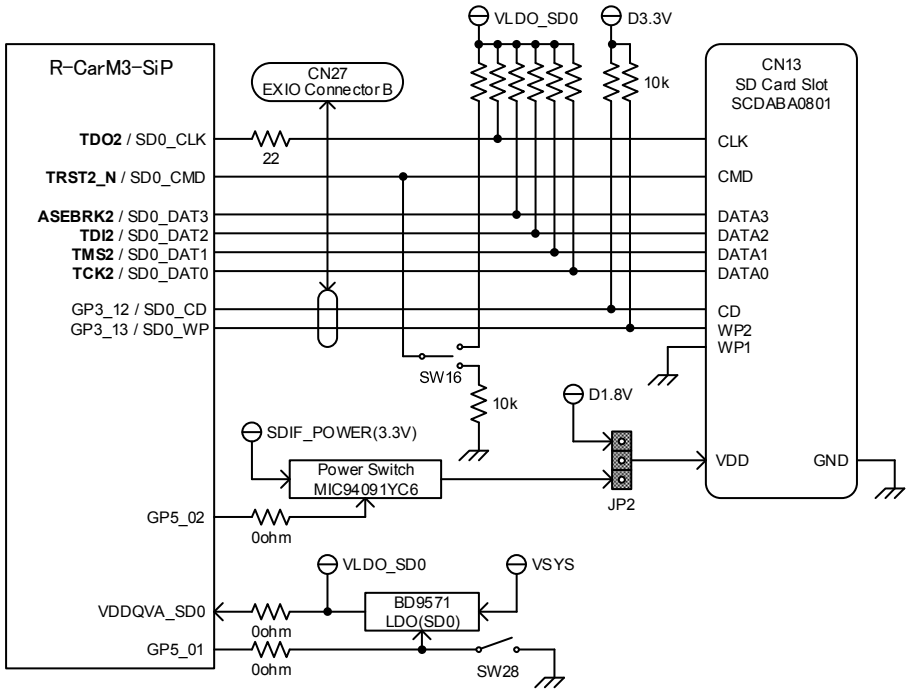

Figure 2.17.2 Block Diagram of the SD Card Slot (DBG2) Debugger Interface

2.18. Debug Serial Interfaces (SCIF2, SCIF1/HSCIF1)

2.18.1. Specifications

The Salvator-X board uses the on-chip SCIF2 (group A) and on-chip SCIF1/HSCIF1 (group A) in the R-CarM3-SiP as debug serial interfaces. For details on the SCIF and HSCIF, see the R-CarM3-SiP Hardware Manual.
The SCIF2 of the R-CarM3-SiP is connected to the USB micro-AB connector (CN25) via the USB to UART bridge CP2102. Similarly, the SCIF1/HSCIF1 (group A) is connected to CN26 via the CP2102 on the board. By connecting CN25 and CN26 to the host PC through USB cables, these interfaces can be used as debug serial interfaces. For details on the CP2102, see the datasheet published by Silicon Labs.

The SCIF_CLK (group A) pin of the R-CarM3-SiP is connected to the crystal oscillator (X1) on the Salvator-X board, which supplies a clock frequency of 14.7456 MHz. When 14.7456 MHz is the frequency of the source clock, since the UART supports 300 bps to 1 Mbps due to the CP2102 device specifications, the maximum transfer rate becomes 921.6 kbps, which is obtained by dividing the source clock by 16.

The host PC connected to the Salvator-X board requires the CP2102 USB driver software. This driver software can be obtained from the following URL.

http://www.silabs.com/products/mcu/Pages/USBtoUARTBridgeVCPDrivers.aspx

On the Salvator-X board, the signals of the SCIF1/HSCIF1 (group A) are also connected to EXIO connector B (CN27). When using the RX1/HRX1 and CTS1#/HCTS1# pins or other functions multiplexed on these pins as input signals to the R-CarM3-SiP via CN27, be sure to remove R690 and R692 (0-Ω resistors) to avoid conflict with the LV1GT08 output (U45 and U46).

Table 2.18.1 Debug Serial Interfaces Specifications

Serial controller	On-chip SCIF2 (group A) and SCIF1/HSCIF1 (group A) controllers in the R-CarM3-SiP
USB to UART Bridge	CP2102 (U42, U44) from Silicon Labs Max. 1 Mbps
Connector	CN25: SCIF2, ZX62D-AB-5P8 from Hirose CN26: SCIF1/HSCIF1, ZX62D-AB-5P8 from Hirose

2.18.2. Block Diagram

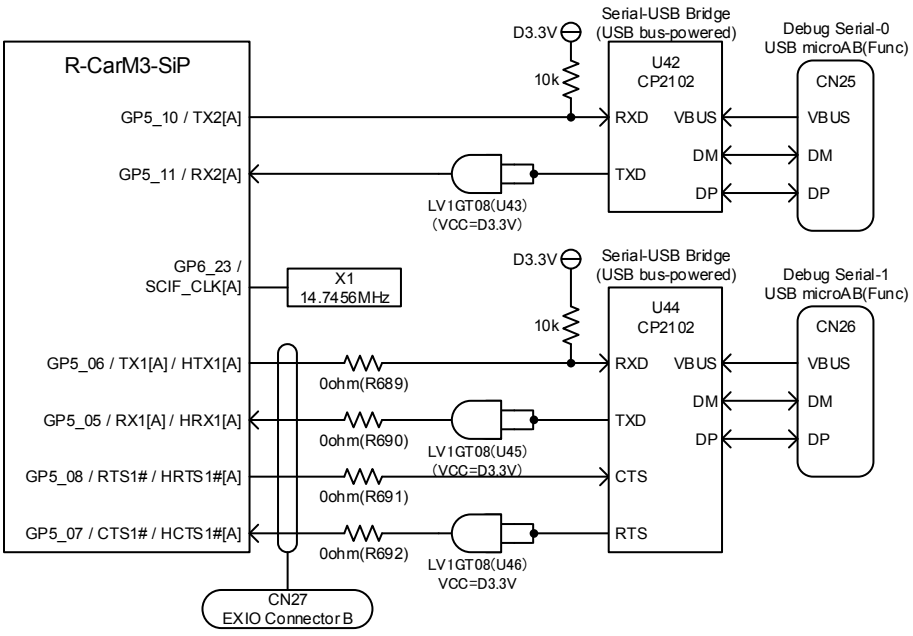

Figure 2.18.1 Block Diagram of the Debug Serial Interfaces

2.19. GPIO Interfaces (Software Switch, Tact Switch, and General-Purpose LEDs)

2.19.1. Specifications

The Salvator-X board incorporates a 4-bit software switch (SW4), three bits of tactile switches (SW20 to SW22), and three bits of LEDs (LED4, LED5, and LED6) for debugging. They are connected to the GPIO of the R-CarM3-SiP as follows. For details on the GPIO, see the R-CarM3-SiP Hardware Manual.

Table 2.19.1 List of Software Switches (General-Purpose Switches)

GPIO	Software Switch
GP5_23	Bit 3 (pin 4 of SW4)
GP5_22	Bit 2 (pin 3 of SW4)
GP5_20	Bit 1 (pin 2 of SW4)
GP5_17	Bit 0 (pin 1 of SW4)

Table 2.19.2 List of Tactile Switches (General-Purpose Switches) or General-Purpose LEDs

GPIO	Tactile Switch	General-Purpose LED
GP6_13	Bit 2 (SW22)	LED6
GP6_12	Bit 1 (SW21)	LED5
GP6_11	Bit 0 (SW20)	LED4

When using the software switches, enable the internal pull-up functions of GP5_17, GP5_20, GP5_22, and GP5_23. On the Salvator-X board, the GPIO pins connected with the tactile switches are also connected with the general-purpose LEDs. When using the GPIO pins for connecting the tactile switches, set them as inputs. When using the GPIO pins for connecting LEDs, set them as outputs.
The GPIO pins used for the tactile switches and general-purpose LEDs are also connected to EXIO connector B (CN27) on the Salvator-X board. When using GP6_11, GP6_12, and GP6_13, or functions multiplexed on these pins, be sure to remove R693, R694, and R695 (0-Ω resistors) to avoid the effect of the capacitor (4.7 uF) for the de-bouncing circuit.

2.19.2. Block Diagram

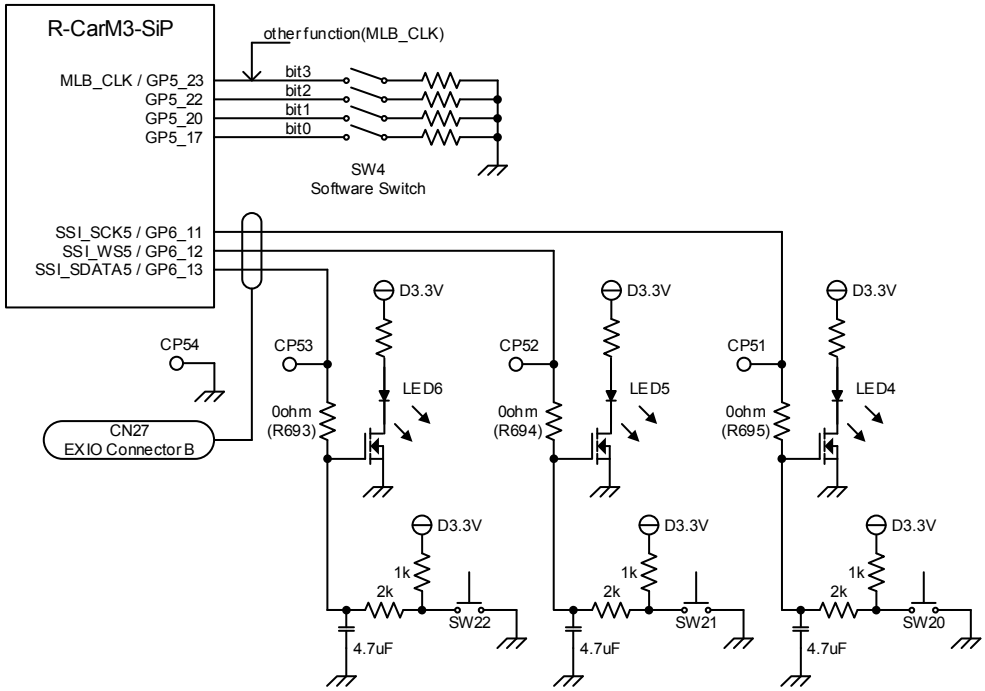

Figure 2.19.1 Block Diagram of the GPIO Interfaces (Software Switches, Tactile Switches, and General-Purpose LEDs)

2.20. I²C Interfaces

2.20.1. Specifications

The R-CarM3-SiP incorporates seven I²C interfaces and a single I²C interface for DVFS. The following devices are connected to the I²C interfaces on the Salvator-X board. For details on the I²C interfaces and I²C interface for DVFS, see the R-CarM3-SiP Hardware Manual.

Table 2.20.1 I²C Interface Specifications

I²C controller	On-chip I²C controllers in the R-CarM3-SiP
I²C devices through I²C (interface 6, group A, B, C)	[3.3 V] CN2: External memory connector CN28: EXIO connector D
I²C devices through I²C (interface 5)	[3.3 V] CP45 and CP46 Note: SCL5 and SDA5 are wired OR with AVB_AVTP_MATCH_A and AVB_AVTP_CAPTURE_A, respectively.
I²C devices through I²C (interface 4)	[3.3 V] U6: PCA9654EDTR2G from On Semiconductor U11: 9FGV0841AKILF from IDT U31: ADV7482WBBCZ from Analog Devices U58 and U59: MAX9611AUB+ from Maxim Integrated U61: 5P49V5923B from IDT CN29: EXIO connector C
I²C devices through I²C (interface 3)	[3.3 V] CN2: External memory connector CN28: EXIO connector D Note: SCL3 and SDA3 are wired OR with PWM1_A and PWM2_A, respectively.
I²C devices through I²C (interface 2, group A)	[3.3 V] U79: LTC4313CMS8-1#PBF from Linear Technology Note: The follwoing devices are connected via the LTC4313-1. U38: AK4613VQ from Asahi Kasei Microdevices U41: CS2000-CP from Cirrus Logic CN23: EtherAVB PHY connector CN27: EXIO connector B
I²C devices through I²C (interface 1, group B)	[3.3 V] CN6: EXIO connector A
I²C devices through I²C (interface 0)	[3.3 V] CN27: EXIO connector B Note: SCL0 and SDA0 are wired OR with GP3_14 and GP3_15, respectively.
I²C devices through I²C for DVFS	[3.3 V] U72: BD9571MWV-M from ROHM U57: BR24T01FVM-W from ROHM

Notes: 1. Note that, when another function (e.g. GP5_04 or GP5_00) multiplexed on the same pins as the I²C (interface 2, group A) functions is selected, access to devices (e.g. AK4613VQ) connected to the I²C bus is not possible.
2. In I²C interface 5, SCL5 and SDA5 are respectively wired-ORed with AVB_AVTP_MATCH_A and AVB_AVTP_CAPTURE_A due to the specifications of the R-CarM3-SiP. Accordingly, only one pair of signals (for I²C or EtherAVB) can be used.
3. In I²C interface 3, SCL3 and SDA3 are respectively wired-ORed with PWM1_A and PWM2_A due to the specifications of the R-CarM3-SiP. Accordingly, only one pair of signals (for I²C or PWM) can be used.
4. In I²C interface 0, SCL0 and SDA0 are respectively wired-ORed with GP3_14 and GP3_15 due to the specifications of the R-CarM3-SiP. Accordingly, only one pair of signals (for I²C or GPIO) can be used.
5. The Salvator-X board does not incorporate pull-up resistors for I²C interfaces 3, 5, and 6. When using I²C transfer through these interfaces, additional pull-up resistors must be connected on the board.

2.20.2. List of Slave Addresses

The table below lists the slave addresses of the I²C devices on the Salvator-X board.

Table 2.20.2 List of I²C Slave Addresses

I²C interface	Ux CNx	Device		Slave Address										Note
				Binary								Hexadecimal		
				7	6	5	4	3	2	1	R/W#	RD	WR	
6	CN28	EXIO CN D	Connector	-	-	-	-	-	-	-	-	-	-	-
5	CP45 CP46	Pad	Test point	-	-	-	-	-	-	-	-	-	-	-
4	U6	PCA9654	I/O expander	0	1	0	0	0	0	0	X	0x41	0x40	-
	U11	9FGV0841	CLK generator	1	1	0	1	0	0	0	X	0xD1	0xD0	-
	U31	ADV7482WBBCZ	Video decoder	1	1	1	0	0	0	0	X	0xE1	0xE0	*1
	U58	MAX9611	Current-sense	1	1	1	1	1	1	1	X	0xFF	0xFE	*2
	U59	MAX9611	Current-sense	1	1	1	1	1	0	0	X	0xF9	0xF8	*3
	U61	5P49V5923	CLK generator	1	1	0	1	0	1	0	X	0xD5	0xD4	-
	CN29	EXIO CN C	Connector	-	-	-	-	-	-	-	-	-	-	-
3	CN28	EXIO CN D	Connector	-	-	-	-	-	-	-	-	-	-	-
2A	U38	AK4613	SSI codec	0	0	1	0	0	0	0	X	0x21	0x20	*4
	U41	CS2000	CLK synthesizer	1	0	0	1	1	1	1	X	0x9F	0x9E	*5
	CN23	EtherAVB CN	Connector	-	-	-	-	-	-	-	-	-	-	-
	CN27	EXIO CN B	Connector	-	-	-	-	-	-	-	-	-	-	-
1B	CN6	EXIO CN A	Connector	-	-	-	-	-	-	-	-	-	-	-
0	CN27	EXIO CN B	Connector	-	-	-	-	-	-	-	-	-	-	-
I²C interface	**Ux CNx**	**Device**		**Binary**								**Hexadecimal**		**Note**
				7	**6**	**5**	**4**	**3**	**2**	**1**	**R/W#**	**RD**	**WR**	
DVFS	U72	BD9571MWV-M	PMIC	0	1	1	0	0	0	0	X	0x61	0x60	-
DVFS	U57	BR24T01FVM-W	EEPROM	1	0	1	0	0	0	0	X	0xA1	0xA0	*6

Notes: 1. ALSB = GND
2. A1 = VCC, A0 = VCC
3. A1 = VCC, A0 = GND
4. CAD1 = GND, CAD0 = GND
5. AD0 = VCC
6. A2 =GND, A1 = GND, A0 = GND

2.20.3. Block Diagram

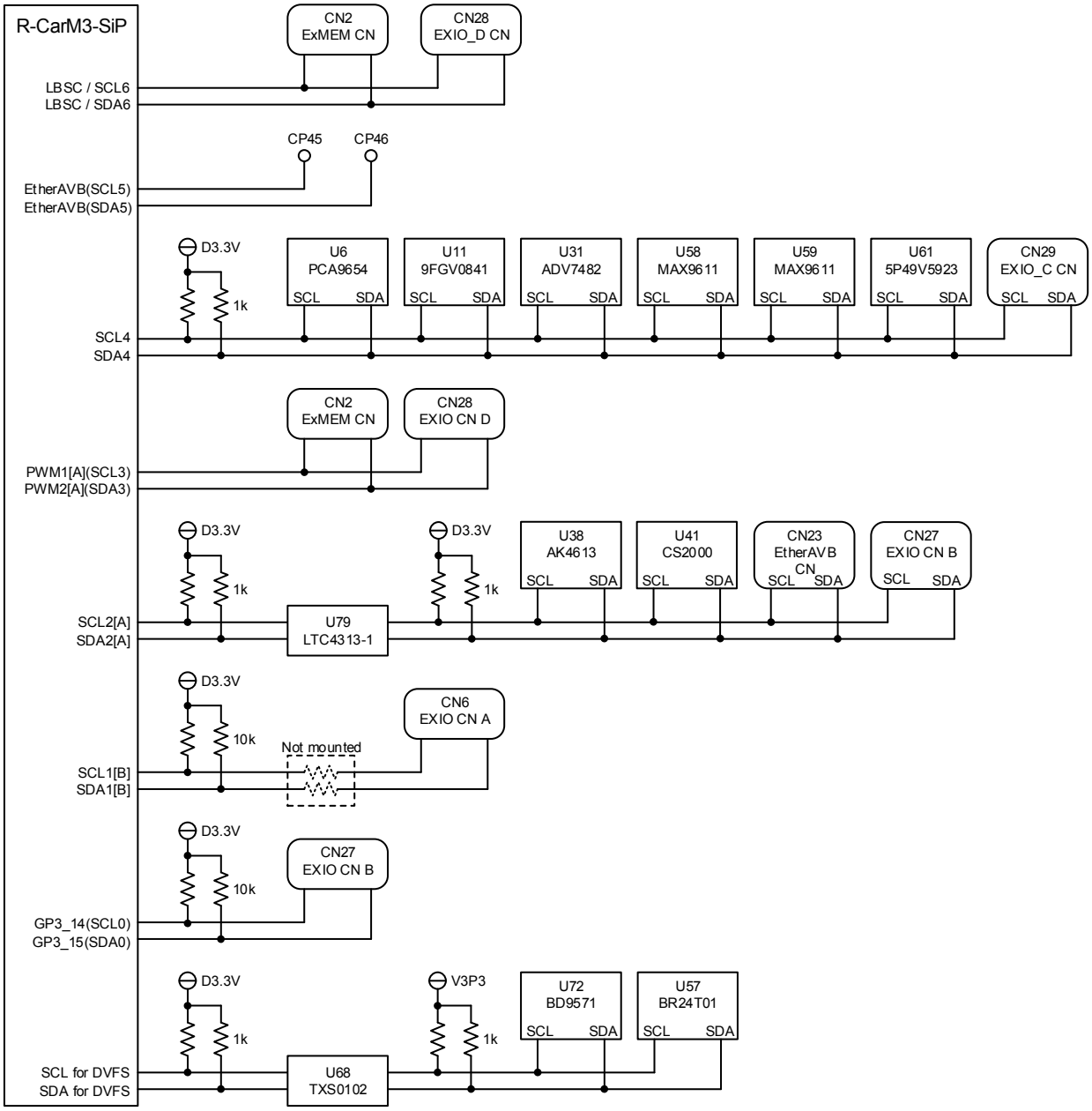

Figure 2.20.1 Block Diagram of the I²C Interfaces

2.21. External Interrupts

2.21.1. Specifications

The R-CarM3-SiP has external interrupt input pins NMI and INTC_IRQ[5:0].
The Salvator-X board uses IRQ0, IRQ1, and IRQ2 as external interrupt input pins, and GP5_25, GP6_30, and GP6_31 as GPIO interrupts. These pins should be used as active-low signals in programs.
For the interrupt functions of the R-CarM3-SiP, see the R-CarM3-SiP Hardware Manual.
The devices and connectors of the interrupt request sources on the Salvator-X board are shown below.

Table 2.21.1 External Interrupt Specifications

Interrupt Pin	Devices that Output Interrupt Request	Connectors
IRQ0	PMIC U72: BD9571MWV from ROHM	CN28: EXIO connector D
IRQ1	----	CN28: EXIO connector D
IRQ2	----	CN2: External memory connector CN28: EXIO connector D
GP5_25	I/O expander U6: PCA9654EDTR2G from On Semiconductor	CN6: EXIO connector A
GP6_30, GP6_31	Video decoder for MIPI CSI-2 U31: ADV7482WBBCZ from Analog Deivces	CN29: EXIO connector C

2.21.2. Block Diagram

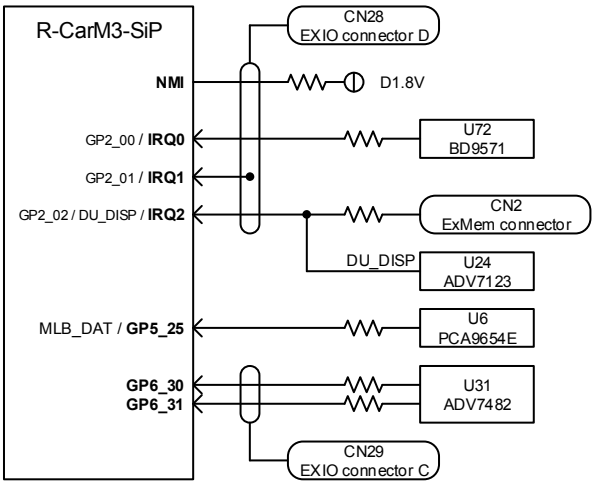

Figure 2.21.1 Block Diagram of the External Interrupts

2.22. External Wait

2.22.1. Specifications

The R-CarM3-SiP supports external wait requests from devices mapped to area 0 (CS0#) and area 1 (CS1#). For details on the external wait function of the R-CarM3-SiP, see the R-CarM3-SiP Hardware Manual.
The Salvator-X board does not incorporate a device to output WAIT or RDY requests. The only signal connected to the R-CarM3-SiP is EX_WAIT0 (group A), which is output from the external memory connector (CN2) and EXIO connector D (CN28). The EX_WAIT0 signal is pulled-up by a 10-kΩ resistor (R25) on the Salvator-X board, and a low level of this signal output to the R-CarM3-SiP specifies a WAIT request.
Due to the specifications of the pin function controller (PFC) of the R-CarM3-SiP, the EX_WAIT0 (group A) and DU_DOTCLKOUT0 functions are multiplexed on the same pin. Accordingly, when the analog RGB outputs are in use on the Salvator-X board, the external wait function is not available.

Table 2.22.1 External Wait Control Interface Specifications

Signal	Devices that Output the WAIT or RDY Request
EX_WAIT0 (group A)	(1) WAIT# request from the EXIO connector D (CN28) (2) WAIT# request from the external memory connector (CN2)

2.22.2. Block Diagram

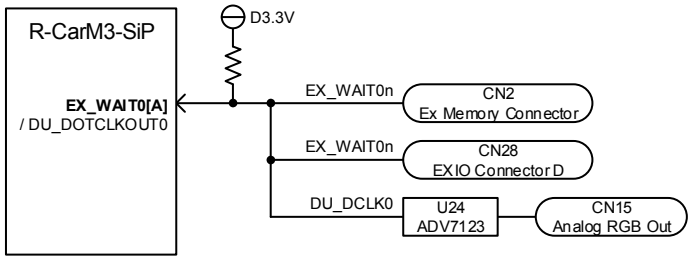

Figure 2.22.1 Block Diagram of the External Wait Interface

2.23. Clock

The Salvator-X board uses the crystal oscillators and resonators shown below.

2.23.1. Clock Signals Supplied to the R-CarM3-SiP

Table 2.23.1 List of Clock Signals and Crystals for the R-CarM3-SiP

No.	Xn	Frequency	Supply Voltage	R-CarM3-SiP Pin Name	Type	Remarks
1	X1	14.7456 MHz	3.3 V	SCIF_CLK (group A)	Oscillator	-
2	X3	16.6666 MHz	---	XTAL, EXTAL	Resonator (not mounted)	*1
3	X4	16.6666 MHz	1.8 V	EXTAL	Oscillator	*2
4	X5	32.768 kHz	1.8 V	EXTALR	Oscillator	-
5	X6	50.0000 MHz	---	USB_XTAL, USB_EXTAL	Resonator	-
6	X10	125.000 MHz	3.3 V	AVB_TXCREFCLK	Oscillator	-
7	X11	22.5792 MHz	3.3 V	AUDIO_CLKA	Oscillator	-
8	X21	33.0000 MHz	1.8 V	DU_DOTCLKIN1	Oscillator	-
9	X22	33.0000 MHz	1.8 V	DU_DOTCLKIN2 through R602	Oscillator	*3

Notes: 1. Not available for use at the same time as No.3
2. Not available for use at the same time as No.2
3. The X22 is not connected to the DOTCLKIN2 pin of the R-CarM3-SiP because the zero-ohm resistor ‘R602’ between X22 and DU_DOTCLKIN2 is not mounted at the initial state. The OUT2 pin of the 5P49V5923B is actually connected to the DOTCLKIN2.

In addition to the clock signals listed above, the 9FGV0841AKILF (U11) manufactured by IDT supplies a 100-MHz differential clock signal to the R-CarM3-SiP. For details, see section 2.15.3, Clock Source Unit of the PCI Express and USB3.0.

Table 2.23.2 List of Differential Clock Signals Supplied to the R-CarM3-SiP

No.	R-CarM3-SiP Pin	R-CarM3-SiP Pin Name	Clock Driver Pin Name	Signal Type
1	AV32	PCIE0_CLK_P	DIF1	Differential signal
2	AV31	PCIE0_CLK_M	DIF1#	
3	AV28	PCIE1_CLK_P	DIF2	Differential signal
4	AV27	PCIE1_CLK_M	DIF2#	
5	AL37	USB3S0_CLK_P	DIF6	Differential signal
6	AL36	USB3S0_CLK_M	DIF6#	

2.23.2. Clock Signals Supplied to Devices Other than R-CarM3-SiP

Table 2.23.3 List of Clocks and Crystals other than for R-CarM3-SiP

No.	Xn	Frequency	Supply Voltage	Device	Device Pin Name	Type
1	X7	25.0000 MHz	---	U11: 9FGV0841AKILF	X1_25, X2	Resonator
2	X8	28.63636 MHz	---	U31: ADV7482WBBCZ	XTALN, XTALP	Resonator
3	X9	25.0000 MHz	---	U78: KSZ9031RNXVA	XI, XO	Resonator
4	X12	24.5760 MHz	---	U41: CS2000-CP	XTI/REF_CLK, XTO	Resonator
5	X23	25.0000 MHz	---	U61: 5P49V5923B	XIN/REF, XOUT	Resonator

In addition to the clock signals listed above, the 9FGV0841AKILF (U11) manufactured by IDT supplies a 100-MHz differential clock signal to the PCI Express slot (CN5) and EXIO connector A (CN6) on the Salvator-X board. For details, see section 2.15.3,Clock Source Unit of the PCI Express and USB3.0.

Table 2.23.4 Differential Clock Inputs other than for R-CarM3-SiP

No.	Connector Pin	Net Name in Schematic	Clock Driver Pin Name	Signal Type
1	CN5 - Pin A13	PCIE0_CN_CLK_P	DIF3	Differential signal
2	CN5 - Pin A14	PCIE0_CN_CLK_M	DIF3#	
3	CN6 - Pin 8	PCIE1_CN_CLK_P	DIF4	Differential signal
4	CN6 - Pin 6	PCIE1_CN_CLK_M	DIF4#	

2.24. Power Supply

2.24.1. Specifications

The Salvator-X board operates on a single 12.0-VDC power supply. The power supplies for use on the Salvator-X board are generated by the switching regulators and low-dropout regulators.
Since the maximum current of the AC adaptor that comes with the Salvator-X board is 9 A, be sure to configure the system so that current during operation does not exceed 9 A. See the table below for regulators used to generate the power supplies on the Salvator-X board, their input voltages (Vin) and output voltages (Vout), and whether the ACC switch can be used to enable or disable their outputs.
The Salvator-X board has AD Converters for current sense (U58,U59) then the current of VDD0.8V and DVFS0.8V can be measured easily.

Table 2.24.1 List of the Switching Controllers and Regulators on the Salvator-X Board

Vin	Vout	Switching Controller/Regulator	Power MOSFET	ACC Switch Control
Power Supply DC12.0V through CN30 or CN36	D12.0V	-	-	No
D12.0V	D5.0V	Maxim integrated MAX16933 (ch1 of U47)	Toshiba TPC8048-H (U48, U49)	Yes
	VSYS (5.0 V)	Maxim integrated MAX16933 (ch2 of U47)	Toshiba TPC8048-H (U50, U51)	Yes
VSYS	VDD0.8V	Rohm Semiconductor BD9571 (U72)	Infineon IPG20N04S4L-08 (U85)	Yes
	D1.8V	Rohm Semiconductor BD9571 (U72)		Yes
	D3.3V	Rohm Semiconductor BD9571 (U72)	-	Yes
	DDR0_1.1V	Rohm Semiconductor BD9571 (U72)	-	Yes
	DDR1_1.1V	Rohm Semiconductor BD9571 (U72)	-	Yes
	DDR0_1.8V	Rohm Semiconductor BD9571 (U72)	-	Yes
	DDR1_1.8V	Rohm Semiconductor BD9571 (U72)	-	Yes
	VLDO_2.5V	Rohm Semiconductor BD9571 (U72)	-	Yes
	VLDO_SD0 (3.3 V/1.8 V)	Rohm Semiconductor BD9571 (U72)	-	Yes
	VLDO_SD1 (3.3 V/1.8 V)	Rohm Semiconductor BD9571 (U72)	-	Yes
	VLDO_SD2 (3.3 V/1.8 V)	Rohm Semiconductor BD9571 (U72)	-	Yes
	VLDO_SD3 (3.3 V/1.8 V)	Rohm Semiconductor BD9571 (U72)	-	Yes
D5.0V	DVFS0.8V	Rohm Semiconductor BD9571 (U72)	Infineon IPG20N04S4L-08 (U84)	Yes
D5.0V	SDIF_POWER (3.3 V)	Analog Devices ADP3339AKCZ-3.3-R7 (U21)	-	Yes
	LVDS_MON_POWER (3.3 V)	Analog Devices ADP3338AKCZ-3.3R7 (U30)	-	Yes
D3.3V	D1.2V	Analog Devices ADP1706ARDZ-1.2-R7 (U37)	-	Yes
D1.8V	D1.8V_PERI	Micrel Semiconductor MIC94091YC6 (U80)	-	Yes

[Caution]
Power from D12.0V is output to the following connectors. Connect and disconnect external boards and cables to and from these connectors while 12 V is not being supplied to CN30 and CN36 (while the 100-VAC switch is off).

- Connector for the PCIe interface (CN5)
- Power supply connector for the serial-ATA interface (CN7)
- Connector for the backlight (CN19)
- Power supply connector for the EXIO board (CN32)
- Dedicated power supply connector for the CPU fan (CN34)

2.24.2. Reset

On the Salvator-X board, once the PMIC (BD9571MWV-M, U72) turns on all power supplies, the reset signal (PRESETn_18) is deasserted. The PMIC monitors all power supplies and unless it detects that all are being supplied normally, the power-on reset signal is not deasserted. The power-on reset signal can be asserted by pressing a push switch (SW27). The reset signal (1.8 V) controlled by the PMIC is input to the PRESET# pin of the R-CarM3-SiP. For details, see the datasheet for the BD9571MWV-M.

2.24.3. Block Diagram

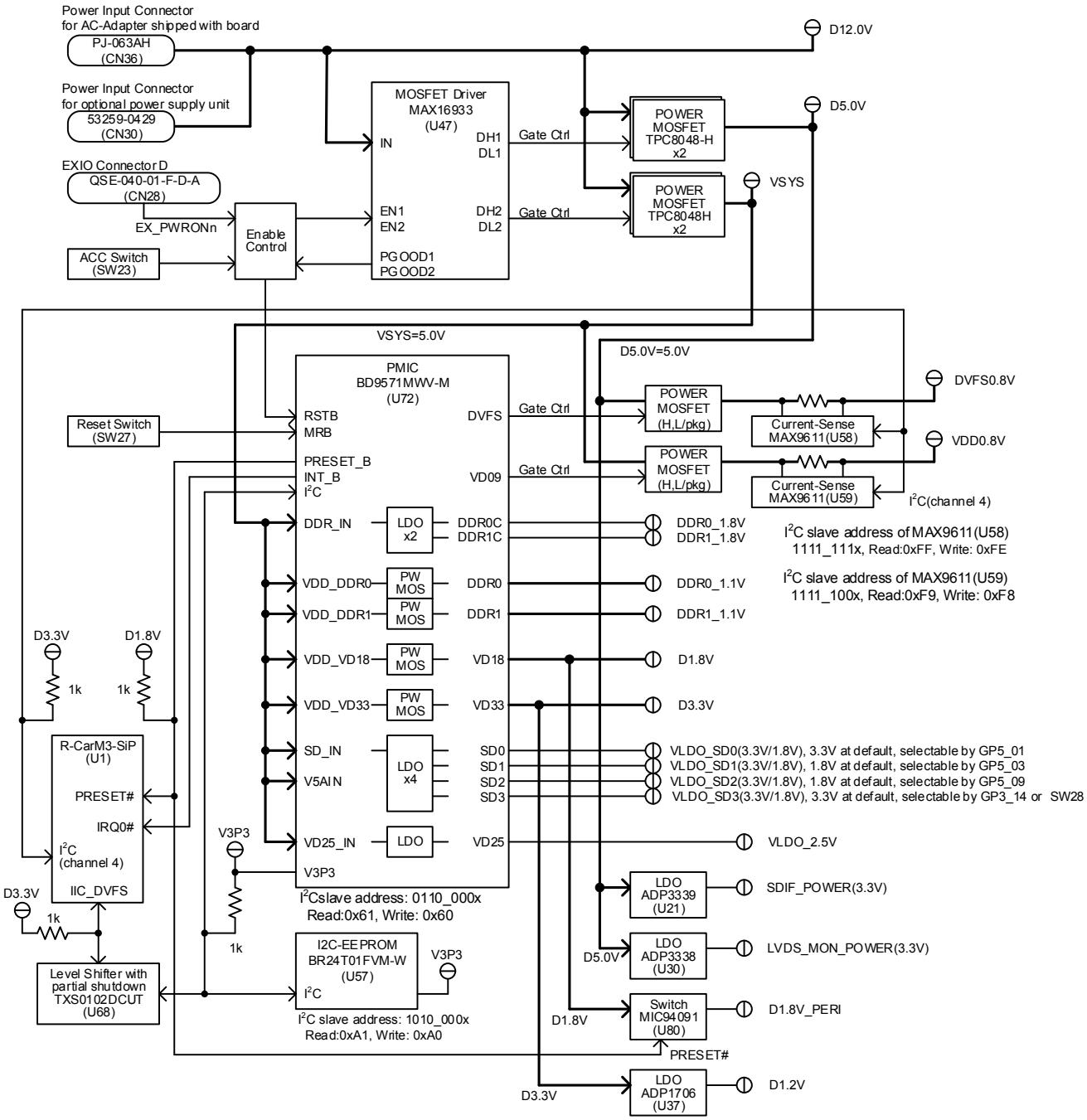

Figure 2.24.1 Block Diagram of Power Supplies

2.24.4. Sequence of Power being Supplied

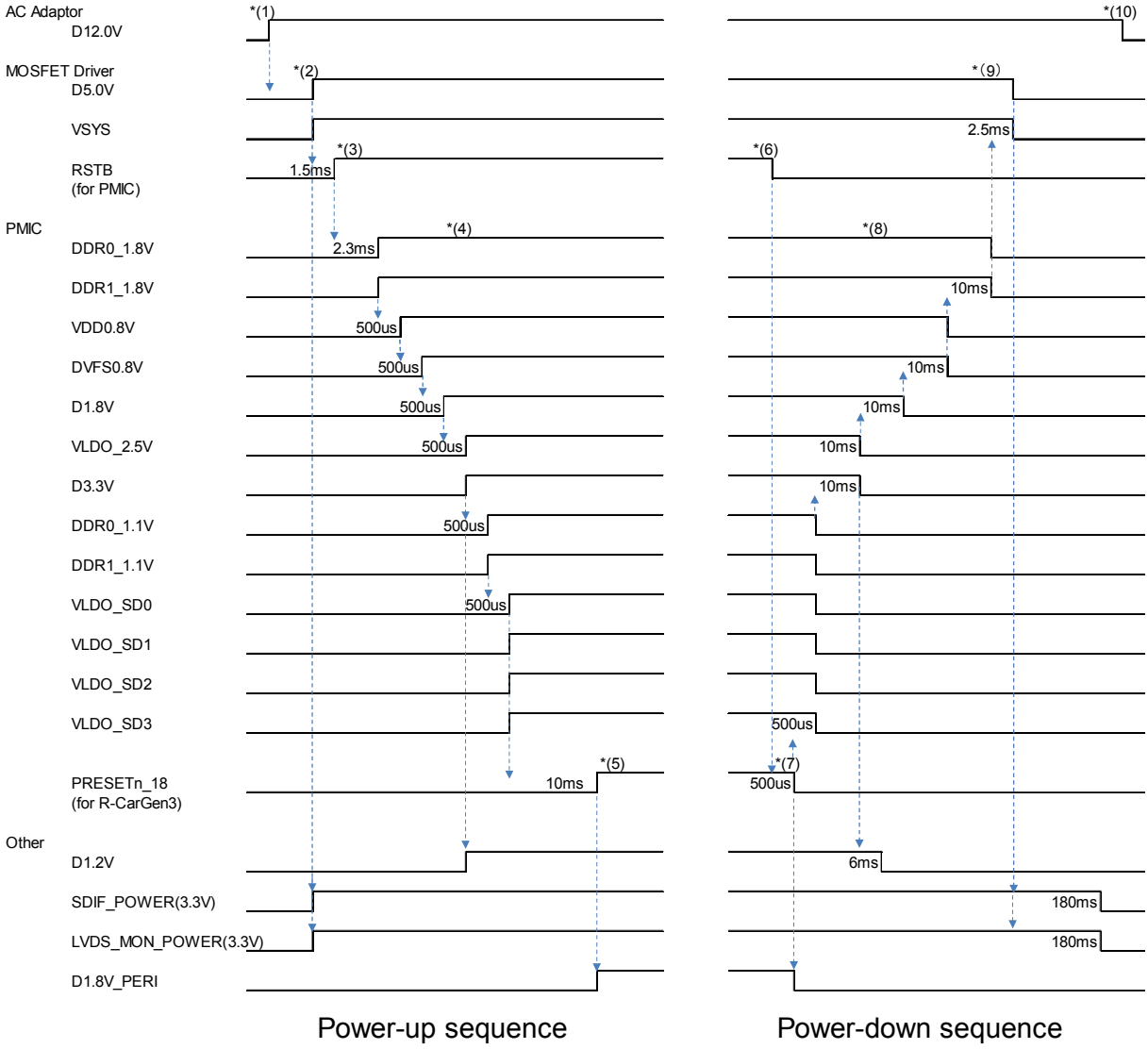

Figure 2.24.2 Power-Up and -Down Sequence

Power-up sequence

(1) When the AC adapter or other external power supply is connected to the board, D12.0V is supplied.
(2) When the ACC switch is turned on, D5.0V and VSYS are turned on.
(3) When D5.0V and VSYS are output, the RSTB signal is driven high.
(4) When the RSTB signal is driven high, each of the other power supplies is turned on in sequence.
(5) Once all the power supplies are turned on, the PRESETn_18 signal is driven high.

Power-down sequence

(6) When the ACC switch is turned off, the RSTB signal is driven low.
(7) When the RSTB signal is driven low, the PRESETn_18 signal is driven low.
(8) When the PRESETn_18 is driven low, all power supplies are turned off in sequence.
(9) When DDR0_1.8V is turned off, D5.0V and VSYS are turned off.
(10) When the AC adapter and external power supply are removed, D12.0V is turned off.

Note: The order or timing for turning on the output power supplies from the PMIC (BD9571MWV-M, U72) can be as desired. The timing of output of the PRESETn_18 signal can also be as desired. However, take note to observe the following when changing the order of the sequence.
When turning power supplies on: Drive PRESETn_18 high after all the power supplies from the PMIC are turned on.
When turning power supplies off: Drive PRESETn_18 low before turning any of the power supplies from the PMIC off.
Also observe any other standards and sequences for the devices (for details, see the respective datasheets).

2.25. EXIO Connectors (CN6, CN27, CN28, and CN29)

2.25.1. Specifications

On the Salvator-X board, the local bus and peripheral I/O signals of the R-CarM3-SiP are connected to four connectors (CN6, CN27, CN28, and CN29). The arrangement of connectors and pins on the Salvator-X board is shown below.

Table 2.25.1 EXIO Connectors Specifications

EXIO connector A (CN6)	QSH-030-01-L-D-A (from Samtec), 60 pins, 0.5-mm pitch.
EXIO connector B (CN27)	QSE-040-01-F-D-A (from Samtec), 80 pins, 0.8-mm pitch
EXIO connector C (CN29)	QSH-030-01-L-D-A (from Samtec), 60 pins, 0.5-mm pitch
EXIO connector D (CN28)	QSE-040-01-F-D-A (from Samtec), 80 pins, 0.8-mm pitch

Table 2.25.2 List of the EXIO Connector A (CN6) Pins

Pin	Net Name	Pin	Net Name
1	(NC)	2	PERST_L
3	GND	4	(NC)
5	EXIO_E_NC_5PIN	6	PCIE1_CN_CLK_M
7	EXIO_E_NC_7PIN	8	PCIE1_CN_CLK_P
9	GND	10	PCIE_CLKREQ_N
11	MLB_CLK	12	GND
13	MLB_SIG	14	PCIE1_RX_M
15	PCIE_PME_L	16	PCIE1_RX_P
17	WL_REG_ON	18	(NC)
19	MLB_DAT	20	(NC)
21	EXIO_E_GPIO_2	22	PCIE1_TX_M
23	GND	24	PCIE1_TX_P
25	EXIO_E_GPIO_3	26	GND
27	EXIO_E_GPIO_5	28	(NC)
29	EXIO_E_GPIO_4	30	PRESETN_J
31	EXIO_E_GPIO_6	32	TRSTN_J
33	BT_PCM_OUT	34	(NC)
35	BT_PCM_IN	36	TDO_J
37	BT_PCM_SYNC	38	TDI_J
39	BT_PCM_CLK	40	TMS_J
41	BT_UART_CTS	42	TCK_J
43	BT_UART_RTS	44	BT_DEV_WAKE
45	BT_UART_TXD	46	BT_HOST_WAKE
47	BT_UART_RXD	48	(NC)
49	(NC)	50	BT_REG_ON
51	(NC)	52	GND
53	D3.3V	54	(NC)
55	D3.3V	56	D1.8V
57	GND	58	GND
59	EXT_LPO	60	(NC)

Table 2.25.3 List of the EXIO Connector B (CN27) Pins

Pin	Net Name	Pin	Net Name
1	SD3_DAT2_V	2	EX_MMC_D0_V
3	SD3_DAT3_V	4	EX_MMC_D1_V
5	SD3_CMD_V	6	EX_MMC_D2_V
7	SD3_CLK_V	8	EX_MMC_D3_V
9	GND	10	EX_MMC_CMD_V
11	SSI_SCK4	12	SSI_WS4
13	GP4_17/SD3_DS_V	14	EX_MMC_DS_V
15	SSI_SDATA4	16	GP6_07/LVDS_BLEN
17	GP6_19/SSI_SDATA7	18	GP6_20/SSI_SDATA8
19	SD3_DAT0_V	20	GND
21	SD3_DAT1_V	22	EX_MMC_CLK_V
23	GP4_15/SD3_DAT6/CD_V	24	GND
25	GP4_16/SD3_DAT7/WP_V	26	EX_MMC_D4_V
27	GP4_13/SD3_DAT4_V	28	EX_MMC_D5_V
29	GP4_14/SD3_DAT5_V	30	EX_MMC_D6_V
31	GND	32	EX_MMC_D7_V
33	GP3_06/SD1_CLK_V	34	GND
35	GND	36	GP3_07/SD1_CMD_V
37	GP3_14/SD3_PWSEL	38	(CP67)
39	D3.3V	40	D3.3V
41	D3.3V	42	D3.3V
43	GP3_15/SD3_PWEN	44	SD0_WP
45	VLDO_SD3	46	VLDO_SD2
47	GP5_07/CTS1N/HCTS1n	48	SD0_CD
49	GP5_08/RTS1N/HRTS1n	50	VLDO_SD1
51	GP6_17/SSI_SCK78	52	GP6_18/SSI_WS78
53	GP5_05/RX1/HRX1	54	GP6_04
55	GP5_06/TX1/HTX1	56	SSI_SDATA1
57	GP6_21	58	SSI_SDATA0
59	GP6_06/OTG_STAT2	60	SSI_WS0129
61	GP6_05/OTG_STAT1	62	SSI_SCK0129
63	GND	64	GND
65	PRESETOUTN	66	EX_AUDIO_CLKB
67	GND	68	GND
69	AUDIO_CLKOUT3	70	EX_AUDIO_CLKA
71	GND	72	GND
73	I2C2_SCL	74	I2C2_SDA
75	GP6_16/OTG_EXTLPn	76	GP6_13/GP_LED/TSW2
77	USB2_OVC	78	GP6_12/GP_LED/TSW1
79	USB2_PWEN	80	GP6_11/GP_LED/TSW0

Table 2.25.4 List of the EXIO Connector C (CN29) Pins

Pin	Net Name	Pin	Net Name
1	---	2	EX_CSI0_DATAN0
3	---	4	EX_CSI0_DATAP0
5	GND	6	GND
7	---	8	EX_CSI0_DATAN1
9	---	10	EX_CSI0_DATAP1
11	GND	12	GND
13	---	14	EX_CSI0_CLKN
15	---	16	EX_CSI0_CLKP
17	GND	18	GND
19	---	20	EX_CSI0_DATAN2
21	---	22	EX_CSI0_DATAP2
23	GND	24	GND
25	---	26	EX_CSI0_DATAN3
27	---	28	EX_CSI0_DATAP3
29	GND	30	GND
31	GND	32	GND
33	---	34	EX_CSI1_DATAN0
35	---	36	EX_CSI1_DATAP0
37	GND	38	GND
39	---	40	EX_CSI1_CLKN
41	---	42	EX_CSI1_CLKP
43	GND	44	GND
45	(CP61)	46	EX_CSI1_DATAN1
47	(CP55)	48	EX_CSI1_DATAP1
49	(CP56)	50	GND
51	I2C4_SCL	52	(CP62)
53	I2C4_SDA	54	PRESETOUTn
55	(CP64)	56	(CP63)
57	(CP65)	58	GP6_30/INTRQ1
59	(CP66)	60	GP6_31/INTRQ2

Table 2.25.5 List of the EXIO Connector D (CN28) Pins

Pin	Net Name	Pin	Net Name
1	PRESETOUTn	2	CLKOUT
3	GND	4	GND
5	PRESETn	6	EX_WAIT0n/DU_DCLK0
7	GND	8	GND
9	IRQ2n/DU_DISP	10	CS1n
11	MDT1/RDn	12	GND
13	WE1n	14	MDT0/BSn
15	WE0n	16	CS0n
17	GND	18	GND
19	EXA12	20	GP2_03/DU_DCLK1
21	EXA11	22	GP2_04/DU_HSYNC
23	EXA10	24	GP2_05/DU_VSYNC
25	EXA9	26	GP2_06
27	EXA8	28	GP2_07/PWM1
29	EXA7	30	GP2_06/PWM2
31	EXA6	32	EXA19
33	EXA5	34	EXA18
35	EXA4	36	EXA17
37	EXA3	38	EXA16
39	EXA2	40	EXA15
41	EXA1	42	EXA14
43	EXA0	44	EXA13
45	GND	46	GND
47	EXD15	48	GP1_24
49	EXD14	50	IRQ1n
51	EXD13	52	IRQ0n
53	EXD12	54	GND
55	EXD11	56	NMIn_18
57	EXD10	58	GND
59	EXD9	60	(CP57)
61	EXD8	62	(CP58)
63	GND	64	(CP59)
65	EXD7	66	SYSRSTn
67	EXD6	68	EX_PWRONn
69	EXD5	70	BKUP_TRG
71	EXD4	72	SYS_TRG
73	EXD3	74	BKUP_REQB
75	EXD2	76	PRESETn_18
77	EXD1	78	PMIC_GPIO0
79	EXD0	80	PMIC_GPIO1

3. Dimensions of the Salvator-X Board

3.1. Dimensions of the Salvator-X Board (Component Surface)

The following shows the dimensions of the component surface of the Salvator-X (unit: mm).

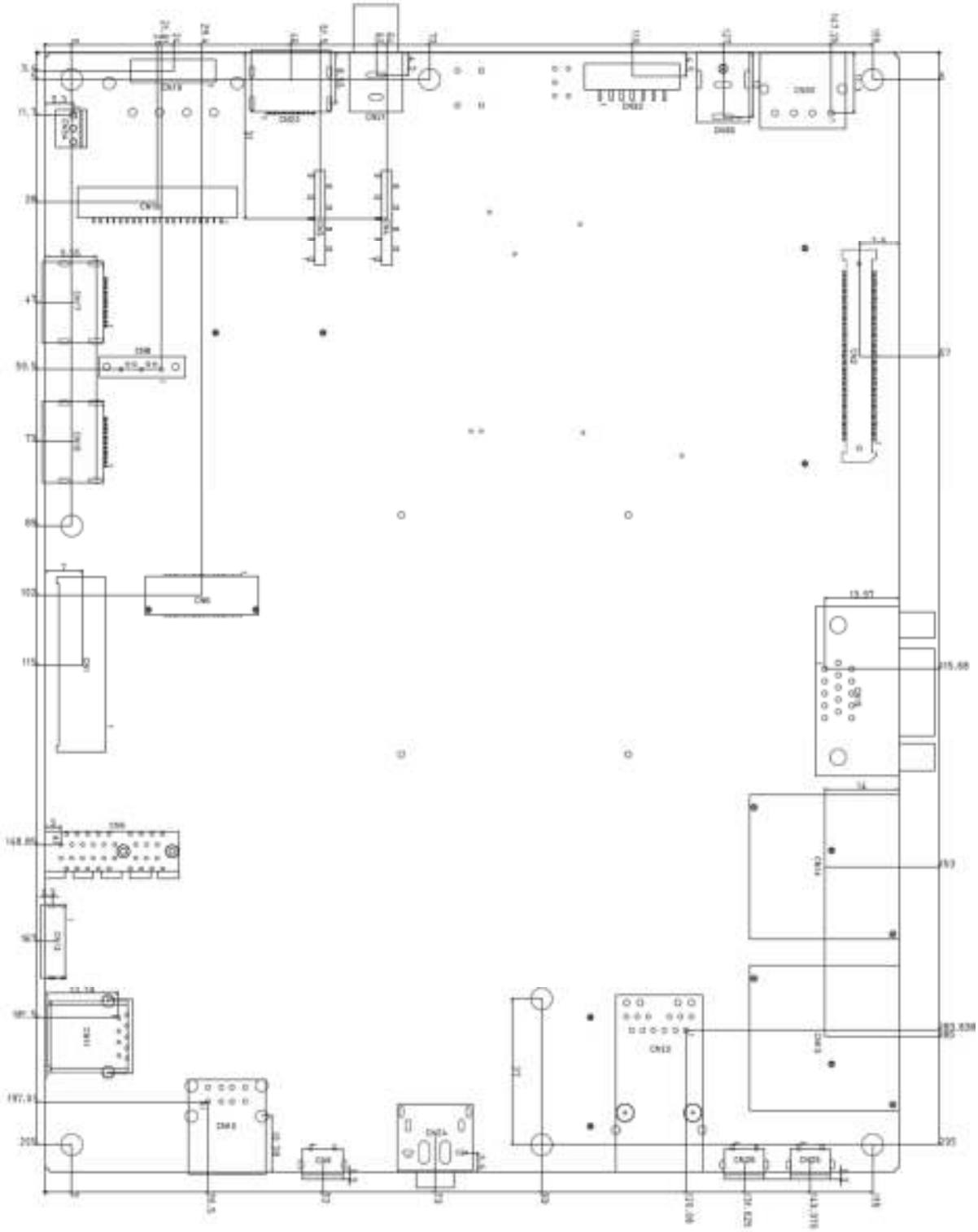

Figure 3.1.1 Locations of Connector on the Salvator-X Board (Component Surface) (Top View)

3.2. Dimensions of the Salvator-X Board (Solder Surface)

The following shows the dimensions of the solder surface of the Salvator-X board. It is a view of the solder surface from the component surface as if the latter were transparent (unit: mm).

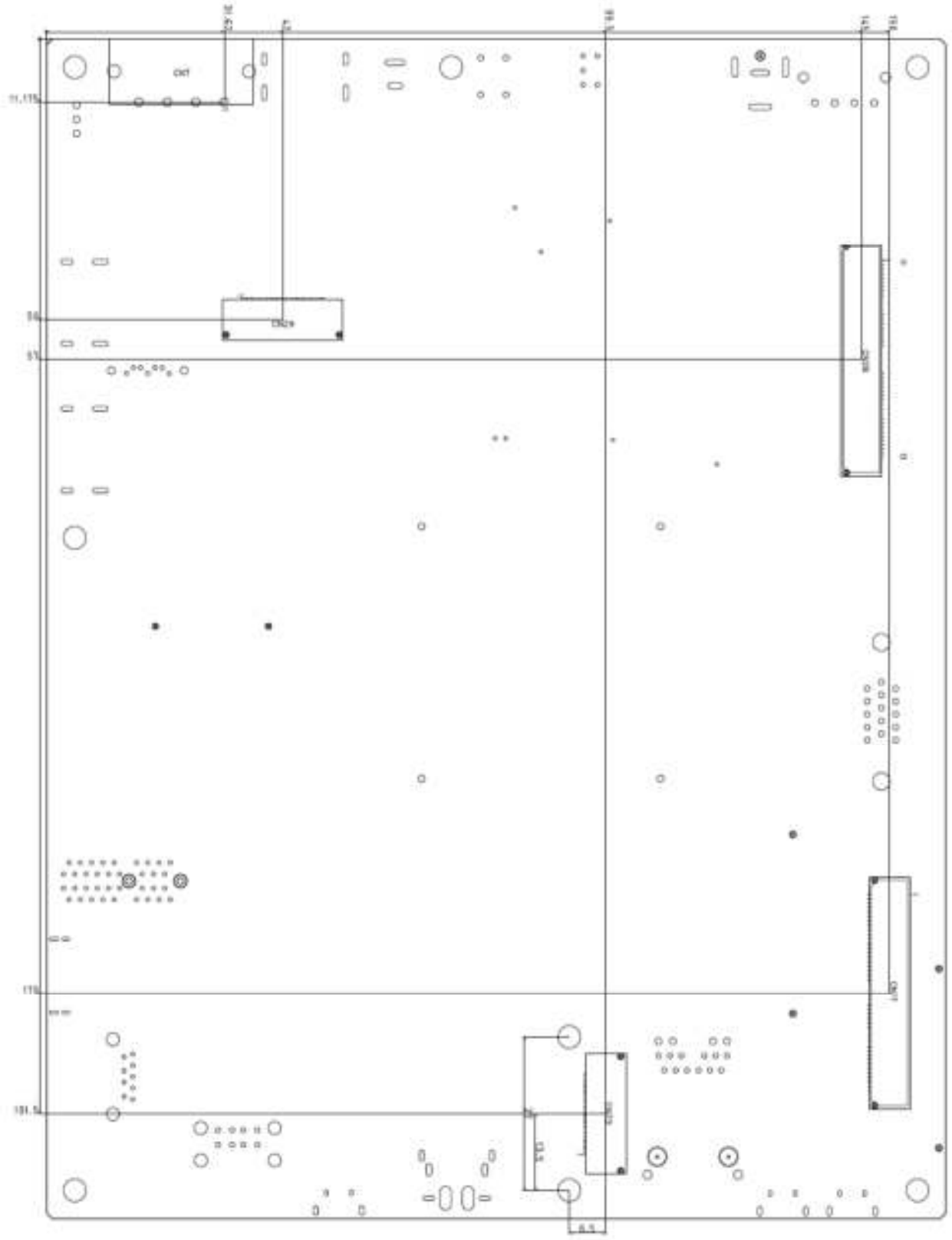

Figure 3.2.1 Locations of Connector on the Salvator-X Board (Solder Surface) (Top View)

R-CarM3-SiP System Evaluation Board (RTP0RC7796SIPB0011S)
Hardware Manual

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